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Master Plan Report (Volume 1)

Upper Little River Watershed Drainage and Stormwater Management Master Plan, Class Environmental Assessment, Windsor and Tecumseh, Ontario

January 2023

SIGN OFF SHEET

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Executive Summary

The Upper Little River watershed is located in the southeast part of the City of Windsor and the west part of the Town of Tecumseh, as shown on the Site Location Plan (Figure E1). The Main branch of Little River originates south of Highway 401 and generally flows north through a well-defined system of municipal drains and channels towards the Detroit River and Lake St. Clair. The drainage area contributing to Upper Little River upstream of the E.C. Row Expressway is approximately 45 km^2.

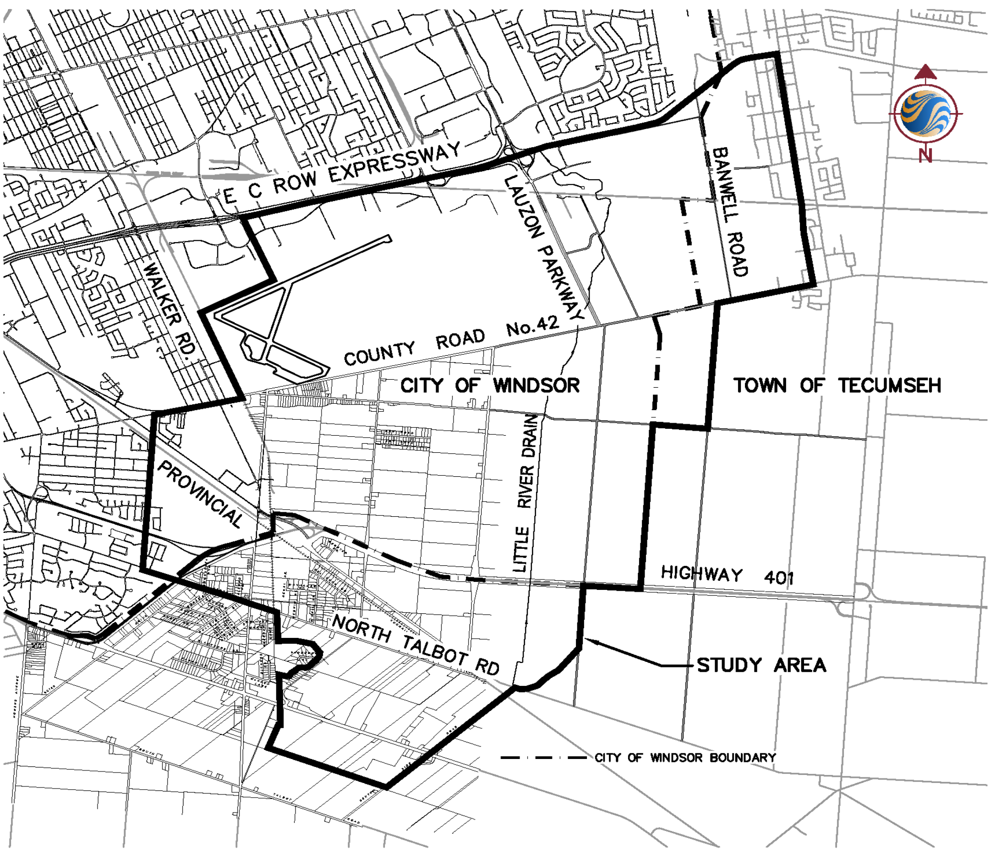

Figure E1: Site Location Plan

The City of Windsor (City), the Town of Tecumseh (Town), and the Essex Region Conservation Authority (ERCA) commenced a study in 2004 to document existing conditions and to recommend stormwater management measures to protect existing resources as development continues in the upper reaches of Little River. In 2005, the City was in the process of completing a Land Use Plan for the Sandwich South Employment Lands, and the Study was put on hold until that process could be completed. The City of Windsor Council adopted a Preferred Concept Land Use Plan on October 23, 2006. The project was put on hold again in 2007 after the Ministry of Transportation (MTO) announced that it had plans for a new highway through the study area.

The project was reinitiated in 2010 at the same time as several adjacent projects. Land use planning, future arterial roadway locations (Lauzon Parkway, County Road 42, and a new East-West Arterial), and the proximity of the Windsor International Airport have all been taken into account in the development of the proposed stormwater management approach.

The Master Plan was originally undertaken following Approach 2 with a Notice of Study Completion filed in September 2017. However, due to the overall duration of the project, changes to the Class EA requirements over that time, and input from the Ministry of the Environment, Conservation and Parks during the review of a Part II Order appeal, the Master Plan was not finalized after the 30-day public review period. The Master Plan is now being completed following Approach 1, which is a broader level of assessment. This change in approach results in the requirement for additional detailed investigations at the project-specific level in order to fulfill Class EA requirements for specific Schedule B and Schedule C projects. Note that recent amendments to the *EA Act* have exempted Schedule A and A+ projects from the provisions of the *EA Act.* No changes have been made to alternatives considered or general Master Plan recommendations since the filing of the initial Notice of Completion in 2017. Correspondence associated with the previous Notice of Completion and Part II Order request can be found in Appendix E.

Stantec Consulting Ltd. is the lead consultant, in cooperation with Parrish Geomorphic Ltd., to complete a Master Plan under the Municipal Class Environmental Assessment process to determine a preferred approach to providing stormwater management control measures for the developing lands upstream of the E.C. Row Expressway and contributing to Upper Little River.

The Project Team, consisting of representatives from the City of Windsor, The Town of Tecumseh, the Essex Region Conservation Authority, and the Consultant Team, has examined a number of alternatives for stormwater management based on a combination of previous documentation and current information. In addition, two Public Open House Meetings (May 29, 2012, and October 22, 2012) have been held to receive input on the alternative options investigated.

A preferred option was developed as a result of an evaluation of alternatives and public/agency input and is considered representative of the most financially and physically appropriate option to achieve the required controls, while maximizing opportunities to conserve existing natural conditions. Details of the study process, from conceptual development of alternative stormwater management strategies through to the identification of recommended projects, are summarized in the following Master Plan Report, which is to be considered for approval by the Councils of the City of Windsor and the Town of Tecumseh.

This project has been completed in accordance with Approach 1 as identified in Appendix 4 of the Municipal Engineers Association (MEA) Municipal Class Environmental Assessment (Class EA) (2000, as amended). In accordance with the MEA Class EA process, this Master Plan was filed on the Public Record for a period of thirty (30) days after adoption of the recommendations by the City of Windsor and the Town of Tecumseh through the issuance of a Notice of Completion. The Notice of Completion was advertised in the local newspaper, and copies of pertinent advertisements are included in the Appendices. It should be noted that the Master Plan Notice of Completion was previously filed in September 2017 but was subsequently re-issued on January 21, 2023, to address the change in Master Plan methodology from Approach 2 to Approach 1.

The problem statement for this Master Plan Class EA is generally summarized as follows:

To ensure that urbanization of the Upper Little River Watershed can occur in a fashion that will not lead to negative impacts on the receiving systems including increased flood risk, the impairment of natural watercourse features, and would allow for future enhancement of the watercourse, stream margins and wetlands.

Alternatives and Evaluation

As part of the Class EA process, it is important that all reasonable and feasible solutions be considered. The following alternatives have been identified for further evaluation through this Master Plan Class EA:

Alternative 1 - The Do-Nothing Alternative

In this alternative, the Little River subwatershed area is developed but no stormwater management control measures are implemented for the watershed. The evaluation of this alternative is required by the EA process; however, ERCA has stated that lands downstream of the study area are currently impacted by flood waters and any increase in flows would require channel improvements with significant costs to ensure that flood levels/damages are not increased.

Alternative 2 - Water Quality and Erosion Control Only

In this alternative, the proposed development will have only water quality treatment and erosion control, and no water quantity or flooding controls. ERCA has stated that lands downstream of the study area are currently impacted by flood waters and any increase in flows would require channel improvements with significant costs to ensure that flood levels/damages are not increased.

Alternative 3 - Communal Stormwater Facilities

This alternative examines the potential to minimize the number of SWM facilities required to serve the study area by consolidating all water quality, erosion, and water quantity controls at a few locations throughout the watershed.

On-line

These large centralized SWM facilities would provide control for anywhere from 150 to 800 ha of development area. This option would retain the existing municipal drain alignments with large ponds at key locations. Multiple forebays could be used to consolidate drainage from different directions. Several of the municipal drains are considered to provide direct fish habitat. Since this alternative provides water quality control downstream of the fish habitat, this option would likely require a permit from the DFO. This alternative would also be classified as an on-line water quality facility (since it would be located on a watercourse). Recent projects attempting to employ this method have had difficulty obtaining approvals from MECP, MNRF, and DFO, primarily due to fisheries/natural heritage concerns. Due to the complications arising from the proximity of the airport and the online water quality controls, it would be difficult to obtain approvals for this alternative.

Off-line

This alternative is similar to the on-line version where a few large centralized SWMFs would be used to provide controls. This alternative differs in that the storm flows would drain through large storm sewers to the SWMFs whereas the on-line version uses the existing municipal drain network to transport flows. Due to flat grades throughout the site and required minimum slopes on storm sewers, flows in the storm sewers would need to be pumped before outletting to the downstream water courses. This option requires significant upfront capital costs for the storm sewers and land acquisition and does not lend itself well to staged construction.

Alternative 4 – On-line Quantity Control with Local Quality and Erosion Controls

This alternative examines the scenario where a few on-line water quantity or flood control facilities are centralized in key locations throughout the study area, but water quality and erosion controls are distributed across the watershed.

Large centralized SWMFs would be used to provide water quantity control for large rainfall events. These large facilities would be located generally in the same locations as for Alternative 3, except that they could be smaller, and they would not require a permanent body of water (although there would be some form of low flow channel). Recent projects employing on-line water quantity controls have been approved by the MNRF and MECP with some additional review time.

Smaller distributed SWMF's would be used to provide a Normal level of water quality control, which could take the form of a dry pond combined with a treatment train approach (i.e., pre-treatment), a wet pond, a wetland, or Low Impact Development methods. The minor system would drain to the small distributed SWMFs where water quality and erosion control would occur. Major flows would either bypass the small distributed SWMF or drain through them with minimal controls to the large downstream SWMFs.

Alternative 5 - Distributed Off-line SWM Controls

This alternative considers the potential for stormwater management controls to be distributed throughout the study area, and each facility would be required to provide water quality, erosion, and water quantity controls separately. It is anticipated that facilities would be designed and constructed as development proceeds on a site-by-site basis.

This form of SWM is typical of most developments where each development block would provide their own SWM controls (water quality, water quantity, and erosion control) before outletting to the drains. It would be the easiest alterative to receive approvals for due to its standard approach.

Similar to Alternative 4, water quality would be provided on a site-by site basis throughout the development area in end-of pipe facilities (i.e., dry pond combined with a treatment train approach, wetland, or wet pond). Flood control would occur above the water quality control volume (so that the water depth would be larger) or in adjacent mixed-use areas (e.g., sports field, woodlots, etc.). Under normal conditions they will operate similar to the Alternative 4 ponds, and it is only under large rainfall events where there will be differences in operation.

Alternative 6 - Grouped Off-line SWM Controls

This alternative considers the potential for all stormwater management controls to be provided before outletting to a watercourse. Each facility would be required to provide water quality, erosion, and water quantity controls similar to Alternative 5. In this alternative the SWM facilities are generally in the same area (co-located) and are congregated into SWM corridors.

This alternative is similar to Alternative 5, with the main differences being that the SWM facilities are intended to provide controls for more than one property, and they are located adjacent to other facilities and a watercourse. Generally, there will be fewer and larger SWMFs compared to Alternative 5 and more and smaller SWMFs compared to Alternative 3.

Evaluation of Alternatives

Throughout the Study process, the various alternatives were reviewed and discussed by the Project Team, the public, and agency representatives. It is obvious that each alternative will result in varying impacts on environmental features, lands available for development by local property owners and the downstream system. As would be expected, the objectives and needs of various groups are not always consistent, and so an appropriate evaluation process was applied by the Project Team to arrive at a preferred concept or recommended concept.

A set of evaluation criteria/indicators was selected to reflect the issues, constraints and concerns considered most important when comparing the alternative stormwater strategies against the different environmental components. The evaluation criteria used to assess the various alternatives were grouped into four major categories as outlined below:

- Natural Environment
  - Terrestrial Resources, Vegetation, and Wildlife Implications
  - Fisheries Resources and Aquatic Habitat Implications
  - Groundwater and Baseflow Implication
  - Surface Water Quality
- Economic Environment
  - Total Capital Cost
  - Total Maintenance Cost
- Technical Environment
  - Ability to Provide Required Flood Protection
  - Ease of Construction/ Implementation
  - Ability to Meet Agency Requirements
- Social/Cultural Environment
  - Aesthetics
  - Health and Safety
  - Recreational Opportunities
  - Archaeological Resources
  - Built Heritage Resources/Cultural Heritage Landscapes

For each evaluation criteria a relative preference rating was assigned to each alternative. That is, for each criterion a particular alternative was either highly preferred, moderately preferred, or was generally not preferred. This information was tabulated for all of the criteria. Based on the evaluation matrix Alternative 6 is the preferred option.

Description of Preferred Alternative

The preliminary preferred alternative (Alternative 6) provides all stormwater management controls before outletting to the downstream watercourses. Each facility would be required to provide water quality, water quantity, and erosion controls on a standalone basis. In this alternative the SWM facilities are grouped into stormwater management corridors to promote natural linkages, recreational trails, and greenways. The SWM facilities can provide controls for more than one property and will be located adjacent to other facilities and a watercourse. It is anticipated that facilities would be designed and constructed as development proceeds. The study area will be developed by multiple landowners and the preferred alternative supports the ability of individual landowners to proceed independently while minimizing the total number of SWM facilities. Lands impacted by the SWM corridor will ultimately be owned by the Municipality. The Municipality will acquire the required property in accordance with the laws of the Province of Ontario.

The stormwater areas are proposed to be congregated into stormwater management corridors which can be combined with trail systems and amenity areas for the surrounding developments. The stormwater management corridor will be located beside watercourses which will accept drainage from the end-of-pipe facilities. Heavy vegetation adjacent to all water bodies and minimal open water will also be implemented in order to make water features less attractive to bird species, a specific request from the Windsor Airport. As part of this work, several of the existing municipal drains are proposed to be abandoned and several new channels will be created that align with the proposed development plan for the area. In addition, the work will include re-grading the stream channel banks to create benches or terraces, which will help dissipate energy and re-connect the bankfull channel to a floodplain area.

Advantages of the preferred alternative include the following:

- Staging Flexibility – This alternative minimizes the number of facilities while providing flexibility with respect to their staging and construction.
- Avian Habitat – The avian habitat area is relatively concentrated, which provides continuous linkages for predators, reduces the number of sites to be monitored, and provides more separation between nesting and foraging areas.

- Ease of Permitting – SWM facilities are located offline of each watercourse easing approval issues. Individual SWM facilities generally follow typical designs leading to easier approval.
- Stormwater Pumping – fewer facilities and grouped locations (with one pump for multiple properties) should lead to fewer pumping stations when compared to standard one facility per property strategies.
- Recreational Opportunities – The potential exists to create new trail networks through the corridors due to the continuity of the grouped SWM system.
- Fish Passage – The stormwater management areas are located offline of the existing watercourses and no additional barriers to fish movement are created. The conveyance system remains fish habitat similar to the existing municipal drain network.
- Erosion - re-grading the banks to create benches or terraces will re-connect the bankfull channel to a floodplain area, thereby reducing erosion and improving fish habitat.

1.0 Introduction and Project Justification

The Upper Little River watershed is located in the southeast part of the City of Windsor and the west part of the Town of Tecumseh, as shown on the Site Location Plan (Figure 1). The Main branch of Little River originates south of Highway 401 and generally flows north through a well-defined system of municipal drains and channels towards the Detroit River and Lake St. Clair. The drainage area contributing to Upper Little River upstream of the E.C. Row Expressway is approximately 45 km^2.

The City of Windsor (City), the Town of Tecumseh (Town), and the Essex Region Conservation Authority (ERCA) commenced a study in 2004 to document existing conditions and to recommend stormwater management measures to protect existing resources as development continues in the upper reaches of Little River. In 2005, the City was in the process of completing a Land Use Plan for the Sandwich South Employment Lands, and the Study was put on hold until that process could be completed. The City of Windsor Council adopted a Preferred Concept Land Use Plan on October 23, 2006. The project was put on hold again in 2007 after the Ministry of Transportation (MTO) announced that it had plans for a new highway through the study area (Figure 1).

The project was reinitiated in 2010 at the same time as several adjacent projects. Land use planning, future arterial roadway locations (Lauzon Parkway, County Road 42, and a new East-West Arterial), and the proximity of the Windsor International Airport have all been taken into account in the development of the proposed stormwater management approach.

The Master Plan was originally undertaken following Approach 2 with a Notice of Study Completion filed in September 2017. However, due to the overall duration of the project, changes to the Class EA requirements over that time, and input from the Ministry of the Environment, Conservation and Parks during the review of a Part II Order appeal, the Master Plan was not finalized after the 30-day public review period. The Master Plan is now being completed following Approach 1, which is a broader level of assessment. This change in approach results in the requirement for additional detailed investigations at the project-specific level in order to fulfill Class EA requirements for specific Schedule B and Schedule C projects. No changes have been made to alternatives considered or general Master Plan recommendations since the filing of the initial Notice of Completion in 2017. Correspondence associated with the previous Notice of Completion and Part II Order request can be found in Appendix E.

Stantec Consulting Ltd. is the lead consultant, in cooperation with Parrish Geomorphic Ltd., to complete a Class Environmental Assessment Study to determine a preferred approach to providing stormwater management control measures for the developing lands upstream of the E.C. Row Expressway and contributing to Upper Little River.

The Project Team, consisting of representatives from the City of Windsor, The Town of Tecumseh, the Essex Region Conservation Authority, and the Consultant Team, has examined a number of alternatives for stormwater management based on a combination of previous documentation and current information. In addition, two Public Open House Meetings (May 29, 2012, and October 22, 2012) have been held to receive input on the alternative options investigated.

A preferred option was developed as a result of an evaluation of alternatives and public/agency input and is considered representative of the most financially and physically appropriate option to achieve the required controls, while maximizing opportunities to conserve existing natural conditions. Details of the study process, from conceptual development of alignment alternatives through to selection and preliminary design of the preferred alternative, are summarized in the following Master Plan Report, which is to be considered for approval by the Councils of the City of Windsor and the Town of Tecumseh.

This project has been completed in accordance with Approach 1 as identified within Appendix 4 of the Municipal Engineers Association (MEA) Municipal Class Environmental Assessment (Class EA) (2000, as amended). In accordance with the MEA Class EA process, this Master Plan was filed on the Public Record for a period of thirty (30) days after adoption of the recommendations by the City of Windsor and the Town of Tecumseh through the issuance of a Notice of Completion. The Notice of Completion was advertised in the local newspaper, and copies of pertinent advertisements are included in the Appendices. It should be noted that the Master Plan Notice of Completion was previously filed on September 30, 2017, but was subsequently re-issued on January 21, 2023, to address the change in Master Plan methodology from Approach 2 to Approach 1.

2.0 Objectives of the Study – Problems and Opportunities

A Drainage and Stormwater Management Master Plan is required for the Upper Little River Watershed including both the City of Windsor Sandwich South Employment Lands and additional Town of Tecumseh lands to coordinate and guide future development in this area. The preferred alternative will provide a balance of relevant natural, social, technical, and economic criteria to establish appropriate drainage and stormwater management requirements at a watershed level that meets the needs of area stakeholders.

The objective of the study is to ensure that permitted development within the watershed can occur in a fashion that will not lead to negative impacts on the receiving systems including increased flood risk, the impairment of natural watercourse features, and would allow for future enhancement of the watercourse, stream margins, and wetlands. The stormwater management system should minimize the impact of urban development on the natural environment and be integrated as an amenity within the existing drain system and the open space system. It should also be capable of meeting applicable water quality and quantity requirements while minimizing any potential impacts on the Windsor International Airport related to waterfowl. The study area will be developed by multiple landowners and the preferred alternative should allow for individual landowners to proceed independently.

The problem statement for this Master Plan Class EA is generally summarized as follows:

To ensure that urbanization of the Upper Little River Watershed can occur in a fashion that will not lead to negative impacts on the receiving systems including increased flood risk, the impairment of natural watercourse features, and would allow for future enhancement of the watercourse, stream margins and wetlands.

The main objectives of this Master Plan Class EA, and how they were generally approached, are summarized as follows:

Objective 1:

"To implement a cooperative and solution-directed approach to liaison with property owners, municipal/government representatives, the general public and other stakeholders, leading to a "consensus oriented" design."

A key element of any Class EA process is the solicitation and evaluation of study dialogue and technical input from various affected property owners, government agencies, the general public, and other stakeholders that lead to the selection of a preferred solution, which generally satisfies a majority of expressed concerns and/or desirable results. By means of Public Open House Meetings, individual consultations, Project Team meetings, and correspondence, a thorough approach was taken to general liaison over the course of the project. At all times, constructive dialogue, in a cooperative environment, was promoted so that the preferred concept represented a “consensus oriented” design.

This approach is the foundation of the Master Plan Class EA process and was a prime focus of the Project Team at all times.

Objective 2:

“To identify and consolidate all relevant natural and social environmental issues and constraints within the study area, and address how the identified solution can be planned to best service future development lands, conserve the natural ecosystem, and reflect a cost effective and technically sound approach.”

This Master Plan Class EA was completed in recognition of previous planning, engineering, and social/environmental studies completed in recent years within the study area. As part of this study, the Project Team was challenged in confirming the relevant environmental and planning issues and constraints that had direct significance in the conservation of the study area ecosystem, while engineers were also required to assess the feasibility of technical solutions.

Objective 3:

“To summarize the environmental assessment and functional design documentation in a concise Master Plan document.”

Upon completion of the overall study details, this Master Plan document summarizes the various aspects of the study, alternative solutions to the provision of flood control, environmental mitigation measures, and other special features.

3.0 Project Approach

3.1 The Class Environmental Assessment Process

All municipalities in Ontario are subject to the provisions of the *Environmental Assessment Act* (*EA Act*) and its requirements to prepare an Environmental Assessment (EA) for applicable public works projects. The Ontario Municipal Engineers Association (MEA) “Municipal Class Environmental Assessment” document (October 2000, as amended) provides municipalities with a five-phase planning procedure approved under the *EA Act* to plan and undertake all municipal infrastructure projects in a manner that protects the environment as defined in the *Act*.

An overview of the 5 Phase process is provided below:

- **Phase 1** - Identify the problem (deficiency) or opportunity, which may include public consultation to confirm/review the problem or opportunity.
- **Phase 2** - Identify a reasonable range of alternative solutions to address the problem or opportunity. This Phase also includes an inventory of the existing environment in order to identify potential mitigation measures, and to assist in the evaluation of alternatives in terms of the identified evaluation criteria. A preferred solution is chosen based on the results of the evaluation and considers input from the public, review agencies, and Aboriginal Communities. It is at this point that the appropriate Schedule (B or C) is chosen for the undertaking. If Schedule B is chosen, the process and decisions are then documented in a Project File. Schedule C projects proceed through the following additional phases.
- **Phase 3 (Schedule C projects only)** - Examine the alternative methods for implementing the preferred solution, which typically involve design alternatives. A detailed inventory of the natural, social, economic, and technical environments are undertaken in order to assess the impacts of the alternative designs, in an attempt to minimize negative effects and maximize positive effects.
- **Phase 4 (Schedule C projects only)** - Document the Class EA Process followed in an Environmental Study Report (ESR), which includes a summary of the rationale and the planning, design, and consultation process followed for the project and make the documentation available for consideration by the public, review agencies, Aboriginal Communities, and the public through a mandatory 30-day review period.
- **Phase 5** - Complete contract drawings and documents and proceed to construction and operation with monitoring to ensure adherence to environmental provisions and commitments.

The Municipal Class EA process and associated documentation serves as a public statement of the decision-making process followed by municipalities for the planning and implementation of necessary infrastructure.

3.1.1 Project Schedules

The MEA Class EA document provides a framework by which projects are classified as Schedule A, A+, B, or C. Classification of a project is based on a variety of factors including the general complexity of the project and level of investigation required, and the potential impacts on the natural and social environment that may occur. It is the responsibility of the proponent to identify the appropriate schedule for a given project, and to review the applicability of the chosen schedule at various stages throughout the project. Each of the schedules requires a different level of documentation and review to satisfy the requirements of the Class EA, and thus comply with the *EA Act* as noted below.

Schedule A projects are limited in scale, have minimal adverse impacts on the natural and social environments, and include the majority of municipal sewage, stormwater management, water operations, and maintenance activities. These projects are pre-approved and may be implemented without following the procedures outlined in the Class EA planning process. Examples of Schedule A projects include watermain and sewer extensions where all such facilities are located within the municipal road allowance or an existing utility corridor. As such, these projects are pre-approved and subsequently do not require any further planning and public consultation.

Schedule A+ projects are similarly pre-approved under the Municipal Class EA but require that potentially affected parties be notified prior to implementation. The public has a right to comment to municipal officials or their council on the project.

Note that recent amendments to the *EA Act* through Bill 108 have exempted Schedule A and A+ projects from the provisions of the *EA Act* (see *EA Act* Section 15.3(4)).

Schedule B projects have the potential for some adverse environmental and social effects. The proponent is required to undertake a screening process involving mandatory contact with potentially affected members of the public, Aboriginal Communities, and relevant review agencies to ensure that they are aware of the project and that their concerns are addressed.

Schedule B projects require that Phases 1 and 2 of the Municipal Class EA planning processes be followed and a Project File report be prepared and filed for a mandatory 30-day review by the public, agencies, and Aboriginal Communities. If all comments or concerns received within this 30-day review period can be addressed, the proponent may proceed to project implementation (Phase 5). If concerns are raised that cannot be resolved, then the Part II Order procedure may be invoked. Projects generally include watermain and sewer extensions where all such facilities are located outside of the municipal road allowance or an existing utility corridor.

Schedule C projects have the potential for significant environmental impacts and must follow the full planning and documentation procedures specified in the Class EA document (Phases 1 to 4). An Environmental Study Report (ESR) must be prepared and filed for review by the public, review agencies and Aboriginal Communities. If concerns are raised that cannot be resolved, then the Part II Order procedure may be invoked. Projects generally include the construction of new facilities and major expansions to existing facilities.

3.1.2 Master Planning Process

This project is being undertaken in accordance with the Master Plan process found within the MEA Municipal Class EA document. This approach was developed to recognize the benefits of considering a group of related projects, or an overall system – in this case stormwater management and drainage – prior to addressing individual projects or areas.

Master Plans are long-range plans undertaken to create a framework for future projects that form part of an integrated system. The projects identified within Master Plans are typically distributed geographically throughout the study area, and are intended to be implemented over an extended period of time based on project triggers including required maintenance, available funding, etc.

The scope and complexity of Master Plans varies significantly. The MEA document emphasizes the need to customize the planning process to fit the needs of the undertaking and offers four general approaches that address Master Plans of varying complexity.

The Master Plan was originally undertaken following Approach 2 with a Notice of Study Completion filed in September 2017. However, due to the overall duration of the project, changes to the Class EA requirements over that time, and input from the Ministry of the Environment, Conservation and Parks during the review of a Part II Order appeal, the Master Plan was not finalized after the 30-day public review period. The Master Plan is now being completed following Approach 1, which is a broader level of assessment. This change in approach results in the requirement for additional detailed investigations at the project-specific level in order to fulfill Class EA requirements for specific Schedule B and Schedule C projects. No changes have been made to alternatives considered or general Master Plan recommendations since the filing of the initial Notice of Completion in 2017. Correspondence associated with the previous Notice of Completion and Part II Order request can be found in Appendix E.

This Master Plan follows Approach 1 as discussed in Appendix 4 of the MEA Class EA document. Master Plan Approach 1 generally follows Phases 1 and 2 of the Class EA process, but additional site-specific assessment and consultation may be required to satisfy Class EA requirements for Schedule B projects identified within the Master Plan. Master Plan Approach 1 is described within Appendix 4 of the MEA Class EA document as follows:

This approach involves the preparation of a Master Plan document at the conclusion of Phases 1 and 2 of the Municipal Class EA process. The Master Plan document would be made available for public comment prior to being approved by the Municipality.

Typically, the Master Plan would be done at a broad level of assessment thereby requiring more detailed investigations at the project-specific level in order to fulfill the Municipal Class EA documentation requirements for the specific Schedule B and C projects identified within the Master Plan. The Master Plan would therefore become the basis for and be used in support of, future investigations for the specific Schedule B and C projects identified within it. Schedule B projects would require the filing of the Project File for public review while Schedule C projects would have to fulfill Phases 3 and 4 prior to filing an Environmental Study Report (ESR) for public review.

3.2 Issues and Constraints

At the outset of the project, and over the balance of the study, various significant issues and constraints were documented. These included the following, in no specific order of relative importance:

- Existence of historic planning documents and their associated impact on future development
- Hydrology of the contributing drainage catchments
- Attractiveness of SWM facilities near the Windsor International Airport to avian species
- Location of proposed road alignments from the Lauzon Parkway EA
- Protection/maintenance of the erosion regime of the Upper Little River
- Limits of the Little River floodplain
- Protection of fish and fish habitat
- Location of significant vegetation communities
- Capital construction costs and long-term maintenance/operating costs
- Mitigate impacts to baseflow
- Limits and quality of significant plant and wildlife communities
- Topographical relief, including areas of flat slopes, depressions and other landform features
- Preliminary development plans as provided by property owners/consultant representatives

3.3 Consultation Process

Consultation is an important element of the Class EA process. A consultation plan was developed with the objective of targeting stakeholders potentially affected by the EA, in order to provide them with an opportunity to comment on the proposed improvements.

3.3.1 Public Involvement

Opportunities for Public Involvement, related to this Class EA Study included the following:

<u>Public Open House Meeting 1: May 29, 2012</u>

A Public Open House/Information Centre Meeting, for was held on Tuesday May 29, 2012, from 3:00 pm to 5:00 pm and from 6:00 pm to 8:00 pm at the Forest Glade Community Centre. Property owners in the immediate study area were notified of the Public Open House Meeting by a newspaper advertisement that was placed in the Windsor Star, a copy of which is included in Appendix B.

A series of displays were prepared for the Open House Meeting depicting existing natural and social environmental conditions, background information, alternative stormwater management control options, an air photo of the study area, and preliminary evaluation criteria for the evaluation of various alternative concepts. The purpose of this Public Open House Meeting was to introduce the public to the various alternative stormwater management options and background information, and to seek input on the presented options. No decisions on a preferred scenario were presented at this meeting.

The Open House portion of the May meeting consisted of a “drop in” format that allowed attendees to view the various displays and discuss the issues with the Project Team, on a one-on-one basis.

The Public Open House/Information Centre Meeting was attended by approximately 40 people, and all attendees were invited to provide written comments to the Project Team on any issues of interest on the study. Comments received at the time focussed primarily on woodlots (both existing and proposed), the trail system, and Upper Little River (including channel alignment, baseflow, and vegetation restoration along the river corridor).

Information on the meeting display material, public responses, attendance sheets and photographs from the meeting are provided in Appendix B.

Public Open House Meeting 2: October 22, 2012

A Public Open House/Information Centre Meeting for the Environmental Assessment was held on Monday October 22, 2012, from 3:00 pm to 5:00 pm and from 6:00 pm to 8:00 pm at the Windsor Christian Fellowship. Property owners in the immediate study area were notified of the Public Open House Meeting by a newspaper advertisement that was placed in the Windsor Star, a copy of which is included in the Appendices. In addition, Public Information Centre 2 for the Lauzon Parkway Environmental Assessment and the third workshop for the Sandwich South Secondary Plan were held concurrently at the same location.

A series of displays were prepared for the Open House Meeting depicting existing natural and social environmental conditions, background information, alternative stormwater management control concepts, an air photo of the study area, criteria for the evaluation of various alternative concepts, and the evaluation scores. The purpose of this Open House was to introduce the public to the preferred alternative and to provide information to the public on the construction schedule and format.

The Open House portion of the May meeting consisted of a “drop in” format that allowed attendees to view the various displays and discuss the issues with the Project Team, on a one-on-one basis.

The Public Open House/Information Centre Meeting was attended by approximately 25 people and all attendees were invited to provide written comments to the Project Team on any issues of interest on the study. Comments received at the time focussed primarily on the designation wood lots and wetlands as well as the widening of Baseline Road.

Information on the meeting display material, public responses, attendance sheets and photographs from the meeting are provided in Appendix B.

Notice of Completion and Part II Order September 2017

A Notice of Completion was previously issued on September 30, 2017, and the Master Plan Class EA posted for public review. A number of comments were received from agencies and the public (see Appendix E). Subsequently, the Notice of Completion was retracted, and revisions made to the overall Master Plan Class EA Approach as discussed above in Section 3.1.2. Additional investigations associated with Cultural Heritage, Drinking Water Source Protection, and consideration for climate change and cumulative project impacts were undertaken and incorporated into this Master Plan Report.

3.3.2 Indigenous Consultation and Engagement

Aboriginal Affairs and Northern Development Canada (AANDC) and the Ontario Ministry of Aboriginal Affairs (MAA) (now the Ministry of Indigenous Relations and Reconciliation) were contacted at study commencement in an effort to confirm Indigenous interests relative to the study area.

Stantec provided direct correspondence and study commencement notification materials to the following Indigenous groups:

- Caldwell First Nation
- Bkejwanong (Walpole Island) First Nation
- Aamjiwnaang First Nation
- Delaware (Moravian of the Thames) First Nation
- Oneida Nation of the Thames First Nation
- Chippewas of Kettle and Stoney Point First Nations
- Chippewa of the Thames First Nations (Fallon Burch)
- Munsee-Delaware Nation
- Windsor-Essex Metis Council
- Metis Nation of Ontario

The Aboriginal Affairs and Northern Development Canada, Consultation and Accommodation Unit sent correspondence to the project team on November 23, 2011, providing information to assist in identifying Indigenous groups within the study area including identification of Aboriginal community rights and claims near the proposed project.

The Caldwell First Nation submitted correspondence on November 27, 2012, indicating that additional consultation was required, and a meeting was held on January 7, 2013, to discuss the project. Additional black willow and milkweed plantings were requested within the study area as well as access to the black willow branches for harvesting.

Delaware Nation submitted correspondence on June 13, 2012, indicating that further discussions were not required.

Aamjiwnaang First Nation submitted correspondence on April 15, 2013, indicating that they had received the letter and information package about the project. The letter indicated that the information would be reviewed, and additional correspondence would be sent. No other letters have been received to date.

Additional follow-up was undertaken with First Nations communities in 2017 to ensure that they had sufficient information and opportunities to discuss the project and any concerns.

Chippewa of the Thames First Nation (Fallon Burch) submitted correspondence on September 11, 2019, asking to be circulated on any future updates or studies and to be notified of any future archaeology assessments.

No additional input was received from other Indigenous groups.

The Indigenous Communication Log is included in Appendix B while correspondence is included in Appendix C.

3.3.3 Consultation Summary

The following list provides a summary of the formal points of contact with the public and stakeholders throughout the study.

Point of Contact	Date/Distribution
Notice of Study Commencement	October 11, 2011. Distributed to stakeholder list and published in Windsor Star.
Public Information Centre 1	May 29, 2012. Invitation distributed to stakeholder list and published in the Windsor Star
Public Information Centre 2	October 22, 2012. Invitation distributed to stakeholder list and published in Windsor Star
Presentations/Updates before City of Windsor Environment, Transportation and Public Safety Standing Committee Windsor City Council Town of Tecumseh Council	March 22, 2017, April 24, 2017, May 23, 2017
Notice of Completion	September 30, 2017. Note that this Notice of Completion was retracted in order to make updates to the Master Plan. Invitation distributed to stakeholder list and published in Windsor Star

Notice of Study Update – issued in order to advise stakeholders of the change in Master Plan Class EA Approach.	August 31st. 2019. Distributed to stakeholder list and published in the Windsor Star.
Notice of Study Completion	January 21, 2023. Distributed to stakeholder list and published in Windsor Star.

3.4 Environmental Planning and Policy Considerations

Various policy and guideline documents exist to characterize the natural environment and assess potential impacts. These documents provide direction and guidance for the selection of a preferred solution that protects significant natural features, avoids and mitigates negative impacts and identifies opportunities to restore and enhance the natural environment. An assessment of the natural features and functions within the study area was undertaken in order to address and comply with the requirements of the following policies and guideline documents.

3.4.1 Provincial Policy Statement

The Provincial Policy Statement (PPS) is a complimentary policy document to the Planning Act (2005), issued under Section 3 of the Act, and sets a policy foundation for regulating the development and use of land in Ontario. It provides direction on matters of provincial interest and supports the enhancement of the quality of life for all citizens of Ontario. Consistency with the PPS shall be considered during the development and evaluation of alternative solutions.

Three general principles are established in the PPS that are further elaborated on in a detailed set of policies that generally address the following matters:

- Building Strong Healthy Communities (PPS Section 1);
- Wise Use and Management of Resources (PPS Section 2); and
- Protecting Public Health and Safety (PPS Section 3).

More specifically, the PPS recognizes that land use must be carefully managed to accommodate appropriate development for a full range of current and future needs, while also achieving efficient development patterns, which optimize the use of land, as well as the investment in public infrastructure, such as stormwater management systems. New development taking place in designated growth areas should occur adjacent to the existing built-up area, that allow for the efficient use of land and public infrastructure, including the optimization of municipal water services. It is the job of

Planning Authorities to direct development of new housing towards locations where appropriate levels of infrastructure exist or will be available to support current and projected needs.

Stormwater management services shall be planned to ensure that these systems are provided in a manner that:

a) minimize, or, where possible, prevent increases in contaminant loads;

b) minimize changes in water balance and erosion;

c) not increase risks to human health and safety and property damage;

d) maximize the extent and function of vegetative and pervious surfaces;

e) promote stormwater management best practices, including stormwater attenuation and re-use, and Low Impact Development methods.

The preferred alternatives and supporting recommendations will meet the objectives of the PPS by providing for infrastructure that is appropriate to address projected needs, protects the natural environment, and protects public health and safety.

3.4.2 City of Windsor Official Plan

The City of Windsor Official Plan (OP) guides the physical development of the municipality for a twenty-year planning horizon. The Official Plan provides the framework for the management and development of land throughout the City.

The policies provide direction to recognize the value of natural areas and provide for their basic protection, but also to build on the concept of a Greenway System of linked natural environment areas and recreational elements through a series of corridors. The Greenway System is considered an integral part of the social and economic systems in the City. The policies of the Official Plan promote development that, wherever possible will enhance, not deteriorate, the ecological and social systems on which people depend (City of Windsor, 2007).

Greenway System features identified in the OP include natural heritage features, waterfront recreation, community and regional parks, waterway corridors, recreation ways and linkages. Natural Heritage lands provide for the protection and conservation of the city’s most environmentally significant and sensitive natural areas, including provincially designated areas of natural and scientific interest (ANSI), woodlots and wetlands. The City of Windsor OP recognizes these significant natural features as Environmental Policy Areas (EPA) that are highly valuable and irreplaceable with interconnections which should be recognized, maintained and enhanced to prevent further fragmentation and degradation of the ecological integrity of the landscape. Any development within or contiguous to an EPA requires the submission of an Environmental Evaluation Report (EER) to the Municipality in support of the development application as part of the review process to assess the sensitivity of the area and its functions and ensure that possible development or site alterations will not detrimentally impact the area.

The City of Windsor and the ERCA undertook a Candidate Natural Heritage Site Biological Inventory to assess environmentally significant areas in the City. This study was not intended to be a complete biological inventory of all-natural heritage features with the City Limits. The study was undertaken as part of the Official Plan review process and will be used as background information in order to set the priorities for developing specific policy and appropriate land use designations.

3.4.3 Town of Tecumseh Official Plans

At the commencement of the Master Plan, land use in the Town of Tecumseh was guided by three separate Official Plans (OP) that represented the three former municipalities (Town of Tecumseh, Township of Sandwich South and Village of St. Clair Beach) that existed separately prior to the January 1, 1999, amalgamation. The Town of Tecumseh and Sandwich South Official Plans applied to portions of the study area.

In 2021 Town Council adopted one (1) new OP to replace the three (3) separate OPs. Following review and approval from the appropriate review agencies the new OP will govern land use planning for all lands in the Town of Tecumseh. The old and new OPs recognize the value of the natural heritage system. The Town of Tecumseh OP reinforces the protection, restoration and enhancement of identified natural heritage features, and promotes the overall diversity and interconnectivity of natural heritage features, functions and areas. The OP supports the development of policies to protect the natural heritage features and corridors that link or enhance existing linkages to improve or enhance ecology.

Baseline information on the remaining significant natural heritage features in the Town of Tecumseh and Township of Sandwich South have been provided in a Natural Heritage Inventory conducted by the ERCA. The study was undertaken as part of the Official Plan review process and will be used as background information in order to set the priorities for natural heritage protection.

3.4.4 Essex Region Conservation Authority Policies and Regulation

The mandate of the ERCA is to work closely with all levels of government to enhance watershed health, to facilitate watershed planning, enhance water quality, reduce flood damages and protect natural areas and biodiversity. One means to achieve these goals is through the implementation of the *Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation* (Ontario Regulation 158/06).

Pursuant to *Ontario Regulation 158/06*, any development in areas defined in the Regulation (i.e., floodplain, valleyland, and hazard land), interference with a wetland or alteration to a river, creek, stream or watercourse channel requires permission from the ERCA. The purpose of the permitting process is to guide development and site alteration while protecting, preserving and enhancing the natural environment.

These policies and regulations support the implementation of policies within the PPS and apply to the protection and preservation of natural hazards, such as floodplains and steep or eroding slopes, and natural heritage resources, such as wetlands, woodlands, wildlife habitat, threatened and endangered species, fish habitat and adjacent land areas. The ERCA's policies also include the protection of all wetlands from development and site alteration, but does allow for some restricted uses (i.e., municipal infrastructure, conservation uses, hazard control structures) provided they are supported by an Environmental Impact Study. Compliance with such policies is required in order to obtain the necessary approvals for any development or alteration within an area regulated by the ERCA.

There are additional policies outlined in the PPS that are not summarized in this report and should be reviewed and considered to ensure compliance of a proposed development with the policies of the ERCA.

3.4.5 Summary of Policy Implications

The Master Plan Class EA should recognize the objectives of the documents noted above and the requirements of the individual agencies. This study should consider these policy requirements and guidelines during the assessment, selection and design of the preferred alternative and in the identification of mitigation measures related to construction and operation. Further studies are typically required to confirm detailed design information for the individual projects and can take the form of reports supporting Draft Plan Applications, detailed design briefs/drawings, or separate Schedule B EAs depending on the required process.

3.5 Background Information

3.5.1 Little River Comprehensive Stream Study

The Little River Comprehensive Stream Study (LCBA, et.al, 1992) was initiated in response to the concerns expressed by the City of Windsor and the MECP in regard to the impairment of the environmental quality of the Little River. The study area generally covers the portion of Little River downstream of the Canadian Pacific Rail Line, which is approximately 1 km upstream of the E.C. Row Expressway (the downstream limit of the current study).

The specific problems identified as causing habitat impairment of the Little River are:

- Lack of adequate wetlands
- Stream channelization
- Contaminant inputs
- Lack of riparian habitat (vegetation adjacent to Little River)
- Contaminated sediments

The following recommendations were put forward for the upper reaches of the Little River:

- The feasibility of re-establishing wetlands should be investigated
- A study should be conducted to identify upstream sources of contaminants

3.5.2 Turkey Creek and Little River Subwatershed Study

The Turkey Creek and Little River Subwatershed Study (Dillon, 1998) provided the municipalities with additional information and guidance needed to continue to update their Official Plan documents and to identify the opportunities for water management and protection of natural heritage.

The heavy agricultural use in the upstream portions of Little River was identified as causing high concentrations of phosphorus due to fertilizer use. Environmental degradation of the watercourse was attributed to:

- Lack of baseflow in the summer
- Sediment and nutrients from agricultural runoff
- Lack of riparian vegetation, increases in stream temperatures
- Accumulation of organic matter
- Toxic organics and metals
- Poor dissolved oxygen concentrations
- Physical habitat disruption by altered and straightened stream channels

Water Quality targets were established based on the “Provincial Water Quality Objectives” (MOE, 1994a), Ontario Drinking Water Guidelines (MOE, 1994b), Canadian Water Quality Guidelines (CCREM, 1993), and the Canadian Water Guidelines (Environment Canada, 1995). The results of the water quality sampling indicated several exceedances of the water quality targets

The recommendations of this study were to:

- Promote land stewardship through preparation of Conservation Farm Plans and landowner initiative to incorporate agricultural/rural Best Management Practices
- Prepare Master Drainage Plans for Baseline Road area, 6th, and 7th Concession Drain subwatershed areas

- Develop wetlands/ponds in upper reaches for baseflow and stormwater management

3.5.3 Windsor Lauzon Parkway Improvements Municipal Class EA

This Class EA study consisted of three parts.

Part A – Lauzon Parkway - The existing section of Lauzon Parkway between E.C. Row Expressway and County Road 42 consists of a 4-lane cross-section at its interchange with E.C. Row Expressway. South of the interchange, the roadway tapers to a 2-lane cross-section. The roadway also includes a grade separated crossing at the CPR rail line, as well as a bridge crossing at the Little River.

The study recommended widening Lauzon Parkway from a 2-lane rural to a 4-lane (2021) and 6-lane (2031) urban cross-section from E.C. Row Expressway to County Road 42; extending a 4-lane (2021) and 6-lane (2031) urban cross-section to Highway 401; a new Lauzon Parkway Interchange with Highway 401 (2021); and further extending Lauzon Parkway to Highway 3 with a 4-lane rural cross-section (2021).

Part B – County Road 42 - County Road 42 between Walker Road and County Road 25 (E. Puce Road) is approximately 15.5 km. This 2-lane roadway includes multiple residential and commercial driveways with direct access.

The study recommended widening County Road 42 from a 2-lane rural to a 4-lane urban cross-section from Walker Road to the City/County Boundary (2021); widening County Road 42 from a 2-lane rural to a 4-lane urban cross-section, with a centre median two-way-left-turn-lane, from the City/County Boundary to County Road 19 (Manning Road) (2021); and widening County Road 42 from a 2-lane rural to a 4-lane rural cross-section from County Road 19 (Manning Road) to County Road 25 (E. Puce Road) (2031).

Part C – Future East/West Arterial - The Future East/West Arterial was identified in the *Windsor Annex Area Master Plan Study* (Stantec, 2006) and further developed in the *East Pelton Secondary Plan* (City of Windsor, 2009) which included a future east-west arterial road connecting Lauzon Parkway to Walker Road. The Windsor Annex Area Master Plan identified a corridor for the new arterial between Walker Road and 10th Concession Road/County Road 17. The East Pelton Secondary Plan also included a future east-west arterial connecting to Walker Road.

The Lauzon Parkway Improvements Class EA recommended a new East-West Arterial roadway with a 2-lane cross-section with provision for an ultimate 4-lane cross-section from Walker Road to 10th Concession Road/County Road 17 (2031).

3.5.4 Windsor Sandwich South Annexed Land's Secondary Plans

The Sandwich South Secondary Plan was carried out for the preparation and approval of a Secondary Plan for the remainder of the annexed lands transferred to the City of Windsor in 2003. The area of the draft Sandwich South Secondary Plan is bounded, in general terms, by: Provincial Highway 401 to the south; the Windsor International Airport, CP Rail mainline, and E.C. Row Expressway to the north; 8th Concession Road to the west; and the Town of Tecumseh to the east. The Sandwich South Secondary Plan was not finalized and instead the County Road 42 Secondary Plan, the East Pelton Secondary Plan and other future Secondary Plans will serve as OP amendments for the Sandwich South lands to guide development and land uses.

3.5.4.1 East Pelton Secondary Plan

The East Pelton Secondary Plan provides direction for the development of the southwestern portion of the Sandwich South Planning Area and accommodates the Southwest Detention Centre. This Secondary Plan applies to approximately 206 hectares of land within an area bounded generally by Seventh Concession Road to the west, Eighth Concession Road to the east, Highway 401 to the south and lands south of Baseline Road. The East Pelton Secondary Plan was adopted by City Council and approved by OMB in in 2016.

3.5.4.2 County Road 42 Secondary Plan

The County Road 42 Secondary Plan study was undertaken to realize a Zoning By-law Amendment to sever 60 acres from an existing farm property to permit the development of a new hospital and for the preparation of a secondary plan for the area located on the south side of County Road 42, between 8th Concession Road and County Road 17, extending approximately 600 m south of Baseline Road. A hospital is proposed to be located near Country Road 42 and Concession Road 9. The Secondary Plan was adopted by City Council and approved by OMB in 2019.

3.5.5 Windsor Growth Management Study

The City of Windsor will be undertaking a Growth Management Study to explore infrastructure implementation and financing tools for development of the Sandwich South Lands in the Upper Little River Watershed. Budget for said study was approved by City Council on January 16, 2018. Funding for the implementation of the EA recommendations will be the subject of said study.

3.5.6 Tecumseh Hamlet Secondary Plan

The Tecumseh Hamlet Secondary Plan was carried out for the preparation and approval of a Secondary Plan for the Tecumseh Hamlet, bound by Manning Road to the

East, County Road 42 to the South, Banwell Road to the West, and County Road 22 to the North. The Tecumseh Hamlet was formerly a hamlet in the Township of Sandwich South and is located in the north-eastern portion of the Upper Little River Watershed.

This Secondary Plan was initiated by the Town years ago, and final revisions are being undertaken. Once the Secondary Plan is finalized and approved, the Town anticipates that the Secondary Plan will ultimately be incorporated into the new Official Plan by way of an amendment.

4.0 Existing Conditions

4.1 Ecology

4.1.1 Introduction

This section of the report characterizes the existing conditions in the study area and analyzes the potential impacts to the natural environment features with respect to the proposed project. These features include Little River and its tributaries, their associated fish habitat, woodlands and significant natural areas. It provides information collected through a review of existing background data supplemented through field investigations as it relates to the proposed undertaking. Environmental descriptions and recommended mitigation measures and opportunities are presented based on the data collected for this project and existing provincial, regional, municipal and conservation authority policies to minimize adverse environmental impacts. The Existing Environmental Features are summarized on Figure 2.

The Upper Little River watershed is located in the southeast part of the City of Windsor and the west part of the Town of Tecumseh, as shown on the Location Plan (Figure 1). The Main branch of Little River originates south of Highway 401 and generally flows north through a well-defined system of municipal drains and channels towards the Detroit River and Lake St. Clair. The majority of lands are used for agricultural purposes, with the exception of the airport in the northwest quadrant of the study area. Small pockets of residential subdivision development, commercial and industrial lands also exist within the area. The drainage area contributing to Upper Little River upstream of the E.C. Row Expressway is approximately 45 km^2.

4.1.2 Methodology for Data Collection and Analysis

A variety of background documents and sources of information were consulted during the preparation of this report, including the following primary data sources:

- Natural Heritage Information Centre database (NHIC, 2016);
- Land Information Ontario Mapping (LIO, 2015);
- City of Windsor Official Plans (2012 Office Consolidation);
- Town of Tecumseh: Township of Sandwich South Official Plan (Consolidated June 2014);
- City of Windsor Candidate Natural Heritage Site Biological Inventory (1992);
- City of Windsor Candidate Natural Heritage Site Biological Inventory Update (2008);
- Town of Tecumseh Natural Heritage Inventory (2011);
- Essex Region Natural Heritage System Strategy (ERCA and County of Essex, 2013);

- Essex Region Source Protection Area: Watershed Characterization (ERCA, 2011);
- ERCA and MNRF Fisheries Data Records;
- ERCA Regulation Mapping;
- The Physiography of Southern Ontario, Third Edition (Chapman and Putnam, 1984);
- Significant Wildlife Habitat Criteria Schedules for Ecoregion 7E (MNRF, 2015);
- Atlas of the Mammals of Ontario (Dobbyn, 1994);
- Ontario Reptile and Amphibian Atlas (Ontario Nature, 2016); and
- Breeding Bird Atlas (Cadman et al., 2007)

Aerial photography (2010) was used to interpret the location of the natural heritage features in the study area. Preliminary findings based on air photos and background data were confirmed and refined during site visits to the study area.

Existing fisheries, aquatic and terrestrial information for Little River and associated tributaries was obtained from the Ministry of Natural Resources and Forestry (MNRF), Essex Region Conservation Authority (ERCA), Natural Heritage Information Centre (NHIC), Fisheries and Oceans Canada (DFO), published reports, and other appropriate sources. This information included:

- Drainage patterns, watercourses/tributaries and drainage basin boundaries
- Fisheries surveys for the study area and throughout the subwatershed
- Mammal, herpetofaunal and bird survey records in the vicinity of the study area
- Location and boundaries of provincially significant and non-provincially significant wetlands
- Records of designated significant species occurrences

4.1.3 Ecological Field Studies and Investigations

Field investigations were completed by Stantec in partnership with Parish Geomorphic, Ecoplans in conjunction with field work being undertaken for the Sandwich South Secondary Plan, Gerry Waldron Consulting Ecologists, and ERCA. To avoid duplication in field work, all data was shared for the completion of this report.

Aquatic habitat assessments were completed by Gerry Waldron Consulting Ecologists and Ecoplans. The assessment completed by Gerry Waldron Consulting Ecologists involved electrofishing, water quality measurements, and botanical observations at 8 locations within and adjacent to the airport lands. Ecoplans assessed 28 reaches within the central portion of the study area delineated in Figure 3 and Figure 4. This assessment included qualitative observations of fish habitat conditions and botanical observations along each reach. ERCA submitted fisheries data for the majority of watercourses within the study area which was collected between 1984 and 2007.

Ecoplans undertook a series of targeted surveys which involved recording the Species at Risk, species of conservation concern and provincially rare species identified within the central portion of the study area. Targeted surveys included spring and summer botanical, odonata and butterflies, breeding birds and reptiles. Stantec completed a roadside ELC survey within three separate portions of the study area; northeast, south and west (Figure 3). Ecoplans completed ELC fieldwork for the central portion of the study area in August 2011.

The fieldwork methodology for this study was designed to generate a dataset sufficient to describe the natural features and ecological functions within the area. It was also intended to allow for the identification of potential impacts and recommendation of appropriate mitigation, restoration and enhancement measures of the preferred alternative. A description, characterization and assessment of the natural features within the study area were based on the existing background data supplemented by site specific observations obtained during the various field investigations.

Field investigations were carried out to characterize and confirm the limit of all-natural vegetation communities within the study area, to identify existing vegetation species, amphibians, wildlife, and to assess the aquatic habitat characteristics in the study area. Table 1 provides a summary of the field investigations completed for this study.

Table 1: Ecological Field Work, Sandwich South Employment Lands

Purpose of Field Work	Date(s) of Field Work	Personnel/Organization
Wildlife Surveys		
Odonata & Butterflies	August 4, 2011 & August 10, 2011	Ecoplans *B. Draper*
Breeding Birds	June 6, 2011 – July 27, 2011	Ecoplans *J. Holdsworth & R.S.*
Reptiles	April 29, 2011 – May 17, 2011	Ecoplans *J. Holdsworth & G.G.*
Incidental Wildlife	September 28-29, 2011 September 2009 – October 2009 April 29, 2011 – May 27, 2011	Stantec Consulting *N. Leava & M. Oxlade* Gerry Waldron Consulting *Various* Ecoplans *J. Holdsworth*

Table 1: Ecological Field Work, Sandwich South Employment Lands

Purpose of Field Work	Date(s) of Field Work	Personnel/Organization
Herpetofaunal	September 2009 – October 2009	Gerry Waldron Consulting *T. Preney & R. Jones*
Butler's Gartersnake	May 1 – May 29, 2009	Gerry Waldron Consulting *J. Choquette & D. Noble*
Vegetation Surveys		
Spring Botanical Inventory	June 2, 2011 – June 29, 2011	Ecoplans *B. Draper*
Summer Botanical Inventory	July 28, 2011 – August 17, 2011	Ecoplans *B. Draper*
Roadside ELC	September 28-29, 2011	Stantec Consulting *N. Leava & M. Oxlade*
ELC	June 2, 2011 – June 29, 2011	Ecoplans *B. Draper*
Aquatic Surveys		
Aquatic Habitat Assessment	2011 2009	Ecoplans *A. Stettler* Gerry Waldron Consulting *G. Waldron, T. Leadly, M. Cook & P. Hurst*
Electrofishing	May 4, 2004 June 2, 2004 September 28, 2007	ERCA *M. Nelson, K. Stammler, C. Casagrande, J. De Laronde*

4.1.3.1 Vegetation Surveys

Vegetation communities were delineated on aerial photographs and checked in the field; community characterizations were then based on the ELC system (Lee et al., 1998with 2008 updates). Common and Latin nomenclature of plant species generally follows Newmaster et al. (1998). Provincial significance of vegetation communities were identified based on draft rankings assigned by the NHIC (Bakowsky, 1996), with updates provided by the NHIC database. Regional and local rarity of plants was assigned using Essex Region's Local Status which is based on Distribution and Status of the Vascular Plants of Southwestern Ontario (MNR, 1993).

Identification of potentially sensitive plant species is based on an assignment of a coefficient of conservatism value (CC) to each native species in southern Ontario (Oldham et al., 1995). The value of CC, ranging from 0 (low) to 10 (high), is based on a species' tolerance of disturbance and fidelity to a specific natural habitat. For example, species with a CC value of 9 or 10 generally exhibit a high degree of fidelity to a narrow range of habitat parameters.

4.1.3.2 Wildlife Surveys

Wildlife observations and habitat surveys were conducted during field investigations to document wildlife and associated habitat, and to confirm natural heritage features in the study area. Wildlife surveys completed by Ecoplans (central portion of the study area), and by Gerry Waldron Consulting Ecologists (within and adjacent to the airport lands), were covered on foot with emphasis on the natural areas associated with Little River and associated tributaries, and the natural riparian areas associated with these watercourses.

Ecoplans conducted odonata and butterfly, breeding birds and reptile surveys during the spring and summer of 2011. The purpose of the survey was to sample the number of species within a specified site area (Figure 3). The presence and numbers of all species at risk, species of conservation concern and provincially rare species detected were recorded.

Breeding Bird Surveys were carried out by Ecoplans by traversing portions of the central portion of the study area on foot and recording all species of birds that were heard or seen. A conservative approach to determining breeding status was taken; all birds seen or heard in appropriate habitat during the breeding season were assumed to be breeding. Birds observed adjacent to the subject property were also recorded. This survey was conducted over 9 site visits.

The purpose of the reptile surveys conducted by Ecoplans was to identify and record the presence and number of reptile species within the central portion of the study area. Surveys were conducted over 9 days.

In addition to the mentioned wildlife surveys, herpetofaunal surveys were conducted between September and October 2009 by Gerry Waldron Consulting Ecologists. The purpose of these surveys was to sample the number of species of reptiles and amphibians within and adjacent to the airport lands in the northwest portion of the study area. The presence and number of each species detected visually and/or by sound was recorded. Random searches were performed throughout the survey area (Figure 3).

The monitoring was completed in the early morning, late afternoon and early evening. The site was visited 14 times.

Surveys for Butler's Gartersnake were also conducted by Gerry Waldron Consulting Ecologists within and adjacent to the Windsor Airport lands on May 1, 5, 12, 25 and 29, 2009. The purpose of the surveys was to confirm the presence of Butler's Gartersnake (*Thamnophis butleri*), a threatened species, and its habitat, and to obtain morphological and genetic data for the preparation of the COSEWIC Status Report update on this species. Survey conditions were sunny with few clouds or sunny and clear during the five survey days.

4.1.3.3 Analysis of Significance and Sensitivity

Biological field data were evaluated to establish the significance of the observed features. The provincial status of wildlife flora and fauna was provided by the Natural Heritage Information Centre (NHIC, 2007). Status rankings (S-Ranks) for both plants and wildlife are based on the number of occurrences in Ontario and have the following meanings:

- S1: Critically Imperiled; often 5 or fewer occurrences
- S2: Imperiled; very few populations, often 20 or fewer
- S3: Vulnerable; relatively few populations, often 80 or fewer
- S4: Apparently Secure; uncommon but not rare
- S5: Secure; common, widespread, and abundant

The global, federal and provincial status of wildlife was determined by reviewing species accounts published by the Natural Heritage Information Centre (NHIC, 2005).

Provincial significance of vegetation communities was based on the draft rankings assigned by the Natural Heritage Information Centre (Bakowsky, 1996). The provincial status of all plant species is based on Newmaster et al. (1998), with updates from the database of the Natural Heritage Information Centre (NHIC, 2005).

4.1.4 Aquatic Surveys

4.1.4.1 Aquatic Habitat Assessment

Stantec and Ecoplans assessed 24 and 28 drainage areas respectively, from the south central to northeast portion of the study area (Figure 3). Characterizations such as width, water depth, vegetation composition and cover were recorded. The thermal regime, substrate type, fish species present and drain classification were surveyed by Ecoplans. ERCA completed electrofishing on 7 drains within or adjacent to the study area in 2004 and 2007. Fish present within each sampling location and corresponding designations were recorded.

Gerry Waldron Consulting Ecologists identified eight potential stream crossings for a proposed trunk sanitary sewer where impacts to fish and fish habitat may occur (Figure 4). The purpose of the aquatic survey was to identify the fish grouping and assess the fish habitat within the areas of the proposed stream crossings. Fish were collected using a Smith-Root Model LR-24 back-pack electro fisher. At least 95% of species composition was determined by sampling at a minimal distance of 50 stream widths on either side of the proposed stream crossing. Longer reaches, including Upper Little River located parallel to the proposed project area, were also sampled where fish habitat was suspected to occur (Waldron, 2009). A number of basic water quality parameters were measured and recorded during the preliminary field survey to assess general water conditions (temperature, pH, conductivity, oxidation-reduction potential, and dissolved oxygen). Gerry Waldron Consulting conducted these surveys from October 18, 2009, to November 22, 2009 (Waldron, 2009).

Observations of physical habitat conditions along watercourses were recorded by Stantec, Ecoplans, and Gerry Waldron Consulting Ecologists through most of the study area. These observations included information on bottom substrate, stream morphology and dimensions, bank stability, in-stream cover and riparian vegetation. These habitat notes, photographs and fish community data formed the basis for assessments of existing habitat conditions and for recommendations with respect to potential habitat enhancement opportunities.

4.1.5 Study Area Description and Natural Features

The purpose of this section is to identify and describe the designated natural features in the study area, as well as the physiographic, hydrologic, hydrogeological, and biologic characteristics of the study area.

4.1.5.1 Designated Environmental Features

The City of Windsor and Township of Sandwich South Official Plans outline the proposed land uses and natural features within the study area. The Official Plans identify six natural environment areas and three ecological linkages within the study area. The Greenway System (City of Windsor OP, Schedule B) identifies a community and regional park corridor located along Little River from the EC ROW Expressway at Lauzon Road extending south to Highway 401. The corridor contains a large portion of woodlands located west of Lauzon Parkway and north of County Road 42.

The Windsor Airport Swamps Provincially Significant Wetland (PSW) occurs in the Study Area within the Airport Lands (LIO 2015). No other wetlands, Areas of Scientific and Natural Interest (ANSIs) or valleylands were identified within the study area (City of Windsor OP, Town of Tecumseh OP, City of Windsor CNHS, 2008; Town of Tecumseh NHI, 2011; LIO, 2015) although other natural features may meet the criteria if there were to be evaluated.

According to the Essex Candidate Natural Heritage System Strategy (ECNHSS) (County of Essex and ERCA, 2013), a total of 17 natural heritage sites and other woodlots occur in the Study Area. Of those 17 sites, only 7 were evaluated for significance. Evaluation criteria included features considered to be significant wetlands, woodlands or valleylands, features containing significant species or communities, and features providing biological diversity, an ecological function or habitat for threatened and endangered species.

Candidate Natural Heritage Site #39 is approximately 40 ha in size and comprised of three woodlots containing the Windsor Airport Swamps PSW. The site meets four criteria for significance and is designated open space/natural heritage in the City of Windsor OP. Candidate Natural Heritage Sites #40 (Sundrop Bend) and #41 (Fairbairn Woods) are located in close proximity to the Windsor Airport Swamps PSW. They meet four and three of the criteria for significance respectively, and have been designated open space/natural heritage in the City of Windsor OP. The remaining Candidate Natural Heritage Sites assessed in the ECNHSS (Sites 42-45) have only met one criterion for significance and have not been designated as open space/natural heritage in the City of Windsor OP. For the purpose of this EA, woodlands not assessed by the ECNHSS have been included as Candidate Natural Heritage Sites (Figure 2). Development within or adjacent to Candidate Natural Heritage Sites may require an Environmental Evaluation Report to determine if development is permitted.

4.1.5.2 Other Natural Environment Considerations

Priority restoration areas have been identified in the Study Area in the Essex Region Natural Heritage System Strategy (ERCA and County of Essex, 2013), should be considered in any future development design concepts. These areas are comprised of buffers to the Windsor Airport Swamps PSW.

A floodplain and development control area exists within the northeast portion of the study area (Township of Sandwich South OP, Schedule B). The floodplain areas associated with Little River are considered Two Zone Floodplain Policy Areas and are regulated by ERCA pursuant to *Ontario Regulation 158/06: Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation* (Figure 2).

4.1.5.3 Current Land Uses

The majority of the study area is presently characterized by agricultural use. Lands designated industrial and commercial, including Business Parks, are located along the north and west borders of the study area. The Windsor International Airport is located on the north portion of the study area, bounded to the north by industrial lands. The east section of the airport lands are proposed future employment lands. Residential development areas exist northeast (Town of Tecumseh) and to the southwest (Pelton) of the study area. Little River and its associated tributaries generally flow through agricultural land from the south to north and drain into Lake St. Clair. Approximately half of Little River and all of the associated tributaries (municipal drains) are channelized. Naturalized reaches of Little River exist downstream of Baseline Road.

4.1.5.4 Physiography

The study area is located within the Essex Region Watershed, which is part of the Essex Clay Plain, recognized as a subdivision of St. Clair Plain physiographic region (Chapman and Putnam, 1984). The area is comprised mostly of agricultural land on clay and sand plains of ancient lake bottoms and bedrock. The majority of this region is characterized by extensive sand and clay plains which extend down 30 to 60 metres before encountering rock (Chapman and Putnam, 1984). Glaciers deposited unsorted stony materials, causing large deposits of sediment and outwash materials as a result.

4.1.5.5 Geology

Essex Region is underlain by a thick succession of Paleozoic sedimentary rocks which are part of the Michigan Basin sedimentary deposits (Watershed Characterization Report, 2010). Surficial geology tends to be relatively uniform throughout the study area and consists largely of stream alluvium (interbedded clay, till, sand and gravel). The alluvium is deposited over older terrace deposits of outwash and ice-contact sand and gravel, which in turn lay over Tavistock Till (clayey silt till) (Watershed Characterization Report, 2010).

4.1.5.6 Hydrology

The study area is located within the Little River watershed. Little River occupies a relatively large drainage basin (64.9 km^2) (Watershed Characterization Report, 2010). The study area is situated in the upstream portion of the watershed (drainage area approximately 45 km^2). Throughout most of the upstream drainage area, dredged ditches and tile drains were installed in order to improve drainage and provide satisfactory conditions for crop growth and tillage (Chapman and Putnam, 1984). Thus, the natural drainage patters of the watersheds have been realigned by artificial means, primarily for agricultural purposes.

4.1.5.7 Terrestrial Resources

Landscape Ecology

The study area is located within the Carolinian Deciduous Forest Region (Rowe, 1972) which is dominated by sugar maple and American beech, mixed with basswood, red maple, red oak, white oak, and bur oak. The bulk of Canada’s black walnuts, sycamores, swamp white oaks, and shagbark hickories are found in this forest region. Other associated species include butternut and bitternut hickories, rock elm, silver maple, and blue beech. Coniferous species are generally limited to scattered white pine, eastern hemlock, eastern red cedar, and, more rarely, black spruce, tamarack, and eastern white cedar.

Tree cover within the Essex Region Watershed is approximately 5.9% and only 2.2% within the Little River Subwatershed (ERCA, ERNHSS 2013).

The Little River watershed lies within the Carolinian Core Natural Areas as defined by Carolinian Canada as part of the “Big Picture” project. A major element of this mapping exercise consists of establishing Meta-Cores and Meta-Corridors that represent the large-scale connections within Carolinian Canada, as well as smaller core areas and corridors that are relevant at the local landscape level.

The Essex Region Watershed is identified as a potential habitat corridor linking core natural areas within southwestern Ontario, as identified by Carolinian Canada as part of their “Big Picture” project. Similarly, the natural areas within the Little River Subwatershed, including woodland features, are identified as part of a core natural area.

Vegetation Communities

The majority of the study area lands are under agricultural cultivation, with small wetland features associated with drainage features. Deciduous forests and cultural meadows are frequent within the area. Mapping of the vegetation communities within Stantec’s investigated area (Figure 3) are based on the botanical surveys and the ELC System (Lee et. al., with 2008 updates 1998), shown on Figure 5. None of the vegetation communities identified are considered rare in the province. The vegetation community types for three portions of the study area (northeast, south and west) were identified by Stantec and are described in Table 2 below.

Table 2: Ecological Land Classification (ELC) Vegetation Types

ELC Type	Community Description
Forest (FO)	
Deciduous Forest (FOD)	
FODa Deciduous Forest	Due to limited accessibility, this FOD community was observed approximately 250 metres from the roadside. Although this forest was within the Study Area, it could not be classified any further due to unknown species composition.
FODb Deciduous Forest	Due to limited accessibility, this FOD community was observed approximately 400 metres from the roadside. Although this forest was within the Study Area, it could not be classified any further due to unknown species composition.

Table 2: Ecological Land Classification (ELC) Vegetation Types

ELC Type	Community Description
FODc Deciduous Forest	Due to limited accessibility, this FOD community was observed approximately 100 metres from the roadside. Although this forest was within the Study Area, it could not be classified any further due to unknown species composition.
FODd Deciduous Forest	Due to limited accessibility, this FOD community was observed approximately 150 metres from the roadside. Although this forest was within the Study Area, it could not be classified any further due to unknown species composition.
FODe Deciduous Forest	Due to limited accessibility, this FOD community was observed approximately 200 metres from the roadside. Although this forest was within the Study Area, it could not be classified any further due to unknown species composition.
FODM2-4 Dry-Fresh Oak – Hardwood Deciduous Forest Type	This community had an abundance of bur oak, with sugar maple, American elm, and cottonwood associates within the canopy cover. The subcanopy consisted of equal presence of sugar maple, cottonwood and bur oak. The understory had an abundance of sugar maple and white ash. The ground layer was difficult to observe due to only roadside access.
FODM7-1a Fresh-Moist White Elm Lowland Deciduous Forest Type	This community was assessed from a pathway due to limited property access. Canopy cover consisted of American elm, with sugar maple and American basswood associates. Similar species composition was observed within the sub canopy, along with bur oak. Understory and ground layer species composition was not observed due to limited visibility along pathway. A small stream was found running along the side and throughout the forest.
FODM7-1b Fresh-Moist White Elm Lowland Deciduous Forest Type	This community was located along a residential property. A small stream ran through the community. Due to limited property access, the full extent of this community's area coverage was difficult to delineate. American elm was dominant throughout this community, with bur oak and cottonwood associates. Riverbank grape was frequently observed within this community as well.
Meadow (ME)	
ME Meadow	This community is highly disturbed, with large areas of open bare ground and gravel scattered throughout. A high dirt mound located at the northeast section of this community is dominated by thistles. Other species found throughout this community

Table 2: Ecological Land Classification (ELC) Vegetation Types

ELC Type	Community Description
	include grasses, common ragweed, garlic mustard, teasel and riverbank grape.
Graminoid Meadow (MEG)	
MEG Graminoid Meadow	Dominated by barnyard grass, this community also contained foxtail, various aster species, wild carrot and goldenrods. This cultural meadow covered a small area, and was located between two residential properties, as well as adjacent to the rail tracks bordered by a hedgerow.
Forb Meadow (MEF)	
MEFM1-1 Goldenrod Forb Meadow Type	This community is located adjacent to agricultural fields and industrial properties. It was disturbed, dominated by goldenrods and occasionally aster species. Phragmites, bird's-foot-trefoil, grasses, and milkweed were observed throughout. A small area of tree cover along the south portion of this community occurred, consisting of cottonwood, trembling aspen, willow species and sumac.
MEFa Forb Meadow	This community is bordered by *Phragmites*, and was adjacent to commercial and residential properties. Wild carrot, tall white aster, new England aster, and goldenrods were found throughout this community.
MEFb Forb Meadow	This community was dominated by green amaranth. Other species such as Canada thistle, foxtail, dock and asters were found throughout. A small section just north of the residential area was absent of amaranth, and was dominated by goldenrods and aster species.

*ELC code not included in the First Approximation of ELC for Southern Ontario

Vascular Plant Species

A total of 53 vascular plant species were recorded within three portions of the study area surveyed by Stantec (Figure 3). Of the 53 species, 31 (58%) are considered native to Ontario. The majority (97%) of identified native species are provincially ranked secure (S5). The remaining 3% of the native species are provincially ranked apparently secure (S4). A total of three species identified are considered regionally significant in Essex Region: Freeman's maple, Alternate-leaved dogwood and Pin Cherry. Though these species are considered rare to Essex Region, they are provincially ranked secure (S5).

Twenty-seven provincially significant plant species were identified as element occurrences in, and around the study area, according to the NHIC database last updated February 18, 2015 (Appendix F).

Eleven of the 27 species were identified either during field investigations conducted by Ecoplans and Gerry Waldron Consulting Ecologists, and/or in the City of Windsor Candidate Natural Heritage Site (WCNHS) Biological Inventory Update (ERCA and Waldron 2008) and the Town of Tecumseh Natural Heritage Inventory (TNHI; ESCR, 2008). In addition to those species identified by NHIC, the field investigations and Natural Heritage Inventories identified eleven additional provincially rare plant species not included in the NHIC search (also shown in Appendix F). The locations of the significant species observed during Gerry Waldron Consulting Ecologists and Ecoplans field investigations are shown on Figure 6. Six other species have also been identified as occurring in the vicinity of the Study Area according to species range maps located on the Species at Risk in Ontario website. In total, 42 provincially rare species and species at risk have been documented as occurring within the Study Area. Appendix F provides a complete list of the provincially rare plant species identified during the background review as potentially occurring in the study area, and provincially rare plant species identified during field investigations, and indicates whether suitable habitat for these species occurs on the subject property.

Significant Wildlife Species

Appendix F provides a list of provincially rare wildlife species identified during the background review as potentially occurring in the study area, and provincially rare wildlife species identified during field investigations, and indicates whether suitable habitat for these species occurs on the subject property.

Based on a review of existing published data sources, including the NHIC database (2016), Atlas of the Mammals of Ontario (Dobbyn, 1994), Ontario Reptile and Amphibian Atlas (Ontario Nature, 2016), and the Breeding Bird Atlas (Cadman et al., 2007), the following provincially rare species and species at risk potentially occur within, or adjacent to, the study area:

- **Reptiles** – Snapping Turtle, Blanding’s Turtle, Northern Map Turtle, Spiny Soft-shell, Common Five-linked Skink, Eastern Foxsnake, Queensnake, Butler’s Gartersnake, Massasauga Rattlesnake, Eastern Milksnake
- **Birds** – Acadian Flycatcher, Bald Eagle, Bank Swallow, Barn Swallow, Bobolink, Chimney Swift, Common Nighthawk, Eastern Meadowlark, Eastern Wood-Pewee, Least Bittern, Peregrine Falcon, Red-Headed Woodpecker, Short-eared Owl, Wood Thrush, Yellow-breasted Chat
- **Mammals** – Little Brown Myotis, Eastern Mole

- **Fish and Mussels** – discussed in Section 4.1.5.8.2
- **Butterflies and Odonata** – Blue-tipped Dancer, Double-striped Bluet, Swamp Darner, Elusive Clubtail, Royal River Cruiser, Great Blue Skimmer, Variegated Meadowhawk, Sleepy Duskywing, Mottled Duskywing, Duke's Skipper, Monarch

The significant species identified within the study area during field investigations are summarized in the sections below.

Significant Wildlife Habitat

Candidate significant wildlife habitat (SWH) pursuant to the Significant Wildlife Habitat Criteria Schedules for Ecoregion 7E (MNRF, 2015) was assessed using the ELC vegetation community and wildlife habitat assessment results and GIS analysis. Criteria include; (a) seasonal concentration areas, (b) rare or specialized habitat, (c) habitat for species of conservation concern, and (d) animal migration corridors. A description of the SWH criteria and an assessment of the potential presence within the Study Area is provided in Appendix F. The following potential candidate significant wildlife habitat features have been identified for the Study Area:

- Candidate significant wildlife habitat for waterfowl stopover and staging areas (terrestrial): Large expanses of agricultural lands in close proximity to Lake Sinclair may provide suitable stopover habitat for migrating tundra swans.
- Candidate significant wildlife habitat for bat maternity colonies: Deciduous forest and/or swamp communities may provide suitable habitat for breeding bats.
- Candidate significant wildlife habitat for turtle wintering areas: Open aquatic areas containing water deep enough not to freeze and soft muddy substrates may provide suitable turtle hibernation habitat. Additionally, candidate habitat for turtle nesting areas may occur in the vicinity of any area qualifying as turtle wintering areas.
- Old foundations may provide candidate significant wildlife habitat for snake hibernacula.
- Woodlands may provide candidate significant wildlife habitat for seeps and springs.
- Candidate significant wildlife habitat for breeding amphibians (woodlands) may occur in or within 120m from woodland habitats.
- Candidate significant wildlife habitat for breeding amphibians (wetlands) may occur >120m from woodland habitats. Candidate significant wildlife habitat corridors may be present if amphibian habitat (wetlands) is identified.

- Candidate significant wildlife habitat for Terrestrial Crayfish may occur in the Study Area adjacent to marsh communities.

Breeding Birds

Three provincially and federally threatened species were identified during breeding bird surveys in the study area: Chimney Swift, Bobolink and Eastern Meadowlark. Common Nighthawk was also identified within the study area and is designated Special Concern in Ontario and federally threatened. Three species were identified as provincially rare: Black-crowned Night Heron (S3B, S3N), Western Kingbird (S1B), and White-eyed Vireo (S2B).

Amphibians & Reptiles

During herpetofaunal surveys completed in 2009 and 2011, a total of seven species were identified. Four of the seven species are considered provincially rare (S1-S3). Butler's Gartersnake (S2) and Eastern Foxsnake (S2) are considered Threatened and Endangered, respectively, by COSSARO; and the Snapping Turtle (S3) and Northern Map Turtle (S3) are both considered Species of Special Concern. The Northern Leopard Frog, Eastern Gartersnake and American Toad were also identified within the study area, all ranked secure in Ontario.

Odonata & Butterfly Surveys

Ecoplans undertook an odonata and butterfly survey on August 4th, 2011 and August 10th, 2011. Of the 89 odonata and 180 butterflies identified, 11 species are considered provincially rare (Appendix F). No provincially or federally threatened or endangered species were observed during the field investigations.

4.1.5.8 Aquatic Resources

Aquatic Habitat

Within the study area, the upper portion of Little River Watershed consists of channelized ditches that parallel the concession roads to the southeast of the Windsor Airport. The majority of these drains are classified as intermittent or ephemeral. Little River, connected downstream of Little River Drain, is classified as a Class 'E' Drain; a permanent, warmwater watercourse (Municipal Drainage Classification and Mapping, 2010). Authorized Class 'E', 'C' and 'F' Drains have been identified in the study area. All drains potentially contain fish and fish habitat that are sensitive to maintenance and construction activities.

The Fisheries Act prohibits projects causing serious harm to fish unless authorized by the Minister of Fisheries and Oceans Canada (DFO). This applies to work being conducted in or near waterbodies that support fish that are part of, or that support, a commercial, recreational or Aboriginal (CRA) fishery. Since November 25, 2013, proponents must take the responsibility to ensure their projects meet the DFO requirements under the Self-Assessment process, or if serious harm cannot be avoided, contact DFO for a formal review or approval under the *Fisheries Act*.

Site inspections were completed along drains within the study area to record the existing habitat characteristics. A summary of aquatic habitat areas within the study area are described below in Table 3 and identified on Figure 4.

Table 3: Aquatic Habitat Reaches and Municipal Drain Classification

Drainage Classification	Reach	Watercourse	Reach	Watercourse
Drain Class C - Permanent, warm with no sensitive species and/or communities present	3	Little River at Twin Oaks to EC ROW	9	Little River at Rivard Drain
	4	Little River at CPR Little River Bridge Crossing	10	Little River at Lauzon Parkway
	5	Little River at Soulliere and Desjardins	11	Little River at Lauzon Parkway Reach
	6	Little River at Lauzon Road	12	Little River at County Road 42
	7	Little River at Lauzon Road	35	6th Concession Drain from 7th Street Drain to Baseline Road
	8	Little River at Watson Drain		
Drain Class E - Permanent, warm with sensitive species and/or communities present	16	6th Concession Drain from Baseline Road to Little River	25	Little River from County Rd 42 to Highway 401
	19	9th Concession Drain from 6th Concession to Highway 401		
Drain Class F - Intermittent or ephemeral (dry for more than two consecutive months)	1	Gouin Drain	26	McGill Outlet (Drain)
	2	Lachance Drain	27	North Townline Drain
	13	Lachance Drain	28	Ray Road Drain
	15	8th Concession Drain Reach	29	Rivard Drain
	17	7th Concession Drain	30	Russette Drain

Table 3: Aquatic Habitat Reaches and Municipal Drain Classification

Drainage Classification	Reach	Watercourse	Reach	Watercourse
	18	7th Street Drain Diversion	31	Soulliere Branch
	20	Little 10th Concession Drain upstream of Quick Drain	32	Soulliere Drain
	21	Little 10th Concession Drain from Upper Little River to Quick Drain	33	St. Louis Drain
	22	Desjardins Drain Reach	36	8th Concession Drain
	23	Hayes D&W Drain		
	24	Hurley Relief Drain		
Not Mapped/No Classification	34	Watson Drain		

Field Investigations from Stantec Consulting, Ecoplans and Gerry Waldron Consulting

A portion of the Watson Drain is classified as a Class ‘C’ permanent warm water drain with the potential for sensitive species and/or communities present. In this reach, the channel is well defined and provides a good diversity of riffles, flats and runs, and good in-stream cover (overhanging vegetation, undercut banks). Bottom substrate is also variable, with clay, silt, gravel, sand and cobble riffles. The banks are generally well-vegetated, however there are some sparse vegetated areas and steep banks; evidence of some erosion. This watercourse experiences moderate to large water inflow, mostly from tile drains, and is flashy; susceptible to flooding during rain events. The width of the banks ranges from 1.5 m - 3.5 m, and a depth of 0.2 m - 1.5 m.

The majority of the Class ‘E’ drains experience significant flow and areas with elevated turbidity, mostly caused by agricultural runoff. Within these reaches, the majority of channels are widely defined and provide a good diversity of gravel riffles, pools, flats and runs, foreshores areas, elevated island bars and good in-stream cover (overhanging vegetation, undercut banks). Bottom substrate is also variable, with clay, silt, gravel, sand and cobble riffles. The banks are generally well-vegetated; however, there are areas with steep and undercut banks that show evidence of erosion. These watercourses experience large water inflow, from smaller tributaries and drains, and direct inflow from agricultural tiles.

The width of Little River ranges from 1.5 m -10 m, and a depth of 0.3 m - 5.5 m. Specifically, within Little River, a series of vertical drops approximately 0.15 m exist along Reach 3. Portions of the 6th, 8th and 9th Concession drains support flat habitat and have significantly denser in-stream vegetation.

The Class 'F' watercourses identified within the study area predominately drain agricultural fields and roads, generally have little flow and are commonly dominated by dense in-stream vegetation. The majority of these drains contained barriers to fish passage or showed evidence of recent maintenance activities. Water depth ranged from dry to approximately 1 m (during heavy rainfall). Woody debris, flat habitat areas and herbaceous riparian vegetation characterized most of these reaches (Ecoplans, 2011; Gerry Waldron Consulting, 2009).

Aquatic Species

In addition to the 2009 and 2011 aquatic surveys compiled by Ecoplans and Gerry Waldron Consulting, ERCA conducted a variety of aquatic surveys between 1979 and 2007. One species identified (Blackside darter) in the ERCA 1999 aquatic survey is ranked as provincially vulnerable (S3). All other species identified in the 1979-2007, 2009 and 2011 aquatic surveys are provincially ranked secure or apparently secure (S4 or S5) and none of the identified species are considered Species at Risk by COSSARO or COSEWIC. ERCA Fish and Mussels Species DFO mapping (DFO, 2015 and the NHIC database (NHIC, 2015) indicate that there are no known Species at Risk occurring within the Little River Watershed.

According to the DFO mapping (DFO, 2015), the following provincially rare species and species at risk potentially occur within the adjacent Pike Creek watershed to the East of the Study Area:

- Grass Pickerel (*Esox americanus vermiculatus*)
- Northern Brook Lamprey (*Ichthyomyzon fossor*)
- Silver Chub (*Macrhybopsis storeriana*)
- Silver Lamprey (*Ichthyomyzon unicuspis*)
- Spotted Sucker (*Minytrema melanops*)
- Warmouth (*Lepomis gulosus*)

Available background information indicates that the Upper Little River Watershed is a warmwater system (LIO Mapping, 2015). A number of surveys have been conducted in Little River, including the collection of fisheries data within the Study area (ERCA, 2011). Fish species captured at each station are summarized in Table 4. Mapping of the fish survey locations are found on Figure 4. Due to the variability of physical characteristics among stations, netting efficiency varied by station. For example, not all fish could be collected from some of the deep pools due to water turbidity and depth.

The fish communities sampled in 2009 and 2011 are dominated by coolwater species (white sucker, common shiner, creek chub and quillback). Several rock bass, banded killfish and yellow perch were also captured, all within Class “E” Drains (Little River Drain, 6th and 8th Concession Drains). Warmwater species were found throughout the study area and include pumpkinseed sunfish and largemouth bass. In addition, one brown bullhead and bluegill were identified at Little River Drain and the 8th Concession Drain, respectively. The greatest number of fish captured and highest diversity was observed at Little River and Lauzon Road, in the downstream end of the Study area. Fishing effort was slightly higher within the airport lands surveys and therefore greater numbers of fish would be expected.

Table 4: Results of the Fish Community Surveys in Little River Watershed

	Reach										
Species and Quantity Captured	1	2	4	6	7	10	12	13	21	26	35
Pumpkinseed Sunfish	X	X	X	X		X					
Mudminnow	X	X		X		X		X			X
Bluntnose Minnow			X	X		X	X				X
Common Shiner			X	X		X					X
Creek Chub			X	X		X					X
Fathead Minnow			X	X		X					X
Largemouth Bass			X	X							
Quillback			X	X		X					X
Spotfin Shiner			X	X		X					X
White Sucker			X	X		X					X
Spottail Shiner				X		X					
Rock Bass			X								
Banded Killfish				X		X					
Brown Bullhead				X							
Gizzard Shad				X							
Striped Shiner						X					X
Common Carp											
Yellow Bullhead											
Centrarchid sp.								X			
Yellow Perch											
Bluegill											
Fish Present (unidentified species)					X				X	X	
*Fish surveys were not completed for all reaches											

The watercourses identified in Table 3, support direct fish habitat (Figure 4). All of the species identified during field investigations are considered provincially secure or apparently secure. None of the species are designated as Species at Risk.

Fish surveys completed by the ERCA from 1979 until 2007 include stations in the Upper Little River Watershed (ERCA data). Fish species identified in the ERCA fish surveys (1979 – 2007) that have not been identified in the 2009 and 2011 aquatic surveys include:

Warmwater fish species: Green sunfish, goldfish, tadpole madtom, tubenose goby, round goby, freshwater drum and log perch

Coolwater fish species: Hornyhead chub, black crappie, white crappie, northern pike, golden shiner, blackside darter

Cold water: Mottled sculpin and brook stickleback

Water Quality

Water quality conditions were recorded by Gerry Waldron Consulting Ecologists along 5 reaches at the time of fish sample collections on October 18, 2009 (Table 5). The low dissolved oxygen and high conductivity in Reach 2 indicates low flow conditions, agricultural runoff and abundant organic material (Gerry Waldron Consulting, 2009). The remaining sites tested show satisfactory values and elevated turbidity conditions, indicating the watercourse is impacted by suspended soils originating upstream.

Table 5: Water Quality Conditions

Reach	Temperature (°C)	D.O. (mg/L)	Conductivity (µS/cm)	pH	Redox (µmhos)	Turbidity (NTU)
1	5.59	9.22	1.168	7.9	218	40.4
2	5.57	4.69	3.00	7.0	214	9.79
4	4.68	10.2	1.3	7.35	218	40.7
6	4.66	10.18	1.330	7.34	217	40.3
10	5.52	10.93	1.172	7.48	218	50.3

Source: Gerry Waldron Consulting Ecologists, 2009

Surface water quality is affected by a number of pollution sources including discharge pipes (point source), rural runoff, contaminated runoff and other types of non-point sources of pollution. Nutrients, bacteria, and sediment are the most widespread and unregulated problems contributing to surface water quality.

The ERCA produced a Watershed Report Card (2012) on the health of the Essex Regions watersheds. The report was developed to summarize the conditions of the priorities (surface water, groundwater, forest condition and watershed health) using a protocol developed by Conservation Ontario. Based on surface water quality parameters which includes total phosphorus, bacteria (E. Coli) levels and benthic invertebrates, the Little River Watershed was one of eight that received a Grade ‘D’, ranking between 1st and 8th out of the 14 watersheds monitored (ERCA, 2012).

4.1.6 Ecology Summary

Based on the information provided, the following is a summary of findings:

- The study area is located within the Upper Little River watershed, comprised predominantly of intermittent drains and warmwater channels.
- The following watercourses support direct fish habitat: Desjardins Drain, Gouin Drain, Hayes Drain, Hurley Relief Drain, Lachance Drain, Little River, Little River Drain, McGill Drain, North Townline Drain, Ray Road Drain, Rivard Drain, Russette Drain, Soulliere Drain, St. Louis Drain, 6th Concession Drain, 7th Concession Drain, 7th Street Drain, 8th Concession Drain, 9th Concession Drain, and Little 10th Concession Drain.
- Provincially significant wetlands are located on the airport lands.
- No significant valley lands or ANSIs exist within the study area.
- Locally and provincially significant woodlands exist within the study area.
- Little River and associated tributaries are subject to flooding during the regulatory (1:100 year) rainfall event.
- Portions of the Little River Watershed have been historically altered from its natural state, and consists of reaches that have been altered, straightened and relocated to accommodate road construction, and to stabilize banks and protect adjacent urban and open space areas.
- Several different types of habitat exist within the study area that provide a range of habitats for a variety of wildlife species. Twenty-two provincially rare plant species or plant species at risk were identified as occurring in the Study Area during Ecoplans and Gerry Waldron Consulting Ecologists field investigations and the City of Windsor and Town of Tecumseh Natural Heritage Inventories. Nineteen have been ranked provincially rare (S1-S3), one as threatened and two as Special Concern under COSSARO. In addition, 20 plant Species at Risk have been identified in published data sources as species that may occur, but were not identified within the study area.
- Provincially rare (S1-S3) species and Special Concern species may indicate Significant Wildlife Habitat.

- Eight birds designated as provincially Endangered or Threatened have been identified in published data sources as species that may occur within the study area, three of which were identified during field investigations (Chimney Swift, Bobolink, Eastern Meadowlark). Seven Special Concern birds were identified in published data sources as species that may occur within the study area, one of which was observed during field investigations (Common Nighthawk).
- Seven reptiles designated as provincially Endangered or Threatened have been identified in published data sources as species that may occur within the study area, two of which were identified during field investigations (Butler's Gartersnake, Eastern Foxsnake). Three Special Concern reptiles were identified in published data sources as species that may occur within the study area, two of which were observed during field investigations (Snapping Turtle, Northern Map Turtle).
- One mammal designated as provincially Endangered or Threatened has been identified in published data sources as a species that may occur within the study area (Little Brown Myotis). One mammal designated as Special Concern was identified in published data sources as species that may occur within the study area (Eastern Mole). Potential habitat for both of these mammal species was observed during field investigations.
- 18 Butterflies and Odonata designated as provincially rare (S1-S3) have been identified in published data sources as species that may occur within the study area, 11 of which were identified during field investigations conducted by Ecoplans, including Monarch which is provincially and federally designated as Special Concern.
- The 36 species of fish identified within the study area indicate the presence of warmwater and coolwater fish community.
- The Blackside Darter is provincially ranked as vulnerable (S3) and was identified within the study area in 1991. All other species identified are ranked secure or apparently secure (S4 or S5) and none are considered Species of Concern under COSSARO or COSEWIC.
- The fish community within Little River watershed is constrained by water quality impacts and historic habitat alterations, suggesting that improvements may be possible through improvements in water quality and habitat conditions within the watershed.

4.1.6.1 Summary of Environmental Constraints

Based on the information provided in this report, and the policies outlined above, the preferred alternative should consider and aim to minimize potential adverse impacts on the following natural heritage and hazard features within the study area (Figure 6):

- Direct fish habitat in the Little River watershed.
- Provincially and Locally significant woodlots.
- Significant wildlife habitat.
- Natural stream morphology (i.e., minimize excessive erosion along the watercourse).
- Natural vegetation communities and provincially rare plant species identified within the study area, with specific attention paid to restoring and enhancing the natural corridors within the study area.
- Flood flows, depths, velocities, and base flow within each watercourse.
- Regulated areas, as delineated on the ERCA Regulation mapping.
- Consultation with the various agencies will be required to confirm the presence of provincially rare species and significant natural heritage features as part of the development design.

4.2 Hydrogeology

4.2.1 Purpose

The purpose of this Section is to characterize the current hydrogeological conditions of the upper portions of the Little River watershed to the east and south of the Windsor Airport in the City of Windsor (the Site) as shown on Figure 1. This component of the study includes the completion of a hydrogeological assessment with the following objectives:

- Document the existing geological and hydrogeological conditions of the Site, specifically the hydraulic relationship between the groundwater system and the Little River and its associated tributaries.
- Complete a preliminary water balance for the Site based on existing and post-development conditions.

- Identify the potential impacts to the hydrogeological system as a result of future land use changes, particularly to groundwater recharge and baseflow contributions to the Little River and its associated tributaries.
- Identify mitigating measures, as necessary.

4.2.2 Physiography and Site Drainage

The Site is located within the physiographic region defined by Chapman and Putnam (1984) as the St. Clair Clay Plains. Specifically, the Site lies within the Essex Clay Plain, an area that was once submerged by glacial Lakes Whittlesey and Warren. Consequently, the deposition of fine-textured glaciolacustrine materials by these glacial lakes has resulted in a landscape that is characterized by relatively flat topography, which is demonstrated by the local topographic contours. In the Site area, topography dips gently from approximately 192.5 m above mean sea level (AMSL) in the southwest to approximately 182 m AMSL in the northeast. Regionally, this glacial lake plain slopes northward and westward from a topographic high of 210 m AMSL near Leamington to a low of 175 m AMSL near Lake St. Clair, with the surface topographic highs corresponding to underlying bedrock highs.

Surface drainage of the plain is primarily northward towards Lake St. Clair, although the low relief of the region has resulted in the formation of numerous undrained areas where peat and muck deposits have accumulated. In agricultural areas of the region, drainage has been enhanced by tile drains and drainage ditches, which have been historically used to establish soil moisture conditions suitable for crop growth and tillage.

Locally, the most significant natural drainage feature is the Little River and its tributaries. The bulk of the Site is situated in the Little River watershed, where many of the drainage features appear to have been constructed for agricultural purposes along concession lines or aligned with crop parcels.

4.2.3 Geology and Hydrostratigraphy

Geological conditions throughout the Site were determined based on a review of available geological mapping (OGS, 2003; Hudec, 1998), the Essex/Chatham-Kent Groundwater Study (Dillon and Golder, 2004), and Ministry of the Environment, Conservation and Parks (MECP) Water Well Records (Appendix G). Figure 7 presents the surficial geology of the Site area and surrounding region as mapped by OGS (2003). Figure 7 indicates that surficial soils across the Site consist predominantly of massive to well laminated glaciolacustrine deposits of silt and clay, which were deposited when the region was submerged by glacial Lakes Whittlesey and Warren. These glaciolacustrine deposits are underlain by the Tavistock Till, which is clayey silt till containing carbonate and shale fragments derived from the underlying bedrock. The Tavistock Till is shown to occur at ground surface within the central and northeastern sections of the Site

(Figure 7). Morris (1994) has reported that the glaciolacustrine deposits of silt and clay and glacial till are typically weathered, desiccated, and characterized by fractures at depths ranging from 2 m to 4 m below ground surface. Underlying this upper weathered layer, the silt and clay deposits are unweathered and contain no visible fractures. Overburden thickness in the Windsor area is generally 20 m to 50 m (Dillon and Golder, 2004).

Discontinuous sand and gravel lenses of varying thickness are encountered at various depths throughout the region, with these soils being associated with morainic deposits (Morris, 1994). A fairly continuous layer of coarse-grained material occurs beneath the Tavistock Till at the bedrock contact. Morris (1994) identified this coarse-grained deposit to be the Catfish Creek Till, which varies from less than one to several metres thick throughout the region. Dillon and Golder (2004) indicate that this formation, described as the Contact Aquifer, overlies bedrock in the Essex region.

Bedrock beneath Essex Clay Plain consists of an evaporate-carbonate sequence that includes the Silurian Salina Formation, the Devonian Bass Islands dolomite, the Detroit River Group, the Dundee Formation, and the Hamilton Group shale. In the Windsor area, only the latter three units occur at the bedrock surface. The bedrock topography throughout the region is relatively flat, with the exception of a significant depression that occurs in the vicinity of the Windsor airport. According to bedrock mapping from Dillon and Golder (2004), bedrock underlying the Site area transitions from the Hamilton Group to the Dundee Formation. The Hamilton Group is described as interbedded shales and calcareous deposits while the Dundee formation is described as a massively bedded brown to light grey fossiliferous limestone / dolostone that may range from 35 m to 45 m thick.

Figure 8 shows the locations of four geologic cross-sections that were used to interpret local hydrostratigraphic conditions beneath the Site, which are presented as Figures 9 through 12. These cross-sections were constructed based on well logs published in MECP Water Well Records (Appendix G). As demonstrated on each of the cross-sections, the overburden consists predominantly of clay intermixed with sand and gravel, which is interpreted to represent a combination of the Tavistock Till and overlying glaciolacustrine deposits. These clay deposits range from 18 m to 62 m thick, with the greatest thickness being encountered beneath the Site in the vicinity of the airport. Sand and gravel of the Catfish Creek Till typically separates the bedrock surface from the base of the Tavistock Till, with this till unit varying from approximately 1 m thick (Figure 11) to 14 m thick (Figure 9) beneath the Site. The cross-sections also confirm the presence of sporadic lenses of sand and gravel within the clay till unit.

Based on a review of the local geology, the subsurface in the Site area is interpreted to consist of four main hydrostratigraphic units:

Aquitard:	Overburden comprised of massive to well laminated glaciolacustrine deposits of silt and clay and Tavistock Till (clayey silt till). The shallow groundwater table is located within this hydrostratigraphic unit
Intermediate Aquifer:	Sporadic zones of sand and gravel (morainic deposits) interbedded within the aquitard
Lower Aquifer:	A confined aquifer system consisting of sand and gravel deposits (Catfish Creek Till) that directly overlie the bedrock surface
Bedrock Aquifer:	A confined bedrock aquifer system consisting of soft shale of the Hamilton Group, underlain by thick-bedded fossiliferous limestone of the Dundee Formation

This local hydrostratigraphic column is similar to that defined as part of the Essex/Chatham-Kent Groundwater Study (Dillon and Golder, 2004), which delineated water table, overburden, contact, and bedrock aquifer formations that were separated by aquitard sequences. The water table aquifer was described as a regionally insignificant feature, which is reflected in the geology of the local Site area where a water table aquifer has not been observed. Similarly, the overburden aquifer is described by Dillon and Golder (2004) as thin and laterally discontinuous, which is also consistent with the geology observed underlying the Site as shown on the cross sections.

4.2.4 Hydrogeology

Groundwater is sometimes used as a potable water source in Essex County (5 to 10% of the population), with the majority of wells within this region being drilled into the basal sand (Lower Aquifer) and Bedrock Aquifer (Hudec, 1998). Hudec (1998) has postulated that the basal sand deposits and underlying bedrock likely act as a single aquifer system, given that no physical barriers (i.e., aquitards) appear to be present that would limit the movement of groundwater between these two hydrostratigraphic units. Since the Lower and Bedrock Aquifers are overlain by tens of metres of unweathered silt and clay, these aquifer systems are interpreted to be under confined conditions and, consequently, have a limited hydraulic connection to the overlying aquifer units.

As shown in Figure 10, some local water supply wells (e.g., MECP Well 21-04024) are completed into the lenses of sand and gravel interbedded within the Tavistock Till (Intermediate Aquifer). The lenses are discontinuous, possess limited storage capacity, and have a hydraulic conductivity that ranges from 10^{-4} m/s to 10^{-7} m/s (Dillon, 1988). Beneath the Site, these sporadic interbedded zones of sand and gravel are encountered from 11 m to 39 m below ground surface (BGS) and, consequently, are interpreted to be under confined conditions given that these deposits are predominantly overlain by unweathered silt and clay.

The groundwater table is typically encountered near the interface of the weathered and unweathered layers of silt and clay. However, groundwater has been found to be well above this interface in some parts of eastern Windsor. The water table generally mirrors topography and is relatively shallow being typically situated at depths of less than 5 m below ground surface (BGS). The majority of shallow groundwater flow occurs within the weathered layer, which is characterized by a hydraulic conductivity that can range from of 10^{-7} m/s to 10^{-10} m/s (Dillon, 1988). In the underlying unweathered deposits, the mean hydraulic conductivity of the silt and clay is reported to be 10^{-10} m/s (Dillon, 1998). As shown on Figures 9 to 12 the potentiometric surface of the lower/bedrock aquifer generally ranges from 175 m AMSL to 185 m AMSL in the vicinity of the Site.

4.2.5 Groundwater Flow

Regional groundwater flow through the overburden of the St. Clair Clay Plain is generally to the north from a groundwater high located within the southern part of Essex County (Crnokrak, 1991). However, groundwater elevations published in the MECP Water Well Records (Appendix G) for wells completed into the Lower and Bedrock Aquifers beneath the Site suggest that flow through these aquifer systems is west to southwest towards the Detroit River.

Shallow groundwater flow across the Site is expected to occur predominantly within the upper weathered silt and clay layer, which extends to depths ranging from 2 m to 4 m BGS. In the underlying unweathered silt and clay, research has shown that groundwater moves through these deposits by molecular diffusion rather than by Darcian flow (Chiasson, 1992; Crnokrak, 1991; Desaulniers et al., 1981). Due to the absence of wells completed into the shallow overburden throughout the Site, groundwater elevations could not be obtained from MECP Water Well Records to determine the direction of flow within this aquifer system. However, groundwater flow through the shallow overburden is expected to follow the Site topography, which predominantly slopes to the north and east across the Site. A component of this shallow overburden flow is likely directed to the Little River and its associated tributaries.

Tile drains have been used extensively in clay areas of the region to permit agricultural development. The tiles direct infiltrated water to nearby surface waters, thereby limiting the amount of water that would otherwise undergo evapotranspiration or recharge groundwater systems. Quantifying flow diversion by tile drains is beyond the scope of this assessment.

4.2.6 Water Balance

Potential groundwater recharge at the Site under existing and proposed post-development conditions has been estimated through the completion of a monthly water balance based on the Thornthwaite model. The Thornthwaite model is essentially an accounting procedure that analyzes the allocation of water among various components of the hydrologic system. Monthly values of precipitation (rainfall plus snowmelt) and potential evapotranspiration rates are input to the model to estimate actual rates of evapotranspiration and the surplus water that would be available for runoff and groundwater infiltration. Groundwater infiltration refers to an area where surface water (e.g., precipitation) enters into the ground, whereas recharge represents the portion of that infiltrating water that moves downward through the unsaturated zone into the water table.

Existing topography and land cover were used to estimate an infiltration factor based on the approach presented in the MECP Stormwater Management Planning and Design (SWMPD) Manual (2003). Soil moisture capacities (also referred to as water holding capacity) were also obtained from the MECP SWMPD Manual (2003) for soil types that were adopted based on the soils mapping.

Precipitation and temperature normals from 1981-2010 were obtained from the Environment Canada website for the Windsor (Airport) Climate Station (WACS) (Appendix G). These data were used to determine the saturation vapour pressure (e_{sat}) and monthly potential evapotranspiration (PET) using the following formulae (Dingman, 1994):

e_{sat} = 6.11exp(17.3T/(T+23.7.3)),

where T is temperature in degrees Celsius and e_{sat} is given in mb; and

PET=0.409(e_{sat}),

where PET is given in cm.

The following assumptions were made as part of the water balance:

- It was assumed that no runoff, infiltration, or evapotranspiration occurred in months where the average daily temperature was below 0°C, which is generally the case for the months of December through March; however, the Windsor temperature normals indicate that February is the last month with average daily temperature was below 0°C.
- Precipitation during freezing months (i.e., December through February) was assumed to accumulate and result in additional precipitation in the first warm (average temperature greater than 0°C) month (i.e., March).

- The water balance assumes that the soil moisture capacity is at its maximum (saturated conditions) in April.
- The soil moisture capacity for each sub-watershed was assumed to be reasonably represented by using a weighting scheme based on the area of each unique soil type within the Site.
- The infiltration factor used to determine runoff for each sub-watershed was assumed to be reasonably represented by using a weighting approach based on the area of each unique land area (as determined by topography, vegetation, and soil) within the Site.

To determine the actual soil moisture content (S_m) at the end of each month, the following approach was used (Dingman, 1994):

When precipitation was greater than PET,

$S_m = \min\{[(Precip_m - PET_m) + S_{m-1}], S_{max}\}$

When precipitation was less than PET

$S_m = S_{m-1} – (Precip_m - PET_m)$

The actual evapotranspiration (ET) was in turn calculated as follows:

$ET_m = PET_m$,

when Precip > PET, or

$ET_m = Precip_m + S_{m-1} - S_m$,

otherwise.

It was assumed that runoff was generated when precipitation exceeded the PET in each month and calculated using the weighted infiltration factor. The difference between the actual ET and runoff was assumed to recharge the groundwater system.

4.2.7 Existing Groundwater Recharge Conditions

Figure 7 presents the soils and Figure 13 presents the existing land uses that provide the basis for determining the annual allocations of precipitation to runoff, evapotranspiration, and recharge.

The results of the existing water balance assessment are presented in Appendix G, which shows the total annual evapotranspiration, groundwater recharge, and runoff projected for the Site. The calculated volume of groundwater recharge across the Site is 5,696,612 m^3/year, which is equivalent to a recharge rate of 181 L/s or 128 mm/yr. This value falls within the upper range of groundwater recharge rates for clayey silt as published by the MECP Hydrogeological Technical Information Requirements (1995), which is not unexpected given the prevalence of clay soils covering the Site (Figure 7).

4.2.8 Little River Flow

On December 14, 2004, March 24, 2005, and July 14, 2011, a series of spot flow measurements were obtained from the Little River and its associated tributaries for the purpose of determining the role that local baseflow has in sustaining flows within these watercourses. Baseflow represents the portion of groundwater recharge that enters into a watercourse through the subsurface (as groundwater discharge), which augments river flow between precipitation/runoff events. The existing tile drain network captures some of the infiltrated water outletting it directory to the surface drain network and prevents it from becoming baseflow, but the exact amount of tile drainage is difficult to quantify.

The flow at each monitoring location was calculated using the velocity-area method (Dingman, 1994). Measurements were obtained by placing a measuring tape across the width of the watercourse and dividing the section into several equally spaced points. At each point, the depth of the watercourse was measured, and the flow velocity recorded using a portable water flow meter (Marsh-McBirney Inc. Model 201). Total flow through the section was then calculated using the U.S. Geological Survey approved mid-section method as discussed in Hipolito and Loureiro (1988) and Dingman (1994). The calculated flow measurements for each monitoring location are shown on Figure 8.

On December 7, 2004, a total rainfall of approximately 26 mm was recorded at the WACS. From December 7 to 14, 2004, an additional 15 mm of rainfall occurred across the Site. In the week prior to the baseflow survey performed on March 24, 2005, a total rainfall of 12.4 mm was recorded at the WACS, with 68% of this rainfall occurring on March 23, 2005. Consequently, flow measurements obtained on the days of the surveys likely reflect a combination of surface runoff and baseflow contributions to the Little River network.

During the first flow survey conducted on December 14, 2004, flows within the 6th Concession Road Drain flowing parallel to Baseline Road increased from 197 L/s at SW4 to 241 L/s at SW8 (Figure 8), representing a flow increase of 44 L/s (increase of 0.23 L/s per metre). Flow into the tributary from the upstream watercourse in which SW6 is located was 5 L/s, accounting for only 10% of the flow increase observed between SW4 and SW8. Consequently, the remaining flow increase of 39 L/s between these two monitoring locations is likely reflective of baseflow and/or tile drain contributions from the surrounding landscape.

From SW3 to SW9, flows were observed to decrease from 36 L/s to 18 L/s, with this decline in flow suggesting that this reach of watercourse is losing surface water (groundwater recharge condition) to the shallow groundwater system. At downstream SW10, flow increased from 18 L/s (SW9) to 299 L/s, with approximately 80% of this increase being attributed to inflows from the Baseline Road tributary (SW8). Between SW10 and downstream SW12, flow within the Little River was observed to decline by 19 L/s (decrease of 0.07 L/s per metre), suggesting that recharge conditions are present along this reach of the watercourse.

Between SW12 and downstream SW15, flow within the Little River increased from 280 L/s to 352 L/s, representing an increase of 72 L/s (increase of 1.3 L/s per metre). Two tributaries discharging into this reach of the Little River had measured flows of 1 L/s (SW11) and 9 L/s (SW13), accounting for 14% of the total flow increase observed between SW12 and SW15. Consequently, the remaining 62 L/s of the observed 72 L/s increase is likely attributable to groundwater sources, although this large increase in flow over a short distance suggests that tile drain discharge may be the predominant contributor to this increase rather than baseflow.

Flows measured downstream of SW15 during the December survey were unusually low and, as a result, Stantec revisited the Site on March 24, 2005, to complete a subsequent round of flow measurements in this area. From SW15 to SW17, flow in the Little River declined from 290 L/s to 276 L/s, even though a tributary in which SW16 is located was discharging water into this reach at a rate of 19 L/s. This decline indicates that this reach of the Little River loses surface water to the shallow groundwater system. In contrast, flow in the Little River between SW17 and SW19 increased from 276 L/s to 324 L/s, with approximately 60% of this increase being attributed to inflows from the tributary draining the lands containing the airport (SW18).

Overall, the greatest flow observed within the Little River network (352 L/s) was approximately twice the annual groundwater recharge rate of 181 L/s calculated for the Site under existing conditions. A percentage of this surplus flow is likely attributed to baseflow being captured and short-circuited to the Little River by the tile drain network, with the remaining surplus being attributable to surface runoff from the rainfall events that occurred prior to the surveys.

On July 14, 2011, an additional baseflow measurement (20 L/s) was made downstream of the intersection of Baseline Road and 9th Concession Road (SW8). Antecedent precipitation at the Windsor International Airport included 11 mm on July 11, 2011, and 43 mm on July 2, 2011. These baseflow measurements are significantly lower than the measurements in 2004 and 2005. These measurements are also approximately half of what would be expected based on the water balance analysis. It is likely that baseflows are being short-circuited by the extensive tile drain system resulting in higher baseflows following rainfall events and lower baseflows between rainfall events.

Overall, the results of the spot flow surveys are inconclusive and cannot be used, with confidence, to confirm the calculated groundwater recharge rate of 181 L/s estimated for the Site due to the confounding influence of the tile drains.

4.2.9 Potential Mitigation Measures

A list of potential mitigation measures for improving groundwater recharge under post-development conditions are presented below. A brief list of advantages and disadvantages for each alternative are also provided. These recharge measures are generalized alternatives and, as such, the feasibility of implementing these measures at various development sites requires a more detailed site-specific assessment complete with geotechnical and hydrogeological investigations.

Perforated Storm Laterals: Subsurface pipes conveying runoff and drainage from individual lot rooftops and foundation drains, respectively, to the storm sewer could be perforated.

Advantages:

- Conveys “clean” runoff
- No additional infrastructure required other than perforating pipes to sewer
- Infiltration of captured runoff distributed evenly across development area rather than at one central location

Disadvantages:

- Limited storage in perforated pipes and, as a result, limited infiltration capacity available on an individual lot basis
- Not overly effective when laterals are completed into low permeability deposits such as silt and clay
- Must ensure infiltrated water does not re-circulate back to the house foundation drains (i.e., cutoff collars required to ensure any infiltrated water does not follow pipe bedding materials as a preferential pathway instead of recharging the groundwater system)

Perforated Pond Outlets: Pipes convey discharge from stormwater management ponds, which receive discharge from storm sewers, to an outlet that discharges overland or directly into the watercourse. The outlet pipes could be perforated to allow for infiltration of treated storm runoff.

Advantages:

- Conveys “clean” runoff
- No additional infrastructure required other than perforating pipes to outlet
- Limited maintenance of pipes required

Disadvantages:

- Not overly effective when perforated pipes are completed into low permeability deposits such as silt and clay
- Infiltration occurs at one central location rather than evenly across the development area
- Limited storage in perforated pipes and, as a result, limited infiltration capacity available along length of outlet pipe
- Cutoff collars required to ensure any infiltrated water does not follow pipe bedding materials as a preferential pathway instead of recharging the groundwater system

Soakaway Pits / Infiltration Trench: Runoff captured from rooftop areas is directed into individual trenches (soakaway pits) constructed into unsaturated deposits within each development parcel or a large trench located within a central area that accepts runoff from several development parcels.

Advantages:

- Conveys “clean” runoff
- Best storage availability of all underground options provided and, as a result, increased potential to infiltrate large volumes of stormwater runoff from area
- Disadvantages:
- Not overly effective when pits / trenches completed in low permeability deposits such as silt and clay
- Infiltration can occur at one central location rather than evenly across development area
- Additional infrastructure and land area required to construct one large central trench

Longer Drawdown times from SWM Facilities: Runoff captured from developed areas will be stored in SWM Facilities and released over an extended period of time to mimic baseflow. Typically, the last 0.1 m of water (above the permanent pool) in the SWM facility would be drawn down over a 48 to 72-hour time period.

Advantages:

- Releases “clean” runoff
- No additional infrastructure required other than SWM Facility outlet modifications
- Limited additional maintenance required in SWM Facilities
- Largest storage availability of all options provided and, as a result, increased potential to release large volumes of stormwater runoff

Disadvantages:

- Baseflow temperatures are higher than groundwater flows

- Limited extended drawdown time of approximately 1 week. Rainfall periods with inter-event larger than 1 week this will result in markedly reduced baseflows
- Extended drawdown of last 0.1 m will affect vegetation growth in this area

4.2.10 Hydrogeology Summary

Based on the results of this hydrogeologic assessment, the following conclusions are presented:

- The subsurface of the Site consists predominantly of massive to well laminated glaciolacustrine deposits of silt and clay and Tavistock Till (clayey silt till), which range from 18 m to 62 m thick and are characterized by low hydraulic conductivity (10^{-8} m/s to 10^{-10} m/s).

- Most private wells located within the Site are completed into sand and gravel deposits directly overlying the bedrock surface (Lower Aquifer) or the Bedrock Aquifer. These aquifers are overlain by tens of metres of unweathered silt and clay and have a limited hydraulic connection to the upper overburden.

- Shallow groundwater flow across the Site is expected to occur predominantly within the upper weathered silt and clay layer, which extends to depths ranging from 2 m to 4 m below ground surface. The overall direction of flow in the shallow overburden is anticipated to be to the north and west, with a component of this flow being directed to the Little River and its associated tributaries.

- Under existing conditions, the total volume of groundwater recharge that occurs across the Site annually is calculated to be 5,696,612 m^3, which is equivalent to a groundwater recharge rate of 181 L/s or 128 mm/yr. However, spot flow surveys conducted by Stantec did not yield results that could be used to confirm this calculated groundwater recharge rate.

- Assuming that all groundwater recharge that occurs across the Site annually eventually discharges to Little River and its associated tributaries, a subsequent reduction in recharge potential throughout the Site resulting from future development could potentially lead to a comparable reduction in the baseflow contribution to these watercourses.

- The existing site has numerous sections of tile drainage. This serves to lower the groundwater table and increases baseflows to Little River versus a similar area with no tile drainage.

4.3 Hydrology

4.3.1 Introduction

The purpose of the hydrologic analysis is to provide the basis for the assessment of flow conditions within the Little River area and the response to rainfall events under existing conditions. This information can then be used for the assessment of flood potential and flow variations over time. Existing conditions have been modelled for this study in order to provide an assessment of the impact of development on the hydrologic functions within the Little River tributary area.

Throughout most of the watershed, dredged ditches and tile drains were installed in order to improve drainage and provide satisfactory conditions for crop growth and tillage (Chapman and Putnam, 1984). Thus, the natural drainage patterns of the watersheds have been realigned by artificial means, primarily for agricultural purposes. The historic alignment of Upper Little River can be seen in air photos upstream of Baseline Road and is located to the west of the current Little River Drain. It appears that surface ditching was run parallel to the road network and may have diverted water away from the upper reaches of Upper Little River.

The software program selected for hydrologic modelling of the study area was PC-SWMM, Version 7.0.2330. PC-SWMM is a dynamic rainfall-runoff simulation model capable of providing all of the hydrologic and hydraulic analysis required for this project including the calculation of runoff from catchments and the routing of flows through stormwater management facilities and channels. This model is widely used to calculate water surface elevations and flow velocities throughout a watercourse based on channel cross section details and flow rates.

An existing HEC-2 model was obtained from ERCA covering approximately 6000 m of Little River from Forest Glade Road (approximately 500 m downstream of the EC Row Expressway) to 1000 m upstream of Baseline Road. This model was imported into PC-SWMM and used as the base of the updated model. Updates to the hydraulic model are discussed in Section 4.4.

4.3.2 Hydrologic Model Commands and Parameters

The SUBCATCHMENT command within PC-SWMM was used to simulate runoff conditions from both developed and undeveloped catchments within the study area. Runoff is based on parameters such as imperviousness, slope, roughness, and shape.

The CONDUIT command within PC-SWMM was used to model the flow attenuation due to stream flow routing using the dynamic wave routing method. CONDUITS are joined using JUNCTIONS.

The STORAGE UNIT command within PC-SWMM was used to model the storage of water in SWM Facilities under proposed conditions. Volumes were calculated using a stage-area method with outflows calculated using a series of ORIFICES and WEIRS.

Soils are identified in the *Little River Flood Line Mapping Report* (MacLaren Engineers, 1985) and the *Turkey Creek and Little River Subwatershed Planning Study* (Dillon Consulting Ltd., 1998) as a clay and clay loam over clay with poor natural drainage, which compares well to soils identified during the hydrogeologic assessment completed as part of this project. Soils area assumed to have a SCS CN (Soil Conservation Service Curve Number) class of C. Crop and other improved lands were assigned a CN value of 82 (from MTO Drainage Management Manual, 1997, Design Chart 1.09).

An average watershed slope of 0.15 % was assumed in the SUBCTCHMENT command, as suggested by the *Turkey Creek and Little River Subwatershed Planning Study* (Dillon consulting Ltd, 1998) and confirmed by topographic mapping. These values have been used to the greatest extent possible for this study, however where deviations occur, notes have been provided.

Parameter values used within the PC-SWMM commands discussed above are provided in Appendix H.

4.3.2.1 Precipitation

The 6-hour and 24-hour Chicago Storm precipitation distributions were evaluated for this study. The previously approved The *Stormwater Management Report – Twin Oaks Business Park* (LaFontaine, Cowie, Buratto & Associates Ltd, 1997) and the *Turkey Creek and Little River Subwatershed Study* (Dillon Consulting, Ltd, 1998) used the 6-hour distribution while the *Manning Road Secondary Plan Area Functional Servicing Report* (Dillon, 2015) used the 24-hour distribution. The 24-hour Chicago distribution (refer to Table 6) (5-minute time steps) was selected as the design storm for this study as the peak flows and runoff volumes were higher.

Table 6: Rainfall Events –City of Windsor Airport

Duration	Return Period Rainfall Amounts (mm)		
	2-Year	5-Year	100-Year
5 minutes	9.4	11.9	18.9
10 minutes	13.7	17.2	26.8
15 minutes	17.0	22.0	35.6
30 minutes	22.2	29.4	49.0
1 hour	27.5	36.9	62.5
2 hours	32.8	42.9	70.6
6 hours	40.5	52.8	86.2
12 hours	46.2	60.1	98.0
24 hours	53.4	68.0	107.9
Total Precipitation – 24 hour Chicago Storm	52.9	67.1	108.2

4.3.3 Existing Land Use

Under existing conditions, much of the study area is in a rural condition, consisting primarily of farmland and pasture; however, development has progressed within the study area to include:

- Commercial and light industrial lands west of 7th Concession Road at the west limits of the study area.
- Commercial and light industrial lands south of Highway 401 and west of the 8th Concession Road.
- Low density residential lands along and near Baseline Road between the 7th and 9th Concession Roads.
- Commercial and light industrial lands immediately south of the E. C. Row. Expressway from Little River to the west limits of the study area.
- Medium density residential area east of Banwell Road at the northeast limits of the study area.

4.3.4 Existing Drainage Conditions and Catchment Delineation

The study area is approximately 4,490 ha and lies within the Little River Watershed, as illustrated on Drawing 1. Within the study area, approximately half of Little River and virtually all of its tributaries (municipal drains) are channelized. Naturalized reaches of Little River exist downstream of Baseline Road where the 6th Concession Drain joins. Downstream of the study area (north of the E.C. Row Expressway) Little River remains in a natural state up to the Via Rail Canada Inc. property which is located approximately 350 m north of Tecumseh Road East. From the Via Rail Canada Inc. property to Riverside Drive East, the Little River has been channelized with flood protection dykes on each side of the waterway that were designed to contain the 1:100-year flows.

The Little River watershed was divided into catchments using several criteria, including:

- Drainage and overland flow directions were largely determined based on Municipal Drainage Reports. While some of these boundaries have likely changed since the reports were written, in the absence of more current information the Municipal Drainage Reports were used. Ontario Base Mapping, using 2.5 m elevation contours, was used where no other information was available

- Delineation at the confluence of major channels and drains. This results in many small catchments south of the E.C. Row Expressway where several large municipal drains join Little River over a short distance. Flows calculated by the hydrologic model at these confluences are used within the hydraulic model (see Section 4.4) to determine water elevations over each river section

- Delineation at major flow restrictions that cannot be easily improved. These flows will be used as a proposed development target flow rate to ensure that flooding conditions do not worsen. Future development conditions must either match these flow rates, enlarge the restriction, or prove that the restriction has the capacity to handle larger flows. These locations are generally either culverts or bridges under roads and railway lines. Culverts under smaller roads were not examined because they are easier to enlarge. The flow restrictions or structures are shown on Figure 14 and include:

    - Forest Glade Drive
    - E.C. Row Expressway
    - Twin Oaks Drive
    - Railway
    - Lauzon Road
    - Lauzon Parkway
    - Country Road 42
    - Baseline Road
    - Highway 401

- Delineation such that catchments have an area less than 300 ha and a length less than 2 km. Catchments longer or larger than this limit were subdivided to incorporate channel routing.
- Catchment boundaries were further delineated based on topographic features and land characteristics in addition to points of interest along Little River

In developing the hydrologic model for existing conditions, the study area was divided into 51 catchments, as illustrated on Drawing 2. The limits of the study area were determined based on Municipal Drainage Reports and discussions with the Town of Tecumseh, the City of Windsor, and the Essex Region Conservation Authority. Table 7 summarizes the existing conditions catchment areas.

Table 7: Existing Conditions Catchment Description

Catchment ID	Description	Area (ha)
Draining to 6th Conc. Drain upstream of Junction with 7th Conc. Drain		
1000	6th Concession Drain west of 7th Conc. Rd. between Chesapeake & Ohio Railway and Conrail Railway	96.4
1002	6th Conc. Rd Drain west of 7th Conc. Rd. between Conrail Railway and Highway 401	158.4
1005	7th Street Drain along 7th Conc. Rd. between Chesapeake & Ohio Railway and Conrail Railway	51.6
1007	7th St. Drain along 7th Conc. Rd. between Conrail Railway and Hwy 401	21.0
1010	7th Street Drain along Walker Road west of Highway 401	38.4
Draining to 6th Conc. Drain before junction with 9th Conc. Drain		
1015	6th Conc. Rd. Drain near 7th Conc. Drain and Baseline Rd.	14.3
1020	7th Conc. Rd. Drain east of 7th Conc. Rd. between Baseline Rd. and Hwy 401	92.9
1025	7th Conc. Rd. Drain east of 7th Conc. Rd. between Hwy. 401 and Conrail Railway	13.9
1027	7th Conc. Rd. Drain east of 7th Conc. Rd. between Conrail Railway and North Talbot Rd.	56.5
1030	6th Conc. Rd. Drain along Baseline Rd. between 7th and 8th Conc. Roads	33.4
1035	8th Conc. Rd. Drain west of 8th Conc. Rd. between Baseline Rd. and Hwy. 401	105.2
1040	8th Conc. Rd. Drain west of 8th Conc. Rd. between Hwy 401 and County Rd. 46	27.4
1045	6th Conc. Rd. Drain along Baseline Rd. east of 8th Conc. Rd.	26.7

Table 7: Existing Conditions Catchment Description

Catchment ID	Description	Area (ha)
1050	Hayes Drain east of 8th Conc. Rd. between Baseline Rd. and Hwy. 401	122.6
Draining to 9th Conc. Drain up to 6th Conc. Drain		
1055	6th Conc. Rd. Drain along Baseline Rd. west of 9th Conc. Rd.	32.0
1060	9th Conc. Rd. Drain west of 9th Conc. Rd. between Baseline Rd. and Hwy. 401	115.3
1065	Hurley Drain west of 9th Conc. Rd. and north of Hwy. 401	29.0
1070	Hurley Drain between 8th and 9th Conc. and Hwy 401 and Conrail Railway	88.0
1072	Hurley Drain near 8th Conc. Rd between Conrail Railway and North Talbot Rd.	53.6
1075	9th Conc. Rd. Drain along 9th Conc. Rd. between Hwy. 401 and Conrail Railway	38.6
1080	Downing and Talbot McCarthy Drains east of Chesapeake & Ohio Railway and south of Conrail Railway	279.4
1085	Beehan Drain west of Sexton Sideroad and south of Conrail Railway	133.0
Draining to Little River up to 6th Conc. Drain		
1090	East of Little River along Baseline Rd.	24.8
1095	Little River Drain from Baseline Rd. to Hwy. 401	161.2
1100	Little River Drain immediately north of Hwy. 401	53.8
1105	Little River Drain south of Hwy. 401	138.2
Little River from 6th Conc. Drain to County Road 42		
1110	Along Little River from County Road 42 to Baseline Rd.	59.5
1115	North Townline Road Drain immediately south of County Road 42 between 7th Conc. Rd. and Little River	113.7
Little River from County Road 42 to Lauzon Rd.		
1120	Rivard Drain, north of County Road 42.	142.0
1125	Watson Drain along Tenth Conc. Rd. from Little River to Baseline Rd.	87.3
1130	Watson Drain along Tenth Conc. Rd. from Baseline Rd. to Hwy. 401	226.5
1133	Watson Drain along Tenth Conc. Rd. east of Hwy. 401	35.3
1135	Along Little River south of Lauzon Rd.	24.4
Little River from Lauzon Rd. to CP Rail Crossing		
1140	Little 10th Conc. Drain along Lauzon Rd. from Little River to County Road 42	25.8

Table 7: Existing Conditions Catchment Description

Catchment ID	Description	Area (ha)
1145	Quick Drain west of 11th Concession Rd. between County Road 42 and Baseline Rd.	161.9
1150	Along Little River immediately north of Lauzon Rd.	13.2
1155	Soulliere Drain east of Little River between CP Railway and County Road 42	110.5
1160	Along Little River between CP Railway and Lauzon Rd.	7.8
1165	Desjardins Drain east of Little River between CP Railway and County Road 42	188.4
1170	Along Little River immediately south of CP Railway	4.6
Little River from CP Rail Crossing to E.C. Row Expressway		
1175	Lachance Drain east of Little River north of CP Railway	145.0
1180	Along Little River north of CP Railway	43.8
1185	McGill Drain west of Little River	131.4
1190	McGill Drain, west of Little River, near Windsor Airport	107.8
1195	Lappan Drain, west of Little River, near Windsor Airport	147.8
1200	Windsor Airport	198.5
1205	Along Little River south of E.C. Row Expressway	59.6
1210	Gouin Drain, east of Little River, south of E.C. Row Expressway	161.8
1215	Russette Drain, west of Little River, near Windsor Airport	127.9
1220	Russette Drain, west of Little River, south of E.C. Row Expressway	117.7
1225	Branch of Russette Drain, west of Little River, south of E.C. Row Expressway	40.6
Total Drainage Area		4488

The study area is approximately 4,490 ha in size, 6 km east to west and 8 km north to south. Existing drainage conditions within the study area are illustrated on Drawing 2 and summarized as follows:

- Areas north of Highway 401, south of Baseline Road and west of Little River including the 7th Street, Hayes Drain, the 7th, 8th, and 9th Concession Drains (Catchments 1000 to 1065) generally flow north in municipal drains, joining the 6th Concession Drain. The 6th Concession Drain flows east until it intersects Little River.

- Areas south of Highway 401 including the Hurley Relief, 9th Concession, Downing, Talbot McCarthy, Washbrooke Drain, Wellwood Drain, Shuttleworth Drain, and Beehan Drains (Catchments 1070 to 1085) generally flow northeast into the 9th

Concession Drain. The 9th Concession Drain flows into the 6th Concession Drain and the Hurley Relief Drain.

- Areas east of Little River and south of County Road 42 drained by Watson Drain (Catchments 1125 to 1133) generally flow north eventually joining Little River after passing under County Road 42.
- Areas between the E.C. Row Expressway and County Road 42 and west of Little River including the North Townline, Rivard, McGill, Lappan, and Russette Drains (Catchments 1115, 1120, 1185 to 1200, and 1215 to 1225) generally flow east into Little River.
- Areas between the E.C. Row Expressway and County Road 42 and east of Little River including the Little 10th Concession, Quick, Soulliere, Desjardins, Lachance, and Gouin Drains (Catchments 1140, 1145, 1155, 1165, 1175, and 1210) generally flow west or northwest into Little River.
- SWM controls were modelled for industrial development along Little River south of E.C. Row Expressway (Catchments 1180 and 1205). Water quality and water quantity controls are provided at source, along the conveyance network, and in a widened section of Upper Little River from between EC Row and the Canadian Pacific Railway.
- The 9th Concession Drain splits approximately 400 m north of Highway 401. Part of the flow proceeds north within the 9th Concession Drain and the remaining flow proceeds east within the Hurley Relief Drain towards the Little River Drain. The channel width, side slope and longitudinal slope of the 9th Concession Drain were noted in the Municipal Drain Report. Channel dimensions of the Hurley Relief Drain and the channel inverts at the split point were determined from survey data of the channels.
- At the junction of the 6th Concession Drain and the 9th Concession Drain there is another flow split. Under normal flow conditions, all flows from this junction will drain along the 6th Concession Drain to Upper Little River. During higher flow events most flow will continue along the 6th Concession Drain, while some flow will be diverted along the 9th Concession Drain to North Townline Road Drain.

4.3.5 Flow Routing

The municipal drain network and Upper Little River were modelled in PC-SWMM to include the effects of flow routing on peak flows. Routing was completed using the dynamic wave method (solving the Saint Venant equation) and is capable of modelling backwater and surcharge flows.

Current survey data of the Little River, 6th Conc., 9th Conc. and Hurley Relief Drains compare well with the Municipal Drain Reports, some of which are over 50 years old. Where survey data was available this data was used to model channel cross sections and slope. Where survey data was not available channel cross-section dimensions and slopes were derived from Municipal Drain Reports, which were available for all modelled drains.

The *CONDUIT* command was included within the hydrologic model, using the available channel information. The purpose of this command is to simulate flow attenuation within the channel. The model results indicated that the majority of the channels are subject to flow depths that exceed the surveyed data from the Municipal Drain Reports during the 100-year storm event. Floodplain dimensions from the ERCA HEC-2 model were used to define the floodplain along Upper Little River from the EC Row Expressway to Baseline Road. Along Upper Little River between the E.C. Row Expressway and the Canadian Pacific Railway the floodplain was based on channel improvements undertaken as part of the Twin Oaks Development. In other locations a generic floodplain was added to the channel geometry within the *CONDUIT* command for each drain and to simulate channel overtopping. The floodplain geometry was assumed to slope upwards at a slope of 0.2% (0.2 m elevation over 100 m) from the top of bank based on the surrounding topography.

A Manning's n value (i.e., roughness coefficient) of 0.045 was assumed for the main channel of each drain and Little River, consistent with a channel with some pools, shoals, weeds, and stones. A Manning's n value of 0.10 was assumed for the floodplain, consistent with floodplains covered with a dense brush.

Appendix H provides a model schematic diagram illustrating the linkage between catchment and channel elements under existing conditions. Copies of the model input and output files are also provided in Appendix H.

4.3.6 Hydrologic Model Results

In reviewing the results of the hydrologic modelling, the key points of interest are flows at roadway crossings and at significant locations within the drainage network. The existing flows at each of these points of interest are summarized in Table 8 for the 24-hour Chicago Storm event. Existing peak flow rates for each catchment area are included in Appendix H.

Table 8: Existing Conditions Flows – PC-SWMM

Drainage Area (ha)	Location	Existing Flow (m^3/s)		
		2 Year	5 Year	100 Year
458	9th Concession Drain at Highway 401 (J46)	3.8	5.6	8.9
859	6th Concession Drain before 9th Concession Road (J51)	13.9	16.4	22.3
2,006	Confluence of Little River and 6th Concession Drain (J5090)	25.8	22.6	34.7
2,179	Little River at County Road 42 (J5110)	21.0	26.4	39.8
3,352	Little River at CP Railway (J24)	21.5	29.0	45.4
4,489	Little River at E.C. Row Expressway (J17)	23.3	31.9	50.6

4.3.7 Alternative Flow Estimates

Historical stream flow data was available for the Water Survey of Canada gauge located on the Little River near Windsor (Gauge 02GH011 – 26 years of data). Flows from the gauge were transposed to the E.C. Row Expressway crossing using the following equation (MTO Drainage Management Manual, 1997):

$Q_2=Q_1*(A_2/A_1)^{0.75}$

Where: Q_1 = peak discharge at the flow gauge

Q_2 = peak discharge for Upper Little River at E.C. Row Expressway

A_1 = basin area at the flow gauge

A_2 = basin area for the Upper Little River at E.C. Row Expressway

Flood frequency analysis using the Three Parameter Log Normal (3-PLN) distribution was performed on the transposed stream flow at the E.C. Row Expressway to determine return period flows. The 3-PLN distribution is recommended for Ontario waterways in *Regional Flood Frequency Analysis for Ontario Streams* (Environment Canada, November 1985). Frequency analysis calculations are presented in Appendix H with the results summarized in Table 9 for the flows in Little River at the E.C. Row Expressway. The length of the stream flow record is sufficient to determine the 2 and 5-year flow events with reliability, but a data record of at least 30 years is desirable to determine the 100-year flow event.

The Modified Index Flood Method was also utilized as outlined in the *MTO Drainage Management Manual* (MTO, 1997). Given that a large fraction of the watershed consists of crops similar to a southern Ontario catchment with clay soils, it was deemed appropriate to model the basin as a Southern Ontario Type Basin. Modified Index Flood Method calculations for the Southern Ontario Type Basin are presented in Appendix H and summarized in Table 9 for the flows in Little River at the E.C. Row Expressway.

Table 9: Existing Conditions Flow Summary at E.C. Row Expressway

Description	Existing Flow (m^3/s)		
Model	***2 Year***	***5 Year***	***100 Year***
PC-SWMM 24 Hour	23.3	31.9	50.6
Flood Frequency Analysis	24.7	32.2	41.8
Modified Index Flood Method	19.0	26.9	53.3

Previous work in the *Little River Flood Line Mapping* report by MacLaren Engineering and the *Turkey Creek and Little River Subwatershed Study* by Dillon Consulting also modelled flows in Little River. MacLaren calculated the 100-year flow using several different methods including a 100-year 24-hour SCS Type II distribution using the computer model HYMO and the Regional Flood Index Method (an empirical method based on the drainage area). MacLaren recommended the Regional Flood Index Method as the more accurate flow. Dillon calculated the 100-year flows using a 100-year 6-hour Chicago Storm distribution. The 100-year flows calculated for the current study were found using the 24-hour Chicago Storm. A flow comparison is shown in Table 10 below.

Table 10: Flow Comparison for the 100-Year Event

Author	Dillon	MacLaren		Stantec		
Method	**OTTHYMO 6-hr Chicago**	**HYMO 24-hr SCS**	**Regional Flood Index Method**	**Flood Frequency Analysis**	**Modified Index Flood Method**	**PC-SWMM 24-hr Chicago**
Location						
County Road 42	35.6	12.7	25.6	25.2	30.8	39.8
CP Railway	51.0	N/A	35.7	34.8	42.7	45.4
E.C. Row Expressway	60.5	N/A	44.8	43.3	53.3	50.6

The flows are generally similar between the different models with the MacLaren HYMO model having the lowest flows and the Dillon model having the highest flows. This variance is due to the differences in individual models and the precipitation events. No modelling specifics were available for the Dillon model during the writing of this report. Hence, most comparisons will be made to the MacLaren model.

The MacLaren model used HYMO which calculated flows using the Williams Instantaneous Unit Hydrographs (IUH) developed by Williams and Hann in 1973. This method is recommended for large rural watersheds where observations indicate a long recession limb and was calibrated on large watersheds (1 to 65 km^2) in the southeast USA. This IUH compares well to large watersheds in Ontario. Most documentation for the Williams IUH recommends that the values for the time to peak and the recession constant be obtained by fitting the IUH curve to measured data. Most of the catchments used in this report are small compared to those used during the calibration process for the Williams IUH. Only two catchments are over 2 km^2 while over half are less than 1 km^2. The clay soils and large areas of tile drained agricultural lands will have a short recession limb.

Flows calculated using the Williams IUH appear to be low compared to other data sources for the Windsor area. The MacLaren Report calculates the flow using HYMO for the 100-year storm to be 13 m^3/s but then states that the Regional Flood Index flow of 26 m^3/s is more accurate. The MacLaren Report then goes on to state that the Flow calculated by HYMO is acceptable.

PC-SWMM models runoff uses a deterministic-based runoff method for generating flows including separate equations for evaporation, infiltration, snowmelt, and overland flow.

Along with the differences in hydrograph calculation there were also several changes made to the catchment parameters between the MacLaren and Stantec models. These changes are summarized below:

- Increased urbanization – It is estimated that the majority of urbanization present within the study area has occurred within the last 5 to 15 years. Most of this urbanization has occurred along the boundaries of the site and is concentrated in the southwest and northeast corners. This increased impervious area would cause increased runoff volumes and higher peak flows. Even with SWM controls in place peak flow increases may occur in Little River due to the additive effects of peak flow timing. It is unlikely that the modelled flow increases are solely due to urbanization because the existing clay soils have a low permeability.

- Smaller Subcatchment sizes - the *Little River Flood Line Mapping* used three catchments draining to Little River at County Road 42 totaling 2,051 ha. The current model has 28 catchments totaling 2,179 ha. Smaller catchments with routing, more accurately reflect the highly channelized nature of the study area.

- Increased watershed size - the *Little River Flood Line Mapping* report has a watershed size of approximately 4,093 ha draining to Little River at the E.C. Row Expressway. The drainage area used in this report assumes an area of 4,489 ha, an increase of approximately 10%. This drainage area increase is expected to increase flows by approximately 10%.

- Steeper Slope - the *Little River Flood Line Mapping* report has an average slope of approximately 0.10% with some catchments having a slope as low at 0.04%. An examination of Ontario Base Mapping topography in the watershed confirms the watershed slope of 0.15% used in this report. This is expected to increase peak flows from catchments by approximately 10% during the 2 through 100-year storm events.
- Less Pervious Soil – both the *Little River Flood Line Mapping* report and this report assume a SCS soil Type of C. MacLaren's work assumes a CN value of approximately 78, which is representative of uncultivated land (pasture). Stantec's work assumes a value of 82, representative of a mix of uncultivated and cultivated agricultural lands (crops). Changing the CN from 78 to 82 increases flows by approximately 3%.

4.3.8 Municipal Drain Capacity

Municipal drains are typically sized to drain lands following rainfall events and do not have capacity for peak flows from intense rainfall events. Typical methods outlined in the Drainage Guidelines of Ontario (Ministry of Agriculture, Food, and Rural Affairs, 2007) were assumed to determine the existing drain capacity (50 mm or 2 inches of runoff evenly spread over 24 hours - approximately equivalent to the 2-year – 24-hour rainfall event). Peak flows were calculated using the formula of peak flow = 0.116 * area (ha) * runoff (50 mm) / 1000 as taken from the *Drainage Guidelines of Ontario* (OMAFRA, 2007). Peak flows calculated using the municipal drain method are less than those generated from the 24-hour Chicago storm as shown in Table 11.

Table 11: Peak Flows from Individual Catchments

Catchment	Area (ha)	24-hour Chicago Flow from PC-SWMM			Municipal Drain Capacity (m^3/s)
		2-year (m^3/s)	5-year (m^3/s)	100-year (m^3/s)	
1000	96.4	5.00	7.24	14.22	0.559
1002	158.4	6.23	8.95	17.76	0.919
1005	51.6	4.41	6.32	12.26	0.299
1007	21.0	1.09	1.57	3.09	0.122
1010	38.4	2.47	3.52	6.77	0.223
1015	14.3	1.36	1.89	3.46	0.083
1020	92.9	1.26	1.74	3.29	0.539
1025	13.9	0.63	0.88	1.63	0.081
1027	56.5	3.97	5.68	11.32	0.328
1030	33.4	3.14	4.48	8.60	0.194
1035	105.2	1.44	2.00	3.80	0.610

Table 11: Peak Flows from Individual Catchments

Catchment	Area (ha)	24-hour Chicago Flow from PC-SWMM			Municipal Drain Capacity (m^3/s)
		2-year (m^3/s)	5-year (m^3/s)	100-year (m^3/s)	
1040	27.4	2.05	2.98	5.94	0.159
1045	26.7	0.39	0.55	1.07	0.155
1050	122.6	2.73	3.76	6.89	0.711
1055	32.0	0.45	0.62	1.19	0.185
1060	115.3	1.50	2.07	3.88	0.669
1065	29.0	1.19	1.65	3.02	0.168
1070	88.0	1.03	1.41	2.60	0.510
1072	53.6	3.41	4.92	9.55	0.311
1075	38.6	0.60	0.86	1.71	0.224
1080	279.4	5.14	7.17	13.28	1.621
1085	135.0	1.66	2.29	4.23	0.783
1090	24.8	0.37	0.52	1.02	0.144
1095	161.2	1.96	2.70	4.97	0.935
1100	53.8	0.66	0.91	1.69	0.312
1105	138.2	4.21	6.01	11.65	0.802
1110	59.5	0.81	1.13	2.14	0.345
1115	113.7	2.92	4.03	7.49	0.660
1120	142.0	1.96	2.72	5.18	0.824
1125	87.3	1.20	1.66	3.16	0.506
1130	226.5	2.69	3.71	6.82	1.314
1133	35.3	0.55	0.78	1.56	0.205
1135	24.4	0.35	0.49	0.94	0.142
1140	25.8	1.43	1.97	3.60	0.150
1145	161.9	3.02	4.21	7.78	0.939
1150	13.2	0.61	0.85	1.57	0.077
1155	110.5	1.43	1.98	3.69	0.641
1160	7.8	0.12	0.17	0.33	0.045
1165	188.4	2.40	3.31	6.16	1.093
1170	4.7	0.08	0.12	0.25	0.027
1175	145.0	3.11	4.30	7.87	0.841
1180	43.8	1.77	2.60	5.28	0.254
1185	131.5	4.11	5.87	11.34	0.762
1190	107.8	1.51	2.10	4.01	0.625
1195	147.8	1.98	2.74	5.16	0.857
1200	198.5	6.95	10.06	19.79	1.151
1205	59.6	2.38	3.50	7.11	0.346

Table 11: Peak Flows from Individual Catchments

Catchment	Area (ha)	24-hour Chicago Flow from PC-SWMM			Municipal Drain Capacity (m^3/s)
		2-year (m^3/s)	5-year (m^3/s)	100-year (m^3/s)	
1210	161.8	5.08	7.16	13.47	0.939
1215	127.9	4.46	6.24	11.60	0.742
1220	117.7	4.74	6.96	14.14	0.683
1225	40.5	4.89	6.85	12.71	0.235

4.3.9 Hydrology Summary

Based on the information provided, the following is a summary of findings:

- The current modelled flows are generally similar to Flood Frequency Analysis of gauged flows and Regional Flood Index methods for the area. The PC-SWMM model flows generated using the 24-hour Chicago storm are appropriate for use in this study
- The existing 100-yr peak flow at the E.C. Row Expressway is approximately 51 m^3/s

4.4 Hydraulics

4.4.1 Introduction

Floodplain hydraulic analyses are used to determine the flood elevations for the Little River corridor, since Provincial and local regulations restrict new development in floodplain areas.

An existing conditions hydrologic and hydraulic model was developed using PC-SWMM as outlined in Section 4.3 in order to determine water surface profiles for various storm events for the significant watercourses within Upper Little River. Previous modelling for the area utilized the HEC-2 model. PC-SWMM was used for the current study since a coupled hydraulic – hydrologic model was used to determine SWM facility sizing caused by back water effects. The PC-SWMM model encompasses both the hydrology and hydraulic modelling for the watershed. The watercourses modelled include:

- Upper Little River
- 6th Concession Drain
- 7th Concession Drain
- 8th Concession Drain
- 9th Concession Drain
- Desjardins Drain

- Gouin Drain
- Hurley Drain
- Hayes Drain
- Lachance Drain
- North Townline Drain
- 7th Street Drain Diversion
- Watson Drain

4.4.2 Methodology

The PC-SWMM model was created using the following information:

- HEC-2 Model obtained from ERCA and included Upper Little River from Forest Glade Drive to Baseline Road was converted to a PC-SWMM model. The PC-SWMM model combines the hydrology and hydraulics of the site into one unsteady state model.

- Channel cross sections were based on a combination of cross sections from the HEC-2 model, surveyed cross sections (completed in 2005 as part of this project), and Municipal Drain Reports.

- Downstream boundary conditions were calculated assuming normal flow at the downstream limits of the model. The model extends approximately 500 m downstream of the E.C. Row Expressway (past Forest Glade Drive).

- Contraction and expansion coefficients of 0.1 and 0.3 respectively were used to model gradual flow transitions in the channel. Contraction and expansion coefficients of 0.3 and 0.5 respectively were used to model flow transitions near bridge and culvert crossings.

- Manning's n coefficients of 0.045 and 0.100 were used to represent the channel and overbanks respectively. The channel coefficient was based on a channel with some pools, shoals, weeds, and stones. The overbank/flood plain coefficient was based on dense brush. These values are based on a well vegetated channel before clean-out.

- When flood plain information was not available the floodplain geometry was assumed to slope upwards at a slope of 0.2% (0.2 m elevation over 100 m width) from the top of bank based on the flat topography.

- The model was completed assuming culverts and bridges in the system where information was available (generally for the major crossings such as municipal roads). Culvert information was generally not available for smaller crossings such as entrance culverts.

- All SWM controls were assumed to be operational (i.e., no failures).
- For the purposes of determining water levels, all existing on-line storage reservoirs, such as those created by road crossings, were retained.
- The maximum flood line was calculated using the 100-year event (the Regulatory Storm event in the Windsor area), with SWM controls and on-line controls (culverts and bridges).
- Modelling methodology generally follows the Technical Guide, River & Stream Systems: Flooding Hazard Limit (MNRF, 2002).

4.4.3 Hydraulic Model Results for Existing Conditions

Flows and flood elevations at significant road crossings are shown in Table 12 for the 100-year event comparing the ERCA HEC-2 floodplain mapping (MacLaren, 1985) and the current PC-SWMM floodplain mapping. The Regional Storm for Essex Region is Hurricane Hazel, but ERCA only regulates to the 100-year rainfall event. Generally, the flows used in the current study are higher, with larger increases in the headwater areas of the watershed. Water levels are generally reflective of the flows, in that the model with the higher flow rate tends to have the higher water level. The PC-SWMM incorporates several changes to the model (including new cross sections and the Twin Oaks Business Park).

Table 12: Existing Water Level Summary

Location	ERCA Floodplain Mapping MacLaren (1985)		Twin Oaks Business Park Lafontaine, etc. (1997)		Current Study Stantec		Elevation Data Windsor Airport (1990)		
	100 yr. Water Level (m)	Flow (m^3/s)	100 yr. Water Level (m)	Flow (m^3/s)	100 yr. Water Level (m)	Flow (m^3/s)	Ground u/s of road crossing (m)	Road Spill (m)	Road at Crossing (m)
Baseline Road	184.08	24.4	N/A	N/A	184.13	34.7	183.9	184.3	184.5
Country Road 42	182.63	24.4	N/A	N/A	183.20	39.8	182.2	182.6	182.9
Lauzon Parkway	182.12	24.4	N/A	N/A	182.52	40.1	182.2	182.3	183.7
Lauzon Road	181.72	27.7	N/A	N/A	182.01	43.7	181.1	181.6	182.0
Railway	181.56	34.0	181.13	39.4	181.64	45.4	181.1	182.4	182.4

Table 12: Existing Water Level Summary

Location	ERCA Floodplain Mapping MacLaren (1985)		Twin Oaks Business Park Lafontaine, etc. (1997)		Current Study Stantec		Elevation Data Windsor Airport (1990)		
	100 yr. Water Level (m)	Flow (m^3/s)	100 yr. Water Level (m)	Flow (m^3/s)	100 yr. Water Level (m)	Flow (m^3/s)	Ground u/s of road crossing (m)	Road Spill (m)	Road at Crossing (m)
Twin Oaks Drive	180.91	39.5	180.86	39.6	180.97	49.5	180.5		
E.C. Row Expressway	180.72	42.8	180.77	40.5	180.81	50.6	180.0	181.4	183.0
Forest Glade Drive	180.32	42.8	N/A	N/A	180.41	51.4	179.5	180.5	181.0

4.4.4 Hydraulics Summary

Based on the information provided, the following is a summary of findings:

- Little River and associated tributaries are subject to flooding during the Regulatory Storm (100-year) Event.
- Calculated water levels based on revised flows and topography are generally within 0.3 m of the currently recognized ERCA floodplain limits (circa 1985).

4.5 Fluvial Geomorphology

4.5.1 Introduction

The fluvial geomorphology analysis included:

- A desktop analysis combined with field visits to establish baseline conditions in the area.
- A field reconnaissance of the study area using rapid channel assessments to confirm the findings of the background review. The site reconnaissance also serves to identify and confirm any physical rates of channel adjustments.
- Detailed geomorphic field assessments including collection of cross-sectional and survey data and re-monitoring of historic channel cross-sections established in 2004.

- Detailed geomorphic analyses determining erosion threshold assessments.
- Restoration recommendations for the channel areas.
- Establishment of corridor width.

4.5.2 Background Review

In 2004/2005, a desktop analysis was conducted to determine the general characteristics of watercourses in the study area. The amount and size of sediment inputs, valley shape, land use or vegetation cover, and other parameters that influence channel form often change as you move downstream along a waterway. In order to account for these changes, channels are often separated into "reaches". Reaches can be defined as stretches of channel that flow through a nearly constant valley setting and incorporate similar physical characteristics along their lengths. Thus, reaches experience similar controlling and modifying influences, which are reflected in similar geomorphological form, function, and process. Watercourses within the subject area were divided into reaches, as illustrated in Figure 15.

A historic analysis was also conducted for each reach using aerial photographs from 1955 and 1978 as well as digital imagery from 2004 to document changes in land use and channel planform. It was noted that the surrounding land use was predominantly agriculture and most of the study reaches had been altered or straightened – most before 1955. Seven monitoring cross-sections were installed following the desktop assessment in order to establish baseline conditions within the study area.

4.5.3 Synoptic Surveys

In order to provide insight regarding existing geomorphic conditions and document any evidence of active erosion, site visits were conducted in 2007. During the visit, channel conditions along the study reaches were evaluated using two established synoptic surveys: the Rapid Geomorphic Assessment and the Rapid Stream Assessment Technique.

Rapid Geomorphic Assessment

The Rapid Geomorphic Assessment (RGA) was designed by the Ontario Ministry of Environment (1999) to assess urban stream channels. It is a qualitative technique based on the presence and (or) absence of key indicators of channel instability such as exposed tree roots, bank failure, excessive deposition, etc. The various indicators are grouped into four categories representing specific geomorphic process: 1) Aggradation, 2) Degradation, 3) Channel Widening, and 4) Planimetric Form Adjustment. Over the course of the survey, the existing geomorphic conditions of each reach are noted and the presence or absence of the specific geomorphic indicators are documented. Upon completion of the field inspection, the indicators are tallied within each category and the subsequent results are used to calculate an overall reach stability index. This index value corresponds to one of three stability classes representing the relative degree of channel adjustment and (or) sensitivity to altered sediment and flow regimes.

Rapid Stream Assessment Technique

The Rapid Stream Assessment Technique (RSAT) provides a purely qualitative assessment of the overall health and function of a reach in order to provide a quick assessment of local stream conditions and to identify and prioritize restoration needs on a watershed scale. This system integrates visual estimates of channel conditions and numerical scoring of stream parameters using six categories:

- Channel Stability
- Erosion and Deposition
- Instream Habitat
- Water Quality
- Riparian Conditions
- Biological Indicators

Once each condition has been assigned a score, values are totaled to produce an overall stream stability score, or health rating, based on a 50-point total. The recommended value is then categorized into one of three classes: low (poor health), moderate (moderate health), and high (good health).

<20	Low (Poor Health)
20-35	Moderate
>35	High (Good Health)

Although the RSAT grades streams from a more biological and water quality perspective than the RGA, this information is still relevant within a geomorphic context. In general, the types of physical features that generate good habitat for aquatic organisms tend to represent healthy geomorphic systems as well (e.g., native fish may prefer a well-established riffle-pool sequence with little fine material on the riffles, quality riparian conditions provide food and shade to streams, woody debris and overhanging banks provide habitat structure, etc.).

Along with the above-mentioned stream assessment protocols, the Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines were taken into consideration in identifying the headwater drainage features. Bank and bed substrates, channel stability, morphology and any discharge points were noted during the field survey.

The results (Table 13) classified all the reaches included in the rapid assessments as either ‘transitional/stressed’ or ‘in adjustment’. The main mode of adjustment is widening, followed by aggradation. These processes were indicated by woody debris jams, bank erosion/slumping, and bar formation. Reaches were characterized by common elements of urban channels such as road crossings, stormwater outfalls, and bank protection/modification. Evidence of modification and straightening was also prevalent, such as the steel walls bordering the downstream Little River reaches (LR-1 and LR-2). Channel dimensions were largest for the main channel reaches ranging from 6-30 m in bankfull width and 1-2.5 m for bankfull depth. While the drain reaches were much narrower, 2-8 m bankfull width, they were somewhat comparable in depth with a range of 0.3-1.2 m. This is indicative of the entrenchment that can occur in straightened agricultural drains.

Table 13: Summary of RGA Results

Reach	Stability Index (RGA)	Condition (RGA)	Dominant Process (RGA)	Assessment Score (RSAT)	Stability Ranking (RSAT)	Bankfull Width (m)	Bankfull Depth (m)	Comments
LR-3	0.41	In Adjustment	Aggradation Widening	22	Moderate	18-26	0.8-1.8	road crossings, weir, storm drainage, woody debris, sandbag with concrete lining on right bank, concrete cinder blocks on left bank, metal retaining wall acting as weir, lateral bar formation, channel migration to right bank
LR-5	0.29	Transitional/ Stressed	Widening	23	Moderate	6-12	0.8-1.6	tile drain, man-made riffles, slumped banks, road crossings, turbid, culvert, stagnant water, densely vegetated
LAD-1	0.34	Transitional/ Stressed	Widening	24.5	Moderate	3-6	0.6-1.2	culvert, road crossing and surrounding concrete drainage outfalls, failing concrete walls, channel highly entrenched, "U" shaped agricultural drain, little riparian cover, soft unconsolidated bed, ducks and 2 dead turtles
SD-1	0.29	Transitional/ Stressed	Widening Aggradation	---	---	2-4	0.3-0.6	culvert, confluence, cinder blocks, very little water, upstream vegetation controlled
DD-1	0.34	Transitional/ Stressed	Widening	24	Moderate	4-8	0.6-1.2	woody debris jams, densely vegetated, stagnant water not connected to main flow, channel appeared natural but altered
MD-1	0.26	Transitional/ Stressed	Aggradation Widening	22	Moderate	2-5	0.4-0.8	road crossings, rail line, riprap, woody debris jams, lined bed, very thin riparian corridor, channel flows as an altered drain through agricultural fields
LRD-4	0.3	Transitional/ Stressed	Widening	31	Moderate	4-6	0.6-1.2	road crossings, urban debris, tile drainage, right bank bridge abutment was exposed, wide straight reach with good riffle-pool delineation, majority of bed consisted of beach sands, ripples forming along bed, scour observed along rocks
LRD-1	0.3	Transitional/ Stressed	Widening Aggradation	27	Moderate	4-8	0.6-1	stormwater outfalls, urban debris, road crossings, gabions, man-made riffles, terra blocks, woody debris jams, two retention ponds, thatch on banks, urban debris, terraced banks
LR-6	0.31	Transitional/ Stressed	Aggradation	21	Moderate	6-15	0.8-1.2	vegetation controlled, road crossings, terra blocks, thatch on banks, vegetation in channel
LRD-2	0.31	Transitional/ Stressed	Widening	32	Moderate	4-6	0.6-1	road crossings, riprap, urban debris, erosion on banks, densely vegetated, thalweg out of alignment, bridge
LRD-3	0.26	Transitional/ Stressed	Widening	33	Moderate	4-7	0.6-1	road crossings, woody debris, terraced banks, erosion on banks, exposed roots
6th Concession	0.22	Transitional/ Stressed	Widening	26	Moderate	2-6	0.8-1.2	road crossings, urban debris, roadside ditch, basal scour on banks
Baseline Drain	0.34	Transitional/ Stressed	Widening	---	---	2-6	0.4-1.2	road crossings, bank slumping, islands in channel

Table 13: Summary of RGA Results

Reach	Stability Index (RGA)	Condition (RGA)	Dominant Process (RGA)	Assessment Score (RSAT)	Stability Ranking (RSAT)	Bankfull Width (m)	Bankfull Depth (m)	Comments
LRD-5	0.32	Transitional/ Stressed	Widening	24	Moderate	2-4	0.4-0.8	road crossings, woody debris jams, densely vegetated, narrow straight drain with little bar formation, exposed clay along bank, exposed tree roots, leaning trees, groundwater seepage from right bank at crossing
9th Concession	0.26	Transitional/ Stressed	Aggradation Widening	22.5	Moderate	3-6	0.6-1.2	road crossings, woody debris jams, bar formations, extensive basal scour, roadside ditch, good riffle-pool spacing, numerous freeway crossings
LR-1	0.25	Transitional/ Stressed	Aggradation	30	Moderate	18-30	1.0-2.5	riprap, bridges, outfalls, steel wall, marine/docks, residential land uses, algae, overhanging vegetation
LR-2	0.22	Transitional/ Stressed	Aggradation	30	Moderate	17-25	1.0-2.0	road & rail crossings, urban debris, outfalls, riprap, steel wall, stagnant water, sediment accumulation mid-channel

4.5.4 Detailed Field Data Collection

Once the desktop analysis of the study area was completed in 2004, a monitoring program was established to track changes in the channels over time. This activity involved the installation of seven cross sections throughout the study area so that historical data could be collected. By monitoring the cross sections over a period of time, historical trends and channel changes can be observed and inferences can be made pertaining to development impacts on the watercourses in the subject area. The locations of the detailed sites were determined to provide a representative coverage of the study area, both from a spatial and morphologic perspective. Monitoring provides frequent, "low-tech" observations which enhance our understanding of a river system. It also enables direct measurements of channel changes, such as bank erosion and bed scour, which can be linked to the historic assessment and provide a clearer picture of channel dynamics. The seven sites were located in Reaches LR-3, LRD-4, LAD-1, DD-1, BRD-1, NC-1, and SC-1 (Figure 15). The cross-sections were benchmarked by installing monuments on the top of both banks such that topographic detail between the pins could be accurately measured on a recurring basis. The cross-sections were again measured in May 2007, but not all cross-sections could be relocated, in some cases, because maintenance along the drain had stripped or buried the monitoring pins. An attempt was also made in September 2011 to update the monitoring, but the field crew was only able to relocate one of the sites (NC-1). Brief descriptions of the general characteristics at each site and the results of the cross-section monitoring is provided in Appendix J. If monitoring is planned for the future, new monitoring locations will need to be established at the sites.

4.5.5 Meander Belt Analysis

4.5.5.1 Meander Belt Width Delineation

Streams and rivers are dynamic features on the landscape. Changes in configuration and position occur through the development and evolution of meanders, and migration processes. Erosion and deposition of sediment is a key component of channel migration, enabling changes in shape and shifts in the position of a watercourse. These changes may cause loss or damage to private property and/or structures located too close to the transitioning watercourse. It is for this reason that, when infrastructure, development or other activities are proposed near a watercourse, it is desirable to designate a corridor intended to contain all of the existing and expected meander development and migration processes. Outside of this corridor, it is assumed that private property and structures will be safe from the erosion potential of the watercourse. The space that a meandering watercourse occupies is its floodplain, and in which all of the natural channel processes occur, is commonly referred to as the meander belt. Due to the spatial variability of modifying and controlling influences on channel form, two reaches situated immediately up/downstream of each other could show marked differences in planform configuration. It is for this reason that meander belt width delineation occurs on a reach-by-reach basis.

4.5.5.2 Preliminary Meander Belt Width

A preliminary meander belt width was delineated for each reach in the study area. Standard methods for delineating meander belt widths rely on air photo analysis. First, a meander belt axis was identified, following the general down-valley orientation of the meander pattern. The meander belt is essentially centered along the meander axis. Second, the preliminary meander belt is established by drawing lines parallel to the governing outermost meanders of the existing channel planform, following the meander axis. This methodology is not applicable when a channel has been altered or straightened, erasing any indication of natural planform configuration. Historical analysis of aerial photos revealed that most of the reaches within the study area have been altered and exhibit very little natural change in planform between 1955 and 2004. A small number of reaches retained planform characteristics which allowed the traditional methodology to be applied.

In the event that a watercourse has been altered and/or necessary data is insufficient, a meander belt width can be derived by means of an empirical analysis based on channel parameters. This involves basic field data collection to quantify channel dimensions for use in calculating an appropriate belt width, such as channel width, depth, or cross-sectional area. These empirical relations are based on measurements of real watercourses; however, their transferability to watercourses situated within southern Ontario may be limited due to differences in hydrologic regime, drainage area, and general controlling factors compared to the areas where the formulas were developed. Reviewed collectively, they provide results that are typically comparable to results attained through use of the standard belt width delineation procedures. Because most of the channels in the study area are straight agricultural drains, the empirical method was used for the majority of the reaches. Where field data was not obtained, meander belt widths were estimated using similar, nearby reaches as references.

4.5.5.3 Erosion Setbacks

From a geomorphic perspective, the 100-year migration rate typically represents the erosion setback to be applied to either side of the meander belt width in order to account for bank erosion and channel migration over time (100 years). However, due to the high degree of planform alteration, 100-year migration rates could not be quantified for this channel. In lieu of applying the 100-year migration rate, an erosion setback representing 10% of the preliminary meander belt width was applied to either side of the channel. Final Meander Belt Widths ranged from 24 m to 216 m.

Belt widths are the smallest for the agricultural drain reaches which are primarily draining headwater areas where small channel dimensions and relatively low gradients limit migration. These conditions result in belt widths between 24 to 35 m. Further downstream, some planform characteristics have been retained (such as SD-3) and these channels have slightly larger belt widths to encompass a more sinuous pattern. The Little River drain reaches (LRD) have belt widths in the range of 40-80 m. The surrounding smaller drains converge with the LRD reaches providing more flow with which to alter channel dimensions resulting in the need for larger belt widths. The main channel reaches (LR) have belt width values that range from 100-200 m. These values result from the increased channel dimensions as well as some large meanders which have been preserved in the channel planform. While these meanders are unlikely to change significantly due to heavy alteration, they are indicative of the channels past migration based on its flow capacity. Detailed analysis is provided in Appendix J and summarized on Figure 16.

4.5.6 Erosion Threshold Analysis

In essence, an erosion threshold analysis determines the hydraulics, such as discharge, channel depth, or average channel velocity, at which the channel produces enough shear stress to initiate the mobilization of sediment of a given size, usually the D_{50}. The analysis also helps to evaluate a reach's erosion sensitivity by comparing the boundary shear stress associated with modelled flows to the critical shear stress required to entrain sediment. Nine different models were used to perform erosion threshold analysis for the Study Area, including models based on critical shear stress and permissible velocity, in order to consider a range of results. The model results were examined for convergence and compatibility with field observations. Selection of appropriate thresholds was also based on an understanding of site conditions and the assumptions and ranges of conditions under which the models are applicable.

The watercourses within the study area are mostly straightened constructed channels with relatively low gradients and fine bed materials. The calculated erosion threshold discharge values varied between 16% and 55% of estimated bankfull flows, with an average of 33%. Sediment generally begins moving at flows around 1/3 to 1/2 of bankfull, so the estimated values suggest that the entrenched channels with fine grained beds and banks might be relatively sensitive to increases in flows. LR-5 and LAD-1 appear to be less sensitive, whereas SD-1, which is steeper and flows through sandy clay, is expected to be the most sensitive as shown in Table 14.

Table 14: Erosion Threshold Analysis Values

Reach	Description	Critical Flow (m^3/s)	Average Critical Velocity (m/s)	Critical / Bankfull Discharge (%)
LR-2	Little River downstream of Tecumseh Road	5.46	0.54	28
LR-5	Little River downstream of E.C. Row Expressway	2.35	0.48	55
LAD-1	Lachance Drain	0.85	0.51	46
SD-1	Soulliere Drain	0.14	0.49	16
LRD-4	Little River Drain upstream of Country Road No. 42	0.40	0.31	23

In addition, it appears that many of the drains within the study site are maintained. Channel widening, bank steepening, and further entrenchment, which may or may not be associated with in-channel maintenance work, could alter the erosion threshold values, channel sensitivity, and the morphology in general (e.g., over steepened banks tend to fail, wider channels tend to have higher threshold discharges.) The current values are based on conditions over the last 5 years, and although they are intended to be conservative, sites may have been altered more recently.

4.5.7 Restoration/Remediation Opportunities

Restoration of altered channels

Previously altered channel sections can be restored and rehabilitated to channels that exhibit natural functions. The majority of the study area consists of drains where natural channel design principals can be implemented. A lot of these channels are deep with high steep banks that are exhibiting erosion. Bank restructuring and floodplain terracing is an option for these entrenched watercourses, as the channels currently cannot access their floodplains due to the high banks. The result of the existing condition is greater stress being exerted on the bed during higher flows. The work should include re-grading the banks to create benches or terraces, which would help dissipate energy and re-connect the bankfull channel to a floodplain area. The re-graded banks should be re-vegetated to help stabilize the banks and create floodplain habitat.

Re-establish riparian vegetation

Re-establishing a healthy riparian vegetation community will not only increase bank stability, but will also provide shading to the river, enhancing aquatic habitat through the contribution of organic debris. It also contributes to the overall aesthetic impact of the system.

Construct channel bed morphology for fish habitat

Many of the channels in the study area lack bed morphology to support any fish habitat due to over-widened channel widths and sediment accumulation. Constructing structures to narrow cross-sectional area (i.e., wood deflectors sticking out of the banks) to promote bed morphology and re-grading the banks to create benches or terraces will help dissipate energy and help sediment transport, thereby providing healthier fish habitat.

Removal of hard structures – bed and banks

There are reaches and portions of reaches that have hardened banks (e.g., LR-2, LRD-1 and MD-1). The conditions of the hard structures (concrete and retaining walls) vary, with some failing and others being undermined, which may ultimately result in failure. By replacing these structures with a ‘softer’ bio-engineered approach such as vegetated riprap or brush layering, it offers the stability and erosion protection of an engineered structure with the aesthetic and ecological benefits of incorporated plantings. These techniques are ideal for the treatment of localized scour issues where lateral expansion or channel migration is undesirable.

Local bank stabilization area

The majority of the reaches in the study area are experiencing bank erosion. In these areas, localized bank treatment could be considered to dissipate the erosive flows. Bio-engineering techniques such as brush layering and crib walls effectively increase the shear strength of the banks, allowing them to withstand higher flows than those tolerated by existing bare soils.

4.5.8 Fluvial Geomorphology Summary

Based on the report findings the following key conclusions can be drawn:

Meander belt widths

Meander belt widths were delineated for all reaches based on either current channel planform or current channel dimensions. Due to a history of alteration and straightening, traditional methods of meander belt width delineation could not be used, in which case channel dimensions (from field data) were used in conjunction with empirical relationships to calculate an appropriate belt width. Erosion setbacks were calculated as 10% of the preliminary belt width as historical migration rates could not be determined. Final belt widths ranged from a minimum of 24 m to a maximum of 216 m. Larger belt widths were determined for reaches with a more sinuous planform and larger channel dimensions. While these meanders are unlikely to change significantly due to heavy alteration, they are indicative of past channel migration based on its flow capacity. Future development of the study area should occur outside of the meander belt widths to ensure channel stability.

Reach characterization

Within the study area, reaches can be grouped into three different categories: the main Little River channel (LR-1 to LR-6), the Little River drain (LRD-1 to LRD-5), and the agricultural drains (all remaining reaches). While the reaches differ widely in channel dimensions, characteristics are similar. The majority of the reaches have been straightened or altered in some way. Banks are protected by various structures ranging from gabions and terra blocks, to large steel retaining walls on the main Little River reaches. The agricultural drains appear to be mostly man-made straight ditches, lacking any natural geomorphic features. Bank erosion is prevalent in the entrenched, agricultural drains as well as in some of the larger reaches where bank protection is slightly undermined. Based on these characteristics noted during rapid assessments, all reaches were classified as in transition or adjustment. Most channels were widening with a secondary process of aggradation. As the channels widen and erode the banks, trees lean and fall into the channel creating woody debris which traps sediment leading to the secondary process of aggradation. Cross section monitoring results support this characterization as well. Both LR-3 and LRD-4 showed slight aggradation between the two times of measurement. Reaches BRD-1, NC-1, and SC-1 had evidence of bank slumping and erosion over the monitoring period.

Erosion thresholds

Erosion thresholds were done for five reaches: two on the Little River main channel, one on the Little River Drain, and two on agricultural drains. This selection gave a representative sample of the reaches within the study area. The critical discharge was on average 33% of the bankfull discharge which is relatively low. This is attributed to the entrenched nature of the majority of the reaches, resulting in a high bankfull discharge relative to grain size within the channel.

4.6 Cultural Heritage Resources

Cultural Heritage Resources include Archaeology, Built Heritage Resources, and Cultural Heritage Landscapes.

4.6.1 Archaeology

A Stage 1 archaeological assessment was conducted under archaeological consulting license P389 issued to Walter McCall, Ph.D., of Stantec by the Ministry of Tourism, Culture and Sport's (MTCS) (currently the Ministry of Heritage, Sport, Tourism, and Culture Industries (MHSTCI). The assessment was conducted in accordance with the MTCS 2011 Standards and Guidelines for Consultant Archaeologists (Government of Ontario, 2011) and a compliance letter was received from the MTCS in 2016 (refer to Appendix L for more details). A site visit was undertaken on April 17, 2014 as per Section 1.2 of the Standards and Guidelines for Consultant Archaeologists (Government of Ontario, 2011).

The archaeology study area occupies all or part of Lots 10 to 19, Concessions 6 to 10, and singular Lots 300- 302, Geographic Township of Sandwich South, and Lots 115 to 149, Concessions 2 to 3, Township of Sandwich East, Essex County, Ontario. It comprises approximately 225 hectares of active and inactive agricultural lands, woodlots, manicured lawns, commercial and residential properties, paved roads and highways, industrial installations, a railway, and land incorporated within the boundaries of Windsor Airport.

The majority of the study area (80%) consists of active and inactive agricultural land accessible for ploughing. A smaller portion of the Study Area comprises woodlots (10%) and manicured lawns (5%) that are unable to be ploughed. The remaining 5 percent of the Study Area consists of roads and highway, a railway line, and private laneways. These areas are previously disturbed and are unable to be assessed.

An examination of the Ontario Archaeological Sites Database (Government of Ontario, n.d.) showed that there are three archaeological sites registered within a one-kilometre radius of the study area: one is a multi–component site and two are Euro - Canadian. The multi – component site, is located within the current study area on Lot 145, Concession 3. It comprises a 30 metre scatter of Euro – Canadian artifacts and one side notched point. An inspection involved random spot-checking of the entire property and its periphery to identify the presence or absence of any features of archaeological potential. During the property inspection the weather was warm and sunny, and visibility of land features was excellent. At no time were field or weather conditions detrimental to the identification of features of archaeological potential.

A possible heritage property, a wooden barn, was noticed during fieldwork at the intersection of Concession Road 10 and Baseline Road. It is located in the northwest corner of Lot 16, Concession 10.

The Canadian Pacific Railway running east -west across the northern portion of the study area is a historic transportation route, having been completed in 1890. Previous disturbance due to maintenance and expansion designates it an area of low archaeological potential.

Various paved roads cross the Study Area as well as their associated rights-of-way and culvert systems. As per Section 2.1, Standard 2b of the Standards and Guidelines for Consultant Archaeologists (Government of Ontario, 2011) these areas have also been evaluated as having low potential due to deep land alteration that has severely damaged the integrity of archaeological resources and as such, Stage 2 survey is not required.

Overall, the Stage 1 archaeological assessment identified portions of the study area that exhibit a moderate to high potential for the identification and recovery of archaeological resources as shown on Figure 17.

4.6.2 Built Heritage Resources and Cultural Heritage Landscapes

A Cultural Heritage Resources Assessment (CHRA) report was competed in June 2021 to identify heritage resources, including built heritage and cultural heritage landscapes, present within, and adjacent to, the Study Area (refer to Appendix N for the full report). The assessment consisted of data collection, background historic research, review of secondary source material, and field review. Potential heritage resources were identified through consultation and a windshield survey, inventoried, and evaluated according to *Ontario Regulation* (O. Reg.) *9/06*, the criteria for determining Cultural Heritage Value or Interest (CHVI). Where CHVI was identified, the resource was mapped, and recommendations made for further study.

In order to identify protected properties, the Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI), the Ontario Heritage Trust (OHT), City of Windsor, and Town of Tecumseh were consulted. As a result of the consultation, eight properties with municipal heritage interest were identified in relation to the Study Area as listed in Table 15. Five of these properties were determined to be situated within the CHRA Study Area. A windshield survey was undertaken to identify potential heritage resources within, and adjacent to, the Study Area and confirm the presence of previously identified potential heritage properties. Where identified, the potential heritage properties were photographed from the public right-of-way. A total of 72 properties were identified as known or potential heritage properties. In each case evaluation of the CHVI of the property was undertaken according to O. Reg. 9/06. Each potential heritage resource was considered both as an individual structure and as a landscape. Following evaluation, 14 Cultural Heritage Resources (CHRs) were identified within the Study Area as shown on Figure 18.

Table 15: Identified and Protected Resources within the Study Area

Municipality	Location / Municipal Address	Level of Recognition	Relationship to the Study Area
City of Windsor	2600 Airport Road (3200 County Road 42)	Listed on municipal register	Outside the Study Area
City of Windsor	5680 Baseline Road	Listed on municipal register	Inside the Study Area
City of Windsor	4639 9th Concession Road	Listed on municipal register	Inside the Study Area
City of Windsor	4799 9th Concession Road	Listed on municipal register	Outside the Study Area
City of Windsor	4601 County Road 17 (10th Concession)	Listed on municipal register	Inside the Study Area
Town of Tecumseh	2300 Banwell Road	Designated Heritage Property	Inside the Study Area
Town of Tecumseh	11945 Intersection Road	Listed on municipal register	Inside the Study Area
Town of Tecumseh	2725 Highway 3 (Talbot Road)	Designated Heritage Property	Outside the Study Area

4.7 Drinking Source Water Protection

The applicable Source Protection Plan for the study area is the Essex Region Source Protection Area – Approved Source Protection Plan (SPP) (2015) and the Essex Region Source Protection Area – Updated Assessment Report (AR) (2015) prepared by ERCA. The Essex Region SPP includes policies for municipal water intakes and does not include private sources of drinking water in the area (i.e., well water). In the study area groundwater is used occasionally for domestic consumption mainly in rural areas.

There are no municipal drinking water systems supplied by groundwater. The Essex Region SPP identifies most of the municipal drains and Upper Little River within the study area as surface water Intake Protection Zone 3 (IPZ-3), having low vulnerability. The Event Based Areas (EBA), where modelling has demonstrated that a spill could cause deterioration to the raw water quality at the drinking water intake, generally are identified to be in the same locations as the IPZ-3 areas.

Event based area policies that apply to the study area include Policies 31 and 32 from the SPP. These apply to the existing and future threat of above grade handling and storage of liquid fuels, in quantities where modelling reported in the Assessment Report has demonstrated that this activity is a significant threat. Any existing storage of fuel above the threshold limit (15,000 L) should have a Risk Management Plan and inform ERCA of the installation of any future fuel storage that exceeds these limits. There are no event based area policies for groundwater.

Through the events based approach, an activity is a significant drinking water threat in an IPZ-1, IPZ-2, or IPZ-3 if modelling demonstrates that a release of a contaminant from the activity would result in a deterioration of the source of drinking water quality. The Essex Region Source Protection Committee has accepted the Ontario Drinking Water Quality Standard (ODWQS) as the benchmark to indicate the deterioration of raw water quality at the intake. Modelling of hypothetical spills of large volumes of liquid fuel at various locations demonstrated exceedances of the ODWQS for benzene, at one or more of the intakes in Lake St. Clair, the Detroit River and Lake Erie. These results were used to identify existing significant threats and establish potential significant threats criteria for the handling and storage of liquid fuel.

There are no highly vulnerable aquifers (HVA) within the study limits but there are groundwater recharge areas identified as Significant Groundwater Recharge Area 2 (SGRA-2). The SGRA-2 areas are located along the western study limits in an already developed area and have a low vulnerability.

Figures showing the IPZ, EBA and SGRA vulnerable areas in the study area are included in Appendix M. Correspondence with the Project Manager for Source Water Protection for the Essex Region (Katie Stammler PhD, ERCA) is also included in Appendix M.

5.0 Alternatives and Evaluation

5.1 General

As part of the Class EA Process, it is important in the environmental review that all reasonable design alternatives be adequately considered. The issue identification provided in Section 2 (“To ensure that urbanization of the Upper Little River Watershed can occur in a fashion that will not lead to negative impacts on the receiving systems including increased flood risk, the impairment of natural watercourse features, and would allow for future enhancement of the watercourse, stream margins and wetlands”) provides the necessary background for the selection and evaluation of alternatives.

The following alternatives have been identified for further evaluation through this Class EA process:

- Alternative 1 – The Do-Nothing Alternative
- Alternative 2 – Water Quality and Erosion Control Only
- Alternative 3 – Communal Stormwater Facilities
- Alternative 4 – On-line Quantity Control with Local Quality and Erosion Controls
- Alternative 5 – Off-line or Distributed SWM Controls
- Alternative 6 – Grouped Stormwater Management Facilities

The following sections describe each of the alternatives in greater detail.

5.2 Alternative Solutions

The intent of this section is to identify and summarize the various alternatives being considered for the Master Plan Class EA. The following six preliminary alternatives have been generated for evaluation within the EA process, as outlined subsequently:

5.2.1 Alternative 1 - The Do-Nothing Alternative

In this alternative, the Little River subwatershed area is developed but no stormwater management control measures are implemented for the watershed. The evaluation of this alternative is required by the EA process; however, ERCA has stated that lands downstream of the study area are currently impacted by flood waters and any increase in flows would require channel improvements with significant costs to ensure that flood levels/damages are not increased.

5.2.2 Alternative 2 - Water Quality and Erosion Control Only

In this alternative, the proposed development will have only water quality treatment and erosion control, no water quantity or flooding controls. ERCA has stated that lands downstream of the study area are currently impacted by flood waters and any increase in flows would require channel improvements with significant costs to ensure that flood levels/damages are not increased.

5.2.3 Alternative 3 - Communal Stormwater Facilities

This alternative analyzes the potential to minimize the number of SWM facilities required to serve the study area by consolidating all water quality, erosion and water quantity controls at a few locations throughout the watershed.

On-line

These large centralized SWM facilities would provide control for anywhere from 150 to 800 ha of development area. This option would retain the existing municipal drain alignments with large ponds at key locations. Multiple forebays could be used to consolidate drainage from different directions. Several of the municipal drains are considered to provide direct fish habitat. Since this alternative provides water quality control downstream of the fish habitat, this option would likely require a permit from the DFO. This alternative would also be classified as an on-line water quality facility (since it would be located on a watercourse). Recent projects attempting to employ this method have had difficulty obtaining approvals from MECP, MNRF, and DFO, primarily due to fisheries/natural heritage concerns. Due to the complications arising from the proximity of the airport and the online water quality controls, it would be difficult to obtain approvals for this alternative.

Off-line

This alternative is similar to the on-line version where a few large centralized SWMFs would be used to provide controls. This alternative differs in that the storm flows would drain through large storm sewers to the SWMFs whereas the on-line version uses the existing municipal drain network to transport flows. Due to flat grades throughout the site and required minimum slopes on storm sewers, flows in the storm sewers would need to be pumped before outletting to the downstream water courses. This option requires significant upfront capital costs for the storm sewers and land acquisition and does not lend itself well to staged construction.

5.2.4 Alternative 4 – On-line Quantity Control with Local Quality and Erosion Controls

This alternative analyzes the scenario where a few on-line water quantity or flood control facilities are centralized in key locations throughout the study area, but water quality and erosion controls are distributed across the watershed.

Large centralized SWMFs would be used to provide water quantity control for large rainfall events. These large facilities would be located generally in the same locations as for Alternative 3, except that they could be smaller, and they would not require a permanent body of water (although there would be some form of low flow channel). Recent projects employing on-line water quantity controls have been approved by the MNRF and MECP with some additional review time.

Smaller distributed SWMF's would be used to provide a Normal level of water quality control, which could take the form of a dry pond combined with a treatment train approach (i.e., pre-treatment), a wet pond, a wetland, or Low Impact Development methods. The minor system would drain to the small distributed SWMFs where water quality and erosion control would occur. Major flows would either bypass the small distributed SWMF or drain through them with minimal controls to the large downstream SWMFs.

5.2.5 Alternative 5 - Distributed Off-line SWM Controls

This alternative considers the potential for stormwater management controls to be distributed throughout the study area, and each facility would be required to provide water quality, erosion and water quantity controls separately. It is anticipated that facilities would be designed and constructed as development proceeds on a site-by-site basis.

This form of SWM is typical of most developments where each development block would provide their own SWM controls (water quality, water quantity, and erosion control) before outletting to the drains. It would be the easiest alterative to receive approvals for due to its standard approach.

Similar to Alternative 4, water quality would be provided on a site-by site basis throughout the development area in end-of pipe facilities (i.e., dry pond (with pre-treatment), wetland, or wet pond). Flood control would occur above the water quality control volume (so that the water depth would be larger) or in adjacent mixed-use areas (e.g., sports field, woodlots, etc.). Under normal conditions they will operate similar to the Alternative 4 ponds, and it is only under large rainfall events where there will be differences in operation.

5.2.6 Alternative 6 - Grouped Off-line SWM Controls

This alternative considers the potential for all stormwater management controls to be provided before outletting to a watercourse. Each facility would be required to provide water quality, erosion, and water quantity controls similar to Alternative 5. In this alternative the SWM facilities are generally in the same area (co-located) and are congregated into SWM corridors.

This alternative is similar to Alternative 5, with the main differences being that the SWM facilities are intended to provide controls for more than one property, and they are located adjacent to other facilities and a watercourse. Generally, there will be fewer and larger SWMFs compared to Alternative 5 and more and smaller SWMFs compared to Alternative 3.

5.3 Evaluation of Alternatives

5.3.1 General

Throughout the Study process, the various alternatives were reviewed and discussed by the Project Team, the public, and agency representatives. It is obvious that each alternative will result in varying impacts on environmental features, lands available for development by local property owners and the downstream system. As would be expected, the objectives and needs of various groups are not always consistent, and so an appropriate evaluation process was applied by the Project Team to arrive at a preferred concept or recommended concept.

A set of evaluation criteria/indicators was selected to reflect the issues, constraints and concerns considered most important when comparing the alternative alignments. The determination of those factors and indicators was a result of the following:

- The requirements of the City of Windsor, the Town of Tecumseh, and the Essex Region Conservation Authority.
- Comments and concerns of the public.
- Comments and concerns raised by various external agencies.
- Analysis undertaken by Project Team members.

The evaluation criteria used to assess the various alternatives were grouped into four major categories as outlined below:

- Natural Environment
    - Terrestrial Resources, Vegetation, and Wildlife Implications
    - Fisheries Resources and Aquatic Habitat Implications
    - Groundwater and Baseflow Implication
    - Surface Water Quality
- Economic Environment
    - Total Capital Cost
    - Total Maintenance Cost

- Technical Environment
  - Ability to Provide Required Flood Protection
  - Ease of Construction/ Implementation
  - Ability to Meet Agency Requirements
- Social/Cultural Environment
  - Aesthetics
  - Health and Safety
  - Recreational Opportunities
  - Archaeological Resources
  - Built Heritage Resources/Cultural Heritage Landscapes

5.3.2 Commentary of Alternatives and Evaluations

A description of the evaluation criteria and a commentary for each alternative are presented in Table 16.

Table 16: Evaluation Criteria

DESIGN ALTERNATIVES								
Evaluation Criteria	**Description**	**Measure**	**Alternative 1 Do-Northing**	**Alternative 2 Off-Line Water Quality and no Water Quantity Control**	**Alternative 3 On-line Water Quality and Quantity Controls**	**Alternative 4 On-line Water Quantity and Off-line Water Quality Controls**	**Alternative 5 Distributed Off-line Water Quality and Quantity Controls**	**Alternative 6 Grouped Off-line Water Quality and Quantity Controls**
NATURAL ENVIRONMENT								
Terrestrial Resources, Vegetation, and Wildlife Implications	The nature and extent of disturbance to terrestrial habitat, vegetation communities, and wildlife resulting from the construction/operation of the alternative. Alternatives that maintain biodiversity and minimize disturbance to native species, regionally significant species and species with a high coefficient of conservatism (species with specific habitat requirements) are preferred	• Nature of disturbance (direct vs. indirect) • Area (ha) of habitat affected • Nature, significance, and sensitivity of affected area or species	• No future controls for water quality or flooding along Upper Little River • Anticipated impacts associated with flood events such as erosion/scouring, sediment deposition and vegetation displacement • Lack of water quality controls will result in increased sediment deposition and nutrient loading	• No future controls for flooding along Upper Little River • Water quality to the downstream watercourse will meet design criteria • Anticipated impacts associated with flood events such as erosion/scouring, sediment deposition and vegetation displacement (assumes water quality and minor system flows are controlled)	• Future controls for water quality and flooding along Upper Little River • Anticipated impacts include impacts associated with flooding and sediment deposition upstream of the online facilities	• Future controls for water quality and flooding along Upper Little River • Peak flows and water quality to the downstream watercourse will meet design criteria	• Future controls on water quality and flooding along Upper Little River • Peak flows and water quality to the downstream watercourse will meet design criteria	• Future controls on water quality and flooding along Upper Little River • Peak flows and water quality to the downstream watercourse will meet design criteria
Fisheries Resources and Aquatic Habitat Implications	Implications of disturbance to fish habitat and/or features that sustain habitat conditions resulting from the construction/operation of the alternative. Alternatives that sustain a fishery are preferred	• Nature and extent of disturbance to fish habitat, including opportunities for movement and potential spawning areas • Nature, significance and	• Anticipated impact to fish habitat through higher flows associated with flood events such as sediment loading, stream bank erosion, riparian vegetation displacement, and displacement or	• Anticipated impact to fish habitat through higher flows associated with flood events such as sediment loading, stream bank erosion, riparian vegetation displacement, and displacement or	• Fish habitat modifications are anticipated through channel realignments in order to accommodate future development patterns. May trigger fish habitat	• Fish habitat modifications are anticipated through channel realignments in order to accommodate future development patterns. May trigger fish habitat	• No additional physical barriers to fish movement if all facilities located off-line	• Fish habitat modifications are anticipated through channel realignments in order to accommodate future development patterns. May trigger fish habitat

Table 16: Evaluation Criteria

DESIGN ALTERNATIVES								
Evaluation Criteria	**Description**	**Measure**	**Alternative 1 Do-Northing**	**Alternative 2 Off-Line Water Quality and no Water Quantity Control**	**Alternative 3 On-line Water Quality and Quantity Controls**	**Alternative 4 On-line Water Quantity and Off-line Water Quality Controls**	**Alternative 5 Distributed Off-line Water Quality and Quantity Controls**	**Alternative 6 Grouped Off-line Water Quality and Quantity Controls**
		sensitivity of fish habitat affected • Nature and extent of any disturbance to features that sustain fish habitat conditions, including flow regime, groundwater seeps and riparian vegetation	disturbance of fish spawning sites • Lack of water quality controls will result in increased sediment deposition and nutrient loading • No physical loss of fish habitat, since there is no modification of the existing drainage network with this alternative	disturbance of fish spawning sites (assumes water quality and minor system flows are controlled) • No additional physical barriers to fish movement if all facilities located off-line	offsetting requirement • On-line ponds may create a barrier to fish movement • Potential for increase in sedimentation upstream of on-line facilities • Larger on-line facilities have higher potential for thermal warming. Facility design can soften but may not eliminate warming for larger storm events	offsetting requirement • No additional physical barriers to fish movement if all water quality facilities are located off-line		offsetting requirement • No additional physical barriers to fish movement if all facilities located off-line
Groundwater and baseflow implications	Impact of the alternative on groundwater levels and baseflows. Alternatives that maintain or enhance groundwater and baseflow are preferred.	• Nature and significance of changes to baseflow • Nature and extent of impact to groundwater levels and well use	• Anticipated reduction in baseflow through reduced infiltration following development • Possible mitigation measures limited without stored water	• Anticipated reduction in baseflow through reduced infiltration following development • Mitigation possible using drawdown of small off-line facilities to mimic baseflow • Small storage volumes limit the available flow	• Anticipated reduction in baseflow through reduced infiltration following development • Mitigation possible using drawdown of large on-line facilities to mimic baseflow • Larger storage volumes allow for longer drawdown	• Anticipated reduction in baseflow through reduced infiltration following development • Mitigation possible using drawdown of large on-line facilities to mimic baseflow • This alternative provides moderate potential to	• Anticipated reduction in baseflow through reduced infiltration following development • Mitigation possible using drawdown of off-line facilities to mimic baseflow • This alternative provides moderate	• Anticipated reduction in baseflow through reduced infiltration following development • Mitigation possible using drawdown of off-line facilities to mimic baseflow • This alternative provides moderate potential to improve baseflow

Table 16: Evaluation Criteria

DESIGN ALTERNATIVES								
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					times and more baseflow in lower reaches • This alternative provides significant potential to improve groundwater resources	improve groundwater resources	potential to improve groundwater resources	
Surface water quality	Impact of the alternative on in-stream water quality	• Number of proposed stormwater management control measures and their location within the study area • Nature and significance of changes to the overall water quality system	• Can be expected to negatively affect water quality through increased bank erosion, riparian vegetation displacement, and sediment accumulation	• Meets design criteria for water quality	• On-line location will result in increased disturbance during construction • Meets design criteria for water quality following construction downstream of facilities but reduced water quality upstream of facilities	• On-line location will result in increased disturbance during construction • Meets design criteria for water quality	• Meets design criteria for water quality	• Meets design criteria for water quality
ECONOMIC ENVIRONMENT								
Total Capital Cost	Relative overall capital costs, including restoration / enhancement costs for the alternative. Lower cost alternatives are preferred	• Capital costs of alternative relative to other alternatives	• No cost	• Less than average costs due to smaller pond sizes	• Average capital costs, but with more front end costs for the municipality	• Average capital costs, but with more front end costs for the municipality	• Average capital costs	• Average capital costs

Table 16: Evaluation Criteria

DESIGN ALTERNATIVES								
Evaluation Criteria	**Description**	**Measure**	**Alternative 1 Do-Northing**	**Alternative 2 Off-Line Water Quality and no Water Quantity Control**	**Alternative 3 On-line Water Quality and Quantity Controls**	**Alternative 4 On-line Water Quantity and Off-line Water Quality Controls**	**Alternative 5 Distributed Off-line Water Quality and Quantity Controls**	**Alternative 6 Grouped Off-line Water Quality and Quantity Controls**
Total Maintenance Cost	Relative annual costs for operation & maintenance activities for the alternative. Lower cost alternatives are preferred	• Operation & Maintenance (O&M) costs of the alternative relative to other alternatives	• No O&M costs for facilities • Additional costs for flood damage caused by lack of water quantity controls	• Average maintenance costs for facilities • Additional costs for flood damage caused by lack of water quantity controls	• Average maintenance costs, but fewer locations	• Average maintenance costs	• Average maintenance costs, but more locations	• Average maintenance costs, but more locations
TECHNICAL ENVIRONMENT								
Ability to Provide Required Flood Protection	The ability of the alternative to maintain/enhance the existing level of flood protection. Alternative must satisfy flood protection requirements	• Flood protection provided to required levels	• Required flood protection not provided	• Required flood protection not provided	• Required flood protection provided	• Required flood protection provided	• Required flood protection provided	• Required flood protection provided
Ease of Construction/ Implementation	The ability of the alternative to be easily implemented on a technical, regulatory, and practical basis. Alternatives that are easier to construct / implement are preferred	• Type of structure/construction required • Permitting / approval requirements • Difficulty of construction / implementation (access, site specific conditions, coordination between facilities)	• No construction is required for this alternative, but it will be difficult from an approval standpoint because it does not provide the required level of stormwater management control	• This alternative is simple to construct since the stormwater management controls can be constructed for individual developments as they are brought online using standard methods • It will be difficult from an approval standpoint because	• This alternative requires the construction of several large facilities with significant land acquisitions and upfront costs borne by the municipalities. The large on-line facilities are non-standard and may require more	• This alternative requires the construction of several large water quantity facilities with land acquisition and upfront costs borne by the municipality. Off-line water quality facilities will be simple to construct.	• This alternative is simple to construct since the stormwater management controls can be constructed on a development basis using standard methods	• This alternative requires the construction of several stormwater management corridors. Construction can be phased with development with some land acquisition and some upfront costs borne by the municipality

Table 16: Evaluation Criteria

DESIGN ALTERNATIVES								
Evaluation Criteria	**Description**	**Measure**	**Alternative 1 Do-Northing**	**Alternative 2 Off-Line Water Quality and no Water Quantity Control**	**Alternative 3 On-line Water Quality and Quantity Controls**	**Alternative 4 On-line Water Quantity and Off-line Water Quality Controls**	**Alternative 5 Distributed Off-line Water Quality and Quantity Controls**	**Alternative 6 Grouped Off-line Water Quality and Quantity Controls**
				it does not provide the required level of stormwater management control	stringent permitting requirements			
Ability to Meet Agency Requirements	The ability of the alternative to meet MECP, Municipalities, Essex Region Conservation Authority, Windsor Airport requirements	• Nature and location of SWM controls • Nature and location of water bodies in relation to the Windsor Airport	• Does not meet most agency requirements • Not attractive to bird species (no permanent water)	• Meets some agency requirements • Average attractiveness to bird species	• Meets most agency requirements • High attractiveness to bird species	• Meets most agency requirements • High attractiveness to bird species	• Meets most agency requirements • Average attractiveness to bird species	• Meets most agency requirements • Average attractiveness to bird species
CULTURAL ENVIRONMENT								
Aesthetics	The ability of the alternative to maintain or enhance the appearance of the existing and newly created local natural areas and stormwater management control measures. Alternatives that maintain or improve existing aesthetic values are preferred	• Nature and location of encroachment within existing natural areas • Nature and location of stormwater management control measures	• This alternative maintains current level of visual aesthetics	• This alternative maintains current level of visual aesthetics	• This alternative provides significant potential to enhance visual aesthetics	• This alternative provides significant potential to enhance visual aesthetics	• This alternative maintains current level of visual aesthetics	• This alternative provides significant potential to enhance visual aesthetics
Health and Safety	The potential risk or liability to the	• Nature and location of risk	• This alternative does not provide	• This alternative does not provide	• This alternative provides the	• This alternative provides the	• This alternative provides the	• This alternative provides the

Table 16: Evaluation Criteria

			DESIGN ALTERNATIVES					
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	community and operations staff health and safety resulting from: • Flood events • Recreational use • Operation and Maintenance Alternatives that maintain or improve safety are preferred	• Public accessibility to risk areas • Flood control operational requirements	the required level of flood control and therefore has a high degree of associated flood risk	the required level of flood control and therefore has a high degree of associated flood risk • This alternative has numerous areas of water storage with a higher probability of public interaction	required level of flood control • This alternative concentrates the water storage area to reduce the interaction with the public compared to the other alternatives	required level of flood control • This alternative has numerous areas of water storage with a higher probability of public interaction	required level of flood control • This alternative has numerous areas of water storage with a higher probability of public interaction	required level of flood control • This alternative concentrates the water storage to reduce interaction with the public compared to other alternatives
Recreational Opportunities	The ability of the alternative to maintain, enhance, and manage recreational opportunities within the study area. Alternatives that maintain or enhance opportunities are preferred	• Nature and location of stormwater management control measures relative to recreational areas including trails, sports fields, and other recreational infrastructure	• This alternative maintains existing opportunities	• This alternative maintains existing opportunities	• Potential enhancement to recreational opportunities from the creation of large water bodies	• Potential enhancement to recreational opportunities from the creation of large water bodies	• This alternative maintains existing opportunities	• Potential enhancement to recreational opportunities from the creation of recreational/SWM corridors
Archaeological Resources	The ability of the alternative to conserve (known and potential) archaeological resources within the study area. Alternatives that avoid or preserve archaeological resources in-situ are	• Proximity of stormwater management areas to archaeological resources and areas of archaeological potential • Nature of potential disturbance. Example of Effect:	• No stormwater construction is proposed. Impacts to potential cultural heritage resources are expected to be minimal	• Some stormwater construction is proposed. Impacts to potential archaeological heritage resources are possible.	• Stormwater construction is concentrated in a few locations. Impacts to potential archaeological resources are possible	• Stormwater construction is concentrated in several locations. Impacts to potential archaeological resources are possible	• Some stormwater construction is proposed. Impacts to potential archaeological resources are possible.	• Some stormwater construction is proposed. Impacts to potential archaeological resources are possible.

Table 16: Evaluation Criteria

			DESIGN ALTERNATIVES					
Evaluation Criteria	**Description**	**Measure**	**Alternative 1 Do-Northing**	**Alternative 2 Off-Line Water Quality and no Water Quantity Control**	**Alternative 3 On-line Water Quality and Quantity Controls**	**Alternative 4 On-line Water Quantity and Off-line Water Quality Controls**	**Alternative 5 Distributed Off-line Water Quality and Quantity Controls**	**Alternative 6 Grouped Off-line Water Quality and Quantity Controls**
	preferred. See areas of archaeological potential on Figure 17.	○ Disturbance requiring mitigation excavation of archaeological resources Impacts to registered and unregistered cemeteries which have been identified and documented						
Built Heritage Resources / Cultural Heritage Landscapes	The ability of the alternative to conserve (known and potential) cultural heritage resources within the study area. Alternatives that avoid or preserve cultural heritage resources in-situ are preferred. See areas identified Cultural Heritage Resources on Figure 18.	• Proximity of stormwater management areas to built heritage resources and cultural heritage landscapes • Nature of potential disturbance. Example of Effect: ○ Displacement of built heritage resources and/or cultural heritage landscape by removal and/or demolition and/or disruption by isolation ○ Disruption of resources by the	• No stormwater construction is proposed. Impacts to potential cultural heritage resources are expected to be minimal	• Some stormwater construction is proposed. Impacts to potential cultural heritage resources are possible.	• Stormwater construction is concentrated in a few locations. Impacts to potential cultural heritage resources are possible	• Stormwater construction is concentrated in several locations. Impacts to potential cultural heritage resources are possible	• Some stormwater construction is proposed. Impacts to potential cultural heritage resources are possible.	• Some stormwater construction is proposed. Impacts to potential cultural heritage resources are possible.

Table 16: Evaluation Criteria

DESIGN ALTERNATIVES								
Evaluation Criteria	**Description**	**Measure**	**Alternative 1 Do-Northing**	**Alternative 2 Off-Line Water Quality and no Water Quantity Control**	**Alternative 3 On-line Water Quality and Quantity Controls**	**Alternative 4 On-line Water Quantity and Off-line Water Quality Controls**	**Alternative 5 Distributed Off-line Water Quality and Quantity Controls**	**Alternative 6 Grouped Off-line Water Quality and Quantity Controls**
		introduction of physical, visual, audible, or atmospheric elements that are not in keeping with the character and setting of the cultural heritage resources						

5.3.3 Summary of Assessment

The following is an assessment of the alternatives:

- The proposed work requires construction within natural hazard areas, including watercourses, potentially impacting water quality, fish and fish habitat. The impacts can be mitigated through the implementation of best management practices, such as water quality and erosion controls, construction timing and site restoration.
- An assessment of whether or not the proposed works will result in serious harm to fish (impact to fish and fish habitat) requiring DFO authorization will be undertaken at the functional design stage with DFO.
- Minor impacts to significant woodlands are anticipated. Vegetation removal is limited and may be mitigated through the implementation of best management practices, such as establishing healthy vegetation and enhancing existing natural corridors.
- The proposed alternatives have the potential to impact riparian vegetation, natural stream morphology and erosion. These can be mitigated through the restoration or improvement of existing grades, vegetation cover following construction and sediment and erosion control measures during construction.
- Alternatives 2, 3, 4, 5, and 6 may result in more bird habitat or attractants to the open water bodies. Discouraging bird use can be promoted by sufficiently vegetating the water’s edge with thick woody species, and constructing berms to limit bird access, habitat and minimize food sources.
- The proposed work may potentially result in the minor loss of significant wildlife habitat that may impact wildlife movement corridors present within the study area. Minor displacement of wildlife may occur during construction; however, it is anticipated that wildlife will return once construction is complete. Areas where provincially threatened or endangered species have been identified should be protected with best management practices (i.e., snake fencing and monitoring during construction).
- Alternatives 2, 3, 4, 5, and 6 have SWM features adjacent to and within the regulated natural hazard features, including construction in the floodplain and will require a permit from ERCA, in addition to MECP and MNRF approvals.
- The proposed works, except of the Do-Nothing option have the potential to impact archaeological and cultural heritage resources. Additional assessment and potential mitigation may be required and will be identified through future studies.

5.3.4 Alternative Evaluation

For each evaluation criteria a relative preference rating was assigned to each alternative. That is, for each criterion a particular alternative was either highly preferred, moderately preferred, or was generally not preferred. This information was tabulated for all of the criteria and is presented in Table 17. Based on this evaluation matrix Alternative 6 is the preferred option. The scores for each alternative were calculated as both a sum of all criteria and an equal weighting for each of the four major categories.

Table 17: Evaluation Summary

	Do-Nothing	Off-line Water Quality and no Water Quantity Control	On-line Water Quantity and Quality Controls	On-line Water Quantity and Off-line Water Quality Controls	Distributed Off-line Water Quantity and Quality Controls	Grouped Off-line Water Quantity and Quality Controls
Criteria	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**	**Alternative 5**	**Alternative 6**
Natural Environment						
Terrestrial Resources, Vegetation and Wildlife Implications	1	5	5	10	10	10
Fisheries Resources and Aquatic Habitat Implications	1	1	1	10	10	10
Groundwater and Baseflow Implications	1	1	10	10	5	5
Surface Water Quality	1	5	5	10	10	10
Total	4	12	21	40	35	35
Average	1	3	5	10	9	9
Economic Environment						
Total Capital Cost	10	5	1	1	1	1
Total Maintenance Cost	1	1	5	5	5	5
Total	11	6	6	6	6	6
Average	5.5	3	3	3	3	3
Technical Environment						
Ability to Provide Required Stormwater Management Controls	1	1	10	10	10	10
Ease of Construction/ Implementation	1	1	1	5	10	5
Ability to Meet Agency Requirements	1	1	1	1	10	10
Total	3	3	12	16	30	25
Average	1	1	4	5	10	8
Social / Cultural Environment						
Aesthetics	5	5	10	10	5	10
Health and Safety	1	1	10	5	5	10
Recreational Opportunities \ Social Infrastructure	5	5	10	10	5	10
Archaeological Resources	10	5	5	5	5	5
Built Heritage Resources / Cultural Heritage Landscapes	10	5	5	5	5	5
Total	31	21	40	35	25	40
Average	6	4	8	7	5	8
Total (sum of all criteria) out of 140	**49**	**42**	**79**	**97**	**96**	**106**
Total (sum of category averages) out of 40	**14**	**11**	**20**	**25**	**27**	**28**

Notes: The rating scale is based on a relative preference where high =10, moderate = 5, and low = 1

6.0 Description of Preferred Alternative

This section describes the preferred solution for the flood control as selected through the evaluation process outlined in Section 5.

6.1 Recommended Stormwater Management Solution

Based on the assessment of the natural, social, and economic impacts of the various alternatives, Alternative 6 was selected as the preferred alternative. The recommended stormwater solution in the context of the proposed land use plan is presented in Drawing 3. Note that land use designations are for information purposes only, and the appropriate Official Plan Land Use Schedules should be consulted for up to date land use information. Future development will be subject to approval under the appropriate Planning Act process.

The preliminary preferred alternative (Alternative 6) provides all stormwater management controls before outletting to the downstream watercourses. Each facility would be required to provide water quality, water quantity, and erosion controls on a standalone basis. In this alternative the SWM facilities are grouped into stormwater management corridors to promote natural linkages, recreational trails, and greenways. The SWM facilities can provide controls for more than one property and will be located adjacent to other facilities and a watercourse. It is anticipated that facilities would be designed and constructed as development proceeds. The study area will be developed by multiple landowners and the preferred alternative supports the ability of individual landowners to proceed independently while minimizing the total number of SWM facilities.

The stormwater areas are proposed to be congregated into stormwater management corridors which can be combined with trail systems and amenity areas for the surrounding developments. The stormwater management corridor will be located beside watercourses which will accept outflow from the end-of-pipe facilities. Heavy vegetation adjacent to all water bodies and minimal open water will also be implemented in order to make water features less attractive to bird species, a specific request from the Windsor Airport. As part of this work, most of the existing municipal drains are proposed to be abandoned and several new channels will be created that align with the proposed land use plan for the area. In addition, the work will include re-grading the stream channel banks to create benches or terraces, which will help dissipate energy and re-connect the bankfull channel to a floodplain area.

Advantages of the preferred location include the following:

- Staging Flexibility – This alternative minimizes the number of facilities while providing flexibility with respect to their staging and construction.
- Avian Habitat – The avian habitat area is relatively concentrated, which provides continuous linkages for predators, reduces the number of sites to be monitored, and provides more separation between nesting and foraging areas.
- Ease of Permitting – SWM facilities are located offline of each watercourse easing approval issues. Individual SWM facilities generally follow typical designs leading to easier approval.
- Stormwater Pumping – fewer facilities and grouped locations (with one pump for multiple properties) should lead to fewer pumping stations when compared to standard one facility per property strategies.
- Recreational Opportunities – The potential exists to create new trail networks through the corridors due to the continuity of the grouped SWM system.
- Fish Passage – The stormwater management areas are located offline of the existing watercourses and no additional barriers to fish movement are created. The conveyance system remains fish habitat similar to the existing municipal drain network.
- Erosion - re-grading the banks to create benches or terraces will re-connect the bankfull channel to a floodplain area, thereby reducing erosion and improving fish habitat.

6.1.1 Design Criteria

Stormwater management (SWM) criteria were established based on discussions with the Essex Region Conservation Authority (ERCA) the Town of Tecumseh (Town) and the City of Windsor (City). The SWM criteria applied to the site are as follows:

- Water Quality - Provide sufficient permanent pool and extended detention volume to meet MECP Normal (Level 2) criteria as identified in Table 3.2 of the SWMPD Manual.
- Water Quantity – Control post-development peak flows to the municipal drain capacity. Greenfield and infill development should control peak flows to the following rates:
  - 2-year – 0.003 m^3/s per hectare of drainage area.
  - 5-year – 0.004 m^3/s per hectare of drainage area.

  - 100-year – 0.006 m^3/s per hectare of drainage area.

- Low Impact Development methods may be considered to provide stormwater management controls, and potentially offset the need for end-of pipe storage and permanent pool volume.

- Erosion Control – Provide erosion control in order to mitigate increased runoff volumes and durations associated with urban development with SWM controls in order to maintain the existing erosion regime in Little River.

- Pumping - Storm sewers are to be pumped out between rainfall events if the sewer invert is below the permanent pool elevation. The City requested that the normal water level in the SWM pond (permanent pool elevation) be at or below the storm sewer invert. If the sewers are lower than the pond outlet, pumping will be required. Based on existing functional design studies completed by The Town, all ponds in the Tecumseh Hamlet require pumps.

- Catchment Areas - Recommended drainage area for SWM Facilities is 20 to 30 ha, with a required minimum of 10 ha.

- Monitoring Program – to confirm the designed features continue to operate as intended. Details to be confirmed with ERCA, the municipality, and MECP regional office.

- Follow specific City of Windsor Design Guidelines. Noteworthy City of Windsor Guidelines include:

  - Primary pedestrian paths/trails should be paved and set above the100-year water level. Secondary paths can be gravel and below the 100-year water level.

  - Prior to the City assuming a new pond an Operations and Maintenance Manual (OMM) is required.

  - Aquatic plants and surrounding landscaping should be selected to discourage large waterfowl and phragmites.

  - Construct ponds and establish vegetation prior to ponds being brought on-line. Temporary facilities can be used until vegetation is established and the permanent SWM facility is brought on-line.

  - Freeboard is required above the 100-year water level and should be mowable (i.e., 4:1 slopes) or planted with vegetation that does not require mowing.

6.1.2 Recommended Stormwater Management Strategy

Generally, the SWM strategy involves traditional SWM ponds grouped along a corridor. The primary benefits of this option include the concentration of stormwater management features to provide support for natural linkages, recreational trails, and greenways. This strategy also provides larger buffers between natural and developed areas, fewer SWM facilities, and flexible staging. Low Impact Development strategies can also be employed to provide stormwater management controls, minimize open water areas and potentially reduce SWM facility footprints.

Minor flows primarily drain through storm sewers toward to the downstream facilities. Pumping stations may be required in some areas due to the flat grades and design standards (such as pipe cover, pipe slope, and suitable outlet elevations). The storm sewer network should be reviewed during functional design.

Major flows generally drain overland towards the downstream receiver, typically along roads or easements. Pumps are not typically used on major system flows, although some depressed storage areas without positive outlets (including SWM facilities) can be pumped down between events. The major flow system should be reviewed during functional design.

Functional stormwater management corridors have been developed based on the existing drain alignments, as well as the proposed transit and recreational corridors as shown on Drawing 3. The location of the SWM corridors and individual SWM facilities are preliminary estimates and modifications are possible as additional design information becomes available.

The SWM corridor will consist of a main channel and an adjacent SWM facility as shown on Figures 19 to 26. The SWM corridor was sized to provide the required volumes for SWM controls and to provide an outlet channel for upstream areas. An additional 15 m of width was included for the SWM Facilities (Figures 24 and 26) to account for additional contingencies. Proposed impervious areas were calculated for each catchment based on an assumed land use plan in order to determine the required permanent pool and active storage volumes. The SWM corridor is approximately 325 m wide for Upper Little River (assuming a SWM facilities on either side of the channel) and 200 m wide for all other tributaries (assuming a SWM facility on one side of the channel). These corridor widths are sufficient to accommodate a permanent pool elevation 6 m below grade with 5:1 side slopes. These corridors are reserved until functional design has confirmed the required corridor width, following which surplus lands will be released.

The cross section includes several benches which are only flooded during high flow events. The 100-year storm is contained within the SWM corridor. The wet ponds were designed assuming 1.5 m of permanent pool depth, although they have sufficient area to accommodate larger depths. For wet ponds the SWMPD Manual recommends mean permanent pool depths between 1 to 2 m with a maximum depth of 3 m. The Town of Tecumseh anticipates that permanent pools deeper than 1.5 m will be required for their ponds.

A cross section was established assuming a distance of 6 m from the permanent pool to the top of the pond block with 5:1 side slopes. An improved channel was also assumed beside the SWM Facility with a valley bottom width of approximately 10 m. The cross sections also include trails, safety benches, and maintenance access roads. As shown on Figures 24 and 26 a SWM Facility with a channel has a corridor width of 200 m while a central channel with SWM Facilities on either side has a corridor width of 325 m. A length of corridor was assigned to each catchment to determine the total storage volumes. The design includes conservative assumptions to accommodate future changes in catchment area, imperviousness, depth to the permanent pool, or climate change. Potential options to increase storage volumes include fewer or smaller trails/access roads/safety benches, a smaller valley bottom width, and use of the 15 m contingency width.

The total length of proposed channel is less than under existing conditions. While portions of Upper Little River resemble a natural channel, the majority of the municipal drain system is considered channelized with a straight channel with no pools, riffles, and minimal shading. The remaining channels are proposed to be improved to offset for the loss of the municipal drains, such that there is a net increase in the available fish habitat.

The proposed conditions model was based on draft land use planning completed as part of the following studies with mapping contained in Appendix H and summarized in Drawing 4:

- Windsor Airport Master Plan (2010)
- Tecumseh Hamlet Secondary Plan (2011)
- Draft Windsor South Sandwich Secondary Plan (2011)
- East Pelton Secondary Plan (2009)

This Master Plan process is intended to guide future development of SWM features based on an assumed land use plan. The final land use plan will be determined through subsequent Planning Act applications (plans of subdivision, official plan/zoning bylaw amendments, etc.).

The average proposed imperviousness of the watershed is approximately 50%. Existing and proposed flows calculated using PC-SWMM are shown in Table 18 for the 24-hour Chicago Storm. Proposed peak flows are less than existing at all locations as the individual SWM Facilities are sized to control the proposed 100-year flow to the existing municipal drain capacity (approximately equal to the 2-year 24-hour rainfall event). The drainage area to Upper Little River and 9th Concession Drain has been increased upstream of Baseline Road in order to increase baseflows to this section of the river similar to pre-agricultural conditions (i.e., before the area was extensively modified for agricultural purposes). The flow to 6th Concession Drain has decreased significantly as water from the south of the existing catchment area was diverted into the SWM corridor along the proposed east-west arterial road, which will mitigate existing capacity and erosion issues documented within this drain. Road crossings were unchanged from the existing conditions model.

Table 18: Flow Summary

Description (model node existing/proposed)	**Existing Flow (m^3/s)**			**Proposed Flow (m^3/s)**		
	2 Yr.	***5 Yr.***	***100 Yr.***	***2 Yr.***	***5 Yr.***	***100 Yr.***
9th Concession Drain at Highway 401 (J46)	3.8	5.6	8.9	3.2	4.5	8.7
6th Concession Drain at 9th Concession Road (J51/J47)	13.9	16.4	22.3	6.9	8.2	10.7
Little River at Baseline Road (J5090/J82)	25.8	22.6	34.7	12.1	15.6	24.4
Little River at County Road 42 (J5110/J92)	21.0	26.4	39.8	10.5	14.9	23.9
Little River at CP Railway (J24)	21.5	29.0	45.4	9.8	13.8	24.1
Little River at E.C. Row Expressway (J5180/J17)	23.3	31.9	50.6	10.6	14.8	26.8

The Upper Little River Drain, 6th Concession Drain, Gouin Drain, Lachance, Drain, Desjardin Drain, Little 10th Concession Drain, McGill Drain, Washbrooke Drain, Downing Drain, Beehan Drain, and portions of 9th Concession Drain are proposed to be retained and enhanced, while most of the remaining drains are proposed to be abandoned as outlined in Table 19.

Table 19: Summary of Proposed Municipal Drain Modifications

	Estimated Channel Length (m)			
	Existing	**Removed**	**Enhanced**	**No Change**
North-South Drains				
6th Concession	1,900	0	0	1,900
7th Street	2,600	0	0	2,600
7th Concession	2,600	2,600	0	0
8th Concession	4,500	4,500	0	0
Hayes	1,750	1,750	0	0
9th Concession	4,400	2,500	1,900	0

Table 19: Summary of Proposed Municipal Drain Modifications

	Estimated Channel Length (m)			
	Existing	**Removed**	**Enhanced**	**No Change**
Little River u/s Baseline Rd.	3,700	0	2,200	1,500
Little River Baseline to Rail line	3,900	0	3,900	0
Watson	4,200	4,200	0	0
10th Concession	2,800	800	1,500	500
Downing	1,600	1,100	500	0
Talbot McCarthy	1,800	1,800	0	0
Beehan	2,700	0	700	2,000
Quick	1,500	0	0	1,500
East-West Drains				
Hurley	2,500	1,000	1,500	0
Washbrook	900	0	900	0
North Townline	3,900	3,900	0	0
6th Concession	4,100	0	4,100	0
Baseline	1,400	0	0	1,400
St. Louis	1,000	200	0	800
Soulliere	3,700	3,300	400	0
Soulliere B	1,000	200	800	0
Desjardins	3,300	400	1,900	1,000
Lachance	2,200	500	1,000	700
Gouin	3,100	700	1,200	1,200
McGill	3,900	0	0	3,900
Rivard	2,400	900	1,500	0
Lappan	3,300	0	0	3,300
Russette	5,700	0	0	5,700
New E-W Arterial	0	0	4,000	0
Total	**82,350**	**30,350**	**28,000**	**28,000**

The existing 100-year flood elevations exceed the banks of the Upper Little River floodplain. Guidance from ERCA requested that flood elevations be reduced below the top of bank elevations. The existing drainage system is generally straight with steep banks while the proposed channel cross section includes a more naturalized cross section allowing for floodplains, riparian zones, a meandering channel, and flatter banks. The proposed stormwater management facilities are located within the proposed drainage corridor and off-line of the improved channels. Outflows from the individual ponds were reduced to the capacity of the existing municipal drainage network to allow individual developments to proceed independently without downstream flooding. Existing and proposed water levels are shown in Table 20 along with the existing ground elevations. At all locations the proposed water levels are less than existing conditions and the 100-year flows is generally contained within the banks of the improved channel cross section with some flooding in undeveloped low areas upstream of the E.C. Row Expressway.

Table 20: Proposed Water Level Summary

Location	Existing Conditions MacLaren (1985)		Existing Conditions Stantec		Proposed Conditions		Elevation Data Windsor Airport Survey (1990)		
	100-year Water Level (m)	Flow (m^3/s)	100-year Water Level (m)	Flow (m^3/s)	100-year Water Level (m)	Flow (m^3/s)	Ground upstream of road crossing (m)	Road Spill (m)	Road at Crossing (m)
Baseline Road	184.08	24.4	184.13	34.7	183.67	24.4	183.9	184.3	184.5
Country Road 42	182.63	24.4	183.20	39.8	181.95	23.9	182.2	182.6	182.9
Lauzon Parkway	182.12	24.4	182.52	40.1	181.49	23.6	182.2	182.3	183.7
Lauzon Road	181.72	27.7	182.01	43.7	181.21	23.2	181.1	181.6	182.0
CP Rail Line	181.56	34.0	181.64	45.4	180.85	24.1	181.1	182.4	182.4
Twin Oaks Drive	180.91	39.5	180.97	49.5	180.28	25.8	180.5	182.0	182.0
E.C. Row Expressway	180.72	42.8	180.81	50.6	180.18	26.8	180.0	181.4	183.0
Forest Glade Drive	180.32	42.8	180.41	51.4	179.84	27.4	179.5	180.5	181.0

The existing conditions model used survey data and municipal drain reports for the channel dimensions. The proposed conditions model assumed improved cross sections with additional flow capacity and fish habitat for all channels upstream of the rail line. The proposed flows are less than existing following stormwater control and any development will result in reduced water levels even without an improved channel. The improved channel is designed to improve fish habitat and contain flood waters in the channel.

The Windsor Airport has several zones it uses to monitor avian species as shown on Drawing 3 and summarized below:

- Zone of no tolerance – if the airport finds birds in this area they will be removed immediately.
- Zones of no confidence – if the airport finds birds in this area they will be monitored closely, and they will likely be removed in the near future.
- 2 and 4 km radius circles (2 km originally but currently 4 km). All features that attract birds (including SWMFs) are inspected monthly. Bird populations are tracked and will only be removed if they present a danger to the Airport.

Open water typically included in constructed wetlands and wet ponds is not preferable near the Windsor Airport (within 2 km) due to its attractiveness to avian species. A combination of a dry pond with additional auxiliary treatment as part of a treatment train is recommended within this zone. Possible auxiliary measures include Oil/Grit Separator units, bio/grass swales, or other Low Impact Development methods. Where space is limited, underground storage with an Oil/Grit Separator may also be used. The permanent pool area should be minimized whenever possible to reduce the attractiveness to avian species.

The preferred alternative includes space for an integrated community parks and trail system. The final design of the SWM corridor is meant to function as SWM controls and a community park. The multi-use trail along the SWM corridor will link to surrounding existing and future trail networks. The trail system will provide a valuable community amenity to residents. It is intended that this corridor and associated trail network will be established as development proceeds, and may be subject to further Class EA, Planning Act, Municipal Drain, or other appropriate processes.

For the proposed conditions modelling, SWM controls for each catchment area were assumed to be provided by a single wet pond type SWM facility. Wet pond type SWM facilities were assumed to reduce the footprint of the facilities, although other facility types and SWM controls are possible. The characteristics of the proposed SWM facilities used in the modelling are shown in Table 21. To achieve sufficient storage volumes a bottom of pond width of 40 m, a permanent pool width of 45 m, and a top of pond width of 65 m were assumed for each pond with the width determined by the length of the corridor. Permanent pool elevations are based on gravity drained ponds (i.e., no pumping was assumed) and may require modification during functional design dependant on site grading. Peak flow and volume requirements for each catchment are shown in Table 22. Due to the large active storage volumes required less than 20% of the SWM block is currently proposed to be permanently wet. During functional design it is expected that more facilities will be required (more than one per catchment area) to suit individual site constraints.

Table 21: Proposed SWM Design Characteristics

Catchment Number	Area	Imperviousness	Outlet Channel Invert	Permanent Pool Elevation	Water Quality Volume Required	Permanent Pool Required	Extended Detention Volume Required	Active Volume Required
	(ha)	(%)	(m)	(m)	(m^3/ha)	(m^3)	(m^3)	(m^3)
2020	66.1	67%	186.40	186.90	126	5,665	2,645	60,814
2030	117.6	49%	184.80	185.30	104	7,555	4,703	80,530
2035	81.4	63%	185.40	185.90	121	6,568	3,257	70,234
2045	63.8	43%	183.20	183.70	98	3,701	2,552	40,319
2050	97.3	47%	184.40	184.90	102	6,011	3,894	64,421
2055	65.1	50%	182.20	182.70	105	4,216	2,604	45,692
2060	112.7	57%	183.40	183.90	113	8,229	4,509	87,571
2065	116.3	77%	185.72	186.22	139	11,478	4,653	121,469
2075	117.7	47%	187.00	187.50	102	7,238	4,708	77,226
2080	69.8	11%	187.00	187.50	66	1,814	2,790	20,626
2085	100.9	35%	187.25	187.75	90	5,045	4,036	54,343
2090	72.8	31%	180.92	182.42	86	3,332	2,913	36,468
2095	118.0	47%	182.40	182.90	102	7,256	4,719	77,412
2100	50.6	56%	180.92	181.92	112	3,624	2,023	39,518
2105	60.9	50%	181.90	182.40	105	3,929	2,436	42,695
2110	49.8	52%	180.06	181.56	107	3,348	1,992	36,640
2115	113.6	37%	180.06	181.56	92	5,906	4,543	63,329
2125	93.4	55%	179.10	180.60	110	6,537	3,735	69,908
2130	80.6	80%	182.40	182.90	143	8,324	3,222	88,554
2133	93.1	65%	183.40	183.90	123	7,757	3,723	82,639
2135	22.8	50%	178.67	180.17	105	1,472	913	17,059
2140	82.1	33%	178.70	179.70	88	3,941	3,284	42,821
2155	77.3	50%	178.68	180.18	105	4,984	3,091	53,706
2165	179.1	53%	179.40	179.90	108	12,135	7,165	128,330
2175	47.3	66%	178.30	178.80	124	3,973	1,892	43,159
2185	65.4	55%	178.00	179.50	110	4,600	2,616	49,698
2190	85.0	54%	178.75	179.25	109	5,820	3,398	62,428
2200	784.1	36%	178.95	179.45	91	40,187	31,366	421,044
2210	58.2	63%	178.40	178.90	121	4,698	2,330	50,723
2215	106.7	57%	179.00	179.50	113	7,787	4,267	82,955

Table 22: Proposed SWM Operating Characteristics

Catchment Number	Area	Maximum Depth			Maximum Flow			Flow per Unit area			Municipal Drain Capacity
		2-year	5-year	100-year	2-year	5-year	100-year	2-year	5-year	100-year	
	(ha)	(m)	(m)	(m)	(m^3/s)	(m^3/s)	(m^3/s)	(L/ha)	(L/ha)	(L/ha)	(m^3/s)
2020	66.1	0.73	0.97	1.65	0.226	0.286	0.409	3.4	4.3	6.2	0.384
2030	117.6	0.80	1.07	1.82	0.396	0.512	0.742	3.4	4.4	6.3	0.682
2035	81.4	0.74	0.99	1.70	0.274	0.348	0.498	3.4	4.3	6.1	0.472
2045	63.8	0.69	0.96	1.81	0.209	0.274	0.413	3.3	4.3	6.5	0.370
2050	97.3	0.71	0.98	1.78	0.310	0.410	0.615	3.2	4.2	6.3	0.565
2055	65.1	0.85	1.15	1.94	0.233	0.294	0.399	3.6	4.5	6.1	0.378
2060	112.7	0.67	0.89	1.58	0.331	0.441	0.667	2.9	3.9	5.9	0.654
2065	116.3	0.67	0.88	1.53	0.326	0.417	0.603	2.8	3.6	5.2	0.675
2075	117.7	0.69	0.92	1.67	0.320	0.426	0.668	2.7	3.6	5.7	0.683
2080	69.8	0.75	1.08	2.09	0.151	0.246	0.686	2.2	3.5	9.8	0.405
2085	100.9	0.71	0.95	1.73	0.189	0.294	0.532	1.9	2.9	5.3	0.585
2090	72.8	0.61	0.85	1.68	0.195	0.265	0.424	2.7	3.6	5.8	0.422
2095	118.0	0.68	0.92	1.71	0.308	0.410	0.618	2.6	3.5	5.2	0.684
2100	50.6	0.79	1.10	1.90	0.194	0.231	0.299	3.8	4.6	5.9	0.293
2105	60.9	0.68	0.96	1.81	0.198	0.254	0.371	3.3	4.2	6.1	0.353
2110	49.8	0.72	0.98	1.77	0.174	0.221	0.313	3.5	4.4	6.3	0.289
2115	133.6	0.61	0.81	1.56	0.289	0.418	0.673	2.5	3.7	5.9	0.659
2125	93.4	0.66	0.89	1.63	0.273	0.349	0.505	2.9	3.7	5.4	0.542
2130	80.6	0.66	0.88	1.50	0.242	0.307	0.426	3.0	3.8	5.3	0.467
2133	93.1	0.66	0.87	1.51	0.271	0.353	0.528	2.9	3.8	5.7	0.540
2135	22.8	0.70	0.98	1.76	0.087	0.108	0.151	3.8	4.7	6.6	0.132
2140	82.1	0.68	0.98	1.92	0.234	0.315	0.482	2.9	3.8	5.9	0.476
2155	77.3	0.70	0.97	1.79	0.238	0.303	0.436	3.1	3.9	5.6	0.448
2165	179.1	0.70	0.92	1.68	0.442	0.635	0.952	2.5	3.5	5.3	1.039
2175	47.3	0.99	1.27	1.95	0.149	0.184	0.254	3.2	3.9	5.4	0.274
2185	65.4	0.68	0.95	1.74	0.204	0.260	0.374	3.1	4.0	5.7	0.379
2190	85.0	0.89	1.11	1.86	0.087	0.200	0.377	1.0	2.4	4.4	0.493
2200	784.1	0.62	0.81	1.42	1.018	1.599	3.142	1.3	2.0	4.0	4.548
2210	58.2	0.98	1.16	1.77	0.040	0.085	0.205	0.7	1.5	3.5	0.338
2215	106.7	0.82	1.03	1.69	0.146	0.256	0.499	1.4	2.4	4.7	0.619
Average		0.79	0.98	1.73	0.26	0.36	0.58	3	4	6	0.63

When an individual area is proposed for development the location of the Ultimate SWM facility should be determined based on Drawing 3. The size of the facility will depend on the method of stormwater controls and the imperviousness of the site. Based on the competed modelling the average permanent pool area is approximately 75 m^2/ha of drainage area, the average area for active storage volume is 420 m^2/ha, and the average storage volume is 725 m^3/ha. Depending on the progress of development interim SWM controls may be required before an ultimate SWM facility can be constructed. Interim SWM facilities will have the same requirements (peak flow, etc.) as the Ultimate facilities.

6.1.2.1 Post Development Groundwater Recharge

A preliminary site-wide post-development monthly water balance was also completed using the same approach described previously for existing conditions. The post development conditions were assigned impervious percentages as follows:

- Residential – 50%;
- Commercial/Industrial – 90%;
- Mixed Use – 80%; and
- Open Space/Natural Heritage – 5%

It was also assumed that the post-development topography could be represented by the existing average slope across the Site. The estimated annual recharge, runoff, and evapotranspiration under the proposed post-development conditions are included in Appendix G. Total annual post-development recharge to the groundwater system is calculated to be 2,810,348 m^3, which is equivalent to 89 L/s or 63 mm/yr. This represents a recharge deficit of approximately 2,886,265 m^3 or 92 L/s (65 mm/yr.) compared to the estimated existing recharge conditions. As noted in Section 4.2, the existing tile drain network captures some of the infiltrated water outletting it directory to the surface drain network and prevents it from becoming baseflow, but the exact amount of tile drainage is difficult to quantify, so the actual deficit is expected to be less than the calculated value. Longer drawdown times from SWM facilities are recommended to extend flow durations in the channel network.

6.1.3 Summary of Proposed Projects

Based on the assessment of the natural, social, and economic impacts of the various alternatives, Alternative 6 was selected as the preferred alternative. The recommended stormwater solution in the context of the proposed land use plan is presented in Drawing 3. Note that land use designations are for information purposes only, and the appropriate Official Plan Land Use Schedules should be consulted for up to date land use information. Future development will be subject to approval under the appropriate Planning Act process.

A summary of the proposed projects that form the recommendations of the Master Plan is included in Table 23 below. The Master Plan will serve as a 'parent' document to subsequent more detailed studies undertaken in the Upper Little River Watershed area. Subsequent SWM Studies which are being completed in a greater level of detail at the time of preparation of this Master Plan are summarized in Table 23. Note that implementation of individual projects will be dependant on available funding or opportunities for incorporation into other capital projects (e.g., planned road improvements). Alternatively, projects may be implemented as part of ongoing development activities (e.g., plans of subdivision under the Planning Act).

The preferred stormwater servicing strategy is intended to be constructed in stages as needed for development to progress. Should upstream areas progress before downstream areas are completed the constructed portions of the SWM corridor would outlet to the existing municipal drain system. Some coordination may be necessary between SWM blocks in areas where pumping stations can be combined to reduce future maintenance costs. The location of the SWM corridor is preliminary and while some modifications are expected during final design individual stages should not compromise other stages. Interim SWM controls may be required on-site while the ultimate facility is constructed and properly vegetated. Interim SWM controls have the same requirements as the ultimate facilities and must drain to a suitable outlet.

Table 23: Master Plan Project List

Project Area	Description/limits	Municipality	Subsequent SWM Study	Catchment
Gouin Drain SWM - Windsor	Section within Windsor	Windsor	Sandwich South Master Servicing Plan	2210
Lachance Drain SWM - Windsor	Section within Windsor	Windsor		2175
Desjardins Drain SWM - Windsor	Section within Windsor	Windsor		2140
Little 10th Conc Drain SWM	From South of CR 42 to Little River	Windsor		2125 and 2155
Little River SWM 1	CR42 to CPR	Windsor		2135, 2185, and 2200
Little River SWM 2	Baseline Road to CR42 (CR42 Secondary Plan)	Windsor		2110 and 2115
Little River SWM 3	E-W Arterial Road to Baseline Rd (CR42 Secondary Plan)	Windsor		2090
Little River SWM 4	Hwy 401 to E-W Arterial Road	Windsor		2095
Baseline Road SWM 1	7th Conc Rd to 8th Conc Rd (East Pelton Planning Area north)	Windsor		2030
Baseline Road SWM 2	8th Conc Rd to 9th Conc Rd (CR42 Secondary Plan)	Windsor		2045 and 2055
Baseline Road SWM 3	9th Conc Rd to Little River (CR42 Secondary Plan)	Windsor		2090
Baseline Road SWM 4	Municipal boundary to CR17	Windsor		2105
Baseline Road SWM 5	CR17 to Little River (CR42 Secondary Plan)	Windsor		2100
E-W Arterial Rd SWM 1	7th Conc Drain to 8th Conc Rd (East Pelton Planning Area south)	Windsor		2020 and 2035
E-W Arterial Rd SWM 2	8th Conc Rd to 9the Conc Rd	Windsor		2050 and 2060
E-W Arterial Rd SWM 3	9th Conc Rd to Little River	Windsor		2095
E-W Arterial Rd SWM 4	Municipal Boundary to CR17	Windsor		2133
E-W Arterial Rd SWM 5	CR17 to Little River	Windsor		2130
Gouin Drain SWM - Tecumseh	Section within Tecumseh	Tecumseh	Tecumseh Hamlet	2215

Table 23: Master Plan Project List

Project Area	Description/limits	Municipality	Subsequent SWM Study	Catchment
Lachance Drain SWM - Tecumseh	Section within Tecumseh	Tecumseh	Secondary Plan, EA & Functional Servicing Review	2190
Desjardins Drain SWM - Tecumseh	Section within Tecumseh	Tecumseh		2165
Oldcastle Stormwater Master Plan	South of Highway 401	Tecumseh	Oldcastle Stormwater Master Plan	2065, 2075, 2080, and 2085

6.2 Impact Assessment and Mitigation for the Preferred Alternative

The following discussion deals with the ecological processes and features of the subject lands in relation to the future development. Mitigation measures for each of the potential ecological impacts of the proposal described above are discussed, followed by a summary of the net impacts following the implementation of the mitigation. Development within 120 m of an existing natural feature will require an Environmental Impact Assessment demonstrating no negative impacts

The primary strategy for maintaining natural heritage features and functions has been the avoidance of the most significant and sensitive areas through design of the proposed development. The following discusses the specific potential impacts on the key natural features in terms of both direct and indirect impacts.

The preliminary layout of the stormwater management controls will be distributed along the following watercourses: Gouin Drain, Lachance Drain, Desjardins Drain, Little 10th Concession Drain, McGill Drain, Little River, Little River Drain, 6th Concession Drain, 9th Concession Drain, Washbrooke Drain, Downing Drain, and Beehan Drain. In addition, a proposed watercourse and stormwater management corridor will run parallel to the new east-west arterial road (located between Baseline Road and Highway 401). The proposed east-west arterial road will cross the existing Hayes Drain, as well as the 7th, 8th, 9th Concession Drains. The proposed alternative requires the widening of existing watercourses and construction of SWM facilities for water quantity, water quality, and erosion control.

During the planning, design, and construction of the preferred alternative, the potential exists for adverse environmental impacts on the natural features and ecological functions identified within the study area. The potential also exists for the preferred alternative to impact flooding, erosion and the natural meander pattern of these watercourses, although mitigation measures to minimize such impacts are provided.

The opportunity exists at this time to provide an environmentally responsible alternative that shows no negative impacts through the implementation of mitigation, restoration and enhancement of areas impacted by the preferred alternative. This approach is consistent with the objectives and policies of the City of Windsor Official Plan, the Town of Tecumseh Official Plan, and Environmental Assessment procedures.

6.2.1 Review of Potential Impacts

6.2.1.1 Wetlands

The Windsor Airport Swamps Provincially Significant Wetlands (PSW) were identified on the Airport Lands. Functional design will need to demonstrate that any proposed development will not have any negative impact to the hydrological functioning of the existing wetlands, or to the hydrologic regime that maintains the wetlands. No other wetlands were identified in the Study Area.

6.2.1.2 Woodlands

One significant woodlot will be directly impacted by the preferred alternative. A proposed stormwater channel runs adjacent to a 2 ha woodlot. The woodlot functions as a hydrological linkage as it is immediately adjacent to the Little River (CNHS, 2008). Vegetation removal is likely to be limited to a small number of trees adjacent to the watercourse to create small ponds for stormwater drainage. The total impact on the woodlot is anticipated to be less than 25%. One rare butterfly species was identified in this community during field investigations, however no species at risk were observed.

6.2.1.3 Wildlife Habitat

A proposed channel located along McGill Drain, extending into the southeast portion of the airport lands is suitable habitat for Eastern Foxsnake (threatened in Ontario) and Butler's gartersnake (endangered in Ontario). These species were identified on site during field investigations within the airport lands area. Potential impacts to snake habitat are anticipated with the preferred alternative. Permitting requirements may require that lands be restored to natural conditions to achieve an overall benefit. The extent of regulated habitat and permitting requirements for these species at risk should be confirmed with MECP during land use planning.

The development of wet ponds and/or wetlands may be attractive to bird species. Bird use of these areas should be discouraged by planting thick vegetation before the ponds are in use to establish healthy vegetation; encouraging perennials by not mowing around the ponds; designing varied topography in/around the ponds, such as berms, mounds or shallow areas to promote woody vegetation; and by keeping water level fluctuations to a minimum to promote larger vegetation.

The preferred alternative could result in the loss of significant wildlife habitat including a portion of the woodlots. The location of the SWM features can be modified to avoid significant habitat and additional studies are required to demonstrate no negative impact to significant habitat. It is not anticipated that the proposed works will impact the function of wildlife movement corridors that may be present within the study area. Minor displacements of wildlife will occur as a result of the loss of some vegetation communities and from temporary work that is proposed to occur within identified snake habitat; however adjacent areas within the study area provide suitable habitat. Minor displacement of wildlife may occur during construction of the stormwater channels; however, it is anticipated that wildlife will return once construction is complete.

6.2.1.4 Fish Habitat

The preferred alternative will require the widening of most of the channels as well as in-water work to enhance fish habitat (such as the creation of pools and riffles) and erosion control. Construction should be completed during dry periods or during low water levels. Channel widening requiring in-water works should be anticipated for the purpose of the impact assessment. In addition to the channel widenings, the proposed alternative requires the construction of SWM facilities. These activities will have a potential impact on aquatic habitat.

A portion of the proposed stormwater system will be located along watercourses that support direct fish habitat. No impacts to fish habitat are anticipated with the construction of small SWM Facilities as long as appropriate mitigation measures are in place during construction to prevent impacts to downstream fish communities. Minor changes to flow contribution are anticipated which could potentially impact fish habitat. Consultation with DFO and ERCA at the final design stage will be required to discuss mitigation of impacts and assess the requirements for offsetting. DFO should be contacted during functional design to provide input on offsetting options and approval requirements.

6.2.1.5 Construction Impacts

Construction impacts have the potential to negatively affect natural features on the subject lands. Standard construction practices should be employed to ensure no sedimentation and/or damage is incurred to the natural areas and features identified for preservation. These practices include the installation of silt fencing around the perimeter of the construction areas to ensure no encroachment into areas identified for preservation. Fencing should be regularly checked and repaired as necessary. Buffers for all natural features being retained should be well-marked, fenced, and respected.

Generally, noise generated by construction activities represents a short-term disturbance to wildlife using the subject lands. It is expected that with the completion of construction, wildlife will quickly return to their normal use patterns within the natural areas adjacent to the development.

6.2.1.6 Human Impacts

The proposed development, through the implementation of additional trails and new development, has the potential to increase impacts to natural features from the introduction of human activity to an area that currently doesn't experience these anthropogenic disturbances. Potential mitigation measures include well-marked walking trails to discourage creation of informal trails, signage to educate trail users about the sensitivity of the natural features in the area, and trash receptacles placed at intervals along the trails to discourage littering. Other mitigation measures may be required to show no negative impacts from residential intensification on wildlife populations.

6.2.1.7 Potential Impacts to Groundwater Supply Aquifers

Private wells completed throughout the Site currently obtain their potable water supply from the Intermediate, Lower, or Bedrock Aquifer. As shown on Figures 9 to 12, these aquifers are overlain by tens of metres of unweathered silt and clay, which are reported to have hydraulic conductivities ranging from 10^{-8} m/s to 10^{-10} m/s (Dillon, 1988). Given the thickness and low permeability of these overlying deposits, the vertical migration of potential contaminants from the surface towards these aquifers is expected to be limited. Consequently, the future development of the Site is not anticipated to cause any detrimental impacts to the underlying groundwater supply aquifers.

6.2.1.8 Potential Impacts to Groundwater Recharge and Baseflow

Under current conditions, the total volume of groundwater recharge that is calculated to occur across the Site annually is 5,696,612 m^3, which is equivalent to a recharge rate of 181 L/s or 128 mm/yr. Assuming that all groundwater recharge that occurs across the Site annually will ultimately discharge to Little River and its tributaries, a subsequent reduction in recharge of 92 L/s resulting from development may result in a comparable reduction in the baseflow to these watercourses. Consequently, mitigation measures will be required to maintain or enhance groundwater recharge across the Site under post-development conditions.

6.2.1.9 Cultural Heritage Resources

Archaeological Resources

The Stage 1 archaeological assessment identified portions of the study area that exhibit a moderate to high potential for the identification and recovery of archaeological resources as shown on Figure 17. The preferred alternative is not defined in enough detail in this Master Plan (Approach 1) to determine areas requiring further archaeological assessment in the study area. The intent is that the Stage 1 archaeological assessment herein be used to further guide detailed design of the preferred alternative in subsequent studies (see Section 8.1).

Avoidance of impacts to archaeological resources and areas of archaeological potential is preferred. Where the proposed design and activities could impact areas of archaeological potential (refer to Figure 17), a Stage 2 AA (and further stages if recommended) shall be undertaken by a licensed archaeologist as early as possible during detail design and prior to any ground disturbance activities.

Cultural Heritage Resources and Cultural Heritage Landscapes

The CHRA identified 14 CHRs in the study area (report in Appendix N). As discussed above, the preferred alternative is not defined in sufficient detail in this Master Plan (Approach 1). Accordingly, an impact assessment or appropriate site plan controls cannot be determined since the relationship of Project Activities to identified CHRs is not known. The intent is that the CHRA herein be used to further guide detailed design of the preferred alternative in subsequent studies. In general, designs that avoid or protect the identified CHRs in-situ are preferred. An impact assessment shall be completed where appropriate in accordance with the MHSTCI Standards and Guidelines (See Section 8.1) and prior to any construction in areas of identified heritage resources.

In general, the following should be taken into account for each CHR to eliminate any potential impacts:

- The design should be planned in a manner that avoids any identified CHRs.
- All staging and construction activities should be planned and undertaken to avoid impacts to an identified CHR.
- Site plan controls should be put in place prior to construction to prevent potential Project impacts. Site plan controls include mapping CHRs on construction mapping and physically demarcating these properties to communicate the presence of these properties to construction crews. Physical protective measures should include at minimum the installation of temporary fencing around CHRs.
- If project work is to occur within 50 metres of identified CHRs, it is recommended that a qualified building condition specialist or geotechnical engineer with previous experience working with heritage structures be consulted to identify appropriate vibration mitigation measures in advance of construction. Mitigation measures for vibration may include developing an appropriate vibration setback distance, a vibration attenuation study, and/or a construction monitoring program.
- Post construction landscaping and rehabilitation plans should be undertaken in a manner that is sympathetic to the overall setting.

Should Project activities require demolition or removal (in its entirety or partial) of any identified (known or potential) built heritage resource / cultural heritage landscape, a heritage impact assessment shall be undertaken by a qualified person in consultation with the City of Windsor Heritage Planner. All technical cultural heritage studies should be undertaken as early as possible during detailed design and prior to any final design being endorsed.

6.2.2 Mitigation for the Preferred Alternative

Impacts could be mitigated through the implementation of best management practices, such as erosion and sediment controls, site restoration and construction timing.

Table 24 summarizes the recommended mitigation and enhancement measures, and their suggested application, to minimize and mitigate the potentially adverse environmental impacts associated with the planning, design and construction of the proposed stormwater and drainage master plan. This information should be used in preparing the final detailed design plans, construction timing, agency approvals and on-going monitoring to ensure that the natural environment features identified within this report are protected, maintained, restored and enhanced (where applicable) through the implementation of the preferred alternative.

Table 24: Potential Impact and Mitigation Measures (Fish, Wildlife, and Vegetation)

Potential Impact	Recommended Mitigation and Enhancement Measures
Aquatic Habitat, Fisheries and Water Quality	
Direct impacts to fish or fish habitat	• Minimize the footprint of any required channel works associated with the stormwater management and drainage plan during the design process to minimize the length of watercourse (fish habitat) affected by channel works • Use natural channel design principals in the design of new/modified channels • Ensure sufficient fish passage is provided at all proposed channel widening locations where direct fish habitat exists • Restore vegetation and aquatic habitat (substrate) to pre-construction condition (or better), ensuring that any habitat features (pools, riffles, structures) are restored or enhanced. • Any serious harm to fish (impact to fish or fish habitat) that may result from the proposed channel widenings and wet ponds causing change in flow contribution may require prior Authorization including

Table 24: Potential Impact and Mitigation Measures (Fish, Wildlife, and Vegetation)

Potential Impact	Recommended Mitigation and Enhancement Measures
	offsetting, from DFO. However, serious harm to fish can likely be adequately avoided through implementation of appropriate avoidance and mitigation measures during the design and construction process • Implement enhancements to riparian vegetation through the planting of over-hanging grasses, shrubs and trees will improve stream cover, reduce temperature impacts, and provide allochthonous inputs (food source for various fish species)
Increased turbidity and siltation in downstream areas resulting in “smothered” plants and animals due to the deposition of silt and increased turbidity of surface watercourses	• Ensure erosion control measures are installed and maintained throughout all phases of construction to protect exposed surfaces, control run-off and minimize the deposition of silt or suspended sediments within downstream habitats • Worksite isolation and dewatering plans should be prepared to identify appropriate isolation methods, siltation controls and dewatering measures to be implemented. • Any pumped water resulting from dewatering activities should be discharged to settling areas or through filter media before entering the surface water bodies • Stage construction activity to minimize the frequency and duration of any in-water work, as much as feasible • Re-vegetate all disturbed areas as soon as possible following disturbance to stabilize the area and minimize erosion potential
Stress on fish communities	• Any fish that may occur within isolated work areas should be captured and released in accordance with appropriate MNRF protocols
Reduced water quality in downstream habitat areas	• Implement provisions during construction for quick and effective spill control, containment and response, ensuring cleanup materials are stored on-site for easy access

Table 24: Potential Impact and Mitigation Measures (Fish, Wildlife, and Vegetation)

Potential Impact	Recommended Mitigation and Enhancement Measures
	• Implement accurate reporting protocols to ensure quick and accurate reporting of all spills • Ensure all equipment entering the water (if deemed necessary) is properly washed and degreased prior to entering the watercourse • Ensure refuelling stations are located outside of the floodplain and at least 30 m from the watercourse • Establish and maintain erosion and control measures throughout all phases of construction
Timing effects of construction on aquatic species	• Staging of work to avoid spawning and breeding activity • No in-water work should occur between March 15th and June 30th in accordance with MNRF Fisheries timing windows. Applicable timing windows shall be confirmed prior to construction.
Loss of aquatic habitat	• Fishery offsetting treatments are proposed to augment the remaining aquatic habitat. Each treatment will fulfill specific design functions that are related to controlling flow direction, maintaining pool features, dissipating flow energy, enhancing aquatic habitat, or combinations thereof • Constructed riffle features are in-water structures that can be constructed of rocks and boulders. Some of the constructed riffles can use logs as part of the structure, to incorporate some wood. Small pocket pools in the constructed riffle, will allow fish passage during periods of lower flow • Stream banks situated along the outside of meanders in pools can be strengthened with woody debris toe protection. These structures are composed of woody debris and soil (below bankfull stage) and coir soil wraps near and above bankfull stage. The purpose of the treatment is to roughen the stream bank, thereby reducing near bank shear stress and reducing the bank erosion potential. Live plantings are installed near the bankfull stage to promote root

Table 24: Potential Impact and Mitigation Measures (Fish, Wildlife, and Vegetation)

Potential Impact	Recommended Mitigation and Enhancement Measures
	penetration and development and to ensure that a living structure becomes established after the woody material decays. The treatments may be constructed at a relatively steep angle, which maximizes pool depth and improves fish habitat • Rock cross vanes are proposed as instream structures for the channel works. The cross-vane is a 'U' shaped grade control structure that acts to decrease near-bank shear stress, while increasing energy in the center of the channel. The cross-vane is positioned to establish grade control at key locations and to provide a small drop in elevation across the structure. A double cross-vane, sometimes called a 'W-weir', can be used at the confluence of two channels • J-Hooks are in-water treatments made from a combination of logs, root wads and boulders or only boulders. The structures are keyed firmly into the bank. The purpose of these features is to control the direction of flow, help maintain pool depths and to enhance aquatic habitat. To prevent the snagging of debris or branches on the logs during high flows, branches and potential snags should be removed and smoothed out from the log prior to installation • A step pool structure is primarily used for grade control. This structure serves to maintain the integrity of the upstream riffle while promoting scouring in the downstream pool. The structure is comprised of a footer log and header log placed across the stream channel at the beginning of a meander bend. A second header and footer log is place downstream at the centre point of the meander. The logs are plated with filter fabric and back filled with riffle substrate mixture. A scour pool is constructed downstream of each log pair • Boulder toe protection is a method of bank protection to reduce the risk of erosion and scour. The structure

Table 24: Potential Impact and Mitigation Measures (Fish, Wildlife, and Vegetation)

Potential Impact	Recommended Mitigation and Enhancement Measures
	is comprised of boulders buried at the toe of the channel bank and boulders placed along the bank to the bankfull elevation. Boulder toe protection is used in areas where it would be difficult to implement a more natural tope protection such as woody debris toe protection
Terrestrial Habitat and Species	
Removal or disturbance of significant trees or ground flora	• Minimize tree removal and bank disturbance during construction. • Stabilize all disturbed areas upon completion of any grading works through re-vegetation of the disturbed areas utilizing native plant species (e.g., seed and mulch, compost mix, tree and shrub planting) • Consider restoration opportunities to compensate for the loss of habitat
Stress on biological communities	• The stress on wildlife is not anticipated to increase significantly due to temporary construction and rehabilitation of work areas. • Any wildlife displaced during construction will likely return upon completion of the work • Avoid construction impacts during sensitive wildlife periods, such as breeding seasons for various fish and bird species • Construction should occur during snake hibernation, and/or snake barrier fencing should be erected around the perimeter of the construction sites
Introduction of exotic species through disturbance	• Use only native species for all re-vegetation work and stabilize with native vegetation as soon as possible following construction activities
Interference with ecological corridors and linkages	• No interference points to the linkage function along the various watercourses are anticipated • Maintain watercourse corridors and woodland corridors to maintain existing wildlife and movement and migration potential

Table 24: Potential Impact and Mitigation Measures (Fish, Wildlife, and Vegetation)

Potential Impact	Recommended Mitigation and Enhancement Measures
Archaeological Resources	
Disturbance or destruction of archaeological resources	(Planning stage) • Undertake Stage 2 archaeological assessment to determine presence of archaeological resources • Avoidance, through alternative selection (Preliminary Design and Detail Design Stage) • Completion of a stage archaeological assessment where it was not undertaken in the Planning stage. At a minimum, a Stage 2, and if any archaeological resources are documented, the MHSTCI's Standards and Guidelines for Consultant Archaeologists will be followed in order to address follow-up Stage 3 archaeological assessment and, if required, Stage 4 archaeological mitigation • "Avoidance and protection" should be the preferred alternative. If the preferred alternative is not possible, a consultant archaeologist licensed under the Ontario Heritage Act should undertake archaeological excavation.
Built Heritage Resources / Cultural Heritage Landscapes	
Displacement of built heritage resources and/or cultural heritage landscape by removal and/or demolition and/or disruption by isolation.	• The full design of the preferred alternative should be suitably planned in a manner that avoids any identified cultural heritage resources (CHRs) • Site plan controls be put in place prior to any construction activities to prevent potential impacts. These controls should be indicated on all construction mapping and communicated to the construction team leads. This includes mapping CHRs within 50 metres of Project activities on construction maps and physically demarcating these properties to communicate the presence of these properties to construction crews. • Communities, groups and individuals with associations to a significant cultural heritage resource that may be affected shall be provided with opportunities to participate in understanding and

Table 24: Potential Impact and Mitigation Measures (Fish, Wildlife, and Vegetation)

Potential Impact	Recommended Mitigation and Enhancement Measures
	articulating the property's cultural heritage value and in making decisions about its future • All other alternatives having been considered, removal or demolition of a significant cultural heritage resource shall be considered as a last resort, subject to heritage impact assessment and public engagement. Best efforts shall be applied to mitigate loss of cultural heritage value.
Disruption of cultural heritage resources by the introduction of physical, visual, audible, or atmospheric elements that are not in keeping with the character and setting of those resources	• Minimize impact through horizontal/vertical alignments, and grading design to permit maximum retention of existing features • Utilize landscape planting plan to provide mitigation, screening and enhancement • Retain and maintain the visual settings and other physical relationships that contribute to culture heritage value. • Explore alternative alignments that retain and maintain the visual settings and physical relationships • Every effort should be made to retain a landscape's key characteristics
(Construction Stage) Disturbance, destruction or other effects on cultural heritage resources (cultural heritage landscapes, built heritage and/or archaeological resources)	• Protect sites by restricting access, reducing noise/vibration, and controlling dust • If work occurs within 50 metres of CHRs, it is recommended that a qualified building conditions specialist or geotechnical engineer with previous experience working with heritage structures be consulted to identify appropriate vibration mitigation measures in advance of construction. Mitigation measures for vibration may include developing an appropriate vibration setback distance, a vibration attenuation study, and/or a construction monitoring program. • Retain and maintain the visual settings and other physical relationships that contribute to cultural heritage value. Ensure that new construction, visual

Table 24: Potential Impact and Mitigation Measures (Fish, Wildlife, and Vegetation)

Potential Impact	Recommended Mitigation and Enhancement Measures
	intrusions, or other interventions do not adversely affect the heritage attributes of the property. • Post-construction landscaping and rehabilitation plans should be undertaken in a manner that is sympathetic to the overall setting

The above-referenced mitigation measures are standard procedures used at locations where in-stream or near stream works are required. Detailed mitigation and offsetting measures should be further developed as the detailed design of the preferred alternative is finalized in consultation with appropriate regulatory agencies.

Prior to any construction, development, or other alteration within or adjacent to Upper Little River Watershed, or associated floodplains, a *Development, Interference with Wetlands and Alterations to Shorelines and Watercourses* Permit will be required from the ERCA pursuant to *Ontario Regulation 158/06*. Other permits and approvals may also be required depending on the final detailed design in accordance with other legislation.

While localized impacts may occur during construction, the preferred alternative should result in a net environmental benefit to the watershed and natural systems. Any potential impacts should be mitigated through the implementation of appropriate measures, specifically designed and tailored to address the impacts and design of the preferred alternative, while any residual impacts should be offset through the implementation of site restoration and enhancement measures.

6.2.3 Recommendations

Opportunities exist to improve the overall terrestrial and aquatic habitat of the system that will help to restore and enhance the natural environment conditions within the study area. The following recommendations are provided for consideration:

- Lands bordered by the Little River and the Lauzon Parkway, from County Road 42 to the CPR main line are of particular natural heritage interest, supporting high species diversity, concentration of large woodlands and the confluence of drainage features. This area should be considered for ecological protection and restoration.
- All large rocks, stumps, large logs or any woody material existing on the present banks and excavation zone should be retained and reinstalled.

- Design the stream channel to accommodate fish passage.
- Cobble and boulders should be embedded into channel substrate to help retain natural stream sediment structure and flow velocities, and substrates should mimic pre-construction channel conditions with gravel, cobble and scattered boulders that will enhance fish habitat.
- In-stream cover should be replaced and enhanced in the construction areas (including woody debris or boulder clusters) to support habitat for invertebrates, predation refuge, and attachment sites for adhesive fish.
- All riparian vegetation cover that is not within the active construction zones shall be left untouched.
- Snake habitat within the airport lands should be enhanced through the construction of a hibernaculum at the direction of the MNRF. A snake monitoring survey should be conducted in association with any snake barrier fencing during construction.
- Fish habitat should be protected from increased erosion and excessive turbidity during construction activities through silt curtains and other protection measures recommended by ERCA and DFO.
- Maintain or enhance groundwater recharge and base flow across the Site under post-development conditions where possible. As a result, each development block within the Site will eventually require the completion of a detailed water balance to identify the constraints to, and opportunities for increased baseflow.
- Development within 120 m of an existing natural feature will require an Environmental Impact Assessment demonstrating no negative impacts.

6.3 Preliminary Opinion of Probable Costs

The development of alternative stormwater management solutions allows for a preliminary opinion of probably costs which are summarized in Table 25 with additional details provided in Appendix L. Alternatives 3 to 6 assume that proposed flows are attenuated to the capacity of the existing municipal drain network and have larger than normal storage volumes. Alternatives 2 to 6 assume the existing municipal drain network is abandoned and offsetting measures are required.

Table 25: Preliminary Opinion of Probable Costs

Description	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
	Do-Nothing	Off-Line Water Quality and no Water Quantity Control	On-line Water Quality and Quantity Controls Communal On-Line SWM	On-line Water Quantity and Off-line Water Quality Controls	Distributed Off-line Water Quality and Quantity Controls	Grouped Off-line Water Quality and Quantity Controls
Channel Improvements	N/A	$28,000,000	$28,000,000	$28,000,000	$28,000,000	$28,000,000
SWM Facilities	N/A	$15,000,000	$21,000,000	$33,000,000	$33,000,000	$30,000,000
Sub Total	N/A	$43,000,000	$49,000,000	$61,000,000	$61,000,000	$58,000,000
Allowance/ Contingency (15%)	N/A	$6,450,000	$7,350,000	$9,150,000	$9,150,000	$8,700,000
Design/ Construction Administration (10%)	N/A	$4,300,000	$4,900,000	$6,100,000	$6,100,000	$5,800,000
Grand Total	N/A	$53,750,000	$61,250,000	$76,250,000	$76,250,000	$72,500,000

7.0 Design Considerations

7.1 Windsor Airport - Avian Management

The containment of stormwater runoff in ponds creates wildlife habitat which can create the potential for increased collision hazards for aircraft (Blackwell et al., 2008). Wildlife incidents are not rare, nor are these incidents insignificant relative to the air safety or cost incurred (Cleary et al., 2007). For example, from 1990 to 2005, 66,382 wildlife collisions with aircraft were reported to the US Federal Aviation Administration; 97.5% of these indecent involved birds.

Based on discussions with the Windsor Airport Authority:

- The Airport authority is currently implementing bird control and monitoring within a 2 km radius of the airport as shown on Drawing 3.
- The airport zone range is 4 km (refer to Drawing 3) which includes:
  - Zone of no tolerance – if a bird is found it will be removed immediately.
  - Zone of no confidence – if a bird is found they will be monitored closely, and they will likely be removed in the near future.
  - 4 km radius – all features that attract birds (including SWM facilities) are inspected monthly. Bird populations are tracked and will be removed if they present a danger to the airport.
- Ponds near the airport that are currently causing issues have large bodies of open water surfaces and extended green space.
- Dry ponds are generally preferred. Wetland or wet ponds are acceptable provided they are sufficiently vegetated. That is, the ponds should have a suitable water's edge treatment (to make it difficult for birds to get into and out of the water), minimal food sources (including emergent vegetation and aquatic species), and generally not provide an attractive or easy habitat for bird species.

The restriction on available SWM controls varies depending on the distance from the airport. On airport property, permanent water is generally not permitted. Water quantity controls are provided in dry detention ponds or in underground storage areas while water quality controls are typically provided using a treatment train approach (a combination of enhanced grass swales, vegetated filter strips, oil/grit separator units, Low Impact Development methods and other best management practices (WSDOT, 2008)).

New ponds can sometimes have difficulty establishing healthy vegetation due to wildlife grazing and changing water levels. The ultimate ponds should be constructed and have established vegetation prior to being brought on-line. Temporary or Interim SWM facilities can be used until the permanent SWM facility is brought on-line.

Key SWM pond features to minimize attractiveness to birds:

- Minimize open water surfaces and fetch length.
- Minimize or eliminate shorelines and green spaces.
- Maximize large woody vegetation in and around ponds to restrict movement.
- Use native vegetation that can withstand being flooded for extended periods of time. This includes Button Bush, Black Willow, Peach Leaved Willow, Cottonwood, and Swamp Maple.
- Reduce emergent vegetation and mowed grass. Wetlands with an intermediate level of emergent cover (33-66% of wetland) had a greater avian species richness (Gibbs et al., 1991).
- The irregularity of the pond perimeter (the ratio of the pond perimeter to the perimeter of a perfect circle) showed that ponds with a more irregular shape were more attractive to birds (Blackwell et al., 2008). The pond perimeter should be minimized to create circular or linear designs.
- Increasing pond size showed a strong correlation with probability of use.
- Complete stormwater drawdown in a short period of time would likely reduce the probability of use by many aquatic foragers, by preventing establishment of a food source.

A critical step in selecting stormwater facilities for the airport environment is determining the wildlife species of concern that may be present in or attracted to new facilities (WSDOT, 2008). Habitat that is unattractive to some species may be attractive to others. The Windsor Airport Authority has identified birds (primarily waterfowl and gulls) as the greatest risk for the surrounding area because of their abundance, size, and ability to fly. In general, if open water areas or wetlands exist near an airport, shorebirds, gulls, ducks, herons, and geese may be an issue.

Waterfowl are commonly found where there is a combination of protection from predators, open water, wetland vegetation, and adjacent uplands for food, cover, and nesting (WSDOT, 2008). Of the shorebirds, gulls typically pose the greatest threat to aircraft. Gulls are highly adaptable birds that hunt prey and scavenge for food.

In general, vegetation that provides food and/or cover for wildlife species identified as hazardous to aircraft should be avoided at or near airports. Vegetation with berries, nuts, desirable forage, attractive flowers, edible tubers or roots, or large, abundant or high-nutrient seeds is a potential wildlife attractant and should be avoided (WSDOT, 2008). If open water is anticipated, provide dense shrub or groundcover vegetation that may deter potentially hazardous wildlife that prefer open water.

Structural features that provide shelter for wildlife species identified as hazardous should be avoided (WSDOT, 2008). Avoid constructing shallow-water wetlands or other habitats that may attract wading birds or that provide nesting habitat for waterfowl. Configure stormwater facilities to reduce line of sight. This includes using steeper embankments, narrower/longer configurations, shrub vegetation, fences, or other installations that disrupt sight lines and reduce comfort and habitat suitability for hazardous wildlife.

Vegetation can be used to discourage wildlife from open water areas (WSDOT, 2008). Waterfowl are attracted to interspersion of open water and emergent vegetation. If this characteristic is replaced by densely planted shrub vegetation, waterfowl may be less likely to use it. Tolerance to inundation varies among shrub vegetation species. Therefore, inundation depth, duration, and frequency may be considered when selecting species and communities. In addition, once the vegetation has been planted, it will take a while to become established enough to discourage birds. Until the vegetation has become established, special care must be taken to avoid excessive ponding, including possible temporary inflow diversion.

There are several methods available for avian management (Smith et al., 1999) including:

- Discontinuing of feeding by the public
- Habitat modification
- Hazing and Scaring Techniques
- Chemical Repellents
- Control of Reproduction
- Removal

Habitat modification techniques can be used in the design of the stormwater management facilities. The preferred habitat for geese is a large, unobstructed lawn area close to open water (Smith et al., 1999). Many urban features including parks, industrial sites, residential complexes, golf courses, and planned residential communities, provide such an environment. The basic principles of habitat modification include eliminating, modifying, or reducing access to areas that currently attract birds. As birds become more accustomed to people and urban landscapes, the success of avian management techniques continues to decrease.

Habitat modification alone usually cannot prevent birds from using an area, especially after a flock is established (Smith et al., 1999). Habitat modification methods include:

- **Elimination of straight shorelines, islands, and peninsulas**. Birds prefer long, straight, uninterrupted shorelines, well removed from heavy human traffic. These areas provide security and a good view of potential predators. Eliminating islands, or peninsulas, and modifying uninterrupted shorelines with shrubs or boulders every 5 to 10 m, may reduce an area's attractiveness to birds.

- **Placement of walking paths by water**. Geese prefer to rest or feed on grassy areas next to water. If walking paths are placed along a shoreline, birds may be less likely to use the immediate area for feeding, nesting, or loafing. This may not be practical for stormwater management ponds due the variation in water levels.

- **Placement of grassy areas away from water**. Placing grassy fields at least 400 m from water may reduce bird use during the molting period when birds are reluctant to move far from the safety of water. Geese with flight capabilities will readily use athletic fields a kilometre or more from water sources.

- **Removal of nesting structures.** Wildlife officials and well-intentioned private citizens sometimes build and maintain artificial nesting structures. Artificial nest structures are designed to reduce the threat of predators and are often safer than natural nest sites. Eliminating these structures may reduce bird production and make the area less attractive for nesting birds.

- **Modification of pond and field water levels**. Increasing the water level in a pond may flood preferred nesting areas. Reducing water levels in ponds may allow increased access to the nesting area by predators. Changes in the water level may impact other wildlife.

- **Encouragement of early water freeze-up**. Favorable winter habitat for geese includes open water. Eliminating fountains or water aerators leads to earlier freeze up, thereby eliminating winter habitat for the birds.

- **Overhead placement of lines or grid wires**. A grid or network of multiple parallel lines of wire, etc. restricts bird landing and takeoff. To increase effectiveness, the grid system should be in place before the birds arrive. Periodic maintenance is necessary to prevent sagging of the lines. Drawbacks to lines and grids include visual degradation of the area; impairment of access by people and other wildlife; and the risk of death, injury, or entanglement of birds.

- **Fence barriers**. Fences can prevent birds from walking from water to grazing areas. Fences are most effective during the pre-nesting period and during flightless periods in the early summer when birds have young or are molting. This technique will not work if birds fly into the area.

- **Vegetative barriers**. Shrubs or hedges may block favored pathways or obstruct their line of sight, making the area less attractive because of the potential for attack from predators. To be successful, a plant barrier must make birds feel that if they are threatened, that their ability to escape is reduced. Vegetative barriers work best when bird numbers are low and available habitat nearby is unoccupied. Any barrier planting will require protection from birds and other animals during establishment. Plants should be high enough (at least 1 m) to prevent adult birds from seeing through or over them, and dense enough to prevent the birds from waking through gaps between the plants or stems.

- **Rock Barriers**. When birds leave a water body, they generally use routes that allow them easy access onto land and a clear view of potential danger. Large boulders placed along the shoreline may create a barrier that discourages bird use and access to grazing sites. The boulders should be at least 0.6 m in diameter to hinder birds when they are getting out of the water.

- **Tall Trees**. On small ponds (less than 2000 m^2) trees located in the flight path between water and grassy areas may prevent birds from landing. The trees must be dense enough to prevent birds from flying through the canopy, and tall enough to increase the angel of climb or ascent above 13 degrees. Because most trees grow very slowly, this technique should be considered only as part of a long term management plan. This technique is effective in only discouraging birds from flying into an area and will not prevent them from walking to a grazing site. Some birds like areas with shade for grazing and loafing, and tall trees may actually attract them.

- **Decreased attractiveness of grazing areas**. Canada Geese prefer to eat grass, especially young shoots, which are found in abundance on mowed lawns. The area around a pond should not be mowed, fertilized, or watered. In addition, geese prefer Kentucky bluegrass and tend to feed less on tall fescue if given a choice. Planting less preferable plants or grass species to discourage birds from a specific area will be more effective if good alternative feeding sites are nearby. Geese will feed on almost any short grass or legume.

7.2 Mosquitoes

SWM facilities contain standing water which enables the breeding of mosquitoes. These mosquitoes can become a nuisance to people around the ponds. Habitat for birds, frogs, insects and other predators of the mosquito should be encouraged to limit the mosquito population. Frequent rain events (approximately every 4 to 5 days in southern Ontario) will provide some circulation of water in the pond, disrupting mosquito breeding. The use of SWM facilities may increase the mosquito population, but the benefits of SWM facilities (increased water quality and reduced flooding) outweighs the risks associated with increased mosquito populations.

The following information provides information on mosquito habitat and guidance for the design of SWM facilities to minimize mosquito use.

West Nile Virus is a mosquito borne illness that usually has no effect on humans. However, in rare cases, it can cause serious health problems and may cause encephalitis (swelling of the brain) which could lead to death. The very young, the elderly, and those with weakened immune systems are most susceptible to the disease, although others can be affected.

The virus' life cycle requires both birds and mosquitoes, and humans can be infected if they are bitten by an infected mosquito. There are two mosquito species of greatest concern for West Nile Virus; *Culex pipiens* and *Culex restuans*. They live in urban areas and although they prefer birds, they may bite both birds and people. *Culex* mosquitoes have a limited flight range (less than 1 kilometre) and this means that the adults are found close to their hatching site. These mosquitoes are usually bred in very sheltered stagnant water and their larvae are often found in tires, eaves troughs, rain barrels, birdbaths and other puddles that last longer than one week. In general, research has shown that stagnant water in urban areas, including roadside catchbasins, have the highest numbers of these mosquito species, while natural wetlands and SWM facilities pose the least risk.

The availability of resources and risk of predation are key factors to success of aquatic organisms. Predator-prey interactions are largely controlled by the availability of structural refuges. Mosquitoes generally do best in temporary water bodies were there are few predators. General guidelines to discourage mosquitoes include:

- Hydrology – A greater water depth will help to ensure that the ponds won't dry up in-between rainfall events and will help to maintain cooler temperatures. Mosquitoes avoid agitated water and female mosquitoes tend to avoid laying eggs in running or agitated water. Mechanical aerators are available, but have an ongoing maintenance cost. Mosquitoes prefer areas with fluctuating water levels. When water levels suddenly rise or fall marginal vegetation is either inundated or left stranded. Predator-free habitat is often created in pools amongst the stems of emergent plants. Mosquitoes prefer temporary (ephemeral) water bodies because they tend to be warmer and have few predators. The presence of predators and competitors often depends on the permanence of the water body. So permanent, deep bodies of water with small changes in water level are best to minimize mosquito habitat. Benching of manholes is also recommended to eliminate ponded water.

- Reduce Nutrients – Mosquitoes require nutrients and algae for successful breeding. It is important to ensure that suspended solids settle out quickly. Mosquito larvae feed on algae and suspended solids and they thrive in warm turbid water. Proper functioning of a SWM facility will reduce the amount of suspended solids and nutrients in the water.
- Biomanipulation – Introduce/encourage predators and competitors into the mosquito habitat. Female mosquitoes can detect the presence of some larval predators and competitors in the water (i.e., fish and tadpoles). Predators include snails, may fly larvae, chironomids, water striders, water boatmen, whirligig beetles, flatworms, leeches, dragonfly, alderfly larvae, water beetles, fish, frogs, and toads. These species will gradually populate SWM ponds but they can be introduced earlier.
- Habitat Enhancement – Mosquito larvae tend to avoid submerged and floating plants so plantings should discourage cattails and encourage floating leaved plants such as water lilies. The design of the SWM facility as a wet pond, where the main body of the pond is too deep for cattail habitat, will help to encourage this type of growth. Visual predators don't like murky water and proper maintenance of the SWM facility will help to ensure that it operates as designed and maintains a suitable habitat for competitors and predators.

7.3 Stormwater Pumping

Due to the grading constraints across the study area some stormwater management facilities may not have a positive outlet during all events and will require mechanical pumps to drain. This is caused by the existing flat topography as well as the minimum storm sewer slopes and depths. The preferred alternative has attempted to reduce the number of SWM facilities to limit the number of pumps and ongoing maintenance costs.

There are two typical configurations for stormwater pumping:

- The storm sewer is below grade and the SWMF is at grade. Where the grade differential is high (where flooding would occur along the storm sewer without a pump), large pumps are required to operate over short durations in order to raise the water into the pond during rainfall events. Where the grade differential is low (where flooding won't occur along the storm sewer without a pump), the storm sewers can be dewatered between rainfall events using a smaller pump.
- The storm sewer and the SWMF are below grade. Pumps are required to raise the water into the outlet channel. Smaller pumps are generally required due to the lower, controlled flows out of the SWM facilities. Ideally the pond would be set less than 1 m below the outlet channel so that high flows do not need to be pumped. This method typically has lower capital and maintenance costs.

General pump guidance includes:

- Provide an overflow outlet in case of pump failure. Ideally the 100-year rainfall event would have a positive outlet to limit flooding.
- Provide backup power.
- If multiple pumps are required for a pump station, they should be the same model. Different sized pumps are not recommended.
- Average slope of the storm sewer should not exceed approximately 0.35%.
- The number of pumping stations should be minimized due to maintenance requirements.
- Where possible one pump station can be used for several facilities. The ponds would be connected together such that the pond outlets are combined.

To determine the suitability of the catchment areas for pumped or gravity outlets a conceptual storm sewer was developed. A sewer was assumed from a SWM facility location to the furthest upstream portion of its catchment area with a slope of 0.35%. Most of the catchments do not have sufficient cover based on these assumptions. The final grading on an individual property will determine the pumping requirements, but it is expected that the majority of the site will require pumping. Detailed calculations are included in Appendix H.

7.4 Landscaping

This section provides guidelines for landscaping the stormwater management corridor. Native trees, shrubs, grasses, wildflowers, and aquatic plants provide food, shelter, and nesting areas for many wildlife species (Native Plant Species of Essex Region, 1998). Native plants are those that originated in Essex Region, not in Europe or other areas, and thus are well adapted to local conditions. They are available at local nurseries, conservation agencies, and from hobby growers.

The areas around a SWM facility can typically be differentiated by their relative wetness into permanently wet areas, shoreline areas, moderate areas, and upland areas. Each zone contains typical (native) vegetation species as outlined in Appendix F.

Mowing should be limited to observation posts and trails, and should be avoided around the pond and natural areas. Some species can tolerate harvesting, including Black Willow limbs, which has been requested by Caldwell First Nation.

Maintenance staff has noted concerns with Phragmites in existing ponds in the area. Invasive Phragmites (not to be confused with native Phragmites) is a perennial grass that was transported from Eurasia and is causing severe damage to coastal wetlands and beaches in North America (MNR, 2011). Stands of Phragmites decrease biodiversity and destroy habitat for other species. Controlling invasive Phragmites before it becomes well established will reduce the environmental impacts, time, and costs. Once invasive Phragmites is confirmed, a control plan should be developed and implemented taking into consideration any site specific conditions such as native plant diversity, wildlife usage, and water table fluctuations.

Management options for control of invasive Phragmites include mechanical excavation, flooding, herbicide application, and prescribed burning (MNR, 2011). In Phragmites stands where there is standing water present (i.e., most SWM facilities) the MNRF recommends that herbicides not be applied, to cut/mow the stalks as low as possible, and to tarp over Phragmites stands. Flooding of the Phragmites (for a minimum of 6 weeks) is another possible management option for SWM ponds, but this method would reduce the pond storage capacity and would result in higher peak flows downstream during a flood event. If only a few ponds were flooded within the entire system, the impact on peak flows would be relatively low.

7.5 Climate Change

Climate change refers to the long term trend in the change of the world’s weather patterns, including changes in average temperature and rainfall distribution. Stormwater runoff is intrinsically a function of rainfall, therefore change in the intensity, duration, and frequency of rainfall events has an impact on runoff, and the response of stormwater systems. Aquatic habitat health is also linked to temperature.

Institute for Catastrophic Loss Reduction

The Institute for Catastrophic Loss Reduction (ICLR) produced two reports of relevance to this study. In the first, they note that with respect to climate change, that there were seven flood producing heavy rain events in the Toronto area with intensities exceeding the expected return period value (the highest precipitation value on average occurring once in a 20-year period) during the period of 1987– 2007 (Institute for Catastrophic Loss Reduction, 2012).

> *While the days with greater than 10 mm precipitation remained unchanged, the number of days with higher precipitation, above 30 mm, has moderately increased with warmer temperature, which has the capability to hold more moisture; this trend is projected to continue. Projecting forward for Ontario, the annual maximum 24-hour precipitation rate that at present occurs once every 20 years, will occur more often and become a once every 12 to14-year event. Meanwhile, in northern Ontario the occurrence rate will lower from once every 20*

> *years to closer to once every 10 years. With more heavy precipitation events over Ontario, there will be an increased risk of flash floods.*
>
> *A study of April–November rainfall extremes of four selected river basins (Grand, Humber, Rideau and Upper Thames) showed large percentage increases in future three-day accumulated rainfall extremes with a warming climate. The 20-year return values of annual maximum three-day accumulated rainfall totals are projected to increase by 30% to 55% for the period 2026 to 2075. Since the observed annual maximum three-day accumulated rainfall totals are about 80 mm, these are larger changes (25–45 mm) than the average projected for Canada as a whole. There are uncertainties in all these projections, but they all show significant increases in the intensity of extreme precipitation events.*

In the second report, it is noted that urban flood damages are a recurrent and growing issue for municipalities, insurers and homeowners across Canada. Damages from urban flood events often total in the $10s and $100s of millions of dollars. In July, 2012, a storm moved through southern Ontario affecting several neighbourhoods in Hamilton and Ottawa, resulting in $90 million in insured damages (ICLR, 2013).

An extreme rainfall event that affected a large region of southern Ontario from Hamilton to Durham Region in August, 2005 resulted in over $500 million in insured damages, $247 million of which was associated with sewer backup.

Canadian municipalities have faced litigation for sewer backup events. Homeowners can have home damage, item loss, and health issues from flooding and sewer backups. Homeowners may also encounter sewer backup insurance coverage limits, increasing premiums or cancellation of sewer backup coverage after the experience of multiple basement flood events. Flood insurance in Canada has historically not covered damages from overland flow.

Therefore, changes in rainfall patterns which affect SWM facility performance can have significant social and economic effects when the systems are no longer able to as effectively meet the objectives they were designed for.

MTO Studies

The MTO published their Identification of the Effect of Climate Change on Future Design Standards of Drainage Infrastructure in Ontario – Final Report in June, 2005, the purpose of which was to identify the effect of climate change on future highway drainage infrastructure in Ontario. Specifically, the study determined that the intensity-duration-frequency (IDF) curves shows significant changes in the precipitation intensity between the current and the future time periods. Climate change that produces an increase in the intensity of precipitation will increase the magnitude of the design discharge and that would most likely result in adverse effects on existing drainage facilities.

The study notes that "Although many organizations are undertaking various researches on climate change, there are no well-established methodologies to relate the anticipated changes in weather to the impact of such changes on the performance of hydraulic structures such as bridges, culverts and sewer systems."

As such, the study developed a methodology to assess the potential impacts of climate change on IDF values. Two study areas of interest were selected: The Grand River Region in southern Ontario, and the Kenora and Rainy River Region in northwestern Ontario.

The study found that:

> *overall, rainfall intensities with an X-year return period (X= 5, 10, 20, 50, 100) under current climate conditions are almost equal to those with (X/2)-year return period under future climate conditions. As an example, rainfall intensities with 10-year return period under current climate conditions are almost equal to those with 5-year return period under predicted climate conditions. As an example, an actual 10-year drainage system will be able to withstand only 5-year storms by 2050s, whereas a current 50-year drainage structure will be able to handle only 20-year storms by 2050s.*

Climate change could compromise the efficacy of existing and proposed conveyance structures if current IDF curves are not updated to reflect projected changes in precipitation intensities. It is therefore recommended that the City and Town investigate the update of their IDF curves for future conditions.

Precipitation measurements would be useful to adapt to changes that will occur as a result of local weather and climate factors. It would help identify intense events that occur within a limited geographical area and over short time frames. The information would prove valuable in predicting increased peak flows and could be used to evaluate whether existing SWMF would be able to still meet the required post to pre requirements or if further retrofits or expansions would be required.

MTO published a memorandum entitled "Implementation of the Ministry's Climate Change Consideration in the Design of Highway Drainage Infrastructure" in 2016 which detailed historical records to account for climate change impacts on rainfall predictions. A linear time trend analysis was completed using observations from 1960 to 2010 and extrapolated forward from this period. MTO recommended that designers ensure that the drainage infrastructure accommodate future rainfall values for the year corresponding to the end of the Design Service Life of the structure in the design for conveyance, erosion, scour, and stormwater management components.

Nottawasaga Valley Conservation Authority

The Nottawasaga Valley Conservation Authority (NVCA) published guidance on Climate Change in their Stormwater Technical Guide in December, 2013. Climate change is defined by Environment Canada as: “a long-term shift in weather conditions measured by changes in temperature, precipitation, wind, snow cover, and other indicators”. Based on research carried out by Natural Resources Canada, there has been an increasing shift in the overall temperature of Canada by more than 1.3°C since 1948. Global climate models are predicting that this trend will increase average annual temperature by 2.7°C to 3.7°C by 2050.

With respect to stormwater management design, storm events in Ontario are becoming more severe and more powerful. From 2000 to 2005, 10 storms were experienced in Ontario alone that exceeded the 1:100-year probability storm event. These include a storm event in Peterborough in 2004 where 240 mm of rain fell over approximately 8 hours and caused $87 million in damage, and a 2005 storm event that hit Toronto with 175 mm of rain in less than an hour and caused $550 million in damage. To put this into perspective, the Timmins Storm event (which is the regional event for the NVCA jurisdiction) is modelled with a total rainfall runoff of 193 mm over a 12-hour period.

Based on the results of 16 climate models predicting 24-hour rainfall intensities, these rainfall intensities would increase by 6 percent per degree Celsius. With the projected temperature change of 3 to 4 degrees for Southern Ontario, including the NVCA jurisdiction, an increase of 18 to 24 percent in the 20-year 24-hour rainfall event could be expected.

Climate change can also be seen in the way that precipitation is falling. It is expected that there will be a decrease in the amount of snowfall and an increase in the amount of precipitation that falls as rain. A change in the number of cold temperature days means less ice on the great Lakes, which will result in lower lake levels in the years to come.

Precipitation patterns will change such that even though there is an increase in the amount of precipitation it will occur in more extreme storm events, exacerbating the problem of summer droughts. These droughts will become more frequent and result in longer dry periods.

The NVCA, as well as organizations at all levels of government, are taking an adaptive approach to the uncertainty of climate change. The Province of Ontario defines adaptation as “the process societies go through in order to cope with an uncertain future". The NVCA recommends that, in the future, stormwater management might include some of the following to offset some of that uncertainty:

- Upsizing storm sewer designs to better handle the more extreme storm events.
- Low-impact development stormwater management features to allow more water to infiltrate back into the ground.
- Achieving a complete post- to pre-development water balance.
- Providing more tree cover within developments to promote evapotranspiration.
- Siting stormwater management facilities outside of the Regulatory Floodplain limit.
- Upsizing bridge and culvert capacity.

A Comparison of Future IDF Curves for Southern Ontario

This study was aimed at understanding the limitations and applicability of different techniques for updating IDF statistics in light of climate change. This study attempted to address this issue by conducting a comparison and analysis of the outcome of using different methods that are available for the development of future IDF curves. Within the study, five different climate model outputs were compared, including two global climate models and three regional climate models. Depending on the model and data availability at the time of the study, two different emission scenarios were also compared. Each model's output was downscaled to 15 Environment Canada precipitation monitoring stations concentrated in the Essex-Windsor and Greater Toronto Areas (GTA) using two different methods: (1) quantile-base bias correction and (2) the delta-change method. Alternative distribution functions were also investigated to determine the influence of that assumption on IDF curves.

Results demonstrated that there is significant variability among the subset of future climate projections, with the greatest uncertainty associated with short-duration and high-intensity events (15 minute to 1-hour event above the 25-year return period). Variability was also greater in the Windsor area compared to the GTA. A comparison of the different models to historical observations revealed significant discrepancies between the modelled and observed extreme precipitation records, suggesting that further downscaling was needed to correct inherent climate model biases. Another critical finding was that, although the Gumbel distribution is used by many who develop IDF curves, it was actually the poorest fit of all distributions identified for comparison. Ultimately, the Generalized Extreme Value (GEV) distribution was determined to be a more robust model for representing extreme precipitation in the study areas examined.

Given the significant uncertainty associated with future and historical IDF curves it is reasonable for water managers to reevaluate the current levels of risk within existing assets and policies, in addition to those contained in guidelines on the design of infrastructure and policies. The findings also concluded that some of the fundamental theoretical and practical assumptions made during the development and use of future

IDF information, are not robust for the areas examined in this study, which are influenced by short-duration, high-intensity storm events that are not well represented in climate models. A key implication of the findings is that precise design thresholds embedded within water management policy and infrastructure design do not capture the full profile to extreme precipitation risk for the study areas considered. Given the uncertainty in future IDF curves (or statistics), it is recommended that weight-of-evidence approaches be used when responding to potential extreme precipitation risks at the local scale.

While future IDF curves may form part of the evidence base for adaptation to extreme precipitation risk, it is also critical that approaches incorporate historical extremes, and information on the thresholds and vulnerabilities of systems exposed to the extreme precipitation regime in question. The corollary for policy and infrastructure decision making is that resiliency-based strategies, including characterizing hydrologic responses and vulnerabilities to a range of extreme precipitation regimes using a combination of empirical evidence of impacts and dynamical stress testing, or modelling, offer the most promising response to changes in extreme precipitation associated with global climate warming.

It was recommended that further study was needed in the selected study areas to better understand and refine the uncertainties involved in the future IDF statistics. This appears necessary before major change in infrastructure design standards in the study areas. Further study should involve the analysis of non-stationarity in the extreme rainfall series, the development of regional IDF statistics using non-stationary methods such as Bayesian inference; and a comprehensive statistical uncertainty analysis.

An Addendum provided IDF statistics, curve plots, and equations in a form similar to Environment and Climate Change Canada's official plots for use by municipal staff and engineering consultants. The future IDF curves were based on an ensemble representation using different data sets and climate models.

Climate Change Impacts on SWM Facilities

While the Provincial Policy Statement includes consideration for the potential impacts of climate change, there is a lack of consensus on the degree of increase/decrease and frequency of climate changes that should be used for assessment. Climate change may cause potential impacts such as increased sediment and contamination in runoff, reduction in groundwater flows, and changes in precipitation, lake levels, erosion and ice cover. Potential impacts of climate change were considered on the effectiveness of the SWM controls within the Upper Little River.

The proposed SWM controls were evaluated by performing a sensitivity analysis on the system and applying a 20% increase to the 100-year, 24-hour Chicago design storm event. This methodology was taken from the *City of Ottawa Sewer Design Guidelines*, *(2012)* and the *Manning Road Secondary Plan Area Functional Servicing Report* (Dillon, 2015).

Runoff from the study area will be impacted by the increased precipitation under the climate change scenario. When the 100-year, 24 hour Chicago design storm event is increased by 20% the runoff volume increases by approximately 20 to 30% in the PC-SWMM model. To maintain flows and water levels in Upper Little River the outflows from the SWM facilities were assumed to remain unchanged requiring approximately 20 to 30% more storage volume to control the additional climate change runoff. This requires approximately an additional 15 m width for the water quantity storage portion of the SWM facilities, resulting in a wider corridor.

7.6 Low Impact Development

Low Impact Development (LID) is a stormwater management strategy that seeks to mitigate the impacts of increased runoff and stormwater pollution by managing runoff as close to its source as possible (LIDSWM Guide, 2010). LID comprises a set of site design strategies that minimize runoff and distributed, small scale structural practices that mimic natural or predevelopment hydrology through the processes of infiltration, evapotranspiration, harvesting, filtration and detention of stormwater. These practices can effectively remove nutrients, pathogens and metals from runoff, and they reduce the volume and intensity of stormwater flows.

Common LID measures include:

- Rainwater harvesting
- Green roofs
- Roof downspout disconnection
- Infiltration galleries
- Bioretention
- Vegetated filter strips
- Permeable pavements
- Enhanced grass swales
- Dry swales
- Perforated pipe systems

Several LID measures provide at source water quality control using filtration which could reduce the amount of permanent pool volume (open water area) required at the end-of-pipe facilities, making them particularly beneficial near the Airport. Infiltration options are generally not feasible, due to the impervious soils within the study area. The MECP is currently working on a LID Stormwater management guidance document to be released in the future (MOECC, 2015). All LIDs may not be suitable for the existing physical constraints within the Essex Region.

7.7 Drinking Water Source Protection

The IPZ-3, EBA and SGRA-2 vulnerable areas in the study area are shown in Appendix M.

The EA proposes stormwater management facilities which will provide water quality and water quantity control for residential, commercial, and industrial lands. The SWM facilities are all located in IPZ-3, outside of the more vulnerable IPZ-1 and IPZ-2. SWM facilities can be managed through Environmental Compliance Approvals (previously Certificate of Approval) which generally address criteria for operation and performance of the stormwater management facility, requirements for monitoring and recording of specific indicators of the environmental impact of the works (water quality, not quantity), reporting on incidents, and provision of contingencies to prevent and deal with accidental spills.

While the project does not involve installing or altering a municipal drinking water intake, modifications to the drainage network are proposed. This will require an update to the IPZ-3 and Event Based Area. Some portions of these vulnerable areas may be removed through a s.51 amendment to the SPP and AR if drains are removed. If new drains are installed or are relocated, the vulnerable areas will need to be extended, which will require either a s.34 amendment to the SPP and AR or would be included in the Essex Region SPA s.36 work plan. As changes to the drainage network are completed the Project Manager for Drinking Source Water Protection for Essex Region shall be notified so that updates to vulnerable areas can be made.

The Ontario Ministry of the Environment, Conservation and Parks (MECP) shall review Municipal Drinking Water Licenses and Permits issued under the Safe Drinking Water Act, in the vulnerable areas where there is an existing or future significant drinking water threat of handling and storage of liquid fuels. The MECP shall ensure that the permits refer to the requirements of the Technical Standards and Safety Act (TSSA), liquid fuel handling code. This may include, but is not limited to, details concerning installation, operation and regular inspection of fuel storage tanks, how fuel is contained, the location of fuel, and how fuel is stored.

The Ministry of Northern Development, Mines, Natural Resources and Forestry (MNRF) shall review instruments under the Aggregate Resources Act (including Aggregate Licenses, Wayside Permits, and Aggregate Permits and Site Plans) with respect to the handling and storage of liquid fuel at aggregate operation sites. The MNRF shall ensure that the permits refer to the requirements of the TSSA, liquid fuel handling code. This may include, but is not limited to, details concerning installation and operation of fuel storage tanks, how fuel is contained, the location of fuel, and how fuel is stored.

7.8 Cumulative Effects

Current and future policy/planning/environment assessment works in the area were consulted to determine land use and future infrastructure locations. Significant policy/planning/environment assessments are documented in Sections 3.4 and 3.5.

Cumulative environmental effects of the proposed stormwater management facilities on Upper Little River were considered by evaluating flows and water levels along the channel. The historic Little River 1:100 year mapped flood elevations, that are used for regulatory flood elevations, were used as the maximum allowable flood elevations for the Upper Little River channel for the future post development condition. Flows from individual facilities are over controlled to compensate for the additive effects or superpositioning of hydrographs from multiple sources to maintain target flow rates and water elevations downstream of the study area. This approach is documented in Section 6.1.

In addition, the study impacts were considered across the entire watershed area and evaluated with consideration of other than just local direct effects. The cumulative effects of distributed versus more centralized or grouped SWM Facilities on the attractiveness of ponds to bird species and their impacts on airport operation was considered in the selection of the preferred alternative as discussed in Table 16 and Section 7.1. Erosion analysis along Upper Little River consider the cumulative flows from the upstream drainage area as discussed in Sections 4.5.6 and 6.1.

8.0 Project Implementation

8.1 Future Municipal Class EA Requirements

This Upper Little River Watershed Drainage and Stormwater Management Master Plan Class Environmental Assessment has generally followed Phases 1 and 2 of the Municipal Class EA process as provided within the Municipal Engineers Class Environmental Assessment Process (2000, as amended). It is intended to provide a framework for future improvements.

Implementation of the recommended solution is intended to include the abandonment of existing municipal drains through the mechanisms within the Drainage Act, and the establishment of municipally owned and maintained stormwater management facilities. The proposed list of projects is identified within 6.1.3 above, but specific projects are subject to change based on triggers including project funding and development activities.

Where the implementation of the recommended stormwater solution represents a Schedule B project (e.g., the establishment of a new stormwater facility or enlargement of existing facility where property acquisition is required), site specific environmental conditions should be confirmed and impacts evaluated. A Project File shall be prepared to document site specific natural heritage, socio-economic, cultural, technical, and environmental conditions and impacts, and placed on public record for the minimum 30-day public review period through a Notice of Completion. Confirmation of the project schedule should be undertaken early in the planning and capital budgeting stages.

It is anticipated that portions of the recommended solution may be implemented as part of ongoing development activities, and may be implemented through Planning Act (e.g., through a Plan of Subdivision application). Development led projects (typically related to the construction of new residential, commercial, or industrial lands) will continue to be required to follow the current municipal stormwater guidelines, criteria, and watershed recommendations as required.

This report is not sufficient to support land use changes under a Planning Act process and additional environmental studies will be required to support future Planning Act approvals/processes. Based on the preferred alternative, open waterways will be removed in some areas and potential offsetting will be required in others. Offsetting will not always be available within the same area. Following completion of this report a fisheries offsetting plan should be developed for the entire study area prior to development. A natural heritage plan is also required to identify natural areas to preserve, remove, or improve to ensure no negative impacts.

Completing the functional design of stormwater management system and enhancement opportunities will also be required. This EA has recommended a preferred stormwater management strategy and potential locations. It is anticipated that some modifications will be required during functional design as new plans and information becomes available. As part of the functional design, additional geotechnical and survey information will be required in order to establish/confirm the design.

Further studies are typically required to confirm functional design information for the individual projects and can take the form of reports supporting Draft Plan Applications, design briefs/drawings, separate Schedule B EAs, etc. depending on the required process. Detail design is generally not completed at the EA stage of the project because the details necessary to complete the final design are not known at that time.

The preferred alternative is intended to be constructed in stages as needed for development to progress. Should upstream areas progress before downstream areas are completed the constructed portions of the SWM corridor would outlet to the existing municipal drain system. Some coordination may be necessary between SWM blocks in areas where pumping stations can be combined to reduce future maintenance costs. The location of the SWM corridor is preliminary and while some modifications are expected during final design individual stages should not compromise other stages. Interim SWM controls may be required on-site while the ultimate facility is constructed and properly vegetated. Interim SWM controls have the same requirements as the ultimate facilities and must drain to a suitable outlet.

8.1.1 Permits and Approval Requirements

Prior to constructing the stormwater management features as well as the enhancement opportunities, a number of permits and approvals will need to be obtained through other process such as the Planning Act, Fisheries Act, and other Class EAs. The process to outline the required studies should be identified thought appropriate consultation with the following elements that may be part of the final implementation:

- **ERCA** – A Development, Interference with Wetlands and Alterations to Shorelines and Watercourses permit, pursuant to Ontario Regulation 158/06 will be required for the sites as the majority of the SWM features and enhancement opportunities are located within or will outlet into regulated areas within the Upper Little River study area.

- **Fisheries and Oceans Canada** – The proponent will be required to have an initial screening of the final design drawings undertaken to determine whether the proposed works will result in serious harm to fish (impact to fish or fish habitat) and if authorization from DFO is required under the *Federal Fisheries Act*. Depending on the proposed works, the proposed mitigation measures and the restoration enhancement opportunities, offsetting measures may be required.

- Where projects pose a relatively low risk and would not result in serious harm to fish (impact to fish or fish habitat), they may proceed without DFO review, but must follow appropriate avoidance and mitigation measures. Proponents of projects that are not on the Minor Impacts List (as defined on DFO's website), and that are not found in Marginal Waterbody Types (as defined on DFO's website), can request a review of their projects by the Department to determine if additional avoidance and mitigation measures are appropriate. The submission would include DFO's Request for Review form and supporting information illustrating all details of the project (e.g., construction methods, equipment, materials, drawings, footprint area of the project, residual effects, etc.). Based on the site-specific review, the Department will then recommend one of the following:
    - That the project proceed following the appropriate avoidance and mitigation measures.
    - That the proponent should seek an authorization for serious harm to fish likely to result from the project.
    - That the project should be relocated or re-designed given the likelihood of unacceptable impacts to fish and fish habitat.
- Ministry of the Environment, Conservation and Parks (MECP)– Approval of EA document, Environmental Compliance Approval (ECA) for the construction of SWM facilities and installation of storm sewers. MECP should also be contacted to confirm regulated habitat and permitting requirements for endangered and threatened species under the Endangered Species Act. An Endangered Species Act Permit may be required where vegetation removal is proposed.
- Endangered Species Act – Species at Risk should not be killed, harmed, or harasses and their habitat should not be damaged or destroyed through the proposed activities. Future studies should confirm ESA species and habitat impacts.
- Ministry of Natural Resources and Forestry – Work located within watercourses or which occupy public land may require approval under the Lakes and Rivers Improvement Act (LRIA) and/or the Public Lands Act. Based on ERCA's agreements with MNRF, ERCA is responsible for review and approval for issues related to Section 14 of the Public Lands Act. The requirement for a LRIA permit will be identified in consultation with MNRF staff.
- Archaeological Assessment – As part of the subsequent EA's a Stage 2 Archaeological Assessment (and further stages, if recommended) should be prepared by a licensed archaeologist where areas of archaeological potential may be impacted as soon as possible during detail design and prior to any ground disturbing activities.

- Cultural Heritage Impact Assessment – As part of the subsequent EA's and prior to the construction of the stormwater management features should project activities require demolition or removal (partial or entirely) of any identified (known or potential) Built Heritage Resource / Cultural Heritage Landscape, a Heritage Impact Assessment shall be undertaken by a qualified person in consultation with the City of Windsor Heritage Planner. All technical heritage studies should be undertaken as early as possible during detailed design and prior to any final design being endorsed.
- Fluvial Geomorphological Design – The proposed channel cross section is conceptual in nature and a fluvial geomorphological design is recommended to determine channel bed morphology (pools and riffles).
- Environmental Impact Assessment (EIA) – Development within 120 m of an existing natural feature will require an EIA demonstrating no negative impacts in support of future Planning Act approvals and process.
- Integrated Fish Offset Plan – open waterways will be removed in some areas and potential offsetting will be required in other areas. Offsetting will not always be available within the same area. Following completion of this report a fisheries offsetting plan should be developed for the entire study area.
- Integrated Natural Heritage System Plan – Identify natural areas to preserve, remove, or improve to ensure no negative impacts. Used to determine land use designation.
- Secondary Plan – to determine land use plans under the Planning Act.
- EA Addendum – may be required to address ultimate land uses or other significant changes to assumptions.
- Land Use – future Planning Act processes are required to change current land uses. Changes in land use designation will require approval under the Planning Act and any such approvals are required to be consistent with the 2014 PPS.
- Climate Change – In accordance with the 2014 PPS, the potential impacts of climate change should be considered in future studies.
- Low Impact Development (LID) – in addition to traditional SWM facilities, future designs may need to consider LID alternatives.
- Functional Design Studies- may be undertaken for individual subcatchments within the overall study area.

- Guideline for Development of Stormwater Management – to enable consistency in the design, construction, and maintenance of the SWM facilities.
- Floodplain mapping – additional floodplain analysis may be needed to determine flood elevations and flood proofing elevations.
- Consultation – Future work will include further consultation with Indigenous Communities and interested stake holders. Additional steps at this stage include circulation of the Notice of Completion.

8.1.2 Other Design Considerations

It is recommended that the following design considerations be included in the functional design:

- Operation and Maintenance Manuals
- Environmental Compliance Approval
- Geotechnical assessment and recommendations including identification of potential groundwater conduits, surface contamination, subsurface contamination while following the Ontario Water Resources Act and Well Regulation
- Landscaping plans
- Erosion and sediment control plans
- Construction access and staging plans, particularly while constructing in the open space
- Water management plan during construction of in-stream works, dewatering, etc.
- Archaeological assessment
- Finalize and implement a performance monitoring program
- Obtain permits from appropriate agencies as required
- Site specific channel alignment review to minimize vegetation loss; avoid significant features where possible, etc.
- Maximize green space and woody vegetation where possible

8.2 Monitoring, Response, and Maintenance

The maintenance, monitoring, and response program monitors for environmental provisions and commitments and ensures that the management practices are performing as designed. The maintenance and monitoring program is intended to ensure the proposed management measures for the development are adequate. The response program will also provide guidance for appropriate response action if problems are identified.

Proper maintenance of SWM facilities is required to ensure they continue to function as designed. Operation and Maintenance Manuals developed during detail design will address potential long-term maintenance issues.

Because a detailed project list with EA schedules is not within the scope of an Approach 1 Master Plan, a Ph.5 monitoring program cannot be prepared from this Master Plan. When future EAs in the Upper Little River watershed identity specific project(s), it is intended that the environmental inventories in the current Master Plan be used in conjunction with subsequent study findings and discussions with municipalities and appropriate regulatory agencies where appropriate (i.e... ERCA, MECP, etc.) to determine a suitable monitoring program. The three periods in which monitoring can occur are as follows:

Pre-Construction Monitoring to establish background levels of the environmental indicators. This information will facilitate comparison with conditions during and following construction and allow an evaluation of the effectiveness of mitigation measures employed as part of the project

During Construction Monitoring to monitor the effectiveness of erosion and sediment control measures to establish impacts of construction, to determine if mitigation measures are necessary and to establish the effectiveness of these measures

Post-Construction Monitoring to ensure that the watershed targets are being met, the ecological health of the adjacent areas are maintained, to determine if mitigation measures are necessary and to establish the effectiveness of these measures

The final Monitoring Program will be prepared in conjunction with the final design work, in order to meet the goals outlined above. Final details should be confirmed with ERCA, the municipality, and the MECP regional office.

9.0 Closing and Filing of Master Plan

9.1 Filing of Master Plan

The Master Plan Class EA is being placed on public record for the mandatory 30-day review period, and all previously identified stakeholders will be provided notification in accordance with the consultation plan followed throughout the project. The Notice of Completion is included in Appendix B and details the 30-day review period (DATE to DATE), the locations at which the Master Plan document is available, where comments should be directed during the review period, and outlines the Part II order procedure as discussed below. The Notice of Completion was published in the Windsor Star (DATE), mailed to all stakeholders and Indigenous communities (DATE), and posted to the Municipality's website starting DATE.

9.2 Part II Order Appeal Information

The Class EA planning process encourages the identification and resolution of concerns early and throughout the project. In accordance with the MEA Class EA document, Master Plans in their entirety are not subject to appeal through the Part II Order (PIIO) process. Implementation of projects associated with the recommended solution, where they are classified as Schedule B or C projects, will be subject to further study and consultation in order to satisfy the Class EA process for Schedule B and C projects. Upon completion of the Master Plan, additional studies will be required to fulfill the requirements of the Municipal Class EA process. Each subsequent specific project that is subject to Schedule 'B' or Schedule 'C' requirements shall have their own EA and Notice of Completion that would be subject to PIIO Appeals under the current Municipal Class EA framework.

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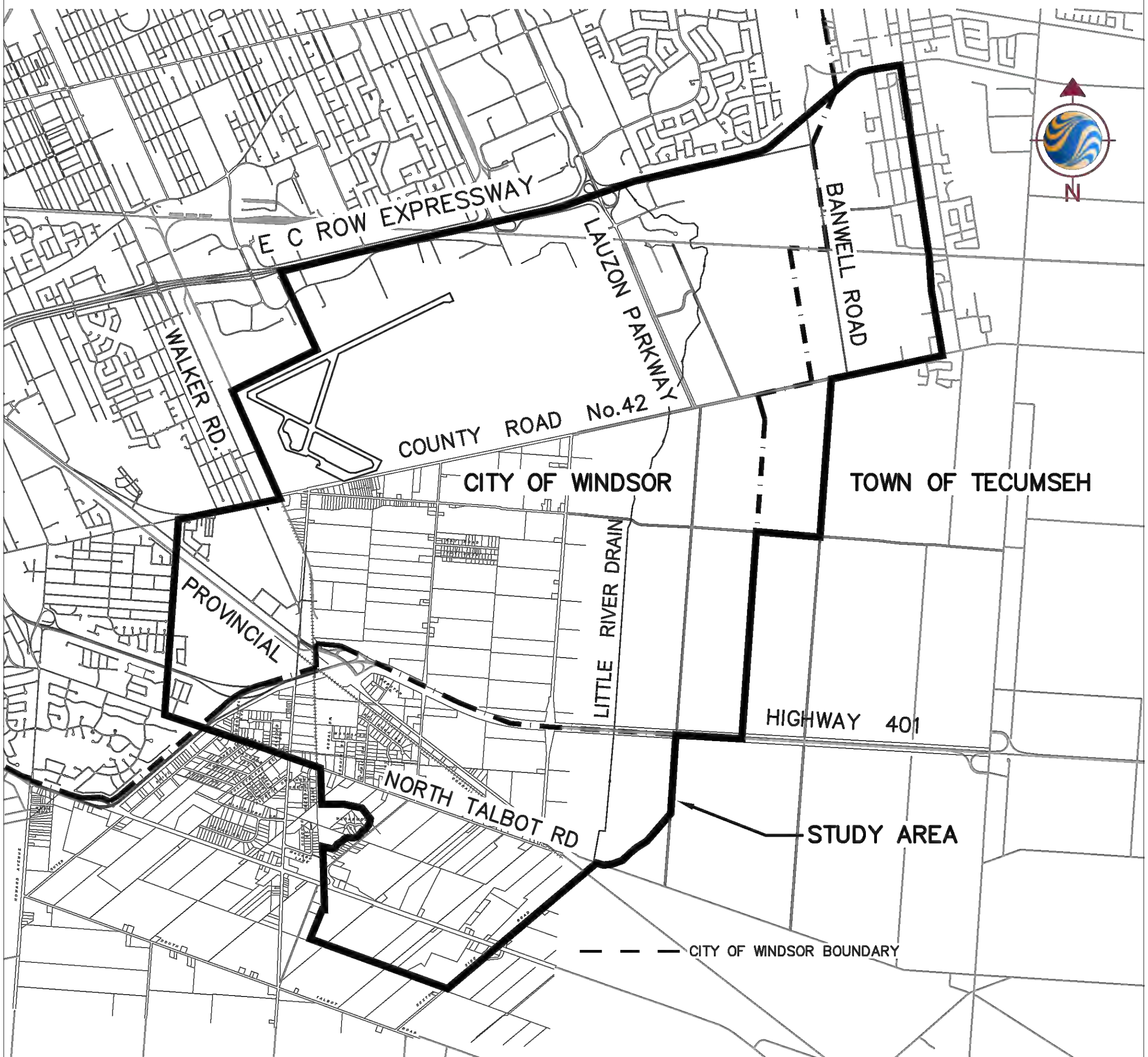
APPENDIX A:
Figures and Drawings



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ORIGINAL SHEET - ANSI A

September 2016
160311265

Stantec
300 Hagey Blvd. Suite 100
Waterloo, ON, N2L 0A4
Tel. 519.579.4410
www.stantec.com

Client/Project

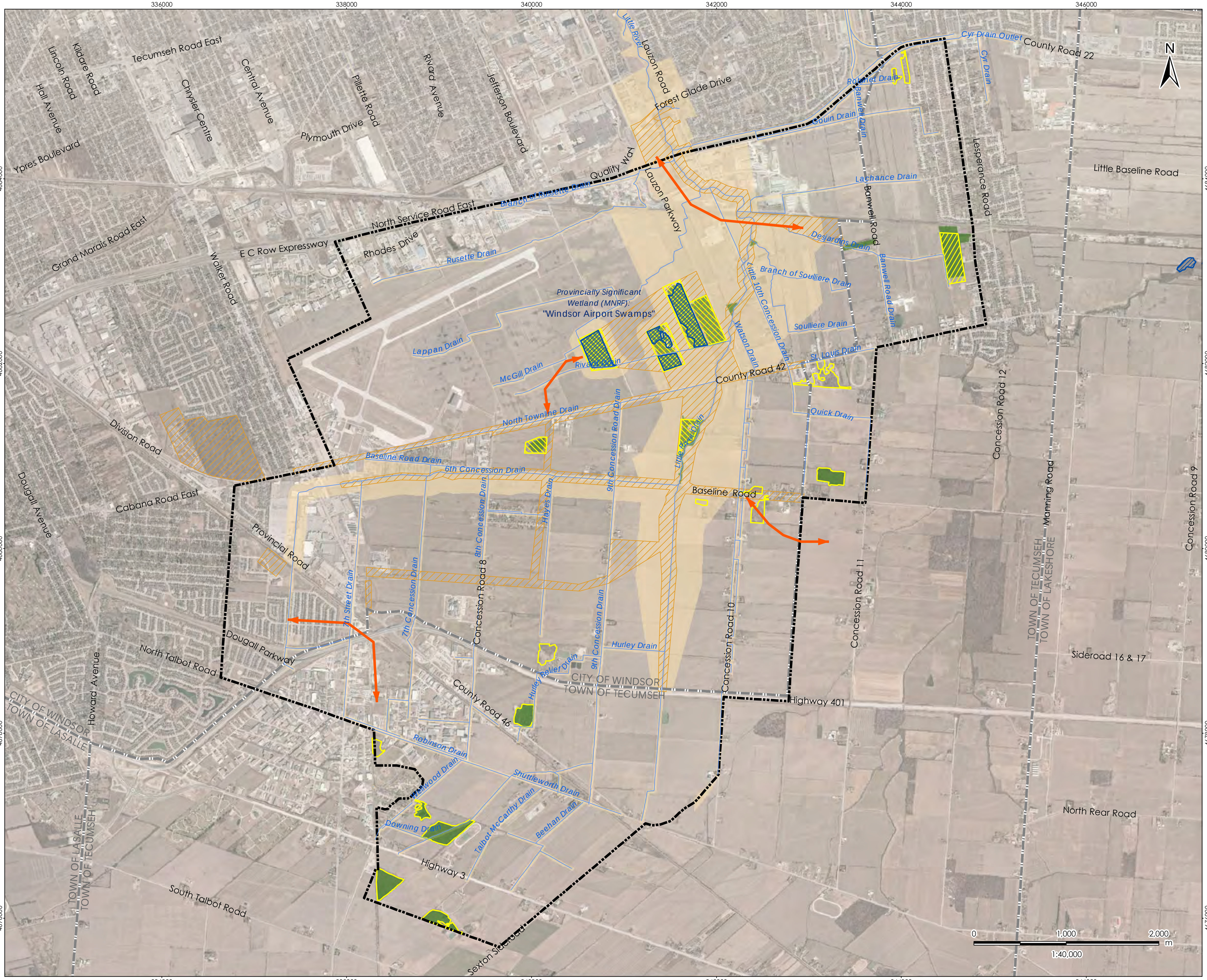
ESSEX REGION CONSERVATION AUTHORITY

Figure No.

1

Title

SITE LOCATION PLAN



Stantec

Legend
- Study Area
- Watercourse
- Linkage (Windsor OP, 2012)
- Community or Regional Park (Windsor OP, 2012)
- Natural Heritage Site (Windsor OP, 2012)
- Natural Environment Feature (Sandwich South OP, 2016)
- Candidate Natural Heritage Site (ERCA, 2012)
- Limit of Regulated Area (ERCA, 2011)
- Wetland (MNRF, 2016)
- Woodland (MNRF, 2012)
- Municipal Boundary

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2016.
3. 2013 orthoimagery © First Base Solutions, 2016.

January 2017
160311625

Client/Project
City of Windsor
Upper Little River Stormwater and Drainage Master Plan

Figure No.
2

Title
Existing Environmental Features

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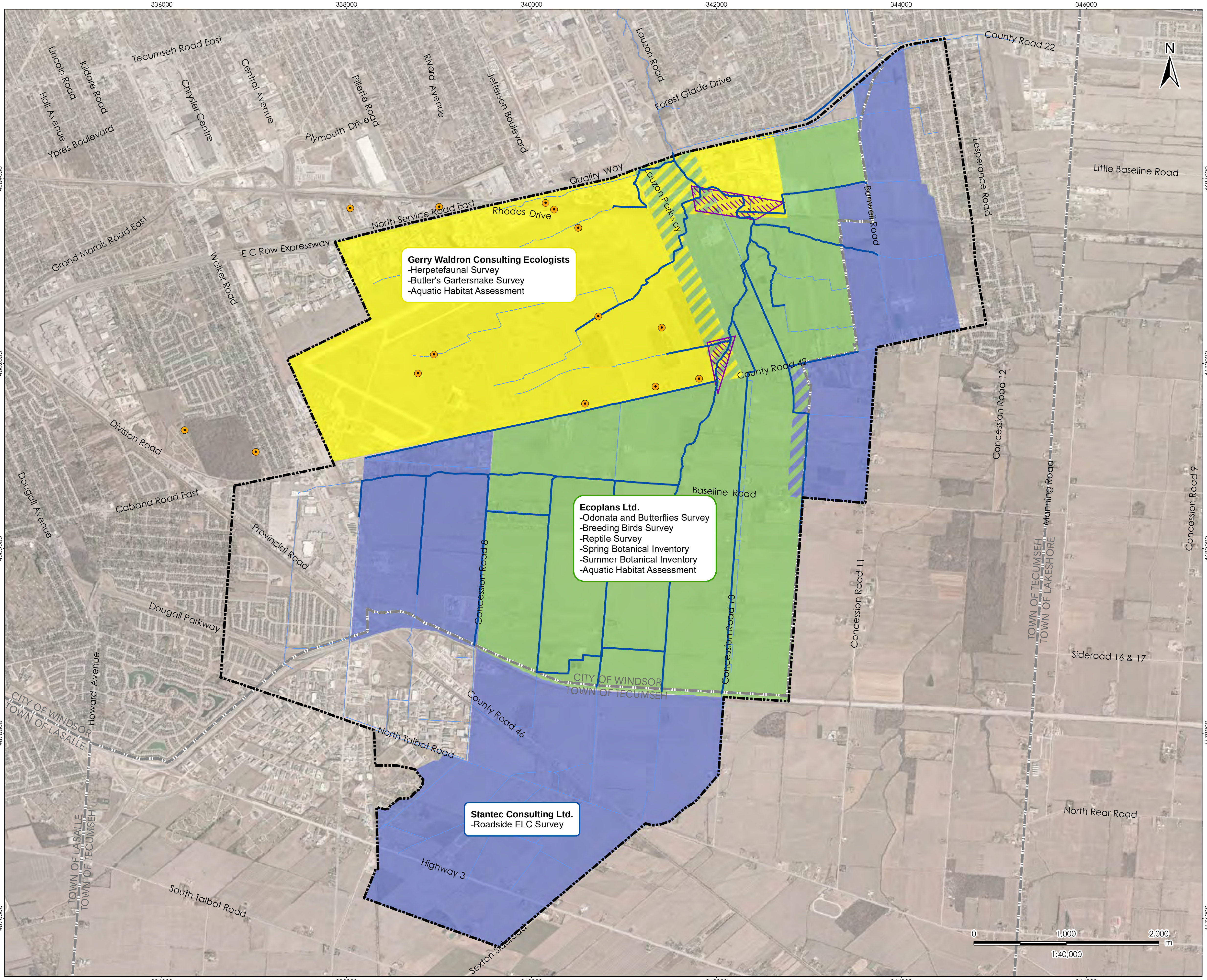
Revised: 2017-01-25 By: kbuchanan



Stantec

Legend

- Study Area
- Butler's Gartersnake Survey
- Aquatic Surveys
- Herpetefaunal Survey

Field Investigation Consultant

- Ecoplans Ltd.
- Gerry Waldron Consulting Ecologists
- Stantec Consulting Ltd.
- Watercourse
- Municipal Boundary

Notes

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City of Windsor
Upper Little River Stormwater
and Drainage Master Plan

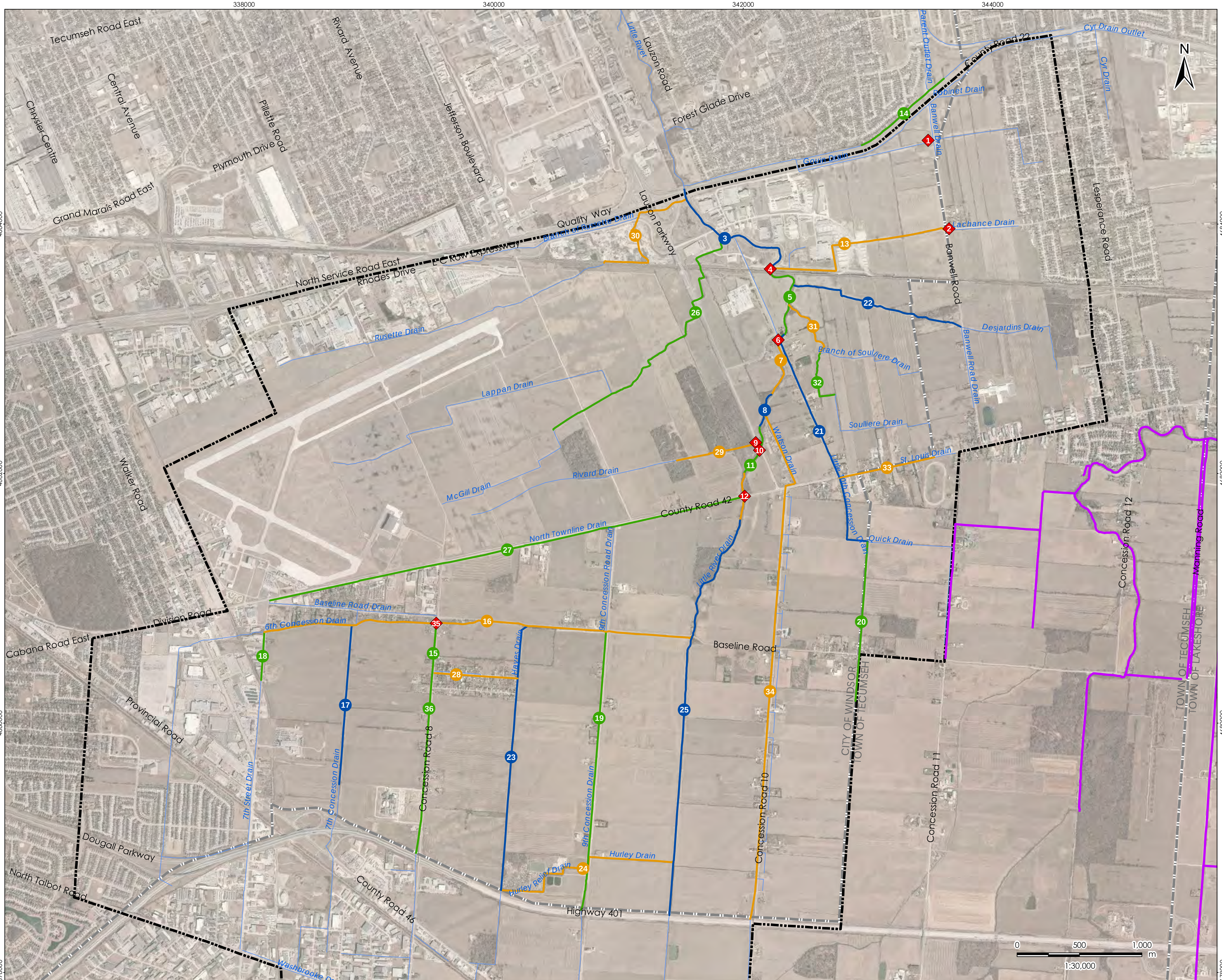
Figure No.

3

Title

Field Investigations

V:\01609\active\160311265 - Upper Little River Stormwater and Drainage MP\drawing\MXD\Terrestrial\2016 Update\160311265_NHS_Fig3_FieldInvest.mxd
Revised: 2016-09-14 By: kbuchanan



Stantec

Legend

- Study Area
- Watercourse
- Municipal Boundary

Fish Species at Risk

- Special Concern Species (including under consideration for listing)

Aquatic Survey Locations and Reaches

- Waldron 2009 Fish Sampling Location
- Ecoplans 2011 Fish Sampling Location
  Line colours have no significance except to differentiate surveyed watercourse reaches.

Notes

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Client/Project
City of Windsor
Upper Little River Stormwater and Drainage Master Plan

Figure No.
4

Title
Aquatic Species at Risk and Survey Locations

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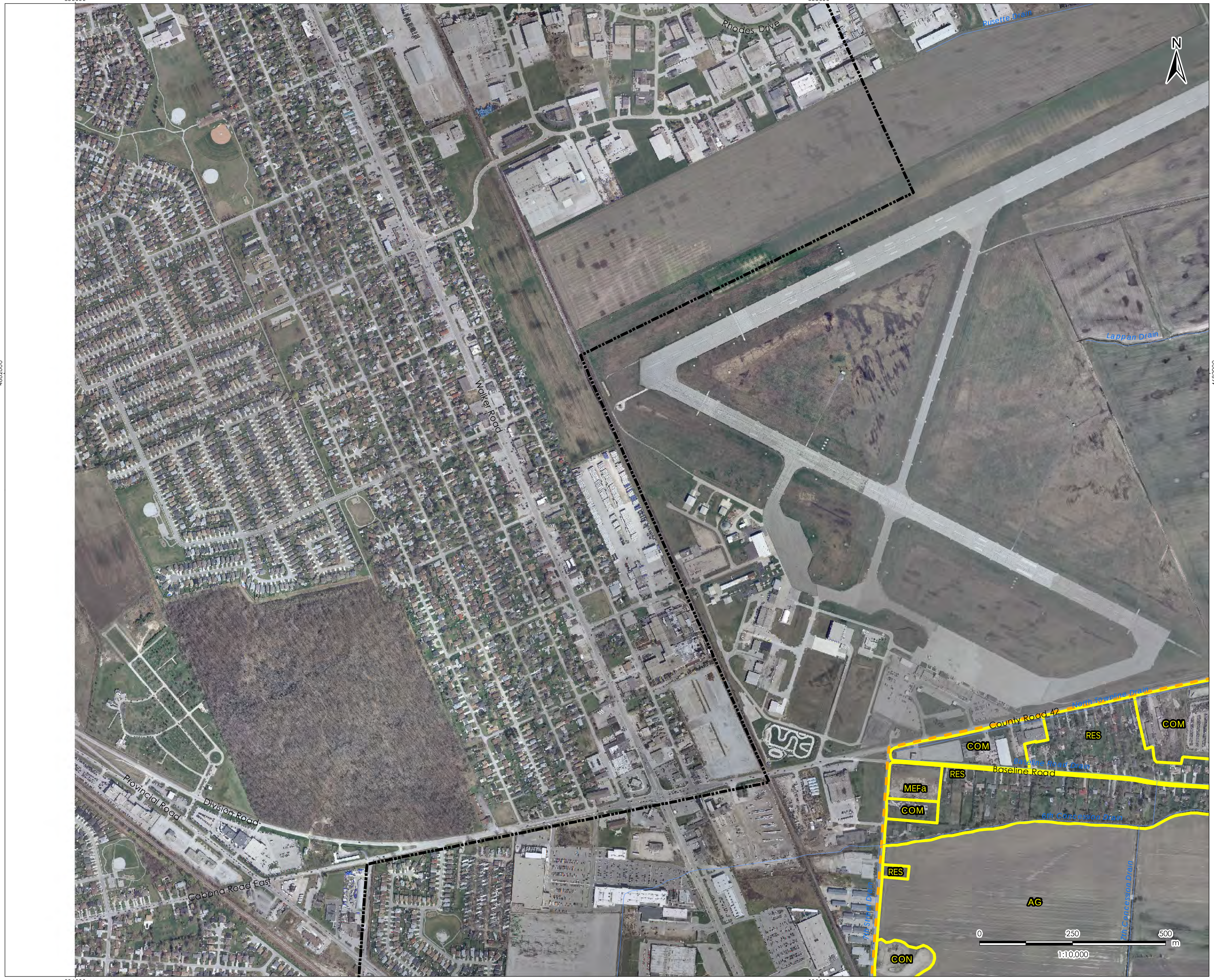
Revised: 2017-01-25 By: kbuchanan



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Revised: 2017-01-25 By: kbuchanan

Stantec

Legend

- Study Area
- Watercourse
- ELC Fieldwork Extent
- ELC Boundary
- Municipal Boundary

ELC Communities

Meadow

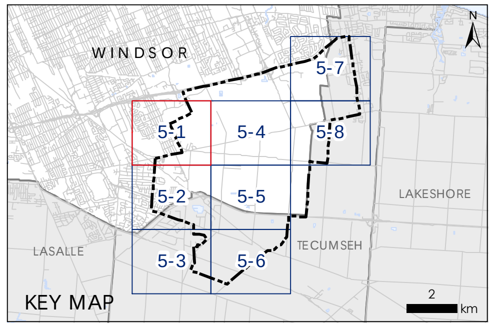
ME	Meadow
MEF	Forb Meadow
MEFM1-1	Goldenrod Forb Meadow
MEG	Graminoid Meadow

Forest

FOD	Deciduous Forest
FODM2-4	Dry-Fresh Oak Hardwood Deciduous Forest
FODM7-1	Fresh-Moist White Elm Lowland Deciduous Forest

Other

AG	Agriculture
BUS	Business
CEM	Cemetary
COM	Commercial
CON	Construction
IND	Industrial
INS	Institutional
OA	Open Aquatic
OS	Open Soil
PAS	Pasture
RES	Residential



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Client/Project

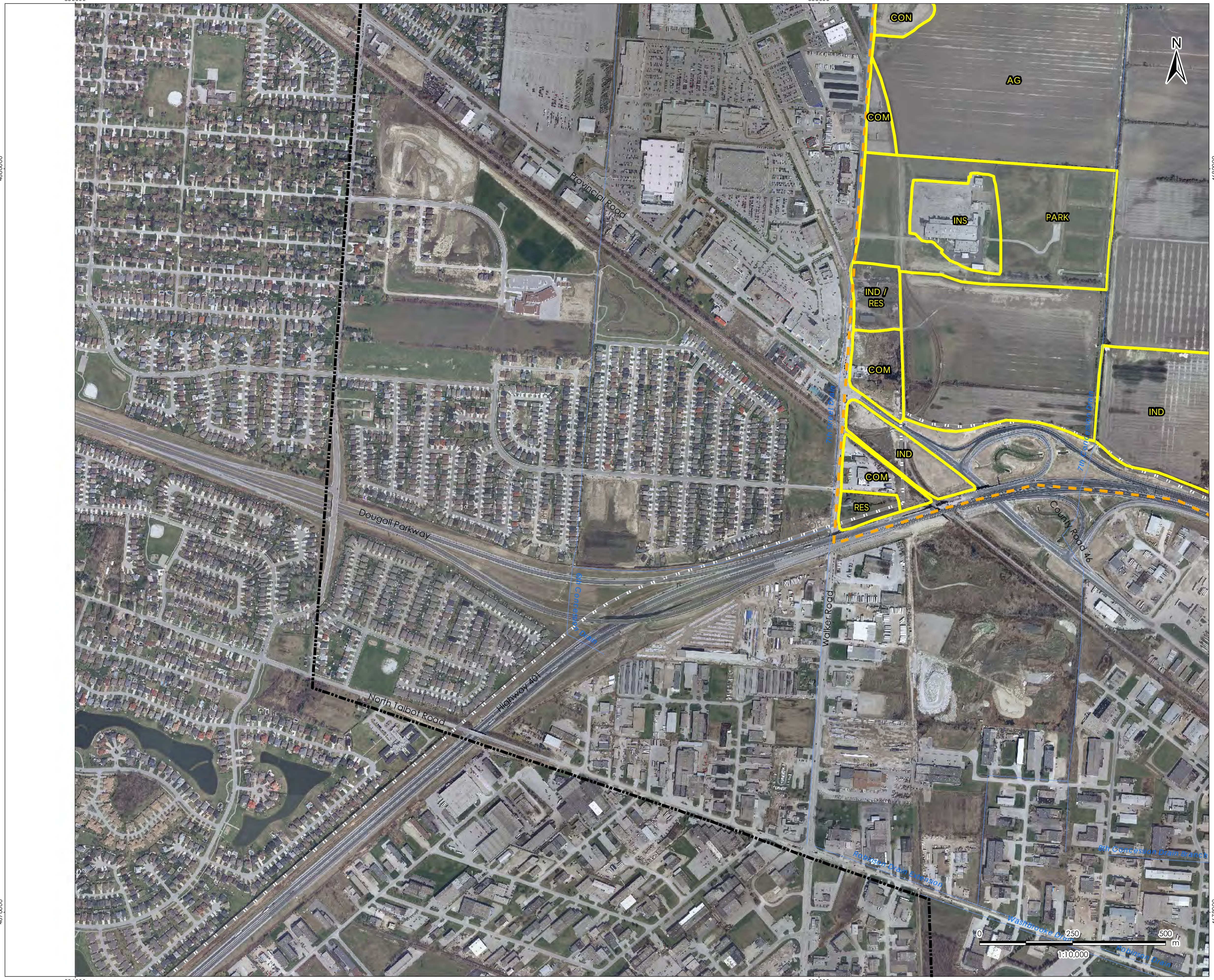
City of Windsor
Upper Little River Stormwater
and Drainage Master Plan

Figure No.

5-1

Title

Roadside Ecological
Land Classification



Stantec

Legend

- Study Area
- Watercourse
- ELC Fieldwork Extent
- ELC Boundary
- Municipal Boundary

ELC Communities

Meadow

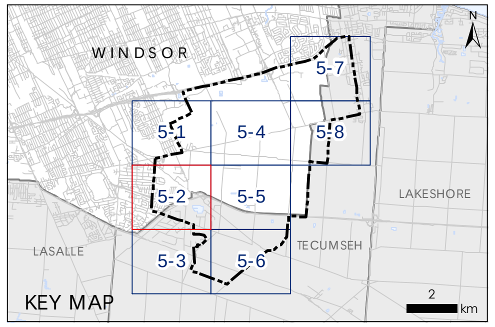
ME	Meadow
MEF	Forb Meadow
MEFM1-1	Goldenrod Forb Meadow
MEG	Graminoid Meadow

Forest

FOD	Deciduous Forest
FODM2-4	Dry-Fresh Oak Hardwood Deciduous Forest
FODM7-1	Fresh-Moist White Elm Lowland Deciduous Forest

Other

AG	Agriculture
BUS	Business
CEM	Cemetary
COM	Commercial
CON	Construction
IND	Industrial
INS	Institutional
OA	Open Aquatic
OS	Open Soil
PAS	Pasture
RES	Residential



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Client/Project

City of Windsor
Upper Little River Stormwater
and Drainage Master Plan

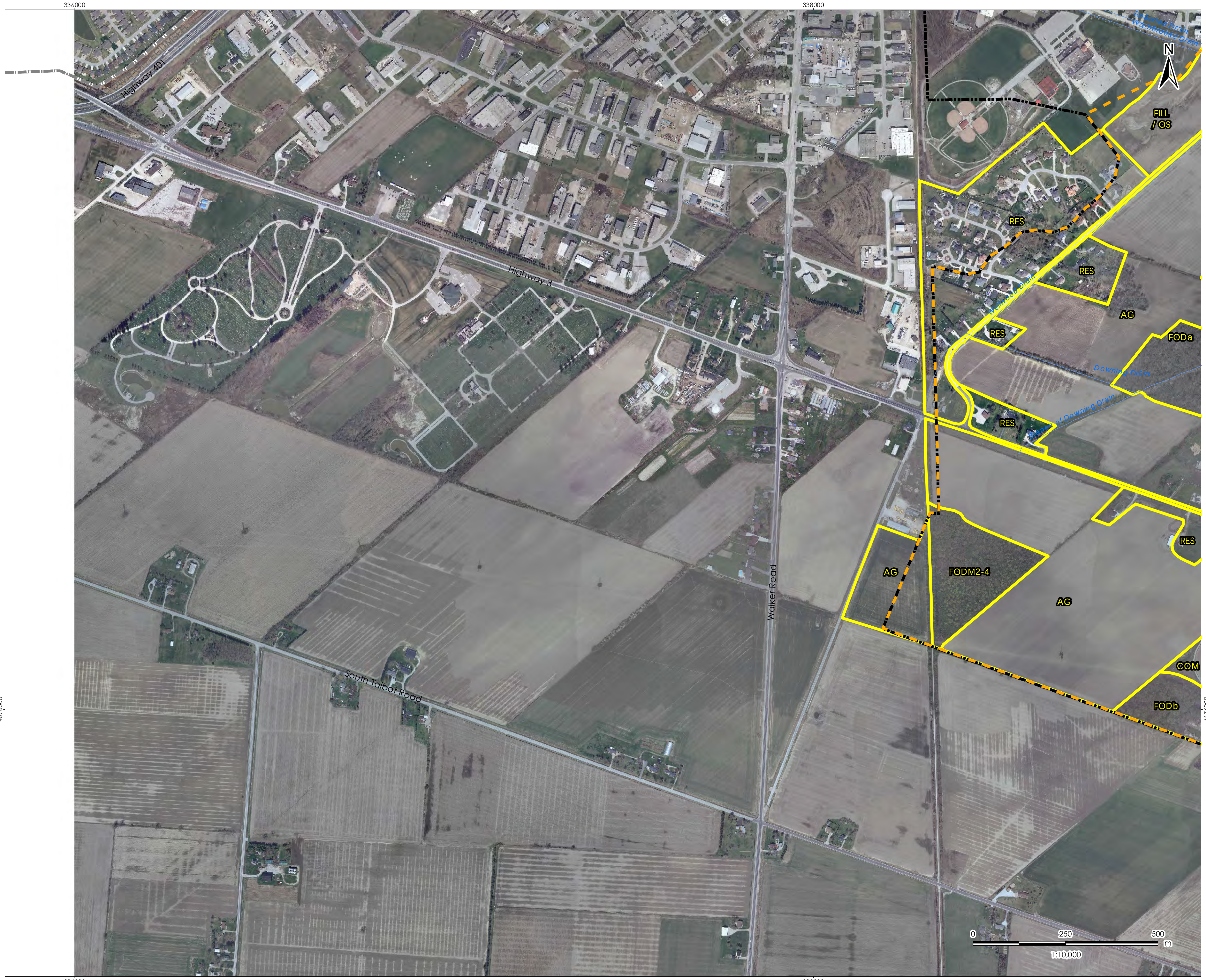
Figure No.

5-2

Title

Roadside Ecological
Land Classification

V:\01609\active\160311265 - Upper Little River Stormwater and Drainage MP\drawing\MXD\Terrestrial\2016 Update\160311265_NHS_Fig5-X_ELC.mxd
Revised: 2017-01-25 By: kbuchanan



Stantec

Legend

- Study Area
- Watercourse
- ELC Fieldwork Extent
- ELC Boundary
- Municipal Boundary

ELC Communities

Meadow

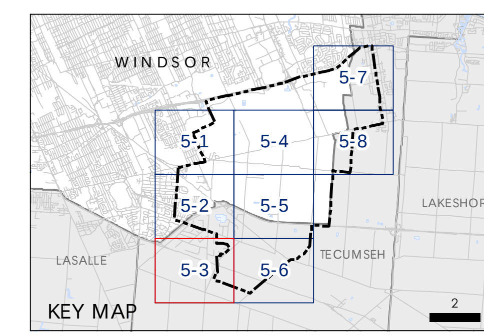
ME	Meadow
MEF	Forb Meadow
MEFM1-1	Goldenrod Forb Meadow
MEG	Graminoid Meadow

Forest

FOD	Deciduous Forest
FODM2-4	Dry-Fresh Oak Hardwood Deciduous Forest
FODM7-1	Fresh-Moist White Elm Lowland Deciduous Forest

Other

AG	Agriculture
BUS	Business
CEM	Cemetary
COM	Commercial
CON	Construction
IND	Industrial
INS	Institutional
OA	Open Aquatic
OS	Open Soil
PAS	Pasture
RES	Residential



Notes

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January 2017
160311625

Client/Project

City of Windsor
Upper Little River Stormwater and Drainage Master Plan

Figure No.
5-3

Title
Roadside Ecological Land Classification

V:\01609\active\160311265 - Upper Little River Stormwater and Drainage MP\drawing\MXD\Terrestrial\2016 Update\160311265_NHS_Fig5-X_ELC.mxd
Revised: 2017-01-25 By: kbuchanan

Stantec

Legend

- Study Area
- Watercourse
- ELC Fieldwork Extent
- ELC Boundary
- Municipal Boundary

ELC Communities

Meadow

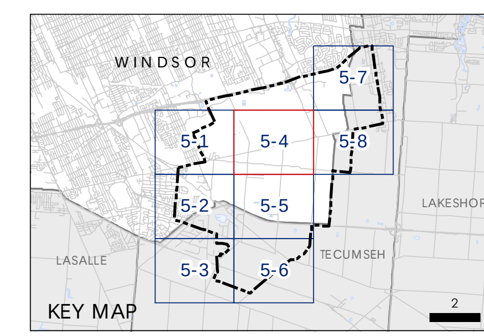
ME	Meadow
MEF	Forb Meadow
MEFM1-1	Goldenrod Forb Meadow
MEG	Graminoid Meadow

Forest

FOD	Deciduous Forest
FODM2-4	Dry-Fresh Oak Hardwood Deciduous Forest
FODM7-1	Fresh-Moist White Elm Lowland Deciduous Forest

Other

AG	Agriculture
BUS	Business
CEM	Cemetary
COM	Commercial
CON	Construction
IND	Industrial
INS	Institutional
OA	Open Aquatic
OS	Open Soil
PAS	Pasture
RES	Residential



Notes

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Client/Project

City of Windsor
Upper Little River Stormwater and Drainage Master Plan

Figure No.

5-4

Title

Roadside Ecological Land Classification

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Revised: 2017-01-25 By: kbuchanan

Legend
- Study Area
- Watercourse
- ELC Fieldwork Extent
- ELC Boundary
- Municipal Boundary

ELC Communities

Meadow

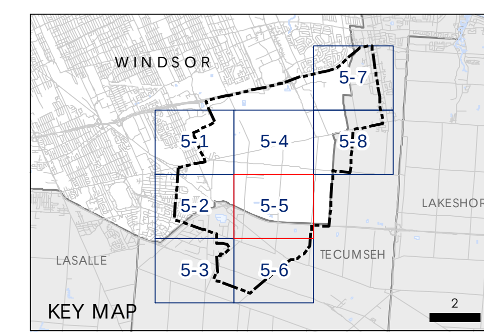
ME	Meadow
MEF	Forb Meadow
MEFM1-1	Goldenrod Forb Meadow
MEG	Graminoid Meadow

Forest

FOD	Deciduous Forest
FODM2-4	Dry-Fresh Oak Hardwood Deciduous Forest
FODM7-1	Fresh-Moist White Elm Lowland Deciduous Forest

Other

AG	Agriculture
BUS	Business
CEM	Cemetary
COM	Commercial
CON	Construction
IND	Industrial
INS	Institutional
OA	Open Aquatic
OS	Open Soil
PAS	Pasture
RES	Residential



Notes
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Client/Project
City of Windsor
Upper Little River Stormwater and Drainage Master Plan

Figure No.
5-5

Title
Roadside Ecological Land Classification

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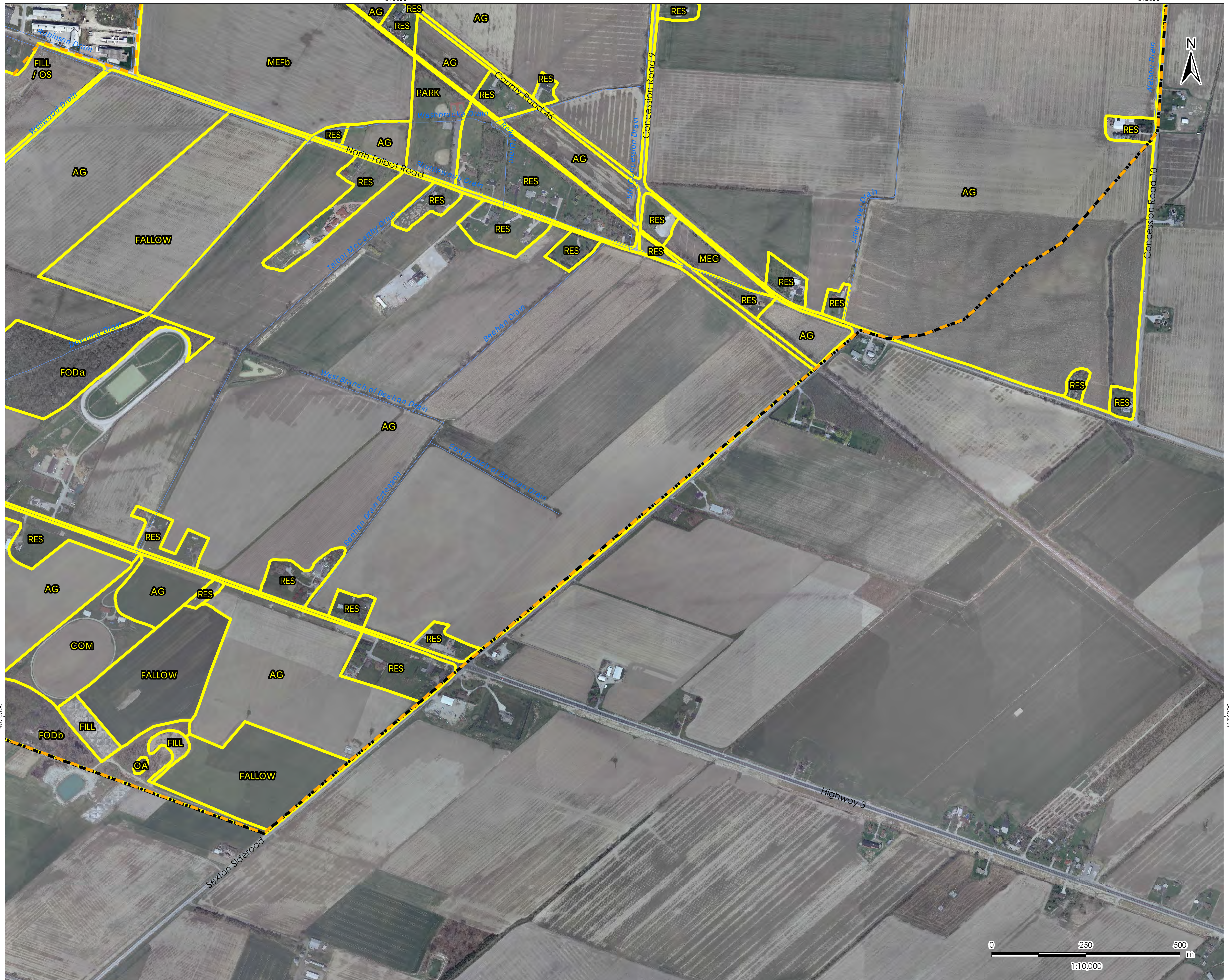
Revised: 2017-01-25 By: kbuchanan



Legend

- Study Area
- Watercourse
- ELC Fieldwork Extent
- ELC Boundary
- Municipal Boundary

ELC Communities

Meadow

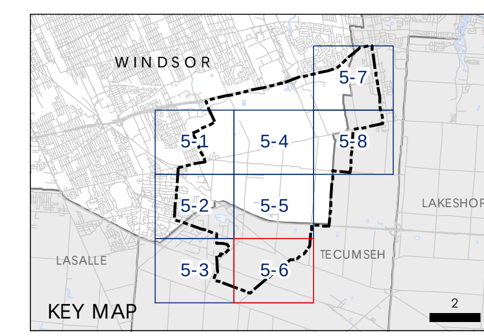
ME	Meadow
MEF	Forb Meadow
MEFM1-1	Goldenrod Forb Meadow
MEG	Graminoid Meadow

Forest

FOD	Deciduous Forest
FODM2-4	Dry-Fresh Oak Hardwood Deciduous Forest
FODM7-1	Fresh-Moist White Elm Lowland Deciduous Forest

Other

AG	Agriculture
BUS	Business
CEM	Cemetary
COM	Commercial
CON	Construction
IND	Industrial
INS	Institutional
OA	Open Aquatic
OS	Open Soil
PAS	Pasture
RES	Residential



Notes

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Client/Project

City of Windsor
Upper Little River Stormwater and Drainage Master Plan

Figure No.

5-6

Title

Roadside Ecological Land Classification

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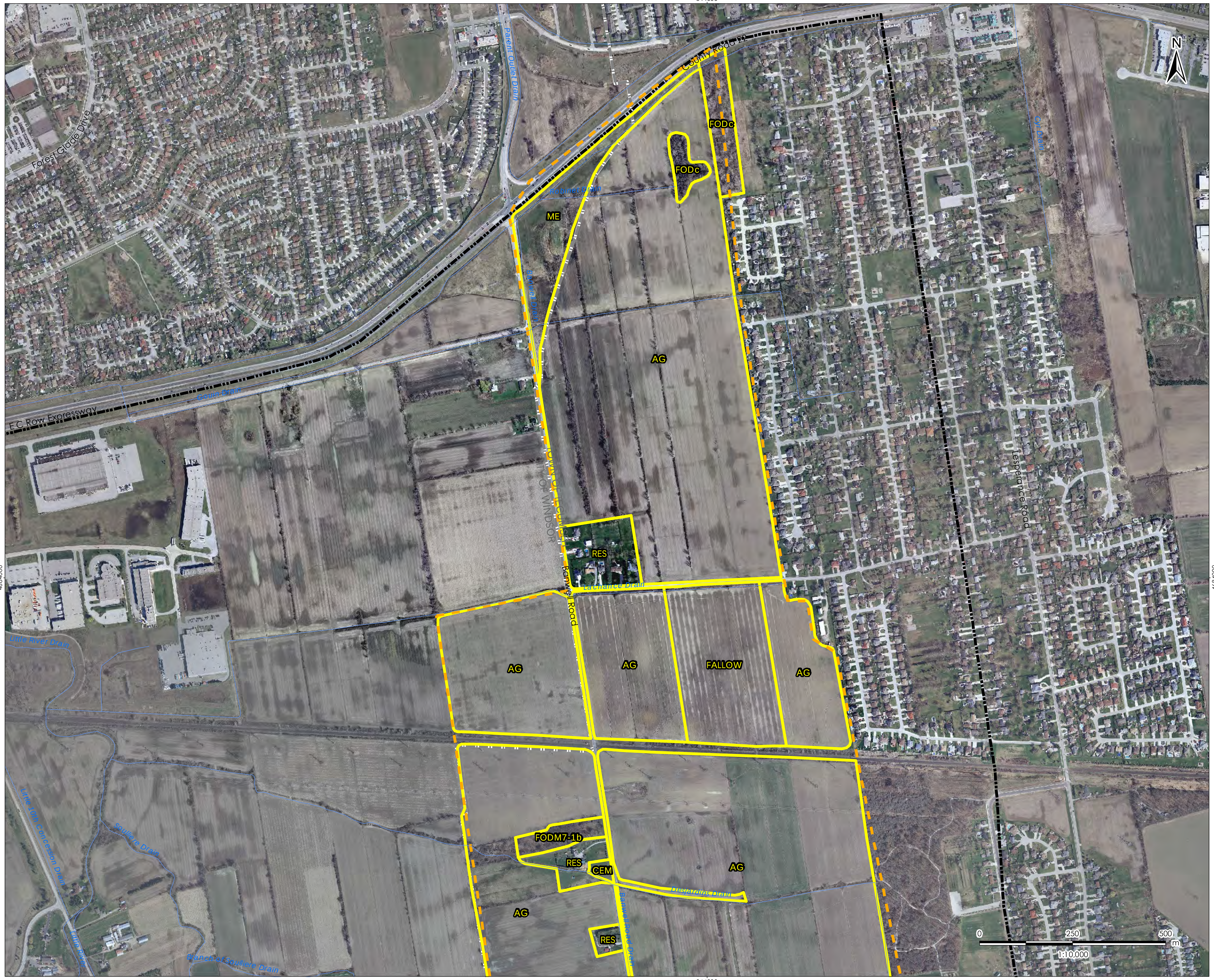
Revised: 2017-01-25 By: kbuchanan



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Revised: 2017-01-25 By: kbuchanan

Stantec

Legend

- Study Area
- Watercourse
- ELC Fieldwork Extent
- ELC Boundary
- Municipal Boundary

ELC Communities

Meadow

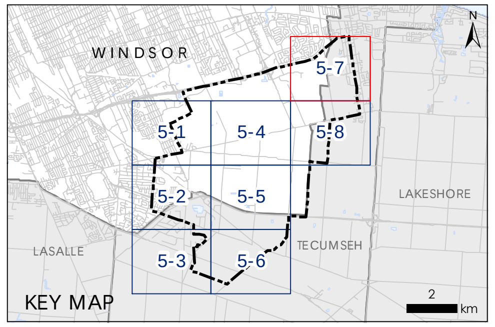
ME	Meadow
MEF	Forb Meadow
MEFM1-1	Goldenrod Forb Meadow
MEG	Graminoid Meadow

Forest

FOD	Deciduous Forest
FODM2-4	Dry-Fresh Oak Hardwood Deciduous Forest
FODM7-1	Fresh-Moist White Elm Lowland Deciduous Forest

Other

AG	Agriculture
BUS	Business
CEM	Cemetary
COM	Commercial
CON	Construction
IND	Industrial
INS	Institutional
OA	Open Aquatic
OS	Open Soil
PAS	Pasture
RES	Residential



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Client/Project

City of Windsor
Upper Little River Stormwater
and Drainage Master Plan

Figure No.

5-7

Title

Roadside Ecological
Land Classification

Legend

- Study Area
- Watercourse
- ELC Fieldwork Extent
- ELC Boundary
- Municipal Boundary

ELC Communities

Meadow

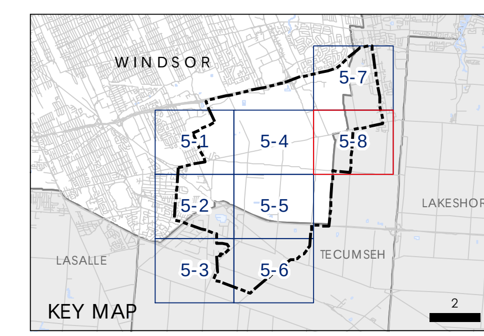
ME	Meadow
MEF	Forb Meadow
MEFM1-1	Goldenrod Forb Meadow
MEG	Graminoid Meadow

Forest

FOD	Deciduous Forest
FODM2-4	Dry-Fresh Oak Hardwood Deciduous Forest
FODM7-1	Fresh-Moist White Elm Lowland Deciduous Forest

Other

AG	Agriculture
BUS	Business
CEM	Cemetary
COM	Commercial
CON	Construction
IND	Industrial
INS	Institutional
OA	Open Aquatic
OS	Open Soil
PAS	Pasture
RES	Residential



Notes

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Client/Project

City of Windsor
Upper Little River Stormwater and Drainage Master Plan

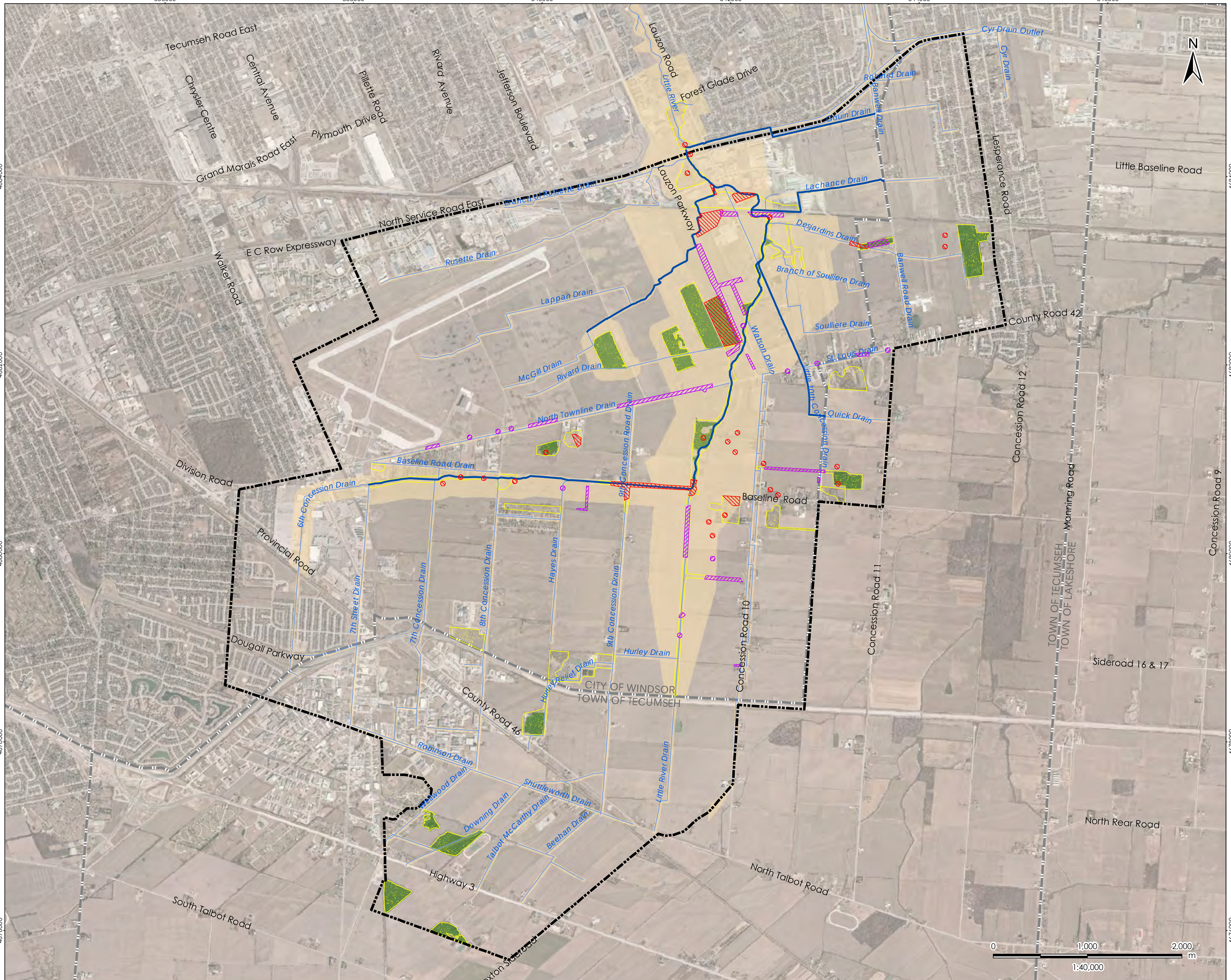
Figure No.

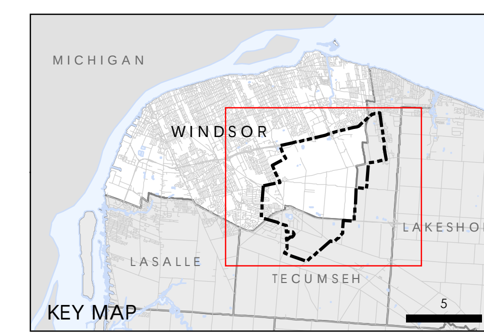
5-8

Title

Roadside Ecological Land Classification

V:\01609\active\160311265 - Upper Little River Stormwater and Drainage MP\drawing\MXD\Terrestrial\2016 Update\160311265_NHS_Fig5-X_ELC.mxd
Revised: 2017-01-25 By: kbuchanan





Stantec

Legend

- Study Area
- Fish Habitat Reach
- Watercourse
- Significant Plant Species Observed
- Significant Wildlife Species Observed
- Habitat Area
- Woodland
- Limit of Regulated Area
- Municipal Boundary

Notes

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March 2017
160311625

Client/Project

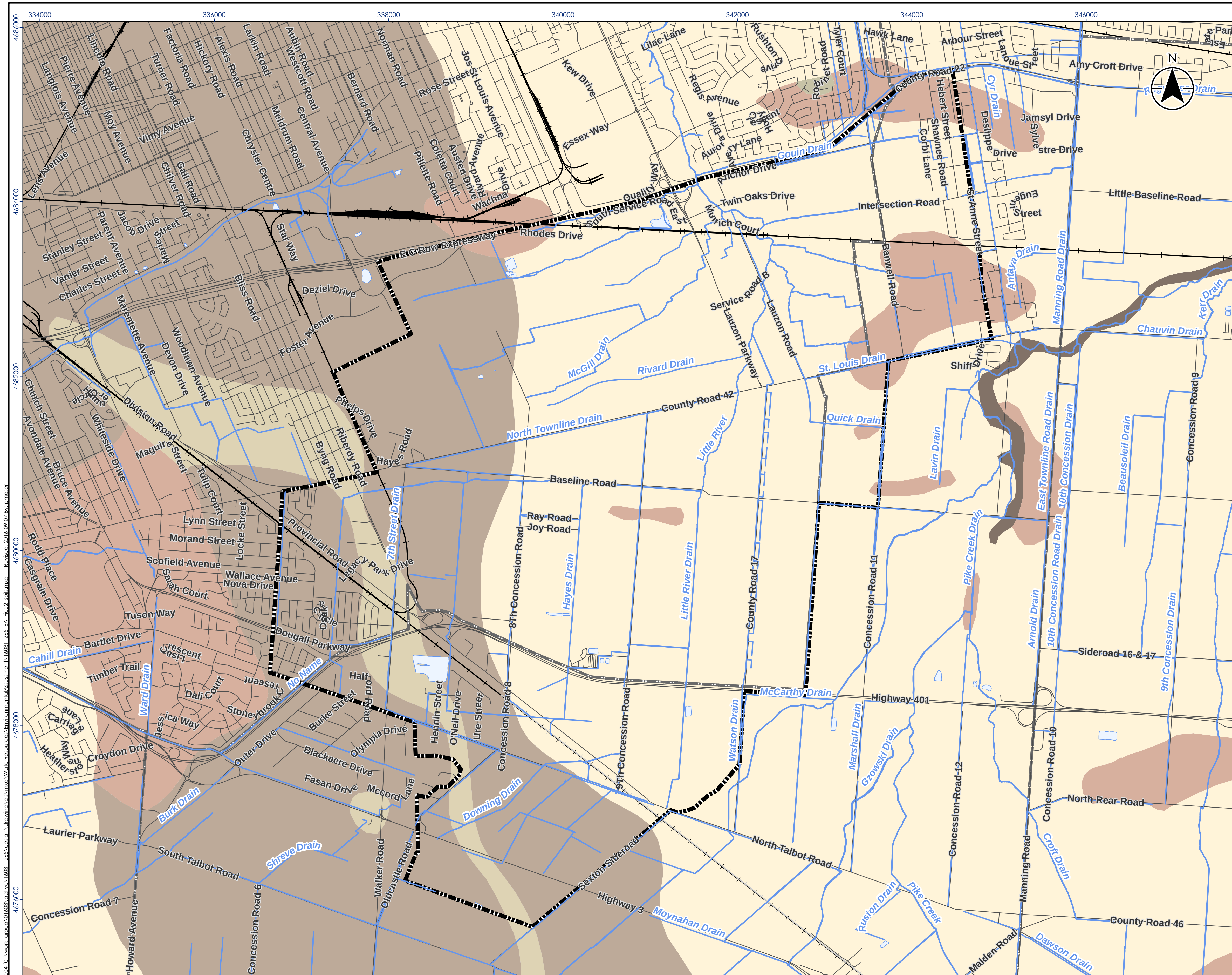
City of Windsor
Upper Little River Stormwater
and Drainage Master Plan

Figure No.
6

Title

Significant Natural Environment Heritage Areas

\\cd1217-f01\work_group\01609\active\160311265 - Upper Little River Stormwater and Drainage MP\drawing\MXD\Terrestrial\2016 Update\160311265_NHS_Fig6_SignatEnvHerAreas.mxd
Revised: 2017-03-01 By: kbuchanan



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Site Boundary
Railway - Operational
Railway - Discontinued
Road
Watercourse
Waterbody
Municipal Boundary - Lower Tier

Soils
Berrien Sandy Loam
Bottom Land
Brookston Clay
Brookston Clay - Sand Spot Phase
Brookston Clay Loam
Burford Loam - Shallow Phase

0 1 2 Kilometers
1:45,000 (At original document size of 11x17)

Notes
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Project Location
Windsor, Ontario

160311265 REVA
Prepared by PRM on 2016-09-07
Technical Review by JI on2016-09-07

Client/Project
CITY OF WINDSOR
UPPER LITTLE RIVER
ENVIRONMENTAL ASSESSMENT

Figure No.
7

Title
Soils

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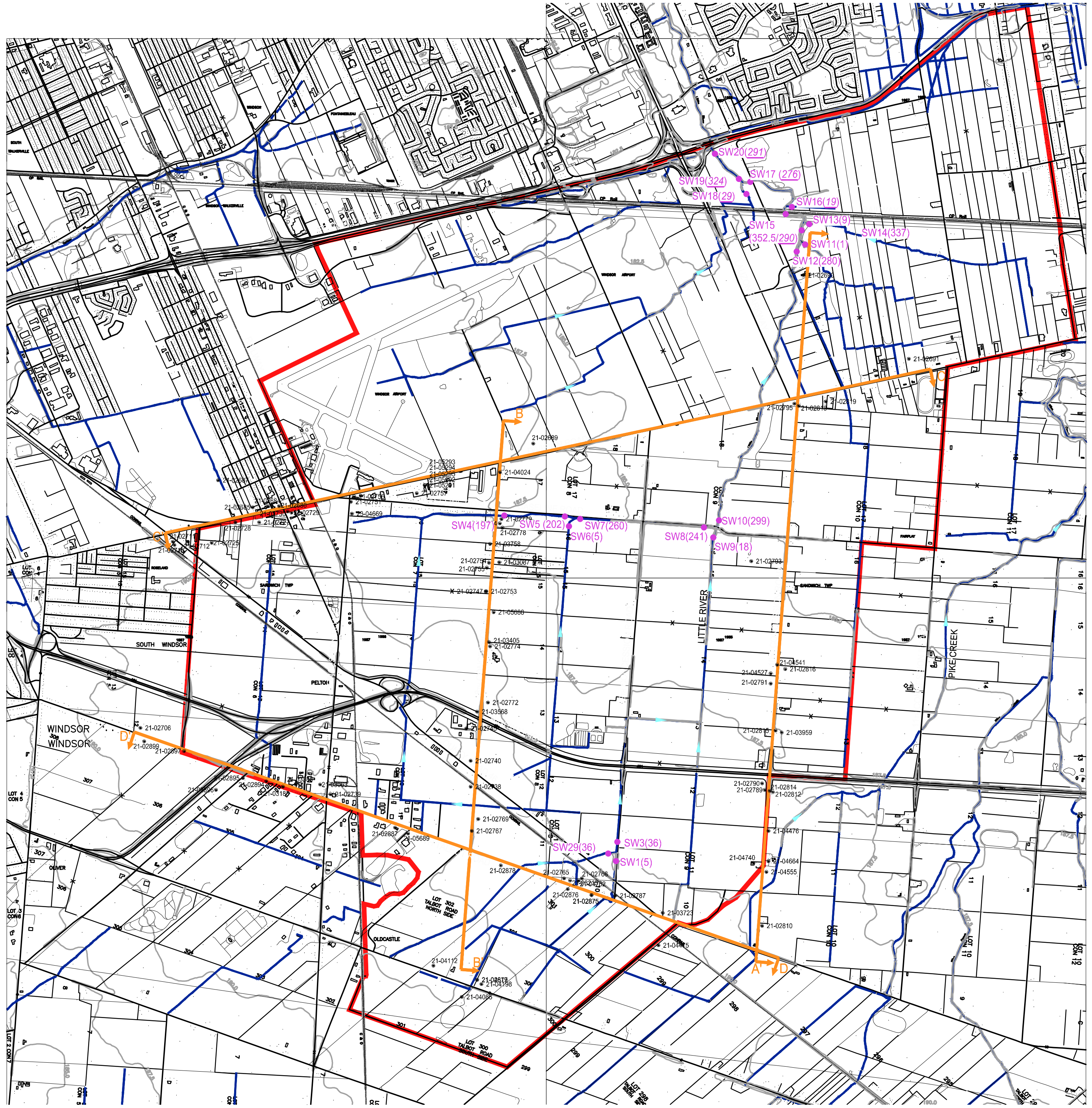
2017/09/06 2:34 PM By: Brook, Randy

N



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September, 2016
160311265

Stantec

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Tel. 519.579.4410
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Legend

Watershed Boundary

SW29(336.8) Flow Measurement (L/s)

⊙ 21-02691 MOE Water Well Record

A A' Cross-Section Location

Notes

0 500 1500 2500m

1:50,000

Client/Project

ESSEX REGIONAL CONSERVATION AUTHORITY

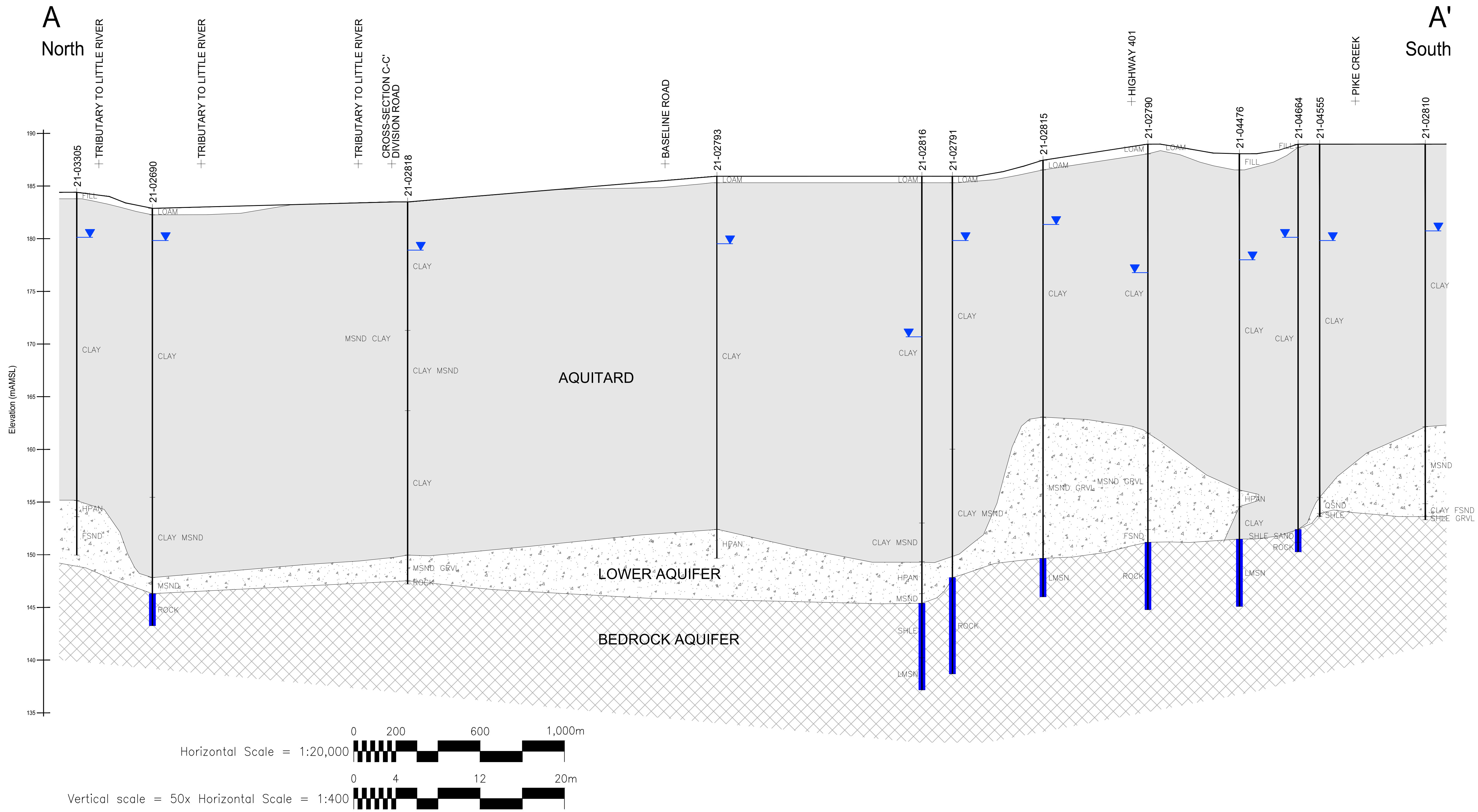
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.

8

Title

HYDROGEOLOGICAL INFORMATION



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2017/01/25 2:42 PM By: Brook, Randy

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Legend

- TW-0 Well ID
- Static Water Level / SAND GRVL Strata Type
- Well Screen
- SAND and GRAVEL
- BEDROCK
- CLAY

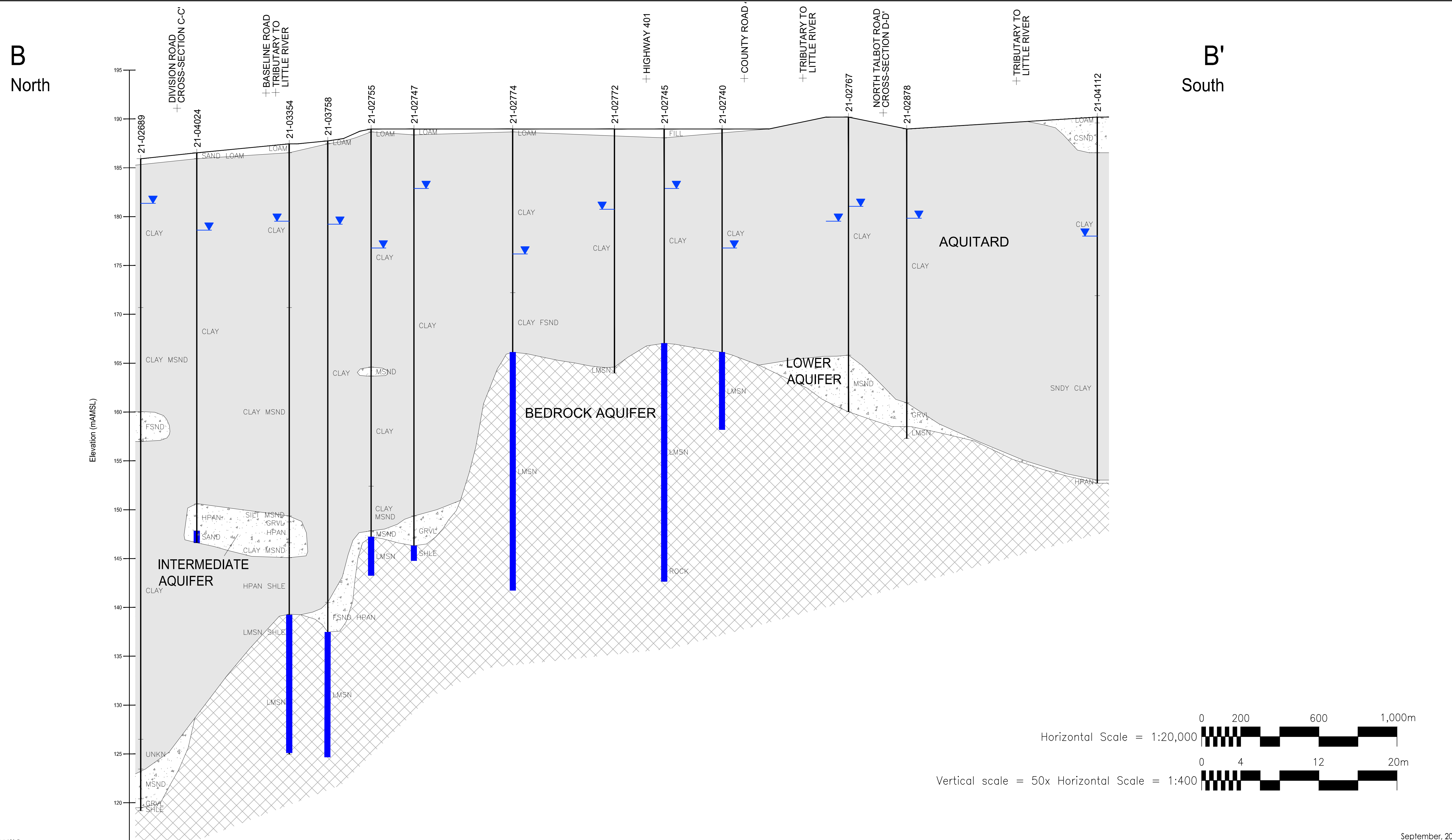
Notes

1. Groundwater levels shown obtained at time of well installation.
2. Refer to Figure 2 for cross–section A–A' location.

Client/Project
ESSEX REGIONAL CONSERVATION AUTHORITY
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.
9

Title
CROSS SECTION A-A



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2017/01/25 2:42 PM By: Brook, Randy

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Legend

- Well ID
- Static Water Level
- Strata Type
- Well Screen
- SAND and GRAVEL
- BEDROCK
- CLAY

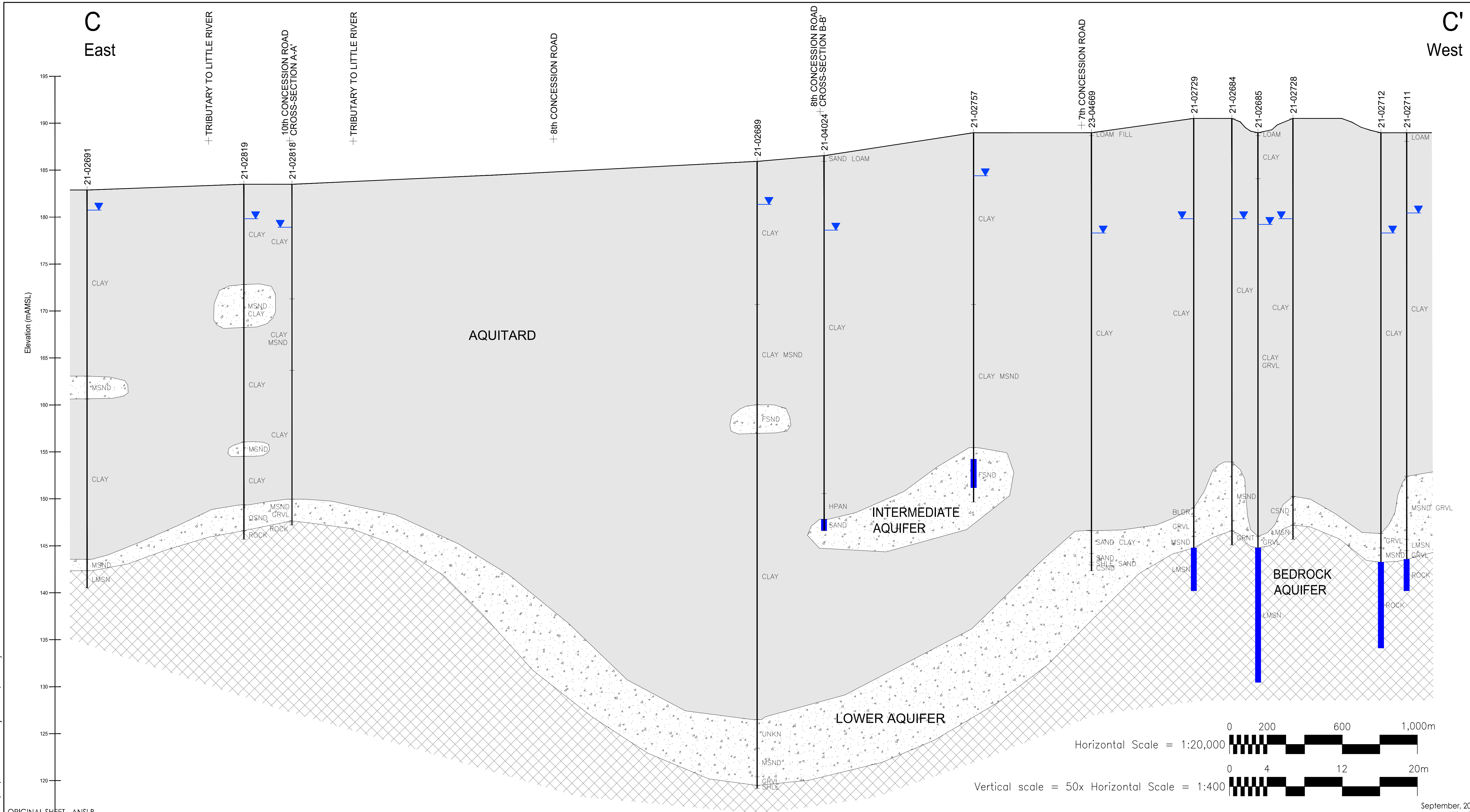
Notes

1. Groundwater levels shown obtained at time of well installation.
2. Refer to Figure 2 for cross-section B-B' location.

Client/Project
ESSEX REGIONAL CONSERVATION AUTHORITY
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.
10

Title
CROSS SECTION B-B



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2017/01/25 2:42 PM By: Brook, Randy

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Waterloo, ON, N2L 0A4
Tel. 519.579.4410
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Legend

- Well ID
- Static Water Level
- Strata Type
- Well Screen
- SAND and GRAVEL
- BEDROCK
- CLAY

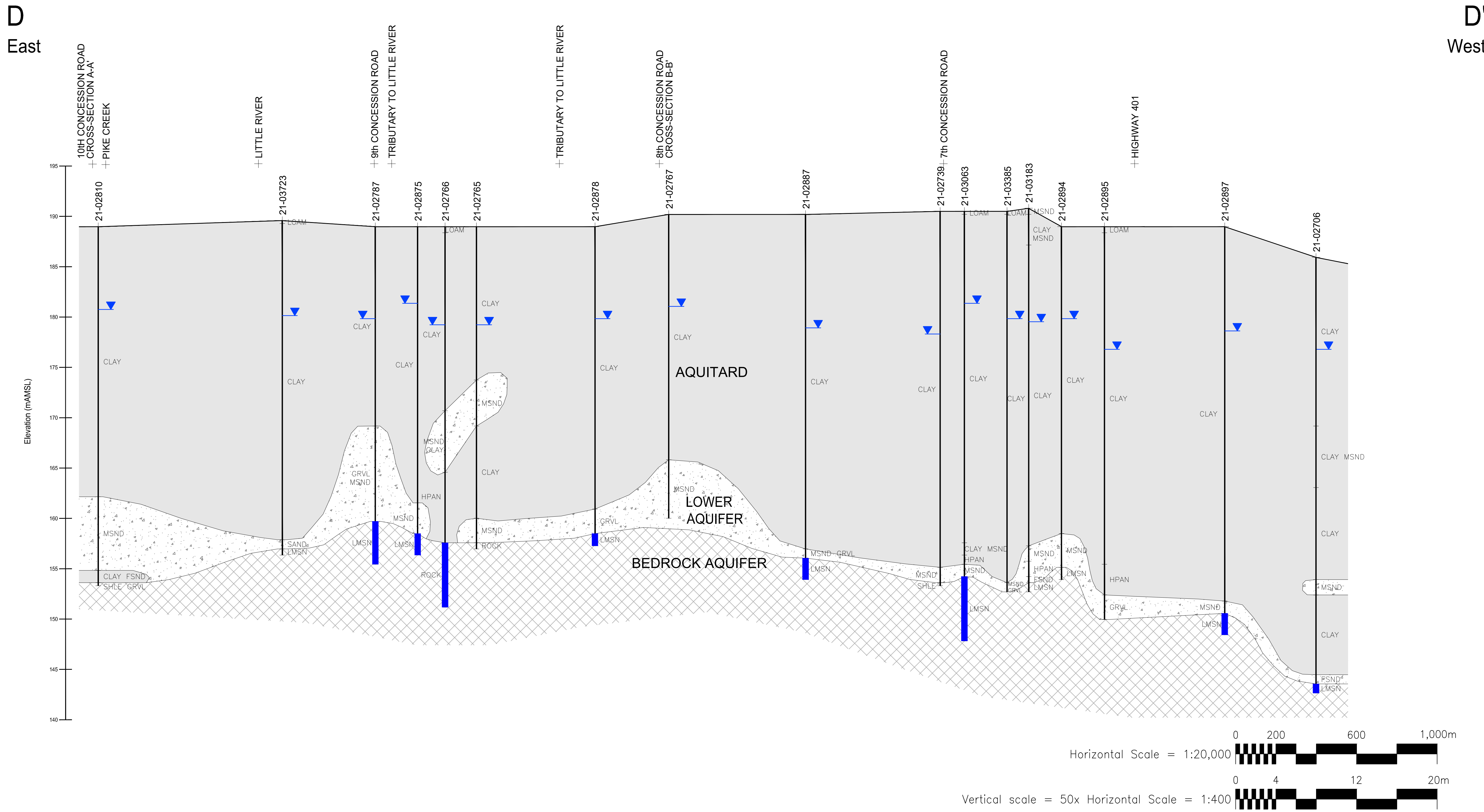
Notes

1. Groundwater levels shown obtained at time of well installation.
2. Refer to Figure 2 for cross-section C–C' location.

Client/Project
ESSEX REGIONAL CONSERVATION AUTHORITY
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.
11

Title
CROSS SECTION C-C



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2017/01/25 2:41 PM By: Brook, Randy

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Legend

TW-C1 Well ID

Static Water Level

SAND GRVL Strata Type

Well Screen

SAND and GRAVEL

BEDROCK

CLAY

Notes

1. Groundwater levels shown obtained at time of well installation.
2. Refer to Figure 2 for cross-section D-D' location.

Client/Project

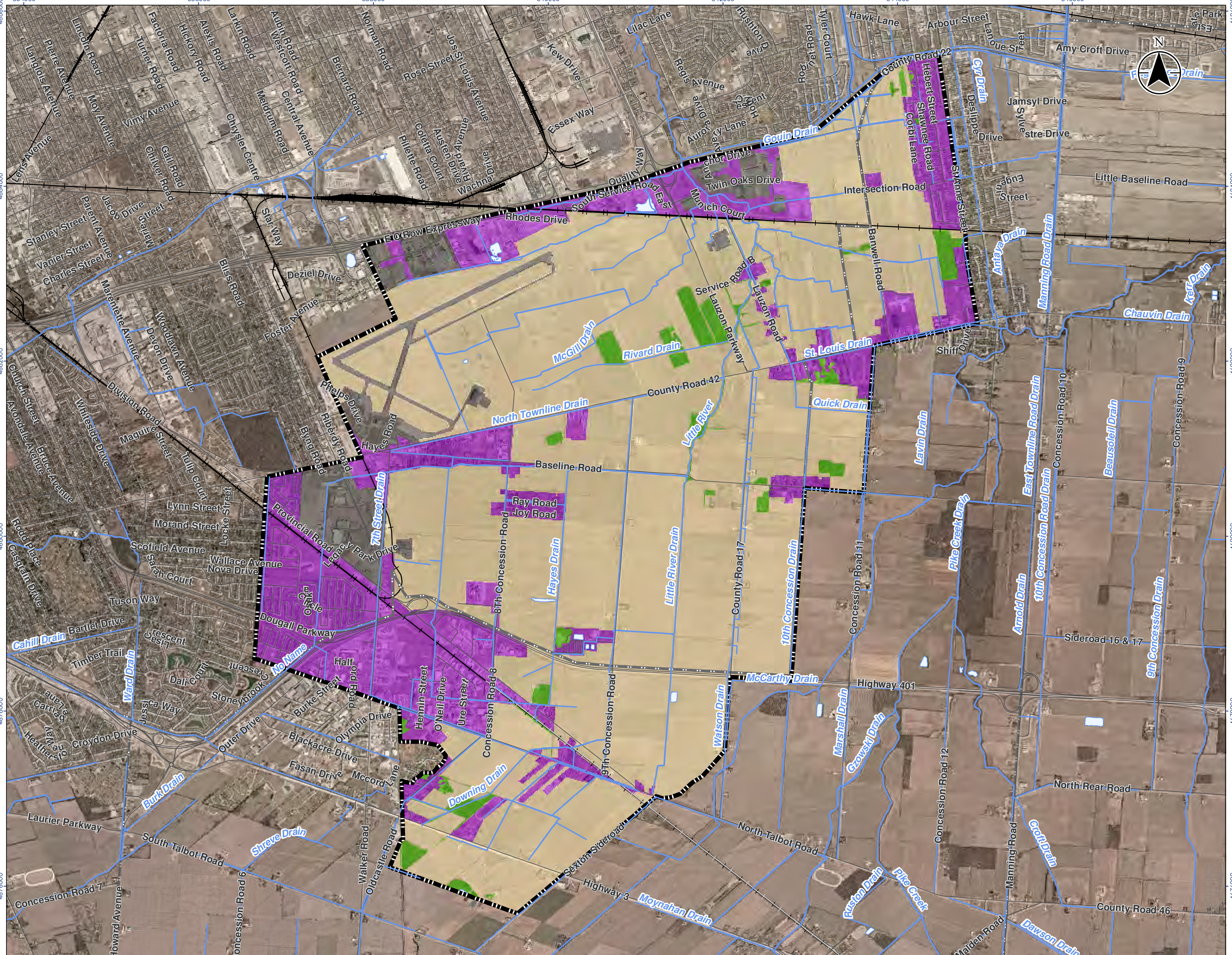
ESSEX REGIONAL CONSERVATION AUTHORITY
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.

12

Title

CROSS SECTION D-D



Notes
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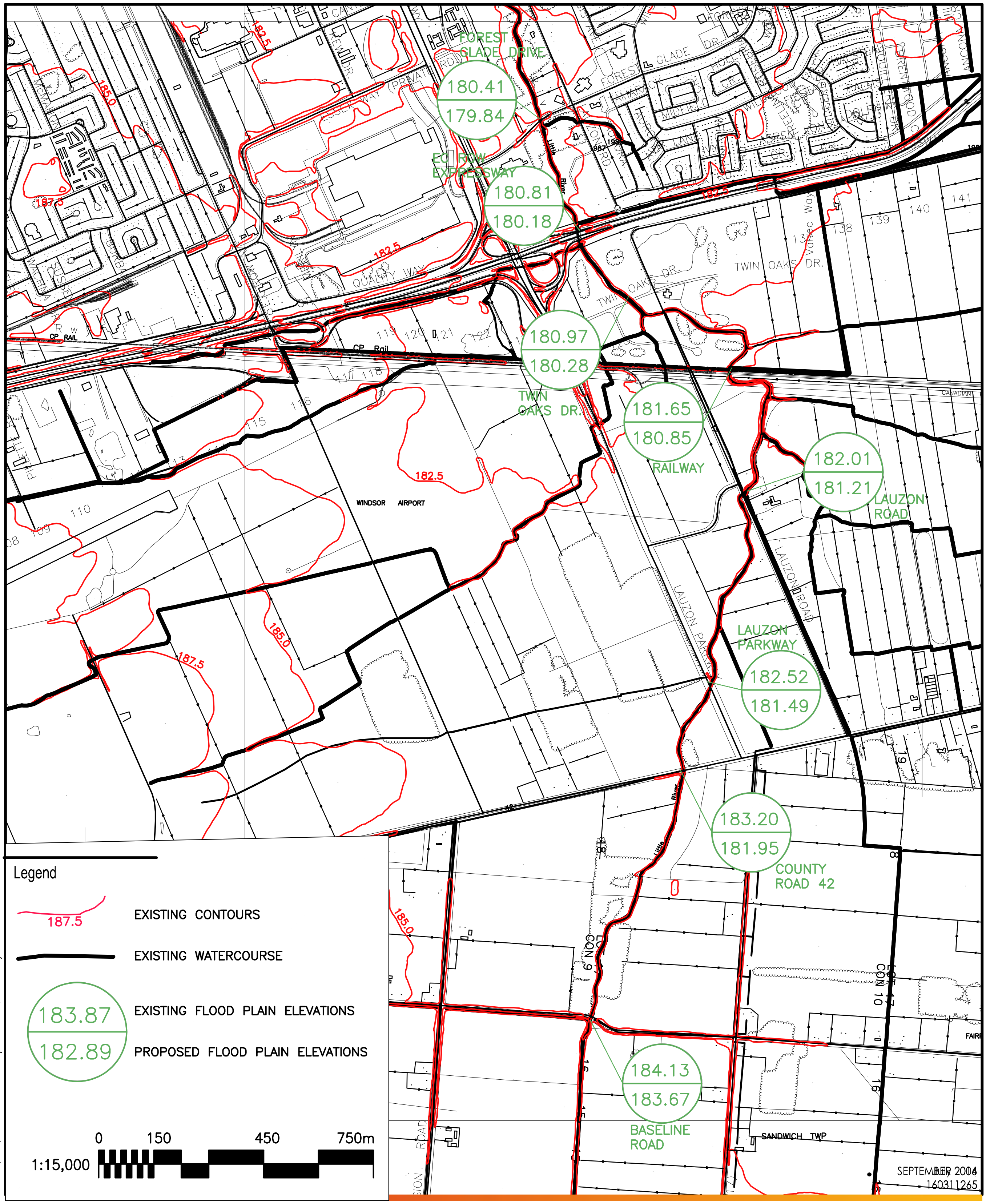
Project Location
Windsor, Ontario

160311265 REVA
Prepared by PRM on 2016-09-07
Technical Review by JI on2016-09-07

Client/Project
CITY OF WINDSOR
UPPER LITTLE RIVER
ENVIRONMENTAL ASSESSMENT

Figure No.
13

Title
Land Cover



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2017/09/06 2:44 PM By: Brook, Randy

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NOTE: FLOOD PLAIN ELEVATIONS ARE PROVIDING AT EXISTING FLOW RESTRICTIONS OR STRUCTURES

Client/Project

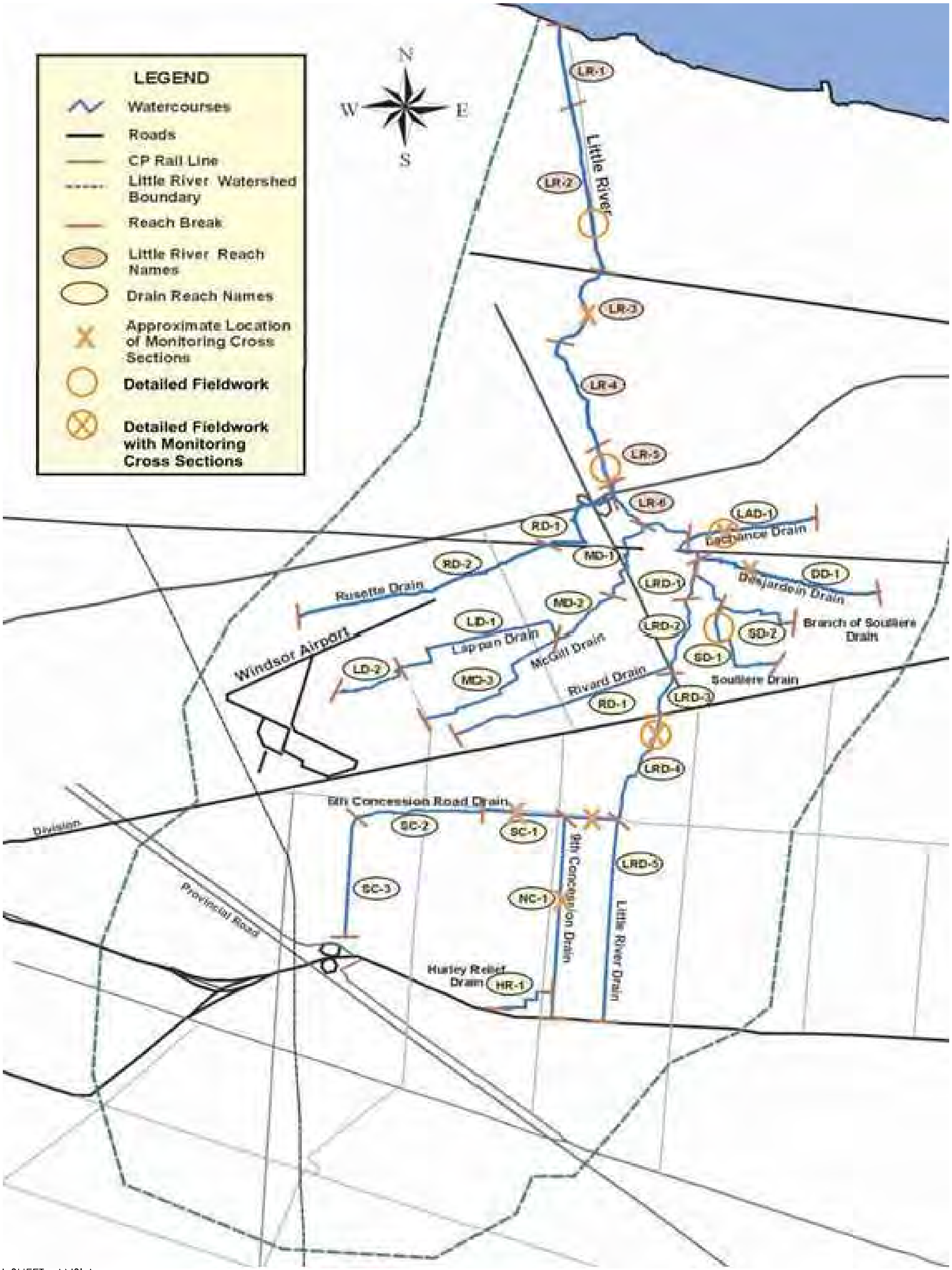
ESSEX REGIONAL CONSERVATION AUTHORITY
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.

14

Title

HYDRAULIC ANALYSIS



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September 2016
160311265

V:\01603\active\160311265\design\drawing\civil\sheet_files\160311265_FIGURE 13.dwg
2017/01/25 1:38 PM By: Brook, Randy

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Client/Project

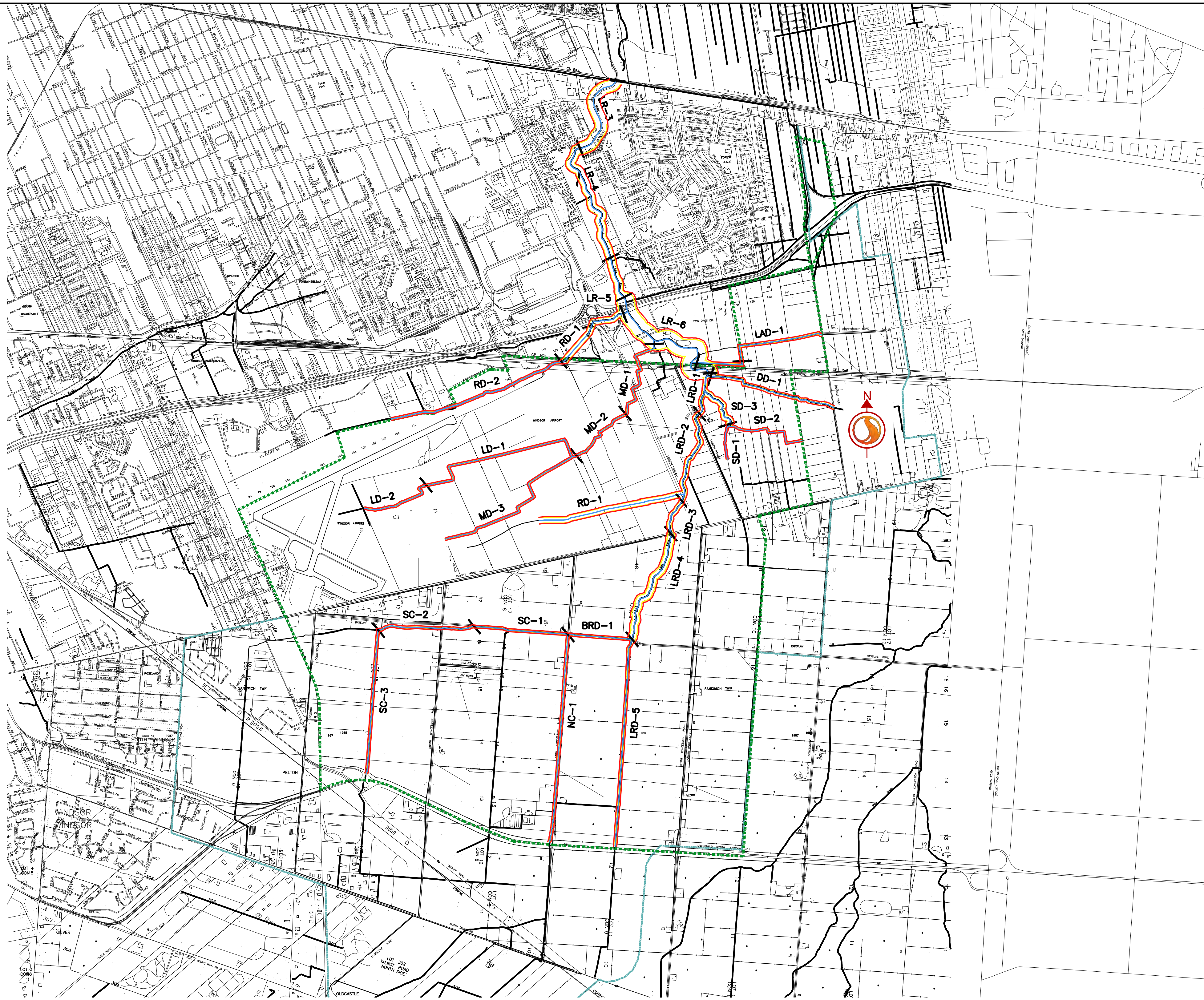
ESSEX REGION CONSERVATION AUTHORITY

Figure No.

FIGURE 15

Title

GEOMORPHOLOGICAL REACH DELINEATION AND MONITORING CROSS SECTIONS



Reach	Preliminary MBW	Final MBW for adjusted (add 10% setback	Method
LR-3	120	143	Field
LR-4	85	102	Reference
LR-5	85	102	Field
LR-6	180	216	Planform
LRD-1	41	50	Field
LRD-2	50	60	Planform
LRD-3	50	60	Field
LRD-4	72	86	Planform
LRD-5	30	36	Planform
LAD-1	28	34	Field
DD-1	36	42	Field
SD-3	60	72	Planform
SD-1	20	24	Field
SD-2	20	24	Reference
RD-1	60	72	Planform
RD-2	23	30	Reference
MD-1	23	28	Field
MD-2	23	28	Reference
MD-3	23	28	Reference
LD-1	23	28	Reference
LD-2	23	28	Reference
RD-1	23	28	Reference
BRD-1	28	32	Field
NC-1	28	32	Field
SC-1	28	32	Field
SC-2	28	32	Reference
SC-3	28	32	Reference

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2017/01/25 2:44 PM By: Brook, Randy

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December, 2015
160311265

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Kitchener, ON, N2H 6M7
Tel. 519.579.4410
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Legend

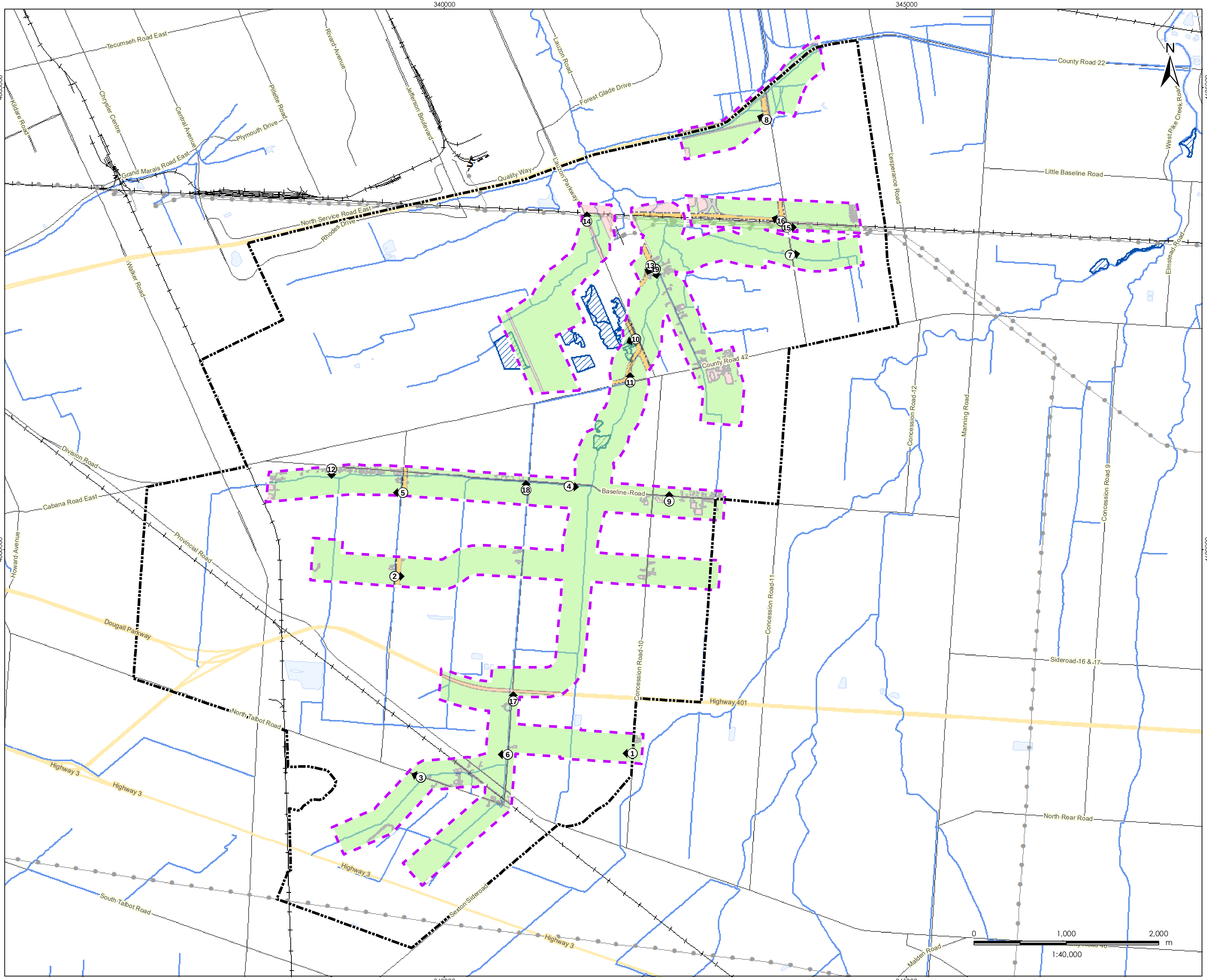
WATERCOURSE
PRELIMINARY MEANDER BELT WIDTH
FINAL MEANDER BELT WIDTH
REACH BREAK
LRD-5 REACH LABEL

Notes

Client/Project
ESSEX REGION CONSERVATION AUTHORITY
WINDSOR ANNEXED AREA
WATERSHED PLAN

Figure No.
16

Title
PRELIMINARY AND FINAL
MEANDER BELT WIDTHS



Stantec

Legend

- Photo Location
- Project Area
- Archaeology Study Area
- Moderate – High Archaeological Potential
- Previously Assessed, Mayer Heritage Consultants Inc. 2010
- Previously Assessed, Archaeoworks 2012
- Previously Disturbed
- Provincially Significant Wetland
- Watercourse
- Railway, Active
- Transmission Line
- -UT- Unknown Pipeline

Notes

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June 2014
160311265

Client/Project

City of Windsor
Upper Little River Stormwater
and Drainage Master Plan

Figure No.
17

Title
Archaeological Potential

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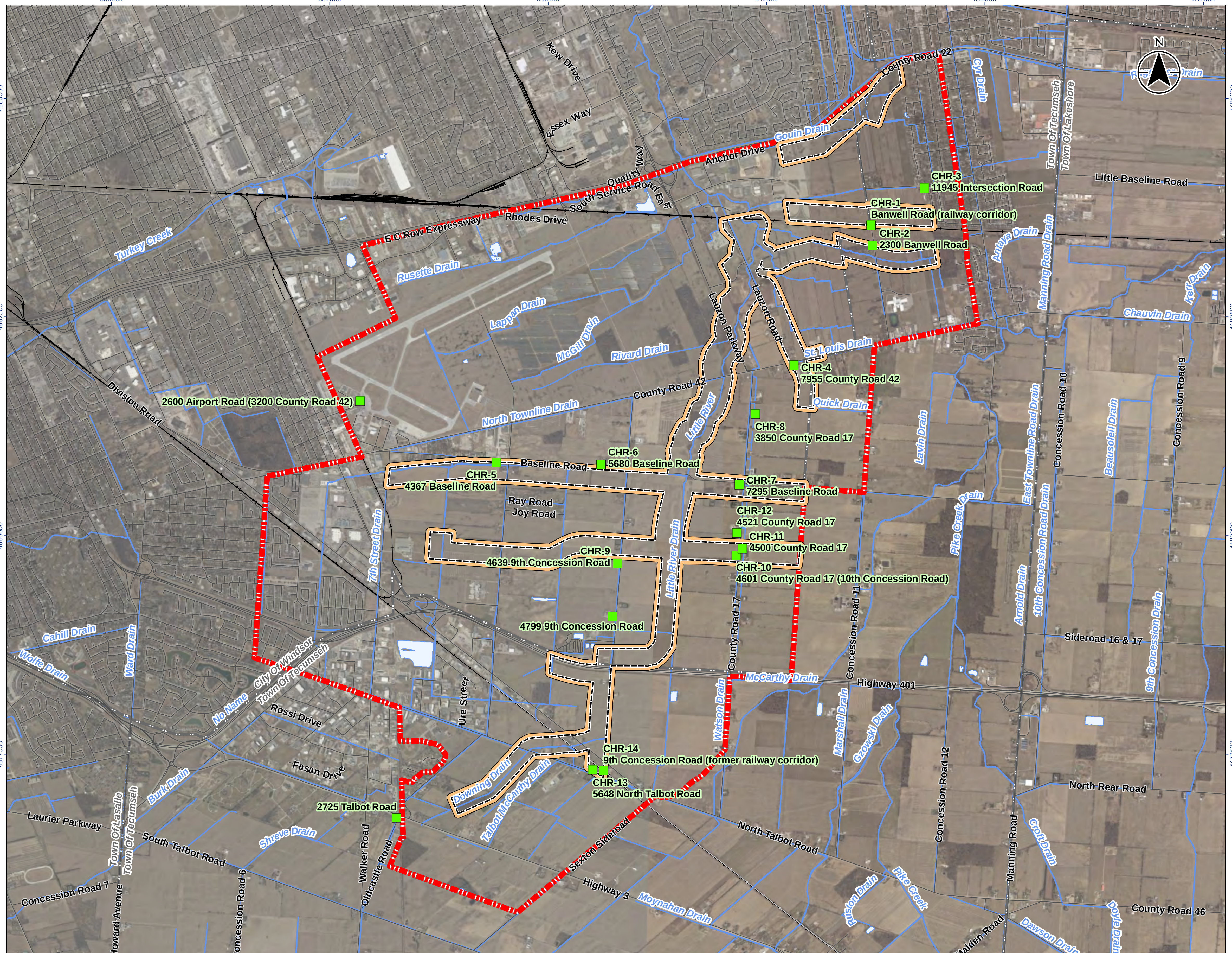
Revised: 2014-06-24 By: sallen



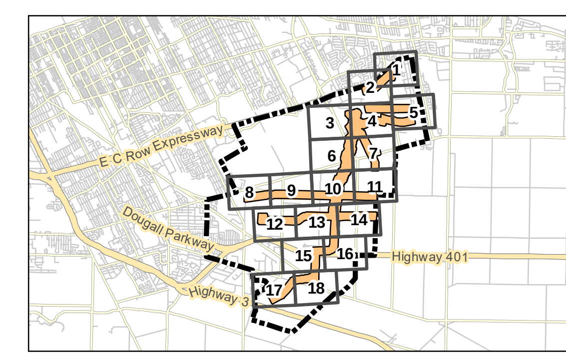
Stantec

- Cultural Heritage Study Area
- Upper Little River Study Area
- SWM Corridor Boundary
- Identified Cultural Heritage Resource
- Railway - Operational
- Railway - Discontinued
- Road
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

0 1,000 2,000 Meters

1:45,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2016.
3. Orthoimagery © First Base Solutions, 2018. Imagery flown in 2017.



Project Location
Windsor, Ontario

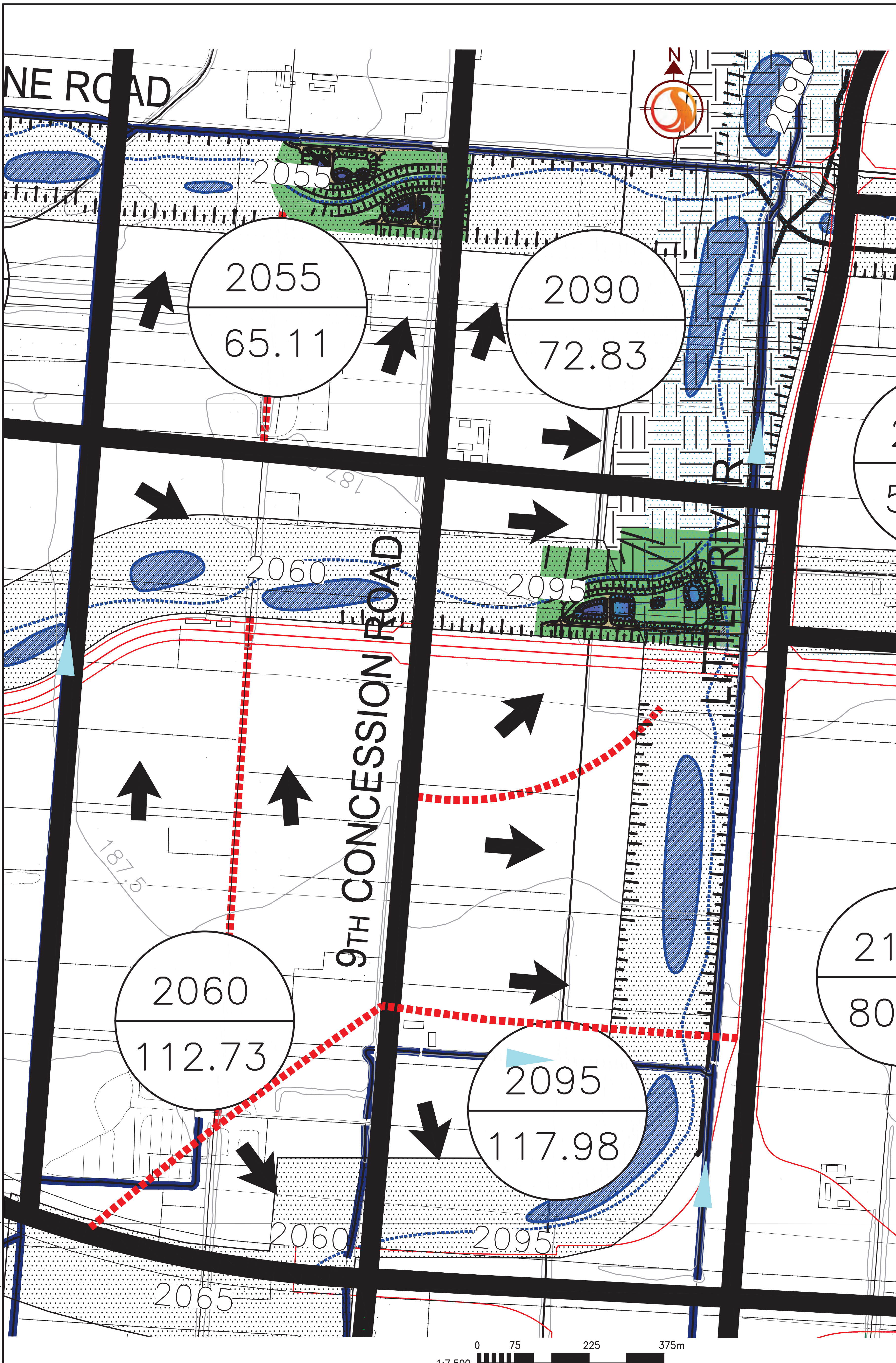
160311265 REVA
Prepared by CMC on 2021-07-02
Technical Review by ABC on xxxx-xx-xx

Client/Project
CITY OF WINDSOR
UPPER LITTLE RIVER
CULTURAL HERITAGE RESOURCES ASSESSMENT

Figure No.
18

Title
Identified Cultural Heritage Resources - Tile

\\cd1004-f01\work_group\01603\active\160311265\design\drawing\gis\mxd\CulturalHeritage\CHRA\MainReport\160311265_CHRA_Fig18_IdentifiedHeritageResources.mxd Revised: 2021-07-02 By: CCoghlan



V:\01603\active\160311265\design\drawing\civil\sheet_files\160311265_C-SWM-CONCEPT.dwg
2017/09/08 9:06 AM By: Brook, Randy

ORIGINAL SHEET - ANSI B

SEPTEMBER 2016
160311265

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Legend

CATCHMENT BOUNDARY
SUB-CATCHMENT BOUNDARY
DIRECTION OF FLOW

Client/Project
ESSEX REGIONAL CONSERVATION ATHORITY
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.
19

Title
CONCEPTUAL STORMWATER
LAYOUT PLAN

V:\01603\active\160311265\design\drawing\civil\sheet_files\160311265_C-POND.dwg
9/6/2017 3:28:08 PM By: Brook, Randy

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FEBRUARY 2012
1603–11265

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TRAIL / ACCESS ROAD

CHANNEL

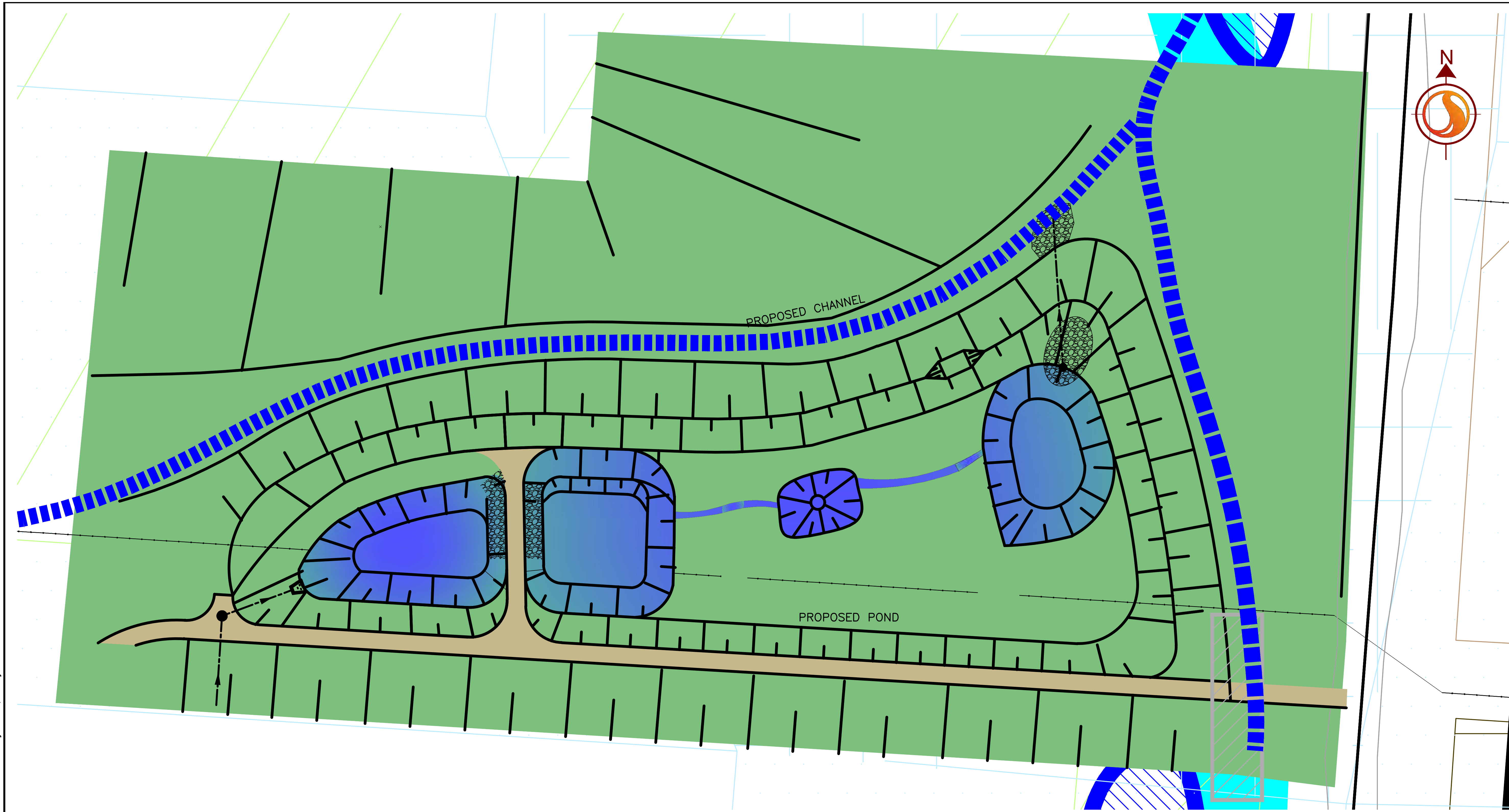
PERMANENT POND

0 12.5 37.5 62.5m
1:1250

Client/Project
ESSEX REGION CONSERVATION AUTHORITY
UPPER LITTLE RIVER
ENVIRONMENTAL ASSESSMENT

Figure No.
20

Title
STORMWATER MANAGEMENT
POND CONCEPT 1



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9/6/2017 3:16:38 PM By: Brook, Randy

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TRAIL / ACCESS ROAD

CHANNEL

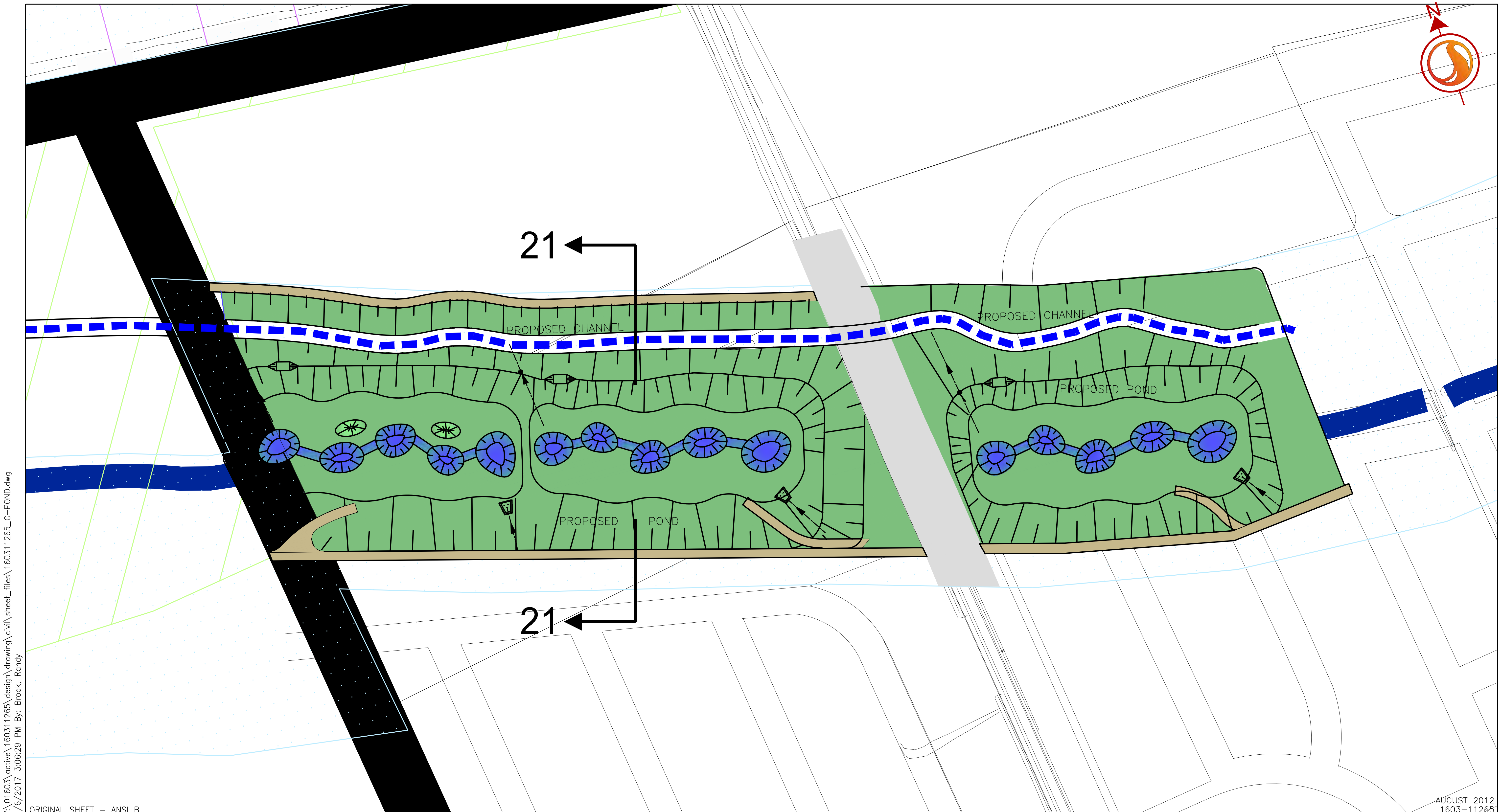
PERMANENT POND

1:1250 0 12.5 37.5 62.5m

Client/Project
ESSEX REGION CONSERVATION AUTHORITY
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.
21

Title
STORMWATER MANAGEMENT
POND CONCEPT 2



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Legend

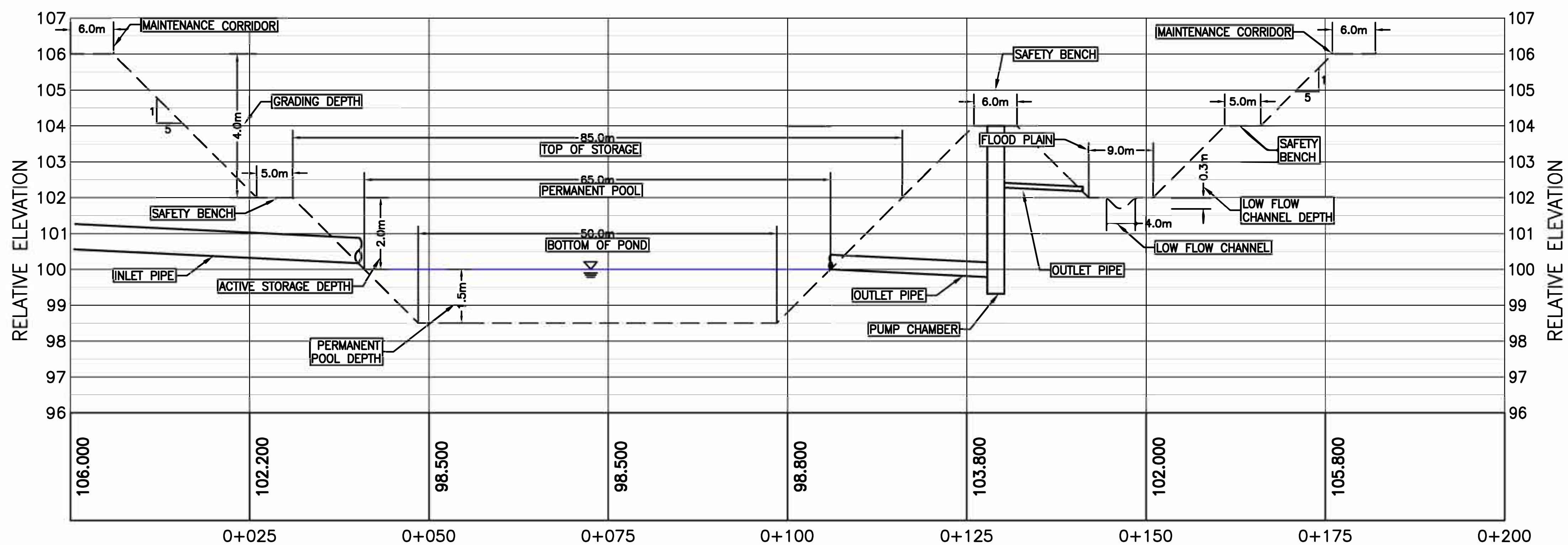
- TRAIL / ACCESS ROAD
- ROAD
- CHANNEL
- PERMANENT POND
- MOUND

1:2500 — 0 25 75 125m

Client/Project
ESSEX REGION CONSERVATION AUTHORITY
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.
22

Title
STORMWATER MANAGEMENT
POND CONCEPT 3



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2017/09/06 2:52 PM By: Brook, Randy

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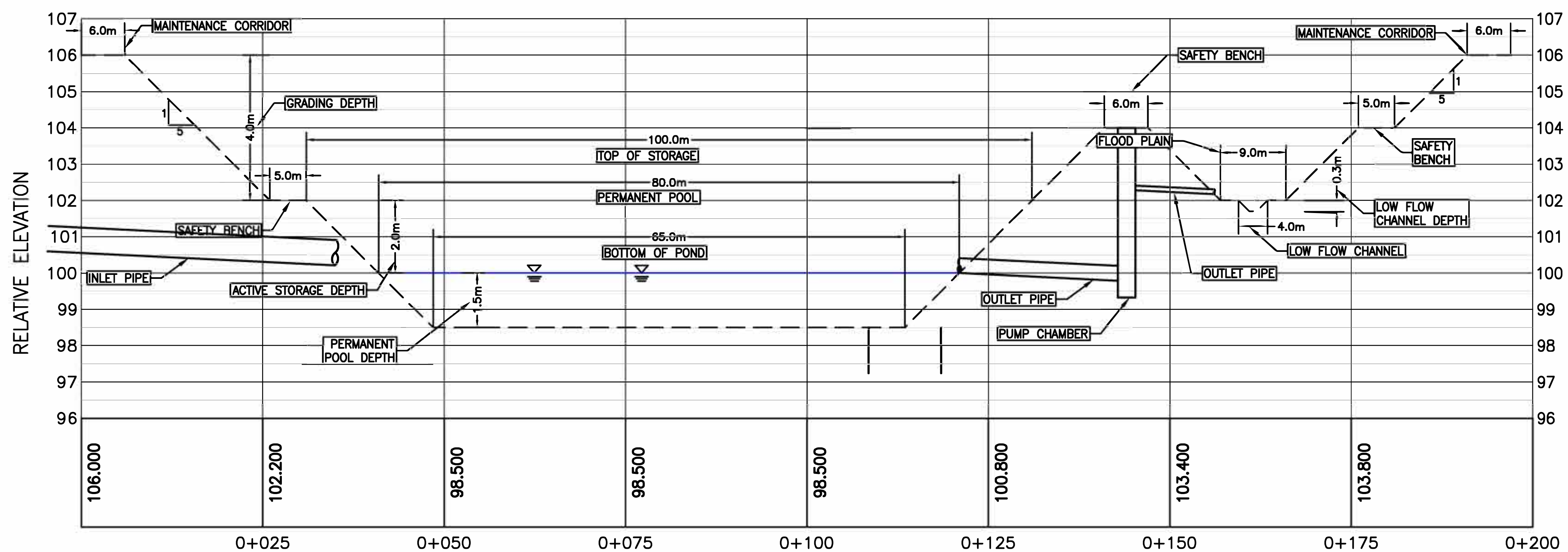
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.
23

Title

TYPICAL CROSS SECTION WITH ONE SWM FACILITY



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2017/09/06 2:52 PM By: Brook, Randy

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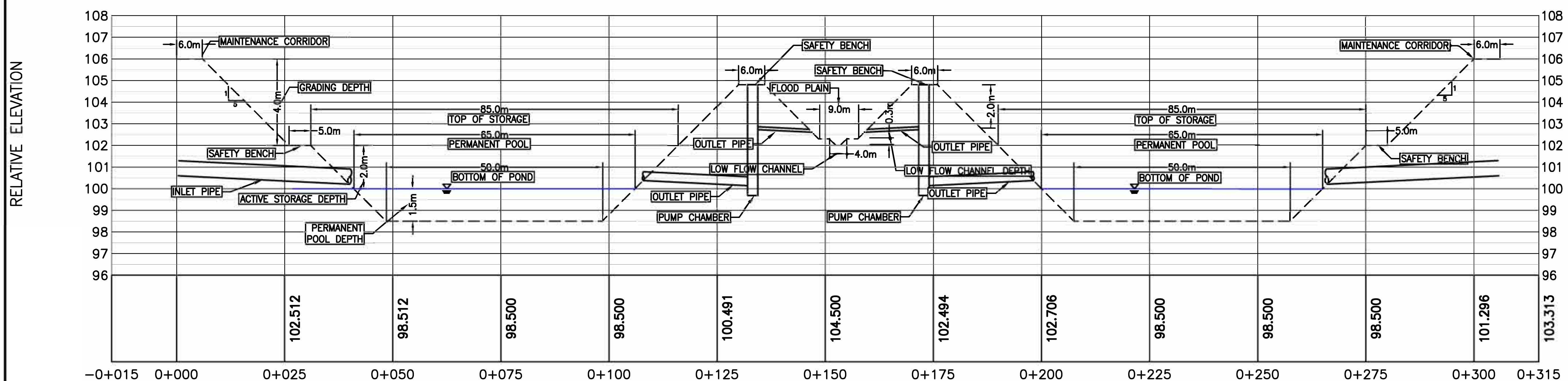
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.
24

Title
CROSS SECTION WITH ONE
SWM FACILITY AND CONTINGENCY



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2017/09/06 2:52 PM By: Brook, Randy

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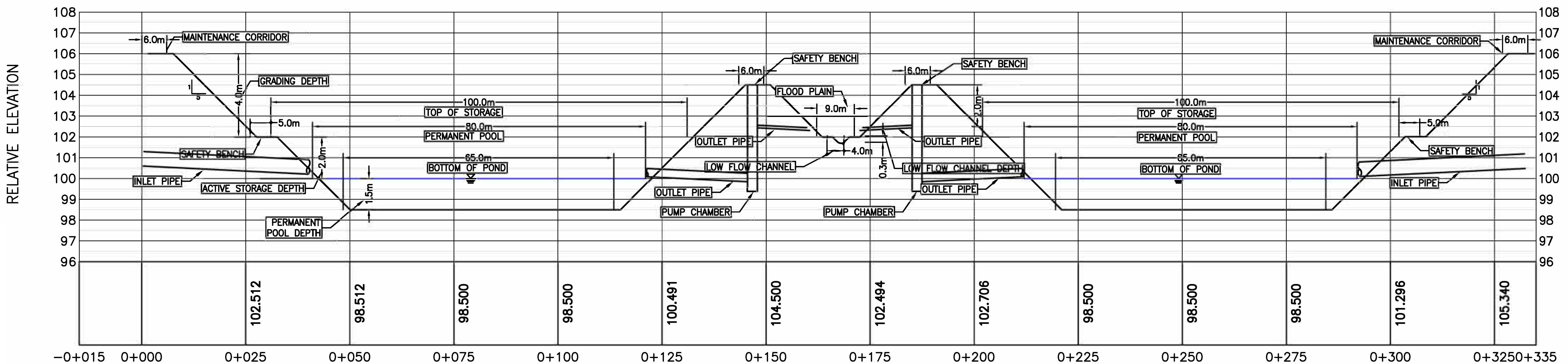
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.
25

Title
TYPICAL CROSS SECTION WITH TWO SWM FACILITIES



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2017/09/06 2:52 PM By: Brook, Randy

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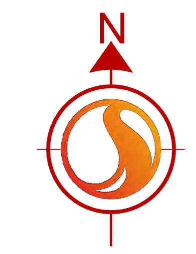
UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Figure No.
26

Title
TYPICAL CROSS SECTION WITH
TWO SWM FACILITIES AND CONTINGENCIES



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STUDY AREA

EXISTING WATERCOURSE

OVERLAND FLOW / TILE DRAIN

CITY OF WINDSOR / TOWN OF TECUMSEH BOUNDARY

Revision	By	Appd.	YY.MM.DD

File Name: 160311265_STUDY-AREA.dwg	Dwn.	Chkd.	Dsgn.	YY.MM.DD
				16.09.16

Permit-Seal

Client/Project

ESSEX REGION CONSERVATION AUTHORITY

UPPER LITTLE RIVER
ENVIORMENTAL ASSESSMENT
Windsor ON Canada

Title

STUDY AREA

Project No. 1603-11265

Scale 1:20,000 0 200 600 1000m

Drawing No. 1

Sheet of

Revision

ORIGINAL SHEET - ARCH D

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187.5 EXISTING CONTOURS
EXISTING WATERCOURSE
STORM DRAINAGE BOUNDARY
1000 CATCHMENT I.D.
50.00 AREA (HECTARES)

Revision		By	Appd.	YY.MM.DD
File Name: 165600836_DB.dwg				21.06.22
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

ESSEX REGION CONSERVATION AUTHORITY

UPPER RIVER RIVER
ENVIROMENTAL ASSESSMENT
Windsor ON Canada

Title

EXISTING CONDITIONS
DRAINAGE PLAN

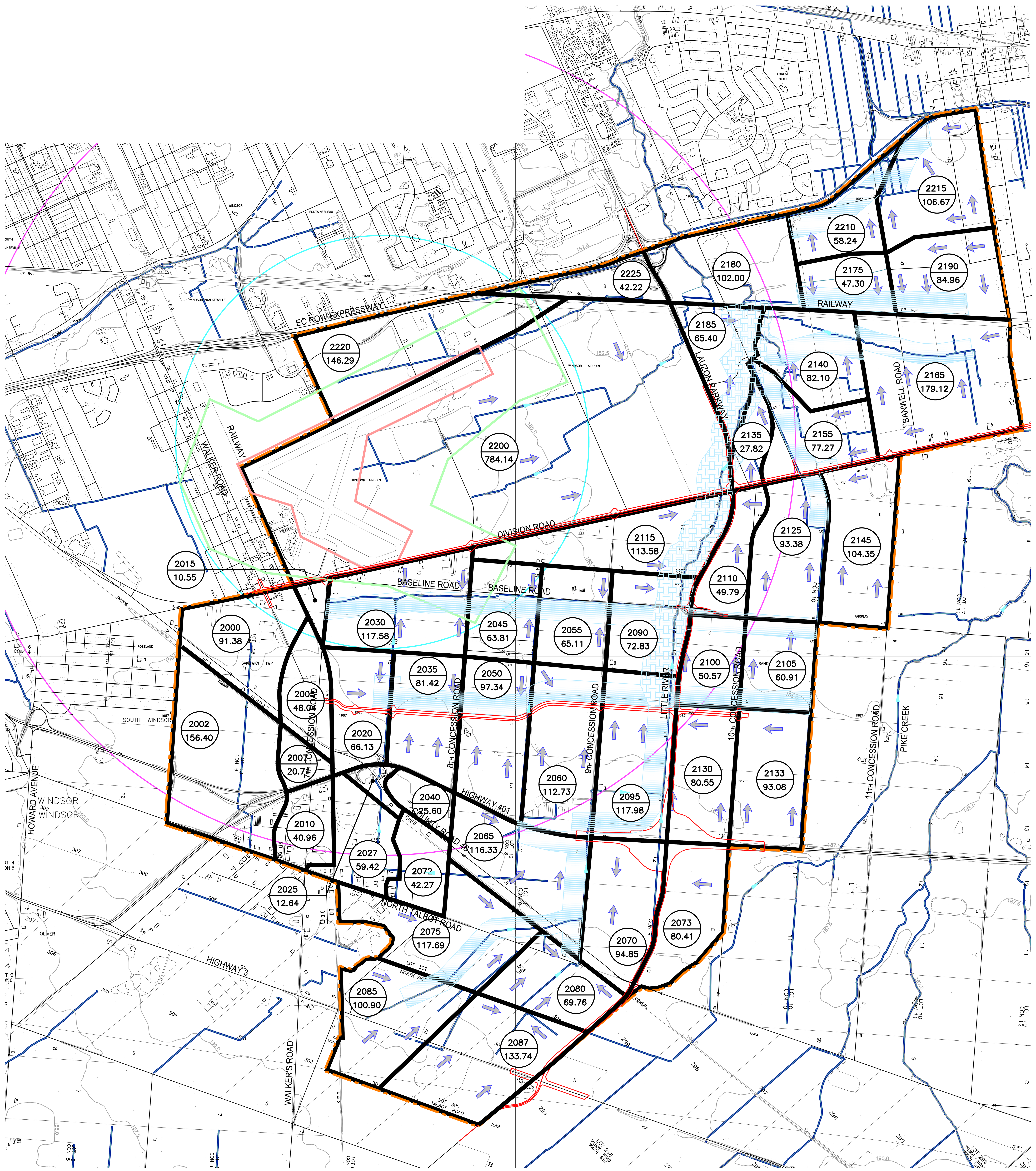
Project No. 1656-00836

Scale 1:15,000 0 150 450 750m

Drawing No. Sheet Revision

165600836_DB of 2 0

ORIGINAL SHEET - ARCH D



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Legend

- STUDY AREA
- STORM DRAINAGE BOUNDARY
- 2165 172.92 — CATCHMENT I.D. / AREA (HECTARES)
- 2 KM RADIUS FROM AIRFIELD CENTRE (WILDLIFE CONTROL ZONE)
- 4 KM RADIUS FROM AIRFIELD CENTRE (WILDLIFE CONTROL ZONE)
- ZONE OF NO TOLERENCE
- ZONE OF NO CONFIDENCE
- STORM WATER MANAGEMENT CORRIDOR (200m WIDE)
- STORM WATER MANAGEMENT CORRIDOR (325m WIDE)
- DIRECTION OF FLOW

Revision	By	Appd.	YY.MM.DD

File Name: 160311265_C-SD.dwg	KS	JI	JI	12.02.02
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

ESSEX REGION CONSERVATION AUTHORITY

UPPER LITTLE RIVER
ENVIROMENTAL ASSESSMENT

Windsor, ON

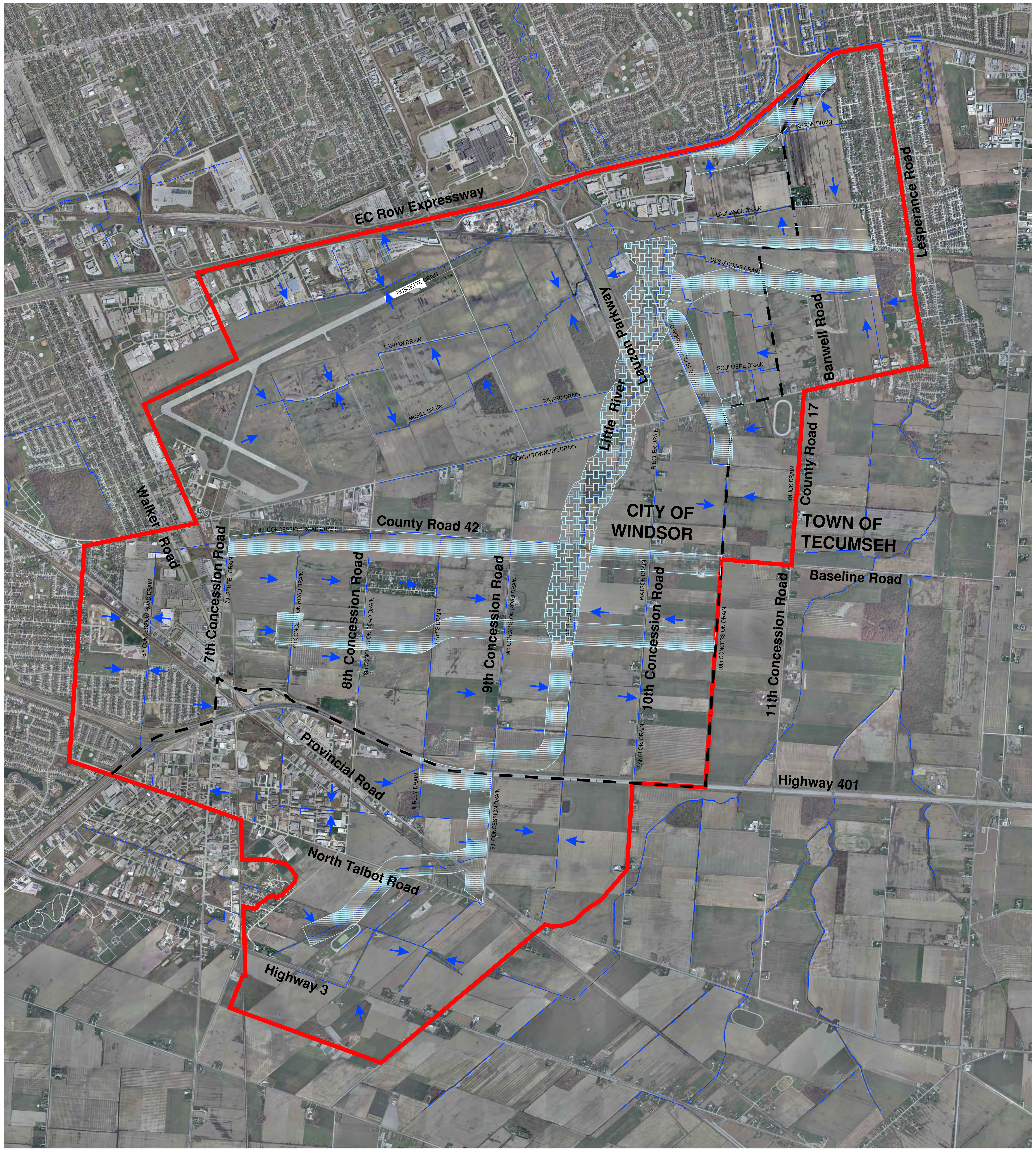
Title

PROPOSED CATCHMENT AREAS

Project No.	Scale
1603-11265	1:20,000 (0, 200, 600, 1000m)

Drawing No.	Sheet	Revision
3	1 of 1	0

ORIGINAL SHEET – ARCH D



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	STUDY AREA
	EXISTING WATERCOURSE
	STORM WATER MANAGEMENT CORRIDOR (200m WIDE)
	STORM WATER MANAGEMENT CORRIDOR (325m WIDE)
	CITY OF WINDSOR / TOWN OF TECUMSEH BOUNDARY
	DIRECTION OF FLOW

Revision	By	Appd.	YY.MM.DD

File Name: 160311265_STUDY-AREA.dwg				16.09.16
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

ESSEX REGION CONSERVATION AUTHORITY

UPPER LITTLE RIVER
ENVIORMENTAL ASSESSMENT
Windsor ON Canada

Title

STORMWATER MANAGEMENT CORRIDOR LOCATION

Project No. 1603-11265

Scale 1:20,000 0 200 600 1000m

Drawing No. 4

Sheet of

Revision

ORIGINAL SHEET - ARCH D