Environmental Impact Study (EIS)

York Road Environmental Design Study
City of Guelph
Project # TP115100

Prepared for:

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

August 2019

Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited
[Comments]
www.woodplc.com

August 23, 2019

Arun Hindupur, M.Sc., P. Eng.,
Supervisor, Infrastructure Engineering
City of Guelph
1 Carden Street
Guelph, ON N1H 3A1

Dear Mr. Hindupur,

Re: Final York Road Environmental Impact Study

Wood is pleased to provide the City of Guelph with the Final York Road Environmental Impact Study (EIS). As part of the EIS, Wood has included the Heritage Impact Assessment (HIA). The EIS and HIA provide the City with the environmental and cultural heritage assessments, supplemental to the 2007 York Road Improvements Class Environmental Assessment (EA). The 2007 Class EA made a number of recommendations for roadway improvements along York Road, including road widening from two (2) to four (4) lanes from Victoria Road to the East City Limits. The EIS and HIA have built upon the Class EA findings and have recommended four (4) lane road with two (2) multi-use paths (MUPs). To facilitate the road improvements, Clythe Creek has been recommended to be realigned and restored south of York Road. The existing cultural heritage resources, will be maintained in place where possible, with the entrance walls to the former Reformatory being relocated away from the road and being restored closer to the original condition and view of the walls from York Road.

The EIS and HIA have facilitated the further development of the York Road Corridor design, to meet the City's transportation requirements while restoring Clythe Creek and protecting cultural heritage resources and environmental resources.

We look forward to the successful completion of this study with the City of Guelph in early 2019. Should you have any questions please contact our office.

Sincerely,

Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited

Per: Maria E. King, P. Eng.
Senior Project Engineer - Transportation

Per: Steve Chipps, P. Eng.
Associate, Senior Water Resources Engineer

LICENSED PROFESSIONAL ENGINEER
08/23/2019
S. CHIPPS
PROVINCE OF ONTARIO

SC/MK/cc

c.c. Todd Fell, Dougan & Associates
Mark Wojda, Matrix Solutions

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Environmental Impact Study (EIS)

York Road Environmental Design Study
Project Location
Project # TP115100

Prepared for:

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

Prepared by:

Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited
[Comments]

August 2019

Executive Summary

Introduction

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood), was retained by the City of Guelph to conduct an Environmental Design Study for the York Road Improvements, Wyndham Street South to East City Limits. The York Road Environmental Design Study (YREDS) is an important undertaking to support and assist with the implementation of the recommendations stemming from the 2007 York Road Improvements Class Environmental Assessment (EA), the limits of which are indicated in Figure 1.

The City of Guelph completed the York Road Improvements Class EA to identify transportation improvements to address the travel needs on York Road between Wyndham Street South and the East City Limits. The need for road improvements on York Road was identified in the Guelph Wellington Transportation Study (GWTS) that was completed in 2005. The impetus for these improvements originates from the proposed development of the Guelph Innovation District (GID, OPA 54) Secondary Plan south of York Road, east of the CP rail line. This area was previously referred to as the Ontario Correctional Institute Lands.

The 2007 EA made a number of recommendations for roadway improvements along York Road, including road widening from Victoria Road to the East City Limits. The proposed road widening (from two lanes to four lanes) is required to assist the City of Guelph achieve its planning and development targets, in particular the proposed development within the Guelph Innovation District lands located to the south of York Road (ref. Figure 1).

As noted within the 2007 EA, the proposed roadway improvements were expected to impact the adjacent watercourse, Clythe Creek; as such, recommendations were made with respect to:

- Extension of the existing Clythe Creek Culvert crossing of York Road;
- Relocation of approximately 135 m +\- of the Clythe Creek Channel to accommodate the proposed road widening; and
- Implementation of riparian plantings to separate the widened roadway from the relocated Clythe Creek channel.

In order to support and assist with the implementation of the EA recommendations, it has been necessary to provide further consideration of the numerous environmental, cultural, and engineering factors associated with the foregoing. The proposed York Road Environmental Design Study addresses all of these considerations in greater detail and ensures that the proposed road widening is conducted in a responsible and well-planned manner.

Alternatives Assessment

Through a consultative process with the City of Guelph, Wood has developed alternatives for both the road sections and profile and for Clythe Creek adjustments to accommodate the proposed road improvements. The EIS discusses how the road alternatives fulfill the requirements of the 2007 Class EA and more recently the input from both City staff and the public. The alternatives for the creek have considered input from City staff, agency stakeholders (GRCA, MNRF), stakeholder groups (e.g. Trout Unlimited), Indigenous Communities and the public.

Since completion of the 2007 York Road Class EA, the City of Guelph has committed to putting a greater focus on active transportation facilities, which includes a desire to provide equivalent levels of service for cycling facilities as is provide for vehicular facilities. Additionally, since completion of the EA, the City has put additional importance on protection of built and cultural heritage features. As a result, the limited cycling and pedestrian facilities contemplated as part of the original 2007 EA are no longer sufficient to meet City objectives. The associated removal of some key heritage features are likewise no longer acceptable. These changes in policy had to be considered within the alternative assessment. The following summarizes the alternatives considered:

Road Alternatives:

- **Alternative 1:** Four lane urbanized cross-section with 3.0 m wide multi-use pathways and minimum 1.0 m wide boulevards on both sides;
- **Alternative 2:** Four lane urbanized cross-section with 3.0 m wide multi-use pathways on both sides, no boulevards along GID lands;
- **Alternative 3:** Four lane urbanized cross-section with 3.0 m wide multi-use pathways reduced to 2.5 m width at Reformatory Entrance on both sides, no boulevards along GID lands;
- **Alternative 4:** Four lane urbanized cross-section with 3.0 m wide multi-use pathways on both sides, no boulevards along GID lands, and relocated Reformatory Entrance heritage walls; and
- **Alternative 5:** Four lane urbanized cross-section with 3.0 m wide multi-use pathway and 1.5 m boulevard on the north side and additional multi-use pathway located south of Clythe Creek.

Clythe Creek Alternatives (Options):

- **Option 1**: Do Nothing: Minimal channel works are considered for which only general maintenance would occur following road widening works. This option does not involve channel realignment, or any significant channel enhancement works. This alternative would require grading into the existing channel to facilitate the road improvements, especially east of the former Reformatory Driveway entrance, which would impact the hydraulic performance of the creek.
- **Option 2**: Improved Form and Function: Option 2 channel works would be considered the minimum required in order to improve channel function. Under Option 2, works within Reach C-9A (ref. Appendix K (K1), Fluvial Appendix B, Figure 4) will include a partial channel realignment that will separate the upstream creek reach from the York Road right-of-way. To improve the functioning of downstream reaches, significant grading works are proposed in order to promote natural channel function and stability.
- **Option 3**: Further channel works beyond those described for Option 2 should be considered in order to maximize the restoration potential within Clythe Creek. The outlet of the northern Reformatory Pond will also be narrowed in addition to the outlet elevation being raised in an effort to limit interactions between the pond and creek channel. Full channel realignment will occur downstream from the Hadati Creek confluence. The recommended creek realignment downstream of the Royal City Jaycee Park driveway to the Eramosa River, could be implemented separately (if required) to the remainder of the proposed creek works, which are associated with the York Road improvements.

Preferred Alternative Selection:

Selection of a preferred alternative for redesign of York Road and realignment of Clythe Creek required consideration, and careful balancing, of the following:

- Defined north property limit;

- Provision of required vehicular and active transportation infrastructure within the corridor;
- Mitigation of impacts to heritage features, particularly the significant features associated with the Reformatory Entrance;
- Provision of equivalent levels of service for vehicular and active transportation modes;
- Need to maintain existing entrances where they could not be combined or relocated;
- Provision of 1.5 m boulevard for snow storage;
- Ability to mitigate impacts / improve existing conditions within Hadati and Clythe Creeks;
- Ability to mitigate impacts / improve existing conditions of adjacent terrestrial and aquatic habitats;
- Minimize impacts to existing utility infrastructure; and
- Minimize construction costs.

Through discussions with the City and key stakeholders, the most critical corridor design constraints were identified as: the defined north property limit, the need for a four vehicular lane cross-section, provision of active transportation facilities with equivalent Level of Service (LOS) as the vehicular facilities on both sides of the roadway, and mitigation of impacts to significant heritage features. Realignment and redesign of the creek and associated habitats was considered to be flexible enough to accommodate any of the short-listed road design; that said, the opportunity to improve the creek is considered a priority by the City.

Only Road Alternative 4 was able to address the aforementioned critical corridor design constraints, with the removal of the boulevard through segments adjacent to the York District Lands identified as an acceptable compromise by the City. Clythe Creek Option 3 was selected as the preferred creek option based on the level of restoration that would occur within the creek.

Recommended Design Alternative:

The preferred York Road cross-section consists of four 3.5 m through lanes (two in each direction), with 3.0 m wide multi-use pathways provided on both the north and south sides. From Victoria Road South to Beaumont Crescent, as well as from approximately 300 m east of the Reformatory Entrance to the East City Limit (unconstrained segments), 1.5 m wide boulevard will be provided on both the north and south sides for snow storage and additional separation between vehicular traffic and pedestrians and cyclists. From Beaumont Crescent to 300 m east of the Reformatory Entrance (constrained segment), the boulevards will be removed to limit impacts to significant heritage features and Clythe Creek.

The creek design has accommodated the proposed grading for Road Alternative 4 by realigning the creek south from the road into a new channel from the Clythe Creek culvert to upstream of the former Reformatory Entrance. The realigned channel would have connection to the existing channel with the cultural heritage features during storm events of a 2 year frequency or greater. West of the driveway proposed grading works would provide a natural form to the channel while maintaining the location of the channel and minimizing the impact to cultural heritage features. The realigned connection to the Eramosa River provides improved sinuosity and maintains a connection to the existing natural heritage system, while improving the thermal regime, by no longer flowing through the online pond system.

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1.0 Introduction

1.1 Project Background and Study Approach

The York Road Environmental Design Study (YREDS) is an important undertaking to support and assist with the implementation of the recommendations stemming from the 2007 York Road Improvements Class Environmental Assessment (EA), the limits of which are indicated in Figure 1.

The 2007 EA made a number of recommendations for roadway improvements along York Road, including road widening to the south for the study area (from Victoria Road to the East City Limits). The proposed road widening (from two lanes to four lanes) is required to assist the City of Guelph achieve its planning and development targets, in particular the proposed development within the Guelph Innovation District lands located to the south of York Road (ref. Figure 1).

As noted within the 2007 EA, the proposed roadway improvements were expected to impact the adjacent watercourse, Clythe Creek; as such, recommendations were made with respect to:

- Extension of the existing Clythe Creek Culvert crossing of York Road;
- Relocation of approximately 135 m +\- of the Clythe Creek Channel to accommodate the proposed road widening; and
- Implementation of riparian plantings to separate the widened roadway from the relocated Clythe Creek channel.

In order to support and assist with the implementation of the EA recommendations, it is necessary to provide further consideration of the numerous environmental, cultural, and engineering factors associated with the foregoing, that were not considered to the extent required within the EA. The proposed York Road Environmental Design Study addresses all of these considerations in greater detail, and ensures that the proposed road widening is conducted in a responsible, comprehensive, integrated and well-planned manner.

As a key component of the YREDS, the Environmental Impact Study (EIS) includes a background review of available data and reporting for the area, and includes additional field work activities to further quantify and assess areas of concern or areas where missing or uncertain information has been noted. These environmental data are being used as part of the process of identifying a preferred alternative for the roadway and creek, and where necessary, to develop mitigation measures to reduce or eliminate environmental impacts and to inform a future detailed design assignment

1.2 Area Planning Context

The City of Guelph commenced preparing a Secondary Plan for the Guelph Innovation District (GID) in 2015, which included developing principles, objectives, and policies for the GID. The City through completion of a three (3) phased Secondary Plan process, with input from the public and numerous stakeholders including the Province, developed the “York District Preferred Land Use Scenario” which led to the preparation and approval of OPA 54 (Guelph Innovation District Secondary Plan) by City Council on May 12, 2014 (ref. City of Guelph Official Plan Section 11.2).

The Guelph Innovation District (GID) comprises 436 ha (1,077 acres) on Guelph’s east side and the Province is the main land owner. It is bounded by York Road, Victoria Road South, the York-Watson Industrial Park and the City’s southern boundary.

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Infrastructure, Development & Enterprise
Engineering Services
July 31, 2015

Figure 1
York Road from Wyndham Street to East City Limits
Study Area

The GID is being planned as a compact mixed-use community that integrates an urban village with an employment area, strives to be carbon neutral and offers meaningful places to live, work, shop, play and learn in a setting rich in natural and cultural heritage. The Innovation District is vital to meeting employment and housing targets consistent with Guelph's Growth Management Strategy and the Province's Growth Plan; supporting an economic cluster focused on green-economy and innovation sector jobs and offering opportunities for integrated energy planning as part of the Community Energy Initiative. The City has developed principles and objectives in accordance with the foregoing.

1.3 Policies and Legislative Framework

The policies and legislative framework applicable to the YREDS study area and the Clythe Creek Corridor include the City of Guelph's current Official Plan (March 2018 Consolidation) which includes the following regulations and policies:

1.3.1 City of Guelph Official Plan (March 2018 Consolidation)

Permitted development and site alteration within the Natural Heritage System is limited to legally existing uses, buildings or structures; passive recreational activities; low impact scientific and educational activities; fish and wildlife management; forest management; habitat conservation; and restoration activities (OP Policy 4.1.2.1). Additional permitted use provisions and prohibitions apply to each Significant Natural Area and Natural Area type (OP Policy 4.1.2.3).

Legally existing infrastructure and its normal maintenance are recognized and may continue within the Natural Heritage System (OP Policy 4.1.2.9). In the context of the City of Guelph Official Plan, normal maintenance refers to activities undertaken in conjunction with infrastructure to maintain regular operation parameters and public safety. Since the proposed undertaking is required to achieve regular operation parameters and maintain public safety, the widening of York Road is considered a General Permitted Use within the Natural Heritage System, including minimum or established buffers.

Official Plan policy 4.1.2.7 specifies that where transportation infrastructure is permitted within minimum or established buffers, the following shall apply:

1. works are to be located as far away from the feature boundary within the minimum or established buffer as possible;
2. the area of construction disturbance shall be kept to a minimum; and
3. disturbed areas of the minimum or established buffers shall be re-vegetated or restored with site-appropriate indigenous plants wherever opportunities exist.

The following table summarizes minimum buffer requirements, per Table 4.1 of the Official Plan:

Table 1.1: Minimum Buffer Widths from Table 4.1 of the OP

Natural Heritage Features and Areas	Minimum Buffer Requirements
Provincially Significant Wetlands	30 m
Locally Significant Wetlands	15 m
Surface Water and Cold/Cool Water Fish Habitat	30 m

Official Plan policy 4.1.2.8 specifies that where transportation infrastructure is permitted within natural heritage features and areas, the following shall apply:

1. the area of construction disturbance shall be kept to a minimum; and
2. disturbed areas shall be re-vegetated or restored with site-appropriate indigenous plants wherever opportunities exist.

In addition to the above mentioned policies, the Official Plan provides the following additional feature-specific policies that apply where development is permitted within the Natural Heritage System and Urban Forest:

- Significant Wetland features or ecological functions that are impaired during the development process will require mitigation, including remedial measures to restore wetland features and functions (OP Policy 4.1.3.4.5.
- Construction within or across surface water features or fish habitat shall: (i) adhere to MNRF fisheries timing windows so as to avoid or minimize impacts on fish, wildlife and water quality; and (ii) implement the best management practices related to construction (OP Policy 4.1.3.5.9).
- Where the City is undertaking infrastructure work, healthy non-invasive trees within the urban forest will be retained to the fullest extent possible. Where trees are required to be removed, relocation or replacement plantings will be provided by the City (OP Policy 4.1.6.1.2)

The following additional Official Plan policies provide direction and guidance for the York Road Environmental Design Study:

- Opportunities to restore permanent and intermittent stream and fish habitat shall be encouraged and supported (OP Policy 4.1.3.5.10).
- The City will continue to investigate the feasibility of removing/modifying structural barriers to fish passage in the Speed and Eramosa Rivers and their tributaries in order to permit natural stream processes, improve fish habitat and the restoration of natural stream morphology (OP Policy 4.1.3.5.12).
- Where Significant Valleylands are disturbed, the City promotes the restoration/naturalization of the Significant Valleylands aimed at improving water quality and quantity, ensuring bank and slope stabilization and enhancing wildlife habitat (OP Policy 4.1.3.7.5).

In addition to addressing conformity with the City of Guelph Official Plan, Provincial or Federal requirements as they relate to Species at Risk, and fish habitat including GRCA requirements are also addressed.

1.3.2 OPA 54: Guelph Innovation District Secondary Plan Amendment

The YREDS study area and Clythe Creek corridor are part of the GID Secondary Plan Area (see Section 1.2). Relevant information from the GID Stormwater Management Study, September 2015, that support polices in the Secondary Plan includes the following:

- Development in the GID Secondary Plan Area shall comply with the secondary plan policies for servicing, storm water management, including water quality and quantity and temperature and water balance and the City of Guelph Official Plan policies regarding water resources, source water protection and related storm water management policies.
- Storm water management criteria should meet the water quality, water quantity and natural environment objectives of the 2012 City of Guelph's Storm Water Management Master Plan.
- Reference any monitoring requirements and targets to be established in subsequent management plans (i.e. monitoring requirements determined during York Road detailed design).
- As per the Clythe Creek Subwatershed Overview, GID development lands draining to Clythe Creek should maintain existing groundwater recharge quantity and quality. Fish barriers along Clythe Creek

should be removed to improve fish habitat. Stormwater management practices, in addition to providing at a minimum an Enhanced Level of water quality treatment, are also to minimize temperature impacts to runoff discharging to Clythe Creek.

- As per the 1999 Eramosa Blue Springs Watershed Study, the Eramosa River corridor should be enhanced through stream corridor restoration.
- The City shall minimize the amount of chloride (salt) infiltration into groundwater through best management practices when applying salt to streets during winter months in accordance with the City's salt management plan. In addition, the City may consider allowing the use of stormwater winter by-pass systems (bypassing the infiltration of best management systems that receive treated runoff from roadways and parking areas); so long as it is demonstrated in technical studies submitted in support of development approvals that a balanced annual water budget (surface runoff, groundwater recharge, evapotranspiration) can still be obtained.
- In order to ensure that a balanced water budget is achieved post-development, the City may require monitoring of stormwater management infrastructure for an appropriate period after development. Where infiltration targets (developed for a balanced water budget) are not being achieved, the City may require additional monitoring for an appropriate period to determine what modifications to the drainage and stormwater management systems would be required to meet the infiltration targets.
- Stormwater management facilities shall be lined to prevent contaminants infiltrating into the groundwater system. Lining of stormwater management facilities may not be required under the following conditions:
  - Pre-treatment of runoff prior to drainage discharging to the facility; and
  - Winter bypass of first flush runoff to prevent contamination of groundwater by chloride (salt) laden runoff. Diversion of the first flush runoff shall not negatively impact the receiving GID drainage system due to potential increase in peak flows (ref. GID Secondary Plan Policies).
- Stormwater management erosion controls should be designed to mitigate the impacts of development on the receiving drainage system. In the absence of determining critical erosion threshold flows for local watercourses (Clythe, Torrance and Hadati Creeks) stormwater erosion controls should be designed using the erosion control sizing guidelines in the MOE's 2003 Stormwater Management Planning and Design Manual. Stormwater erosion controls should be flexible and adaptive in design to facilitate potential changes once critical flows have been established and erosion controls assessed using continuous hydrologic modelling as part of future studies.
- Development within the GID will need to comply with current City of Guelph and Ministry of the Environment and Climate Change (MOECC) stormwater management design requirements and any supplemental conceptual design standards established in the GID Stormwater Management Plan, such as seasonal stormwater management strategies for infiltration.

1.4 Role of the River Systems Advisory Committee

As per the terms of reference (TOR) for the York Road Environmental Design Study, a scope of work and associated TOR was developed for the EIS, in particular for the recommended field work investigations (a copy has been included in Appendix A). This document has been prepared in accordance with the TOR. The City's River Systems Advisory Committee (RSAC) reviewed the TOR and passed a motion of support at the April 19, 2017 RSAC meeting (refer to City website for meeting minutes), and provided input and comments which informed the EIS TOR.

The RSAC reviewed the EIS and passed a motion of support at the April 17, 2019 RSAC meeting (refer to City website for meeting minutes, and provided input and comments within that informed this EIS.

1.5 Description of Study Area

The study area for the EIS is indicated in Figure 2, as per the original study TOR included in the original Request for Proposal (RFP). It is noted that the area indicated in Figure 2 is substantial (4 km^2 +\-), and has been interpreted by the Project Team to reflect the area associated with background review work only. Detailed field work investigations have been scoped to the area immediately around the primary study area (i.e. York Road from Victoria Road to the East City Limits), and in particular those areas identified in the original (2007) EA as being potentially impacted by the proposed widening of York Road.

The primary watercourse through the YREDS study area is Clythe Creek, which crosses York Road approximately 200 m +\- west of Watson Parkway (ref. Figure 2). Clythe Creek is a unique watercourse within the City, as its headwaters are characterized as a coldwater stream, as per the Eramosa-Blue Springs Watershed Study (Beak and Aquafor, 1999) that has historically sustained a trout population. It is feasible that at some point in time, the lower section of the creek also supported *cold* to *cool* water fish populations, however current temperature monitoring suggests this is no longer the case. Bands of wetland vegetation are found along the length of Clythe Creek. The abundance of groundwater, near or at the ground surface in this watershed plays a key role in influencing the composition and distribution of vegetation within the watershed.

Presently, the creek is highly altered, with numerous drop structures (many of which have cultural heritage implications (ref. Appendix L), which must be assessed as part of the overall Environmental Design Study) and on-line ponds (or over-widened pools) that restrict fish passage and warm the water. Clythe Creek is further constrained by the available area between York Road and two large on-line ponds (referred to as the Reformatory Ponds). Appendix B includes a photographic inventory of Clythe Creek.

In addition to Clythe Creek, consideration must also be given to Hadati Creek, which drains in an easterly direction along Elizabeth Street before outletting across York Road to Clythe Creek. Although less of a focus than Clythe Creek in this study, the section of Hadati Creek between Industrial Street and Clythe Creek has also been assessed as part of the EIS (specifically with respect to hydrology, geomorphology, and fisheries considerations), to take into consideration the City's proposed stormwater management and conveyance works upstream of this point along Elizabeth Street. This includes a trunk storm sewer along Elizabeth Street (partially constructed) which is intended to ultimately divert flows from an existing over-capacity storm sewer in the lower Ward One area. This sewer has been known historically as part of the Stevenson Creek system.

Several other minor tributaries of Clythe Creek (through the GID lands and in the YREDS study area) also contribute flow. These other tributaries have also been considered, albeit at a higher level.

N
0 75 150 300 450 600 m

Produced by the City of Guelph
Planning, Urban Design and Building Services, Development Planning
July 2015

Figure 2
York Road Environmental Design Study Area

1.6 Study Staging and Implementation

The following study staging and implementation process has been used for this study:

- Stage 1 Background Review
- Stage 2 Field Work Investigations
- Stage 3 Impact Assessment/Mitigation and Final Management Strategy

2.0 Stage 1 Background Review

2.1 Overview

Stage 1 involves an assessment of multiple environmental disciplines, integrated to develop an improved understanding of existing environmental conditions within the YREDS study area. The disciplines considered as part of this background review include:

- Hydrogeology and Geology
- Hydrology and Hydraulics
- Water Quality
- Fluvial Geomorphology
- Fisheries and Aquatic Habitat
- Terrestrial Ecology

A key document to be reviewed as part of this process is the "Environmental Input to the EA for the Widening of York Road, Victoria Road to the East City Limit, Guelph, Ontario", as completed by Natural Resource Solutions Inc. (September 2006), in support of the overall York Road Improvements Environmental Assessment. This report was focused primarily on aquatic habitat considerations.

The background review process is intended to ensure that the history of the YREDS study area is fully understood, and that any previously identified constraints or concerns are understood and accounted for prior to proceeding to Stage 2 (Field Work Investigations). In this way, field investigations and modelling assessments can be suitably scoped and focused upon areas of particular sensitivity, or where available information is lacking.

2.2 Hydrogeology and Geology

The groundwater flow system within the YREDS study area is controlled by the local and more regional geologic setting including the surficial geology, the overburden thickness and related stratigraphy, the characteristics of the shallow underlying bedrock and the bedrock topography.

The surficial geology (Quaternary Geology – Figure B1 in Appendix C) generally indicates the potential for recharge and potential linkage to surface water features. A significant portion of the study area consists of more permeable sand and gravel glaciofluvial deposits. In addition, the overburden thickness (Figure B2 in Appendix C) is generally less than 5 metres thus allowing a more direct connection to the underlying bedrock. The underlying bedrock consists of the dolostone of the Guelph Formation. The upper portion of the bedrock is expected to have a relatively high permeability as well. Portions of the Clythe Creek within the YREDS study area appear to be in direct contact with the bedrock. This combination of overburden and bedrock hydrostratigraphy provides for a significant groundwater-surface water connection.

Various regional hydrogeologic studies including the Eramosa-Blue Springs Subwatershed Study (Beak International and Aquafor Beech Limited, 1999) and the City of Guelph Groundwater Resources Study for the Northeast Quadrant (Jagger Hims Limited, 1995) indicate the shallow groundwater flow to be generally from northeast to southwest. This flow correlates well with the general regional surficial topography as well as with the bedrock topography. A significant bedrock channel originates to the northeast and appears to intersect Clythe Creek within and adjacent to the YREDS study area (Figure B3 in Appendix C). This bedrock channel may act to direct shallow bedrock groundwater to the study area and provide for a significant groundwater discharge potential.

A detailed research study immediately north of the YREDS study area by Hailey Ashworth at the University of Guelph (Groundwater-Surface Water Interactions and Thermal Regime of Clythe Creek, Guelph Ontario:

Threats and Opportunities for Restoration - M.A.Sc. Thesis, 2012) presents findings supporting the groundwater discharge potential within and adjacent to Clythe Creek.

A natural heritage assessment carried out at the Guelph Correctional Centre (Natural Resource Solutions Inc., January 2013) presents significant observations of water-cress within the study area indicating groundwater discharge. This study also notes shallow groundwater conditions within the city park. It should be noted that the assessment does not meet the City's NHS requirements and was not considered acceptable by the City.

Measurements and observations of the groundwater water table at or near the ground surface have been presented in various hydrogeologic studies in support of development adjacent to the study area along Watson Parkway.

The fisheries background review (Section 2.6) documents Clythe Creek as being classified as coldwater upstream of the confluence of Hadati Creek and coolwater downstream of the confluence of Hadati Creek indicating potential groundwater discharge particularly in the upper reach within the YREDS study area.

2.3 Hydrology and Hydraulics

2.3.1 Hydrology

With respect to subwatershed hydrology, the approved frequency-based peak flows for Clythe Creek (2 through 100 year storm events) are currently sourced from a MIDUSS model using design storms (ref. Gamsby & Mannerow, 2006), while the Regulatory Event flows (Regional Storm – Hurricane Hazel) are sourced from a GAWSER model (ref. Schroeter & Associates, 1988). The GRCA has noted the need for review, given that the 100-year storm peak flow is greater than that for the Regulatory Event (Regional Storm - Hurricane Hazel).

Separate, more refined hydrologic modelling using MIDUSS and design storms has also been completed for Hadati Creek (a tributary of Clythe Creek) to support a study on channel improvements (ref. Gamsby & Mannerow, 2003).

In addition to the foregoing, Amec Foster Wheeler has undertaken a number of different hydrologic modelling assessments within the Clythe Creek watershed, all using the integrated hydrologic-hydraulic modelling platform of PCSWMM (which uses the US-EPA SWMM computational engine). This includes hydrologic modelling of local sewersheds for the City's Stormwater Management Master Plan (2012), modelling of the majority of Hadati Creek to support the design of the Elizabeth Street trunk storm sewer (2015), and on-going stormwater management and hydrologic modelling support for the GID area to the south of York Road (2017, on-going). The first two modelling assessments have used design storm methodology; the latter modelling work for the GID area (on-going) employs continuous simulation.

Based on the foregoing, it has been considered necessary to generate an updated, integrated hydrologic modelling approach that reflects current land use and stormwater management controls (including recent development within the Watson Parkway area) into a single modelling platform. An integrated PCSWMM model has been developed as part of this study accordingly (ref. Appendix D). Although design storms have been employed for the current study, the model can be run in continuous simulation mode if required. The current hydrologic modelling scope does not include the incorporation of a groundwater component to the modelling; the modelling would reflect surface water hydrology only. Notwithstanding, it would be possible to update PCSWMM to include a groundwater component in the future.

The base existing conditions modelling has been updated in order to assess the impacts of the proposed widening of York Road. As part of the stormwater management reporting, the preferred stormwater management strategy will also be modelled.

2.3.2 Hydraulics

For Clythe Creek, a HEC-RAS hydraulic model has been made available from the GRCA, which has been incrementally updated (most recently in 2007) to reflect changes in hydraulic structures and development, particularly in the Watson Parkway area. The model extends from 500 m +\- upstream of Watson Road to just downstream of York Road.

For Hadati Creek, a HEC-2 hydraulic model was developed as part of the 2003 Channel Improvements Study (Gamsby & Mannerow). The HEC-2 model was refined as part of the Elizabeth Street Flow Splitter assessment (ref. Section 4.1.5).

For the Eramosa River, a HEC-2 hydraulic model was made available by the GRCA. The model was developed in 1989 as part of a floodline mapping study completed by Paragon Engineering Limited. The model extends past the confluence of the Eramosa River and Clythe Creek.

For the purposes of the current study, a HEC-RAS hydraulic model of Clythe Creek has been created to assess the hydraulic conditions within the YREDS study area. The model extends from the upstream side of York Road, down to the confluence with the Eramosa River. The hydraulic model has been developed based on topographic survey and 2012 contour mapping. Updated peak flow data from the hydrologic modelling effort have been used to verify the expected change in flood levels (if any), and to verify the expected impacts to York Road (i.e. frequency of expected roadway overtopping). The hydraulic modelling has also been used to assess the expected impacts of channel re-alignment and road widening on floodplain extents and depths, to ensure that there are no negative impacts.

2.4 Water Quality and Temperature

2.4.1 Water Quality

Water quality sampling data are more readily available for larger scale studies for the Speed and Eramosa Rivers. Such information can be found in Beak International and Aquafor Beech, Eramosa -Blue Springs Watershed Report (1999). A more general characterization of the overall watershed can be found in the City of Guelph's River System Management Report (ref. Weinstein Leeming + Associates, 1993). More limited information is available for watercourses within the YREDS study area (i.e. Clythe Creek). No water quality sampling information was found for Hadati Creek.

A group of University of Waterloo 4th year students (2007) conducted water quality sampling along Clythe Creek as part of their overall assessment of the watercourse. This included sampling for biochemical oxygen demand (BOD_5), nitrate, phosphate, and dissolved oxygen (DO). Concentrations of phosphate were found to be below the Provincial Water Quality Objective (PWQO). DO concentrations ranged between 7 and 10 mg/L, which is above the minimum PWQO of 6 mg/L for cold water habitat, based on a water temperature of approximately 15^{o}C.

Dissolved oxygen (DO) sampling was completed by Ashworth (2012) using a hand-held probe at 12 different locations along Clythe Creek on five (5) different days. Values ranged between 5 and 10 mg/L, which are consistent with minimum Provincial standards (5-8 mg/L for warm water biota, 4-7 mg/L for cold water biota). Lower values of DO were typically found around a wetland and SWM facility outlet.

2.4.2 Water Temperature

Trout Unlimited monitored water temperature at multiple locations in Clythe Creek, from its headwaters to just upstream from the confluence with the Eramosa Rive from May to October of 2007 (Todd and D'Amelio, 2006; D'Amelio, 2007). In both years, temperatures were recorded at half hour intervals using WaterTemp Pro loggers (Onset Corporation). In 2006, a large increase in temperature was documented between County

Road 29 and Jones Baseline which was attributed to a large pond that is present through that reach. Mean August temperature decreased at successive stations from Jones Baseline to the furthest downstream station, which was located within this study area, south of York Road. In 2007, summer water temperature was suitable for brook trout in the headwaters, at and upstream from Wellington County Road 29, but was exceeded at all of the monitoring locations further downstream. Clythe Creek through the YREDS study area was classified as *cool* to *warm* water, based on the thermal classification system of Stoneman (1996). Maximum water temperatures in Clythe Creek near the confluence with Hadati Creek approached 30°C. The report recommended removal of an impoundment upstream from Jones Baseline in order to potentially return this creek to a coldwater classification capable of sustaining brook trout.

Ashworth monitored the water temperature in Clythe Creek at several locations between an upstream crossing of York Road and a location just downstream from Watson Parkway in the summers of 2010 and 2011. Average maximum water temperatures exceeded 25°C at all locations and approached 30°C at some. Using the thermal classification of Chu et al (2009), the sites would be classified as either *warmwater* or *cool-warmwater*. A decrease in summer water temperature upstream from Watson Parkway was attributed to groundwater discharge and shading by trees.

2.5 Fluvial Geomorphology

2.5.1 Previous Studies

While numerous reports have been prepared within the vicinity of the YREDS study area, information on the fluvial geomorphology (the study of the form and function of stream channels through the interaction between water and sediment transport) and existing conditions of the area is lacking and often outdated leading to numerous opportunities, as well as constraints moving forward.

Prior to the initiation of the geomorphic field assessment, a review of background reports and previous studies was conducted to determine any relevant information that may be applicable to this specific study. This background review was intended to identify any reaches that have been delineated and studied by others such that redundancy would not occur. Watershed-based studies (e.g., Ecologistics, 1998 and Beak International and Aquafor Beech, 1999) have been completed during the recent past that report the state of the stream's health, understanding the available geomorphic information and areas where updates are required and gaps to be filled, will be valid.

Overall, none of the available studies provide a detailed characterization of the entire subwatershed; however, site specific information on channel dimensions and characteristics were obtained for several locations along the channel and in relation to the YREDS study area adjacent to York Road. Several conceptual channel designs have also been created for Clythe Creek as a result of the proposed York Road widening.

A historical aerial image from 1930 (ref. Appendix F) was obtained for the study area during the background review process and was used to infer past and present land uses within the area. This aerial image indicates that the majority of the existing site features were present at that time, with the exception of the Reformatory ponds (both north and south).

2.5.2 Reach Break Analysis

Reaches are lengths of channel that display similarity with respect to valley setting, planform, floodplain materials, and land-use/cover. Reach length will vary with channel scale since the morphology of low-order watercourses will vary over a smaller distance than those of higher-order watercourses. At the reach scale, characteristics of the stream corridor exert a direct influence on channel form, function and processes.

Within the Clythe Creek Subwatershed Overview (ref. Ecologistics, 1998), ten reaches were identified along the watercourse based on habitat characteristics. Of these reaches, two (2) are located within the YREDS study area: Reach C-9 and Reach C-10. A summary figure, Figure 3.1 is included in Appendix F for reference. Generally, the upper reach section (C-9) is narrower and steeper and includes online weir structures, when compared to the lower reach section (C-10) downstream of the existing Jaycees Park, which is much wider and typically stagnant.

Further refinement of this previous delineation is warranted for the current study due to the variation in channel morphology and planform that exists. For the purposes of the current study, Reach C-9A represents the upstream segment, extending for approximately 445 m downstream from York Road to the historical stone arch bridge at the Reformatory driveway. Reach C-9B represents the downstream segment, extending from the Reformatory driveway 500 m downstream to the confluence with Hadati Creek. Reach C-10, 450 m +/- in length, continues to represent the channel downstream from Hadati Creek to the Eramosa River.

A 280 m long reach of Hadati Creek, Reach HC-1, which extends upstream from the confluence with Clythe Creek to Suburban Avenue was also delineated for the study.

2.6 Fisheries and Aquatic Habitat

The Eramosa-Blue Springs Watershed Study (Beak International and Aquafor Beach Limited, 1999; Table 4.4) reported that eight fish species were present in the Clythe Creek watershed. These were bluntnose minnow (*Pimephales notatus*), fathead minnow (*Pimephales promelas*), hornyhead chub (*Nocomis biguttatus*), central mudminnow (*Umbra limi*), fantail darter (*Etheostoma flabellare*), northern hogsucker (*Hypentelium nigricans*) and brook trout (*Salvelinus fontinalis*). However, the text of that document states that brook trout appear to be absent from Clythe Creek (p. 4-31) and none have been reported captured in recent years, that said Clythe Creek, according to historical records, once supported brook trout.

Fish capture information summarized in the natural environment report for the environmental assessment for the widening of York Road. (Natural Resource Solutions, 2006) and more recent information contained in OMNR files is presented in Table 2.6.1. The Clythe Creek subwatershed study (Ecologistics Limited, 1997), which appears to have relied on the same sources as the Eramosa-Blue Springs Watershed Study, reported 14 fish species occurred in the Clythe Creek subwatershed, including brook trout and mottled sculpin, which are considered coldwater species. Mottled sculpin were also captured in Clythe Creek, within the YREDS study area, on two occasions in 2007 and one occasion in 2009. Several species that are considered coolwater species have also been captured in Clythe Creek within the study area including fantail darter, rainbow darter, northern redbelly dace and central mudminnow. This presence of rainbow and fantail darter was corroborated by Ashworth (2012), who reported that these two species, in addition to creek chub and fathead minnow, were captured in Clythe Creek by Trout Unlimited staff during an electrofishing field day in June 2011 (ref. Appendix G).

The large ponds on the York District Lands are frequented by anglers. Species reported to have been captured by anglers include northern pike (*Esox lucius*), smallmouth bass (*Micropterus dolomieui)*, largemouth bass (*M. salmoides*) crappie (*Pomoxis* sp.), bullheads (*Ameiurus* sp.), sunfish (*Lepomis* sp.) and yellow perch (*Perca flavescens;* ref. Timmerman, 2001).

A 117 m long reach of the tributary that enters Clythe Creek from the south, approximately 150 m upstream from the entrance to the York District Lands, was electrofished by C. Portt and Associates staff on October 8, 2009. No fish were captured (Ontario Ministry of Natural Resources Guelph Office files). There is a record in the OMNR files of unidentified minnows being observed in the lower 10 m of this tributary on August 30, 1994 (Aquatic Habitat Inventory Stream Survey Summary prepared by D. Coulson). This document indicates that the watercourse was channelized circa 1984 and that seepage was observed at a number of locations.

Timmerman (2001) described the habitat conditions in Clythe Creek downstream from confluence with Hadati Creek, noting channel modifications that included excavated pools and a culvert and a weir that may be barriers to upstream fish migration. Timmerman (2001) also reported potential pike spawning habitat in the lower reaches, closer to the Eramosa River.

Mapping prepared by Fisheries and Oceans Canada indicates that there are no records of fish or mussel aquatic species at risk present in the YREDS study area (http://www.dfo-mpo.gc.ca/Library/356763_GrandRiver_EN.pdf accessed September 2, 2016). Greenside Darter (Etheostoma blennioides), which has been captured in the vicinity, is considered a species of special concern under the Species at Risk Act, but was assessed to be not at risk in the most recent (November 2006) COSEWIC assessment (http://www.registrelep-sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=99; accessed January 4, 2016).

The GRCA has classified Clythe Creek from its headwaters to Hadati Creek as coldwater habitat (GRINS mapping accessed September 2, 2016). The small tributary that enters Clythe Creek from the south approximately 150 m upstream from the entrance to the York District Lands is also classified as coldwater habitat. Clythe Creek is classified as coolwater habitat from the confluence with Hadati Creek downstream to the Eramosa River, which is also classified as coolwater habitat. The large ponds on the York District Lands, including the channel connecting the north pond to Clythe Creek, are classified as warmwater habitat as is Hadati Creek. It should be noted that Schedule 4B of the City of Guelph Official Plan (March 2018 Consolidation) indicates that the large ponds on the York District lands and the channel connecting those ponds to Clythe Creek are coolwater.

The Grand River Fisheries Management Plan (Ontario Ministry of Natural Resources and Grand River Conservation Authority, 1998) identifies Clythe Creek as a mixed water tributary. The fish community objective for Clythe Creek and the other mixed water tributaries is a coldwater fish community in areas where geological and biophysical characteristics are present and habitat exists or has been rehabilitated and a warmwater fish community in reaches that cannot support coldwater fish. Management strategies described in the Grand River Fisheries Management Plan for these watercourses include:

- Encourage tributary restoration,
- Consider modifications to remove existing barriers to fish passage, and
- Rehabilitate degraded habitat to restore functional system.

Management tactics identified in the Grand River Fisheries Management Plan for the mixed water tributaries include:

- Prepare habitat rehabilitation plan which incorporates a natural channel design approach to identify priority areas for restoration, and
- Rehabilitate degraded habitat and restore riparian vegetation.

Table 2.6.1: Fish species captured at various locations in Clythe Creek, compiled from OMNRF files. Source: Natural Resource Solutions, Inc. 2006

Source			Information compiled by Natural Resource Solutions (2006)				OMNRF files				
Watercourse			Clythe Creek Subwatershed	Clythe Creek		York Lands ponds	Clythe Creek			Clythe Creek tributary	Hadati Creek
Location description			Subwatershed	Upstream of Watson Rd.	Between York Rd. and Watson Rd.	York Lands ponds	From confluence with Hadati Cr. upstream	Between confluence with Hadati Cr. and connection to north pond		From confluence with Clythe Cr. upstream	From just downstream of Elizabeth St. Upstream
Investigator			Compilation in Subwatershed Study	GRCA	Fisheries and Oceans Canada	University of Guelph	Stantec (electrofishing course)			C. Portt and Associates	Fisheries and Oceans Canada
Easting			na	na	na	na	563272.531	563181.3	563157.4	563690	562848.2
Northing			na	na	na	na	4822953.355	4822851	4822842	4823286	4822838
Date			historic to 1998	1990	2001	2005	15-May-07	15-Oct-07	5-May-09	8-Oct-09	13-Jul-07
Site length (m)			na	na	na	na	600	~200	na	117	~70
Sampling method			na	na	na	na	backpack electrofisher				
Common Name	Scientific Name	Provincial Rank (S-Rank)									
black crappie	*Pomoxis nigromaculatus*	S4							×		
blacknose dace	*Rhinichthys atratulus*	S5	×	×				×			×
blacknose shiner	*Notropis heterolepis*	S5	×								
bluntnose minnow	*Pimephales notatus*	S5			×	×	×	×	×		
brook stickleback	*Culaea inconstans*	S5	×	×	×		×	×	×		×
brook trout	*Salvelinus fontinalis*	S5	×								
brown bullhead	*Ameiurus nebuiosus*	S5			×		×				
central mudminnow	*Umbra limi*	S5	×	×	×		×				
common shiner	*Luxilus cornutus*	S5	×	×			×		×		×
creek chub	*Semotilus atromaculatus*	S5	×	×		×	×		×		×
emerald shiner[1]	*Notropis atherinoides*	S5					×				
fantail darter	*Etheostoma flabellare*	S4	×		×	×					
fathead minnow	*Pimephales promelas*	S5	×	×				×	×		×
finescale dace	*Phoxinus neogaeus*	S5	×	×							
greenside darter	*Etheostoma blennioides*	S4				×	×				
hornyhead chub	*Nocomis biguttatus*	S4					×				
johnny darter	*Etheostoma nigrum*	S5				×	×				
largemouth bass	*Micropterus salmoides*	S5						×			
mottled sculpin	*Cottus bairdi*	S5	×	×			×	×	×		
northern hog sucker	*Hypentelium nigricans*	S4	×								
northern redbelly dace	*Phoxinus eos*	S5	×	×			×	×	×		×
pumpkinseed	*Lepomis gibbosus*	S5						×	×		×
rainbow darter	*Etheostoma caeruleum*	S4				×	×				
rock bass	*Ambloplites rupestris*	S5					×				
white sucker	*Catostomus commersoni*	S5	×	×			×	×			
yellow perch	*Perca flavescens*	S5					×				

2.7 Terrestrial Ecology

As part of the background review, available information with respect to natural heritage information has been reviewed for relevant information. The following sources were checked as part of the background review for vegetation resources and wildlife records for the YREDS study area:

- Natural Heritage Information Centre (NHIC) Biodiversity Explorer query (NHIC 2015);
- Consultation with Guelph District MNRF for SAR records (via an Information Request);
- Ontario Breeding Bird Atlas (OBBA), 2001 – 2005 (Cadman et al. 2007);
- Atlas of the Mammals of Ontario (Dobbyn 1994);
- Ontario Reptile and Amphibian Atlas (Ontario Nature 2015);
- Ontario Butterfly Atlas Online (Toronto Entomologists' Association 2015);
- City of Guelph Municipal List of Species at Risk (SAR) – provided by Guelph District MNRF on September 29, 2015;
- Groundwater-Surface Water Interactions and Thermal Regime in Clythe Creek, Guelph, Ontario: Threats and Opportunities for Restoration Thesis (Ashworth 2012);
- Assessment and Remedial Activities for Clythe Creek Phase I Report (Saavedra et al. 2007);
- Rehabilitation of Clythe Creek Phase II Design Report (Saavedra et al. 2008);
- Clythe Creek Subwatershed Overview (Ecologistics Ltd. and Blackport and Associates. 1998);
- Eramosa - Blue Springs Watershed Study Report (Beak International Inc. and Aquafor Beech Ltd. 1999);
- Eramosa River - Blue Springs Creek Linear Corridor Initiative (Proctor & Redfern Ltd. et al. 1995);
- Eramosa – Blue Springs Watershed Study – Part 3: Recommended Plan and Implementation Plan (Beak International Inc. et al. 1999);
- Conservation Plan for the Guelph Correctional Centre Heritage Place (Contentworks Inc. and Tacoma Engineers Inc. 2009); and
- Guelph Correctional Centre Natural Heritage Assessment (Natural Resources Solutions Inc. 2013).

The information gathered provides an initial understanding of the YREDS study area, and facilitates decision-making during the study. The species records from the background documents have been compiled in Appendix H-1 and Appendix I-1.

2.7.1 Vegetation Resources

Natural Heritage Information Centre (NHIC) Biodiversity Explorer query (NHIC 2015)

The NHIC database was queried in October 2015, to identify any records of SAR and/or provincially significant plant species (Sranks of S1 to S3) in the site vicinity. A total of 20 1 km X 1 km squares were checked; these 20 grid squares included the six (6) squares containing the various sections of the study site and adjacent lands as well as the 14 surrounding squares. The 20 squares queried are as follows: 17NJ6121/22; 17NJ6221/22/23/24/25; 17NJ6321/22/23/24/25; 17NJ6422/23/24/25; and 17NJ6522/23/24/25.

Based on this query, one historic record (June 8, 1905) exists for a significant plant species within the grid squares searched in the vicinity of the YREDS study area: Carey's Sedge (*Carex careyana*). This species has a provincial Srank of S2 and is Rare within Wellington County, but is not a federal or provincial Species at Risk. This species occurs within rich deciduous beech-maple forest (Hipp 2008; Anderson and Frank 2009). Based on the ELC mapping by NRSI (2013), there is limited potential for this species to occur within the YREDS study area.

City of Guelph Municipal List of Species at Risk (SAR) (City of Guelph 2015)

One plant Species at Risk was listed on the City of Guelph Municipal List: Butternut (*Juglans cinerea*); this species is considered Endangered at both the federal and provincial level. The habitat for this species is variable, but typically includes rich, moist, well-drained loam and gravel soils of limestone origin (EC 2010). Butternut is also shade-intolerant, and is therefore most often found in early-successional habitats or sparsely in later successional deciduous forests. Based on the ELC mapping for the study area by NRSI (2013), there is a high potential for Butternut to occur within the YREDS study area.

Wellington Upper Tier SAR List (OMNRF 2013)

Based on the Wellington Upper Tier list of Species at Risk list provided by Guelph District MNRF (OMNRF 2013), several Species at Risk are suspected or known to occur within Wellington County (Table 2.7.1).

Table 2.7.1: Suspected or known Species at Risk within Wellington County (OMNRF 2013)

Scientific Name	Common Name	NHIC Srank	Federal status	Provincial status
Arnoglossum plantagineum	Tuberous Indian Plantain	S3	SC	SC
Castanea dentata	American Chestnut	S2	END	END
Juglans cinerea	Butternut	S3?	END	END
Panax quinquefolius	American Ginseng	S2	END	END
Potamogeton hillii	Hill's Pondweed	S2	SC	SC

American Chestnut grows in dry, sandy upland deciduous forests, while American Ginseng is found in moist, mature deciduous forest. Based on the ELC mapping for the study area by NRSI (2013), these habitats are likely not present within the YREDS study area based on existing mapping for the study area. Hill's Pondweed is associated with clear, cold ponds and slow-moving watercourses, and Tuberous Indian Plantain typically occurs in wet calcium-rich meadows. These habitats may be present along Clythe Creek and Eramosa floodplain. As noted, Butternut has a high potential for occurring within the study area.

Assessment and Remedial Activities for Clythe Creek Phase I Report (Saavedra et al. 2007)

Saavedra et al. (2007) do not identify any specific species or vegetation communities along the Clythe Creek, but describe the vegetation as mainly manicured lawn with deciduous trees and shrubs growing along the creek. Based on the presence of 'reeds' (likely *Typha* spp), they suggest that wetland conditions exist along some portions of the creek. No federal or provincial species at risk were reported.

Rehabilitation of Clythe Creek Phase II Design Report (Saavedra et al. 2008)

Saavedra et al. (2008) provide no additional observations of vegetation, but do make recommendations for the design of Clythe Creek. They recommend planting a 5m wide riparian buffer strip with native trees to improve bank stabilization, nutrient and temperature control, and to deter wildlife (e.g. Canada Geese). No federal or provincial species at risk were reported.

Clythe Creek Subwatershed Overview (Ecologistics Ltd. and Blackport and Associates 1998)

Ecologistics Ltd. et al., (1998) provide a characterization of the biotic and abiotic attributes of the Clythe Creek subwatershed. This document provides a high-level summary of the biological resources found within the subwatershed, including a variety of upland and wetland vegetation communities. Vegetation community descriptions are broad and not ELC-based, so determining if specific rare vegetation communities were present is not possible. Furthermore, no information specific to the YREDS study area was provided.

Overall, 170 vascular plants species were reported to occur within the Clythe Creek subwatershed, of which 29% are non-native. No federal or provincial Species at Risk were reported. The list of species provided was also reviewed to determine if species that are significant within the City of Guelph or Wellington County were listed. Highbush Blueberry (*Vaccinium corymbosum*) is listed as locally significant within the City of Guelph, and rare (R1) within Wellington County as it is known from only 2 sites. This species occurs in wet, sandy, peaty places, low-woods, and swamp-bog borders (Frank and Anderson 2009), and is unlikely to be present within the study area based on existing ELC mapping (NRSI 2013). No additional locally rare species were reported; however, an unidentified pondweed species (*Potamogeton sp*) was listed, which could potentially have been Hill's Pondweed (*Potamogeton hillii)*, a Species at Risk in Ontario (Table 2.7.1) which requires cold, clear, alkaline water (Parks Canada Agency, 2014). Although suitable habitat is present, it was not found during vegetation surveys.

Eramosa - Blue Springs Watershed Study Report (Beak International Inc. and Aquafor Beech Ltd., 1999)

This study identified vegetation resources within the Eramosa-Blue Springs watershed. They report 405 plant species within the watershed, of which 21% are non-native. They also list 13 significant plant species, of which 10 are rare within the City of Guelph, 10 are regionally rare, and 3 are provincially rare. Four of these records are considered historical, occurring prior to 1967.

Eramosa River - Blue Springs Creek Linear Corridor Initiative (Proctor & Redfern Ltd. et al. 1995)

This study listed twelve rare plant species within the study area and listed Closed Gentian (*Gentiana rubrucaulis*) and Kalm's Lobelia (*Lobelia kalmii*); however, a species list was not provided, so the status of the remaining ten species cannot be confirmed.

Eramosa – Blue Springs Watershed Study – Part 3: Recommended Plan and Implementation Plan (Beak International Inc. et al. 1999)

No specific natural heritage information or data were reported for the Clythe Creek system or YREDS study area within this report.

Conservation Plan for the Guelph Correctional Centre Heritage Place (Contentworks Inc., 2009)

No specific natural heritage information or data were reported for the Clythe Creek system or YREDS study area within this report.

Guelph Correctional Centre Natural Heritage Assessment (Natural Resources Solutions Inc., 2013)

NRSI conducted Ecological Land Classification (Lee et al. 1998) for the Guelph Correctional Centre study area on three dates during December of 2011. They identified 15 vegetation communities within the study area (Lee 2008). Six of these occur within 120m of the York Road corridor, including; Open Aquatic (OA), Landscaped Area (L), Fresh-Moist Manitoba Maple Lowland Deciduous Forest (FODM7-7), Buckthorn Deciduous Shrub Thicket (THDM2-6), and Dry-Fresh Graminoid Meadow (MEGM3). Wetland community boundaries were initially flagged by NRSI staff and later reviewed and approved by the Grand River

Conservation Authority on May 14, 2012. No rare vegetation communities are reported to occur within the YREDS study area. No soils information was collected or reported for the YREDS study area.

Vascular plant surveys were also limited to December of 2011. As a result, species peaking during early- to mid-season may have been missed, including potentially significant species. A total of 130 vascular plant species were observed by NRSI within their study area, and they list an additional 47 species observed in an earlier study (Stantec, 2006). No Species at Risk were found during these surveys; however, they confirmed that Butternut (*Juglans cinerea*) does occur on site through communication with Guelph District OMNRF staff. However, two significant species were observed within landscaped areas; Burning Bush (*Euonymus atropurpurea var. atropurpurea*) and Common Hackberry (*Celtis occidentalis*), which are considered planted. The specific locations of these species were not provided, so it is not known if they occur within the YREDS study area.

2.7.2 Wildlife Records

Natural Heritage Information Centre (NHIC) Biodiversity Explorer query (NHIC 2015)

The NHIC database was queried in October 2015 to identify any records of SAR and/or provincially significant wildlife species (Sranks of S1 to S3) in the site vicinity. A total of 20 1 km X 1 km squares were checked; these 20 grid squares included the six (6) squares containing the various sections of the study site and adjacent lands as well as the 14 surrounding squares. The 20 squares queried are as follows: 17NJ6121/22; 17NJ6221/22/23/24/25; 17NJ6321/22/23/24/25; 17NJ6422/23/24/25; and 17NJ6522/23/24/25. The results of the query are displayed below in Table 2.7.2.

Table 2.7.2: Results of the NHIC database query for the YREDS study area and surrounding lands

Scientific Name	Common Name	NHIC Srank	Federal status	Provincial status	Local Status	Last observation date
Insects						
Libellula semifasciata	Painted Skimmer	S2	---	---		1913-05-26
Polystoechotes punctatus	Giant Lacewing	SH	---	---		1948-06
Reptiles						
Lampropeltis triangulum	Eastern Milksnake	S3	---	---	Rare	1978-09-28
Thamnophis sauritus	Eastern Ribbonsnake	S3	SC	SC	Rare	1990-04-25
Graptemys geographica	Northern Map Turtle	S3	SC	SC	Rare	1924-07-?

Four of the wildlife species found in the query are historic in nature: Painted Skimmer, Giant Lacewing, Eastern Milksnake, and Northern Map Turtle. Although the record of Eastern Milksnake is historic (1978), this species is known to remain extant at isolated sites with suitable habitat, even if surrounding areas become largely developed (Rowell 2012). The preferred habitats of Eastern Milksnake include the edges of woodlands adjacent to open meadows or agricultural fields (ecotones) as well as old foundations, rock piles or hedgerows, and barns, where its main prey (rodents) are present. Given that these habitats are largely absent from the study area, the suitability of the site for this species would be considered low and therefore the species is currently not likely present, even though it may have been in the past. It should be noted that in June 2016, the status of Eastern Milksnake was changed by the MNRF and it is no longer considered a Species at Risk. Finally, two of the species (Eastern Ribbonsnake and Northern Map Turtle) are associated with wetlands and river systems, so these species could persist in the vicinity of the study area, and were targeted in field studies.

Guelph District MNRF Species at Risk records

On October 27, 2015, an Information Request was submitted to Guelph District MNRF for any SAR records that are on file for the study area and immediate surroundings. A reply was received on November 25, 2015, from Melinda J. Thompson, OMNRF Management Biologist. The Ministry has records of two SAR on file for the study area, both of them reptiles: Eastern Milksnake (*Lampropeltis triangulum*) and Snapping Turtle (*Chelydra serpentina*). Snapping Turtle is considered Special Concern at both a federal and provincial level; as noted above, Eastern Milksnake has been delisted since June 2016 and is no longer considered Special Concern. Field staff screened for both these species during field studies.

Ontario Breeding Bird Atlas (OBBA), 2001 – 2005 (Cadman et al. 2007)

The study area is contained within the 10 x 10 km atlas square 17NJ62; a total of 114 species of birds were listed for this square. The significant species from this list are as follows:

- Provincially Threatened or Endangered (seven species): Barn Swallow, Bank Swallow, Yellow-breasted Chat, Bobolink, Chimney Swift, Eastern Meadowlark, and Least Bittern;
- Provincial Species of Conservation Concern (Special Concern and SRanks of S1 to S3) (six species): Bald Eagle, Common Nighthawk, Eastern Wood-Pewee, Grasshopper Sparrow, Red-headed Woodpecker, and Wood Thrush;
- Local Species of Conservation Concern (Wellington County): 44 species.

The significant species from the OBBA provides a context for future field studies and is not site specific. Field staff screened for these species during field studies.

Atlas of the Mammals of Ontario (Dobbyn 1994)

A total of 44 species of mammals were listed for the 10 x 10 km square that contains the present study area. The significant species from this list are as follows:

- Threatened or Endangered (three species): Eastern Small-footed Myotis (*Myotis leibii*), Little Brown Myotis (*M. lucifugus*), and Northern Myotis (*M. septentrionalis*);
- Provincial Species of Conservation Concern (Special Concern and SRanks of S1 to S3) (one species): Woodland Vole (*Microtis pinetorum*)(Special Concern);
- Local Species of Conservation Concern (16 species): the three bat species listed above plus Deer Mouse (*Peromyscus maniculatus*), Hairy-tailed Mole (*Parascalops breweri*), Hoary Bat (*Lasiurus cinereus*), Long-tailed Weasel (*Mustela frenata*), Northern Flying Squirrel (*Glaucomys sabrinus*), Red Bat (*Lasiurus borealis*), Silver-haired Bat (*Lasionycteris noctivagans*), Smokey Shrew (*Sorex fumeus*), Snowshoe Hare (*Lepus americanus*), Southern Flying Squirrel (*Glaucomys volans*), Star-nosed Mole (*Condylura cristata*), Water Shrew (*Sorex palustris*), and Woodland Jumping Mouse (*Napaeozapus insignis*). Note that Woodland Vole (*Microtus pinetorum*) is not considered locally significant.

The significant species from the Atlas of Mammals provides a context for future field studies and is not site specific. Field staff screened for these species during field studies.

Ontario Reptile and Amphibian Atlas (Ontario Nature 2015)

A total of 28 species of reptiles and amphibians have been reported from the 10 x 10 km square that contains the study area. The significant species from this list are as follows:

- Threatened or Endangered (three species): Blanding's Turtle (*Emydoidea blandingii*), Jefferson Salamander (*Ambystoma jeffersonianum*) – historic record, and Western Chorus Frog (*Pseudacris triseriata*);
- Provincial Species of Conservation Concern (Special Concern and provincial SRanks of S1 to S3) (four species): Eastern Ribbonsnake (*Thamnophis sauritus septentrionalis*) - historic, Eastern Milksnake (*Lampropeltis t. triangulum*), Northern Map Turtle (*Graptemys geographica*) - historic, and Snapping Turtle (*Chelydra serpentina*);
- Local Species of Conservation Concern (17 species): those species listed above plus American Bullfrog (*Lithobates catesbeianus*), Blue-spotted Salamander (*Ambystoma laterale*), DeKay's Brownsnake (*Storeria dekayi*), Mudpuppy (*Necturus maculosus*), Northern Watersnake (*Nerodia sipedon sipedon*), Pickerel Frog (*Lithobates palustris*), Red-bellied Snake (*Storeria o. occipitomaculata*), Red-spotted Newt (*Notophthalmus viridescens viridescens*), and Smooth Greensnake (*Opheodrys vernalis*).

The significant species from the Ontario Reptile and Amphibian Atlas provides a context for future field studies and is not site specific. Field staff screened for these species during field studies.

Ontario Butterfly Atlas Online (Toronto Entomologists' Association 2015)

A total of 73 species of butterflies were found to have records within the 10 x 10 km square that contains the study area. The significant species from this list are as follows:

- Threatened or Endangered: none;
- Provincial Species of Conservation Concern (Special Concern and provincial SRanks of S1 to S3) (nine species): Black Dash, Common Sootywing, Delaware Skipper, Dion Skipper, Giant Swallowtail, Hickory Hairstreak, Little Glassywing, Monarch (Special Concern), and West Virginia White (Special Concern);
- Local Species of Conservation Concern: 8 species; as above, except for Monarch.

The significant species from the Ontario Butterfly Atlas provides a context for future field studies and is not site specific. Field staff screened for these species during field studies.

MNRF City of Guelph Municipal List – Wildlife SAR

On September 29, 2015, the Guelph District MNRF generated a list of wildlife SAR that are known to be present within the City of Guelph. This list contained the following species:

- Birds – 13 species; Bald Eagle, Bank Swallow, Barn Swallow, Bobolink, Canada Warbler, Chimney Swift, Common Nighthawk, Eastern Meadowlark, Eastern Wood-Pewee, Golden-winged Warbler, Red-headed Woodpecker, Wood Thrush, and Yellow-breasted Chat;
- Amphibians – Jefferson Salamander;
- Reptiles – Blanding's Turtle, Eastern Ribbonsnake, Eastern Milksnake (note: no longer a SAR), and Snapping Turtle;
- Mammals – three bat species: Eastern Small-footed Myotis, Little Brown Myotis, and Northern Myotis;
- Insects – Monarch, Rusty-patched Bumble Bee, and West Virginia White.

The significant species from Guelph's Wildlife SAR list provides a context for future field studies and is not site specific.

Clythe Creek Subwatershed Overview (Ecologistics Ltd. and Blackport and Associates, 1998)

This report gathered background information available at the time; however, no specific wildlife field surveys (such as breeding bird or nocturnal amphibian surveys) were undertaken for the project. In addition, the species listed in the report were based on older sources, such as the first Ontario Breeding Bird Atlas (1981 – 1985); most of these sources are now considered historical, with the information contained therein being out of date.

They reported 57 species of birds within the subwatershed, with one of them (Least Bittern) being considered a SAR at the time. They also found historic records of four other provincially and locally significant species: Red-shouldered Hawk, Northern Bobwhite, Henslow's Sparrow, and Western Meadowlark. With regard to mammals, a total of nine species were found, including one significant species (Smokey Shrew). Finally, records of 21 species of amphibians and reptiles were listed, including Jefferson Salamander. None of these wildlife records were specific to the present study area along York Road.

Guelph Correctional Centre Natural Heritage Assessment (Natural Resources Solutions Inc., 2013)

This report gathered background information available at the time, which included the sources listed above. The project did not conduct any wildlife surveys within the study area, with observations only noted on an incidental basis during other surveys (e.g. vegetation surveys and tree inventory). The sources they checked were also reviewed by D&A staff in 2015, and included the Ontario Breeding Bird Atlas (2001 – 2005), MNRF records, and the Ontario Reptile and Amphibian, Mammal, and Butterfly Atlases; the results of our reviews of these sources and others are outlined in the respective sections above.

In December 2011 and May 2012, NRSI observed 21 species of birds. In 2005 incidental observations of 10 bird species were made by Stantec (2006), for a combined total of 24 species of birds. All of these observations were of common and widespread species in southern Ontario. However, six of the species observed are considered significant within Wellington County; it should be noted that at least three of these six species (Ring-billed Gull, American Redstart, and Dark-eyed Junco) would only be considered as migrants or non-breeders within the study area due to the dates of the survey and the habitat availability. All six of these significant species are not considered rare in Wellington County. Their background review also identified 19 other species of birds that are considered locally significant within Wellington County that could also occur within the study area. It should be noted that the species list generated by NRSI was based on the OBBA (2001 – 2005) so none of these species have confirmed records from the study area and, again, no field surveys for birds were undertaken by NRSI.

No species of reptiles or amphibians were observed by either NRSI in 2011 and 2012, or Stantec in 2005. A total of eight species of mammals were reported by NRSI and Stantec; all of them are considered common and widespread in southern Ontario, with no conservation concerns. Finally, four species of butterflies were observed by NRSI in May 2012, including Monarch (Special Concern).

No odonates were reported from field investigations by NRSI or Stantec; no dedicated odonate surveys were undertaken by either group. A review of odonate records by the then available Ontario Odonate Atlas (online) revealed that 67 species of dragonflies and damselflies had been recorded within the 10 x 10 km square that contained the study area. None of them are considered Species at Risk (including Special Concern), however 14 of them had Sranks of S1 to S3 (indicating vulnerable populations in Ontario). It should be noted that the Sranks of odonates have been updated since the NRSI report, and six of the 14 species then ranked as S1 to S3 have been reclassified as S4 (indicating secure provincial populations). These six species are as follows: Brush-tipped Emerald, Eastern Amberwing, Eastern Red Damsel, Halloween Pennant, Northern Bluet, and Williamson's Emerald. Finally, 25 of the 67 species listed by NRSI are considered locally significant (i.e. within Wellington County).

Other Reports

As general reports, these did not provide any field observations, hence there were no relevant wildlife records for the general vicinity of the York Road study area found within the following reports: *Conservation Plan for the Guelph Correctional Centre Heritage Place* (Content Works 2009), *Eramosa - Blue Springs Watershed Study Report* (Beak International Inc. and Aquafor Beech Ltd. 1999), *Eramosa River - Blue Springs Creek Linear Corridor Initiative* (Proctor & Redfern Ltd. 1995), *Assessment and Remedial Activities for Clythe Creek Phase I Report* (Saavedra et al. 2007), and *Rehabilitation of Clythe Creek Phase II Design Report* (Saavedra et al. 2008).

2.8 Transportation Facilities

As part the current undertaking, the EA-documented need, justification and design for the widening of York Road between Victoria Avenue and the East City Limits, was reviewed and updated to reflect current objectives and standards in the City of Guelph. The following sections provide a summary of the previous York Road Class EA (2007) findings.

2.8.1 2007 York Road Class Environmental Assessment

In February 2007, the City of Guelph, with assistance from TSH, filed the York Road Improvements: Wyndham Street South to East City Limits Class Environmental Assessment. The following sections briefly outline the transportation-related outcomes of that study.

Need and Justification

Traffic modelling and a general site assessment were completed as a component of the Class EA, using 2006 base and 2016 horizon years. The traffic modelling took into consideration anticipated development of the York District Lands on the south side of York Road, which were to support a residential population of 750, and an employment population of 6,280, by 2021 as documented within the Class EA. This area, now known as the Guelph Innovation District (GID), will ultimately support 6,600 residents and 6,250 employees per Official Plan Amendment 54. Development of the GID has yet to occur as parts of the proposed plan are currently under review by the Ontario Municipal Board (now Local Planning Appeal Tribunal, LPAT). Based on the results of the EA site assessment and traffic study, the following transportation 'Need and Justification Statement' was developed:

Widening of York Road east of Victoria Road is required because:

a) *Turning lanes and additional through lanes are required to facilitate better traffic operations as traffic volumes and congestion increase, and service would otherwise be exacerbated by traffic delays and unsafe driving conditions.*
b) *The lack of continuous sidewalks and bicycle routes contributes to unsatisfactory conditions for existing and future bicyclists and pedestrians.*

EA-Recommended Roadway Design

The EA-recommended roadway design was based on results of detailed traffic modelling and consultation with Guelph city staff, key stakeholders and members of the public. The design generally recommended a four-lane cross-section with a continuous on-road cycling lane and sidewalk on the north side. Similar facilities were to be provided on the south side, west of Elizabeth Street only. East of Elizabeth Street, a paved shoulder (rural section) would partially serve as a cycling lane, with pedestrian facilities assumed to be provided within the York District Lands.

In addition to modifications to the roadway cross-section, the EA also recommended realignment of Elizabeth Street to correct the existing skewed connection to York Road, as well as closure of the Beaumont Crescent and Cityview Drive intersections.

2.9 Integrated Summary

Based on the background review process, it is understood that there have been a number of studies completed previously for the current study area. These studies have assisted team members in gaining an initial understanding of the characteristics of the study area, and in identifying analyses and tasks that have been previously completed which do not need to be repeated. Conversely, the background review process has also guided the development of the field work investigations (Section 3), by identifying those data and knowledge gaps that exist and should be addressed in order to ensure a fulsome environmental characterization.

3.0 Stage 2 Field Work Investigations

3.1 Hydrogeology and Geology

Based on the scope of the current assessment, and the available background information and modelling, no hydrogeologic or geologic field work activities were completed as part of the current EIS.

The fisheries and terrestrial assessments (Sections 3.5.3 and 3.6.3) both described observations of watercress which can be indicative of groundwater discharge.

3.2 Hydrology and Hydraulics

3.2.1 Hydrology

Based on discussions with City staff and staff from the GRCA, no hydrologic field work activities have been considered required as part of the current EIS. A flow monitoring program was originally envisioned by the City as part of this study, however it has been agreed that this program will not be conducted as part of this study, primarily due to constraints with respect to the project schedule, and the availability of City monitoring equipment. As such, hydrologic modelling has been validated using previously completed modelling and unitary flow comparisons to similar watersheds in other jurisdictions (ref. Table 3.2.2). It is considered that this approach is defensible and appropriate for the current study purposes.

An integrated PCSWMM hydrologic model has been developed as part of this study. The base PCSWMM model combined the previous hydrologic modelling assessments undertaken by Amec Foster Wheeler in the Clythe Creek Watershed. This includes hydrologic modelling of local sewersheds for the City's Stormwater Management Master Plan (2012), modelling of the majority of Hadati Creek to support the design of the Elizabeth Street trunk storm sewer (2015), and on-going stormwater management and hydrologic modelling support for the GID area to the south of York Road (2017, on-going). The integrated PCSWMM model has been updated to include the Hadati Creek watercourse, as well as the large upstream Clythe Creek watershed, and any contributing drainage areas.

The Hadati Creek Watershed is mostly urbanized with a 50 ha +/- significant natural area(Significant Woodland and Provincially Significant Wetland) located southwest of Pollinators Park (ref. Figures 3.2.1 to 3.2.6). Flows in Hadati Creek are attenuated in the existing wetland area upstream of Starwood Drive (ref. Cosburn Patterson Wardman Limited, November 1992). The Starwood Drive crossing and wetland area provides control up to the 100 year storm event. The channel downstream of Starwood Drive continues through a 1 km creek block through a residential subdivision with crossings at Chesterton Lane and Grange Road. The flows are attenuated and controlled at the CNR crossing up to and including the 100 year storm event and Regional Storm (ref. Schaeffers, 1997). The flow from the CNR crossing enters a highly urbanized channel prior to crossing York Road where it enters Clythe Creek

With the development of drainage area boundaries, appropriate hydrologic modelling parameters (which represent the runoff potential of each individual subcatchment) are required. The following has been considered in determining the hydrologic modelling parameterization for Hadati Creek.

- Directly connected imperviousness (the value required by PCSWMM) has been calculated based on standard assumed values for different land uses. Total imperviousness has also been calculated in order to properly adjust infiltration parameters using the Green-Ampt methodology.
- Imperviousness for existing residential land uses has been determined using measurements of lot coverage from the 2016 aerial photography.
- Slopes and overland flow lengths have been calculated using available 2012 City of Guelph contour mapping, property boundaries, and 2016 aerial photography.

- Manning's roughness coefficients of 0.013 and 0.2 have been applied for impervious and pervious overland flow components respectively.
- Base depression storage depths of 1 and 5 mm have been applied for impervious and pervious catchment portions respectively.
- The recommended default value of 25% has been applied for the zero depression storage imperviousness ratio (the portion of the impervious area with no depression storage).
- Hydrologic parameters for individual catchments are provided in Appendix D.

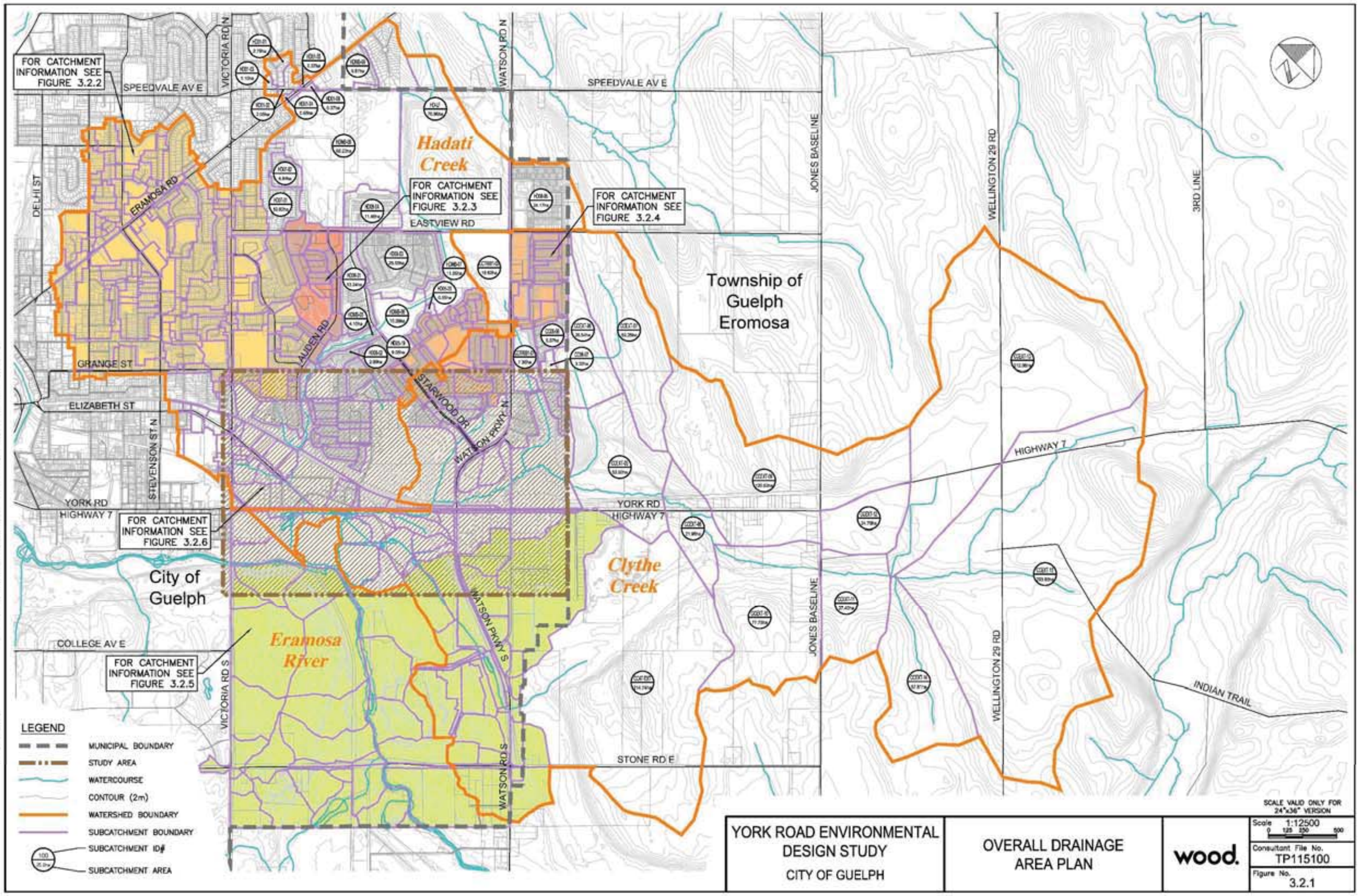
The City of Guelph has 4 stormwater management facilities (i.e. ponds) within the Hadati Creek Watershed. There is a water quality stormwater management pond (City pond #54) located in Carter Park in the headwaters of Hadati Creek. The 3 remaining stormwater management ponds are located in the Grangehill Estates subdivisions. City pond #115 located within Grangehill Estates Phase 7 provides control up and including the 100 year storm event. The two remaining ponds (City pond #31 and #37) provide water quality controls and discharge into the wetland area upstream of Starwood Drive.

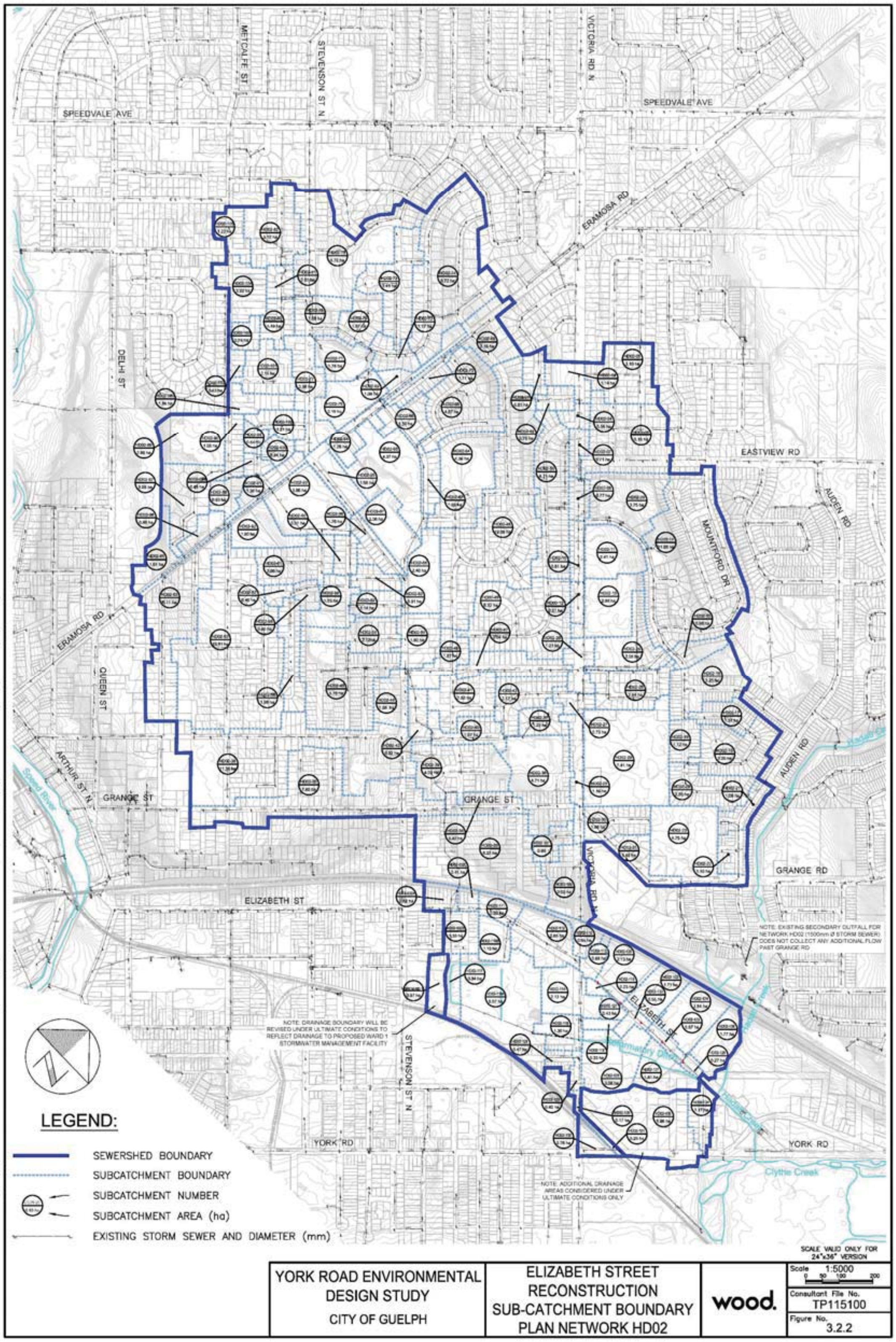
The Clythe Creek Watershed has headwaters which consist of 1200 ha +/- of predominantly rural land uses (ref. Figure 3.2.1). The Clythe Creek Watershed extends beyond the eastern limits of the City of Guelph and is thus situated beyond the limits of the City's available mapping. For the area of the Clythe Creek Watershed beyond the City's available mapping, aerial photography available from Google Map™ as well as the Grand River Conservation Authority's 2000 DTM 1 m contours was used. The external Clythe Creek catchments have been discretized at a much larger resolution (25 ha +\- to 300 ha +\-) compared to the urban areas in accordance with the available data.

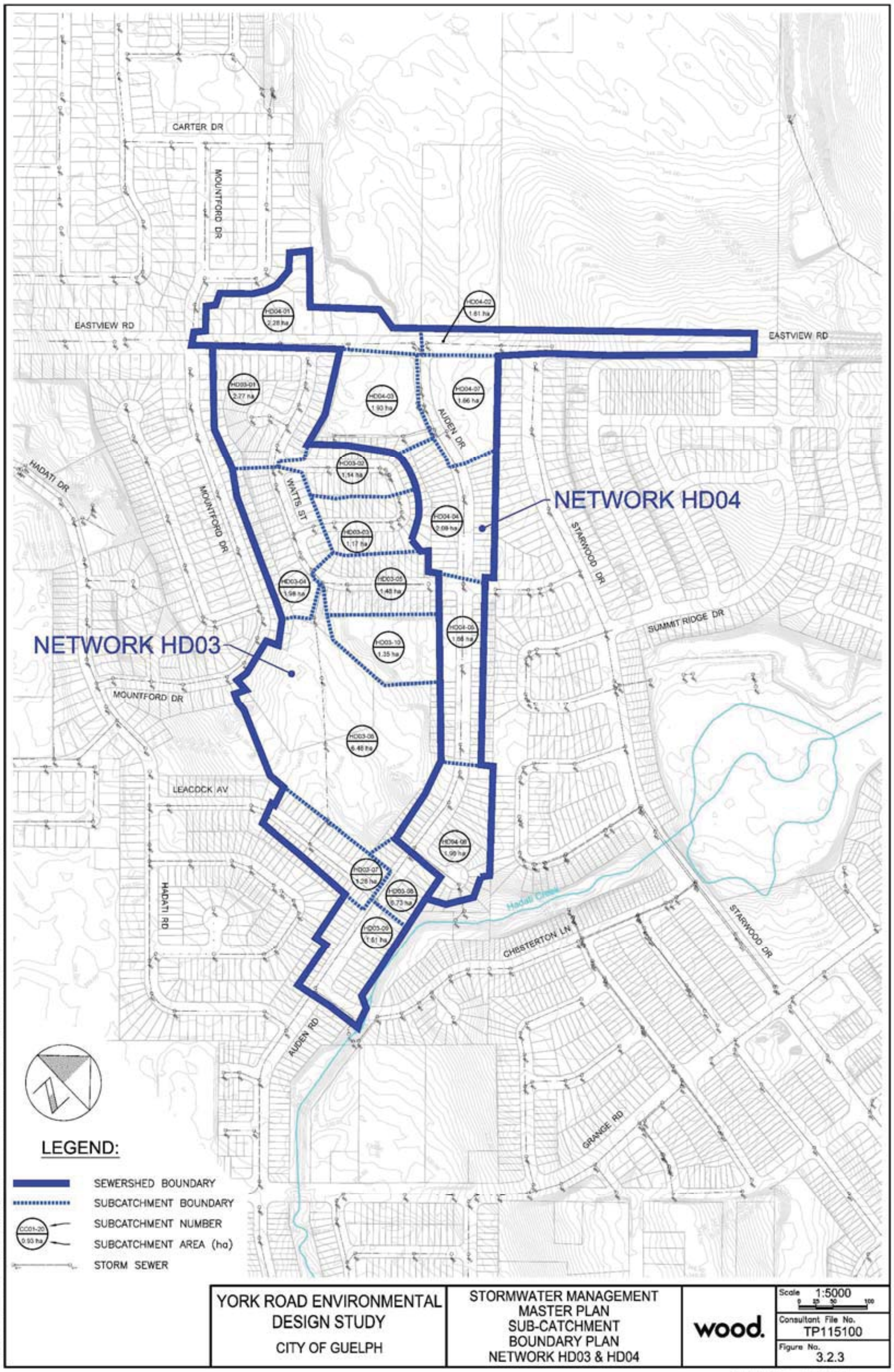
The urban areas within the Clythe Creek Watershed have been parameterized using the same methodology as those in the Hadati Creek Watershed (ref. Figures 3.2.4 and 3.2.6). The large rural headwaters required a different methodology for determining the subcatchment length. Subcatchment length is a key parameter within PCSWMM, as it is used to represent sheet flow/overland flow, and accounts for the expected degree of attenuation (i.e. is a surrogate for time of concentration or time to peak used in unit hydrograph methodologies). Given that in most cases flow is defined by the channel (i.e. ditch) length, the subcatchment length for the large rural areas has been defined using generally accepted relationships between channel length and flow path length, namely the Proctor & Redfern method (Proctor and Redfern, Ltd. and MacLaren, J.F. Ltd, 1976, "Stormwater Management Model Study – Vol 1". Research Rep. No. 7, Canada-Ontario Research Program, Environmental Protection Service, Ottawa), which indicated that the subcatchment width (width of the kinematic wave plane) should be 1.7 times the channel length. Thus subcatchment length has been set equal to the drainage area divided by 1.7 times the channel length.

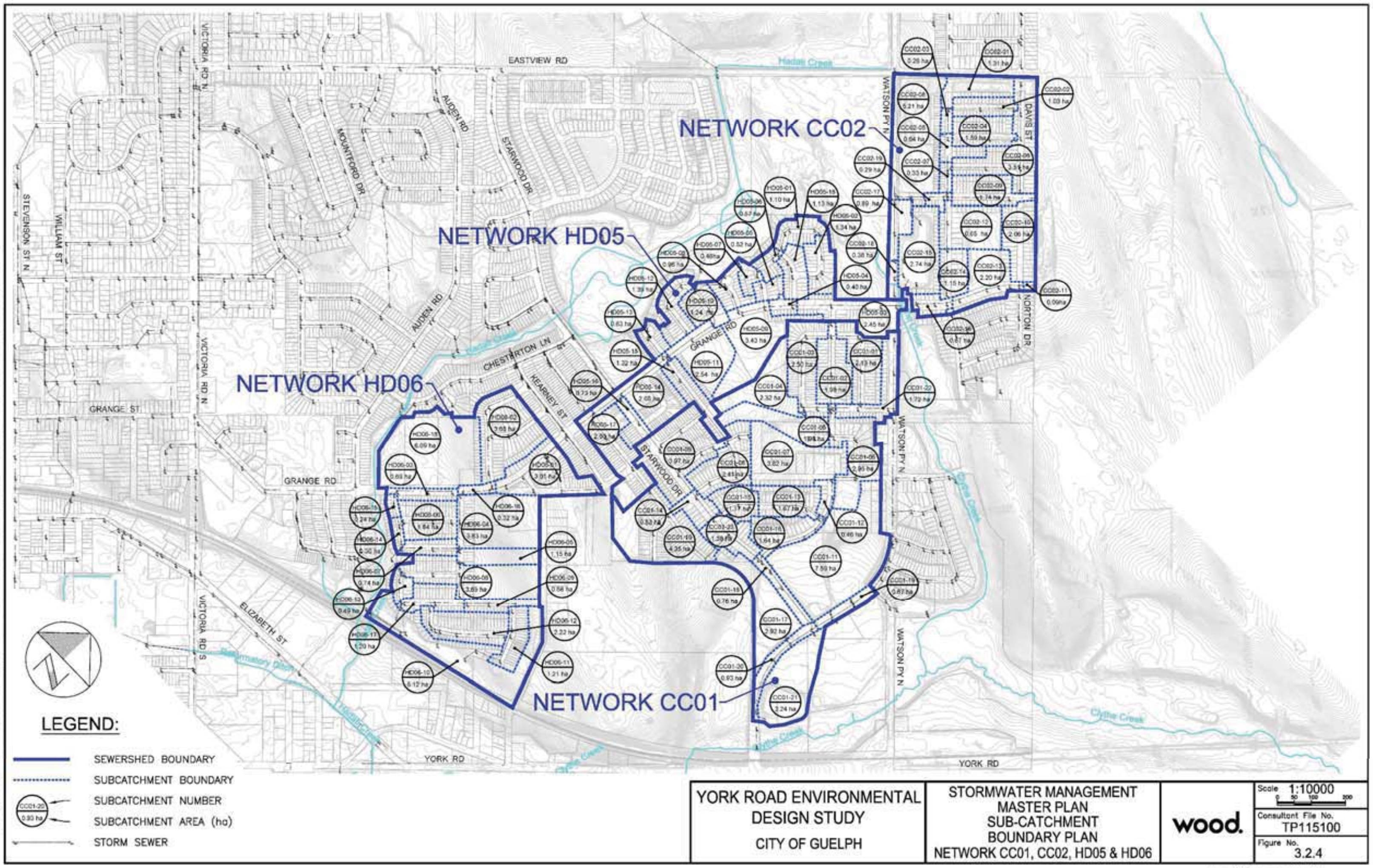
The City of Guelph has 5 stormwater management ponds within the Clythe Creek Watershed upstream of the York Road crossing. There are 4 stormwater management ponds in the Watson Creek Tributary from the Watson Subdivisions. Three of the stormwater management ponds (City ponds #86, #87, and #111) in the Watson Subdivisions provide controlled flows up to and including the 100 year while the fourth (City Pond #88) only provides water quality controls. The fifth pond (City Pond #53) is located upstream of the Watson Parkway crossing and controls flows from the eastern Grangehill Subdivision up to and including the 100 year storm event. There are also 4 stormwater management ponds within the GID lands which contribute to Clythe Creek. These ponds include City Ponds #38 and #96 as well as the Waste Resource Innovation Centre and PDI ponds (ref. Figure 3.2.5).

The subcatchments along York Road (ref. Figure 3.2.6) have been discretized at a high resolution in order to isolate the localized road drainage contributing to Clythe Creek and assess the impacts of widening the road and therefore increasing the level of imperviousness (ref. Figure 3.2.6). Impervious areas of the York


FOR CATCHMENT INFORMATION SEE FIGURE 3.2.2
FOR CATCHMENT INFORMATION SEE FIGURE 3.2.3
FOR CATCHMENT INFORMATION SEE FIGURE 3.2.4
FOR CATCHMENT INFORMATION SEE FIGURE 3.2.5
FOR CATCHMENT INFORMATION SEE FIGURE 3.2.6
SPEEDVALE AV E
VICTORIA RD N
WATSON RD N
DELHI ST
ERAMOSA RD
EASTVIEW RD
AUDEN RD
GRANGE ST
ELIZABETH ST
STEVENSON ST N
STARWOOD DR
WATSON PKWY N
YORK RD
HIGHWAY 7
COLLEGE AV E
VICTORIA RD S
WATSON PKWY S
WATSON RD S
STONE RD E
JONES BASELINE
WELLINGTON 29 RD
3RD LINE
INDIAN TRAIL
Hadati Creek
Clythe Creek
Eramosa River
Township of Guelph Eromosa
City of Guelph
LEGEND
MUNICIPAL BOUNDARY
STUDY AREA
WATERCOURSE
CONTOUR (2m)
WATERSHED BOUNDARY
SUBCATCHMENT BOUNDARY
SUBCATCHMENT ID#
SUBCATCHMENT AREA
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
OVERALL DRAINAGE AREA PLAN
wood.
SCALE VALID ONLY FOR 24"x36" VERSION
Scale 1:12500
Consultant File No. TP115100
Figure No. 3.2.1


SPEEDVALE AVE
METCALFE ST
STEVENSON ST N
VICTORIA RD N
ERAMOSA RD
DELHI ST
EASTVIEW RD
AUDEN RD
MOUNTFORD DR
QUEEN ST
ARTHUR ST N
GRANGE ST
GRANGE RD
ELIZABETH ST
VICTORIA RD
YORK RD
Clythe Creek
NOTE: EXISTING SECONDARY OUTFALL FOR NETWORK HD02 (1500mm Ø STORM SEWER) DOES NOT COLLECT ANY ADDITIONAL FLOW PAST GRANGE RD
NOTE: DRAINAGE BOUNDARY WILL BE REVISED UNDER ULTIMATE CONDITIONS TO REFLECT DRAINAGE TO PROPOSED WARD 1 STORMWATER MANAGEMENT FACILITY
NOTE: ADDITIONAL DRAINAGE AREAS CONSIDERED UNDER ULTIMATE CONDITIONS ONLY
LEGEND:
SEWERSHED BOUNDARY
SUBCATCHMENT BOUNDARY
SUBCATCHMENT NUMBER
SUBCATCHMENT AREA (ha)
EXISTING STORM SEWER AND DIAMETER (mm)
SCALE VALID ONLY FOR 24"x36" VERSION
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
ELIZABETH STREET RECONSTRUCTION SUB-CATCHMENT BOUNDARY PLAN NETWORK HD02
wood.
Scale 1:5000
Consultant File No. TP115100
Figure No. 3.2.2


CARTER DR
MOUNTFORD DR
EASTVIEW RD
EASTVIEW RD
NETWORK HD04
NETWORK HD03
HADATI DR
WATTS ST
AUDEN DR
STARWOOD DR
SUMMIT RIDGE DR
MOUNTFORD DR
MOUNTFORD DR
LEACOCK AV
HADATI RD
CHESTERTON LN
STARWOOD DR
AUDEN RD
GRANGE RD
LEGEND:
SEWERSHED BOUNDARY
SUBCATCHMENT BOUNDARY
SUBCATCHMENT NUMBER
SUBCATCHMENT AREA (ha)
STORM SEWER
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
STORMWATER MANAGEMENT MASTER PLAN SUB-CATCHMENT BOUNDARY PLAN NETWORK HD03 & HD04
wood.
Scale 1:5000
Consultant File No. TP115100
Figure No. 3.2.3


NETWORK CC02
NETWORK HD05
NETWORK HD06
NETWORK CC01
EASTVIEW RD
WATSON PY N
DAVIS ST
NORTON DR
STARWOOD DR
AUDEN RD
MOUNTFORD DR
VICTORIA RD N
VICTORIA RD S
GRANGE ST
GRANGE RD
CHESTERTON LN
KEARNEY ST
ELIZABETH ST
YORK RD
WILLIAM ST
STEVENSON ST N
LEGEND:
SEWERSHED BOUNDARY
SUBCATCHMENT BOUNDARY
SUBCATCHMENT NUMBER
SUBCATCHMENT AREA (ha)
STORM SEWER
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
STORMWATER MANAGEMENT MASTER PLAN SUB-CATCHMENT BOUNDARY PLAN
NETWORK CC01, CC02, HD05 & HD06
wood.
Scale 1:10000
Consultant File No. TP115100
Figure No. 3.2.4

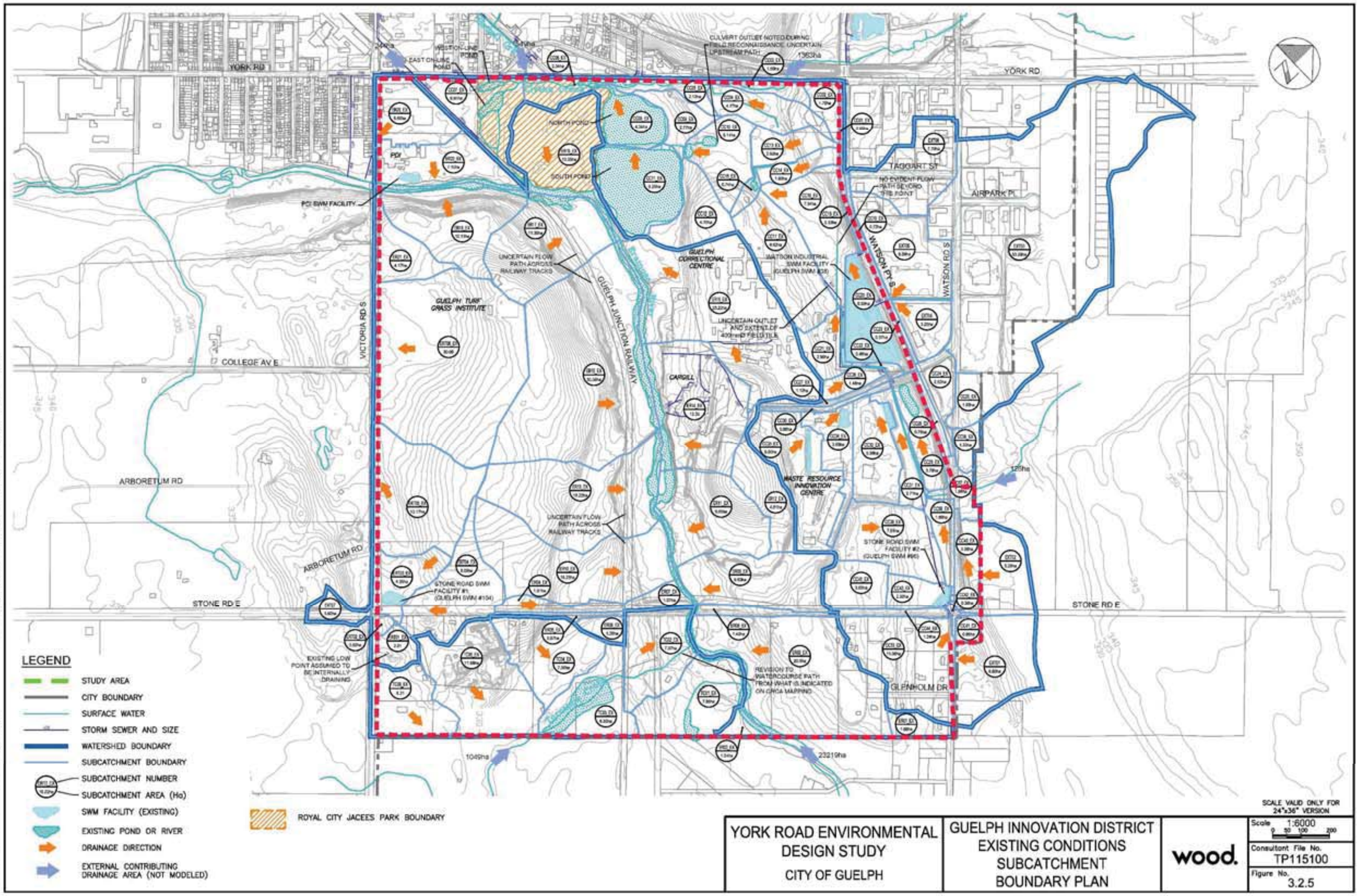

YORK RD
TAGGART ST
AIRPARK PL
WATSON PY S
WATSON RD S
VICTORIA RD S
COLLEGE AV E
ARBORETUM RD
STONE RD E
GLENHOLM DR
GUELPH JUNCTION RAILWAY
GUELPH TURF GRASS INSTITUTE
GUELPH CORRECTIONAL CENTRE
CARGILL
WASTE RESOURCE INNOVATION CENTRE
NORTH POND
SOUTH POND
PDI
PDI SWM FACILITY
EAST ON-LINE POND
WESTON ON-LINE POND
CULVERT OUTLET NOTED DURING FIELD RECONNAISSANCE. UNCERTAIN UPSTREAM PATH
NO EVIDENT FLOW PATH BEYOND THIS POINT
WATSON INDUSTRIAL SWM FACILITY (GUELPH SWM #38)
UNCERTAIN OUTLET AND EXTENT OF 400mmØ FIELD TILE
UNCERTAIN FLOW PATH ACROSS RAILWAY TRACKS
STONE ROAD SWM FACILITY #1 (GUELPH SWM #104)
STONE ROAD SWM FACILITY #2 (GUELPH SWM #80)
EXISTING LOW POINT ASSUMED TO BE INTERNALLY DRAINING
REVISION TO WATERCOURSE PATH FROM WHAT IS INDICATED ON GRCA MAPPING
1363ha
125ha
1049ha
23219ha
LEGEND
STUDY AREA
CITY BOUNDARY
SURFACE WATER
STORM SEWER AND SIZE
WATERSHED BOUNDARY
SUBCATCHMENT BOUNDARY
SUBCATCHMENT NUMBER
SUBCATCHMENT AREA (Ha)
SWM FACILITY (EXISTING)
EXISTING POND OR RIVER
DRAINAGE DIRECTION
EXTERNAL CONTRIBUTING DRAINAGE AREA (NOT MODELED)
ROYAL CITY JACEES PARK BOUNDARY
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
GUELPH INNOVATION DISTRICT EXISTING CONDITIONS SUBCATCHMENT BOUNDARY PLAN
wood.
SCALE VALID ONLY FOR 24"x36" VERSION
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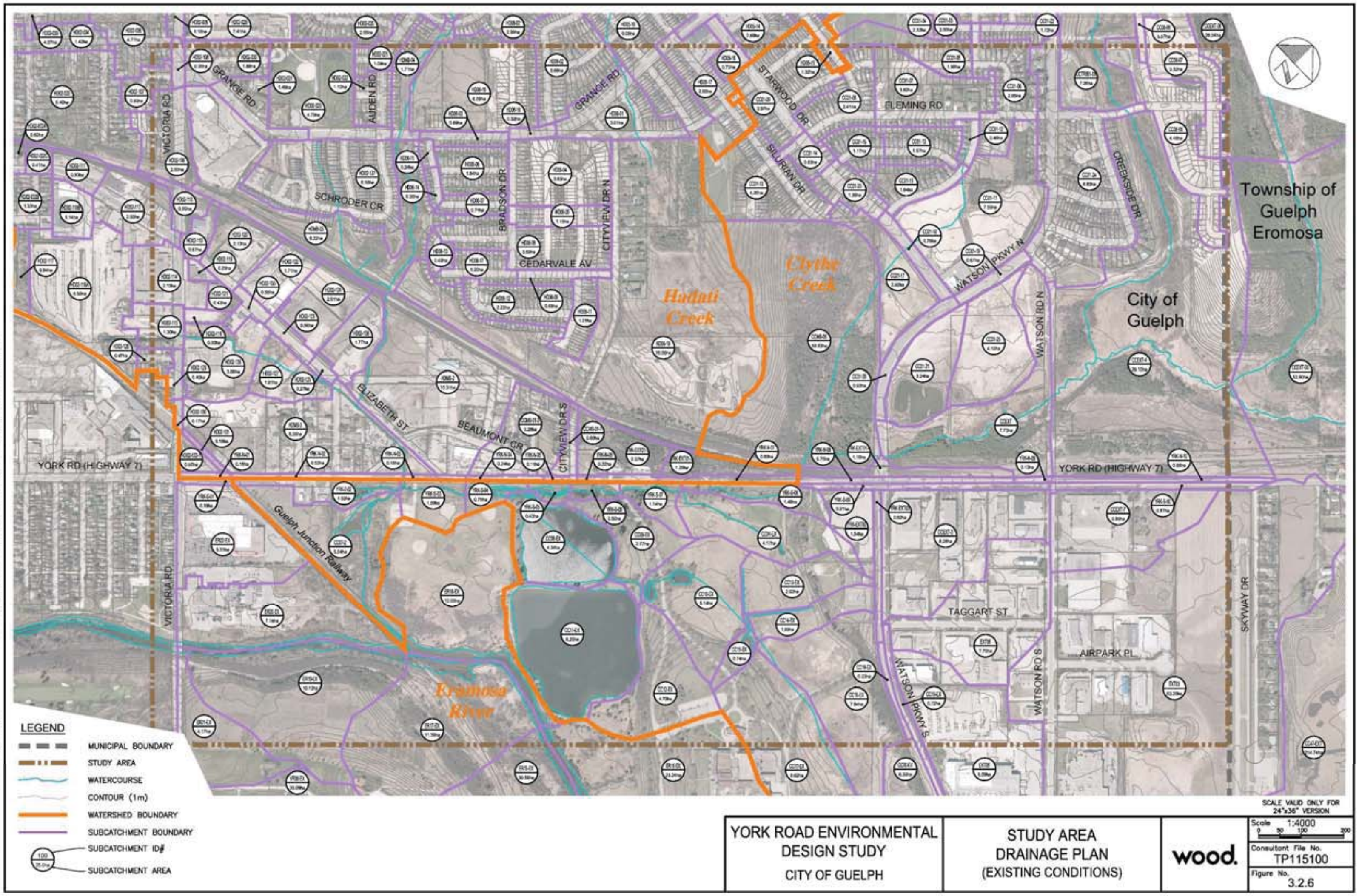
Figure No. 3.2.5


Township of Guelph Eromosa
City of Guelph
Clythe Creek
Hadati Creek
Eramosa River
YORK RD (HIGHWAY 7)
VICTORIA RD
GRANGE RD
AUDEN RD
SCHRODER CR
BRADSON DR
CEDARVALE AV
CITYVIEW DR N
CITYVIEW DR S
ELIZABETH ST
BEAUMONT CR
STARWOOD DR
SILURIAN DR
FLEMING RD
CREEKSIDE DR
WATSON PKWY N
WATSON PKWY S
WATSON RD N
WATSON RD S
TAGGART ST
AIRPARK PL
SKYWAY DR
Guelph Junction Railway
LEGEND
MUNICIPAL BOUNDARY
STUDY AREA
WATERCOURSE
CONTOUR (1m)
WATERSHED BOUNDARY
SUBCATCHMENT BOUNDARY
SUBCATCHMENT ID#
SUBCATCHMENT AREA
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
STUDY AREA DRAINAGE PLAN (EXISTING CONDITIONS)
wood.
SCALE VALID ONLY FOR 24"x36" VERSION
Scale 1:4000
0 50 100 200
Consultant File No. TP115100
Figure No. 3.2.6

Road subcatchments have been measured from the 2016 aerial photography. Where drainage from the York Road catchments enter a ditch along the road a nominal 10 percent directly connect imperviousness has been applied for the existing condition. This represents a conservative estimate for comparison to the future alternative which will utilize storm sewers to capture the runoff prior to outletting into Clythe Creek. The City of Guelph 2012 topographic contour mapping and storm drainage layer have been utilized to determine the existing outlets for York Road drainage along Clythe Creek.

An event-based methodology has been applied, based on the City of Guelph's standard 5 and 100 year design storms (Chicago storms with variable durations of approximately 3 hours). The City of Guelph does not have a specified 10 year or 25 year design storm distribution, however the City's design storms are based on Chicago temporal distributions which have variable durations of approximately 3 hours. Accordingly, a 3 hour Chicago distribution storm event has been generated, using the City's current IDF parameters for both a 10 year and 25 year event, and the same peaking factor (approximately 0.42) as was applied in the other storm distributions.

In addition, the Regional Storm for the study area (Hurricane Hazel) has been used for simulation purposes. Given that the study area is less than 25 km^2, no reduction factor is required. The Green-Ampt infiltration methodology has been applied in the PCSWMM modelling, as such the 12-hour version of the Regional Storm could not be applied for the study area. The full 48-hour version of the Regional Storm has been simulated to represent AMC-III – saturated conditions for area soils.

The MOECC recommended water quality storm of 25 mm 4 hour storm with a Chicago distribution has also been simulated. The results of the existing conditions for the various storm events are provided in Table 3.2.1 (ref. Figure 3.2.6, for flow nodes).

Table 3.2.1: Clythe Creek Existing Conditions Peak Flows (m^3/s)

Location	Node	Area (ha)	25 mm Chicago	Return Period Flows - 3 Hour Chicago						Regional
				2	5	10	25	50	100	
York Road	J_CC00	1198	1.8	3.0	4.8	8.6	15.9	24.0	33.3	82.9
Reformatory Driveway	J_York_05	1206	1.8	2.9	5.2	8.6	15.9	24.0	33.1	81.6
Royal City Jacees Park ponds	J_York_03	1347	2.4	4.1	7.5	10.9	19.1	28.5	37.7	89.6
Hadati Creek confluence	J_CC04	2130	3.8	6.4	12.8	20.4	30.0	40.7	51.2	100.8
Eramosa confluence	J_CC05	2138	6.0	8.8	15.8	23.5	33.2	43.5	53.4	100.8

Verification of the resulting flows has been conducted by comparing the York Road unitary flows to the unitary flow rates of frequency flows from various studies and watercourse systems (ref. Table 3.2.2). The results indicate that the return period flows are reasonable but in the lower range of flows. This is attributed to the use of the 3 hour Chicago design storm versus a longer duration design storm. A sensitivity test on the 100 year event rainfall determined that the 24 hour Chicago distribution would produce unitary rates of 0.036 m^3/s/ha for Clythe Creek at York Road and 0.029 m^3/s/ha at the Hadati Creek confluence of Clythe Creek.

Table 3.2.2: Watercourse Unitary Peak Flow Comparison

Land Use	Location	Unitary Flow Rates ($m^3/s/ha$) for Design Storms						
		2	5	10	20/25	50	100	Regional
Urban + Rural	Clythe Creek at York Road	0.003	0.004	0.007	0.013	0.020	0.028	0.069
	Hadati Creek Confluence	0.003	0.006	0.010	0.014	0.019	0.024	0.047
Urban + Rural	14 Mile Creek	0.0156	0.020	0.025	0.033	0.035	0.042	0.079
Urban + Rural	McCraney	0.0275	0.029	0.030	0.036	0.037	0.041	0.072
Rural	North Waterdown	0.006	0.011	0.014	0.018	0.021	0.023	0.090
Rural	Sixteen Mile Creek	0.003	0.006	0.009	0.012	0.016	0.019	0.075
2009 Urban + Rural	Stoney (Escarp.)	0.004	0.007	0.011	0.015	0.018	0.022	0.073
	Battlefield (Escarp.)	0.004	0.008	0.011	0.015	0.019	0.022	0.073
	Stoney (Outlet)	0.004	0.007	0.01	0.014	0.017	0.020	0.063

3.2.2 Hydraulics

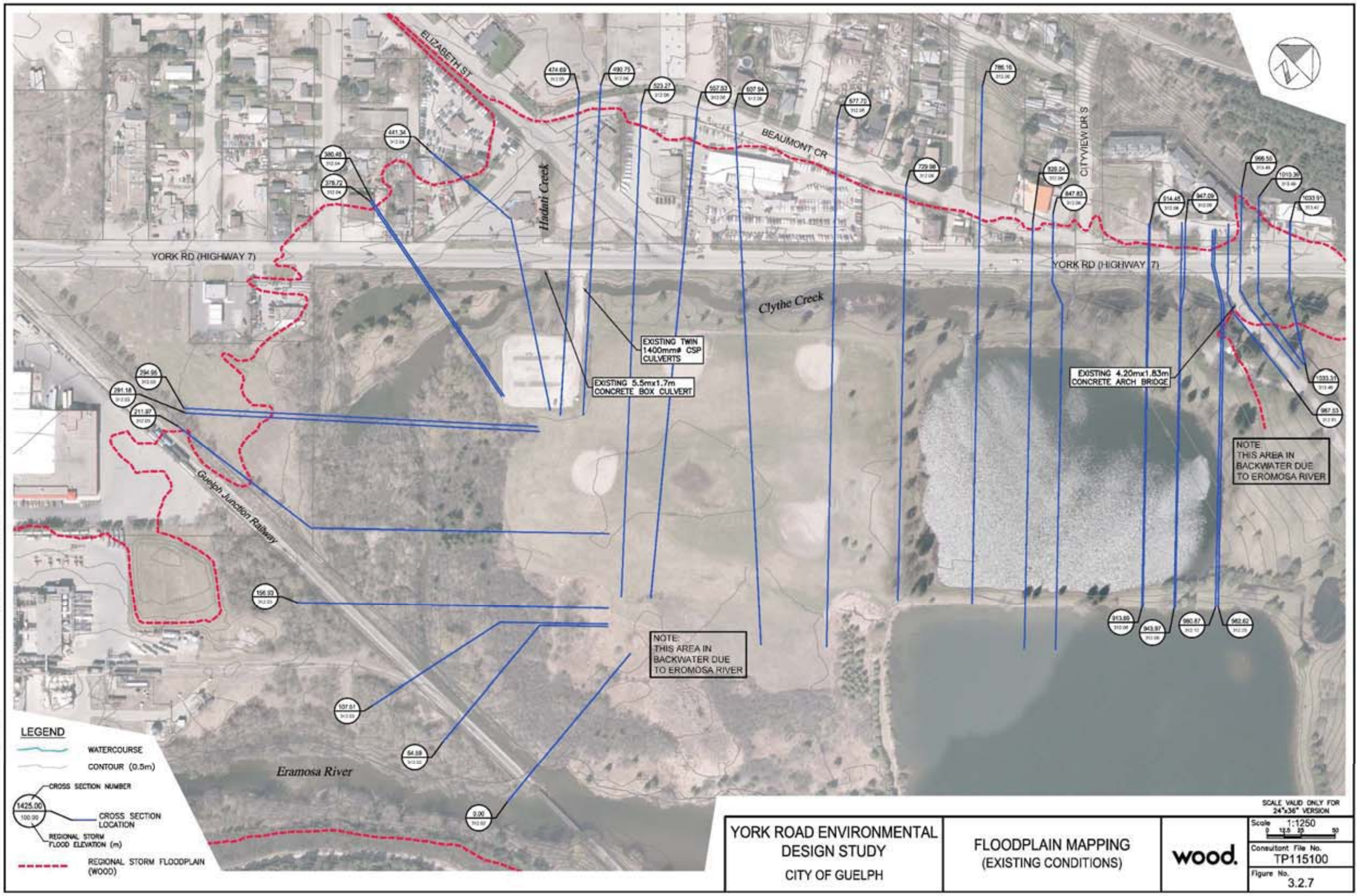
With respect to channel hydraulics, topographic survey has been conducted for selected sections of Clythe Creek to support updated hydraulic modelling and design work. No additional topographic survey was conducted for Hadati Creek, as the channel geometry available within the existing hydraulic modelling is considered sufficient for study purposes. A topographic survey for the York Road right-of-way has been previously completed by the City of Guelph and has been used as part of this study.

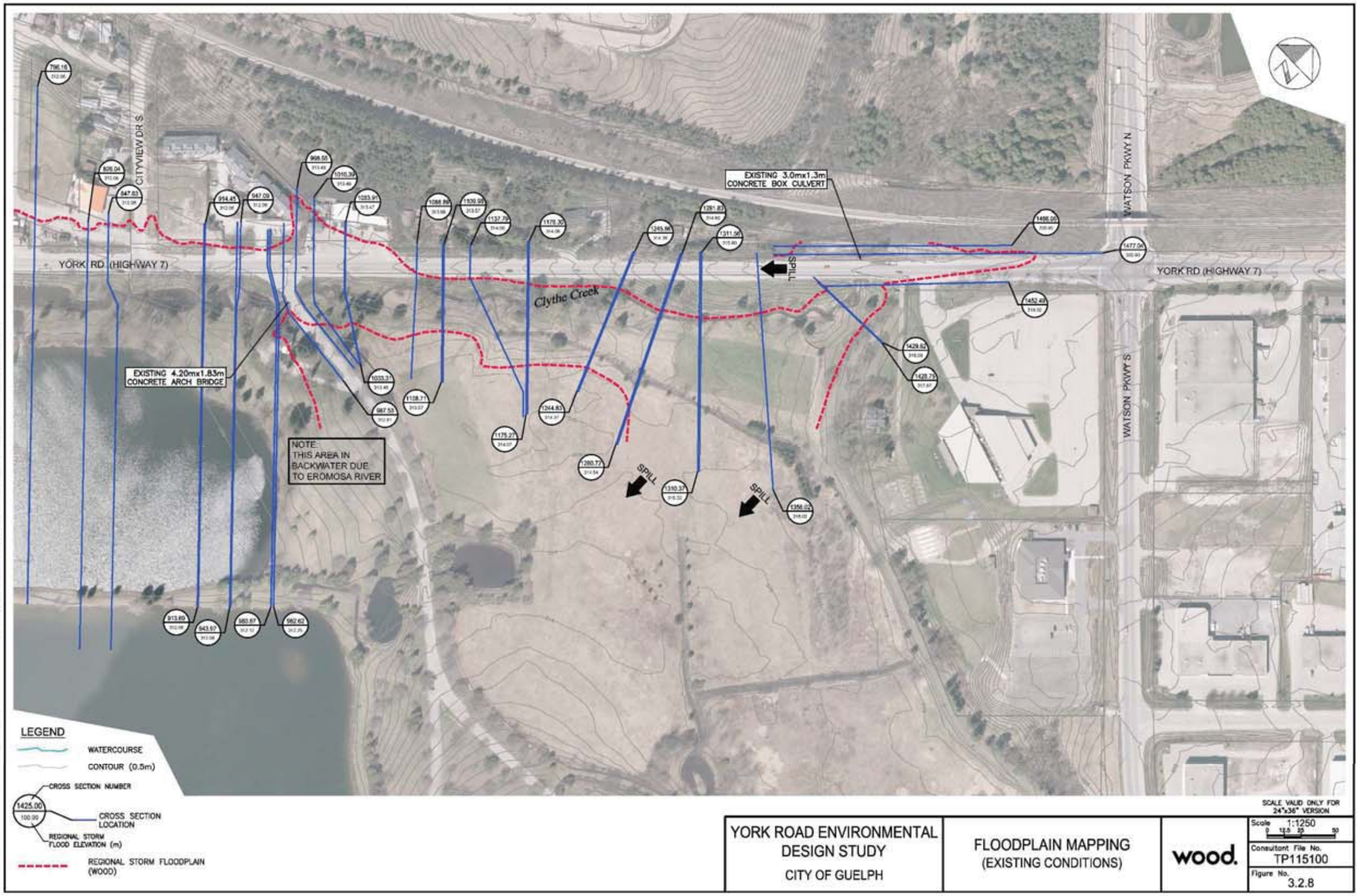
As previously mentioned, a HEC-RAS hydraulic model was created for the section of Clythe Creek located within the study area. The model extends form the upstream side of York Road, down to the confluence with the Eramosa River. The model was developed using topographic survey and 2012 contour mapping. Cross-section data were developed using GIS software tools.

Three existing hydraulic crossings were added to the model. The crossings are shown on Figures 3.2.7 and 3.2.8, and are as follows:

- York Road crossing of Clythe Creek, 3.0 m span by 1.3 m rise concrete box culvert;
- Former Reformatory Driveway crossing of Clythe Creek, 4.20 m span by 1.83 m rise concrete arch bridge; and
- Parking Lot Driveway crossing, twin 1.4 m diameter CSP culverts.

Peak flows for the 2 to 100 year and Regional Storm events were obtained from the aforementioned PCSWMM hydrology model created for the current study, and flow change locations were set at key locations within the model. A downstream boundary condition of a known water surface elevation was set for each storm event based on water surface elevations being obtained from the HEC-2 model of the Eramosa Rover (ref. Paragon Engineering Limited, 1989).


ELIZABETH ST
BEAUMONT CR
CITYVIEW DR S
YORK RD (HIGHWAY 7)
YORK RD (HIGHWAY 7)
Hadati Creek
Clythe Creek
Guelph Junction Railway
Eramosa River
EXISTING TWIN 1400mmø CSP CULVERTS
EXISTING 5.5mx1.7m CONCRETE BOX CULVERT
EXISTING 4.20mx1.83m CONCRETE ARCH BRIDGE
NOTE: THIS AREA IN BACKWATER DUE TO EROMOSA RIVER
NOTE: THIS AREA IN BACKWATER DUE TO EROMOSA RIVER
LEGEND
WATERCOURSE
CONTOUR (0.5m)
CROSS SECTION NUMBER
1425.00
100.00
CROSS SECTION LOCATION
REGIONAL STORM FLOOD ELEVATION (m)
REGIONAL STORM FLOODPLAIN (WOOD)
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
FLOODPLAIN MAPPING (EXISTING CONDITIONS)
wood.
SCALE VALID ONLY FOR 24"x36" VERSION
Scale 1:1250
Consultant File No. TP115100
Figure No. 3.2.7


YORK RD (HIGHWAY 7)
WATSON PKWY N
WATSON PKWY S
CITYVIEW DR S
Clythe Creek
EXISTING 3.0mx1.3m CONCRETE BOX CULVERT
EXISTING 4.20mx1.83m CONCRETE ARCH BRIDGE
NOTE: THIS AREA IN BACKWATER DUE TO EROMOSA RIVER
SPILL
SPILL
SPILL
LEGEND
WATERCOURSE
CONTOUR (0.5m)
CROSS SECTION NUMBER
1425.00
100.00
CROSS SECTION LOCATION
REGIONAL STORM FLOOD ELEVATION (m)
REGIONAL STORM FLOODPLAIN (WOOD)
SCALE VALID ONLY FOR 24"x36" VERSION
Scale 1:1250
Consultant File No. TP115100
Figure No. 3.2.8
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
FLOODPLAIN MAPPING (EXISTING CONDITIONS)
wood.

As noted in Section 2.5, several in-line weir structures exist along Clythe Creek. Cross-sections were placed on the upstream and downstream sides of each weir structure. The structures were incorporated into the model as blockages on the respective upstream cross-section.

Existing Conditions Results

The results for the 2 – 100 year and Regional Storm events are provided in Appendix D. The Regional Storm floodline is represented on Figures 3.2.7 and 3.2.8. It is noted that the downstream boundary conditions of the Eramosa River causes a significant backwater condition in the Regional Storm event that extends up to the downstream side of the Reformatory driveway crossing. York Road is also overtopped due to the backwater condition.

The Eramosa River produces a significant backwater condition for the 2 to 100 year storm events as well. The backwater condition extends up to 130 m downstream of the former Reformatory driveway crossing (cross-section 847.82). Due to the significant backwater conditions, several sections downstream of the former Reformatory driveway crossing do not contain the flood elevations.

Also of note, two spill conditions occur upstream of the former Reformatory driveway crossing. The first spill condition occurs on the upstream side of York Road, where the Regional Storm spills west along the north ditch of York Road. The spilled flows will drain along the ditch and rejoin the system near the downstream side of the former Reformatory driveway crossing. The second spill condition occurs downstream of York Road between cross-sections 1280.724 and 1356.024. The spilled flows will drain overland to the south and join the Eramosa River. The HEC-RAS model has been provided in Appendix D on a CD.

Existing Culverts

The hydraulic model was used to assess the performance of the existing York Road crossing of Clythe Creek in order to understand the potential for the existing culvert to satisfy the future needs of the York Road widening.

The existing culvert has been characterized based on its performance with respect to current Ministry of Transportation (MTO) guidelines for conveyance and freeboard (Highway Design Standards, MTO, January 2008) and Ministry of Natural Resources and Forestry (MNRF) guidelines for safe ingress and egress (Technical Guide – River and Stream Systems: Flooding Hazard Limit, MNR, 2002). The MTO and MNRF guidelines only provide guidance to the City, but it is the roadway is within the City's jurisdiction, not the jurisdiction of MTO and MNRF.

MTO guidelines for culvert and bridge hydraulic design are based on providing a set freeboard and clearance. Freeboard is measured from the design event water surface elevation to the edge of travelled right-of-way. Clearance is measured from the design event water surface elevation to the obvert of the crossing. The design event, freeboard and clearance required consider the road classification and the total structure span. MTO guidelines are summarized in Table 3.2.3.

Table 3.2.3: Design Flow Return Period for Bridges and Culverts (Years) – Standard Road Classifications

Functional Road Classification	MTO[1]		Freeboard Criteria (m) [1]	Clearance Criteria for Bridges (m) [1]	Clearance Criteria for Open-Footing Culverts (m) [1,2]
	Total Span less than or equal to 6.0 m	Total Span greater than 6.0 m			
Freeway, Urban Arterial	50	100	1.0	1.0	0.3
Rural Arterial, Collector	25	50	1.0	1.0	0.3
Local	10	25	0.3	0.3	0.3

Note: [1] Highway Drainage Design Standard (MTO, January 2008)
[2] It is noted that there is no clearance criteria for closed-footing culverts.

The MNRF's guidelines relate to the safe passage of pedestrians and passenger and emergency vehicles across the length of road over which the Regulatory event may overtop. Safe passage is determined by overtopping depths, overtopping velocities and consideration for the combined impact (i.e. product of depth and velocity) and represents 'low risk' to the method of transportation (i.e. pedestrian or vehicle). Table 3.2.4 summarizes the maximum allowable depths and velocities.

Table 3.2.4: Design Criteria for Pedestrian and Vehicular Access (Source: MNR Technical Guide – River and Stream Systems)

Vehicular Access	Maximum Overtopping Depth (m)	Maximum Overtopping Velocity (m/s)	Maximum Product (m^2/s)
Pedestrian	0.3	1.7	0.4
Passenger Vehicle	0.3	3.0	N/A
Emergency Vehicle	0.9	4.5	N/A

York Road is proposed to be classified as Urban Arterial in the future and has been assessed on this basis. The criteria for safe passage has been applied assuming ingress/egress for passenger vehicles. The assessment has been completed using existing conditions peak flows. The results of the crossing performance assessment are summarized in Tables 3.2.5 and 3.2.6. It is noted the existing Reformatory driveway crossing and the existing south parking lot driveway crossing have been included in the tables for the purpose of demonstrating their existing performance. These driveway crossings are privately-owned and are not subject to the aforementioned MTO and MNRF criteria.

Table 3.2.5: Existing Crossing Performance – MTO Criteria

Culvert ID	Structure		Future Road Classification	Design Criteria (Frequency in Years)	Actual Capacity (Frequency in Years)	Required Freeboard (m)	Provided Freeboard (m)[1]	Required Clearance (m)	Provided Clearance (m)[1]	Criteria Achieved?
	Type	Size (m)								
York Road	Concrete Box Culvert - Open Bottom	3.00 x 1.30	Urban Arterial	50 Year	25 year	1.00	<0.00	0.30	<0.00	No
Reformatory Driveway	Concrete Arch Bridge	4.20 x 1.80	N/A	N/A	25 year	N/A	0.31	N/A	<0.00	N/A
Parking Lot Driveway	Twin CSP Culvert	1.40	N/A	N/A	<2 year	N/A	<0.00	N/A	0.02	N/A

Notes: [1] Value shown is value at design storm conveyance requirement, or actual design storm capacity

Table 3.2.6: Existing Crossing Performance – MNRF Criteria

Culvert ID	Structure		Vehicular Access	Max Overtopping Depth (m)	Provided Overtopping Depth (m)	Max Overtopping Velocity (m/s)	Provided Overtopping Velocity (m/s)	Maximum Product	Criteria Achieved?
	Type	Size (m)							
York Road	Concrete Box Culvert - Open Bottom	3.00 x 1.30	Passenger Vehicle	0.30	1.03	3	2.43	N/A	No
Reformatory Driveway	Concrete Arch Bridge	4.20 x 1.80	N/A	N/A	0.74	N/A	1.62	N/A	N/A
Parking Lot Driveway	Twin CSP Culvert	1.40	N/A	N/A	2.50	N/A	0.37	N/A	N/A

Notes: *Provided values are for Regulatory event (Regional Storm)

The results in Tables 3.2.5 and 3.2.6 indicate that the existing York Road crossing does not meet the applicable MTO and MNRF design criteria and is therefore considered for upgrade as part of the preferred alternative (ref. Section 7).

Hadati Creek

The HEC-2 hydraulic model of Hadati Creek (ref. Gamsby & Mannerow, 2003) was reviewed to determine the existing performance of the York Road culvert crossing of Hadati Creek. A 5.5 m by 1.7 m concrete box culvert conveys flows from the north side of York Road to the south side, where Hadati Creek joins into Clythe Creek. Based on the review of the HEC-2 model, the 5, 25, 100 and Regional Storm events were modelled in the 2003 study. A boundary condition of known water surface elevations was set at the downstream end of the HEC-2 model, and are noted to be in accordance with the boundary conditions set for the aforementioned HEC-RAS model developed for Clythe Creek.

As York Road is proposed to be classified as Urban Arterial, the applicable MTO criteria requires the existing culvert to convey the 50 year design storm without overtopping York Road. Although the HEC-2 model did not simulate the 50 year the design storm, the results of the 100 year design storm were provided. The results indicate that the 100 year design storm does not overtop York Road, therefore indicating that the 50 year design storm should not overtop as well.

As shown on Figure 3.2.7., the backwater condition produced by Eramosa River results in an overtopping of York Road at the Hadati Creek crossing during the Regional Storm event, with a flood depth of approximately 1.40 m. In order to reduce the flood depth to satisfy the cited ingress/egress criteria, the only solution would be to propose significant increases in the vertical profile of York Road. Given the impracticality of this solution, it is not recommended that this be advanced. Furthermore, it is understood that the City is not expecting the existing culvert to be improved to satisfy the applicable MTO and MNRF criteria. Reference Section 4.1.4 for the preferred alternative of the Hadati Creek culvert.

3.3 Water Quality

No specific water quality testing or field work has been conducted as part of the current EIS. It is not considered that additional sampling information would impact upon the likely mitigation strategy for the proposed roadway widening given the relatively minor contributing drainage area in this case. Water quality impacts associated with the proposed road widening will be addressed directly as part of the Environmental Design Study, specifically Stage 3 (Impact Assessment/Mitigation for Preferred Alternative) and the subsequent detailed stormwater management report. Longer term water quality monitoring as part of future works and detail design of York Road could include collecting baseline data along Clythe Creek both upstream and downstream of Hadati Creek, including the identification of the primary sources of sediment loading.

3.4 Fluvial Geomorphology

To fill gaps in the fluvial geomorphic understanding of the study area, a field program was completed with results outlined in detail in the Fluvial Geomorphic Existing Conditions and Design Options Report (Matrix, 2018) (ref. Appendix F). Site reconnaissance was performed on December 22, 2015 and May 2, 2016 by Matrix Solutions. Information gathered during the field activities provides qualitative and quantitative data regarding channel processes which are valuable in the development of functional channel designs. Note that additional data collection may be necessary to support the development of a detailed design.

3.4.1 Rapid Field Assessments

To further confirm and refine results of the desktop analyses, rapid field assessments (i.e., the Rapid Geomorphic Assessment (RGA) and Rapid Stream Assessment Technique RSAT) and additional field reconnaissance have been conducted to confirm the reach setting and the dominant geomorphic forces in the study watercourses. Four reaches were identified within the study area; three along Clythe Creek and one on Hadati Creek upstream from the confluence with Clythe Creek, as outlined in Section 2.5.2.

During this evaluation, areas of active channel adjustments (e.g., erosion, deposition) have been identified. Measurements of pool depth and average depth measurements to channel bed in the area of the in-stream weirs have been documented. An inventory of all weir structures was compiled and crossing assessments completed for all bridges and culverts. A photographic inventory containing geomorphic observations has been compiled in Appendix F.

In the study area Clythe Creek flows for approximately 950 m adjacent to the south-east side of York Road, between Industrial Avenue and Watson Parkway, before changing direction to flow south east to its confluence with the Eramosa River. The upstream reach (Reach 9) is delineated further into two distinct sub-reaches (C-9A and C-9B) based on overall channel gradient and cross section dimensions. The reach divide is located at the Historical Stone Arch Bridge that acts as the main entryway to the Former Guelph Correctional Facility.

Along C-9A, the bankfull channel is 2 – 3 m wide and 0.5 m deep. The gradient is low to moderate, and is controlled by a series of weir structures. Channel planform is sinuous and banks are protected with stone. Water within the channel at the time of survey was moderately turbid and multiple occurrences of water cress and cattails were observed. A groundwater-fed tributary enters the channel approximately 140 m upstream from the historic bridge. A pool-riffle morphology was not apparent, and only one riffle feature was observed immediately downstream from the York Road crossing.

Downstream from the historical stone arch bridge along C-9B, the bankfull channel width is 4 – 5 m wide at pinch points and widens to 15 – 18 m at ponded sections. Multiple channel branches, due to the introduction of aesthetic islands, contribute in some instances to the widened channel form. Bankfull depth was not identifiable. The channel is generally straight, with a low gradient and stone protection along the banks. Similar to upstream reach C9-A, multiple weir structures are present along with the occurrence of pedestrian bridges and culvert crossings. Beaver activity was also observed between the Industrial Ponds and the confluence with the Eramosa River.

Hadati Creek upstream from the Clythe Creek, confluence is partially channelized with the right bank lined with eroding cement cushions. Bank heights are approximately 1.5 to 2.0 m tall and are near vertical. At several locations along the outer meander bends the cement cushions are undermined. Bankfull width was measured at approximately 3.0 m and bankfull depth at 1.0 m. Bankfull measurements were determined by the height of exposed tree roots and an inflection in the exposed soil profile. At Beaumont Crescent, the channel becomes concrete lined as it flows through a box culvert. Upstream from Beaumont Crescent the channel is heavily entrenched within the roadside ditch with bank heights over 2.0 m and vertical. The exaggerated entrenchment of the channel upstream from Beaumont Crescent is likely a result of historical trenching. Approximately 120 m upstream from Beaumont Crescent, the main Hadati Creek Channel and a tributary converge.

Rapid Assessment Results

- Rapid Assessment results for each reach are summarized; the reaches of Clythe Creek are generally transitional or stressed and should be considered as moderately sensitive to future change in sediment or flow regimes. Field indicators of channel morphology are within the range of variance for streams of similar characteristics however there is frequent evidence of instability.
- Aggradation is the dominant geomorphic process contributing to instability, including evidence of embedded riffles, siltation in pools, deposition in the overbank zone, and poor sorting.
- Hadati Creek within the study area is considered to be in a transitional or stressed state with degradation as the dominant geomorphic process; undermined bank stabilization, knick-point formation, exposed bedrock, elevated outfalls, scour pools downstream from outfalls.
- The study reaches are considered to be in low to moderate overall health with limiting factors found relating to instream habitat, water quality, riparian conditions and biological indicators.

3.4.2 Clythe Creek Detailed Field Data Collection

In order to better quantify channel dynamics, a detailed field assessment of the Clythe Creek study reaches was completed. The field work follows standard geomorphic field protocols and included the total station survey of nine (9) bankfull cross-sections, a longitudinal profile survey from York Road to the Eramosa River confluence, characterization of the bed and banks, and documentation of any other features that may be affecting flow and sediment movement (i.e., weir structures, tributaries, stormwater outfalls).

Existing Bankfull Geometry

Five bankfull channel cross sections were surveyed within Reach C-9A between York Road and the main Reformatory entrance (Historical Stone Bridge). An additional four bankfull cross sections were surveyed within Reach C-9B between the Reformatory entrance and the confluence with Hadati Creek.

The typical cross-section for Reach C-9A (ref. Appendix F) depicts generally consistent bank heights and a U-shape channel bed. Due to the U-shape cross-section, the thalweg through the reach is typically located in the center of the channel. Bankfull channel width ranged from 3 to 4 m, with an average of 3.39 m. Bankfull hydraulic depths (i.e., average depth across the cross-section) varied between 0.29 and 0.42 m, averaging 0.36 m. The average maximum depth was 0.64 m. These recorded channel widths and depths form cross-sections with areas between 0.93 and 1.75 m^2 and an average width to depth ratio of 9.67.

The typical cross-section for Reach C-9B (ref. Appendix F) is drastically different from what is observed upstream. Bankfull channel widths range from 9 to 11 m, with an average of 10.19 m. Bankfull hydraulic depths varied between 0.31 and 0.53 m, averaging 0.44 m. The average maximum depth was 0.8 m. The recorded channel widths and depths form cross-sections with areas averaging 6 m^2 and an average width to depth ratio of 23.83.

Existing Channel Profile

The existing channel profile (ref. Figure 4.3 Appendix F) indicates that the gradient along through Reach C-9A from York Road to the Reformatory entrance is low to moderate, with an average slope of 0.012 m/m. Within Reach C-9B the gradient is low, with an average slope of 0.0049 m/m. Although the gradient throughout the reach is predominantly flat, several weir structures controlling the gradient are located within the upstream quarter of the Reach C-9B near the Reformatory entrance. A reverse gradient is observed within the reach upstream of the confluence with Hadati Creek, contributing to the observed standing water downstream from the pond outlet.

3.4.3 Interpretation of Fluvial Geomorphic Processes

From a fluvial geomorphological stand point, a natural watercourse is considered stable, and in a state of 'dynamic equilibrium', when flow and sediment supply are balanced and over time. Channel cross-sectional dimensions, planform and profile are maintained with no indicators of pronounced erosion or deposition. This stable state allows for minor adjustments to occur over long time periods (i.e., meander bend migration). The Lane Balance Equation (Lane, 1955) states that sediment load (Q_s) and size (D_{50}) should be proportional to water discharge (Q_w) and channel slope (S). By altering any one of these variables, the balance would shift and one or more of the other variables must compensate.

Anthropogenic influences, such as land-use changes and storm water management practices or the introduction of in-stream barriers such as weirs and dams, can alter the variables, disrupting the ability of the channel to balance flow and sediment supply, and shift the overall characterization of the channel from 'stable' to 'transitional' or 'in-adjustment'. Based on the geomorphic characterization assessment completed for Clythe Creek, a variety of disturbances were identified that have altered natural fluvial processes in the system. In particular, alterations in channel slope and discharge have resulted from the introduction of in-stream structures/barriers and changes in drainage patterns. It is possible that anthropogenic disturbances locally, such as slope and cross-sectional alterations (over widening), and within the greater watershed have resulted in changes to sediment load and size delivered to the creek. Overall, an imbalance between flow, slope, and sediment has pushed the channel to a transitional or stressed state that is adjusting to return to a state of dynamic equilibrium.

3.5 Fisheries and Aquatic Habitat

3.5.1 Field Investigations

The study area was examined by C. Portt on April 18, 2016, to observe spring conditions and, in particular, assess the potential for northern pike spawning. The study area was examined again on August 31 and September 1, 2016, to observe summer habitat conditions. Habitat conditions were observed and key locations were photographed.

3.5.2 Habitat Assessment

No northern pike spawning was observed during the April 18, 2016, site visit. It should be noted that the site visit was conducted later in the spring, after pike spawning would normally occur, due to the unusually cold spring weather in 2016. Patches of emergent macrophytes that could be used by spawning northern pike were present in the lower reaches of Clythe Creek, near the Eramosa River, however better quality spawning habitat is present in a number of locations in the flood plain along the south side of the Eramosa River (C. Portt has observed spawning pike at those locations). No habitat suitable for northern pike spawning was observed in the Reformatory ponds, in the reach of Clythe Creek that is parallel to York Road, or in Hadati Creek between Clythe Creek and Elizabeth Street.

3.5.3 Clythe Creek

Clythe Creek has been extensively modified through the study area, from the culvert that conveys it beneath York Road to its confluence with the Eramosa River. The modifications include a series of dams and weirs whose vertical drops are partial or complete barriers to upstream fish migration. From a fish habitat standpoint, the creek can be divided into two (2) sections with the break occurring at the road entrance into the York District Lands. Upstream from that entrance the channel dimensions appear appropriate to the flow, although the channel does appear to have been straightened and the banks are armoured with boulder and cobble along most of this reach. The substrate is varied, ranging from silt to cobble and boulder. There are numerous patches of watercress (*Nasturtium officinale*) along this reach which is typically indicative of groundwater discharge, A small (ditched) tributary enters this reach from the south. There was a small amount of flow in this tributary on September 1, 2016.

The existing culvert beneath York Road has natural substrate throughout and is not a barrier to upstream fish migration. There are six structures between the entrance to the York District Lands and the culvert beneath York Road that block or impede upstream fish migration. Three of these are rock structures that may be passable by some fish under some flow conditions. Two have vertical drops of 1 – 1.5 m and are considered to be complete barriers to upstream migration. One is a concrete and rock structure with a vertical drop of approximately 1 m and a perched pipe through the structure; it is also probably a complete barrier to upstream migration. Upstream of York Road, the first obstacle to fish passage is the Watson Road North crossing.

Downstream from the entrance to the York District Lands the channel has been widened to create a series of 'ponds' separated by dams/weirs that block or impede upstream fish migration. This landscaping, which included digging the two large ponds on the site, was initiated in the early 1930's (Guelph Correctional Centre, 2002). The result is a series wide, slow-moving sections with fine substrate and, in many locations, dense submergent aquatic vegetation. The banks are armoured with boulder and cobble and short sections of coarse substrate occur immediately downstream from the dams/weirs.

Moving upstream from the Eramosa River, the first concrete weir is located approximately 75 m downstream from the confluence of Hadati and Clythe Creeks. It may be possible for fish to move upstream via a second, more westerly channel although an abandoned culvert on that branch is also an impediment to upstream fish movement. On November 1, 2016, this weir was observed to be submerged and no longer a barrier to upstream fish migration, as a result of backwater conditions created by a downstream beaver dam that was constructed in the fall of 2016. The two (2) large corrugated steel pipes which convey Clythe Creek beneath the driveway to the former playing fields are not barriers to upstream fish migration.

There are four structures between the channel connecting Clythe Creek to the north pond and the entrance to the York District Lands. Two of these are concrete and stone structures that are probably passable by fish, at least during higher flows. One is a vertical stone and concrete structure approximately 0.8 m high with a perched pipe through it that passes low flows. This may be a complete barrier to upstream fish migration. The structure closest to the entrance is a concrete ramp with embedded stones that may by passable at high flows but is a barrier to upstream fish migration at low flows.

3.5.4 Hadati Creek

Immediately upstream from York Road, Hadati Creek flows in a constructed channel with straight banks armoured with stone and concrete. The channel is shallow with substrate ranging from sand to cobble to bedrock. No barriers to upstream fish migration were observed between York Road and Elizabeth Street. Cyprinids (minnows) and small sunfish (Lepomis spp.) were observed in a number of locations when this watercourse was examined on September 1, 2016.

3.5.5 North Reformatory Pond

The shoreline of the north pond is armoured with boulder and cobble, much like the landscaped portion of Clythe Creek. Submergent macrophytes are sparse and there is a narrow band of emergents along the shoreline in many places. The bottom of this pond is relatively flat with depths, determined by Trout Unlimited investigators, of between 2.5 m and 2.7 m (unpublished data provided by J. Imhoff, Trout Unlimited).

3.6 Terrestrial Ecology

Surveys (ref. Appendices H and I) have included a Vegetation Assessment including Ecological Land Classification (ELC) and a vegetation inventory, tree inventory and hazard assessment, breeding bird surveys, turtle surveys, Eastern Milksnake surveys, Significant Wildlife Habitat (SWH) screening, and Species at Risk (SAR) screening. Incidental wildlife observations will be recorded as part of all field surveys.

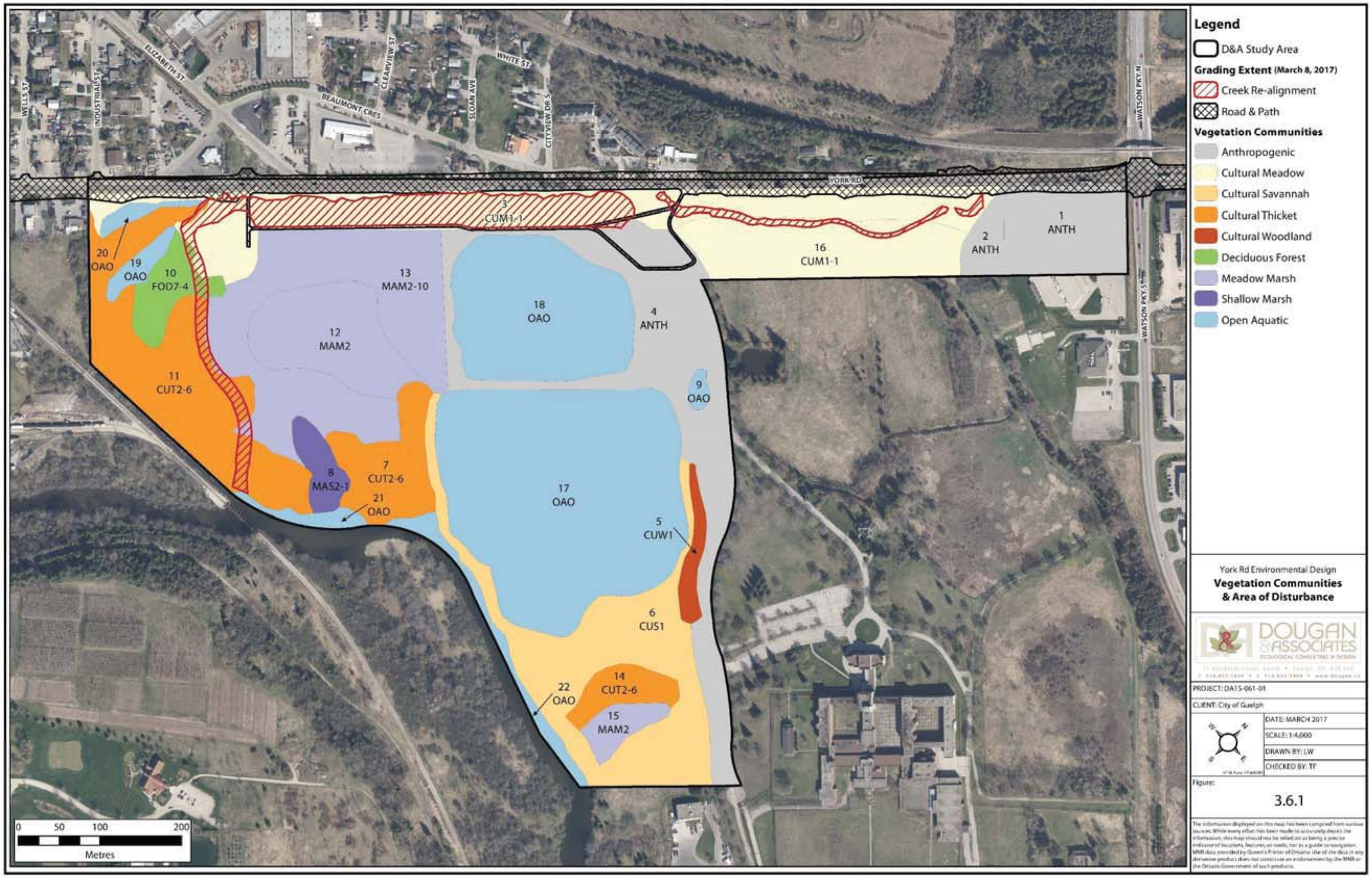
The following vegetation field surveys were completed within the YREDS study area, as well as the adjacent lands (to 120 metres from the study area boundary as per the PPS (2014)):

- Ecological Land Classification (ELC);
- Vegetation Inventory;
- Tree Inventory and hazard assessment;
- Species at Risk (SAR);
- Breeding bird surveys;
- Nocturnal Amphibian Surveys;
- Turtle surveys;
- Eastern Milksnake surveys;
- Significant Wildlife Habitat (SWH) screening;
- Species at Risk (SAR) screening; and
- Incidental wildlife.

3.6.1 Methods: Vegetation Resources

Ecological Land Classification (ELC)

The vegetation community survey was conducted within the lands shown on Figure 3.6.1. Ecological Land Classification for Southern Ontario (Lee et al, 1998) was utilized to characterize the landscape in order to develop an understanding of impacts to the natural heritage systems within the YREDS study area. No soil texture or moisture information was collected at the request of the landowners; therefore, soil texture and moisture regime was approximated based on visual assessment of the soils. ELC was previously completed for the YREDS study area in 2012 (NRSI 2012); this mapping served as a base for updates based on changes to the land cover, or where the previous mapping was insufficient. For an additional degree of accuracy in identifying ELC boundaries, soil testing would be required. ELC Community data observed in the field were mapped using ESRI ArcGISv10. Surveys were completed on May 12, 2016, June 17th, 2016, and August 8th, 2016 by Dougan & Associates. (Table 3.6.1).


Legend
D&A Study Area
Grading Extent (March 8, 2017)
Creek Re-alignment
Road & Path
Vegetation Communities
Anthropogenic
Cultural Meadow
Cultural Savannah
Cultural Thicket
Cultural Woodland
Deciduous Forest
Meadow Marsh
Shallow Marsh
Open Aquatic
1 ANTH
2 ANTH
3 CUM1-1
4 ANTH
5 CUW1
6 CUS1
7 CUT2-6
8 MAS2-1
9 OAO
10 FOD7-4
11 CUT2-6
12 MAM2
13 MAM2-10
14 CUT2-6
15 MAM2
16 CUM1-1
17 OAO
18 OAO
19 OAO
20 OAO
21 OAO
22 OAO
WELLS ST
INDUSTRIAL ST
ELIZABETH ST
BEAUMONT CRES
CLEARVIEW ST
SLOAN AVE
WHITE ST
CITYVIEW DR S
YORK RD
WATSON PKY N
WATSON PKY S
0 50 100 200
Metres
York Rd Environmental Design
Vegetation Communities
& Area of Disturbance
DOUGAN & ASSOCIATES
PROJECT: DA15-061-01
CLIENT: City of Guelph
DATE: MARCH 2017
SCALE: 1:4,000
DRAWN BY: LW
CHECKED BY: TF
Figure:
3.6.1

Vegetation Inventory

A survey of the dominant flora was conducted in each vegetation community polygon within the YREDS study area. Surveys took place on May 12, 2016, June 17th, 2016, and August 8th, 2016, Incidental wildlife observations were also noted on these dates. The data were corroborated with current status lists applied to identify species of significant conservation status. The data from NRSI (2012) were also incorporated to provide a comprehensive list of species for the YREDS study area. All nomenclature is based on the Natural Heritage Information Centre's list of species for Ontario (NHIC 2016).

Tree Inventory and Hazard Assessment

An inventory and assessment of all potentially impacted trees of 10cm DBH (diameter at breast height) or larger was conducted within the area shown on Figure 3.6.2. Surveys were conducted on June 14th, 2016 and June 17th by an ISA certified Arborist (Table 3.6.2).

Trees were assessed for species, size, structural condition and biological health. Tree location data were collected using a Trimble GeoXH unit to facilitate data collection. In optimal conditions this hand-held global positioning system (GPS) provides real-time sub-meter accuracy of tree locations. Data collection was combined with tree tagging using a metal forestry tag to allow for effective future identification of each tree.

Once GPS data had been recorded, each tree was identified, assessed for biological and structural health, assigned a preservation priority value and its size including DBH, height, and crown reserve were recorded.

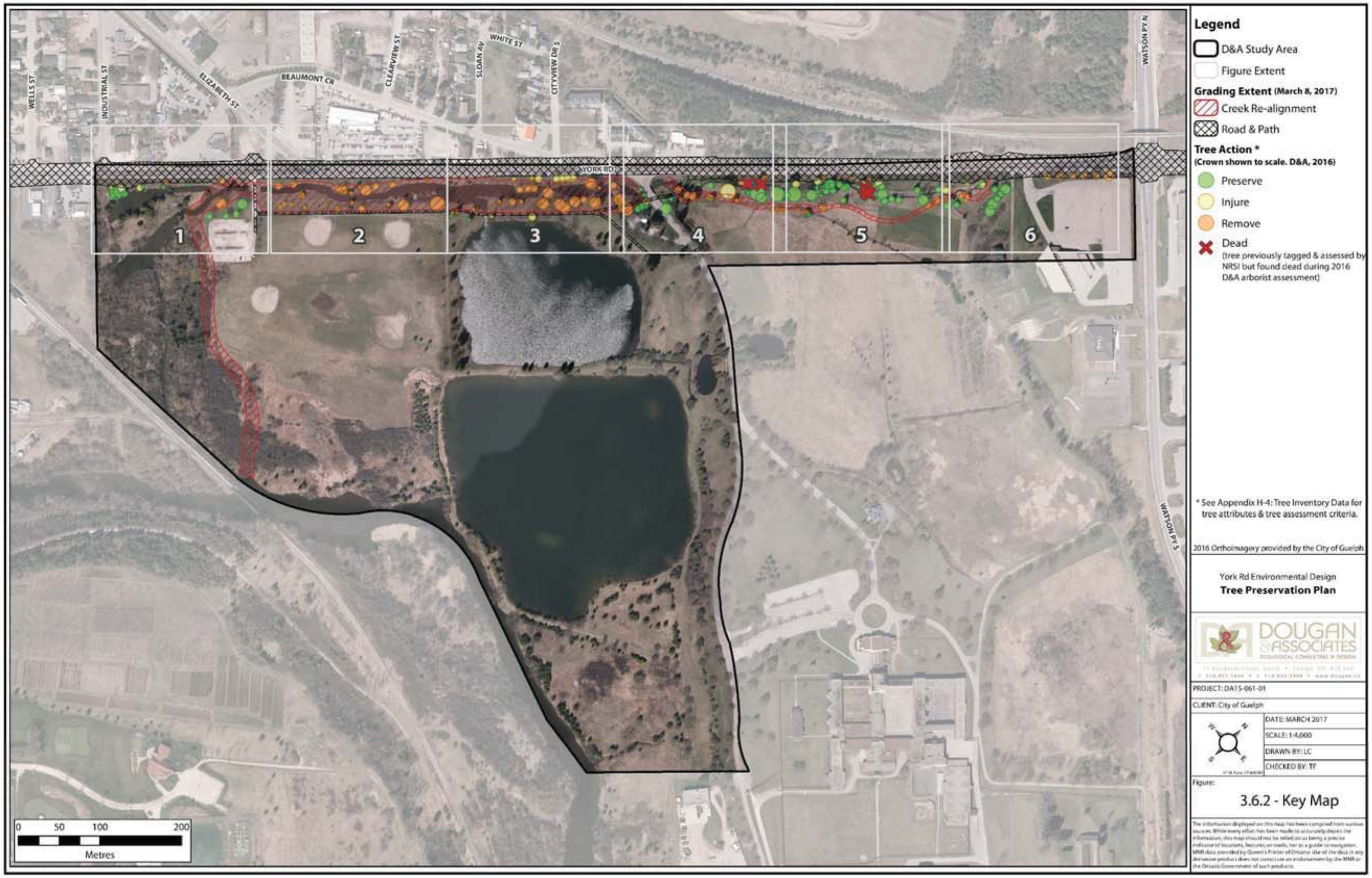
Vegetation Species at Risk (SAR)

During the flora surveys, the habitats present were assessed as to its suitability to Species-at-Risk (SAR) vegetation and wildlife species that may be present in the area. A short-list of potential SAR species was generated during the background review. For each of these species, the study was assessed as to the likelihood of that species occurring, whether presently or in the future.

3.6.2 Methods: Wildlife Resources

Breeding Bird Surveys

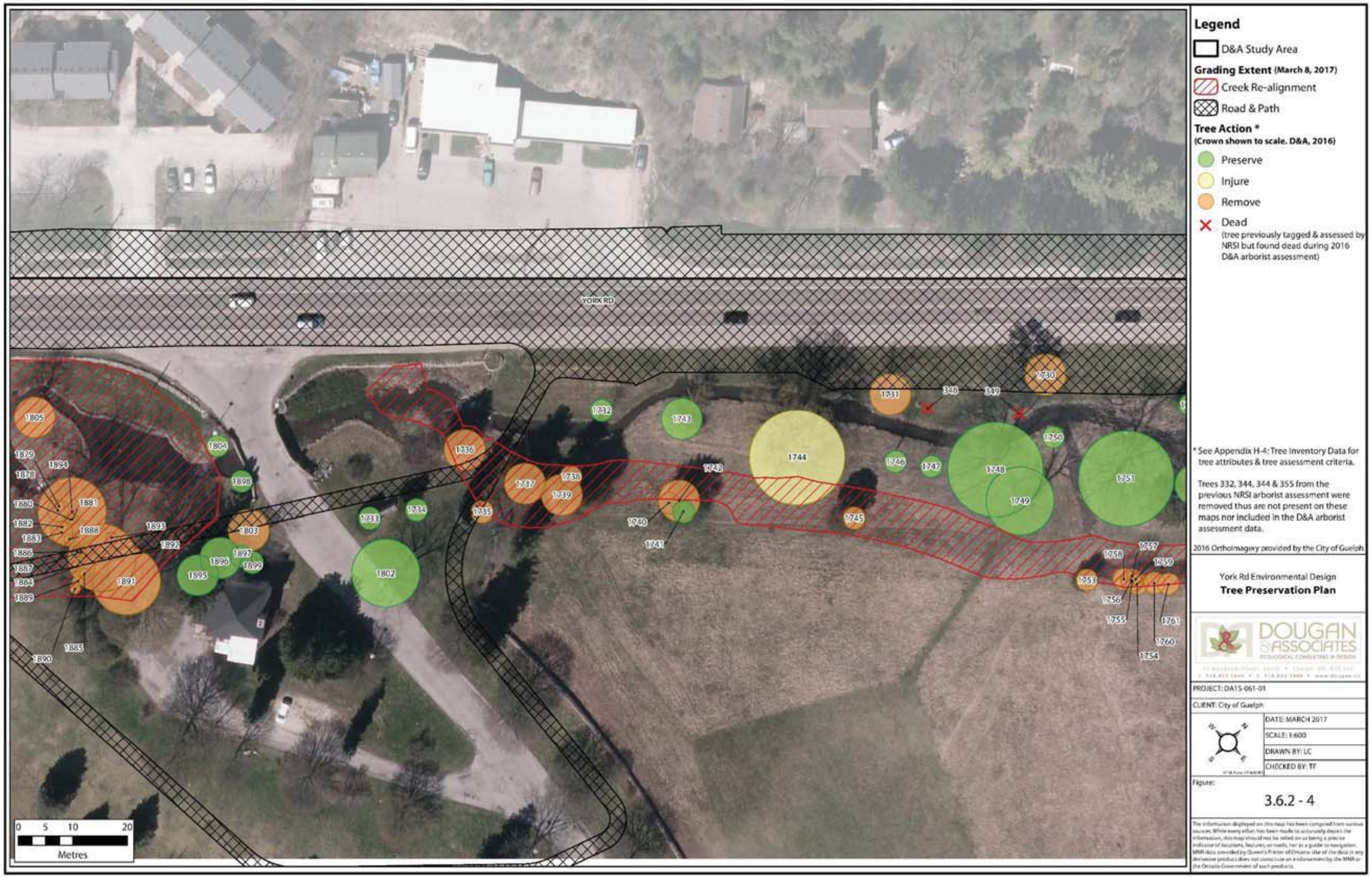
Two breeding bird surveys were conducted on June 3 and June 17, 2016, following the protocols outlined by the Ontario Breeding Bird Atlas (OBBA 2001). This protocol stipulates that the surveys be conducted between sunrise and 10:00 a.m., between May 24 and July 12, during appropriate weather conditions (i.e., light winds, no heavy rains).


WELLS ST
INDUSTRIAL ST
ELIZABETH ST
BEAUMONT CR
CLEARVIEW ST
SLOAN AV
WHITE ST
CITYVIEW DR S
YORK RD
WATSON PY N
WATSON PY S
1
2
3
4
5
6
0
50
100
200
Metres
Legend
D&A Study Area
Figure Extent
Grading Extent (March 8, 2017)
Creek Re-alignment
Road & Path
Tree Action *
(Crown shown to scale. D&A, 2016)
Preserve
Injure
Remove
Dead
(tree previously tagged & assessed by NRSI but found dead during 2016 D&A arborist assessment)
* See Appendix H-4: Tree Inventory Data for tree attributes & tree assessment criteria.
2016 Orthoimagery provided by the City of Guelph
York Rd Environmental Design
Tree Preservation Plan
DOUGAN & ASSOCIATES
PROJECT: DA15-061-01
CLIENT: City of Guelph
DATE: MARCH 2017
SCALE: 1:4,000
DRAWN BY: LC
CHECKED BY: TF
Figure:
3.6.2 - Key Map


Legend
D&A Study Area
Grading Extent (March 8, 2017)
Creek Re-alignment
Road & Path
Tree Action *
(Crown shown to scale. D&A, 2016)
Preserve
Injure
Remove
Dead
(tree previously tagged & assessed by NRSI but found dead during 2016 D&A arborist assessment)
* See Appendix H-4: Tree Inventory Data for tree attributes & tree assessment criteria.
Trees 332, 344, 344 & 355 from the previous NRSI arborist assessment were removed thus are not present on these maps nor included in the D&A arborist assessment data.
2016 Orthoimagery provided by the City of Guelph
York Rd Environmental Design
Tree Preservation Plan
DOUGAN & ASSOCIATES
PROJECT: DA15-061-01
CLIENT: City of Guelph
DATE: MARCH 2017
SCALE: 1:600
DRAWN BY: LC
CHECKED BY: TF
Figure:
3.6.2 - 1
INDUSTRIAL ST
BEAUMONT CR
ELIZABETH ST
YORK RD
1688
1687
1689
1694
1692
1693
1691
1690
1695
1696
1697
1698
1699
1700
1900
1830
1831
1832
1833
1834
1835
0
5
10
20
Metres

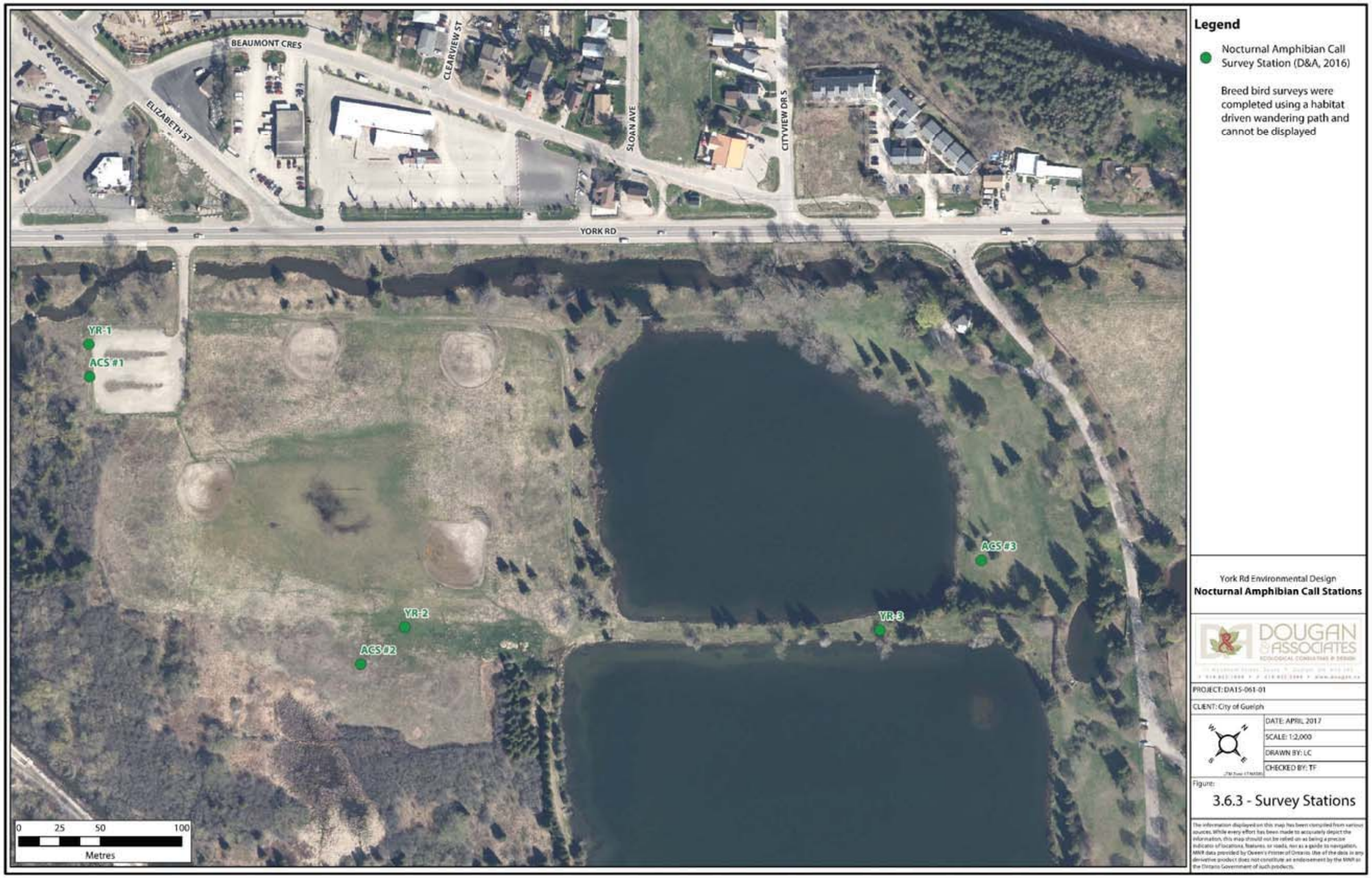

ELIZABETH ST
YORK RD
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
0 5 10 20
Metres
Legend
D&A Study Area
Grading Extent (March 8, 2017)
Creek Re-alignment
Road & Path
Tree Action *
(Crown shown to scale. D&A, 2016)
Remove
Dead
(tree previously tagged & assessed by NRSI but found dead during 2016 D&A arborist assessment)
* See Appendix H-4: Tree Inventory Data for tree attributes & tree assessment criteria.
Trees 332, 344, 344 & 355 from the previous NRSI arborist assessment were removed thus are not present on these maps nor included in the D&A arborist assessment data.
2016 Orthoimagery provided by the City of Guelph
York Rd Environmental Design
Tree Preservation Plan
DOUGAN & ASSOCIATES
PROJECT: DA15-061-01
CLIENT: City of Guelph
DATE: MARCH 2017
SCALE: 1:600
DRAWN BY: LC
CHECKED BY: TF
Figure:
3.6.2 - 2


Legend
D&A Study Area
Grading Extent (March 8, 2017)
Creek Re-alignment
Road & Path
Tree Action *
(Crown shown to scale. D&A, 2016)
Preserve
Injure
Remove
Dead
(tree previously tagged & assessed by NRSI but found dead during 2016 D&A arborist assessment)
* See Appendix H-4: Tree Inventory Data for tree attributes & tree assessment criteria.
Trees 332, 344, 344 & 355 from the previous NRSI arborist assessment were removed thus are not present on these maps nor included in the D&A arborist assessment data.
2016 Orthoimagery provided by the City of Guelph
York Rd Environmental Design
Tree Preservation Plan
DOUGAN & ASSOCIATES
PROJECT: DA15-061-01
CLIENT: City of Guelph
DATE: MARCH 2017
SCALE: 1:600
DRAWN BY: LC
CHECKED BY: TF
Figure:
3.6.2 - 3
SLOAN AV
BEAUMONT CR
CITYVIEW DR S
YORK RD
0 5 10 20
Metres


Legend
D&A Study Area
Grading Extent (March 8, 2017)
Creek Re-alignment
Road & Path
Tree Action *
(Crown shown to scale. D&A, 2016)
Preserve
Injure
Remove
Dead
(tree previously tagged & assessed by NRSI but found dead during 2016 D&A arborist assessment)
* See Appendix H-4: Tree Inventory Data for tree attributes & tree assessment criteria.
Trees 332, 344, 344 & 355 from the previous NRSI arborist assessment were removed thus are not present on these maps nor included in the D&A arborist assessment data.
2016 Orthoimagery provided by the City of Guelph
York Rd Environmental Design
Tree Preservation Plan
DOUGAN & ASSOCIATES
PROJECT: DA15-061-01
CLIENT: City of Guelph
DATE: MARCH 2017
SCALE: 1:600
DRAWN BY: LC
CHECKED BY: TF
Figure:
3.6.2 - 4
YORK RD
0 5 10 20
Metres


Legend
D&A Study Area
Grading Extent (March 8, 2017)
Creek Re-alignment
Road & Path
Tree Action *
(Crown shown to scale. D&A, 2016)
Preserve
Injure
Remove
Dead
(tree previously tagged & assessed by NRSI but found dead during 2016 D&A arborist assessment)
* See Appendix H-4: Tree Inventory Data for tree attributes & tree assessment criteria.
Trees 332, 344, 344 & 355 from the previous NRSI arborist assessment were removed thus are not present on these maps nor included in the D&A arborist assessment data.
2016 Orthoimagery provided by the City of Guelph
York Rd Environmental Design
Tree Preservation Plan
DOUGAN & ASSOCIATES
PROJECT: DA15-061-01
CLIENT: City of Guelph
DATE: MARCH 2017
SCALE: 1:600
DRAWN BY: LC
CHECKED BY: TF
Figure:
3.6.2 - 5
0 5 10 20
Metres
YORK RD


Legend
D&A Study Area
Grading Extent (March 8, 2017)
Creek Re-alignment
Road & Path
Tree Action *
(Crown shown to scale. D&A, 2016)
Preserve
Injure
Remove
Dead
(tree previously tagged & assessed by NRSI but found dead during 2016 D&A arborist assessment)
* See Appendix H-4: Tree Inventory Data for tree attributes & tree assessment criteria.
Trees 332, 344, 344 & 355 from the previous NRSI arborist assessment were removed thus are not present on these maps nor included in the D&A arborist assessment data.
2016 Orthoimagery provided by the City of Guelph
York Rd Environmental Design
Tree Preservation Plan
DOUGAN & ASSOCIATES
ECOLOGICAL CONSULTING & DESIGN
PROJECT: DA15-061-01
CLIENT: City of Guelph
DATE: MARCH 2017
SCALE: 1:600
DRAWN BY: LC
CHECKED BY: TF
Figure:
3.6.2 - 6
YORK RD
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
0 5 10 20
Metres


Legend
Nocturnal Amphibian Call Survey Station (D&A, 2016)
Breed bird surveys were completed using a habitat driven wandering path and cannot be displayed
BEAUMONT CRES
CLEARVIEW ST
ELIZABETH ST
SLOAN AVE
CITYVIEW DR S
YORK RD
YR-1
ACS #1
YR-2
ACS #2
YR-3
ACS #3
0 25 50 100
Metres
York Rd Environmental Design
Nocturnal Amphibian Call Stations
DOUGAN & ASSOCIATES
PROJECT: DA15-061-01
CLIENT: City of Guelph
DATE: APRIL 2017
SCALE: 1:2,000
DRAWN BY: LC
CHECKED BY: TF
Figure:
3.6.3 - Survey Stations

Nocturnal Amphibian Surveys

Three nocturnal amphibian surveys were conducted on April 21, May 9, and June 21, 2016, following protocols outlined by the Ontario Marsh Monitoring Program (BSC 2003). These protocols stipulate that surveys take place from April 15 – 30, May 15 – 31, and June 15 – 30, from sunset until midnight, with temperatures of at least 5 °C, 10 °C, and 17 °C, respectively. Three point count stations were established within the YREDS study area (Table 3.6.1).

Table 3.6.1: Point Count Station Locations

Point Count Station	Easting	Northing
1	563101.00 m E	4822695.00 m N
2	563343.00 m E	4822688.00 m N
3	563567.00 m E	4823002.00 m N

Turtle Surveys

Basking turtle surveys were undertaken on May 3, May 20, and June 17, 2016. Surveys were conducted during warm sunny weather, and involved scanning all rocks, floating logs, and shoreline within the two main ponds and also along Clythe Creek for the presence of basking turtles. During other surveys, such as ELC and breeding bird surveys, these searches were also undertaken although the weather and timing may have not been as ideal. High quality optics were used to search for turtles and the location, number, and species sighted were noted. In addition, suitable areas for nesting (i.e., exposed areas of sand or gravel with a southerly aspect) were searched for, especially in areas adjacent to Clythe Creek and York Road. York Road was walked during all wildlife surveys to check for the presence of dead or injured turtles.

Eastern Milksnake Surveys

Three Milksnake surveys were conducted on the subject lands on May 3, May 20, and June 17, 2016, during warm and sunny weather, and after mid-morning to ensure that any snakes present would be active. The dates of the surveys coincided with the peak activity period of this species, which is generally late April to late June in southern Ontario. The methodology followed draft protocols provided by the Guelph District OMNR, dated June 2013 (OMNR 2013). The methodology parameters, as per the protocol, were as follows:

- Active hand searches were conducted over the entire site, with all objects (where possible) such as rocks, logs, and other cover, turned over and replaced;
- Careful attention was paid to areas on the property such as forest edges, compost, rock and woody debris piles, old foundations, and exposed bedrock fractures;
- Surveys were conducted between early May and mid-June;
- All surveys occurred on sunny days, with air temperatures between 8°C and 25°C (when overcast, with temperatures above 15 °C);
- Three surveys (minimum number required under protocol) were conducted, with the surveys separated by at least 14 days.

Artificial cover boards were not utilized as the protocol stipulates against it unless they can be placed at least two or three years ahead (if placed for less time, negative results are considered inconclusive).

Significant Wildlife Habitat (SWH) Screening

During all field investigations, habitats on site were screened against the Significant Wildlife Habitat (SWH) categories contained within the *Significant Wildlife Habitat Technical Guide* (OMNR 2000) and the *Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E* (OMNRF 2015) (Appendix I-2).

Species at Risk (SAR) Screening

A screening of all known wildlife Species at Risk (SAR) that have been known to occur in the City of Guelph through 2015 was undertaken; the list was obtained from the Guelph District MNRF office. The known habitats for these wildlife species were screened against the habitats contained within the subject lands, based on 2016 field investigations, with the likelihood of their presence being indicated. The full screening is presented as Appendix H-2.

Table 3.6.2. Summary of Wildlife Survey Visits in w016 to the Study Area

Date (2016)	Observer	Time	Weather Conditions	Purpose
April 21	Zack Harris, Heather Schibli	20:44 – 21:18	Cloudy, calm, 11 – 14 °C	Nocturnal Amphibian Survey #1
May 3	Ian Richards	10:00 – 15:00	Clear to partly cloudy, calm, 9 – 14 °C	Snake & Turtle Survey #1
May 9	Zack Harris, Heather Schibli	21:13 – 21:45	Partly cloudy, calm, 9 – 11 °C	Nocturnal Amphibian Survey #2
May 12	Zack Harris	09:00 – 16:30	Clear, calm, 12-24°C	Ecological Land Classification and Vegetation Inventory, Incidental Wildlife Observations
May 20	Ian Richards	10:30 – 15:30	Partly cloudy, light north winds, 18 – 20 °C	Snake & Turtle Survey #2
June 3	Ian Richards	06:15 – 09:45	Clear, calm, 14 – 19 °C	Breeding Bird Survey #1
June 14	Zack Harris, Kristen Beauchamp	08:30 – 17:00	Clear, calm, 16 – 22 °C	Tree Inventory
June 17	Ian Richards	06:30 – 10:30	Clear, calm, 17 – 20 °C	Breeding Bird Survey #2 and Turtle & Snake Survey #3
June 17	Zack Harris	08:30 – 13:00	Clear to partly cloudy, calm, 20 - 29°C	Tree Inventory, Ecological Land Classification and Vegetation Inventory, Incidental Wildlife Observations
June 21	Zack Harris	21:47 – 22:16	Partly cloudy, calm, 21 °C	Nocturnal Amphibian Survey #3
August 8	Zack Harris	12-00 – 17:00	Clear, slight wind, 25 - 28°C	Ecological Land Classification and Vegetation Inventory, Incidental Wildlife Observations

Incidental Wildlife

No surveys were conducted for other wildlife groups, such as mammals and insects. Any sightings of these groups were done on an incidental basis during all other surveys.

3.6.3 Findings: Vegetation Resources

Ecological Land Classification (ELC)

A total of 21 vegetation community polygons were mapped for the YREDS study area, as shown on Figure 3.6.1. These polygons are comprised of 10 different ELC vegetation types or ecosites, which are described below. A complete list of the vascular plants observed within each polygon, including previous studies by NRSI (2012) and Stantec (2006) is provided in Appendix H-3.

No soils information was collected at the request of the landowner; therefore, the identification of wetland vegetation communities was based on whether or not the relative abundance of wetland indicator species was greater than 50%. Visual assessment of the soil surface throughout the YREDS study area, other than the upland landscaped areas (polygon 4), suggest that the soils were rich with organics, and contained a moderate sand component. The YREDS study area is located in an area that is typically Till Plain with Drumlins surrounded by Spillway (Chapman and Putman, 1984). Based on the Soil Survey of Wellington County Ontario, the soils are Burford Loam which tend to be “well drained soils consisting of loam surface horizons on gravel deposits” (Hoffman et al. 1963).

Anthropogenic (ANTH)

Anthropogenic areas include 3 polygons (1, 2, and 4) and account for 6.71 ha of the YREDS study area. Polygons 1 and 2 are located within the northwestern portion of the YREDS study area near the intersection of Watson Road and York Road (Figure 3.6.1), and polygon 4 is located within the central portion of the study are and surrounds several large ponds (polygons 17 and 18). All anthropogenic areas are dominated by mowed grass, with scattered, mostly planted, trees and shrubs. Tree species included Norway Maple (*Acer platanoides*), Silver Maple (*Acer saccharinum*), Norway Spruce (*Picea abies*), White Spruce (*Picea glauca*), Red Pine (*Pinus resinosa*), Eastern White Pine (*Pinus strobus*), and Scotch Pine (*Pinus sylvestris*). Occasional shrubs include Common Buckthorn (*Rhamnus cathartica*), Red osier Dogwood (*Cornus stolonifera*), Serviceberry (*Amelanchier* species), Rugosa Rose (*Rosa rugosa*), and Ground Juniper (*Juniperus communis*). The ground cover is dominated by lawn grasses, with scattered Dandelion (*Taraxacum officinale*) and Common Plantain (*Plantago major*). These areas were previously mapped as Landscaped Areas by NRSI (2012).

Buckthorn Cultural Thicket Type (CUT2-6)

Polygons 7, 11, and 14 are located along the north shore of the Eramosa River (ref. Figure 3.6.1), and consist of Buckthorn Cultural Thicket. Combined, these polygons make up 5.77 ha of the YREDS study area. Most of these polygons are a near monoculture of Common Buckthorn, but also contained other exotic and invasive shrubs such as European Privet (*Ligustrum vulgare*) and Glossy Buckthorn (*Frangula alnus*) to the exclusion of other trees, shrubs, and ground cover species. As a result of these species and historic disturbance, these polygons were generally low in diversity ranging from 55% - 60% native species. Mature tree cover was low, and was mostly restricted to Manitoba Maple (*Acer negundo*) and exotic tree willows (e.g. *Salix x fragilis*) along the Eramosa River and small plantations of spruce (*Picea* spp). Groundcover composition within drier areas of these polygons was general low, with Yellow Avens (*Geum aleppicum*), Dame’s Rocket (*Hesperis matronalis*), Braod-leaved Enchanter’s Nightshade (*Circaea canadensis*), and Creeping Buttercup (*Ranunculus acris*).

These polygons also contained pockets of Broadleaved Sedge Mineral Meadow Marsh (MAM2-6), which tended to have the highest native species diversity, including wetland species such as Eastern White Cedar, Lake Sedge (*Carex lacustris*), White Turtlehead (*Chelone galbra*), Spotted Joe Pye Weed (*Eutrochium maculatum var maculatum*), Stinging Nettle (*Urtica dioica* s.l), and Blue Vervain (*Verbena hastata*).

Note: Soils information was not collected as instructed by the landowners. ELC communities were determined through referencing previous studies and the vegetative response to the moisture and edaphic factors of the site. For greater accuracy in identifying ELC boundaries, soil testing would be required.

Dry-Moist Old Field Meadow Type (CUM1-1)

Polygons 3 and 16 are located along the northwestern edge of the YREDS study area, make up approximately 7.34 ha of the study area (ref. Figure 3.6.1). Polygon 16, being slightly up gradient from Clythe Creek, was drier and less diverse than polygon 3 which contained moist pockets of Forb Mineral Meadow Marsh (MAM2-10) throughout riparian areas. The vegetation within polygon 16 was typical of old field conditions, and included species such as Orchard Grass (Dactylis glomerata), Queen Anne's Lace (Daucus carota), Goldenrod (Solidago altissima ssp. altissima and S. canadensis), Canary Reed Grass (Phalaris arundinacea), and Common Mullen (Verbascum thapsus). There was little tree cover within polygon 16 except for the occasional spruce (Picea sp.) along a small channel and tributary flowing into Clythe Creek. This channel did contain some wetland and aquatic species, including Watercress (Nasturtium officinale) and Great Angelica (Angelica atropurpurea).

The vegetation community within polygon 3 is similar to polygon 16 in dry areas. However, the low-lying meadow marsh riparian areas along Clythe Creek contain a variety of wetland and aquatic species, including Watercress, sedges (Carex bebbii, C. flava, C. stipata, C. stricta, and C. vulpenoidea), Bulb-bearing Water-hemlock (Cicuta bulbifera), Spotted Water-hemlock (C. maculata), Hairy Willowherb (Epilobium hirsutum), Spotted Joe Pye Weed, Marsh Bedstraw (Galium palustre), Harlequin Blue Flag (Iris versicolor), Mannagrass (Glyceria striata and G. grandis), and Soft Rush (Juncus effusus). Tree and shrub cover is low overall (<25%) within polygon 3, however some areas contained small but dense stands of Eastern Red Cedar, and Red Osier Dogwood lined the banks of Clythe Creek in some areas. Most trees are assumed to be planted, and included Silver Maple, Norway Maple, and Eastern Red Cedar.

Note: Soils information was not collected as instructed by the landowners. ELC communities were determined through referencing previous studies and the vegetative response to the moisture and edaphic factors of the site. For greater accuracy in identifying ELC boundaries, soil testing would be required

Cattail Mineral Shallow Marsh Type (MAS2-1)

Polygon 8 is a small (0.46 ha) Cattail Mineral Meadow Marsh located along the Eramosa River in the southern portion of the YREDS study area (ref. Figure 3.6.1). This polygon contained is dominated by Broad-leaved Cattail (*Typha latifolia*),but contained forbs such as Canada Anemone (*Anemone canadensis*), Bulb-bearing Water-hemlock, Stinging Nettle, as well as Lake Sedge. Shrubs such as willows (*Salix discolor, S. eriocephala*), Nannyberry (*Viburnum lentago*), and Red-osier Dogwood were uncommon and mostly along the edge. At the southern portion of polygon 8, a small inclusion of Reed-canary Grass Mineral Meadow Marsh (MAM2-2) inclusion borders the Eramosa River. Several small drainage features flowed from this area into the Eramosa, and were dry by the June 17th, 2016 visit.

Fresh-Moist Lowland Deciduous Forest Type (FOD7-4)

This 0.71 ha forest is located in the south western portion of the YREDS study area (ref. polygon 10; Figure 3.6.1). This feature is defined by a canopy of Crack Willow (*Salix x fragilis*) and Manitoba Maple with an understory and shrub layer of Glossy and Common Buckthorn, Riverbank Grape (*Vitis riparia*), and Red-osier Dogwood. Herbaceous species included Spotted Jewelweed (*Impatiens capensis*), Ostrich Fern (*Matteuccia struthiopteris*), and Stinging Nettle (*Urtica dioica* s.l.), and Panicled Aster (*Symphyotrichum lanceolatum ssp lanceolatum*). This feature contains the lower portion of Clythe Creek as it flows from polygon 19 into the Eramosa River.

Note: Soils information was not collected as instructed by the landowners. ELC communities were determined through referencing previous studies and the vegetative response to the moisture and edaphic factors of the site. For greater accuracy in identifying ELC boundaries, soil testing would be required.

Forb Mineral Meadow Marsh Type (MAM2-10)

Polygon 13, a 4.35ha Forb Mineral Meadow Marsh, has regenerated from former parkland, including portions of old baseball diamonds. The inner portions of this feature were flooded to a depth of 5-10cm in some areas in early spring. The vegetation is abundant with wetland species such as Canada Anemone, Late Goldenrod (*Solidago gigantea*), Field Mint (*Mentha arvensis*), Northern Rough-leaved Goldenrod (*Solidago rugosa var. rugosa*), Swamp Aster (*Symphyotrichum puniceum*), Fox Sedge , Bebb's Sedge, Dark-green Bulrush (*Scirpus atrovirens*), and Spotted Joe Pye Weed. Few trees are present, though Peach-leaved Willow (*Salix amygdaloides*), Balsam Poplar (*Populus balsamifera*), and Red-osier Dogwood are beginning to establish. A small watercourse through polygon 2 indicates that the hydrology of this feature is most likely driven by season flooding of the large southern pond, polygon 17. Given the state of this feature during the dry conditions in 2016, it is likely that this feature will continue to succeed to a shallow meadow marsh community in the future.

Mineral Cultural Savannah Ecosite (CUS1)

This community type was found within polygon 6, a 3.53ha polygon located in the eastern portion of the YREDS study area. A sparse canopy of scattered Northern White Cedar and Spruce species define this community. Shrub species included Glossy Buckthorn, Choke Cherry (*Prunus virginiana*), Common Bukjthorn, Staghorn Sumac (*Rhus typhina*), and young American Elm (*Ulmus americana*). Groundcover species included White Sweet Clover (*Melilotus alba*), Common Evening Primrose (*Oenothera biennis*), Goldenrod , and Queen Anne's Lace . In moist areas, Canada Anemone, Blue Vervain, Bebb's Sedge, and Reed Canary Grass were also present.

Mineral Cultural Woodland Ecosite (CUW1)

A narrow patch of Mineral Cultural Woodland approximately 0.33 ha in size extends along a slope bordering the north east end of the large south pond (polygon 17). This feature contains elements of a small Northern White Cedar hedgerow, and a canopy of American Elm, Black Cherry (*Prunus serotina*), European Mountain-ash, Scotch Pine (*Pinus sylvestris*), Downy Serviceberry (*Amelanchier arborea*) and Dotted Hawthorn (*Crataegus punctata*). The shrub layer is mostly exotic, and included Tatarian Honeysuckle (*Lonicera tatarica*), Wayfaring-tree (*Viburnum lantata*), Common Buckthorn, and Common Lilac (*Syringa vulgaris*), as well as Chokecherry and Red Raspberry (*Rubus idaeus*). Due to the dense canopy cover, herbaceous groundcover was sparse, and included Common Dandelion, avens species, Broad-leaved Enchanter's Nightshade, and goldenrod species along the edge.

Mineral Meadow Marsh Ecosite (MAM2)

Mineral Meadow Marsh Ecosite was present in two locations; polygons 12 (1.94ha) and 15 (0.63ha) (Figure 3.6.1). Like polygon 13, polygon 12 has regenerated from abandoned baseball diamonds, and was flooded in 2016 until late spring. The most abundant groundcover species were Creeping Bentgrass (*Agrostis stolonifera*), Many-headed Sedge (*Carex synchocephala*), spikerush species (*Eleocharis* sp.), True Forget-me-not (*Impatiens capensis*), and Mints (*Mentha arvensis, M. spicata, M. x piperita*), and occasional patches of Retrorse Sedge (*Carex retrorsa*) and Fox Sedge. No tree or shrub species have established yet. As with polygon 13, the hydrology of this feature is driven by the flooding of polygon 17, and will likely continue succeeding from an anthropogenic community to a wetland.

Open Aquatic Community Series (OAO)

Two large (polygon 17, 7.43ha; polygon 18, 3.45ha) and three small artificial ponds (polygon 9, 0.10ha; polygon 19, 0.26ha; polygon 20, 0.17ha; Figure 3.6.1)) occur within the YREDS study area. Polygons 17 and 18 contained very low cover of submergent, floating, or emergent vegetation except for along the ponds edges, whereas polygons 9, 19, and 20 had more substantial cover throughout. Aquatic species included Curly-leaved Pondweed (*Potamogeton crispus*), Broad-leaved Arrowhead (*Sagittaria latifolia*), Eurasian Watermilfoil (*Myriophyllum spicatum*), and Fragrant Waterlily (*Nyphaea odorata ssp. odorata*). The ponds were bordered by vegetation typical of the surrounding polygons, including Crack Willow, Manitoba Maple, Northern White Cedar, and Red-osier Dogwood.

Vegetation Inventory

A complete list of vascular plants observed within the YREDS study area is provided in Appendix H, including species listed in NRSI (2012). A total of 285 vascular plants have been observed to-date including the two previous studies by NRSI (2012) and Stantec (2006), though some of the species listed in these reports may have occurred outside of the YREDS study area. A total of 251 species, including 145 (58%) native species were observed in the study area in 2016. No species with Species at Risk status in Ontario were observed, though Downy Serviceberry (*Amelanchier arborea*), Red Fescue (*Festuca rubra ssp. rubra*), Rough Aven's (*Geum laciniatum*), and Hairy Solomon's Seal (*Polygonatum pubescens*) are considered rare in Wellington County (Appendix H-3). Furthermore, Rough Avens, Variegated Horsetail (*Equisetum variegatum*), and Many-headed Sedge (*Carex synchnocephala*) are considered significant in Wellington County (ref. Appendix H-3). Only one species noted in the background studies, Prairie Willow (*Salix humilis*), was observed within the YREDS study area. This species is not considered provincially or regionally rare in Wellington County (Frank and Anderson 2009), but is rare throughout much of south central and south western Ontario. Of the six species with local significance, (Table 3.6.3) three have the potential to be impacted. Rough Aven's were recorded near the watercourse in polygon 3 as well as in polygon 11 and will likely be removed when the creek is relocated. Red Fescue and Hairy Solomon's Seal were recorded in the Meadow Marsh (polygon 13) and may be impacted by the footprint of the proposed watercourse.

Table 3.6.3: Locally Significant Species Habitat

Common Name	Scientific Name	Wellington County		Preferred Habitat	Recorded in ELC Polygon(s)
		Rare	Significant		
Downy Serviceberry	*Amelanchier arborea*	X		Forests, meadows and fields, woodlands, and anthropogenic sites	5 (CUW1)
Red Fescue	*Festuca rubra ssp. rubra*	X		Meadows and fields, cliffs, talus, and rocky slopes	13 (MAM2-10)
Rough Aven's	*Geum laciniatum*	X	X	Savannahs, thickets, woodlands, and moist meadow	3 (CUM1-1), 11 (CUT2-6)
Hairy Solomon's Seal	*Polygonatum pubescens*	X		Forests, forest edges, and rocky slopes	8 (MAS2-1), 13 (MAM2-10)
Variegated Horsetail	*Equisetum variegatum*		X	Shores of rivers and lakes, anthropogenic sites	13 (MAM2-10)
Many-headed Sedge	*Carex synchnocephala*		X	Shores of rivers and lakes, anthropogenic sites	12 (MAM2)

Tree Inventory and Hazard Assessment

A total of 228 trees were tagged within the YREDS study area boundary during the tree inventory and assessment. A total of 20 species of trees were tagged and evaluated. Figure 3.6.2 shows the locations of the trees surveyed, their respective crown reserve (diameter of the canopy), and preservation priority. Appendix H-4 contains a summary of all tagged tree data including definitions of the parameters used in the arborist assessment.

Of the species identified, eleven are native to Ontario, eight are non-native, and one was identified to the genus level. The most abundant species was Eastern White Cedar (*Thuja occidentalis*), a native tree, with a total of 58 trees tagged, followed by Silver Maple (*Acer saccharinum*) at 55 trees and Norway Maple (*Acer platanoides*) at 47 trees. Chart 1 illustrates the count of each tree species tagged during the survey. The majority of trees surveyed were native to Ontario – a total of 137 native trees and 90 non-native trees.

The trees surveyed were generally scattered throughout ELC polygons 1, 2 and 3 (Figures 3.6.1 and 3.6.2). The proposed road widening and creek realignment extends outside of the surveyed area, ELC polygons 10, 11, and 21 (Figure 3.6.1), and a supplemental survey will be completed at as a part of the detailed design. Planted Silver and Norway Maples border York Road near the inter section with Watson Road within polygon 1 and along the driveway leading into the house within polygon 2. The canopy structure within the north east half of polygon 3 consists of mature Silver Maple over Northern White Cedar that border much of Clythe Creek. Towards the south west end the canopy is sparser and more immature, and consists of more Spruce species (*Picea* sp.).

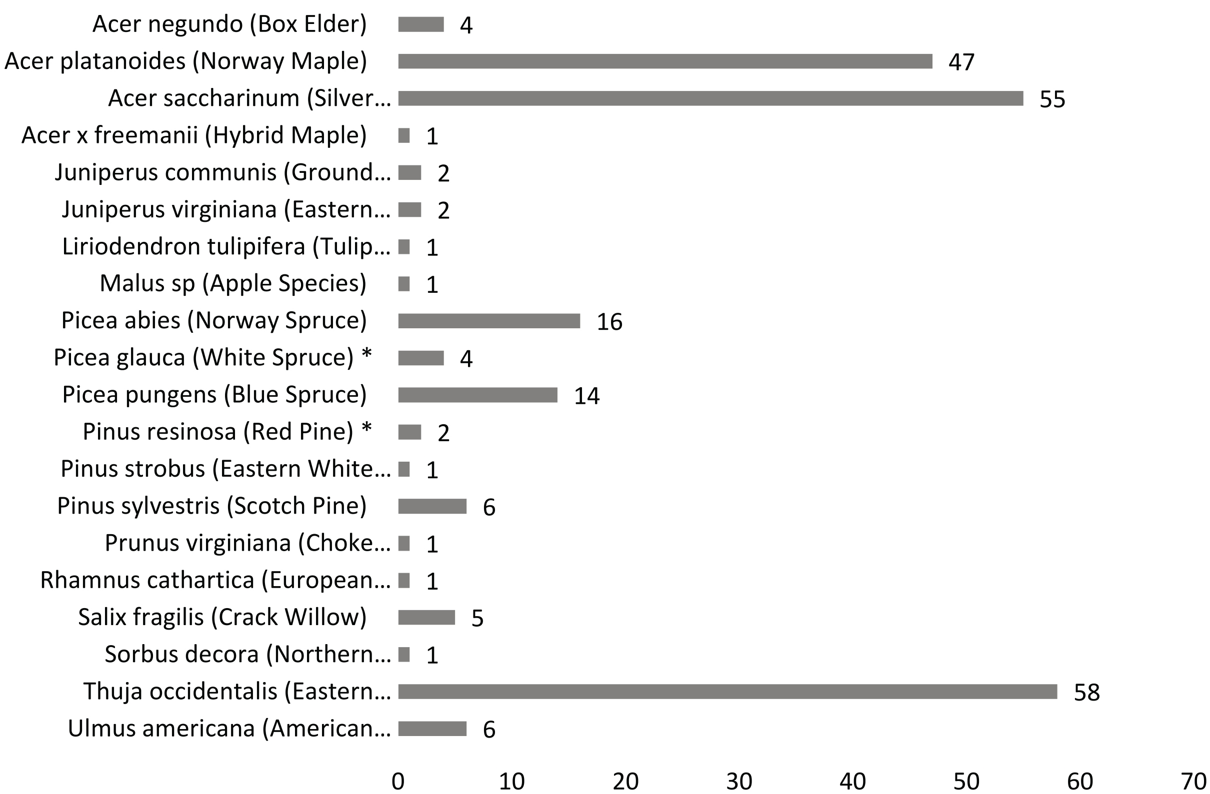


Chart 3.6.1: Overall Tree Tally by Species

**indicates tree is native to Ontario*

The largest trees surveyed were Crack Willow (*Salix fragilis*) with two trees with a dbh of 200cm followed by Silver Maple (*A. saccharinum*), with 6 trees between 115 cm and 140 cm dbh. Including these trees, 50 trees surveyed were of a large trunk diameter (50cm DBH or larger) which include 30 Silver Maple and seven Norway Maple (ref. Table 3.6.3). Chart 3.6.2 provides a breakdown of the size distribution of the trees surveyed.

Table 3.6.3: Surveyed Tree Species with greater than or equal to 50 cm DBH

Scientific Name	Tree Count >= 50 cm DBH
Acer saccharinum	30
Acer platanoides	7
Salix fragilis	3
Picea abies	2
Picea pungens	2
Pinus resinosa	2
Thuja occidentalis	2
Ulmus americana	2
Picea glauca	1

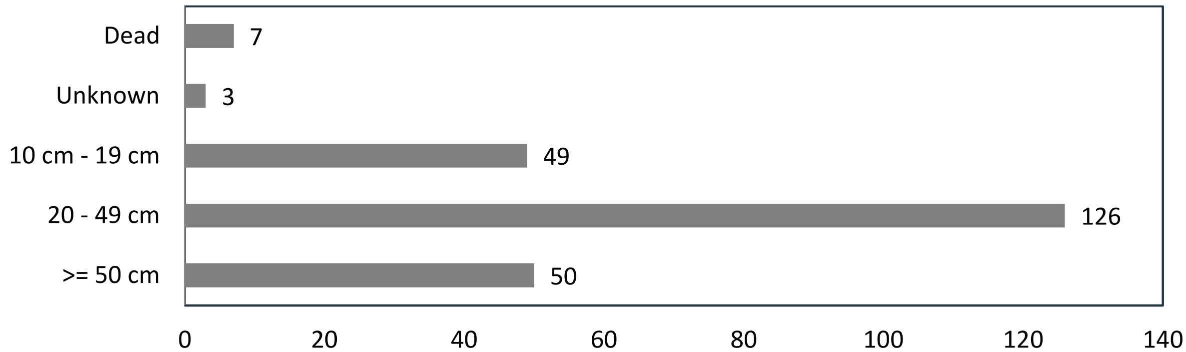


Chart 3.6.2: Size Distribution of Trees by DBH

Table 3.6.4 provides a breakdown of the number of specimens that ranked either High, Medium, or Low for Structural Condition, Biological Health, and Preservation Priority parameters. Data were collected on the Structural Condition, Biological Health, and Preservation Priority for each tree tagged. The term Structural Condition refers to the physical structure of the tree. Trees with poor condition may be leaning or have cracks, multiple stems, or broken branches. Biological Health was assessed by observing signs of tree health such as rot, cavities, epicormic shoots, crown dieback, bulges, fissures, and insect holes. Preservation Priority is a function of size, desirable species, high condition ranking, and/or high health ranking; of the remaining trees. The primary biological issues included crown and branch dieback, as many of the trees are mature for their species in a landscape setting, while structural defects included cracks and poor form (e.g. leaning) (ref. Appendix H-4).

Table 3.6.4: Summary of Structural Condition, Biological Health, and Preservation Priority rankings

	Structural Condition (No. of Trees)	Biological Health (No. of Trees)	Preservation Priority (No. of Trees)
High	36	109	58
Medium	112	75	76
Low	66	29	80
Unknown (previous survey)	14	15	14
Dead	7	7	7

Species at Risk (SAR)

No plant Species at Risk were observed within the YREDS study area.

3.6.4 Findings: Wildlife Resources

Breeding Bird Surveys

A total of 50 species of birds were detected during the breeding bird surveys and other wildlife surveys; 42 of these species were considered as at least possibly breeding on the site. Six species – Great Blue Heron, Green Heron, Turkey Vulture, Osprey, Herring Gull, and Rock Pigeon – were observed flying over the site only, and are not considered breeding within or adjacent to the site. Two other species – Ring-necked Duck and Sharp-shinned Hawk – were considered migrants only. Of the 42 species of breeding birds, three of them are considered introduced (non-native): Mute Swan, European Starling, and House Sparrow. Of the remaining 39 species, three of them are considered Species at Risk (SAR): Chimney Swift (*Chaetura pelagica*), Barn Swallow (*Hirundo rustica*), and Eastern Meadowlark (*Sturnella magna*), all of which are designated as "Threatened" at both a federal level (COSEWIC 2015) and a provincial level (OMNRF 2016). See the "Species at Risk" section for further details.

At a provincial level, all of the 39 native breeding species have been assigned a Srank of either S4 or S5 by the Natural Heritage Information Centre (NHIC 2016b), which indicates that their provincial populations are "apparently secure" or "secure", respectively (NHIC 2016a).

At a local level, none of the breeding species are considered "rare" within either the Regional Municipality of Waterloo (RMW 1996) or Wellington County (D&A 2009).

The Ontario Ministry of Natural Resources and Forestry (OMNR 2000) considers two species – Savannah Sparrow and Eastern Meadowlark – as being area sensitive, which indicates that they require large areas of suitable habitat for their long-term survival and thus are more sensitive to development.

The highest level of breeding evidence obtained during the surveys was "confirmed" breeding (OBBA 2001), as indicated by the presence of fledged young (FY). This evidence was collected for the following five species: American Robin, European Starling, Song Sparrow, Common Grackle, and Brown-headed Cowbird. The next highest level of breeding evidence was "probable" breeding (OBBA 2001), either by the observation of pairs of birds (code P) or territorial males (code T), which is defined as a singing male being present at the same location at least seven days apart). This evidence was the highest level obtained for 31 species (ref. Appendix I-3). The next highest level of breeding evidence was "possible" breeding (OBBA 2001), as seen with singing males (code S) or birds being present in appropriate breeding habitat during the breeding season (code H); this evidence was the highest breeding level for 5 species.

For application of the Migratory Birds Convention Act (MBCA 1994), 34 of the 42 species recorded as at least possibly breeding are protected by the Act. As such, it means that it is illegal to harm or kill these species, or to harm or destroy their nests and nesting habitat. The eight species that are afforded no protection from the Act are Red-tailed Hawk, Blue Jay, American Crow, European Starling, Red-winged Blackbird, Common Grackle, Brown-headed Cowbird, and House Sparrow.

Red-tailed Hawk and Blue Jay are protected under the Fish and Wildlife Conservation Act (1997) under Schedule 7 and 8 respectively.

Wildlife Species at Risk

For application of the Endangered Species Act (ESA) and the Species at Risk Act (SARA), there were three avian Species at Risk detected on the site, as follows:

- Chimney Swift – Threatened (federal and provincial); up to three birds were seen foraging over the main ponds on May 20, June 3, and June 17. However, they are not suspected as nesting on site as there are no suitable chimneys or large (dbh greater than 50 cm) trees with cavities present; these birds were likely nesting offsite and using the ponds for foraging. The foraging habitat will not be negatively impacted by the proposed works nor will any suitable nesting trees or structures be damaged or removed.
- Barn Swallow – Threatened (federal and provincial); during the breeding bird surveys, up to four birds were seen foraging over the baseball fields on the west side of the YREDS study area and also up to

four birds in the open field on the east side of the study area. There are no suitable structures on site to support their nesting although there are many in surrounding areas. There were no signs of nesting on, or foraging activity around, the gatehouse. It is unlikely that Barn Swallows would nest on the gatehouse as the location is not open enough; it is too treed in nature. Regulated Habitat Categories 1 and 2 for Barn Swallows (per MNRF) is within 5 metres (~16 feet) of the nest (areas where they are most vulnerable to disturbance). The foraging habitat on site will not be negatively impacted by the proposed works nor will any suitable nesting structures be damaged or removed.

- Eastern Meadowlark – Threatened (federal and provincial); one pair was present during both breeding bird surveys in the fields on the east side of the YREDS study area (south of polygon 16 on Figure 3.6.1), south of Clythe Creek and east of the driveway to the correctional institute. The proposed work will be confined to the creek corridor and, as such, will not negatively impact these fields.

For full details on the breeding bird surveys for this site, refer to Appendix I-3.

Nocturnal Amphibian Surveys

Overall, the number and diversity of amphibians calling on the three dates were very low, with a total of three species detected: American Toad (*Anaxyrus americanus*), Spring Peeper (*Pseudacris crucifer*), and Green Frog (*Lithobates clamitans*). Survey station 1 had no species calling on all three dates; survey station 2 only had American Toad and Spring Peeper on the April and May surveys while survey station 3 only had Spring Peeper on the May survey. Green Frog was not detected at any of the three survey stations but was heard on the June 21 survey in three areas outside of the survey areas. This species was also recorded incidentally during daytime surveys. Given these results, it seems that the YREDS study area does not contain significant amphibian breeding habitat.

Appendix I-3 provides details on the nocturnal amphibian surveys with survey locations displayed in Figure 3.6.3.

Turtle Surveys

Three species of turtles were detected during the 2016 field investigations. One of these – Pond or Red-eared Slider (*Trachemys scripta*) – is an introduced species and was likely released at the site. A low number of Painted Turtles were observed, mostly basking on rocks on the west side of the northernmost pond. Finally, a Snapping Turtle was observed on June 17, 2016 within the small pond, just east of the main correctional institution driveway (outside of the study area). Although turtles are likely nesting in the general vicinity, such as along the Eramosa River to the south, there were no significant areas of potential nesting habitat along Clythe Creek and York Road. The two main ponds likely represent overwintering habitat for all three turtle species.

No dead or injured turtles were found along York Road during the field investigations.

Eastern Milksnake Surveys

No Milksnakes were found during the surveys. The habitat on-site is not optimal for the species but they could persist in the area or adjacent lands. Therefore, general mitigation measures are recommended for the construction works (see section 4.3).

Eastern Gartersnake (*Thamnophis sirtalis*); this species has a rank of S5 (provincial population is secure) and is common and widespread in Wellington County and within the City of Guelph.

Species at Risk (SAR) Screening

A list of SAR for the City of Guelph, updated to September 29, 2015, was provided by Guelph District MNRF. The habitats on site were screened against known habitat requirements of these species to determine if any potential species could be present. The results of this screening is found in Appendix I-1.

Five SAR were documented during 2016 field investigations: Chimney Swift, Barn Swallow, Eastern Meadowlark, Snapping Turtle, and Monarch. From the list of SAR for the City of Guelph, the following species could potentially be present:

- Bald Eagle (Special Concern) – although not found during 2016 breeding bird surveys, this species could be present along the Eramosa River in the winter. No negative impacts to this area are anticipated from the proposed works;
- Eastern Wood-Pewee (Special Concern) – potential habitat on site and in adjacent lands; however, none were detected during the 2016 breeding bird surveys;
- Wood Thrush (Special Concern) – potential habitat in adjacent lands; however, none were detected during the 2016 breeding bird surveys;
- Eastern Ribbonsnake (Special Concern) – habitat occurs along the southern sections of the site within wetland areas and along the Eramosa River; the species could also occur along Clythe Creek. However, none were found during the snake surveys;

It was recognized during the development of the Terms of Reference, that Bald Eagle are present within the general area of this development but studies and an agreement that Bald Eagle winter surveys were not required as a part of this study, r*ather this work would be more appropriately completed as part of the environmental studies required through the future block plan process for the GID area.*

Three species of Endangered bats are known from the City of Guelph: Eastern Small-footed Myotis (*Myotis leibii*), Little Brown Myotis (*Myotis lucifugus*), and Northern Myotis (*Myotis septentrionalis*). As outlined elsewhere in this report, there are no suitable overwintering sites for any of these three species on site, nor are there any suitable large trees (25+ cm dbh with snags) for setting up maternity roosts. There are also no habitats on-site that would be considered significant from a SWH perspective (e.g. Seasonal Concentration Areas of Animals: Bat Hibernacula and Bat Maternity Colonies). Furthermore, there are no buildings on site that could be utilized for roosting by any of the three species, especially Little Brown Myotis. The species may be present during migration roosting in buildings adjacent to the YREDS study area and likely use the open fields, ponds, and river as foraging habitat; none of these habitats are going to be negatively impacted by the proposed creek alignment works.

Incidental Wildlife

No surveys were conducted for other wildlife groups, such as mammals and insects. Any sightings of these groups were done on an incidental basis during all other surveys.

One snake species was seen during the field investigations: Eastern Gartersnake (*Thamnophis sirtalis sirtalis*). This species is common and widespread in Wellington County (D&A 2009) and the Region of Waterloo (RMW 1985) and has a Srank of S5 in Ontario, indicating that its populations is "secure" (NHIC 2015).

Three species of mammals were detected: Gray Squirrel (*Sciurus carolinensis*), Raccoon (*Procyon lotor*), and Beaver (*Castor canadensis*). All of these species are common and widespread in Wellington County (D&A 2009) and the Region of Waterloo (RMW 1985) and have Sranks of S5 in Ontario, indicating that their populations are "secure" (NHIC 2015).

One species of amphibian was observed on an incidental basis during the 2016 field investigations: Green Frog (*Lithobates clamitans*). Several individuals of this species were seen around the edges of the main ponds during diurnal surveys. This species was also detected during the nocturnal amphibian surveys in May and June.

Thirteen (13) species of butterflies were observed during the 2016 field investigations. Twelve of these species are considered common and widespread in Wellington County (D&A 2009) and the Region of Waterloo (RMW 1985) and have Sranks of S5 in Ontario, indicating that their populations are "secure" (NHIC 2015). Monarch is considered Special Concern at a provincial and federal level, and has a Srank of S2 (imperiled population) and is considered rare in Wellington County (D&A 2009). Two individuals of this species were seen in the northeast field (polygon 6) on June 17; its hostplant (Common Milkweed) is present here so they are potentially breeding. See Appendix I-3 for details on lepidoptera.

3.6.5 Summary of Significance

Wetlands

The YREDS study area contains four wetland polygons, none of which have provincial significance (Figure 3.6.1). Three have local significance and one is classified as an Other Wetland as defined by City of Guelph Official Plan + OPA 42: Natural Heritage System (2014). Locally Significant Wetlands are defined as "evaluated wetlands (including wetland complexes) of at least two (2) ha in size which are not identified as provincially significant, and unevaluated wetlands at least 0.5 ha in size" and Other Wetlands include all unevaluated wetlands between 0.2 and 0.5 ha in size and "i) located within a floodplain or riparian community; ii) identified as a bog or fen; iii) providing Habitat for Significant Species (as per policies under 6A.3.4); iv) part of an ecologically functional corridor or linkage between Significant Natural Areas; or v) part of a seep or spring or is hydrologically linked to a Significant Wetland". None of the wetlands in the YREDS Study Area have been evaluated by MNRF as per OWES.

Table 3.6.5: Summary of Wetlands

ELC Polygon	ELC	Size	Significance
Polygon 8	Cattail Mineral Shallow Marsh Type (MAS2-1) with a small Reed-canary Grass Mineral Meadow Marsh (MAM2-2) inclusion	0.46 ha	Other Wetland
Polygon 13	Forb Mineral Meadow Marsh (MAM2-10)	4.35ha	Locally Significant Wetland
Polygon 12	Mineral Meadow Marsh Ecosite (MAM2)	1.94ha	Locally Significant Wetland
Polygon 15	Mineral Meadow Marsh Ecosite (MAM2)	0.63ha	Locally Significant Wetland

Significant Wildlife Habitat

Of the 38 categories of SWH, the following categories have candidate habitats present within or adjacent to the YREDS study area:

- Seasonal Concentration of Animals: Turtle Wintering Areas:

  Open waters of the two main ponds and the adjacent Eramosa River could serve as over-wintering habitat for Painted Turtle and Snapping Turtle (both confirmed from the site). The ponds are depicted on Figure 3.6.1 as ELC polygons 17 and 18.

- Specialized Habitat for Wildlife: Turtle Nesting Areas:

  Potential nesting areas occur along the Eramosa River and in open areas with sand and gravel. No suitable habitat was observed along Clythe Creek. The potential areas are depicted on Figure 3.6.1 as ELC polygons 21 and 22.

- Habitats for Species of Conservation Concern (not including Endangered and Threatened Species): Special Concern and Rare Wildlife Species:

  Only one Special Concern species was found during the 2016 field investigations:

  Snapping Turtle. No S1 to S3 species of fauna were observed in 2016. They may winter in the two main ponds (Figure 3.6.1, ELC polygons 17 and 18).

  - Monarch (SC) may occur in non-significant numbers during migration and may also breed as Common Milkweed is present although there was insufficient abundance of Common Milkweed to represent significant habitat.

- Animal Movement Corridors: Amphibian Movement Corridor:
- Small numbers of amphibians were detected in the two main ponds in 2016; amphibian movement would not be to the north as no habitat exists in that direction. Eramosa River, immediately to the south, likely serves as an amphibian movement corridor. The potential areas are depicted on Figure 3.6.1 as ELC polygons 21 and 22.

For details on these four categories, refer to the SWH screening table (Appendix I-2).

Habitat for Locally Significant Species

This analysis is based on a comparison of the wildlife species observed from within a the YREDS study area in 2017 and the City's "Locally Significant Species List" (2012) http://guelph.ca/wp-content/uploads/LocallySignificantSpeciesListCityofGuelphJune2014.pdf. Note that this list does not include Species at Risk as they are addressed through Endangered Species Act (ESA) and Significant Wildlife Habitat (SWH) requirements.

In total, six species of potentially breeding birds were documented which are locally significant.

Table 3.6.6 identifies the locally significant species and the habitat requirements for each of these locally significant species that could be affected by the York Road expansion.

Table 3.6.6: Locally Significant Species Habitat

Common Name	Scientific Name	Area Sensitive	Target Community Types	Represented by ELC Polygon(s)
Belted Kingfisher	*Megaceryle alcyon*	No	**Wetlands/Open Water.** streams, rivers, ponds, lakes, estuaries, and calm marine waters	12, 13, 15, 17, 18, 21 and 22
Northern Flicker	*Colaptes auratus*	No	**Open Woods.** Open habitats near trees, including forest edges, parks, yards, and woodlands.	5, 6, 7, 10, 11, and 14
Eastern Kingbird	*Tyrannus*	No	**Grass/Agriculture/Open.** Along forest edges, orchards, and fields with scattered trees and shrubs. Also parks, golf courses, and urban areas with tall trees and open spaces. Often found near water.	5, 6, 7, 10, 11, and 14
Savannah Sparrow	*Passerculus sandwichensis*	Yes	**Grass/Agriculture/Open.** Grasslands with few trees; meadows, sedge wetlands, grassy roadsides, and cultivated fields planted with cover crops (e.g. alfalfa).	11 and 13
Baltimore Oriole	*Icterus galbula*	No	**Open Woods.** Open deciduous woodland, forest edges, river banks, and small tree stands. Often found in parks, backyards, and orchards.	5, 6, 7, 10, 11, and 14
Willow Flycatcher	*Empidonax traillii*	No	**Shrub/Early Successional.** Shrubby fields and pastures, often dominated by hawthorns, willows, or willow-dogwood thickets	6, 7, and 11

Significant Valleylands

Schedule 10D of the City of Guelph OP depicts a portion of the YREDS study area as Significant Valleylands, specifically Undeveloped Portions of the Regulatory Floodplain. ELC Polygons 3, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 19, 20, 21, and 22 (Figure 3.6.1) are either completely or partially within the designated area.

Woodlands

The YREDS study area contains two wooded polygons, Polygon 10 and 5. Both polygons have been evaluated against the criteria for Significant Woodlands and Cultural Woodlands as defined in Guelph Official Plan (2018 Consolidation) in the table below. Neither community fits the criteria for the either designation.

Table 3.6.5: Woodland Assessment

		Polygon 10 (Fresh-Moist Lowland Deciduous Forest Type (FOD7-4))	Polygon 5 (Mineral Cultural Woodland Ecosite (CUW1))
Significant Woodland Criteria *Must meet one if the criteria*	Woodlands (not identified as cultural woodlands or plantations) of 1 hectare or greater in size, and a 10 metre minimum buffer.	**No**, polygon is only 0.71 ha	**No**, polygon is only 0.33 ha
	Woodlands 0.5 hectare in size or greater consisting of Dry-Fresh Sugar Maple Deciduous Forest and a 10 metre minimum buffer	**No**, the polygon is not a Dry-Fresh Sugar Maple Deciduous Forest	**No**, polygon is only 0.33 ha
	Woodland types ranked as S1 (Critically Imperiled), S2 (Imperiled) or S3 (Vulnerable) by the MNR Natural Heritage Information Centre, and a 10 metre minimum buffer	**No**, not a S1, S2, or S3 community	**No**, not a S1, S2, or S3 community
	Conclusion	Not a Significant Woodland	Not a Significant Woodland
Cultural Woodlands *Must meet all criteria*	equal to or greater than 1 hectare in size	**No**, polygon is only 0.71 ha	**No**, polygon is only 0.33 ha
	not dominated by non-indigenous, invasive species.	**No**, dominant canopy species include Crack Willow and Manitoba Maple; both are non-indigenous and may be considered invasive.	**Not likely**, canopy contains many species some native but some non-indigenous such as Scots Pine which is a known invasive species.
	Conclusion	Not a Cultural Woodland	Not a Cultural Woodland

3.7 Transportation Network

York Road is classified as an arterial roadway, and is identified as one of the major gateways for the City of Guelph. York Road between Wyndham Street South and the East City Limit is also an MTO 'Connecting Link' for Highway 7, and as such, requires Provincial approval for any changes. Modifications to this portion of road are also applicable for partial provincial funding. From east of Victoria Road South to Skyway Drive, York Road currently exists as a two lane rural roadway with approximately 4.2 m wide through lanes with variable width granular shoulders. Turning lanes are currently only provided at Victoria Road and Watson Parkway North. While the City of Guelph Cycling Master Plan – Bicycle-Friendly Guelph (2012), recommends provision of bike lanes on York Road from west of the study limit to Watson Parkway South, there are currently no cycling facilities provided along the corridor. Likewise, there are currently no sidewalks within the study portion of York Road.

From Victoria Road South to east of the Reformatory Property entrance, the north side of York Road is closely bounded by existing residential and commercial properties. Additional commercial properties abut the right of way from east of the Reformatory property to the East City Limit. The south side of York Road is fronted by the York District Lands (former Reformatory), which includes several heritage features and Clythe Creek. A rail line crosses York Road at-grade at a 45 degree angle approximately 120 m east of Victoria Road South.

Based on traffic studies completed as part of the 2006 York Road EA, traffic volumes along the corridor were predicted to be >900 vehicles/hour for the peak direction by end of full buildout of the York District Lands, warranting the provision of an additional through lane in both directions. Based on City review, these volumes are still considered valid.

3.8 Integrated Summary

All field work activities have been intended to address the data gaps for the YREDS study area identified as part of the background review process discussed in Section 2. The additional data provide a full environmental characterization of the study area, and will support the Environmental Impact Study process by ensuring that all constraints, opportunities, and environmental considerations are understood.

4.0 Long-List of Alternatives

Through a consultative process with the City of Guelph, Wood has developed alternatives for both the road sections and profile and for Clythe Creek adjustments to accommodate the proposed road improvements. The following section discusses road alternatives that fulfill the requirements of the 2007 Class EA and more recently the input from both City staff and the public. The alternatives for the creek have considered input from City staff, agency stakeholders (GRCA, MNRF), stakeholder groups (e.g. Trout Unlimited) and the public.

4.1 Road Alternatives

4.1.1 Rationale for Changes to the EA-Proposed York Road Cross-Section

Since completion of the 2007 York Road Class EA, City of Guelph policies regarding Active Transportation, Cultural Heritage, Built Heritage, and Natural Heritage have changed. Guelph has committed to putting a greater focus on active transportation facilities, which includes a desire to provide equivalent levels of service (LOS) for cycling facilities as is provided for vehicular facilities. As a result, the limited cycling and pedestrian facilities contemplated as part of the original 2007 EA are no longer sufficient to meet City objectives. Additionally, the associated removal of some key heritage features (both natural and cultural) are likewise no longer acceptable. These changes in policy necessitated an update to the original design, as discussed in the following sections.

Stakeholder Recommendations for Additional Improvements

Consultation with City staff, stakeholders and members of the public through a Public Open House held at City Hall on February 23, 2016 for this project resulted in the design recommendations outlined in the following sections.

City Staff

Alternative roadway cross-sections were circulated to City of Guelph staff to solicit input on design preferences. The following comments were received:

- Preferred offset from face of curb to sidewalks or multi-use pathways is 1.5 m to ensure adequate space for snow storage (later comments indicated a preference for a minimum of 2.0 m adjacent to heritage features);
- Required minimum lane widths of 3.5 m (as a component of an MTO 'Connecting Link');
- On-road cycle lanes require a buffer per OTM Book 18; and
- Listed and designated heritage features to be protected from roadway and grading encroachment.

Key Stakeholders

Agency stakeholders were asked to provide comment on the proposed road widening and creek realignment. Individual agencies that provided comments included the Ministry of Natural Resources and Forestry (MNRF), Ministry of the Environment and Climate Change (MOECC), Ministry of Tourism, Culture and Sport (MTCS), Infrastructure Ontario (IO), Trout Unlimited, Grand River Consultation Authority (GRCA) and the Ministry of Transportation Ontario (MTO). The only road-related comments were received from the MTO as York Road functions as a 'Connecting Link' between portions of provincial Highway 7. Certain rules and regulations apply to 'Connecting Link' highways, including:

- There shall be no new installations of traffic control signal systems without explicit approval of the MTO;

- All replacement traffic control systems must undergo MTO review and approval;
- All staging plans must undergo MTO review and approval;
- MTO review is required for any by-laws that affect traffic on the connecting link (i.e. Elizabeth Street realignment and the closure of Beaumont Crescent);
- No sidewalks or cycle lanes must be located within the designated Highway 7 right-of-way (portion not considered part of the 'Connecting Link');
- The transition between 2 and 4 lanes must utilize proper geometrics; and
- The intersection of Skyway Drive and Highway 7 must be constructed to MTO standards.

The MTCS provided comment that appropriate Stage 2 Archaeological Assessments must be completed, and that the heritage value of any existing features was to be assessed per its published guidelines.

First Nations

Consultation was conducted with representatives of the following First Nations communities:

- Six Nations Elected Council (SNEC),
- Six Nations of the Grand River (SNGR),
- Haudensaunee Development Institute (HDI),
- Mississaugas of the New Credit First Nation (MCFN), and
- Métis Nation of Ontario (MNO).

No road design-related comments were received from any of the First Nations representatives.

General Public

Comments were solicited from members of the public through a Public Information Centre held at City Hall on February 23, 2016, as well as via email and written letters throughout the duration of the study. The primary road design-related comments can be summarized as follows:

- Requirement for provision of multi-use pathways which are set back from the roadway, and/or physically separated cycle lanes (commented in all submissions);
- Provision of safe signalized or bridged pedestrian crossing locations;
- Conservation of heritage features;
- Implementation of traffic calming features; and
- Provisions for turning lanes.

Built Heritage

In addition to design changes to address updated stakeholder concerns, several human-made structures on the adjacent Reformatory (York District) property have been designated by the MTCS as having heritage value following completion of the York Road Class EA in 2007. As such, it was necessary to shift the southern limit of roadway construction to the north, providing a minimum 2.0 m buffer between any new infrastructure and the identified heritage features (to allow for adequate protection and snow storage). Of particular concern with respect to design of the roadway was preservation of the following features:

Reformatory Entranceway

This feature includes hand-laid stone walls, bridge, weirs and circular wall terminus structures. As with the other features on the Reformatory property, these features were built by inmates and help to tell the story of the site.

Gateway

This high-integrity hand-laid stone gateway is located at the east extent of the York District (Reformatory) property.

Bridge Railing

Although currently partially embedded within a gabion basket wall, an existing bridge railing located on the north side of the culvert immediately east of 850 York Road, holds heritage value as it bears the mark of an architect who was instrumental in forming the City of Guelph. As this culvert will require resizing, this railing will require relocation.

Stone Retaining Wall

A stone wall with identified heritage value is located immediately east of the Publix Variety/Lewis Upholstery complex located at 804 York Road.

In-Water Features

Preservation of two weirs located in close proximity to the proposed roadway are to potentially be maintained through the use of retained soil systems (RSS). These two features are located approximately midway between the Reformatory Entrance and the eastern limits of the Reformatory property.

Traffic Calming

Members of the City's Infrastructure, Development and Enterprise Department, as well as members of the public (through the 2016 PIC), requested that opportunities for traffic calming and safety improvements be investigated along the study corridor. Of particular concern were the following aspects of the EA - proposed transportation facilities:

- Operating speeds and need for traffic calming;
- Lack of turning lanes and impacts on through-moving vehicles;
- Provision of safe crossing locations for pedestrians and cyclists;
- Safety of pedestrians and cyclists on the north side, given the number of entrances; and
- Lack of dedicated cycling and pedestrian facilities on the south side of York Road.

Typical 'traffic calming' tools that are available, but which may not be appropriate for this corridor, include: reduced lane widths (not be permitted due to the 'Connecting Link' status of the roadway); introduction of curves along the roadway; median treatments (may be appropriate through certain sections); roundabouts; landscaping/streetscaping beyond the clear zone; and signage and enforcement. The EA-approved York Road right-of-way (ROW), which is highly constrained by development and Clythe Creek, make use of the majority of these traffic calming measures infeasible. However, use of enforced speed limit reductions, median treatments, and streetscaping can be further examined during detailed design. The lack of ability to provide turning lanes on York Road from east of Industrial Street to west of Watson Parkway South, is also the result of the highly constrained ROW.

Provision of safe, high level-of-service pedestrian and cycling facilities on both sides of York Road is one of the primary driving factors for changes to the EA-proposed cross-section. The design and function of these facilities is described in greater detail in Section 4.1.2.

4.1.2 Long List of York Road Cross-Section Alternatives

In order to accommodate changes in City-wide policy and meet the needs of the public and other key stakeholders, revisions to the EA-proposed cross-section and alignment of York Road will be required. Working within the approximate 22.3 m ROW between the north property limit and the heritage features to the south, Wood developed a set of 29 alternative sections aimed at meeting the diverse needs and constraints identified for the corridor. An overview of the long list of alternative sections is provided in Table 4.1, along with commentary on why each alternative was, or was not, recommended for further consideration.

It is important to note that while the original study objective was to find a balance between creek, active transportation and cultural heritage impacts, the desire to provide full-width active transportation facilities along both the north and south sides of York Road became increasingly important. As a result, the desirability of each alternative road cross-section changed over the course of the project.

Table 4.1: Long List of Road Alternatives

Alt. #	General Description	Lane Widths (m)		Cycle Lane Width (m)		Sidewalk Width (m)		Multi-Use Pathway Width (m)		Curb and Gutter Width (m)		Boulevard Width (m)		Shoulder Width (m)		Heritage Buffer (m)	Total Width (m)	Recommended for Further Consideration (Yes = ✓, No = X)	
		Inside	Outside	North	South	North	South	North	South	North	South	North	South	North	South				
1	Sidewalks and Cycle Lanes on Both Sides	3.5	4.0	1.5	1.5	1.5	1.5			0.5	0.5	1.0	1.0				24.00	X	Total width exceeds available ROW width.
2		3.5	3.5	1.5	1.5	1.5	1.5			0.5	0.5	1.0	1.0				23.00	X	Total width exceeds available ROW width.
3		3.5	4.0	1.5	1.5	1.8	1.8			0.5	0.5						22.60	X	Total width exceeds available ROW width.
4		3.5	3.5	1.5	1.5	1.8	1.8			0.5	0.5						21.60	X	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage. On-road cycle lanes not preferred for 85th percentile operating speeds of greater than 50 km/h and AADTs >15,000.
5	Sidewalks Only, with and without Shared Use Lanes	3.5	4.3			1.5	1.5			0.5	0.5	1.0	1.0				21.60	X	On-road cycle lanes not preferred for 85th percentile operating speeds of greater than 50 km/h and AADTs >15,000.
6		3.5	4.3			1.8	1.8			0.5	0.5						20.20	X	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage. On-road cycle lanes not preferred for 85th percentile operating speeds of greater than 50 km/h and AADTs >15,000.
7		3.5	3.5			1.5	1.5			0.5	0.5	1.0	1.0				20.00	X	Provision of cycling facilities identified as a key requirement.
8		3.5	3.5			1.8	1.8			0.5	0.5						18.60	X	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage. Provision of cycling facilities identified as a key requirement.
9		3.5	3.5			1.5				0.5	0.5	1.0	0.5				18.00	X	Lack of pedestrian facilities on south side. Provision of cycling facilities identified as a key requirement.
10		3.5	3.5			1.8				0.5	0.5		0.5			0.5	17.80	X	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage. South side pedestrian facilities would need to be provided within the York District Lands. Provision of cycling facilities identified as a key requirement.
11		3.5	3.5			1.5				0.5		1.0			3.0		20.00	X	South side pedestrian facilities would need to be provided within the York District Lands. Provision of cycling facilities on both sides of roadway later identified as a key requirement.
12		3.5	3.5			1.8				0.5					3.0		19.30	X	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage. South side pedestrian facilities would need to be provided within the York District Lands. Provision of cycling facilities identified as a key requirement.
13	Sidewalk on North Side, Cycle Lanes on Both Sides	3.5	3.5	1.5	1.5	1.5				0.5		1.0			1.5	1.0	22.50	X	Total width exceeds available ROW width.
14		3.5	3.5	1.5	1.5	1.8				0.5					1.5	1.0	21.80	X	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage. South side pedestrian facilities would need to be provided within the York District Lands.

Alt. #	General Description	Lane Widths (m)		Cycle Lane Width (m)		Sidewalk Width (m)		Multi-Use Pathway Width (m)		Curb and Gutter Width (m)		Boulevard Width (m)		Shoulder Width (m)		Heritage Buffer (m)	Total Width (m)	Recommended for Further Consideration (Yes = ✓, No = X)	
		Inside	Outside	North	South	North	South	North	South	North	South	North	South	North	South				
15		3.5	3.5	1.5	1.5	1.5				0.5	0.5	1.0	0.5			0.5	21.50	X	South side pedestrian facilities would need to be provided within the York District Lands.
16		3.5	3.5	1.5	1.5	1.8				0.5	0.5		0.5			0.5	20.80	X	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage. South side pedestrian facilities would need to be provided within the York District Lands.
17	Multi-Use on Both Sides, With Boulevards	3.5	4.3					3.0	3.0	0.5	0.5	1.0	1.0			1.0	25.60	X	Total width exceeds available ROW width.
18		3.5	4.0					3.0	3.0	0.5	0.5	1.0	1.0			1.0	25.00	X	Total width exceeds available ROW width.
19		3.5	3.5					3.0	3.0	0.5	0.5	1.0	1.0			1.0	24.00	✓	Total width exceeds available ROW width, however delivers all requested aspects of the transportation network.
20	Multi-Use on Both Sides, Without Boulevards	3.5	4.3					3.0	3.0	0.5	0.5					1.0	23.60	X	Total width exceeds available ROW width.
21		3.5	4.0					3.0	3.0	0.5	0.5					1.0	23.00	X	Total width exceeds available ROW width.
22		3.5	3.5					3.0	3.0	0.5	0.5					1.0	22.00	✓	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage.
23		3.5	3.5					2.5	2.5	0.5	0.5					1.0	22.00	✓	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage. Multi-use path is narrower than standard.
24	Sidewalk and Shared-Use Lane on North Side, Multi-Use on South Side	3.5	4.3/3.5			1.5			3.0	0.5	0.5	1.0	1.0			1.0	23.20	X	Total width exceeds available ROW width. On-road cycle lanes not preferred for 85th percentile operating speeds of greater than 50 km/h and AADTs >15,000.
25		3.5	4.3/3.5			1.5			3.0	0.5	0.5	1.0				1.0	22.20	X	On-road cycle lanes not preferred for 85th percentile operating speeds of greater than 50 km/h and AADTs >15,000.
26		3.5	4.3/3.5			1.8			3.0	0.5	0.5					1.0	21.50	X	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage. On-road cycle lanes not preferred for 85th percentile operating speeds of greater than 50 km/h and AADTs >15,000.
27	Sidewalk on North Side, Multi-Use on South Side	3.5	3.5			1.5			3.0	0.5	0.5	1.0				1.0	21.50	X	Provision of cycling facilities on both sides of roadway later identified as a key requirement.
28		3.5	3.5			1.8			3.0	0.5	0.5		1.0			1.0	21.80	X	Provision of cycling facilities on both sides of roadway later identified as a key requirement.
29		3.5	3.5			1.8			3.0	0.5	0.5					1.0	20.80	X	Lack of boulevard is not preferred due to inability to provide adequate space for snow storage. Provision of cycling facilities on both sides of roadway later identified as a key requirement.

4.2 Creek Alternatives (Options)

Several creek design options, in addition to the Do-Nothing Option, were developed for consideration. Due to the altered and degraded channel form characterized during the field study, opportunities to improve channel conditions beyond the minimum requirements to accommodate road grading were contemplated. The primary focus of creek improvements is optimizing channel form and function by addressing the imbalance of creek elements (i.e. discharge, sediment load, and slope) that currently exists. The is achieved through the establishment of a graded stream, described by Mackin (1948) as "one in which, over a period of years, slope is delicately adjusted to provide, with available discharge and with prevailing channel characteristics, just the velocity required for the transport of the load supplied from the drainage basin". This is particularly applicable within the lower reaches of the YREDS study area (i.e., Reaches C-9B and C-10) where Clythe Creek is of low gradient, typically over-widened, and experiencing excessive deposition. Concurrently, considerations of in-stream structures of cultural importance that were installed in the past, as well as possible improvements to aquatic habitat (e.g. fish passage) are factored into the designs. It is important to consider a range of options comprising various levels of intervention and assess how each would ultimately impact the channel. Based on the foregoing the following creek alternatives (Options) have been prepared:

- Option 1: Do Nothing
- Option 2: Improved Form and Function
- Option 3: Ultimate Channel Configuration

In addition to the above noted alternatives, a broader range of alternatives was considered based on input received during consultation and review activities, including potential creek realignment of Clythe Creek to disconnect the channel from Hadati Creek. It is possible for this separation of the creeks to occur in the future following monitoring of the impacts to Clythe Creek that result from realignment in the YREDS study area. This option was not selected for advancement as a preliminary design alternative.

4.3 Screening of Alternatives

4.3.1 Road Alternatives

Significant input was provided by City staff, stakeholder groups and the public for the portion of York Road between Victoria Street and the East City Limits in 2016 and 2017, to ensure pedestrian and cycling facilities were provided on both sides of the roadway. Based on results of the detailed cycling infrastructure alternative evaluation process laid out in OTM Book 18, recommendations were made to provide either buffered on-street cycling lanes (acceptable) or off-road cycle track or multi-use pathway (preferred) to accommodate cyclists in the corridor. In order to limit the cross-sectional width required to accommodate active transportation infrastructure, multi-use pathways, on both the north and south sides of York Road, were recommended. Along the majority of the corridor, it was recommended that the multi-use pathways be located adjacent to the roadway, set back by a 1.5 m boulevard to facilitate snow storage.

Based on the requirements outlined above, screening of the long list of transportation design alternatives was completed based on the following:

- Multi-use pathways to be provided on both the north and south sides of York Road;
- Minimum 1.0 m boulevard (1.5 m preferred) to be provided on both sides of York Road, for snow storage and as an additional buffer between vehicles and pedestrians and cyclists;
- Four lane cross-section;
- Minimum lane width of 3.5 m; and
- Avoidance or mitigation of impacts to significant heritage features.

Based on these requirements, a short-list of four road design alternatives was carried forward for further consideration. These alternatives were identified in Table 4.1 and are expanded upon in Sections 5 and 6. Note that short-listed Alternatives 4 and 5 were not identified as part of the original long-list but were developed based on discussions with Guelph City Staff. A summary of recommended changes to the EA – proposed cross-section are provided in Table 4.2.

Table 4.2: Summary of Roadway Design Revisions

Design Component	2006 EA Recommendation	2016 Update	Reason for Change
Through Lanes	4 x 3.5 m Through Lanes	No Change	No Change
Pedestrian Facilities	1.5 m sidewalk on north side only	3.0 m multi-use pathways on north and south sides	Public and city interest in providing pedestrian facilities on the north side to link commercial and residential areas, and on the south side to allow for enjoyment of the cultural heritage lands.
Cycling Facilities	1.5 m cycle lanes on north and south sides	3.0 m multi-use pathways on north and south sides	In accordance with OTM Book 18, use of a multi-use pathway is recommended[1] for 85th percentile operating speeds of greater than 50 km/h and AADTs >15,000 (York Road EA traffic study estimated AADTs of >18,000 with an 85th percentile operating speed of 80 km/h).
Cross-Section Type	Partial rural	Urban	Allow for collection and pre-treatment of roadway runoff. Additionally, barrier curb provides protection

1 Ontario Ministry of Transportation (2013). *Ontario Traffic Manual Book 18 – Cycling Facilities*. Figure 3.3 – Desirable Bicycle Facility Pre-Selection Nomograph.

Design Component	2006 EA Recommendation	2016 Update	Reason for Change
			for adjacent features when 85th percentile operating speeds are <60 km/h (clear zone reduced to 0.5 m).
Horizontal Alignment	Maintain existing centerline with exception of the portion between the entrances to the Reformatory and 919 York Road, where the alignment was shifted to the south.	Shift centerline south between Victoria Road and Wells Road, then north of existing east to Watson Parkway.	Shift to the south at Victoria Road was made to maintain existing north right-of-way limit as identified in the 2007 EA. East of Wells Road, York Road is shifted north as necessary to provide required setback from heritage features.
Vertical Alignment	Maintain existing	Maintain existing with exception of segment between Elizabeth Street and Cityview Drive which is steepened to 0.5%.	Urban cross-section requires a minimum longitudinal slope of 0.5% to facilitate drainage of stormwater.

The following Road Alternatives have been short-listed for further evaluation and assessment based on the design requirements highlighted in Table 4.1:

- **Alternative 1:** Four lane urbanized cross-section with 3.0 m wide multi-use pathways and minimum 1.0 m wide boulevards on both sides (original long list alternative 19);
- **Alternative 2:** Four lane urbanized cross-section with 3.0 m wide multi-use pathways on both sides, no boulevards adjacent to the GID lands (original long list alternative 22);
- **Alternative 3:** Four lane urbanized cross-section with 3.0 m wide multi-use pathways reduced to 2.5 m width at Reformatory Entrance on both sides, no boulevards adjacent to the GID lands (original long list alternative 23);
- **Alternative 4:** Four lane urbanized cross-section with 3.0 m wide multi-use pathways on both sides, no adjacent to the GID lands, and relocated Reformatory Entrance heritage walls; and
- **Alternative 5:** Four lane urbanized cross-section with 3.0 m wide multi-use pathway and 1.5 m boulevard on the north side and additional multi-use pathway located south of Clythe Creek.

4.3.2 Creek Alternatives

A geomorphic assessment has been completed to assist with the detailed design and restoration of Clythe Creek within the YREDS study area. This assessment reviewed background information, which included past documents, aerial photos, and contour mapping. Watercourse reaches were identified along the study corridor using desktop analyses and were further assessed in the field. During the field investigation, indicators of active geomorphic processes were noted, channel dimensions were measures and a stability index was provided for each reach as required. Additional detailed geomorphic surveys were carried out along two tributaries within the study corridor in order to investigate possible bed degradation that could pose a hazard to proposed sanitary sewer infrastructure.

As a result of proposed widening of York Road, it is necessary to consider the impact these works will have on Clythe Creek which flows parallel to the roadway. As existing channel conditions are severely impaired, the opportunity exists to improve overall health and function of the creek. Following a review and analysis of existing conditions, three options for channel improvements have been made which correspond to the minimum amount of work required (consistent with the 2007 EA), which will improve the fluvial form and function of the channel and fish passage. Grand River Conservation Authority (GRCA) regulates Clythe Creek, as such, when the preferred creek option undergoes detailed design, approval from GRCA will be required.

Option 1 - Do Nothing: Minimal channel works are considered as Option 1 for which only general maintenance would occur following road widening works. This option does not involve channel realignment, or any significant channel enhancement works. As a result, the existing impaired fluvial form and function and fish passage issues are not addressed. Minor encroachment into the existing floodplain is necessary at certain locations to accommodate road widening thereby reducing the existing floodplain and riparian area adjacent to the road and potentially minimizing natural benefits of the buffer (e.g. stabilizing riparian vegetation and flow overbank energy dissipation). Within Reach C-9A, localized channel improvement works will be required to restore the channel following a culvert extension or replacement at York Road. There will be no impact associated with this option with regard to cultural heritage features located within the channel. In order to maintain the cultural heritage features, a retaining wall will be constructed adjacent to features 9 and 10 in order to accommodate grading requirements of the road widening.

Option 2 - Improved Form and Function: Option 2 channel works would be considered the minimum required in order to improve channel function. Under Option 2, works within Reach C-9A will include a channel realignment that will separate the creek from the York Road right-of-way and utilize a greater extent of the floodplain. The realignment will also utilize the existing groundwater tributary planform. The outlet of the northern Reformatory Pond will also be removed where it connects to the creek in an effort to limit interactions between the pond and creek channel. As a result of the channel realignment, the majority of the cultural heritage features will be taken off-line but remain within the landscape. The realignment for Reach C-9A has an optional fish passage channel that would split flow around a significant cultural heritage feature. To improve the functioning of Reaches C-9B and C-10, significant grading works are proposed in order to narrow the channel cross-section and create a consistent bed profile, promoting natural channel function and stability. The bed and bank grading will continue downstream to the existing flow splitter which will be removed.

Option 3 - Ultimate Channel Configuration: Further channel works beyond those described for Option 2 should be considered in order to maximize the restoration potential within Clythe Creek. Under Option 3, works within Reach C-9A will correspond to works proposed under Option 2. Channel realignment will separate the creek from the York Road right-of-way and utilize a greater extent of the existing floodplain. The realignment will also utilize the existing groundwater tributary planform. The outlet of the northern Reformatory Pond will also be narrowed in addition to the outlet elevation being raised in an effort to limit interactions between the pond and creek channel. As a result of the channel realignment, the majority of the cultural heritage features will be taken off-line but remain within the landscape. The realignment for Reach C-9A has an optional fish passage channel that would split flow around a significant cultural heritage feature. To improve the functioning of Reaches C-9B and C-10, significant grading works are proposed in order to narrow the channel cross-section and create a consistent bed profile, promoting natural channel function and stability. Differing from Option 2, for Option 3 the bed and bank grading will continue downstream within Reach C-10 where full channel realignment will occur downstream from the Hadati Creek confluence. As a result, the existing flow splitter will be taken off-line.

Based on the assessment of the creek alternatives (options), the short-listed option is Option 3.

5.0 Short-Listed Alternatives Assessment

5.1 Combined Road and Creek Alternatives

Based on the screening of long-list alternatives, road cross-section Alternatives 1 to 5 were further assessed for use between Beaumont Crescent to east of the Reformatory Entrance. An overview of the assessment is provided in the following sections, with additional details provided in Appendix K.

The cross-section illustrated in Figure 5.1 is recommended for use between Victoria Avenue and Beaumont Crescent, and from east of the Reformatory Entrance to the East City Limit for all of the short-listed alternatives presented in Sections 5.1.1 to 5.1.5.

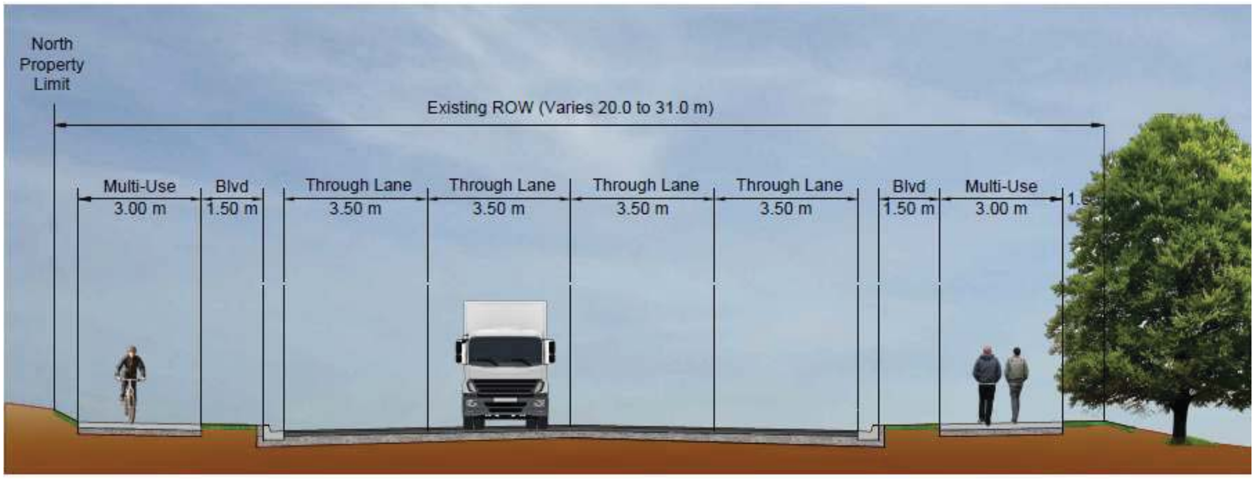


Figure 5.1 Typical Roadway Cross-Section for York Road West of Beaumont Crescent and East of the Reformatory Entrance.

5.1.1 Alternative 1 : 3.0 m Multi-Use Pathways and 1.0 m Boulevards on Both Sides

Roadway Alternative 1 considers the provision of both north and south multi-use pathways within the York Road right-of-way (ROW), along with 1.0 m wide boulevards, a 1.0 m platform and 0.5 m rounding on the south side (per City direction), and 3:1 embankment slopes. Although the boulevards used in Alternative 1 are 0.5 m narrower than what was recommended in the 2007 York Road Improvements Environmental Study Report, and 3.5 m narrower than the City standard, they do provide some snow storage adjacent to the roadway. In order to optimize available space within the ROW, the roadway alignment has been shifted 0.5m to the north relative to the design presented in the 2007 EA. The profile has also been adjusted to minimize grading impacts on adjacent properties. Accommodating this cross-section would require extension of the Hadati Creek culvert and removal of the Reformatory Entrance wing walls, which would be located within the proposed MUP. Opportunities to reduce impacts to the creek and in-water heritage features through implementation of various segments of retaining walls/soil systems could be investigated, although not completed at this time. Roadway cross-section Alternative 1 is illustrated in Figure 5.2, with the associated plan and profile drawings provided in Sub-Appendix A, Appendix K1.

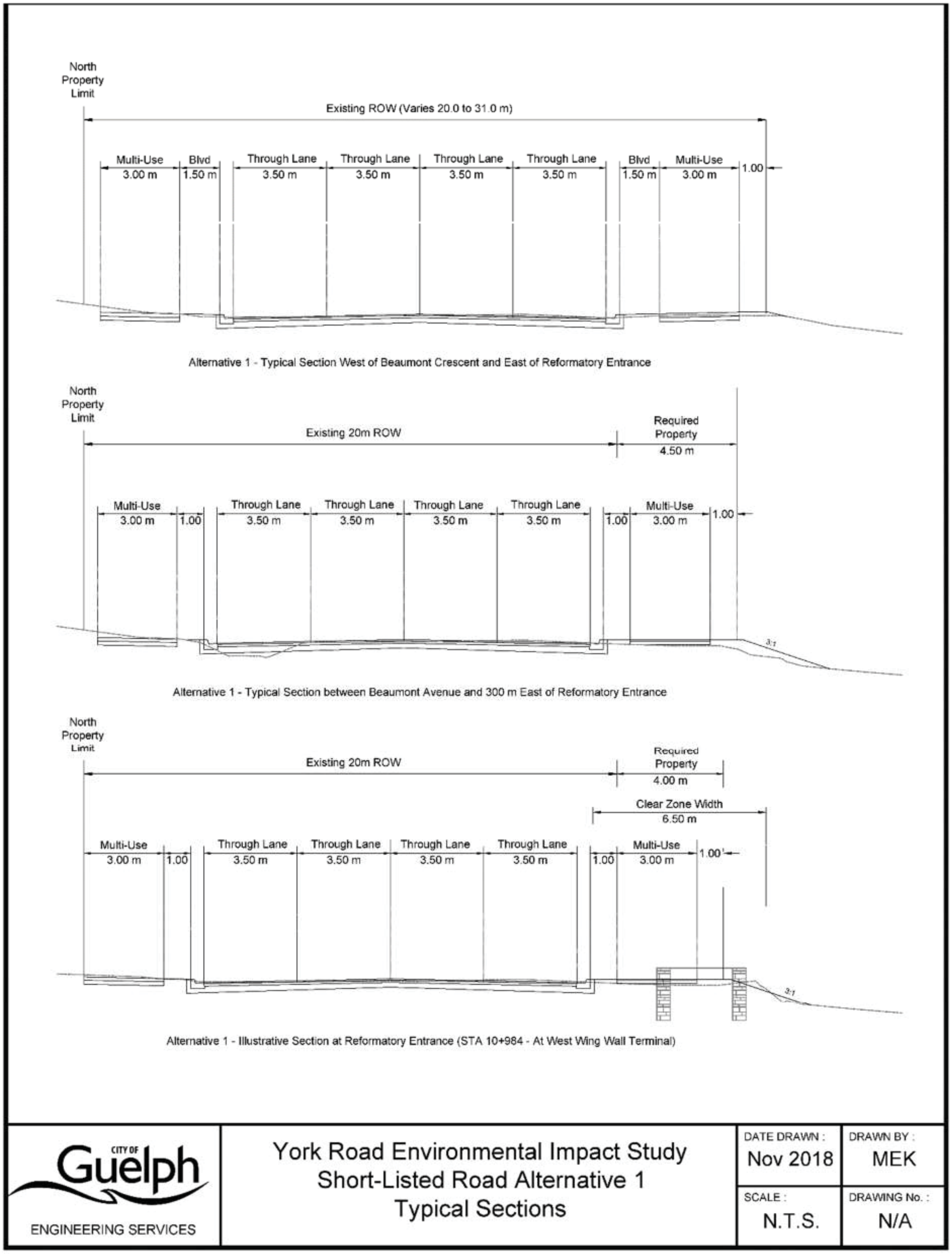


Figure 5.2 Typical Roadway Cross-Section for York Road Alternative 1.

Road Alternative 1: Option 3 - Ultimate Channel Configuration:

The grading slopes (i.e. either 2:1 or 3:1 H:V) that are required to accommodate the proposed 3 m wide MUP alongside York Road and adjacent to Clythe Creek extends further south into the floodplain area than the previously-established preferred alternative (ref. Appendices A and B). Matrix Solutions (Stream Morphologists) selected the 3:1 H:V roadway grading slope in order to establish the constraining limits when considering changes to the channel planform. An evaluation of the new grading limit for Alternative 1 reveals that it overlaps with the preferred channel alignment at two separate locations.

The first location where the revised grading slope intersects with the preferred channel alignment is within Reach C-9A, upstream of the Reformatory driveway (approximate chainage 0+425 m, Sheet 01). Within this reach, the existing planform of Clythe Creek flows over a stone weir (Cultural Feature '14'). The preferred channel alignment option realigns the primary flow pathway further south around the stone weir, reconnecting to the existing channel at a pool immediately downstream of the weir. From this location, the creek then flows under the Reformatory Bridge. At the stone weir, the preferred alignment has incorporated a 'high-flow' channel that directs flows exceeding bankfull (i.e., close to overtopping the channel banks) towards and through the existing channel at the weir. This approach supports fish passage through the primary channel but also allows for the weir to be activated at higher flows, partially mitigating its disconnection from the main channel. However, to accommodate the 3:1 H:V road grading associated with Alternative 1, an adjustment to the currently preferred channel alignment is necessary. Based on the new grading, it is not possible to re-connect the channel at the pool immediately downstream of the weir, as the pool must be infilled to achieve the desired grading. As this pool becomes unusable, the proposed channel alignment must tie-in to the existing channel further downstream. In addition, this new configuration would eliminate the 'high-flow' channel and any continued flow through the weir as the grading and fill would cut off the connection location. The adjustments required at this location do not otherwise impact the form and function of Clythe Creek from the previously-identified preferred channel alignment.

The second location requiring adjustment is in the vicinity of the Hadati Creek confluence (approximate chainage 0+850 to 1+050 m, Sheet 03). The grading to accommodate the alternative roadway/MUP cross section would necessitate shifting the design planform slightly south. The shifted planform aligns with the concrete box culvert that is proposed to replace the existing corrugated steel pipes at this location. Downstream of the crossing, Hadati Creek flows south through a box culvert under York Road where it enters Clythe Creek at the outlet. The box culvert is to be extended on the south side, facilitated by the shift south of the Clythe Creek planform. Whereas the preferred channel alignment utilized the existing creek planform for approximately 40 m west of the culvert, the revised planform requires additional cut, as the creek bend begins further upstream. The existing length of creek that was previously intended as part of the design channel will need to be filled. The design change at the second location does not have significant implications on channel function when compared to the original preferred channel alignment.

5.1.2 Alternative 2: 3.0 m Multi-Use Pathway on Both Sides with No Boulevards

Roadway Alternative 2 considers the provision of both north and south multi-use pathways within the York Road ROW, a 1.0 m green space and 0.5 m rounding on the south side (per City direction), and 3:1 embankment slopes. The boulevard has been eliminated from this alternative, in order to determine the minimum potential impacts associated with locating the south MUP within the road ROW. To maximize available space within the ROW, the roadway alignment has been shifted 1.5 m to the north relative to the design presented in the 2007 EA. The profile has been also adjusted to minimize grading impacts on adjacent properties. Similar to Alternative 1, extension of the Hadati Creek culvert would be required. While the MUP does not directly impact the Reformatory Entrance wingwalls, the walls are located within the roadway clear zone (clear zone for AADT of 18,320 and a design speed of 80 km/h is 6.5 m) and would require protection through use a of guiderail system. Unfortunately, the 0.5 m between the MUP and walls is not sufficient to accommodate guiderail, and the walls would need to be removed.

Opportunities to reduce impacts to the creek and in-water heritage features through implementation of segments of retaining walls/soil systems could be investigated, although not completed at this time. Roadway cross-section Alternative 2 is illustrated in Figure 5.3, with the associated plan and profile drawings provided in Appendix K1. Alternative 2 represents the least impactful alternative possible with the north property limit held and the south MUP located within the York Road ROW. Note that this alternative limits opportunities to locate overhead utilities on the north side without additional property acquisition and/or clear zone protection (guiderail). Overhead utilities could be relocated underground or to the south side with protection and/or localized extension of the 1.5 m wide green space on the south side.

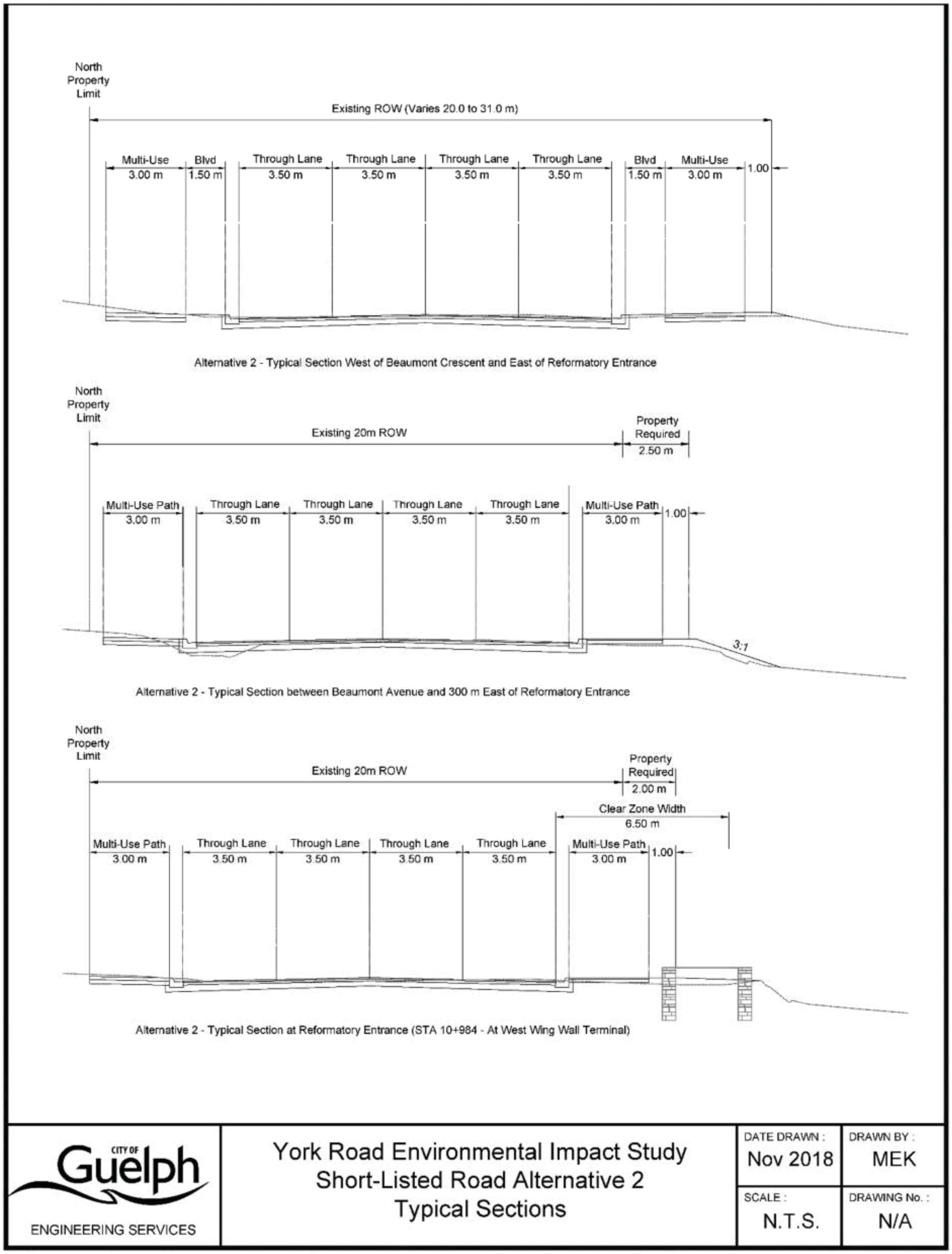


Figure 5.3 Typical Cross-Section for York Road Alternative 2.

Road Alternative 2: Option 3: Ultimate Channel Configuration:

A second channel design (for Alternative 2) has been prepared for consideration based on the grading required to accommodate Road Alternative 23 (ref. Sub-Appendix B, Appendix K1). The Alternative 2 creek design is similar to Alternative 1 aside from the weir location (approximate chainage 0+375 to 0+425 m, Sheet 04). The grading associated with Alternative 2 does not encroach on the channel to the extent of Alternative 1 and, as a result, it is possible to incorporate the 'high-flow' channel that conveys higher flows over the weir structure. This design would involve the establishment of an island-type feature downstream of the weir that separates the newly constructed primary channel and the existing length of channel that will be maintained to convey flows passing over the weir. The two channels connect further downstream, towards the Reformatory driveway at approximate chainage 0+430 m, same as the previously-identified preferred alignment in the EIS. The design at this location is differentiated from the preferred channel alignment based on the absence of a crossing for the MUP, which is considered a benefit from a corridor connectivity standpoint. The adjustments required at this location do not otherwise impact the form and function of Clythe Creek, from the previously-identified preferred channel alignment in the EIS.

The second location requiring adjustment for Alternative 2 (approximate chainage 0+850 to 1+050 m, Sheet 06) is the same as Alternative 1. The associated implications to the planform and proposed design refinements discussed for Alternative 1, are consistent between the two Alternatives.

5.1.3 Alternative 3: Remove Boulevards and Reduce Multi-Use Pathways to 2.5 m Adjacent to the Reformatory Entrance

Adjacent to the Reformatory Property, Road Alternative 3 considers the elimination of boulevards and provision of narrowed 2.5 m multi-use paths within the York Road right-of-way. Per City direction provided at the December 20, 2017 meeting, a 1.0 m platform, 0.5 m rounding, and minimum 3:1 embankment slopes are provided on the south side.

The justification for the change in cross-section is to maximize separation between the driving lanes and heritage features at the former Reformatory property. The reduced infrastructure widths permit the roadway alignment to be shifted 2.0 m to the north relative to the Class EA design. with the northerly shift in road alignment and reduction in the multi-use path width from 3.0 m to 2.5 m, the south multi-use path would be located a minimum of 1.5 m from the eastern heritage wall, with an average separation distance of approximately 2.5 m. While the driving lanes would be moved further away from the heritage wall as compared to Road Alternatives 1 and 2, the distance would not be sufficient to ensure the wall would be located beyond the recommended 6.5 m clear zone of the roadway. As a result, a guiderail would need to be provided within the 1.5 m-2.5 m space between the multi-use path and heritage wall, significantly limiting both snow storage and visibility of the heritage features along this segment of York Road. Additionally, with the north side multi-use path located immediately adjacent to the property line with no boulevard, all overhead lighting and utilities would need to be located south of the roadway.

While Road Alternative 3 would have impacts on snow storage, utilities and visibility of the heritage wall, the northerly realignment and reduced cross-sectional width would minimize the impacts to the creek and would not directly impact the heritage walls. Where grading limits would impact the creek and in-water heritage features, similar to Road Alternatives 1 and 2, implementation of various segments of retaining walls/soil systems should be considered.

Roadway cross-section Alternative 3 is illustrated in Figure 5.4, with the associated plan and profile drawings provided in Appendix K2. The guiderail layout is illustrated in Figure 5.5.

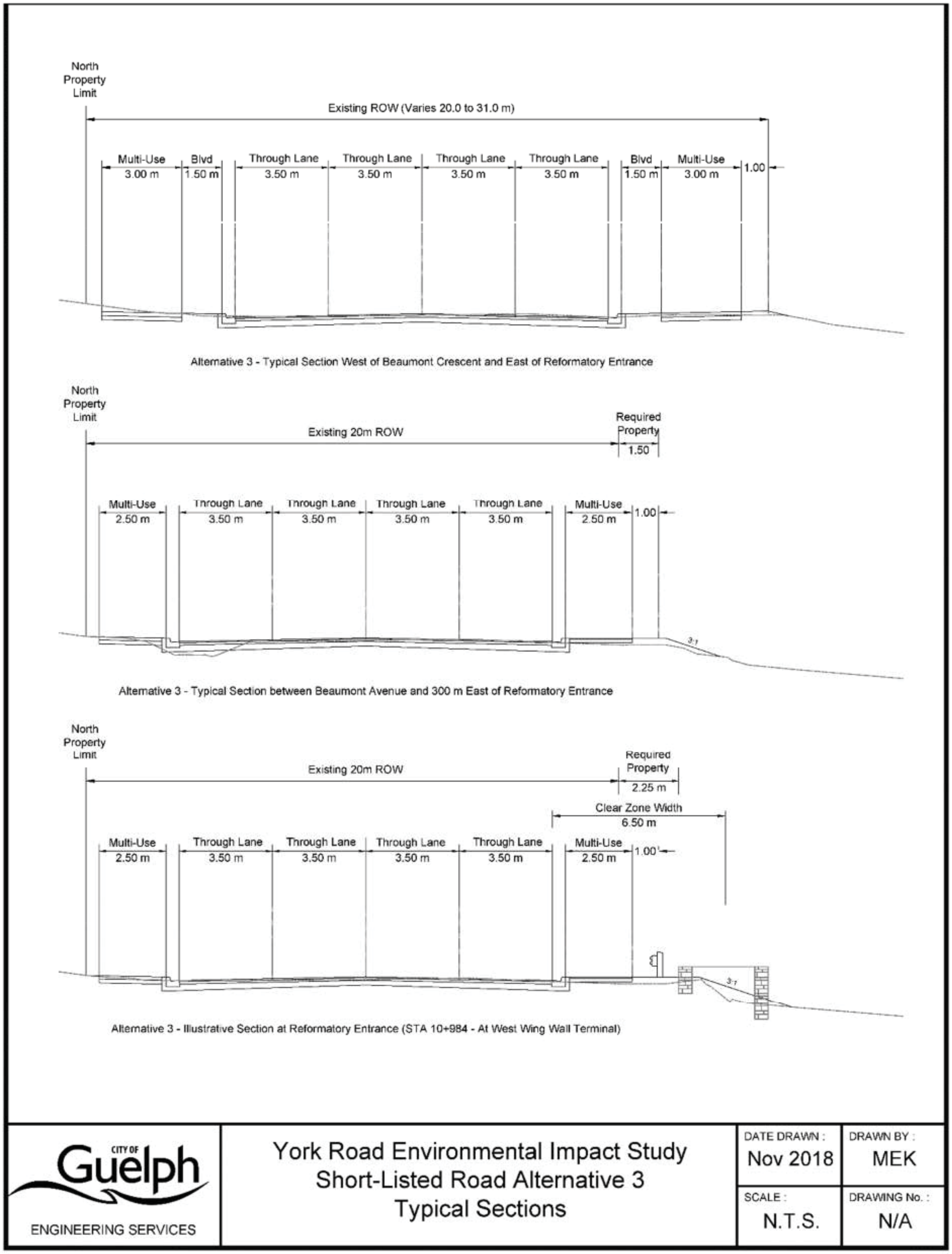


Figure 5.4 Typical Roadway Cross-Section for York Road Alternative 3.

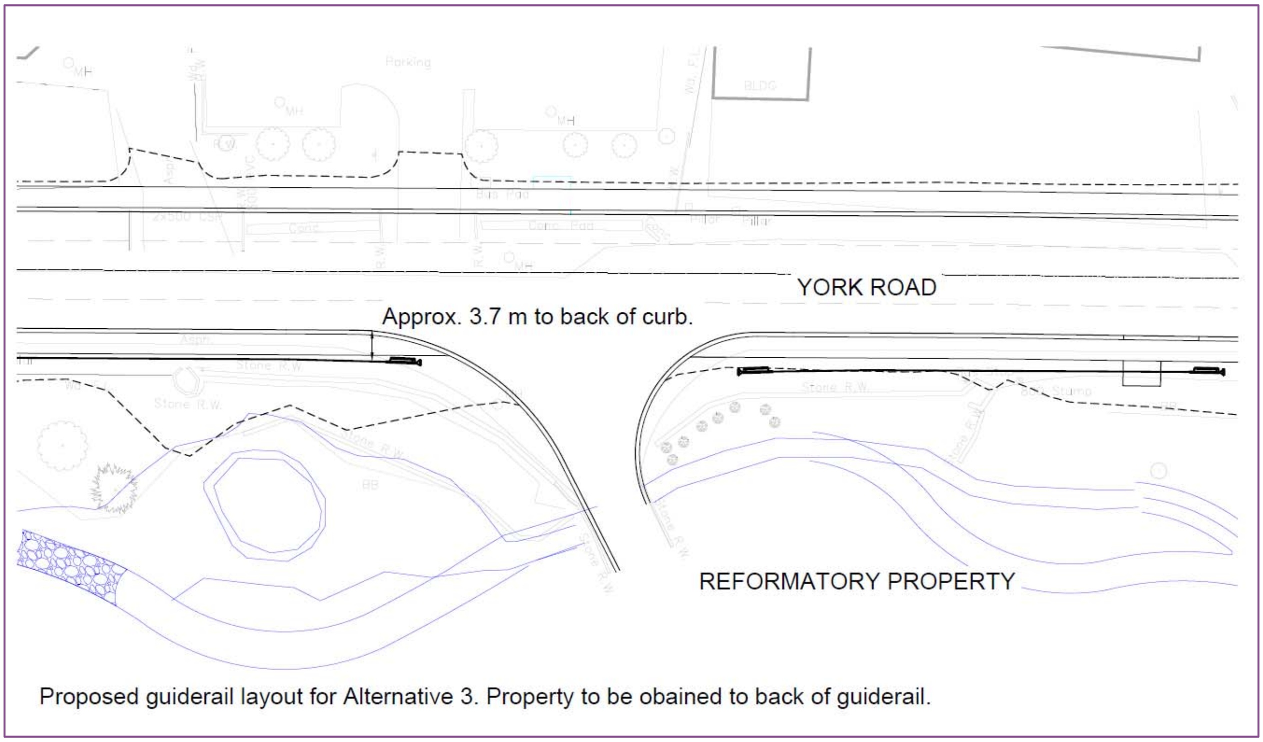


Figure 5. 5: Roadway Plan View for York Road Alternative 3.

Road Alternative 3: Option 3: Ultimate Channel Configuration:

A 3:1 H:V roadway grading slope has been selected to establish the constraining limits when considering changes to the channel planform. An evaluation of the new grading limit for Road Alternative 3 reveals that it overlaps with the preferred channel alignment at two separate locations.

The first location where the revised grading slope intersects with the preferred channel alignment is within Reach C-9A, upstream of the Reformatory driveway (approximate chainage 0+425 m, Sheet 4, Sub Appendix B, Appendix K2). Within this reach, the existing planform of Clythe Creek flows over a stone weir (Cultural Feature '14'). The preferred channel alignment option realigns the primary flow south around the stone weir, reconnecting to the existing channel downstream of the weir. It is possible to incorporate the 'high-flow' channel that conveys higher flows over the weir structure. This design involves the establishment of an island-type feature downstream of the weir that separates the newly constructed primary channel and the existing length of channel that will be maintained to convey flows passing over the weir. The two channels connect further downstream towards the Reformatory driveway at approximate chainage 0+430 m (ref. Sheet 4, Sub- Appendix B, Appendix K2).

From this location, the creek then flows under the Reformatory Bridge. At the stone weir, the EIS preferred alignment incorporated a 'high-flow' channel that directs flows exceeding bankfull (i.e., close to overtopping the channel banks) towards and through the existing channel at the weir. This approach supports fish passage through the primary channel but also allows for the weir to be activated at higher flows, partially mitigating its disconnection from the main channel. However, to accommodate the 3:1 H:V road grading an adjustment to the preferred channel alignment is necessary. Based on the required grading, it is not possible to re-connect the channel at the pool immediately downstream of the weir as the pool must be infilled to achieve the desired grading. As this pool becomes unusable, the proposed channel alignment must tie-in to the existing channel further downstream. As such the creek configuration eliminates the 'high-flow' channel and any continued flow through the weir as the grading and fill would cut off the connection location. The adjustments required at this location do not otherwise impact the form and function of Clythe Creek from the EIS preferred channel alignment.

The second location requiring adjustment is in the vicinity of the Hadati Creek confluence (approximate chainage 0+850 to 1+050 m, Sheet 5, Sub-Appendix B, Appendix K2). The grading to accommodate the alternative roadway/MUP cross section necessitates shifting the EIS design planform slightly south. The shifted planform aligns with the concrete box culvert that is proposed to replace the existing corrugated steel pipes at this location. Downstream of the crossing, Hadati Creek flows south through a box culvert under York Road where it enters Clythe Creek at the outlet. The box culvert is to be extended on the south side, facilitated by the shift south of the Clythe Creek planform. Whereas the preferred channel alignment utilized the existing creek planform for approximately 40 m west of the culvert, the revised planform requires additional cut as the creek bend begins further upstream. The existing length of creek that was previously intended as part of the design channel will be filled. The design change at the second location does not have significant implications on channel function when compared to the original preferred channel alignment. The Clythe Creek realignment could have commenced further upstream to facilitate complete separation from Hadati Creek and potential benefit in Clythe Creek's thermal regime, but the issue with this realignment approach is that it would significantly reduce the Clythe Creek length and the flow regime within the lower reach of Clythe Creek. No improvements would be made to Hadati Creek north of York Road as part of the York Road works.

5.1.4 Alternative 4: Remove Boulevards, Maintain 3.0 m Multi-Use Pathways and Relocate Heritage Walls Beyond Clear Zone Limit.

Similar to Road Alternative 2, Road Alternative 4 would eliminate the boulevards and provide full 3.0 m wide multi-use paths on both the north and south sides of York Road from Beaumont Avenue to east of the Reformatory property. The removal of the boulevard is necessary to prevent fill limits of a widened corridor from significantly impacting the in-water heritage features, although this should be reconsidered at the detailed design phase.

Alternative 4 would require the dismantling and relocation of the Reformatory Entrance walls to facilitate a 6.5 m separation from the edge of pavement.

Relocation of the cultural heritage walls, per a City-approved Conservation Plan, would provide additional space for snow storage and utilities, while eliminating the need to provide a guiderail along the roadside of the heritage features. Relocation of the wall will need to be undertaken by skilled heritage masons, and will require additional embankment grading and use of retained soil systems (or retaining walls) between the heritage wall and the creek. Interpretive signage would add to the understanding of the significance of the walls.

Although the walls would be further south, the relocation would bring them back to their original 1920 appearance. This, along with interpretive signage, would improve the public's view and understanding of the history of the entranceway.

Since preservation in situ is not feasible for all of the heritage resources, rehabilitation, adaptive reuse and restoration must be done in a sensitive manner in order to protect the site's heritage value.

It is recommended that a Conservation Plan (ref. Section 6: Recommendations of the Revised Heritage Impact Assessment) be prepared during the detailed design plan phase for improvements to York Road. Formulation of the detailed design plan phase will clearly show in-depth elements of how and where the protection of the heritage resources will be. A Conservation Plan would be prepared by a qualified heritage consultant and would guide the work of relocating the built heritage resources within this locally and provincially significant cultural heritage landscape.

The scope of the Conservation Plan should include the following:

- Preliminary recommendations for restoration, rehabilitation and/or adaptive reuse;
- Critical short-term maintenance required to stabilize the heritage resources and prevent deterioration;
- Measures to ensure interim protection of heritage resources during phases of construction or related development;
- Security requirements;
- Restoration and replication measures required to return the property to a higher level of cultural heritage value or interest integrity, as required;
- Appropriate conservation principles and practices, and qualifications of contractors and trades people that should be applied, especially in the dismantling and reassembling of the wing walls;
- Longer term maintenance and conservation work intended to preserve existing heritage fabric and attributes;
- Drawings, plans, specifications sufficient to describe all works outlined in the Conservation Plan;
- An implementation strategy outlining consecutive phases or milestones;
- Cost estimates for the various components of the plan; and
- Compliance with recognized Standards and Guidelines for the Conservation of Historic Places in Canada, the Guelph Innovation District (York District Lands) Official Plan Amendment 54, City of Guelph Official Plan (2014) and other recognized heritage protocols and standards.

In order to optimize the available space within the right-of-way, the roadway alignment would be shifted 1.5 m to the north relative to the design presented in the Class EA. The road profile has also been adjusted to minimize grading impacts on adjacent properties. As with all other Alternatives, s, extension of the Hadati Creek culvert would be required. Opportunities to reduce impacts to the creek and in-water heritage features through implementation of various segments of retaining walls/soil systems could be investigated as part of detailed design. The Alternative 4 roadway cross-section adjacent to the relocated heritage walls is illustrated in Figure 5.6 and Figure 5.7, with the associated plan and profile drawings provided in Appendix K2.

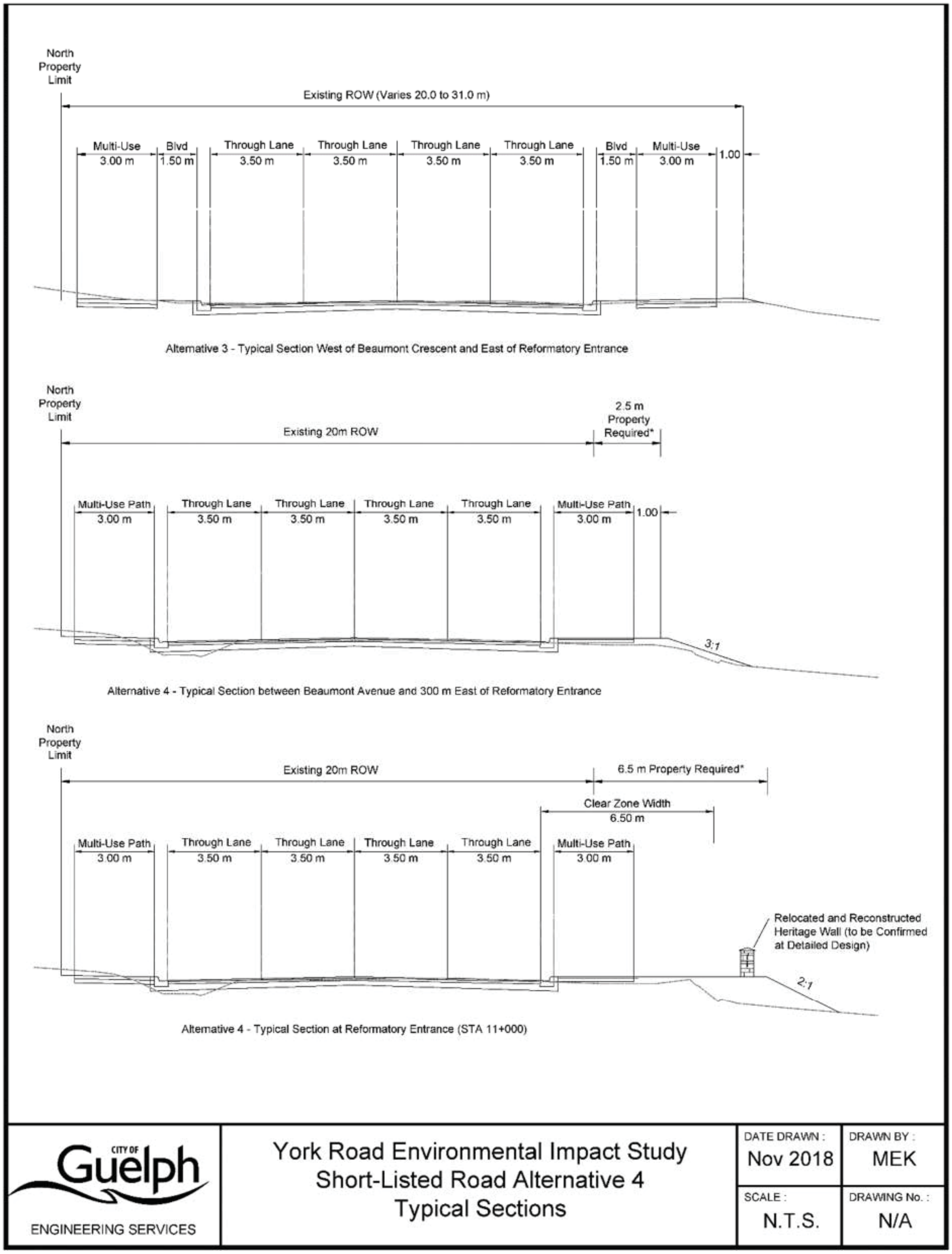


Figure 5.6: Typical Roadway Cross-Section for York Road Alternative 4.

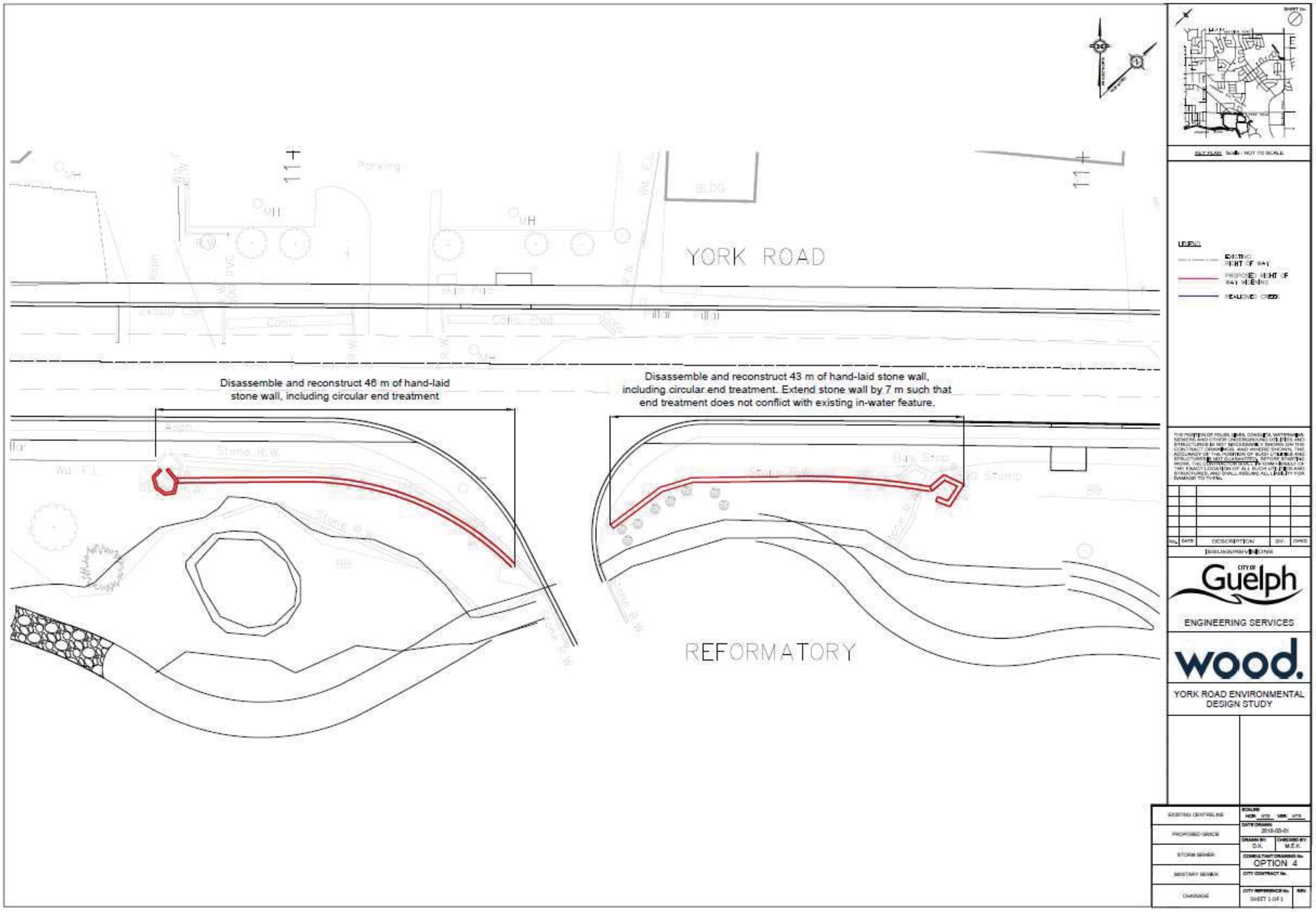


Figure 5.7: Roadway Plan View at Reformatory Entrance for York Road Alternative 4.

Road Alternative 4: Option 3: Ultimate Channel Configuration:

Refer to Alternative 3 for Creek Option 3.

5.1.5 Alternative 5: 3.0 m Wide Multi-use Pathway on the North Side and Additional Multi-use Pathway Located South of Clythe Creek

In an attempt to minimize impacts to the significant heritage features at the Reformatory Entrance, as well as provide the desirable boulevard width for snow storage, Road Alternative 5 relocates the south multi-use pathway to the land south of Clythe Creek from the future Elizabeth Street intersection, to beyond the Reformatory Entrance gates. Outside of these limits, 3.0 m wide MUPs and 1.5 m boulevards can be provided on both the north and south sides of the roadway, within the available ROW. The typical section for this alternative is provided as Figure 5.8.

Road Alternative 5: Option 3: Ultimate Channel Configuration:

Refer to Alternative 3 for Creek Option 3.

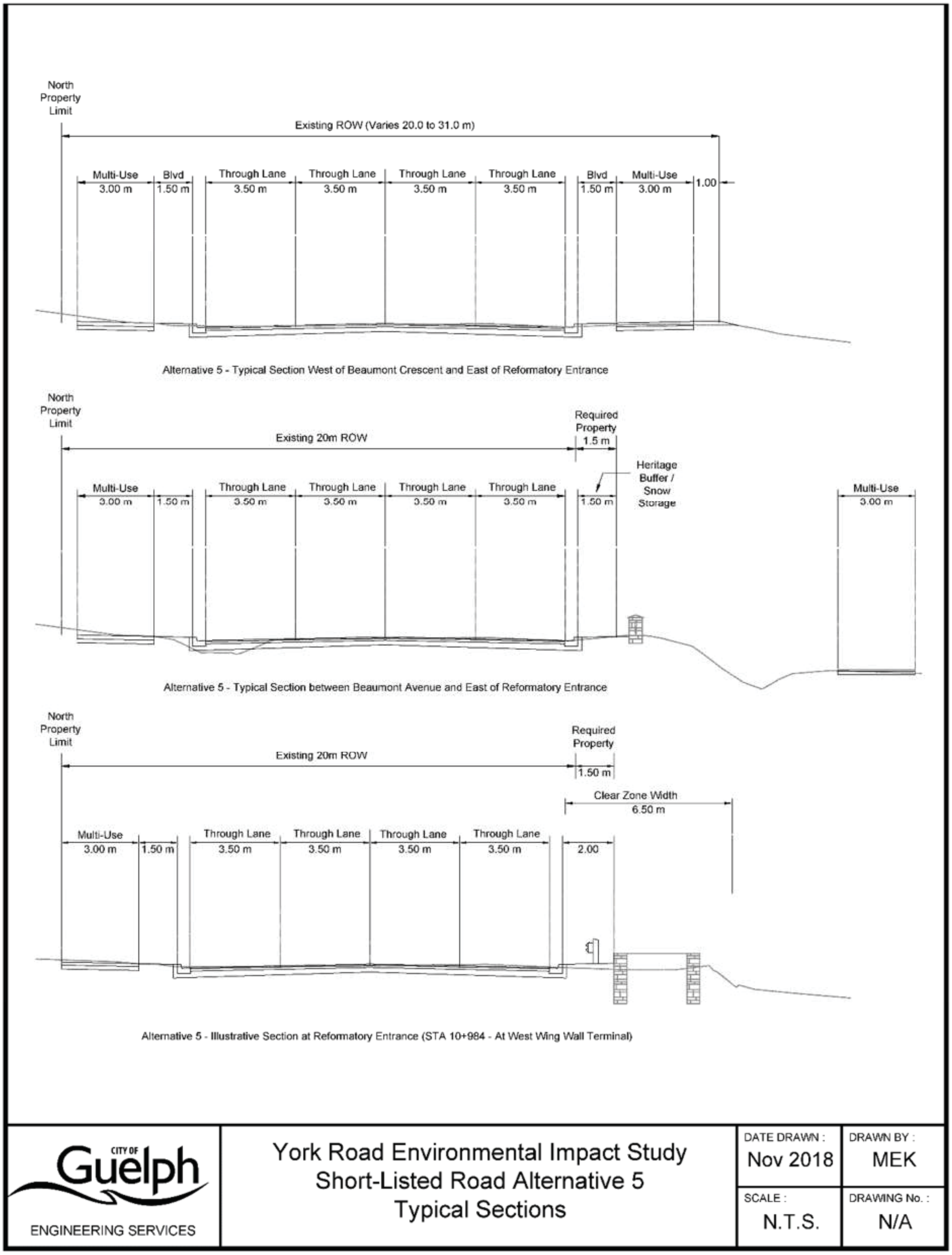


Figure 5.8: Alternative 5 -Typical Section Adjacent to York District Lands

6.0 Identification of a Preferred Alternatives

Selection of a preferred alternative for redesign of York Road and realignment of Clythe Creek required consideration, and careful balancing, of the following:

- Defined north property limit;
- Provision of required vehicular and active transportation infrastructure within the corridor;
- Mitigation of impacts to heritage features, particularly the significant features associated with the Reformatory Entrance;
- Provision of equivalent levels of service for vehicular and active transportation modes;
- Need to maintain existing entrances where they could not be combined or relocated;
- Provision of 1.5 m boulevard for snow storage;
- Ability to mitigate impacts / improve existing conditions within Hadati and Clythe Creeks;
- Ability to mitigate impacts / improve existing conditions of adjacent terrestrial and aquatic habitats;
- Minimize impacts to existing utility infrastructure; and
- Minimize construction costs.

Through discussions with the City and key stakeholders, the most critical corridor design constraints were identified as: the defined north property limit, the need for a four vehicular lane cross-section, provision of active transportation facilities with equivalent LOS as the vehicular facilities on both sides of the roadway, and mitigation of impacts to significant natural and cultural heritage features. Realignment and redesign of the creek and associated habitats was considered to be flexible enough to accommodate any of the short-listed road design, based on the space availability adjacent to the proposed right-of-way.

Only Road Alternative 4 was able to address the aforementioned critical corridor design constraints, with the removal of the boulevard through segments adjacent to the York District Lands identified as an acceptable compromise by the City. Discussion regarding screening of the Road Alternatives is briefly highlighted in Table 6.1 and further expanded upon in Appendix K.

Table 6.1: Summary of Short-listed Alternatives Assessment

Short-Listed Road Alternative	Key Details Relative to Critical Corridor Design Constraints	Recommended for Further Consideration
1	• Provides all required transportation infrastructure • Results in significant fill being added into the existing Clythe Creek floodplain. • Significant impacts to both in-water and Reformatory Entrance heritage features, with no ability to relocate features between the road and creek.	No
2	• Significant impacts to the Reformatory Entrance walls.	No

Short-Listed Road Alternative	Key Details Relative to Critical Corridor Design Constraints	Recommended for Further Consideration
3	• No boulevards and substandard multi-use pathways widths. • Reformatory Entrance heritage features would be located within the roadway clear zone, requiring protection with guiderail, and limiting ability to see walls and provide snow storage.	No
4	• Limited ability to provide boulevards adjacent to the York District Lands in order to mitigate impacts to in-water heritage features (to be reconfirmed during detailed design) • Reformatory Entrance features would be relocated and rehabilitated outside of the roadway clear zone.	Yes
5	• Relocation of the south multi-use pathway into the floodplain of Clythe Creek would result in reduced active transportation levels-of-service relative to that provided for vehicular traffic due to flood potential.	No

7.0 Recommended Design Alternative

7.1 Recommended Design Alternative Summary

The preferred alternative has been developed from the recommendations of the Class EA with consideration to input from the public, stakeholder groups, City staff and government agencies. The recommended design has been summarized as per the following, with additional detail in the subsequent report sections:

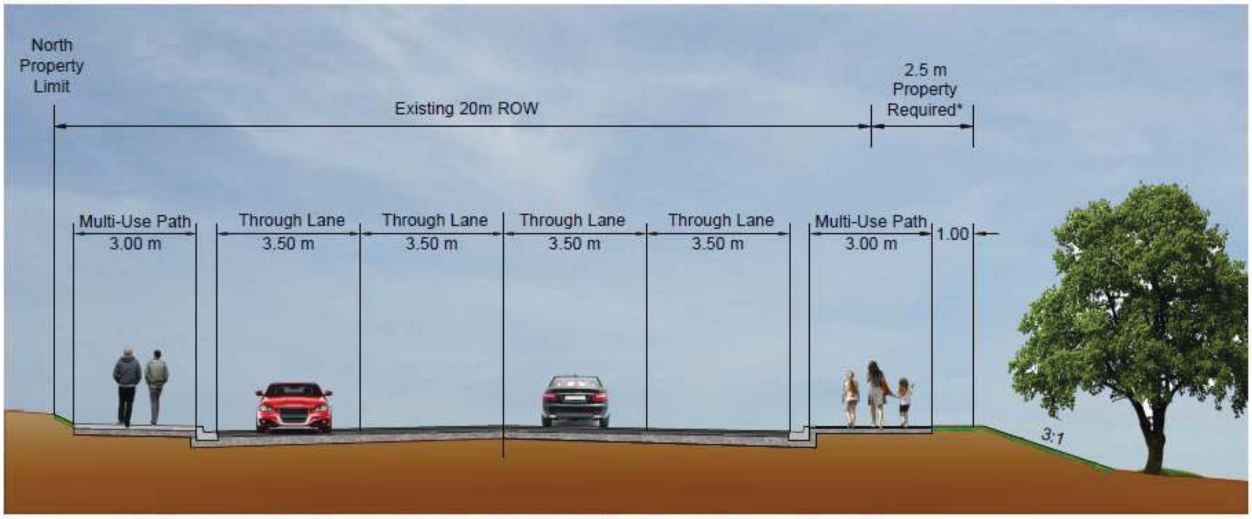
- York Road will consist of four 3.5 m wide lanes with 3.0 m wide multi-use pathways on both the north and south sides, within the York Road right-of-way. Boulevard widths will vary to limit impacts to adjacent heritage features (both in-water and at-grade) and Clythe Creek.
- The Reformatory Entrance Walls will be shifted south, beyond the clear zone limit of the roadway, by a qualified heritage mason;
- Clythe Creek will be realigned upstream of the former Reformatory driveway, with the creek partially realigned and altered downstream of the driveway to the confluence with Hadati Creek. Downstream of the confluence, Clythe Creek will be realigned to facilitate an improved outlet with the Eramosa Creek; this could be completed as a separate phase of creek works, independent from the creek works required for the York Road improvements. The connection between the ponds would be relocated from Clythe Creek to the Eramosa River; there is already a connection to the river from the south pond. Both the York Road and Royal Jaycees' Park driveway crossings would be replaced to improve hydraulics and for stream morphology considerations.

7.1.1 York Road

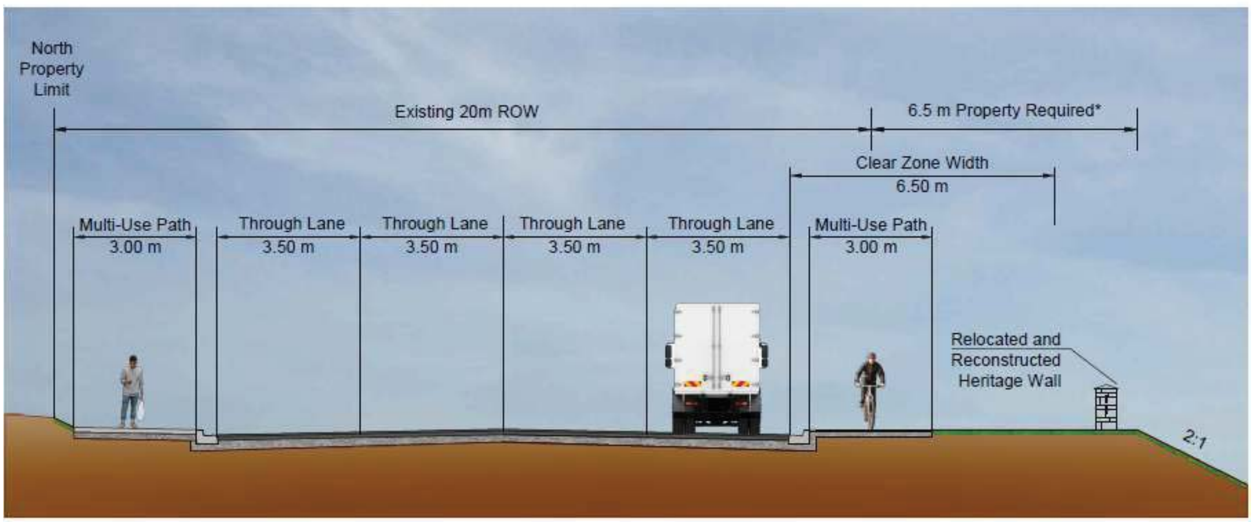
7.1.1.1 Recommended Cross-Section

The preferred York Road cross-section consists of four 3.5 m through lanes (two in each direction), with 3.0 m wide multi-use pathways provided on both the north and south sides. From Victoria Road South to Beaumont Crescent, as well as from approximately 300 m east of the Reformatory Entrance to the East City Limit (unconstrained segments), 1.5 m wide boulevard will be provided on both the north and south sides for snow storage and to provide additional separation between vehicular traffic and pedestrians and cyclists. From Beaumont Crescent to 300 m east of the Reformatory Entrance (constrained segment), the boulevards will be removed to limit impacts to significant heritage features and Clythe Creek. The ability to provide boulevards within the constrained section is to be reconsidered during detailed design. The typical recommended cross-sections through both the constrained and unconstrained segments of York Road are illustrated in Figure 7.1.

Note that due to right-of-way constraints, no additional width is available for provision of turning lanes at intersections adjacent to the York District (Reformatory) Lands.



Alternative 4 - Typical Section between Beaumont Avenue and 300 m East of Reformatory Entrance



Alternative 4 - Typical Section at Reformatory Entrance (STA 11+000)

Figure 7.1: Typical Cross-Sections

7.1.1.2 Horizontal Alignment

The recommended horizontal alignment primarily parallels the existing centerline, with the exception of a few critical locations where it shifts to avoid impacts to property limits, Clythe Creek and various heritage features. Starting at Victoria Road, the York Road alignment curves to the south to limit the amount of property required on the north side. East of Wells Road, the alignment moves back to the north, bringing the north edge of the proposed multi-use pathway in line with the EA-proposed north property limit. From Elizabeth Street, the alignment moves further to the north of the existing centerline (~ 2.75 m) to maximize separation of 2.0 m between the Reformatory entrance features and the back of the proposed curb. Beyond the Reformatory entrance, the alignment shifts back to the south to maintain suitable grades on the steep entrances to 820 and 840 York Road. The alignment then shifts to follow the existing centerline from the heritage gateway feature at the eastern limit of the Reformatory property to Watson Parkway. Between Watson Parkway and Skyway Drive, the proposed centerline follows south of the existing centerline such that the proposed infrastructure is centered within the available right-of-way (ref. Appendix N). Additional property will be required at the intersections of York Road with Victoria Street, Watson Parkway and Watson Road, as well as at future bus pad locations (to be confirmed with Guelph Transit). Locations where additional property is required are illustrated in the road plan and profile drawings provided in Appendix N, with additional details provided in Section 7.1.6.

7.1.1.3 Vertical Alignment (Profile)

The recommended vertical alignment for the widened York Road primarily follows that of the existing two-lane roadway to minimize impacts to adjacent properties. The only significant variance from the existing profile is proposed for between Elizabeth Street and Cityview Drive, in order to provide the minimum 0.5% longitudinal grade required for drainage of the urbanized cross-section.

7.1.1.4 Intersections and Traffic Calming

A number of comments were raised by members of the public regarding the need for improved pedestrian crossing facilities and traffic calming features. While these aspects of roadway design were not within the scope of the current study, several discussions were regarding feasibility of implementation. As discussed in Section 5 the Class EA-approved York Road right-of-way (ROW), which is highly constrained by development and Clythe Creek, make use of the majority of the traditional traffic calming measures infeasible. However, use of enforced speed limit reductions, median treatments, and streetscaping should be further examined during detailed design.

It should be noted that, as the study portion of York Road functions as an MTO 'Connecting Link' bringing Highway 7 through the City of Guelph, the implementation of these types of measures must be confirmed with the Ministry during the detailed design phase.

7.1.2 Creek Design

The creek design has accommodated the proposed grading for Road Alternative 4 by realigning the creek, south from the road into a new channel from the Clythe Creek/ York Road culvert to upstream of the former Reformatory driveway. The realigned channel would have connection to the existing channel with the cultural heritage features during storm events of a 2 year frequency or greater. West of the driveway proposed grading works would provide a natural form to the channel while maintaining the location of the channel and minimizing the impact to cultural heritage features. The realigned connection to the Eramosa River provides improved sinuosity and maintains a connection to the existing natural heritage system, while improving the thermal regime, by no longer flowing through the online pond system.

7.1.3 Cultural Heritage Assessment

Road Alternative 4 is preferred from a cultural heritage perspective, as although it would require relocation of the walls on each side of the former Reformatory entranceway, the cultural heritage walls would be viewable to the public and the condition of the walls would be improved (ref. photos #15 and #16, this section).

Under Alternative 4 the proposed roadway improvements include the widening of York Road and a 3.0 m wide multi-use path on each side of the roadway in the vicinity of the former Reformatory entranceway. Based on the required 6.5 m clear zone width from the south inside road curb, without the use of a guiderail, the cultural heritage walls would have to be relocated outside the clear zone. As such, a minimum distance of 3.5 m from the south edge of the multi-use path to the walls would result. As indicated previously, the removal of the boulevard is necessary to prevent fill limits of a widened corridor from significantly impacting the creek. A qualified heritage stone mason would be required to remove the existing walls, clean the stones, add additional stones as required and rebuild the walls and the circular end treatments. Although costly, relocating the walls would provide a resemblance of the original walls appearance from the 1920's, when the walls were viewable from the road. The current roadway elevation has been raised from the road that existed in the 1920s, as such reducing the view of the walls. Relocation of the walls would improve the public's view and understanding of the history of the entranceway.

Photo No	Photo	Description	Impacts
15		Fieldstone east entrance wall, curved with sentinel stones and circular end treatment	Relocation: This feature would be relocated in Option 4 due to the grading needed for road widening and multi-use path and for snow removal requirements.
16		Fieldstone west entrance wall, curved with sentinel stones and circular end treatment	Relocation: This feature would be relocated in Option 4 due to the grading needed for road widening and multi-use path and for snow removal requirements.

Three (3) heritage masons were contacted regarding the cost of the removal and replacement of the fieldstone entrance wing walls on both sides of the entranceway. They were provided an explanation of the work that was required; photos of the current walls, including a 1920's photo of how the wall looked originally; and the plan and cross-sections illustrating the extent of the wall relocations (full wall relocation, not partial relocation as per plans provided in Sub-Appendix E, Appendix K2).

The three heritage masons chosen for preliminary quotes and subsequently contacted were all members of the Canadian Association of Heritage Professionals (CAHP), (versus local mason with no membership in the CAHP), as per the following:

- Barkley Hunt: Owner, Hunt Heritage Masonry, 549 Runnymede Road, Toronto, ON 416-219-1616, info@huntheritage.ca
- Chris Huntley: Vice President, Heritage Restoration Inc., 14 Paisley Lane, Stouffville, ON 416-567-4522, Chris.Huntley@hrigroup.ca

- Dean McLellan: Owner, Stonework and Dry-Stone Walling, 392018 Main Street, Holstein, ON 519-321-1586, dean.mclellan@yahoo.ca

The preliminary quotes received for dismantling and rebuilding the cultural heritage walls were the following:

- Barkley Hunt: $150,000.00
- Chris Huntley: $300,000.00
- Dean McLellan: $150,000.00

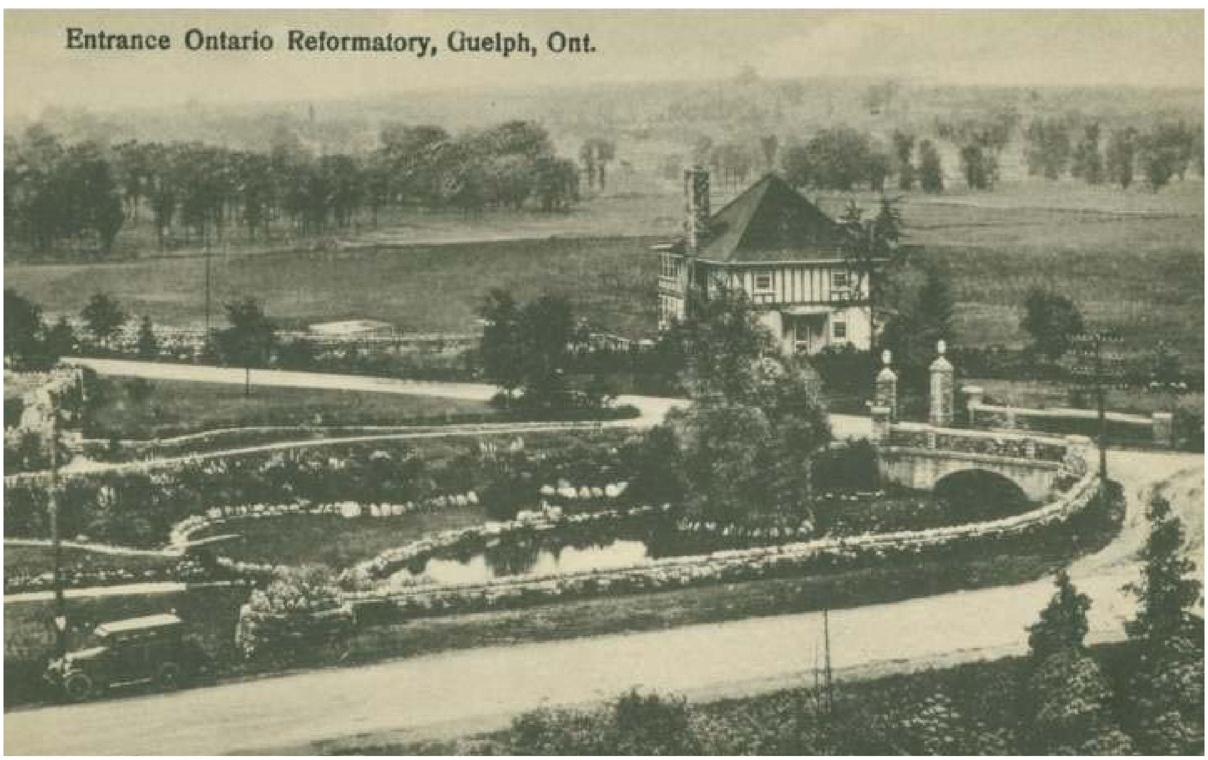
These quotes are based on phone conversations, emails, photographs (ref. Photographs 1A-5A) and plan drawings (ref. Sub- Appendix E, Appendix K2), and are considered to be preliminary cost estimates only. None of the stone masons visited the site for additional understanding of the wall reconstruction scope. Due to the limited nature of the information available, the preliminary cost estimates are considered to be lower than the anticipated construction costs. Detailed cost estimates from stone masons during the detailed design stage (when more information could be made available), and tender stage (requiring a mandatory site visit), would be expected to be significantly higher than the estimates received, based on the three (3) heritage masons not being able to assesses the walls in detail through a site visit, and determine more accurately the potential scope for relocation of the walls.

Photograph 1A: East side of entrance bridge. Only top of wall is visible

Photograph 2A: Taken from inside the property with wall more visible

Photograph 3A: The circular end treatment east of the entrance bridge.

Photograph 4A: West of the entrance. Only the top of the wall is visible.



Photograph 5A: 1920 picture of dry stone wing wall with circular end treatment. The height of the wall is noticeably taller. The existing wall has been partially buried due to road grading.

A Heritage Impact Assessment (HIA) of the Preferred Alternative - Road Alternative 4 and Option 3 Creek, has been included in Appendix L. The HIA provides recommendations for heritage resources rehabilitation, adaptive reuse and restoration. In addition, the HIA provides recommendations for the scope of work for a Conservation Plan to be conducted by a qualified heritage consultant as part of detailed design.

7.1.4 Terrestrial Habitat

The key sensitivities potentially present within the YREDS Study Area include sensitive ELC communities including locally significant wetlands and cultural woodlands, Species at Risk (SAR), regionally important vegetation - City of Guelph (City of Guelph, 2012) & Wellington County (Frank and Anderson 2009) and other significant vegetation, area sensitive birds, potentially breeding locally sensitive birds; and candidate Significant Wildlife Habitat (SWH) (ref. Sub-Appendix C-1, Appendix K2).

The potential impacts to terrestrial habitat include changes to soil permeability, water balance, drainage patterns, runoff, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance to wildlife; import/export of fill; removal of Open Country Bird Habitat encroachment of natural areas indirect pollution; and removal of significant species and their habitat. For a description of each impact, its potential magnitude, and the duration; review Section 8 and Sub-Appendix C-2, Appendix K2.

The proposed area of impact, determined using the limit of grading activities, is very similar between Alternatives. For Alternative 4 a key difference in the creek alignment is between creek interval 0+450 and 0+350, upstream from the Reformatory bridge. The road alignment Alternatives are also quite similar in area of impact, as they only vary slightly due to the addition/removal of a 1 m boulevard. The recommended Road Alternative has the following potential to impact:

- Sensitive ELC communities (both direct and indirect);
- Regionally Important Vegetation and their habitat (both direct and indirect);
- Other significant vegetation;
- Species at Risk (SAR);
- Area Sensitive Birds;
- Potentially Breeding Locally Sensitive Birds; and
- Candidate Significant Wildlife Habitat (SWH).

For a description of each impact, its potential magnitude, and the duration, review Section 8 and in Sub-Appendix C-2, Appendix K2. Many potential indirect impacts can be avoided through mitigation measures and recommendations, discussed further in Section 8.

The preferred road alternative has the potential for both direct and indirect negative impacts to terrestrial habitat. There would be minimally expected or potential induced negative impacts to terrestrial habitat, as the general use of the road corridor is not changing, nor is the way that people would interact with it. Mitigation and compensation efforts should be reviewed and finalized as a part of Detailed Design. That being said, mitigation measures to reduce or eliminate the magnitude and duration of the potential negative impacts can be developed (ref. Sub-Appendix C-3, Appendix K2). Additional recommendations to verify that there are no negative impacts include:

- Development of a monitoring plan with quantitative thresholds to ensure that the proposed mitigation and compensation measures perform as intended. The monitoring plan will need to consist of baseline, during construction, and post-construction stages. It should include monitoring stations, design and reporting guidelines and deadlines. Deficiencies identified through monitoring activities will need to be addressed to the satisfaction of the City of Guelph. The post-development monitoring program will need to include potential management responses to rectify potential negative impacts, verify performance targets (e.g. habitat for target species), and unforeseen negative ecological impacts.
- Bald Eagle winter surveys as part of the environmental studies required through the future block plan process for the GID area.
- Further assessment of the area towards the western edge of the YREDS study area to identify its potential to support wetland communities; identification of biosalvage opportunities; and development of a protocol to check for nesting

7.1.5 Stormwater Management Strategy

To determine the preferred stormwater management approach for the recommended road works, the impact of the proposed road widening on Clythe Creek peak flows has to be determined. The existing condition PCSWMM model has been updated for the proposed road widening and improvements to determine if quantity controls are required. An assessment of pavement areas has also been conducted to facilitate stormwater quality controls assessment.

7.1.5.1 Future Conditions (Stormwater Quantity Control Verification)

A hydrologic analysis for York Road under existing and proposed conditions was conducted to determine if stormwater quantity controls are necessary. Six (6) nodes for flow comparison were selected along Clythe Creek at the following intersections:

1. York Road (Node J_CC00)
2. Reformatory Driveway (Node J_York_05)
3. Royal City Jaycees Park Ponds (Node J_York_03)
4. Hadati Creek Confluence (Node J_CC04)
5. Eramosa Confluence (J_CC05)

Under existing conditions, York Road is a two-lane road with the centerline as the highpoint. The drainage from the majority of the roadway currently drains via roadside ditches except at the York Road and Watson Parkway intersection, where drainage is captured and conveyed via a storm sewer system that outlets to Clythe Creek at the York Road crossing.

Under proposed conditions, York Road is to be widened to a four (4) lane road with a multiuse path along both sides of the Right-of-Way (ROW). The drainage from the proposed York Road ROW will be captured and conveyed through a storm sewer system and outlet at various locations to Clythe Creek.

York Road subcatchments have been measured from the proposed widened York Road (ref. Figure 7.1). The multi-use pathway has been assumed to be directly connected impervious (connected to a storm sewer system or equivalent drainage system) where it runs parallel to York Road and indirectly connected impervious where it turns to the south in Royal City Jaycees Park. The future York Road catchments range from 65% to 90% impervious. The outlets of the York Road catchments have been adjusted to match the updated profile of York Road (ref. Figure 7.1). The outlets along Clythe Creek have been placed in locations where there the most room to place stormwater management controls.

Using the PCSWMM hydrologic model, the peak flows for the existing and proposed conditions at the specified nodes were compared. Tables 7.1 and 7.2 summarize the contributing drainage area for each flow comparison node and the existing and proposed conditions peak flow rates for the 2 to 100-year storm events (3 hour Chicago distribution), as well as the 25 mm and Regional Storm events. Table 7.3 shows the percent difference between existing and proposed peak flows.

Table 7.1: Simulated Peak Flows for Existing York Road Conditions (m^3/s)

Location	Node	Area (ha)	25mm Chicago	Return Period Flows – 3 Hour Chicago						Regional Storm
				2	5	10	25	50	100	
York Road	J_CC00	1198	2.1	3.6	5.6	8.6	15.9	24.0	33.3	81.4
Reformatory Driveway	J_York_05	1207	2.0	3.4	5.8	8.6	15.9	24.0	33.1	81.6
Royal City Jaycees Park	J_York_03	1347	2.8	4.8	8.4	11.5	19.1	28.5	37.7	88.4
Hadati Creek	J_CC04	2130	4.0	6.9	12.7	20.3	30.0	40.6	51.1	88.7
Eramosa River	J_CC05	2138	6.0	9.0	15.7	23.4	33.1	43.4	53.3	82.4

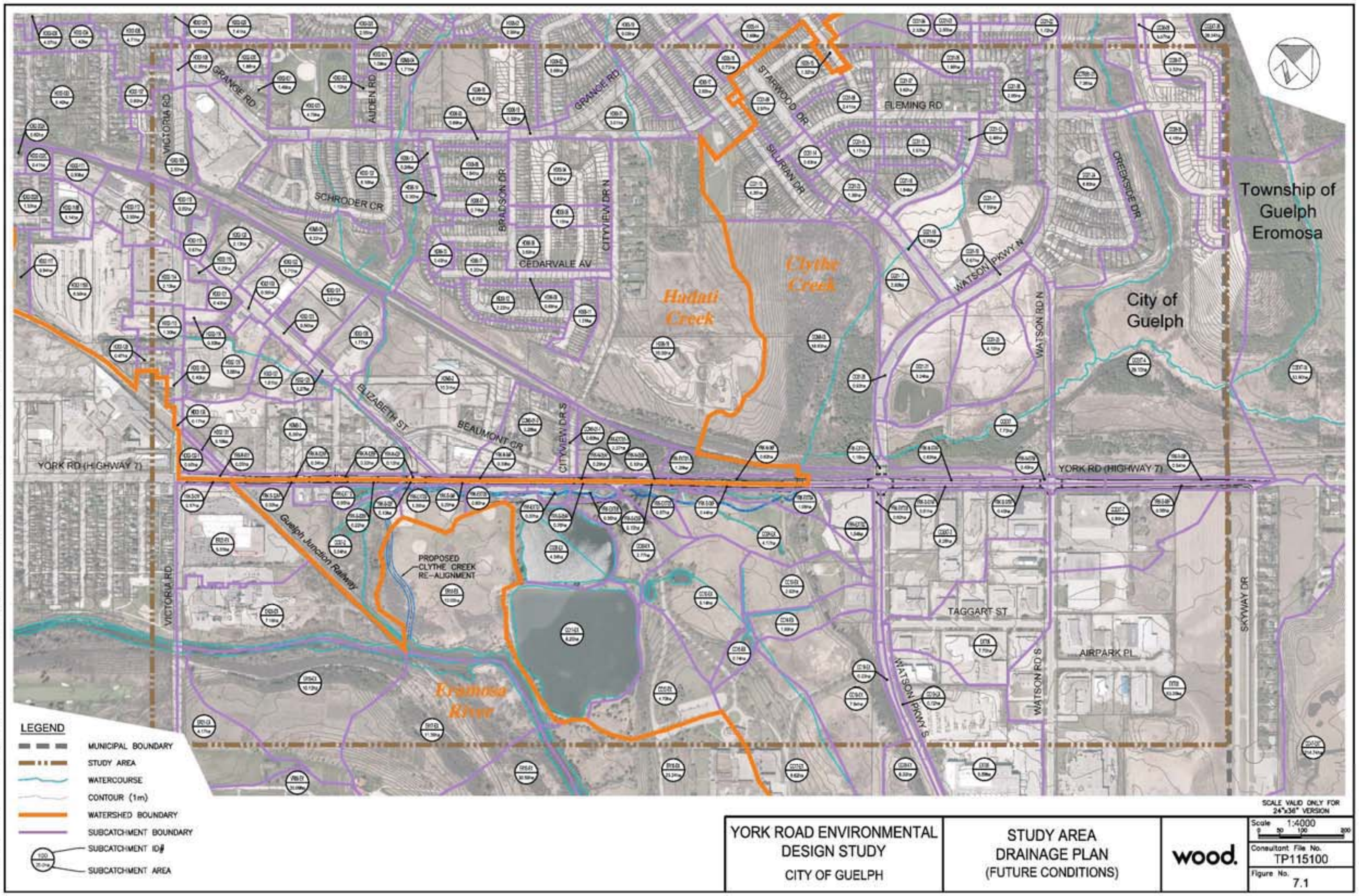
Table 7.2: Simulated Peak Flows for Proposed York Road Conditions (m^3/s)

Location	Node	Area (ha)	25mm Chicago	Return Period Flows – 3 Hour Chicago						Regional Storm
				2	5	10	25	50	100	
York Road	J_CC00	1198	2.2	3.8	5.8	8.6	15.9	24.0	33.3	81.4
Reformatory Driveway	J_York_05	1207	2.1	3.5	5.9	8.6	15.9	24.0	33.1	81.6
Royal City Jaycees Park	J_York_03	1347	2.9	4.8	8.4	11.5	19.2	28.5	37.7	88.4
Hadati Creek	J_CC04	2130	4.1	6.9	12.7	20.4	30.1	40.7	51.1	88.7
Eramosa River	J_CC05	2138	6.1	9.0	15.7	23.4	33.2	43.5	53.3	82.4

Table 7.3: Difference Between Existing and Proposed Peak Flows (%)

Location	Node	25mm Chicago	Return Period Flows – 3 Hour Chicago						Regional Storm
			2	5	10	25	50	100	
York Road	J_CC00	5.5	4.9	3.7	0.0	0.0	0.0	0.2	0.0
Reformatory Driveway	J_York_05	3.9	1.8	0.6	0.1	0.1	0.0	-0.1	0.0
Royal City Jaycees Park	J_York_03	3.7	1.6	-0.3	-0.2	0.1	0.0	-0.2	0.0
Hadati Creek	J_CC04	1.6	0.3	-0.1	0.1	0.1	0.0	0.0	0.0
Eramosa River	J_CC05	0.6	-0.1	0.0	0.1	0.1	0.1	0.1	0.0

The greatest increases in peak flows occur at the York Road crossing (Node J_CC00) for the 25 mm and 2-year storm events (5.5% and 4.9%, respectively). However, these percentages only correspond to a total actual increase of 0.1 m^3/s and 0.2 m^3/s, respectively. Therefore, based on the lack of difference in peak flows within Clythe Creek between Existing and Proposed conditions, stormwater management quantity controls are deemed to not be required. The lack in difference in peak flows is partially attributed to York Road being immediately next to Clythe Creek and the proposed road improvements being located at the downstream end of the subwatershed. It would be anticipated that a slight increase in runoff volume to Clythe Creek would occur due to the road widening, which would be partially offset by the recommended infiltration systems (discussed later in this section). That said, an increase in runoff volume or duration is not considered to be a negative impact on the creek system, based on the creek being realigned and designed for the contributing drainage area and proposed York Road drainage system.


Township of Guelph Eromosa
City of Guelph
Clythe Creek
Hadati Creek
Eromosa River
PROPOSED CLYTHE CREEK RE-ALIGNMENT
Guelph Junction Railway
YORK RD (HIGHWAY 7)
VICTORIA RD
GRANGE RD
AUDEN RD
SCHRODER CR
BRADSON DR
CEDARVALE AV
CITYVIEW DR N
CITYVIEW DR S
ELIZABETH ST
BEAUMONT CR
STARWOOD DR
SILURIAN DR
FLEMING RD
WATSON PKWY N
WATSON PKWY S
WATSON RD N
WATSON RD S
CREEKSIDE DR
TAGGART ST
AIRPARK PL
SKYWAY DR
LEGEND
MUNICIPAL BOUNDARY
STUDY AREA
WATERCOURSE
CONTOUR (1m)
WATERSHED BOUNDARY
SUBCATCHMENT BOUNDARY
SUBCATCHMENT ID#
SUBCATCHMENT AREA
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
STUDY AREA
DRAINAGE PLAN
(FUTURE CONDITIONS)
wood.
SCALE VALID ONLY FOR 24"x36" VERSION
Scale 1:4000
Consultant File No. TP115100
Figure No. 7.1

7.1.5.2 Quality Control

The proposed widening of York Road will increase the total paved area contributing to Clythe Creek, therefore stormwater management quality controls are considered necessary for this development. Under proposed conditions, the storm sewer system will outlet to Clythe Creek at five (5) locations along York Road. These outlet locations include Industrial Street, Hadati Creek, Elizabeth Street, Reformatory Driveway and Clythe Creek at York Road. Table 7.4 summarizes the total increase in paved area contributing to each outlet (ref. Appendix M), and the corresponding water quality storage volume required. The storage requirements are based on 27 mm of rainfall depth (based on the pending Ministry of Environment, Conservation and Parks Low Impact Development Guidance Manual) and an average runoff coefficient of 0.9 (ref. Appendix M).

Table 7.4: Increase in Paved Drainage Area Contributing Flows to Each Outlet

	York Road Outlets				
	Industrial Street	Hadati Creek	Elizabeth Street	Reformatory Driveway	Clythe Creek
Existing Paved Area (m^2)	3,041	1,678	7,411	3,989	12,984
Proposed Paved Area (m^2)	5,151	3,359	12,210	8,673	24,263
Increase in Paved Area (m^2)	2,110	1,681	4,799	4,684	11,279
Water Quality Storage Volume (m^3)	51.3	40.8	116.6	113.8	274.1

The assessment of drainage impacts associated with the proposed road condition indicates that quantity controls are not required, based on the minimal difference between future and existing road right-of-way conditions (i.e. net imperviousness). Notwithstanding the lack or need for stormwater quantity controls to mitigate the estimated differences in peak flows for the 2 year to 100 year storm events and Regional Storm, quality and erosion controls are still considered necessary and important. In general, there are numerous stormwater management practices, which can be used to provide either erosion control and/ or treatment of contaminated stormwater runoff from roadway surfaces, these include the following (but not limited to):

a. Wet ponds/wetlands/hybrids (generally linear facilities)
b. Enhanced grass swales
c. Filter Strips
d. Bioretention Systems
e. Infiltration Systems
f. Oil and grit separators
g. Off-site stormwater management facilities

The respective characteristics, advantages and disadvantages of the foregoing have been well documented in previous municipal and provincial literature and hence this information has not been repeated within this document. The advantages and disadvantages of the various Best Management Practices associated with both quantity (erosion) and quality control measures are as follows:

7.1.5.3 Erosion Control

For erosion control, on-site measures to temporarily detain runoff volume and reduce peak flow impacts can be highly constraining due to the general lack of properly configured land. Roadway corridors, due to their inherent linear nature, can only effectively manage relatively small volumes of increased runoff (peak flows), in the absence of stand-alone land acquisition and / or costly subsurface storage system. Combinations of measures to mitigate impacts through some on-site underground storage, along with off-site upgrades as necessary, can be required to offset impacts.

Quality Control

i) Wet ponds, Wetlands, Hybrids

For York Road, this particular opportunity (new stormwater management facilities) is not considered practical and has not been considered further for the preferred road alternative.

ii) Enhanced Grassed Swales

Grassed swales designed with a trapezoidal geometry and flat longitudinal profiles with largely un-maintained turf can provide excellent filtration and treatment for storm runoff from roadways. Gutter outlets along outside lanes function to convey flow from the road to enhanced grass swales next to sidewalks or multi-use trails. That said, there is little to no space on either side of the proposed multi-use paths for enhanced grass swales, as such this alternative has not been short-listed.

iii) Filter Strips

Filter strips require flat areas with slopes ranging from 1 to 5% and are usually in the range of 10 to 20 m in length in the direction of flow. Based on the space requirement, this water quality measure has not been considered further.

iv) Oil and Grit Separators (OGS)

These systems tend to serve limited drainage areas of 2 ha +/- and provide levels of treatment often (less than Enhanced 80% TSS removal, formerly Level 1 unless combined with other measures as part of a treatment train). GRCA requires that OGS units that have been tested within the Environmental Technology Verification Program (ETV) are used, which results in OGS units with 70% or less TSS removal. Disadvantages include the need for frequent maintenance, as well as relatively high capital costs and the ability to only serve small drainage areas. Given these systems consume comparatively less space, this water quality measure has been short-listed for further consideration.

v) Catch Basin Shields

These systems tend to serve limited drainage areas of 0.5 ha +/- and provide levels of treatment often (less than Basic 60% TSS removal, formerly Level 3 unless combined with other measures as part of a treatment train). Catch basin shields can provide up to 50% TSS removal depending on the drainage area. Disadvantages include the need for frequent maintenance and the ability to only serve small drainage areas. Given these systems consume comparatively less space, this water quality measure has been short-listed for further consideration.

vi) Off-Site Stormwater Management Facilities

There are no practical opportunities for roadway runoff conveyance to off-site facilities for the York Road improvements, as such, this alternative has not been considered further.

vii) Low Impact Development Best Management Practices (LID BMPs)

Low Impact Development represents the application of a suite of BMPs normally related to source and conveyance storm water management controls to promote infiltration and pollutant removal on a local site by site basis. These measures rely on eliminating the direct connection between impervious surfaces such as roofs, roads, parking areas, and the storm drainage system, as well as the promotion of infiltration on each development or redevelopment site, including related infrastructure improvements, such as roadway upgrades. The benefits from LID BMPs are generally focused on the more frequent storm events (e.g. 2 year storm) with lower volumes, as opposed to the less frequent storm events (e.g. 100 year storm) with higher volumes. It is also recognized that the forms of LID BMPs which promote infiltration or filtration through a granular medium, can provide thermal mitigation for storm runoff.

Various LID BMPs, as well as their function and applicability to York Road are summarized in Table 7.5.

Table 7.5: LID Source and Conveyance Controls

Technique	Function
Bio-retention Cells	• Vegetated technique for filtration of storm runoff • Storm water quality control provided through filtration of runoff through soil medium and vegetation • Infiltration/ evapotranspiration/ water balance maintenance and additional erosion control may be achieved if no subdrain provided • *Due to the lack of space with the ROW, this technique could not be practically used for most of the YREDS study area, that said, a few isolated locations could consider this measure (Alternative carried forward)*
Grassed Swales	• Vegetated technique to provide storm water quality control • Storm water quality control provided by filtration through vegetated system • Runoff volume reduction may be achieved by supplementing with soil amendments • *Due to the lack of space with the ROW, this technique could not be practically used (Alternative not carried forward)*
Infiltration/ Filtration Trenches	• Infiltration technique to provide storm water quality control and maintain water balance • Erosion controls may be achieved depending upon soil conditions • If infiltration is not possible due to localized high groundwater levels, the trench system could be designed to provide filtration of runoff

Technique	Function
	• This alternative could be practically used within the ROW with pre-treatment measures • This alternative requires 1 m vertical separation from the trench base to groundwater and rock. • *Alternative carried forward*
Permeable Pavers/Pavement	• Infiltration technique to reduce surface runoff volume • Benefits to storm water quality and erosion control are informal • Multi-use path could be permeable to reduce runoff • *Alternative carried forward*
Pervious Pipes	• Technique to reduce storm runoff through the implementation of perforated pipes within storm sewers • Promotion of infiltration can potentially maintain water balance and provides storm water quality and erosion control benefits • This alternative would not provide the volume required for water quality or erosion control, as such it has not been considered further • *Alternative not carried forward*

7.1.5.4 Short-listed Stormwater Management Alternatives

The assessment of stormwater management alternatives for both quantity (erosion) and quality control has focused on alternatives that could be implemented within the road right-of-way. Erosion control storage would have to use underground storage, based on the lack of available space in the right-of-way. The assessment has been conducted as per the following:

- **Underground Storage**

Underground storage within infiltration filtration systems for erosion control for the proposed York Road improvements could use cellular tank systems, stone trench systems or combinations thereof. Based upon the anticipated limited storage volumes (ref. Appendix M) required to provide 24 hours of detention of the 25 mm storm event, underground storage could be considered feasible. The proposed storm sewer depths, bedrock and water table elevations (based on available information) will have to be considered prior to the preliminary design. Further consideration of this alternative will be provided within the future stormwater management reporting.

- **Infiltration/ Filtration Systems**

Underground storage for water quality control for the proposed York Road improvements could be used and would have the added benefit of providing thermal mitigation of road runoff. Based upon the anticipated limited storage volumes required to provide storage of a 27 mm stormwater quality event, infiltration trenches could be considered feasible. Proposed storm sewer depths, bedrock and water table elevations (ref. Sub-Appendix D, Appendix K2) will have to be considered prior to the preliminary design.

Further consideration of this alternative will be provided within the future stormwater management reporting.

- **Bioretention Systems**

Water quality treatment for isolated sections of road could be provided by bioretention systems. Typically, bioretention systems infiltrate surface runoff from the road areas. Based on the concern of infiltration road runoff without providing pre-treatment, the bioretention system would only be used for filtration of road runoff and would have a discharge back to the roadway and storm sewer system. Based upon the anticipated limited storage volumes required to provide storage of a (27 mm) stormwater quality event, small bioretention systems could be considered feasible, west of the Industrial Street storm sewer outlet (ref. Appendix M).

- **Oil/ Grit Separators**

To provide an Enhanced (80%) Level of water quality treatment, oil/grit separators could be used as part of a treatment train approach. Each drainage system outlet could use an appropriately sized oil/grit separator in combination with vegetative filtering (where space is available) and other associated infiltration systems.

- **CB Shields**

To provide up to 50% TSS removal, oil/grit separators could be used as part of a treatment train approach and provide pretreatment to infiltration/ filtration systems.

- **Permeable Pavers/Pavement**

The City of Guelph has stated that permeable or porous pavements are not recommended within a 2 year time of travel zone within well head protection areas. Based on the November 2015 Grand River Source Water Protection Plan, York Road is located adjacent to a wellhead protection zone (ref. Appendix D). This perspective is understood to be based on guidance from CVC and TRCA's 2011 Low Impact Development Stormwater Management Planning and Design Guide, which refers to road or parking surfaces where salt would be applied, rather than multi-use-paths (MUP) where the City could use alternative snow and ice management techniques. In addition, the City has indicated that a permeable pavement should be at least 1 m above ground water level, as such ground water elevations need to be determined along the York Road corridor. For winter operations, sand or other granular materials could not be applied as anti-skid agents, as the open spaces within the permeable pavement could clog, hence snow would need to be cleared using plowing and ice melted with de-icing liquids, applied sparingly. Based on the foregoing, only the MUPs could be considered for permeable pavements. In discussions with City staff, it was determined that it could not be guaranteed that anti-skid agents would not be applied to the MUPs, as such this alternative has not been considered further.

7.1.5.5 Preferred Stormwater Management Alternatives

The preferred roadway stormwater management approach based on the foregoing assessment would include oil/grit separators, CB shields, bioretention (filtration) systems and combinations of infiltration/ filtration cooling trenches to provide an *Enhanced* Level of stormwater quality treatment (80 %) and erosion control (25 mm). The following provides an assessment of the preferred stormwater management alternatives.

Bioretention Facilities - Industrial Street Outlet

As shown in Figure 7.1, subcatchments YRK-N-02A-FUT and YRK-S-02A-FUT (York Road ROW in-between the Guelph Junction Railway and Industrial Street) outlet at the Industrial Street storm sewer outlet. The drainage area is approximately 0.66 ha with 0.21 ha of additional proposed paved area.

It is proposed to route the stormwater flows from the south half of York Road (subcatchment YRK-S-02A-FUT) through three (3) bioretention facilities in series. The bioretention facilities have been sized as per the Low Impact Development Stormwater Management Planning and Design Guide (CVC, 2010). The native soils in the area are comprised of sandy and gravelly deposits, which corresponds to an infiltration rate of approximately 75 mm/hour. The combined storage volume provided by the bioretention facilities would be 53 m^3+/-, which is greater than the required storage volume for this outlet (ref. Table 7.5). Table 7.6 summarizes the sizing of the three (3) facilities. Full calculations are provided in Appendix M.

Table 7.6: Bioretention Facilities Design Summary

	Bioretention Facility No.		
	1	2	3
Drainage Area (m^2)	1,480	569	610
Storage Volume (m^3)	29.5	11.3	12.2
Depth (m)	1.5	1.5	1.5
Footprint Surface Area (m^2)	49.2	18.8	20.3

The total TSS removal achievable by a bioretention facility ranges from 54 to 100%, based on performance results from both laboratory and field studies (CVC, 2010). To ensure adequate water quality treatment is achieved, it is proposed to further treat the stormwater through an OGS unit directly prior to discharging to Clythe Creek. The stormwater from the bioretention facility will outlet directly to the storm sewer system, where water will combine with flows from the north portion of York Road (Subcatchment YRK-N-02A-FUT) and be conveyed to the OGS unit. The OGS sizing for all outlets is further discussed in this section.

Catch Basin Shield (CB Shield) – All Outlets Except Industrial Street

As a first step of quality treatment for all the outlets, it is proposed to place CB Shield inserts into the proposed catch basins and double catch basins. CB Shield inserts prevent sediment and grit in the catch basin sump from overflowing into the outlet pipe. Table 7.7 indicates the percentage of TSS removal achievable using a CB Shield (as indicated by the manufacture). The original design table by CB Shield manufacturer has been provided in Appendix M.

The maximum spacing of the proposed catch basins will be 100 m and the maximum width of the proposed ROW is 35 m. Therefore, the maximum drainage area (worst case) for any catch basin will be approximately 1,750 m^2 or 0.175 ha (100 m x 35 m/2). The average impervious coverage of the ROW is 80%, therefore the TSS removal achievable by the CB Shield for each catch basin is at a minimum of 51% (ref. Table 7.7).

Table 7.7: Average Annual Sediment Removal Rates (%) using a CB Shield (based on ETV – 1 to 1000 micron Particle Size Distribution)[1]

Area to CB (ha)	Imperviousness (%)					
	20%	35%	50%	65%	80%	100%
0.02	57	57	57	57	56	56
0.05	56	56	56	55	55	54
0.10	56	55	54	53	52	51
0.20	54	53	51	49	48	46
0.30	53	50	48	46	45	43
0.40	51	48	46	44	42	40
0.50	50	47	44	42	40	38
0.60	49	45	43	40	39	36

Note: [1] Table obtained from CB Shield webpage at 'http://www.cbshield.com/drawings-and-tech-info'

Subsurface Infiltration / Filtration Trench - All Outlets Except Industrial Street

In addition to the CB shields for all the outlets except Industrial Street, it is proposed to convey stormwater flows through subsurface stone-media infiltration/filtration trenches below the proposed multiuse paths (ref. Appendix M).

Using available groundwater information from the York Road Reconstruction and Trunk Watermain Drawings, constructed in 1988 (ref. Appendix D), the groundwater profile has been estimated along York Road. The groundwater elevation is close to Clythe Creek invert elevation west of the York Road and Elizabeth Street intersection. East of Elizabeth Street, the estimated groundwater profile is above Clythe Creek and is within 1.2 m to 1.5 m of the proposed road profile. At road station 11+100 m, 60 m east of the former Reformatory driveway, the estimated groundwater profile and the proposed road profile begin to diverge with the estimated groundwater depths being greater than 1.5 m. Groundwater depths east of the Clythe Creek crossing are not known, due to a lack of available information, however are estimated to be deeper than 1.5 m from the proposed road profile.

Based on the shallow groundwater depth, infiltration trenches using a designated 1 m minimum height) are not considered practical until at least road station 11+230 m, 190 m east of the former Reformatory driveway. As such, west of road station 11+230 m, it is proposed to use filtration trenches, while east of road station 11+230 m, it may be possible to use infiltration trenches. Both the filtration trenches and infiltration trenches would have pre-treatment systems such as catchbasins with CB shields and goss traps and/or oil/grit chambers depending on locations. Oil/grit chambers would receive drainage from the trenches, prior to each drainage system outlet to Clythe Creek.

Both the infiltration trenches and filtration trenches could be designed to allow drainage to overflow through the top of the trenches to a Cultec™ Contractor™ 0.32 m height and 0.92 m wide underground storage chamber system (or equivalent). The underground chamber system (ref. Appendix D) would be 3 units wide and would fit under the multi-use trail. Each filtration trench would have a controlled outlet. Infiltration trenches would rely on infiltration with an overflow to the Cultec™ chamber system. Using the combined method of trench and chamber system, would provide both water quality and erosion control and would reduce the overall storm sewer length and sizing required. The combined trench and chamber system could replace portions of the typical storm sewer system, for west of the Clythe Creek crossing, while east of the crossing, due to large contributing area, sewers would be required.

Proposed catchbasins along the York Road ROW will be connected directly to the subsurface trenches under the MUPs, which will provide filtration through the stone media. The sizing of the trenches is based on the required storage volume for each outlet (ref. Table 6.4) and an average stone porosity of 0.40. Runoff volumes for each storm event have been conservatively estimated using 100% runoff from the increase in paved areas Table 7.8 summarizes the sizing requirements for each outlet.

Table 7.8: Infiltration/Filtration Subsurface Trench Sizing

	York Road Outlets			
	Hadati Creek	Elizabeth Street	Reformatory Driveway	Clythe Creek
Stone Porosity	0.40	0.40	0.40	0.40
Width (m)	3.0	3.0	3.0	3.0
Length (m)	60	355	300	350
Required Minimum	0.600	0.300	0.350	0.650

OGS Units – All Outlets

As the final step in stormwater quality control, it is proposed to treat all flows through an oil/grit separator at each outlet. All the OGS units have been sized using the Canadian Environmental Technology Verification (ETV) particle size distribution. The OGS sizing parameters are summarized in Table 7.9 for each outlet and the OGS sizing summary is presented in Table 7.10.

Table 7.9: Oil/Grit Separator Sizing Parameters

	York Road Outlets				
	Industrial Street	Hadati Creek	Elizabeth Street	Reformatory Driveway	Clythe Creek
Total Drainage Area (ha)	0.66	0.45	1.44	1.27	2.36
Proposed Impervious Coverage (%)	79.8	75.4	85.0	68.2	47.9
Particle Size Distribution	CA ETV	CA ETV	CA ETV	CA ETV	CA ETV
Min. TSS Removal (%)	60	60	60	60	60

Table 7.10: Stormceptor® EFO Sizing Summary - % TSS Removal Provided

EFO Model	York Road Outlets				
	Industrial Street	Hadati Creek	Elizabeth Street	Reformatory Driveway	Clythe Creek
EFO4	54	57	49	51	49
EFO6	63	67	56	57	56
EFO8	69	72	60	63	60
EFO10	72	74	65	68	64
EFO12	74	75	70	72	69

The highlighted EFO models presented in Table 7.9 are the required Stromceptor® OGS units for each outlet to achieve a minimum of 60% TSS removal. The Stormceptor® EFO6 model is recommended for Industrial Street and Hadati Creek outlets and a Stormceptor® EFO8 model is recommended for the Elizabeth Street, Reformatory Driveway and the Clythe Creek outlets. The selected Stormceptor® EFO models are also able to provide a runoff volume capture rate of over 90%. The detailed Stormceptor® sizing reports are provided in Appendix M. Equivalent performing OGS units could also be used.

Clythe Creek Outlet

The total drainage area contributing flows to the Clythe Creek outlet located immediately downstream of the Clythe Creek/ York Road crossing is approximately 20.7 ha, which includes the ROW and all external draining areas. However, the total increase in paved area contributing to this outlet is approximately 1.13 ha (ref. Table 7.4). Due to the limitations of OGS unit capacities and infiltration/filtration trenches, it is not recommended to treat runoff from drainage areas of this size. For this reason, it is proposed to treat drainage from 2.36 ha with an average impervious coverage of 47.9%, which is equal to the additional paved area for this outlet (1.13 imp. ha).

This method will require a trunk storm sewer system starting from just west of Skyway Drive and discharging at the Clythe Creek outlet. The trunk storm sewer system would collect and convey stormwater flows from majority of the York Road ROW and external contributing areas (18.34 ha). The trunk storm sewer could be situated on the south side of the York Road ROW under the proposed multiuse pathway. To provide stormwater quality control, a smaller storm sewer system could be used to collect flows from the 2.36 ha of drainage area and convey through the infiltration/filtration trench and OGS unit prior to discharging to the Clythe Creek outlet. The infiltration/filtration trench would be situated on the north side of the York Road ROW under the multiuse pathway with catch basin leads feeding into the system. The smaller system would start approximately 180m east of Watson Parkway up to the Clythe Creek outlet. As an additional quality control measure, it is still proposed to place CB shield inserts in all catch basins contributing to the Clythe Creek outlet.

7.1.6 Property Requirements

Approximately 2,300 m^2 of property will be required at select intersections to facilitate construction of the widened York Road cross-section and provision of standard City of Guelph bus pads at all stop locations. Table 7.11 provides a summary of the anticipated transportation-related property requirements if a minimum 1.5 m property line setback and 1.5 m boulevards are provided through unconstrained road segments (i.e. west of Beaumont Crescent and east of the Reformatory Entrance). These requirements could be reduced through elimination of the boulevards and setbacks, as well as through provision of smaller bus pads. Revised property limits are illustrated in the road plan and profile drawings provided in Appendix N.

Table 7.11: Identified Transportation-Related Property Requirements

Property Location/Purpose	Required Area (m^2)
East of Victoria Road to west of the Rail Crossing	1,150
Immediately east of the Clythe Creek Culvert	340
At Watson Parkway Intersection	154
At Watson Road Intersection	310
West of Skyway	240
To Accommodate Standard Bus Pads	120
Total Area of Required Property	**2,314**

Note that the identified property requirements do not include property related to the creek, the creek's meander belt width, nor any GRCA setback requirements. These additional property requirements are to be confirmed during detailed design.

7.1.7 Preliminary Capital Costs

Preliminary capital costs for the preferred alternative have been determined for the proposed road, heritage wall relocation and components of the York Road improvements (ref. Sub-Appendix E, Sub-Appendix K2). Stormwater, drainage and culvert preliminary costs have been provided in Appendix M. The following assumptions and considerations have been used to develop the preliminary capital works costing:

- Storm sewer system costing has been estimated using approximate storm sewer sizing and would require validation using modelling as part of the detailed design process.
- Costing does not include staging, sediment and erosion controls, or utility relocations (with exception of overhead hydro);
- Costing does not include tree protection, planting and seeding
- Costing does not include property purchase or facilitation of easements

The following preliminary capital costing has been determined for Road Alternative 4.

Drainage system and stormwater management:	$2,420,000
Culvert Upgrades	$2,750,000
Road system and MUP	$13,680,000
Heritage Wall Relocation (by approved Heritage Masons)	$ 300,000
Creek works	$ 859,230
Subtotal Costs	**$20,009,230**

8.0 Impact Assessment / Mitigation for Preferred Alternative

As part of the overall Environmental Design Study work, a number of potential alternatives have been examined, leading to the identification of a preferred alternative for the re-alignment of Clythe Creek and widening of the road to four (4) lanes, including two (2) multi-use pathways and preserving/conserving/recreating cultural heritage features. The process of developing this preferred alternative has taken into account the environmental sensitivities assessed as part of both the Stage 1 (Characterization) and Stage 2 (Field Work Investigation) works.

The preferred alternative consists of the road section(s), alignment and profile. The selection of the preferred road alternative is discussed in Section 7. In summary the road section has been further developed from the 2007 Class EA road section of four (4) lanes and one (1) sidewalk through consultation with City staff, stakeholder groups and the public. In addition, selection of the preferred alternative has had consider City's operational requirements, cultural heritage features and recommended setbacks, property requirements and mobility requirements along the road corridor.

The process for selection of the preferred creek treatment has been similar to the determining the preferred road alternative. The 2007 Class EA recommended that 135 m of creek be realigned to the south due to grading requirements for the road intruding into the creek upstream of the former Reformatory driveway. Consultation has occurred with the public, City staff from the relevant City groups, private stakeholder groups such as Trout Unlimited, government agencies including Grand River Conservation Authority (GRCA), Ministry of Natural Resources and Forestry (MNRF), Infrastructure Ontario (IO) and Ontario Heritage Trust (OHT). The preferred creek realignment has considered the preferred road alignment, natural stream morphology, fish passage and habitat and minimizing impacts to cultural heritage features.

The process for selection of the preferred stormwater management has considered input from City staff that would prefer to see a treatment train approach integrating low impact development (LID) best management measures (BMPs). City staff has also expressed concerns with salt, however as discussed with staff, unless salt is not used, it will infiltrate into the groundwater system and discharge to the surface water systems.

8.1 Roadway Stormwater Management

To determine the preferred stormwater management for the recommended road works, the impact of the proposed road widening on Clythe Creek peak flows needed to be determined. The existing condition PCSWMM model has been updated for the proposed road widening and improvements.

York Road subcatchments have been measured from the proposed widened York Road (ref. Figure 7.1). The multi-use pathway has been assumed to be directly connected impervious where it runs parallel to York Road and indirectly connected impervious where it turns to the south in Royal City Jaycees Park. The future York Road catchments range from 65% to 90% impervious. The outlets of the York Road catchments have been adjusted to match the updated profile of York Road (ref. Appendix N). The outlets along Clythe Creek have been placed in locations where there would be the most space to place stormwater management controls.

The updated future conditions PCSWMM model has been simulated using the 3 hour Chicago distribution design storms, as well as the MOECC 25 mm 4 hour Chicago design storm. Additionally, the Regional Storm (Hurricane Hazel) has been simulated using the full 48-hour duration event. The resulting peak flows are provided in Table 7.2 and a comparison to the existing conditions peak flows is provided in Table 7.3. No quantity controls have been determined to be required based on a comparison of the peak flows.

To address the additional pavement area, quality controls have been assessed. Section 7 outlines the assessment and stormwater management measure selection and sizing process. Water quality controls will consist of a treatment train of bio-filtration (where space allows), catch basin shields, oil/grit separators and combinations of infiltration/ cooling trenches to provide an *Enhanced* Level of stormwater quality treatment (27 mm) and erosion control (25 mm).

8.2 Clythe Creek

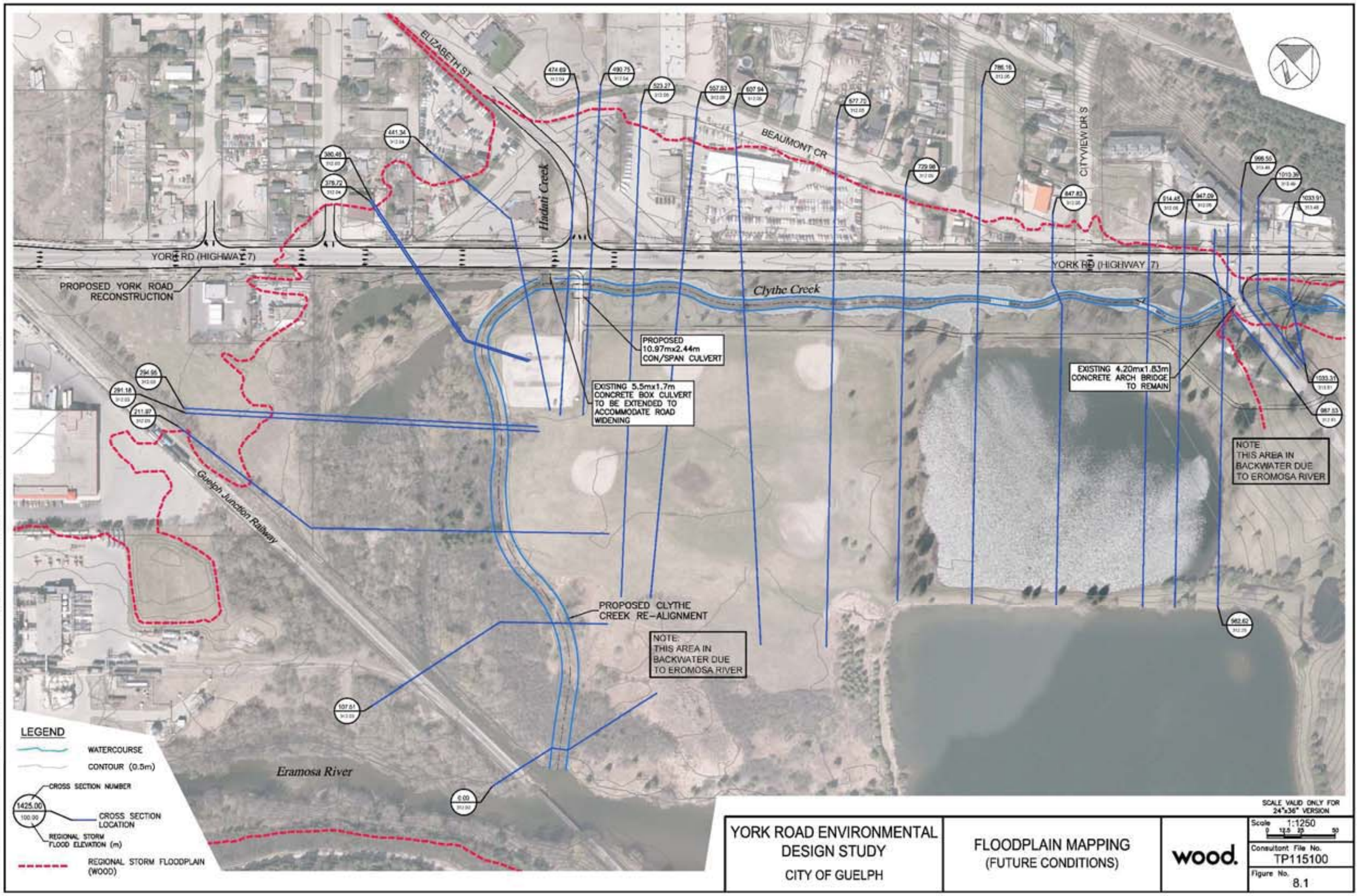
Improvements will be made to the overall function and habitat of Clythe Creek, with channel works being considered in order to maximize the restoration potential within Clythe Creek (ref. Appendix F and Appendix K2). Channel realignment will separate the creek from the York Road right-of-way, providing a natural buffer to the corridor. The proposed planform will utilize a greater extent of the existing floodplain, including a portion of an existing tributary planform. The northern Reformatory Pond will be disconnected from the creek in an effort to limit interactions between the pond and creek channel. As a result of the channel realignment, the majority of the cultural heritage features will be taken off-line but remain within the landscape. The realignment for Reach C-9A has incorporated a 'high-flow' channel that directs flows exceeding bankfull (i.e., close to overtopping the channel banks) towards and through the existing channel at a weir (Cultural Feature '14') upstream of the Reformatory driveway. This approach supports fish passage through the primary channel but also allows for the weir to be activated at higher flows, partially mitigating its disconnection from the main channel.

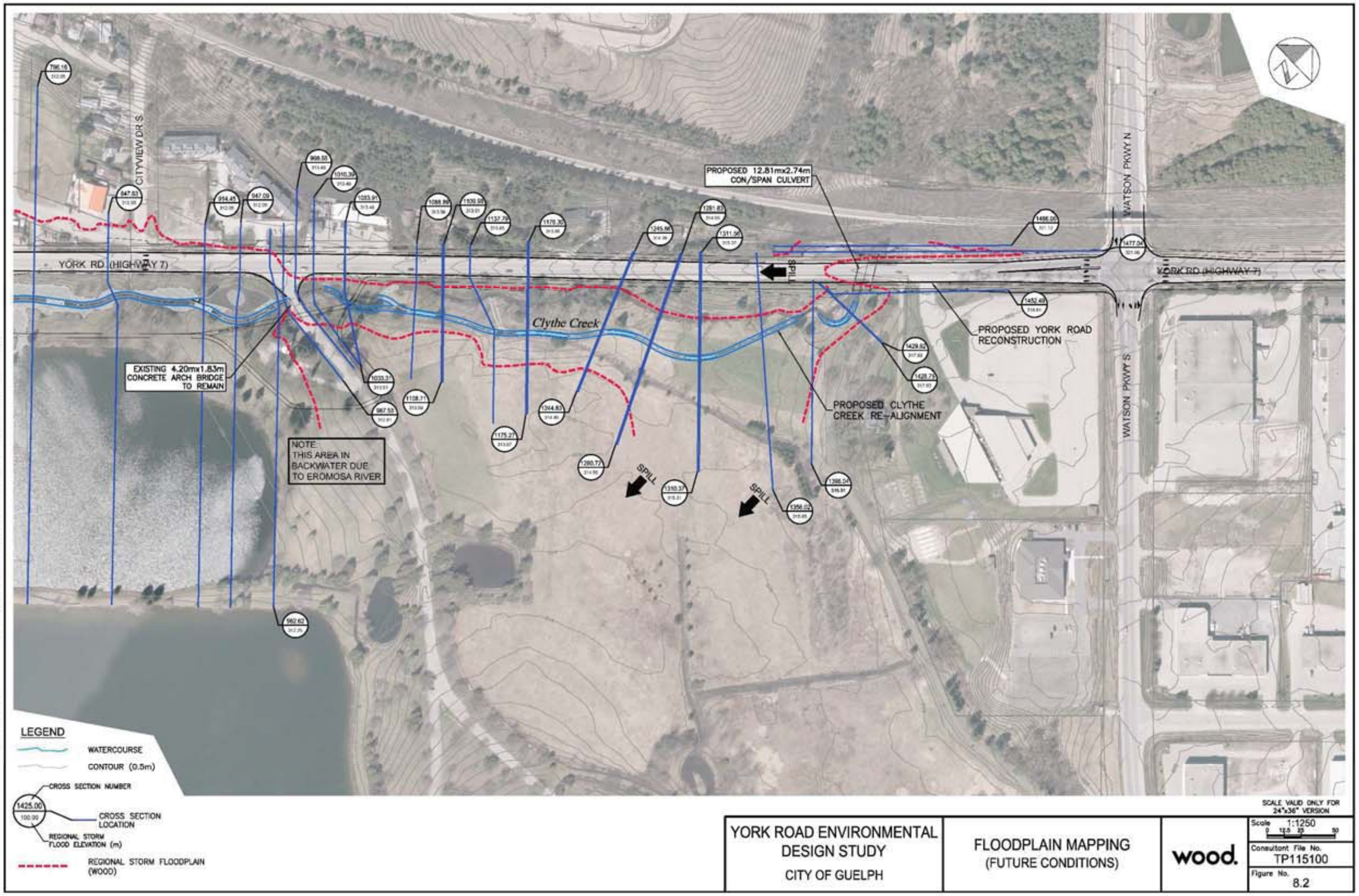
To improve the functioning of Reaches C-9B and C-10, significant grading works are proposed that narrow the channel cross-section and create a consistent bed profile, promoting improved natural channel function and stability. The bed and bank grading will continue downstream within Reach C-10 where full channel realignment will occur downstream from the confluence with Hadati Creek to the Eramosa River. As a result, the existing flow splitter downstream of the confluence with Hadati Creek will be taken off-line. The existing channel downstream of the flow splitter will be repurposed as necessary to accommodate storm water management practices.

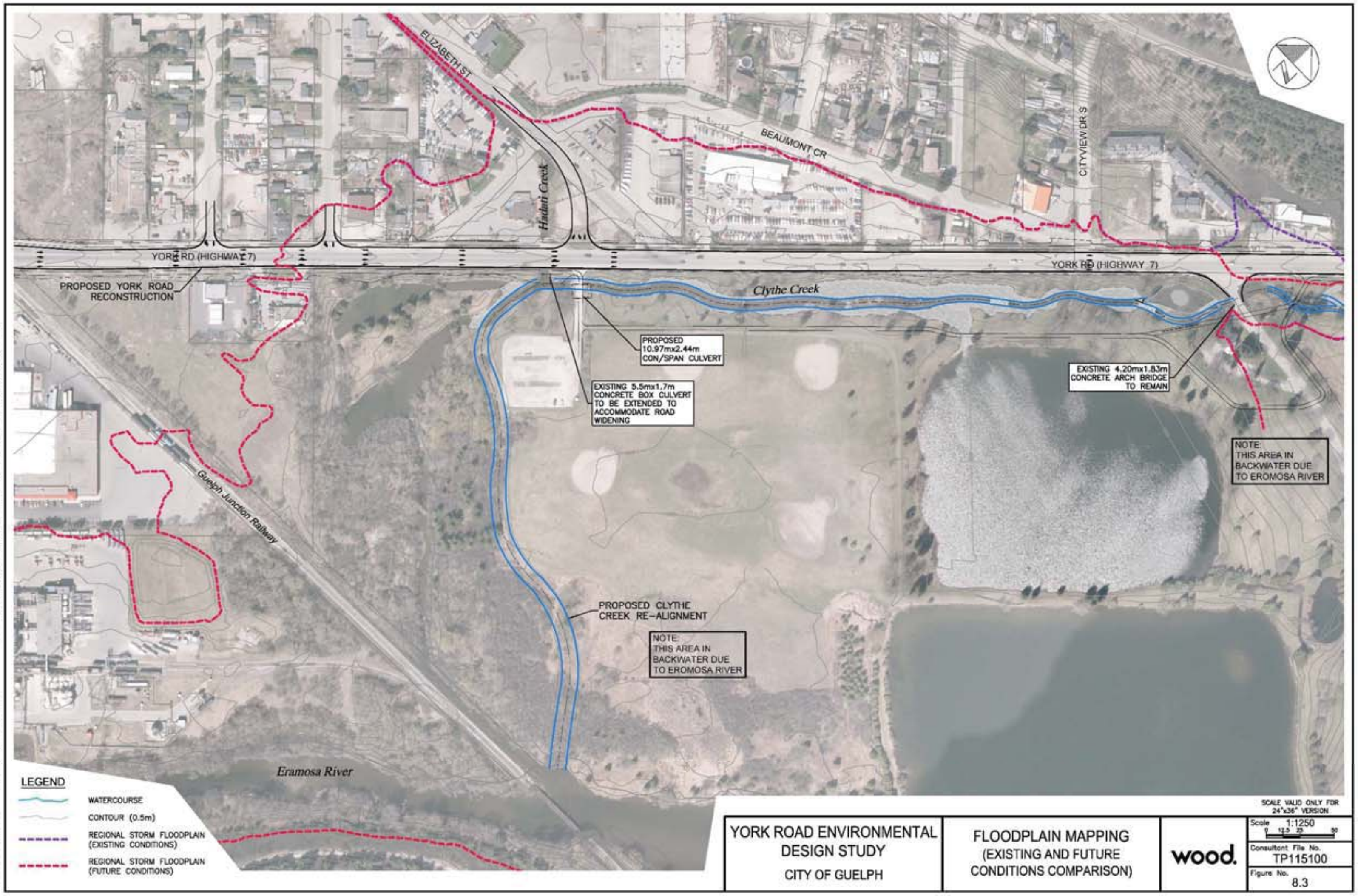
8.3 Clythe Creek Hydraulics

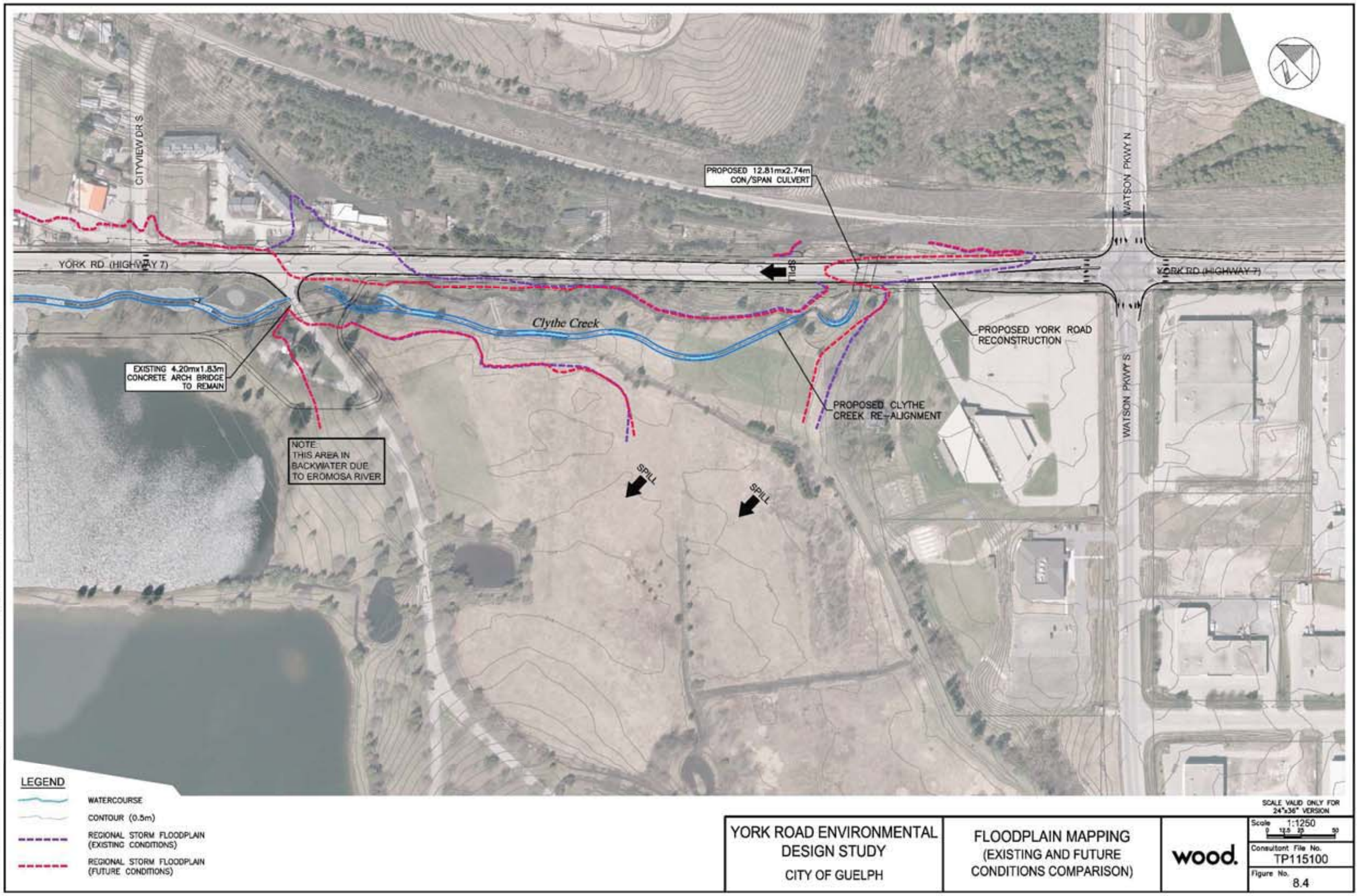
The HEC-RAS model has been revised to reflect the hydraulic impacts to Clythe Creek resulting from the York Road widening and the channel realignment. HEC-RAS cross-sections were modified, added and removed where necessary. The results for the 2 – 100 year and Regional Storm events are provided in Appendix D. The Regional Storm floodline is represented on Figures 8.1 to 8.4. It is noted that the significant backwater condition remains under future conditions, with the Regional Storm backwatering up to the downstream side of the Reformatory driveway crossing, and the 2 – 100 year storm events backwatering up to 135 m downstream of the Reformatory driveway crossing (cross-section 765.49). The overtopping of York Road during the Regional Storm remains as well.

As shown on Figures 8.1 to 8.4 the aforementioned spill conditions on the upstream and downstream side of York Road occurring under existing conditions remain under future conditions. The HEC-RAS model is provided in Appendix D on a CD.


ELIZABETH ST
BEAUMONT CR
CITYVIEW DR S
YORK RD (HIGHWAY 7)
PROPOSED YORK ROAD RECONSTRUCTION
Hadati Creek
Clythe Creek
PROPOSED 10.97mx2.44m CON/SPAN CULVERT
EXISTING 5.5mx1.7m CONCRETE BOX CULVERT TO BE EXTENDED TO ACCOMMODATE ROAD WIDENING
EXISTING 4.20mx1.83m CONCRETE ARCH BRIDGE TO REMAIN
NOTE: THIS AREA IN BACKWATER DUE TO EROMOSA RIVER
PROPOSED CLYTHE CREEK RE-ALIGNMENT
NOTE: THIS AREA IN BACKWATER DUE TO EROMOSA RIVER
Guelph Junction Railway
Eramosa River
LEGEND
WATERCOURSE
CONTOUR (0.5m)
CROSS SECTION NUMBER
CROSS SECTION LOCATION
REGIONAL STORM FLOOD ELEVATION (m)
REGIONAL STORM FLOODPLAIN (WOOD)
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
FLOODPLAIN MAPPING
(FUTURE CONDITIONS)
wood.
SCALE VALID ONLY FOR 24"x36" VERSION
Scale 1:1250
Consultant File No. TP115100
Figure No. 8.1


PROPOSED 12.81mx2.74m CON/SPAN CULVERT
YORK RD (HIGHWAY 7)
WATSON PKWY N
WATSON PKWY S
CITYVIEW DR S
Clythe Creek
SPILL
EXISTING 4.20mx1.83m CONCRETE ARCH BRIDGE TO REMAIN
NOTE: THIS AREA IN BACKWATER DUE TO EROMOSA RIVER
PROPOSED YORK ROAD RECONSTRUCTION
PROPOSED CLYTHE CREEK RE-ALIGNMENT
LEGEND
WATERCOURSE
CONTOUR (0.5m)
CROSS SECTION NUMBER
CROSS SECTION LOCATION
REGIONAL STORM FLOOD ELEVATION (m)
REGIONAL STORM FLOODPLAIN (WOOD)
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
FLOODPLAIN MAPPING
(FUTURE CONDITIONS)
wood.
SCALE VALID ONLY FOR 24"x36" VERSION
Scale 1:1250
Consultant File No. TP115100
Figure No. 8.2


ELIZABETH ST
BEAUMONT CR
CITYVIEW DR S
YORK RD (HIGHWAY 7)
Hadati Creek
Clythe Creek
PROPOSED YORK ROAD RECONSTRUCTION
PROPOSED 10.97mx2.44m CON/SPAN CULVERT
EXISTING 5.5mx1.7m CONCRETE BOX CULVERT TO BE EXTENDED TO ACCOMMODATE ROAD WIDENING
EXISTING 4.20mx1.83m CONCRETE ARCH BRIDGE TO REMAIN
NOTE: THIS AREA IN BACKWATER DUE TO EROMOSA RIVER
PROPOSED CLYTHE CREEK RE-ALIGNMENT
NOTE: THIS AREA IN BACKWATER DUE TO EROMOSA RIVER
Guelph Junction Railway
Eramosa River
LEGEND
WATERCOURSE
CONTOUR (0.5m)
REGIONAL STORM FLOODPLAIN (EXISTING CONDITIONS)
REGIONAL STORM FLOODPLAIN (FUTURE CONDITIONS)
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
FLOODPLAIN MAPPING (EXISTING AND FUTURE CONDITIONS COMPARISON)
wood.
SCALE VALID ONLY FOR 24"x36" VERSION
Scale 1:1250
Consultant File No. TP115100
Figure No. 8.3


CITYVIEW DR S
YORK RD (HIGHWAY 7)
WATSON PKWY N
WATSON PKWY S
PROPOSED 12.81mx2.74m CON/SPAN CULVERT
SPILL
PROPOSED YORK ROAD RECONSTRUCTION
Clythe Creek
EXISTING 4.20mx1.83m CONCRETE ARCH BRIDGE TO REMAIN
PROPOSED CLYTHE CREEK RE-ALIGNMENT
NOTE: THIS AREA IN BACKWATER DUE TO EROMOSA RIVER
SPILL
SPILL
LEGEND
WATERCOURSE
CONTOUR (0.5m)
REGIONAL STORM FLOODPLAIN (EXISTING CONDITIONS)
REGIONAL STORM FLOODPLAIN (FUTURE CONDITIONS)
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH
FLOODPLAIN MAPPING (EXISTING AND FUTURE CONDITIONS COMPARISON)
wood.
SCALE VALID ONLY FOR 24"x36" VERSION
Scale 1:1250
Consultant File No. TP115100
Figure No. 8.4

Assessment of Crossings

As outlined in Section 3.2.3, the existing York Road crossing of Clythe Creek does not meet the applicable MTO and MNRF criteria for culvert performance outlined in Tables 8.1 and 8.2. As such, the HEC-RAS model was used to complete a preliminary resizing of this culvert. The resulting structure size required is a 28.8 m long by 12.81 m by 2.74 m CON/SPAN™ arch culvert.

Table 8.1: Future Culvert Performance - MTO Criteria

Culvert ID	Structure		Future Road Classification	Design Criteria (Frequency in Years)	Actual Capacity (Frequency in Years)	Required Freeboard (m)	Provided Freeboard (m)[1]	Required Clearance (m)	Provided Clearance (m)[1]	Recommended?
	Type	Size (m)								
York Road	Concrete Arch Culvert - Open Bottom	12.81 x 2.74	Urban Arterial	100 Year	100 Year	1.00	1.11	0.30	0.27	Yes
Former Reformatory Driveway	Concrete Arch Bridge	4.20 x 1.80	N/A	N/A	25 year	N/A	0.31	N/A	<0.00	N/A
Parking Lot Driveway	Concrete Arch Culvert - Open Bottom	10.97 x 1.44	N/A	N/A	<2 year	N/A	0.22	N/A	0.02	N/A

Note: [1] Value shown is value at design storm conveyance requirement, or actual design storm capacity

Table 8.2: Future Culvert Performance - MNRF Criteria

Culvert ID	Structure		Vehicular Access	Max Overtopping Depth (m)	Provided Overtopping Depth (m)	Max Overtopping Velocity (m/s)	Provided Overtopping Velocity (m/s)	Maximum Product	Recommended?
	Type	Size (m)							
York Road	Concrete Arch Culvert - Open Bottom	12.81 x 2.74	Passenger Vehicle	0.30	0.91	3	2.04	N/A	Yes
Former Reformatory Driveway	Concrete Arch Bridge	4.20 x 1.80	N/A	N/A	0.74	N/A	1.62	N/A	N/A
Parking Lot Driveway	Concrete Arch Culvert - Open Bottom	10.97 x 1.44	N/A	N/A	2.48	N/A	0.39	N/A	N/A

Note: *Provided values are for Regulatory event (Regional Storm)

As outlined in Tables 8.1 and 8.2, the proposed York Road crossing achieves the applicable MTO and MNRF criteria, with the exception of the minimum clearance and maximum flooding depth requirements. Although the culvert does not explicitly meet the criteria for clearance, the performance should be considered satisfactory, as the deficiency is considered insignificant. The provided overtopping depth of 0.91 m significantly surpasses the criterion of 0.30 m. In order to achieve this criterion, both the proposed culvert and the vertical profile of York Road would require a significant increase. Given the costs versus benefits associated with this capital work, it does not seem practical to satisfy this criteria.

It is noted the existing Reformatory driveway crossing has been included in the assessment to demonstrate that the crossing performance will not be hindered due to the proposed York Road widening and Clythe Creek channel modifications. The south parking lot driveway crossing has also been included in the assessment. Per the requirements of the Geomorphology portion of the current study, the existing twin 1.40 m diameter CSP culverts require replacement to accommodate the proposed channel works. The proposed channel through this culvert will have a bankfull width of 8.0 m, and requires a culvert with a minimum span of 24.0 m (i.e. three (3) times the bankfull width). A culvert of such span would require a cast-in-place type design/construction which would be costly. Furthermore, a culvert of this span would likely require a large rise resulting in significant grade increases along the south parking lot driveway. Additionally, the existing south parking lot driveway experiences a backwater conditions in all storm events, and increasing the structure size would not have any significant benefit to the hydraulics of Clythe Creek. For these reasons, it is not recommended that a culvert with a 24.0 m span be provided for this crossing. Rather, a culvert with a span that accommodates the proposed channel is recommended. Therefore, a 14.2 m long by 10.97 m by 2.44 m CON/SPAN arch culvert is proposed. In an effort to minimize the grade changes to the south parking lot driveway, the culvert would be sunk 1.0 m into the ground, providing an effective rise of 1.44 m. Furthermore, CON/SPAN culverts require a minimum 0.60 m of cover, however it is recommended that a 0.30 m thick concrete transfer slab be implemented in place of the 0.60 m cover depth. The concrete transfer slab will accommodate vehicular passage, while reducing the driveway grade increases by 0.30 m.

8.4 Hadati Creek Hydraulics

As outlined in Section 3.2.3, the York Road 5.5 m by 1.7 m concrete box crossing of Hadati Creek conveys the 50 year storm event, as required per MTO criteria. Given the significant backwater over this section of York Road during the Regional Storm event, it is not feasible to achieve all applicable MTO and MNRF criteria for freeboard, clearance and passenger vehicle ingress/egress. Therefore, it is recommended that the only modifications to the existing culvert be the extension from 25.8 m to 36.4 m +/-required to accommodate the widening of York Road.

8.5 Elizabeth Street Flow Splitter (Hadati Creek)

In 2013, WalterFedy was retained by the City of Guelph to undertake the detailed design of the reconstruction of Elizabeth Street, including the proposed trunk storm sewer (and interim outlet to Hadati Creek). Amec Foster Wheeler provided support to the project by conducting PCSWMM hydrologic and hydraulic modelling (ref Appendix D). Interim conditions reflected the proposed reconstruction works along Elizabeth Street including the proposed trunk storm sewer with the interim outlet to Hadati Creek. To summarize the hydrologic/hydraulic modelling under interim conditions the following were considered:

- New trunk storm sewer along Elizabeth Street from Victoria Road (connecting in to the existing trunk sewer) to Industrial Avenue, with an interim outlet to Hadati Creek

- Roadway re-grading along Elizabeth Street for the same extents, including the proposed modifications to the number and locations of all inlets/catchbasins (as per the detailed design completed by Walter Fedy)
- The Elizabeth flow splitter had been considered as part of the assessment of interim conditions however, since without the flow splitter box, inflows to the trunk storm sewer would be minimal (from local drainage only), and would not be representative of expected flows. The flow splitter preliminary design as completed by Amec Foster Wheeler was incorporated into the interim assessment. A 900 mm equivalent pipe (1145x735 horizontal elliptical pipe) was selected for the direction of low flows towards the PDI lands (and future Ward One SWM facility) given capacity constraints in this location. The balance of the flows within the splitter box were directed towards the trunk storm sewer system along Elizabeth Street.

The proposed interim outlet for the Elizabeth Street trunk storm sewer resulted in temporary peak flow increases to the lower sections of Hadati Creek. The simulated increases in peak flows under less formative, more frequent storm events (2-10 year storm events) were considered minor. Similarly, the simulated hydraulic impact to Hadati Creek under the 5-year storm event was also considered to be minor, with an average water surface elevation increase of 0.015 m, and a maximum simulated increase in channel velocity of 0.04 m/s, both of which are considered to be nominal.

In addition to the previously noted interim conditions scenario (which reflect the proposed construction works along Elizabeth Street, as well as the proposed flow splitter at 292 Elizabeth Street), an ultimate conditions scenario has also been assessed. This scenario would reflect a full build-out of all currently considered or proposed works within the Ward One area. To summarize the additional changes considered within the updated hydrologic/hydraulic modelling under ultimate conditions (in addition to those discussed previously under interim conditions):

- Construction of the proposed Ward One SWM facility adjacent to the PDI lands
- Re-construction of Victoria Road between Elizabeth Street and the Reformatory ditch to include a new storm sewer (against grade) which will connect in to the 1200 mm storm sewer stub at Victoria Road and Elizabeth Street constructed as part of the currently proposed works; additional inlet capacity improvements (catch basins) at the existing sag point along Victoria Road (refer to Drawing 2 for details)
- Re-direction of the trunk storm sewer along Elizabeth Street from its interim outlet to Hadati Creek to a new outlet to Clythe Creek, via Industrial Avenue

Table 8.3 provides a comparison of the existing versus interim conditions scenario peak flows for Hadati Creek, demonstrating a minimal increase in peak flows for the interim conditions.

Table 8.3: Interim Conditions Estimated Peak Flows (m^3/s) for Hadati Creek

Location	Simulated Peak Flow (m^3/s) for Specified Land Use					
	5 year		25 year		100 year	
	Existing	Interim	Existing	Interim	Existing	Interim
D/S of Elizabeth Street	10.5	10.7	15.7	16.2	18.4	19.5
D/S of Beaumont Crescent	12.8	13.0	18.5	19.0	22.6	22.7
D/S of York Road	12.9	13.1	18.7	19.2	22.9	24.0
Outflow to Clythe Creek (Eramosa River)	12.9	13.1	18.7	19.2	22.9	24.0

Tailwater conditions from Hadati Creek have a significant impact upon surcharging within the Elizabeth Street trunk storm sewer system. Accordingly, it was determined that the most effective solution would be to outlet the proposed storm sewer to Clythe Creek at York Road, via Industrial Avenue. Tailwater conditions in Clythe Creek (based on levels within the Eramosa River) would be significantly lower, up to 2.57 m lower for the 100 year storm event.

A preliminary design for the Industrial Avenue sewer was incorporated into the ultimate conditions modelling. The updated ultimate conditions modelling has also included additional expected drainage areas from Industrial Avenue, as well as from areas to the west along York Road (refer to Drawings 1 and 2, Appendix D). Due to the need for sufficient cover, and the presence of a trunk sanitary sewer at York Road which must be crossed to reach Clythe Creek, the downstream limits of the proposed trunk sewer transition from a 3000 mm x 1500 mm box to twin 1800 mm x 900 mm boxes (refer to drawings in Appendix D). Table 8.4 provides the ultimate conditions scenario peak flows at key locations relevant to the York Road Corridor, Hadati Creek and Clythe Creek.

Table 8.4: Simulated Peak Flow Summary (m^3/s) – Ultimate Conditions

Location Reference	Node	24-Hour Chicago Distribution					
		2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
9	Total Discharge to Hadati Creek at Elizabeth Street and Industrial Avenue	0	0	0	0	0	0
10	Flow to Industrial Avenue (Clythe Creek)	3.61 [3.83] (0)	5.21 [5.54] (0)	6.43 [6.85] (0)	7.65 [8.05] (0)	8.51 [9.04] (0)	9.17 [9.83] (0)
11	Discharge to Clythe Creek from Existing 1650 mm Storm Sewer	1.93	2.25	2.34	2.45	2.55	2.68

Notes: 1 Where relevant, bracketed values indicate major system (overland) flows, preceding values are minor system flows (storm sewer).
2 Values in square brackets indicate the total flow within the minor system at the downstream limits of the proposed ultimate storm sewer (i.e. the outlet to Clythe Creek) as compared to the upstream limits of Industrial Avenue.

Under ultimate conditions, there would clearly be a reduction in peak flows to Hadati Creek; as evident from Table 8.5, the 100 year discharge to Hadati Creek would be reduced by some 5.66 m^3/s as compared to existing conditions (since all flow other than overland would be directed towards Clythe Creek via Industrial Avenue). Although not assessed in detail, this would clearly be beneficial in further reducing flood risk to downstream properties adjacent to Hadati Creek.

Table 8.5: Simulated Difference in Peak Flows (m^3/s) between various Scenarios

Location Reference	Node	Scenario Comparison	24-Hour Chicago Distribution					
			2Year	5 Year	10 Year	25 Year	50 Year	100 Year
9	Total Discharge to Hadati Creek at Elizabeth Street and Industrial Avenue	Existing	-1.40	-2.43	-3.39	-4.42	-5.06	-5.66
		Interim	-3.53	-4.86	-5.91	-7.09	-7.86	-8.34
10	Flow to Industrial Avenue (Clythe Creek)	Existing	+3.61 (-0.04)	+5.21 (-0.09)	+6.43 (-0.17)	+7.65 (-0.36)	+8.51 (-0.63)	+9.17 (-0.91)
		Interim	+3.61 (-0.02)	+5.21 (-0.03)	+6.43 (-0.05)	+7.65 (-0.08)	+8.51 (-0.10)	+9.17 (-0.13)
11	Discharge to Clythe Creek from Existing 1650 mm Storm Sewer	Existing	-1.14	-0.84	-0.76	-0.66	-0.56	-0.44
		Interim	-0.57	-0.49	-0.54	-0.53	-0.48	-0.37

Notes: 1 Where relevant, bracketed values indicate major system (overland) flows, preceding values are minor system flows (storm sewer).

Additional assessment of the simulated peak flow increases due to the proposed flow splitter at 292 Elizabeth Street will be incorporated into the detailed stormwater management assessment during detailed design.

8.6 Potential Impacts

The preferred alternative has considered and taken into account the environmental sensitivities of the YREDS study area. Notwithstanding, there are environmental impacts that could result from the implementation of the preferred alternative. As such, all disciplines have assessed the potential for environmental impacts, and have generated mitigation measures to reduce or eliminate these potential impacts.

Impacts can be defined as the consequences that result from an activity or site alteration and can be either positive, neutral, or negative. Impacts can be divided into three categories as defined by the City of Guelph's Guidelines for the Preparation of Environmental Impact Studies (2014).

Direct Impact: Impacts that specifically result from the proposed development layout and/or construction activities. These impacts can be mitigated through modification of site plans and managing construction practices.

Indirect Impact: Impacts that may be caused by altered uses and activities after construction is completed.

Induced Impact: These impacts are a subset of indirect impacts and are the consequences of the changes in human behaviours resulting from the new development.

Direct, indirect, and induced impacts have been considered along with potential avoidance measures. The time period of any identified impacts (i.e. short-term vs. long-term) has also been taken into consideration.

8.6.1 Changes to Permeability

Soil permeability is the measure of how well a fluid passes through it. A soil with high permeability such as sand, allows for faster and greater infiltration than a soil with low permeability such as clay. Changes in the soil permeability will be a one-time occurrence (i.e., during construction). All effort to use in situ soils for creek and road works should be made. It is understood that compaction of the soils within the proposed road widening would occur, that said beyond the road area the area for machinery access should be minimized to reduce soil compaction.

8.6.2 Changes to Water Balance

Water balance analysis allows the quantification of different components of a hydrologic cycle. Water balance analysis is an integral part of the decision support or policy evaluation process at the strategic or functional planning stages of the project. Water balance models are decision support and scenario management tools for promoting rainwater management and stream health protection. Changes in the water balance will be a one-time occurrence (i.e., during construction). Wetland communities have the greatest sensitivity to changes in water balance. The communities along the existing watercourse are likely to be impacted directly but can be compensated for along the relocated watercourse. Wetland vegetation can be salvaged during the construction process to help expedite the naturalization process of the new creek alignment. Wildlife that relies on the impacted wetland communities will be temporarily indirectly negatively impacted during the construction and planting phases. There are no expected induced impacts.

As previously discussed, the potential for groundwater discharge exists along the Clythe Creek reaches within the YREDS study area. The potential exists due to the permeable nature and thickness of the overburden and the existence of a bedrock channel within the larger scale hydrogeologic setting. This setting is prevalent within the study area including the proposed realigned reach. As such it is expected there would be no significant change to the groundwater discharge potential. In addition, where possible, infiltration trenches with pre-treatment will contribute to shallow groundwater in the immediate vicinity of York Road.

8.6.3 Potential Alteration of Drainage Patterns

Grading activities are often required to accommodate the relocation of the creek and may also alter the way water flows in the YREDS study area. Proposed site development will result in an alteration of drainage pattern of the existing study area. Changes in the grading will be a one-time occurrence (i.e., during construction) and will result in a permanent alteration of drainage patterns. The proposed changes are not likely to change the drainage pattern to the catchment but local changes to permeability could directly negatively impact wetlands by modifying the amount of water they retain as well as the duration of the hydroperiod. Wetland communities along the existing watercourse are going to be impacted but can be mitigated though compensating wetland area along the proposed watercourse. Wildlife that relies on the impacted wetland communities will be temporarily indirectly negatively impacted during the construction and planting phases. There are no expected induced impacts.

It is understood that sections of Clythe Creek upstream of the former Reformatory will not be receiving external contributing flow due to the proposed partial creek realignment. Under less frequent storm events, commencing at the 2 year storm, flow would overtop the proposed low flow channel and enter the existing low flow channel. In addition, local drainage from York Road will drain to the existing low flow channel via proposed storm sewer outlets (ref. Appendix M).

Drainage patterns would also change from removing the connection from the Royal Jaycees Park north pond to Clythe Creek. The south pond is currently connected to the north pond and the Eramosa River, as such there would be additional flow contribution directly to the Eramosa River from both ponds. Assessment of the thermal benefits to Clythe Creek and potential impacts to the Eramosa River are beyond the scope of this EIS.

8.6.4 Potential Increases in Runoff

The addition of two (2) road lanes each 3.5 m in width and the two (2) multi-use pathways will increase the runoff from York Road to Clythe Creek. The proposed two (2) multi-use paths each 3 m wide will not have a considerable impact to runoff as it proposed to use permeable pavement (apart from driveway areas). To offset the increase in runoff from York Road, it is proposed to use infiltration cells along the corridor, capable of storing approximately the 27 mm storm event, sized for the additional road paved area. The infiltration of 27 mm would mean no increase in runoff volume from the additional paved road areas for up to 90% of local storm events (ref. Appendix M). Additional detail will be provided in detailed design.

8.6.5 Potential Changes in Water Quality and Temperature

Stormwater water quality will be provided in a treatment train approach, using bio-filtering (when space allows), catch basin shields, oil/grit separators and infiltration/filtration trenches. The recommended infiltration/filtration stormwater trenches would also act as cooling trenches for any flow that is not infiltrated from the paved area of York Road. The water temperature of Clythe Creek should also benefit from the removal of the north pond connection to the creek.

8.6.6 Potential Changes in Channel Stability

The preferred alternative channel alignment establishes a channel with a form suitable for the discharge, slope, and sediment at the site, promoting natural fluvial processes (sediment transport, erosion and deposition) and long-term dynamic stability of the creek. Contact with the majority of the in-stream cultural heritage features is eliminated with the preferred alignment and the structures will therefore no longer be a controlling aspect of the channel morphology. Immediately following construction of the new channel, the channel boundaries (banks and floodplain) may be susceptible to erosion prior to the establishment of dense vegetation that provides additional channel stability once grow in has occurred Excessive erosion may be mitigated with erosion and sediment control practices and employing offline construction as possible.

8.6.7 Potential Changes in Fish Passage

Clythe Creek has been extensively altered through the YREDS study area and contains several barriers to upstream fish migration. The existing barriers only allow downstream fish movement, thus creating a series of semi-isolated reaches. Barriers such as these are considered detrimental, as they prevent fish from undertaking movements such as spawning migrations or seasonal movements to locations with more favourable temperatures. Such movements allow fish to make optimal use of the available habitats. Removing such barriers, as recommended in the Grand River Fisheries Management Plan (Ontario Ministry of Natural Resources and Grand River Conservation Authority, 1998), is therefore considered to be positive.

8.6.8 Potential Changes in Fish Habitat

There do not appear to be any critical habitats present within the YREDS study area, such as spawning areas for fish from the Eramosa River, where modification would have a negative impact that would extend beyond the modification footprint. The elimination of several barriers to upstream migration, can be expected to provide benefits that extend throughout and beyond the study area by allowing fish to move freely between habitats, thus making use of seasonally optimal conditions and avoiding seasonally incompatible conditions, such as high summer water temperatures.

The series of small ponds that has been created along Clythe Creek downstream from the entrance to the York District lands differs from the stream habitat that would originally have been present. The decreased water velocity and large surface area probably results in increased summer water temperatures and the submergent aquatic vegetation may cause low night-time dissolved oxygen concentrations during the summer. These ponds provide habitat for tolerant fish species and restoring Clythe Creek to a more natural channel configuration would reduce the amount of that habitat present. The proposed channel realignment is a return to conditions that would naturally occur in a stream of this nature, as recommended in the Grand River Fisheries Management Plan (Ontario Ministry of Natural Resources and Grand River Conservation Authority, 1998).

The proposed plan does result in a reduction in the length of the small tributary that enters Clythe Creek upstream from the York District Lands entrance (Feature #13). Currently, however, this watercourse is only contiguous, in a fish utilization sense, with the short reach of Clythe Creek that is between the barriers to fish movement identified as Features #11 and #14. Elimination of the migration barriers would make this watercourse contiguous with a much longer reach of Hadati Creek. It should be noted that no fish were captured when 117 m of this tributary were electrofished in 2009 (Table 2.6.1).

8.6.9 Modification of Vegetation Communities

The modification of existing vegetation communities to accommodate the relocation of the creek and widening of York Road. Vegetation Removal will be a one-time occurrence (i.e. during construction) and will result in permanent shift in vegetation community composition (ref. Figure 3.6.1). The proposed development will directly impact vegetation communities by removing a total of 3.41 ha of vegetation communities from the YREDS study area (Table 4.2.1). The majority of the removed vegetation occurs in cultural communities. There will be removals of some Forest communities and some marsh communities. Planting along the proposed creeks of equal or greater area will replace natural cover removed.

Table 8.6: Vegetation Removal Areas

ELC Code		Vegetation Community Name	Total Area (ha)	Area to be Impacted (ha)	Area to be Impacted (%)
Cultural Communities					
16	CUM1-1	Dry-Moist Old Field Meadow	2.39	0.13	5.4
7, 11, 14	CUT2-6	Buckthorn Cultural Thicket Type	3.69	0.33	8.9
3	CUM1-1/MAM 2-10	Dry-Moist Old Field Meadow Type/Forb Mineral Meadow Marsh Type Complex	4.94	2.86	57.9
1, 2, 4	ANTH	Anthropogenic	2.05	0.19	9.3
Natural Communities					
10	FOD7-4	Fresh-Moist Lowland Willow Deciduous Forest Type	0.71	0.07	9.9
13	MAM2-10	Forb Mineral Meadow Marsh Type	4.35	0.06	1.4
9, 18, 19, 20, 21, 22	OAO	Open Aquatic	12.10	0	0

Wildlife that relies on the impacted vegetation communities will be temporarily indirectly negatively impacted during the construction and planting phases. There are no expected induced impacts. Restoration along the proposed creek alignment, implementing vegetation salvages can compensate for the removed communities. Salvaging vegetation can advance the rehabilitation of vegetation communities, making them accessible to wildlife sooner.

8.6.10 Modification of Arboricultural Resources

Modification of arboricultural resources includes the proposed removal and/or potential injury of trees to accommodate the creek realignment. Removal and potential damage of trees should be avoided if possible. The location and extent of arboricultural resources were considered during site plan development with the intent to avoid impacts wherever feasible. The arborist study completed in 2016 did not survey the extent of the proposed creek realignment and a supplemental survey is proposed for the remaining portion of the modification footprint and will be included in the Vegetation Compensation Plan (Figure 3.6.2). Tree removal is to be a one-time event during construction. The loss will be temporary as new plantings are proposed to replace trees being removed.

The proposed actions summarized in Section 7 will apply to accommodate the site alterations. The realignment along York Road will require 115 trees removed and may injure an additional 79 trees (ref. Table 8.7); refer to Section 3.6.3 for details. Additional trees may be injured or removed pending the results of the remaining arborist assessment.

Table 8.7: Tree Impact Summary

Proposed Action	Total (No. of Trees)
Preserve	20
Injure	79
Remove	115
Replacement Requirement (1:1)	**194**

The permanent removal of trees will result in a loss of canopy habitat. The City of Guelph's Private Tree Protection By-law (2010) – 19058 does not apply to publicly-owned lands. However, policies contained within the Urban Forest section of the Official Plan (March 2018 Consolidation) specify that: "Where the City is undertaking infrastructure work, healthy non-invasive trees within the urban forest will be retained to the fullest extent possible. Where trees are required to be removed, relocation or replacement plantings will be provided by the City." (4.1.6.1.2). Given time to grow, the canopy will increase in size and will consist of more native species. No induced impacts are expected. A Vegetation Compensation Plan and Tree Protection Plan will be prepared in the detailed design stage.

8.6.11 Construction Disturbance of Wildlife

Construction activities often result in a number of direct impacts to wildlife inhabiting the YREDS study area, including but not limited to: increased noise, light pollution, and vibrations which may result in avoidance behaviors of local wildlife. Clearing and grading operations may disturb wildlife and interfere with nesting birds if conducted during breeding season. Impacts are possible from the commencement of construction activities, and could range between 6 months to a year. Construction activities are a single occurrence activity. Clearing and grading activities could directly negatively impact birds by interfering with nesting. There is specific concern for Eastern Meadowlark which was recorded on the adjacent property. Avoidance behaviour of wildlife may occur for a short period after construction activities have ceased. Minor increases in noise and light pollution may also deter area sensitive species. No induced impacts are expected. Impacts prior to mitigation measures are negative and of moderate significance. Construction activities including, but not limited to, clearing and grading activities should occur outside of the breeding season (April 1st to August 25th) to avoid impacts to nesting of significant species. Impacts after mitigation measures are neutral, and of moderate significance as impacts are temporary and can be avoided by timing activities outside of breeding season. It is possible to avoid or reduce the magnitude of the disturbance if clearing, grading, and/or general construction works take place outside the breeding bird season In Guelph the breeding bird season corresponds roughly to the period of April 1stand August 25th. This window will also protect nesting turtles and breeding frogs which tend to breed between last week of May and first week of July and mid-April to late June respectively.

The installation of silt fencing around construction site before the breeding window will also act as a barrier for most wildlife from entering the construction site. Workers should still be educated on potential wildlife present and how to properly relocate any specimens found within the construction site, with special attention to Species at Risk.

8.6.12 Decreased Soil Stability

Decreased soil stability is caused by clearing of vegetation and grading activities as it breaks up soil layers, reduces compaction, and increases bare soil which is more susceptible to erosion and/or sedimentation leading to loss of soil. Impacts are possible from the commencement of construction activities and could range between 6 months to a year. Construction activities are a single occurrence activity and soil stability will be restored upon revegetation of the site. Construction activities are a single occurrence short term activity. Soil stability will be restored upon revegetation of the site, therefore impacts are temporary. Decreased soil stability can cause more erosion and sedimentation resulting in reduced vegetation vigor and decreased water quality and fish habitat. By adhering to Greater Golden Horseshoe Area Conservation Authorities (GGHACA) 2006 Erosion and Sedimentation Control Guidelines for Urban Construction, little soil erosion and sedimentation should occur, minimizing the indirect impacts. If guidelines are not adhered to, prolonged reduction in plant vigor and fish habitat quality may occur. There are no expected induced impacts.

Impacts prior to mitigation and compensation measures are negative and of moderate significance due to:

- Minimal magnitude relative to area disturbed;
- Duration is temporary; and
- The frequency is a single occurrence event.

Soil destabilization is reversible through revegetation following construction using temporary seed mix/annual nurse crop grass species within limits of disturbance. Adjacent natural feature should be protected from sedimentation through the use of siltation fencing outlined in GGHACA's Erosion and Sedimentation Control Guidelines for Urban Construction (2006).

The proposed site alterations were developed to require minimal grading, but some grading is still required to accommodate site activities. It is not possible to avoid soil disturbance in order to grub out the root systems of trees and other vegetation to accommodate construction. Sedimentation in the adjacent natural areas can be avoided through use of siltation fencing erected around disturbance zone in conformance with GGHACA 2006 Erosion and Sedimentation Control Guidelines for Urban Construction. Soil destabilization is reversible through revegetation following construction.

Impacts after mitigation and compensation measures are neutral, as negative impacts can be avoided through the use of GGHACA 2006 Erosion and Sedimentation Control Guidelines for Urban Construction, and soil destabilization can be reversed through revegetation.

8.6.13 Import/Export of Fill

Imported fill will be of divergent origin and character to that of existing soils and may affect stability and/or permeability functions. However, as the imported material will be used primarily as a base for the road widening and the overall magnitude will be commensurate to that caused by the construction of new roads, and proposed creek. Importation of topsoil may bring in weed seed from non-native invasive species. Once imported, the duration of the fill placement is considered permanent. This is a single occurrence event. Some top soil may be imported to amend landscaping areas. It is not likely that this presents a significant source of non-native invasive seeds. Introduction of non-native invasive seeds may lower the quality of vegetation communities by out competing native species for resources, reducing the biodiversity of the YREDS study area, and the resiliency of the plant communities. The plant communities are all cultural in nature and many non-native invasive species are already present, therefore the impacts are likely insignificant. No induced impacts are expected.

Impacts prior to mitigation measures are negative and of low significance due to sensitivity of target is low and the extent is limited and the effect of the impact is permanent. Careful stockpiling and amendment of existing topsoil may allow avoidance of importing additional topsoil. If importing soil is unavoidable, top soil should be sourced in a manner that has the least potential for containing invasive exotic seeds. Granular fill is required to construct stable foundation for proposed roads and is therefore unavoidable. Once imported and placed it is not possible to reverse this impact while maintaining the proposed roads. Impacts after mitigation measures are neutral. Soil quantities would be determined during the detailed design stage.

8.6.14 Removal of Open Country Bird Habitat

A pair of Eastern Meadowlark was recorded during the 2016 breeding bird survey on the property adjacent to the east of the YREDS study area (south of polygon 16 on Figure 3.6.1), south of Clythe Creek and east of the driveway to the correctional institute. The proposed work will be confined to the creek corridor and, as such, will not negatively impact these fields, therefore, there are no direct impacts expected. The pair may be indirectly impacted by the noise and other indirect pollution created during the construction period. No induced impacts are expected. Indirect impacts can be avoided by limiting construction activities to outside of the breeding season (April 1st to August 25th). If the detailed design requires the removal of any Open Country Bird Habitat, consultation with MNRF is required to ensure full compliance with Endangered Species Act (2007).

8.6.15 Removal or Encroachment to Area Sensitive Bird Habitat

Two bird species, Savannah Sparrow and Eastern Meadowlark, are considered to be area sensitive (OMNR 2000), which indicates that they require large areas of suitable habitat for their long-term survival and thus are more sensitive to development. Impacts to Eastern Meadowlark is discussed further in Section 8.6.14. Two pairs of Savannah Sparrows were present along south end of baseball fields and are probably breeding onsite. It is not likely that their breeding habitat will be directly impacted but construction noise could result in avoidance behaviours. Restricting construction activities to outside of the breeding window will avoid this negative impact.

8.6.16 Encroachment of Natural Areas

Encroachment is the induced impact caused by human occupation or use of land adjacent to natural areas and the associated buffers. Encroachment activities following establishment of buffers could affect the long-term success of NHS features and functions if encroachment is severe or excessive. Construction activities will result in temporary avoidance behaviour of many wildlife species. Noise and light pollution is likely limited to the lands immediately adjacent to York Road. Impacts would likely occur post construction and are potentially long term and iterative. Increased encroachment to the natural areas is not expected to increase significantly and would only incur by the increased traffic on York Rd. Very little to no induced impacts are expected as the land use is not changing from parkland.

8.6.17 Indirect Pollution

Pollution from the creek realignment and road widening include noise, light, and chemicals. Wildlife tend to respond through behavior modifications such as avoidance. Introduction of chemicals into the environment leads to reduced fecundity of aquatic and terrestrial wildlife and flora. Dust can cause avoidance behavior from wildlife and reduce the success of flora along roadsides. Potential effects of indirect pollution on wildlife include:

- Reduced habitat quality;
- Potential loss of habitat due to quality reduction;
- Reduced population densities (particularly breeding birds);
- Reduced species diversity;
- Increased susceptibility to predation;
- Negative physiological effect; and
- Alteration of reproductive behavior (particularly herpetofauna).

Impacts would likely occur post-construction and are potentially long-term and iterative. Construction activities will likely result in noise, light, and chemical pollution which may cause avoidance behaviours in many wildlife species.

Based on available information and the existing park lands surrounding the natural features, lighting is not expected to change and, therefore, is expected to have a negligible effect on wildlife habitat use or bird migration. Wildlife species that are crepuscular (active during dawn and dusk) or nocturnal may avoid suitable habitat located near roadways due to light pollution. The YREDS study area is likely to be occupied mostly during daylight hours, reducing the amount of noise and light pollution during key times for crepuscular species.

Contaminants from York Rd are not likely to change dramatically but may increase slightly due to increased road use. Contaminants can directly impact vegetation community, resulting in increased abundance of salt tolerant weedy species. It can indirectly impact wildlife by modifying the habitat adjacent to the road. The impacts are not expected to be significant as the communities adjacent to the roadways are cultural. No induced impacts are expected.

8.6.18 Removal of Significant Species

The Endangered Species Act (2007) (O. Reg. 242/08) protects flora and fauna that is Threatened, Endangered or Special Concern at the provincial level. Significant habitats of provincially Endangered and Threatened species are specifically protected from development in the PPS, and habitats of provincial Special Concern species are recognized under the Province's Significant Wildlife Habitat categories.

Three Species at Risk birds were recorded including Chimney Swift – Threatened (federal and provincial); Barn Swallow – Threatened (federal and provincial); and Eastern Meadowlark – Threatened (federal and provincial). Chimney Swift and Barn Swallow are not suspected to be nesting in the YREDS study area, as there is no suitable habitat present. Barn Swallows are known to be nesting in the vicinity and four birds were seen foraging over the baseball fields on the west side of the study area and in the open field on the east side of the study area. Eastern Meadowlark was recorded in the field east of the study area (south of polygon 16 on Figure 3.6.1), south of Clythe Creek and east of the driveway to the correctional institute. The proposed work will be confined to the creek corridor and, as such, will not negatively impact these fields.

A Snapping Turtle – Special Concern (federal and provincial) was observed in the pond. Although turtles are likely nesting in the general vicinity, such as along the Eramosa River to the south, there were no significant areas of potential nesting habitat along Clythe Creek and York Road. The two main ponds likely represent overwintering habitat for all three (3) turtle species.

Construction activities could result in avoidance behaviours of Eastern Meadowlark in the field adjacent to the study area and Snapping Turtles in the pond. During the 2016 wildlife surveys, there was no evidence of snapping turtles nesting along the existing watercourse, or anywhere else within the study area. It is likely that they are nesting offsite. Construction should occur outside of the breeding window to mitigate any impacts to breeding birds. No induced impacts are expected. Locally rare vegetation may be directly impacted by the creek realignment but through biosalvage efforts specimens should be able to be relocated to the new creek alignment. Three (3) locally significant vegetation species and their associated habitat are likely to be directly impacted. They include Rough Avens, Red Fescue, and Hairy Solomon's Seal. Through biosalvage efforts specimens should be able to be relocated to the new creek alignment. Plantings along the proposed alignment should be designed to replicate the habitat for these three species.

Although there is open country bird habitat, no habitat is to be removed as a part of the road widening and creek relocation.

8.7 Proposed Mitigation Measures

A mitigation, as defined in the City of Guelph's Guidelines for the Preparation of Environmental Impact Studies (2017), includes avoidance, minimization, and compensation. The following summarizes proposed avoidance and minimization measures.

8.7.1 Sediment & Erosion Control

Silt fencing should be maintained around the construction areas to ensure that no terrestrial wildlife, such as snakes or amphibians, can access the site and potentially be injured; a protocol should be in place to guide workers with regards to actions to take to minimize injury to wildlife and procedures to follow should they discover wildlife within restricted areas. Other sediment and erosion controls could include sediment control socks, permeable check dams, sediment control bags, turbidity curtains in ponds and other measures to facilitate road and creek works. Creek works are to be done in the dry.

8.7.2 Migratory Birds

To ensure compliance with the Endangered Species Act (2007), the habitat of Eastern Meadowlark (Threatened) should not be negatively impacted; works along Clythe Creek should stay as confined as possible to the creek and its associated riparian habitats; in addition, these open fields represent foraging for Barn Swallow (Threatened) which nest in the vicinity; any removal of this open field habitat will potentially require approval from the MNRF.

To avoid any potential impacts to nesting wildlife and to be in compliance with the Migratory Bird Convention Act (MBCA 1994), any vegetation removal on the site should be done outside of the breeding bird window, which for this site would be approximately May 1 to July 31. If any vegetation removal is to occur within this window, a qualified avian ecologist should first check the vegetation to be removed to ensure that there are no migratory birds covered by the Act nesting within it. If any birds are found nesting then, in consultation with Environment Canada, a suitable buffer should be established around the nest, and no activities will be permitted with this buffer until the birds have left.

8.7.3 Vegetation Resources

The City will replace or relocate trees to compensate for the number of trees that are to be removed or injured. Trees within the portion of the modification footprint not previously surveyed should be assessed to better determine the replacement requirements prior to construction. Hazard trees should be documented along trail alignment in consultation with environmental and parks planning staff.

Vegetation Compensation Plan and Tree Protection Plan must be completed to comply with City of Guelph Tree-Bylaw (2010).

Vegetation Compensation Plan should include biosalvage opportunities of native material and Regionally rare vegetation in particular within the modification footprint that could be transplanted elsewhere on site.

8.7.4 Buffers

The York Road Environmental Design Project falls within the category of essential transportation infrastructure and/or trails which are permitted within natural heritage features and adjacent areas/buffers under policies 6A.2 and 6A.3. Conditions post construction and site alteration shall apply standard buffer requirements to the new creek, riparian corridor, existing ponds, wetlands, adjacent forest, and open country bird habitat as described in Section 6A.1.1 of City of Guelph Official Plan (2018) under Table 6.1 Minimum Buffers, Established Buffers and Adjacent Lands to natural heritage features and areas.

8.8 Compensation Measures

The following summarizes the proposed compensation measures.

8.8.1 Open Country Bird Habitat

To ensure compliance with the Endangered Species Act (2007), the habitat of Eastern Meadowlark (Threatened) should not be negatively impacted; works along Clythe Creek should stay as confined as possible to the creek and its associated riparian habitats; in addition, these open fields represent foraging for Barn Swallow (Threatened) which nest in the vicinity; any removal of this open field habitat will potentially require approval from the MNRF.

8.8.2 Tree Replacement

The removed trees will be either relocated or replanted by the City.

8.9 Enhancement Measures

The following summarizes the recommended enhancement measures.

8.9.1 Wildlife

- Do not remove Common Milkweed, which is the hostplant for Monarch (Special Concern); if this plant is to be removed, it must be replaced elsewhere on the site.
- Turtles – areas of sand and gravel should be constructed in areas to the west and south of the two main ponds; these areas will encourage turtles to nest and will also entice them away from York Road to the north, which is a potential source of mortality. The two main ponds and areas along Clythe Creek should have logs and rocks provide to be utilized as basking sites. A permanent fence should be installed along the south side of York Road to stop turtles from attempting to cross York Road.
- Addition of turtle nesting habitat along the proposed creek alignment will better support the 3 turtle species observed on site.

- Nesting boxes for Wood Duck and platforms for Osprey should be considered in the pond redesign.
- Snake hibernacula could be designed into the edges of the main ponds to provide overwinter sites; the locations should be in southern portions of the ponds to be as far away from York Road as possible.

8.9.2 Vegetation

- The low-lying meadow marsh riparian areas along Clythe creek contain a variety of wetland and aquatic species that could be salvaged and transplanted along the new creek alignment.
- Biosalvage of native material and Regionally rare vegetation in particular within the modification footprint could be transplanted elsewhere on site. Biosalvage of other materials should be considered to facilitate recolonization of the creek by wildlife including odonates and benthic invertebrates.
- Native flower patches with Common Milkweed could be incorporated into the pond and creek designs to provide nectar sources for Monarch butterfly.
- Invasive species control.

9.0 Conclusions

The following conclusions have been prepared based on the findings documented herein.

9.1 Road Design

As part of the current undertaking, the 2007 Class EA-proposed York Road design between Victoria Street and the East City Limits was reviewed and revised to reflect updated City policies and Official Plan polices, as well as the desires of the public and other stakeholders. Since 2007, the City has placed an increased emphasis on provision of active transportation facilities. Retention of heritage features has also become increasingly important, as they help to tell the City's history and create places of interest for the public. With an increased emphasis on Active Transportation and heritage, the York Road cross-section was revised to provide multi-use pathways on both sides of the road, as well as a minimum 2.0 m buffer between any designated heritage features and the edge of the travelled way. The EA-proposed cross-section did not consider impacts to heritage features but did provide cycle lanes and sidewalks on the both sides of the road away from the York District (Reformatory) lands. Adjacent to the York District lands, the sidewalk was dropped on the south side. The recommendation to modify the proposed cross-section was based on extensive consultation and evaluation of feasible alternatives. The current study also recommends the realignment of York Road in order to provide enhanced active transportation and limit impacts to adjacent heritage features and Clythe Creek while maintaining the EA-approved north property limit, which results in land being required (0.23 Ha)

9.2 Hydrology and Hydraulics

Hydrology and hydraulics for existing and proposed Clythe Creek and York Road corridor has been developed. Based on no impact on Clythe Creek peak flows resulting from the proposed road improvements, stormwater management is only required for erosion and quality control, consisting of bio-filtration, catch basin shields, oil/grit chambers and infiltration/ filtration cooling trenches along the road right-of-way.

The proposed Clythe Creek realignment and culvert replacements will provide a slight reduction to the Regulatory floodplain and will reduce overtopping depths of York Road at the Clythe Creek crossing.

9.3 Stream Morphology

Based on a fluvial geomorphologic assessment, Clythe Creek was identified to be in a transitional or stressed state due to past alterations and a variety of disturbances that have disrupted natural fluvial processes in the system. In particular, alterations in channel slope and discharge have occurred due to the introduction of instream barriers and changes in drainage patterns. Significant deposition in downstream channel reaches due to low gradients, backwatered conditions, and a widened out cross-section has resulted in degraded conditions. A preferred alternative for channel realignment has been identified (ref. Appendix F) that involves establishment of a stable planform and profile with form that is appropriate for the discharge, slope, and sediment at the site. The planform is separated from the road right of way and a majority of in-stream structures are removed from the profile. The newly established channel will provide improved function, promoting natural channel processes and in turn is expected to improve overall aquatic habitat via removal of barriers to fish passage and establishment of stable habitat (e.g. riffle-pool profile).

9.4 Fisheries

From a fish habitat perspective, the proposed realignment using natural channel design can be considered a restoration of the existing channel and is entirely consistent with the recommendations of the Grand River Fisheries Management Plan (Ontario Ministry of Natural Resources and Grand River Conservation Authority, 1998). The proposed works will change the nature and amount of fish habitat that is present, and the proposed works will require review by Fisheries and Oceans Canada under the Fisheries Act. A quantitative assessment of the proposed works will be required during detailed design to support that review. The restoration will result in a reduction in the area of habitat that is present due to the narrowing of the channel between the entrance to the York District Lands and the confluence with Hadati Creek and shortening of the channel between the confluence with Hadati Creek and the confluence with the Eramosa River. Support for the current proposal, which is based on the position that the benefits that will occur as a result of the channel restoration would offset the reduction in pond-like habitat along the existing channel should be sought from the relevant agencies, including Fisheries and Oceans, as soon as it is feasible. It can be anticipated that a Fisheries Act authorization will be required for the channel works. Approval from GRCA would also be required for any channel works.

9.5 Wildlife and Vegetation

The study area and the adjacent lands present several ecological sensitivities including but not limited to natural vegetation communities, open country bird habitat, turtle habitat, three Species at Risk birds, and existing trees. The widening of York Road and the creek realignment will cause some direct negative impacts, specifically to trees and natural vegetation. The negative impacts can be compensated for as a part of the new creek realignment design. Further arboricultural assessment is required to properly evaluate the number of trees that will be removed or injured but replacement will occur by the City. Area of natural communities will be compensated for at a 1:1 ratio and the selection of native species will improve the biodiversity onsite. Salvaging riparian vegetation from the existing creek will both expedite the naturalization of the new alignment and benefit from the existing mycorrhizae and propagules in the soil. The proposed development may indirectly impact wildlife including turtles, open country birds, and Species a Risk birds. No habitat for any of the species is proposed to be removed but avoidance during construction is possible. This can be mitigated through limiting construction to outside of the breeding window (April 1st to August 25th). If any vegetation removal is to occur within this window, a qualified avian ecologist should first check the vegetation to be removed to ensure that there are no migratory birds covered by the Act nesting within it. Although turtles are not currently breeding along the existing creek alignment, the addition of turtle breeding habitat in the proposed design will benefit turtles present onsite. There are no expected induced impacts. York Road is already a heavily used road, therefore widening it is not likely to cause a noticeable change in human use. The park land is remaining parkland with not additional programming. In conclusion, the widening of York Road and the realignment of the creek will cause some negative impacts but can be mitigated and compensated completely, resulting a net neutral or positive impact.

9.6 Cultural Heritage

While the development approaches that have been currently determined for the York Road improvements, leave few options for mitigation of the heritage resources, suggestions are enumerated below. The heritage resources of the former GCC lands that front York Road in the City of Guelph, are unique and highly valued and, as such, would require careful planning. They include stone wing walls, a creek with multiple weirs, retaining walls and stairways, ponds and both vehicular and pedestrian bridges and form an extensive landscape enjoyed both in the past and the present by the Guelph community.

The wing walls at the entrance off York Road to the GCC would need to be dismantled and rebuilt with the east wall in the approximate same location but extended by 7 m so that the end treatment does not conflict with the existing in-water feature. The west wall would be moved further south, away from the roadway and the clear zone. If the walls were left in the current locations, a guiderail would need to be placed approximately 0.5 m to 1.5 m in front of the walls, and with the walls remaining partially buried, the view of the walls would be greatly diminished. There would also be a possibility of damage to the walls during the road construction. In addition, snow could be piled up next to them due to the lack of space from the road and multi-use pathway. This could potentially also result in structural damage to the walls.

A qualified heritage stone mason would be required to remove the existing walls, clean the stones, add additional stones as required and rebuild the walls and the circular end treatments. Interpretive signage would add to the understanding of the significance of the walls.

Although the west wall would be further south and the east wall would be extended, the rebuilding of the two walls would bring the walls closer to the original 1920 appearance. This, along with interpretive signage, would improve the public's view and understanding of the history of the entranceway.

The realignment of major portions of Clythe Creek also impacts the heritage features. While some of the features would need to be removed, others would stay in situ but without regular water flow; flow would occur in large storm events (i.e. ≥ 2-year storm event). Some field stone weirs and steps would remain in situ but without water flow. Were possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structures.

10.0 Recommendations

10.1 General Recommendations

The following general recommendations have been developed based on the assessment of road and creek alternatives for the York Road corridor:

10.1.1 Transportation

1. York Road will consist of four 3.5 m wide lanes with 3.0 m wide multi-use pathways on both the north and south sides, within the York Road right-of-way. Boulevard widths will vary to limit impacts to adjacent heritage features and Clythe Creek.
2. The Reformatory Entrance Walls will be shifted south, beyond the clear zone limit of the roadway, by a qualified heritage mason;

10.1.2 Drainage and Stormwater Management

1. Drainage improvements will include culvert replacements as per the following:
   - York Road Clythe Creek culvert to be upgraded to a 28.8 m long by 12.81 m by 2.74 m conspan arch.
   - The park driveway culvert is to be upgraded to a 14.2 m long by 10.97 m by 2.44 m conspan arch.
   - The 25.8 m long by 5.5 m by 1.7 m Hadati Creek box culvert is to be extended by 10.6 m to 36.4 m length
2. Stormwater management would include bio-filtration, catch basin shields, infiltration/ filtration trenches and oil/grit separators.

10.1.3 Fluvial Geomorphology

1. Major mitigation activities during construction will be associated with the implementation of Best Management Practices (BMPs), particularly for erosion and sediment control measures and timely site restoration designed to address specific requirements for vegetation establishment as a function of season. Contractors should be evaluated on the basis of their previous creek rehabilitation and erosion control experience, with particular emphasis on in-water channel restoration work experience, to help contribute to the quality and effectiveness of implementation. To ensure that the objectives of the channel design are realized, it is important that someone with experience in channel design and channel construction perform regular construction supervision.
2. Implementation of the creek realignment will benefit from the ability to construct a portion of the proposed new channel offline. In other words, where the proposed planform is outside of the footprint of the current creek, the new channel can be constructed largely without disrupting flow in the existing channel. If timing allows, this also provides the opportunity for vegetation to establish along the channel margins and in the floodplain prior to connecting flow through the new channel (i.e. grow in period). In locations where constructing offline is not possible, the realignments may be accomplished using a “dam and pump” system. A flume may be used in combination with a pumping system to assist in conveying flow, if necessary. The bypass will depend on the volume of flow expected at the time of construction, and coffer dam dimensions will need to be designed in accordance with the serviceability requirements. During stream bypass operation, fish relocation will be required in order to limit the number of stranded fish during each

phase of construction. Ideally construction would take place during seasons of low flow to reduce the risk of nuisance flood and erosion susceptibility.

3. Pre and Post-Construction Monitoring is proposed to ensure constructed design elements are functioning as desired. As proposed channel restoration works may be completed in phases, holistic monitoring of the YREDS study area, and within each reach, should take place each year regardless of whether or not restoration activities have taken place. Although proposed channel restoration activities are reach specific, the intent of the monitoring plan is to maintain overall connectivity through the entire study area. By monitoring the study area holistically, changes within downstream reaches can be identified and future restoration activities can be planned accordingly.

10.1.4 Terrestrial Ecology

1. Development of a monitoring plan with quantitative thresholds to ensure that the proposed mitigation and compensation measures perform as intended. The monitoring plan will consist of baseline, during construction, and post-construction stages. It should include monitoring stations, design and reporting guidelines and deadlines. Deficiencies identified through monitoring activities will be addressed to the satisfaction of the City of Guelph. The post-development monitoring program will include potential management responses to rectify potential negative impacts, verify performance targets (e.g. habitat for target species), and unforeseen negative ecological impacts.
2. Tree tagging in the preferred creek alignment area.
3. Bald Eagle winter surveys as part of the environmental studies required through the future block plan process for the GID area.
4. The creek alignment and road work are occurring within what would traditionally be the buffer area of the watercourse. To avoid any additional impacts to the natural features development activities should be restricted to inside of the limit of grading.

10.2 Recommendations for Detailed Design Requirements

The following recommendations for detailed design requirements have been developed based on the preferred road and creek alternatives for the York Road corridor:

10.2.1 Transportation

1. Provision of vehicular and active transportation infrastructure within the EA-established property limit was identified as the key priority by the City during completion of this study. Additional effort will be required to confirm relocation requirements for overhead and at-grade utilities, as well as street lighting. Use of solar powered LED lighting should be considered to reduce costs associated with wiring and powering of the relocated light standards.
2. Provision of traffic calming measures was identified as a priority by members of the public and City. While not within the scope of the current study, opportunities to provide some level of calming through reduced (and enforced) speed limits, as well as landscaping of adjacent properties should be further investigated. This should also be discussed through completion of the York District Lands study.
3. Portions of the corridor will require specialized snow clearing techniques due to the lack of boulevards for storage. Methods, volumes, and storage locations should be considered when winter maintenance plans are developed for the area.

4. A roadside safety assessment was not completed for the corridor to identify locations where guiderails will be required. Formal assessment and design of barriers will be required during detailed design.
5. As part of the roadside safety assessment and detailed design, physical barriers should considered for use between the edge of pavement and the multi-use pathways.
6. Prior to detailed design, the traffic study completed in support of the 2007 York Road EA should be reviewed and updated to confirm auxiliary and through lane requirements, particularly given the apparent change in land use numbers within the Guelph Innovation District;
7. Location and requirements for bus stops and shelters will need to be completed as a component of detailed design.

10.2.2 Drainage and Stormwater Management

1. Further assessment of the proposed drainage systems and stormwater management will require additional detailed topographic survey of the corridor including existing underground servicing.
2. Both groundwater and bedrock elevations should be determined along the corridor.
3. Soil permeability testing and chemical analysis should be conducted to facilitate LID BMP design and earth removal from the corridor.
4. Further understanding of the fish habitat and flow and thermal regime contribution to Clythe Creek from the Royal City Jaycees Park pond system is required before determining how the ponds could be disconnected from Clythe Creek. The potential impact to the Eramosa would also have to be assessed.
5. During the detailed design phase flow monitoring within both Clythe Creek and Hadati Creek could be implemented to facilitate additional PCSWMM hydrologic modelling verification.
6. A monitoring program be established for groundwater levels and hydraulic gradients for pre-development, construction and post development conditions along the road corridor.
7. A Water Quality Monitoring Program should be developed to be implemented for pre-development, construction and post development conditions. The water quality program should assess the impact of road runoff on Clythe Creek and assess the level of performance of stormwater quality measures. Water quality parameters to be monitored would be determined through consultation with the City and GRCA, that said, a potential list of parameters to sample for could include the following (to be refined during detailed design:
   - Oil and Grease
   - Total Phosphorus
   - Dissolved Phosphorus
   - Anions (Nitrate, Nitrite, Phosphate, Chloride)
   - Ammonia
   - Total Kjeldahl Nitrogen (TKN)
   - Conductivity
   - Total Solids (TS)
   - Total Suspended Solids (TSS)
   - BOD_5
   - Dissolved Oxygen
   - pH/alkalinity

- Chloride
- E.coli
- PAH
- Metals (Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, P, K, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, W, U, V, Zn, Zr).

8. A Construction Staging Plan will have to be developed. The staging plan will not only have to consider drainage works such as stormwater management measures, but cultural heritage resources relocation and restoration, Clythe creek restoration, culvert replacements and road works. Creek realignment when possible should be conducted off-line. When the creek is online, creek works should be conducted during low flow conditions using temporary flow passage measures.

10.2.3 Fluvial Geomorphology

1. At the detailed design stage, design parameters can be finalized through an iterative process that optimizes the channel design from multiple perspectives (fluvial geomorphology, fish passage/aquatic habitat, floodplain health). The preferred alternative provides the basis from which design parameters can be further refined. Design discharge and cross-sections, planform geometry (meander wavelength and amplitude, radius of curvature), profile detail (e.g. riffle-pool spacing), bed and bank treatments, habitat elements, and floodplain and vegetation considerations are developed to greater detail.
2. Additional topography/site information should be collected as necessary (e.g. up to date tie-in point elevations, confirmation of groundwater input and soil conditions along the tributary, etc.).
3. The hydraulic modelling should be advanced based on confirmation of design conditions and will be instrumental in confirming that the proposed configuration promotes project objectives including natural sediment transport processes and reduction of deposition trends and facilitation of fish passage.
4. Species-specific habitat preferences for target species can be introduced into the design.

10.2.4 Fisheries and Aquatic Habitat

1. Fisheries windows (Restrictive in-water work period) to consider not only Clythe Creek, but the Eramosa River (March 15th to June 30th), for creek works at the confluence of the Eramosa River.

10.2.5 Terrestrial Ecology

1. Further assessment of the area towards the western edge of the YREDS study area to identify it's potential to support wetland communities. This should include confirmation of wetland boundary with GRCA as to ensure the proposed creek realignment does not have an impact.
2. Wetland polygons 8, 12, 13 and 15 have their boundaries confirmed with the GRCA. An updated evaluation of significance based on City Official Plan policy and GRCA policy/regulation will be required at the detailed design stage.
3. A Schedule A – Application for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Permit should be submitted to GRCA.
4. Identification of biosalvage opportunities.
5. Creek design should include naturalized wetland communities with native species including Rough Avens, Red Fescue, and Hairy Solomon's Seal, three locally significant species that are likely to be directly impacted. Wetland pockets along the existing creek should be salvaged and replanted

along the new creek alignment. Target communities should be tailored to the species found using the existing creek alignment.

6. Develop a Vegetation Compensation Plan, detailed Tree Protection Plan, and a Tree Compensation Plan in accordance to the City`s Urban Forest policies.
7. Development of a protocol to check for nesting. If nesting Barn Swallows were detected any construction activities should be 5 m or greater from the nest. If construction is necessary within 5 m and Barn Swallows are present for the month of July. If construction is necessary and anticipated to occur within this window, then the gatehouse should be tarped before May 1 to prevent any swallows from initiating nesting.
8. Careful stockpiling and amendment of existing topsoil to avoid/reduce the need to import additional topsoil. If importing soil is unavoidable, top soil should be sourced in a manner that has the least potential for containing invasive exotic seeds.
9. Interpretative signs should be considered along trail and opens spaces to educate residence about the environmental sensitivities and how they can protect and enhance the natural features present.
10. If the detailed design requires the removal of any Open Country Bird Habitat must be removed, consultation with MNRF is required to ensure full compliance with Endangered Species Act (ESA).
11. The TOR for Detailed Design should confirm whether or not soils study are a requirement for community classification. If future studies reclassify these communities as wetland appropriate City and GRCA policy must be applied to the evaluation of impacts and permitted uses.

10.2.6 Cultural Heritage

1. Since preservation in situ is not feasible for all of the heritage resources, rehabilitation, adaptive reuse and restoration must be done in a sensitive manner in order to protect the site's heritage value.
2. It is recommended that a Conservation Plan be prepared during the detailed design plan phase for improvements to York Road. A Conservation Plan would be prepared by a qualified heritage consultant and would guide the work of relocating the built heritage resources within this locally and provincially significant cultural heritage landscape. The scope of the Conservation Plan should include the following:
    - Preliminary recommendations for restoration, rehabilitation and/or adaptive reuse;
    - Critical short-term maintenance required to stabilize the heritage resources and prevent deterioration;
    - Measures to ensure interim protection of heritage resources during phases of construction or related development;
    - Security requirements;
    - Restoration and replication measures required to return the property to a higher level of cultural heritage value or interest integrity, as required;
    - Appropriate conservation principles and practices, and qualifications of contractors and trades people that should be applied, especially in the dismantling and reassembling of the wing walls;
    - Longer term maintenance and conservation work intended to preserve existing heritage fabric and attributes;

- Drawings, plans, specifications sufficient to describe all works outlined in the Conservation Plan;
- An implementation strategy outlining consecutive phases or milestones;
- Cost estimates for the various components of the plan; and,
- Compliance with recognized *Standards and Guidelines for the Conservation of Historic Places in Canada*, the *Guelph Innovation District* (York District Lands) *Official Plan Amendment 54,* City of Guelph Official Plan (2014) and other recognized heritage protocols and standards. As stated in the *Standards and Guidelines for the Conservation of Historic Places in Canada*, it is important to begin with a thorough understanding of the heritage value of the site, along with its condition, evolution over time, and past and current importance to the community (pg.3). The author of the Conservation Plan should work closely with the City of Guelph and the Province of Ontario (Infrastructure Ontario) to compile all available information pertinent to defining the YREDS study area's unique character-defining elements

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Appendix A

EIS Terms of Reference

Draft Terms of Reference

Environmental Impact Study (EIS)

York Road Environmental Design Study

City of Guelph

Prepared for:

City of Guelph
River Systems Advisory Committee (RSAC)

Prepared by:

Amec Foster Wheeler
Dougan & Associates
Matrix Solutions (including Parish Aquatic Services)
Blackport and Associates

January 2016

Project No. TP115100

DRAFT TERMS OF REFERENCE
ENVIRONMENTAL IMPACT STUDY (EIS)
YORK ROAD ENVIRONMENTAL DESIGN STUDY
CITY OF GUELPH

CITY OF GUELPH

Submitted to:

City of Guelph River Systems Advisory Committee

Submitted by:

Amec Foster Wheeler
Dougan & Associates
Matrix Solutions (including Parish Aquatic Services)
Blackport and Associates

January 2016

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1. PROJECT BACKGROUND AND STUDY APPROACH

The proposed York Road Environmental Design Study (YREDS) will be an important undertaking to support and assist with the implementation of the recommendations stemming from the 2007 York Road Improvements Class Environmental Assessment (EA), the limits of which are indicated in Figure 1. The original EA made a number of recommendations for roadway improvements along York Road, including road widening to the south for the study area (from Victoria Road to the East City Limits). The proposed road widening is required to assist the City of Guelph achieve its planning and development targets, in particular the proposed development within the Guelph Innovation District lands located to the south of York Road.

As noted within the original EA, the proposed roadway improvements were expected to impact the adjacent watercourse, Clythe Creek; as such, recommendations were made with respect to:

- Extension of the existing Clythe Creek Culvert crossing of York Road;
- Relocation of approximately 135 m +\- of the Clythe Creek Channel to accommodate the proposed road widening; and
- Implementation of riparian plantings to separate the widened roadway from the relocated Clythe Creek channel.

In order to support and assist with the implementation of the EA recommendations, it is necessary to provide further consideration of the numerous environmental, cultural, and engineering factors associated with the foregoing. The proposed York Road Environmental Design will address all of these considerations in greater detail, and ensure that proposed road widening is conducted in a responsible and well-planned manner.

A key component of the YREDS will be the completion of an Environmental Impact Study (EIS). This study is to include a background review of available data and reporting for the area, and undertake additional field work activities to further quantify and assess areas of concern or areas where missing or uncertain information has been noted. This environmental data will be used as part of the process of identifying a preferred alternative for the roadway and creek, and where necessary, to develop mitigation measures to reduce or eliminate environmental impacts.

2. AREA PLANNING CONTEXT

The Clythe Creek stream corridor is a significant natural area (City of Guelph Official Plan Schedule 10) that includes wetlands and a Special Study Area (City of Guelph Official Plan Schedule 1). The stream corridor is also part of the City's Natural Heritage System

The City of Guelph commenced preparing a Secondary Plan for the Guelph Innovation District (GID) in 2015. The City through completion of a three (3) phased Secondary Plan process with input from the public and numerous stakeholders including the Province, developed the "York District Preferred Land Use Scenario" which led to the preparation and approval of OPA 54 (Guelph Innovation District Secondary Plan) by City Council on May 12, 2014.

The Guelph Innovation District (GID) comprises 436 ha (1,077 acres) on Guelph's east side. It is bounded by York Road, Victoria Road South, the York-Watson Industrial Park and the City's southern boundary.

The GID is being planned as a compact mixed-use community that integrates an urban village with an employment area, strives to be carbon neutral and offers meaningful places to live, work, shop, play and learn in a setting rich in natural and cultural heritage. The Innovation District is vital to meeting employment and housing targets consistent with Guelph's Growth Management Strategy and the Province's Growth Plan; supporting an economic cluster focused on green-economy and innovation sector jobs; and offering opportunities for integrated energy planning as part of the Community Energy Initiative. The City has developed principles and objectives in accordance with the foregoing.

3. POLICIES AND LEGISLATIVE FRAMEWORK

Current Official Plan, regulations, and policies include the following:

- Extension Urban Forest (OP Policy 6A.5):
  - Tree destruction or removal of trees on private property is regulated by the City's tree by-law (OP Policy 6A.5.1,City of Guelph, 2001)
  - A permit is required for destruction of trees on private property (Tree Bylaw Policy 2.2, City of Guelph, 2010b).
  - Vegetation Compensation Plans are required for all new development and site alterations involving the destruction of healthy non-invasive trees that cannot be retained (OP Policy 6A5.1, City of Guelph 2001).
- Environmental Study Requirements (OP Policy 6A.7):
  - To be prepared in accordance with the Official Plan (City of Guelph, 2001) where development is proposed within or adjacent to natural heritage features.
- Natural Heritage Strategy Designations applicable to the stream and 15 m stream corridor:
  - Natural Heritage System (OP Policy 2.4.14 and Schedule 10, City of Guelph, 2010a).
  - Significant Natural Area (OP Policy 6A.1 and 6A.2 and Schedule 10, City of Guelph, 2010a).
  - Warm water fish habitat (OP Policy 6A.1.1 and Schedule 10b, City of Guelph, 2010a).

Normally, development and site alteration is not permitted within the Natural Heritage System including minimum or established buffers (Policy 6A.1.2, City of Guelph, 2001). Development that may negatively affect the Natural Heritage System is subject to City approval. Permitted development and site alteration within and/or adjacent to natural heritage features are required to demonstrate, through an EIS to the satisfaction of the City, in consultation with the GRCA, the Province and Federal government, as applicable, that there will be no negative impacts on the natural heritage features and areas to be protected, or their ecological and hydrologic functions (City of Guelph, 2001). The EIS will also address any Provincial or Federal requirements as they relate to Species at Risk.

The City of Guelph source protection policies are incorporated into the Grand River Source Water Protection Plan and the Lake Erie Region Source Protection Plan, the latter of which received approval from the Ministry of the Environment and Climate Change in December 2015 and will commence on July 1, 2016. The City of Guelph was required to develop a Source Water Protection Plan due to the requirements of the Province' s Clean Water Act. The City' Source Water Protection Policies serve to protect the 25 municipally owned wells, of which 21 are operable and to various amounts supply the City with its drinking water. Policies have been developed to address established drinking water threats, with specific focus on water quality threats. Water quantity threats are also addressed in the City's policies. The option exists to either manage the risk associated with drinking water threats activities or to prohibit the activity.

The Source Water Protection Plan Polices were developed with consideration of:

- Protection and safety of our drinking water supplies;
- Fairness to landowners;
- Impact on citizens;
- Ease of implementation;
- Consistency across boundaries;
- Cost to City and taxpayers;
- Constraint on economic development and existing businesses.

4. ROLE OF THE RIVER SYSTEMS ADVISORY COMMITTEE

As per the terms of reference (TOR) for the York Road Environmental Design Study, a TOR is to be developed for the EIS, in particular for the recommended field work investigations. This document is intended to address this requirement. It is expected that the City's River Systems Advisory Committee (RSAC) will review the TOR, and provide input and comments which will help to form the final TOR, prior to the Project Team proceeding with field work activities. It is expected that the findings of the EIS (including field work activities) will be presented to RSAC upon completion, with further input and comments to be incorporated into final reporting.

5. DESCRIPTION OF STUDY AREA

The approximate study area for the EIS is indicated in Figure 2, as per the original study TOR included in the original Request for Proposal (RFP). It is noted that the area indicated in Figure 2 is substantial (4 km^2 +\-), and has been interpreted by the project team to reflect the area involved with background review work only. Detailed field work investigations would be scoped to the area immediately around the primary study area (i.e. York Road from Victoria Road to the East City Limits), and in particular those areas identified in the original (2007) EA as being impacted by the proposed widening of York Road.

The primary watercourse through the study area is Clythe Creek, which crosses York Road approximately 200 m +\- west of Watson Parkway (ref. Figure 2). Clythe Creek is an interesting watercourse within the City, as its headwaters are a coldwater stream that has historically sustained a trout population. It is feasible that at some point in time, the lower section of the creek also supported cold to cool water fish populations, however current temperature monitoring suggests this is no longer the case. Bands of wetland vegetation are found along the length of Clythe Creek. The abundance of groundwater, near or at the ground surface in this watershed plays a key role in influencing the composition and distribution of vegetation within the watershed.

Presently, the creek is highly altered, with numerous drop structures (many of which have cultural heritage implications, which must be assessed as part of the overall Environmental Design Study) and on-line ponds (or over-widened pools) that restrict fish passage and warm the water. Clythe Creek is further constrained by the available area between York Road and two large on-line ponds (referred to as the Reformatory Ponds). Appendix A includes a photographic inventory of Clythe Creek.

In addition to Clythe Creek, consideration must also be given to Hadati Creek, which drains in an easterly direction along Elizabeth Street before outletting across York Road to Clythe Creek. Although less of a focus than Clythe Creek, the section of Hadati Creek between Industrial Street and Clythe Creek will also be assessed as part of the EIS (with respect to hydrology, geomorphology, and fisheries considerations specifically), to take into consideration the City's proposed stormwater management and conveyance works upstream of this point along Elizabeth Street. This includes a trunk storm sewer along Elizabeth Street (partially constructed) which is intended to ultimately divert flows from an existing over-capacity storm sewer in the lower Ward One area.

6. STUDY STAGING AND IMPLEMENTATION

The following study staging and implementation process is envisioned for this study:

Stage 1	Background Review
Stage 2	Field Work Investigations
Stage 3	Impact Assessment/Mitigation and Final Management Strategy

7. STAGE 1 – BACKGROUND REVIEW

Stage 1 involves an assessment of multiple environmental disciplines, integrated to develop an improved understanding of existing environmental conditions within the study area. The disciplines considered as part of this background review includes:

- Hydrogeology and Geology
- Hydrology and Hydraulics
- Water Quality
- Fluvial Geomorphology
- Fisheries and Aquatic Habitat
- Terrestrial Ecology

The background review process is intended to ensure that the history of the study area is fully understood, and that any previously identified constraints or concerns are understood and accounted prior to proceeding to Stage 2 (Field Work Investigations). In this way field investigations can be suitably scoped and focused upon areas of particular sensitivity, or where available information is lacking.

7.1. Hydrogeology and Geology

The groundwater flow system within the study area will be controlled by the local and more regional geologic setting including the surficial geology, the overburden thickness and related stratigraphy, the characteristics of the shallow underlying bedrock and the bedrock topography.

The surficial geology (Quaternary Geology – Figure B1 in Appendix B) generally indicates the potential for recharge and potential linkage to surface water features. A significant portion of the study area consists of more permeable sand and gravel glaciofluvial deposits. In addition the overburden thickness (Figure B2 in Appendix B) is generally less than 5 metres thus allowing a more direct connection to the underlying bedrock. The underlying bedrock consists of the dolostone of the Guelph Formation. The upper portion of the bedrock is expected to have a relatively high permeability as well. Portions of the Clythe Creek within the study area appear to be in direct contact with the bedrock. This combination of overburden and bedrock hydrostratigraphy provides for a significant groundwater-surface water connection.

Various regional hydrogeologic studies including the Eramosa-Blue Springs Subwatershed Study (Beak International and Aquafor Beech Limited, 1999) and the City of Guelph Groundwater

Resources Study for the Northeast Quadrant (Jagger Hims Limited, 1995) indicate the shallow groundwater flow to be generally from northeast to southwest. This flow correlates well with the general regional surficial topography as well as with the bedrock topography. A significant bedrock channel originates to the northeast and appears to intersect Clythe Creek within and adjacent to the study area (Figure B3 in Appendix B). This bedrock channel may act to direct shallow bedrock groundwater to the study area and provide for a significant groundwater discharge potential.

A detailed research study immediately north of the study area by Hailey Ashworth at the University of Guelph (Groundwater-Surface Water Interactions and Thermal Regime of Clythe Creek, Guelph Ontario: Threats and Opportunities for Restoration - M.Asc. Thesis, 2012) presents findings supporting the groundwater discharge potential within and adjacent to Clythe Creek.

A natural heritage assessment carried out at the Guelph Correctional Centre (Natural Resource Solutions Inc., January 2013) presents significant observations of water-cress within the study area indicating groundwater discharge. This study also notes shallow groundwater conditions within the city park.

Measurements and observations of the groundwater water table at or near the ground surface have been presented in various hydrogeologic studies in support of development adjacent to the study area along Watson Parkway.

7.2. Hydrology and Hydraulics

Hydrology

With respect to watershed hydrology, the approved frequency flows for Clythe Creek (2 through 100 year peak flows) are currently sourced from a MIDUSS model using design storms (Gamsby & Mannerow, 2006), while Regulatory Event flows (Regional Storm – Hurricane Hazel) are sourced from a GAWSER model (Schroeter & Associates, 1988). The GRCA has noted the need for review, given that the 100-year storm peak flow is greater than that for the Regulatory Event (Hurricane Hazel).

Separate, more refined hydrologic modelling using MIDUSS and design storms has also been completed for Hadati Creek (a tributary of Clythe Creek) to support a study on channel improvements (Gamsby & Mannerow, 2003).

In addition to the foregoing, Amec Foster Wheeler has undertaken a number of different hydrologic modelling assessments within the Clythe Creek watershed, all using the integrated hydrologic-hydraulic modelling platform of PCSWMM (which uses the US-EPA SWMM computational engine). This includes hydrologic modelling of local sewersheds for the City's Stormwater Management Master Plan (2012), modelling of the majority of Hadati Creek to support the design of the Elizabeth Street trunk storm sewer (2015), and on-going stormwater management and hydrologic modelling support for the GID area to the south of York Road (2015, on-going). The first two modelling assessments have used design storm methodology; the latter modelling work for the GID area (on-going) will employ continuous simulation.

Based on the foregoing, it is considered necessary to generate an updated, integrated hydrologic modelling approach that reflects current land use and stormwater management controls (including recent development within the Watson Parkway area) into a single modelling platform. An integrated PCSWMM model will be developed as part of this study accordingly. While it is anticipated that design storms will be employed for the current study, the model can be run in continuous simulation mode if required. The current hydrologic modelling scope does not include the incorporation of a groundwater component to the modelling; the modelling would reflect surface water hydrology only. Notwithstanding, it would be possible to update PCSWMM to include a groundwater component in the future.

The base existing conditions modelling will be updated in order to assess the impacts of the proposed widening of York Road and associated stormwater management strategies. PCSWMM includes a full Low Impact Development/Best Management Practices (LID/BMPs) toolkit, which will facilitate the consideration of these measures, if determined to be appropriate.

Hydraulics

For Clythe Creek, a HEC-RAS hydraulic model is available from the GRCA, which has been incrementally updated (most recently in 2007) to reflect changes in hydraulics structures and development, particularly in the Watson Parkway area. The model extends from 500 m +\- upstream of Watson Road to the confluence with the Eramosa River, with fixed water levels specified for the model boundary condition, based on the expected frequency levels within the Eramosa River.

For Hadati Creek, a HEC2 hydraulic model was developed as part of the 2003 Channel Improvements Study (Gamsby & Mannerow).

For the purposes of the current study, no significant changes are envisioned for these hydraulic models, beyond localized channel geometry updates as required based on the results of the additional survey to be completed as part of field work activities (refer to Sections 8.2 and 8.4). Updated peak flow data from the hydrologic modelling effort will be employed to verify the expected change in flood levels (if any), and to verify the expected impacts to York Road (i.e. frequency of expected roadway overtopping). This hydraulic modelling will also be used as required to assess the expected impacts of channel re-alignment and road widening on floodplain extents and depths, to ensure that there are no negative impacts.

7.3. Water Quality

Water quality sampling data is more readily available for larger scale studies for the Speed and Eramosa Rivers. Such information can be found in Beak International and Aquafor Beech (1999). A more general characterization of the overall watershed can be found in the City of Guelph's River System Management Report (Weinstein Leeming + Associates, 1993). More limited information is available for watercourses within the study area (i.e. Clythe Creek). No water quality sampling information was found for Hadati Creek.

A group of University of Waterloo 4th year students (2007) conducted water quality sampling along Clythe Creek as part of their overall assessment of the watercourse. This included sampling for biochemical oxygen demand (BOD_5), nitrate, phosphate, and dissolved oxygen (DO). Concentrations of phosphate were found to be below the Provincial Water Quality Objective (PWQO). DO concentrations ranged between 7 and 10 mg/L, which is above the minimum PWQO of 6 mg/L for cold water habitat, based on a water temperature of approximately 15^{o}C.

Dissolved oxygen (DO) sampling was completed by Ashworth (2012) using a hand-held probe at 12 different locations along Clythe Creek on five (5) different days. Values ranged between 5 and 10 mg/L, which is consistent with minimum Provincial standards (5-8 mg/L for warm water biota, 4-7 mg/L for cold water biota). Lower values of DO were typically found around a wetland and SWM facility outlet.

7.4. Fluvial Geomorphology

Previous Studies

While numerous reports have been prepared within the vicinity of the Clythe Creek-York Road study area, information on the fluvial geomorphology (the study of the form and function of stream channels through the interaction between water and sediment transport) and existing conditions of the area is lacking and often outdated leading to numerous opportunities as well as constraints moving forward.

Prior to the initiation of the geomorphic field assessment, a review of background reports and previous studies was conducted to determine any relevant information that may be applicable to this specific study. This background review was intended to identify any reaches that have been delineated and studied by others such that redundancy would not occur. Watershed-based studies (e.g., Ecologistics, 1998 and Beak International and Aquafor Beech, 1999) have been completed during the last few decades that report the state of the stream's health, understanding the available geomorphic information and areas where updates are required and gaps to be filled will be valid.

Overall, no study was able to provide a detailed characterization of the entire subwatershed; however site specific information on channel dimensions and characteristics were obtained for several locations along the channel and in relation to the current study area adjacent to York Road. Several conceptual channel designs have also been created for Clythe Creek as a result of the proposed York Road widening.

A historical aerial image from 1930 was obtained for the study area during the background review process and was used to infer past and present land uses within the area. This aerial image indicates that the majority of the existing site features were present at that time, with the exception of the reformatory ponds (both north and south).

Reach Break Analysis

Reaches are lengths of channel (typically 200 m to 2 km) that display similarity with respect to valley setting, planform, floodplain materials, and land-use/cover. Reach length will vary with channel scale since the morphology of low-order watercourses will vary over a smaller distance than those of higher-order watercourses. At the reach scale, characteristics of the stream corridor exert a direct influence on channel form, function and processes.

Within the Clythe Creek Subwatershed Overview (Ecologistics, 1998), ten reaches were identified along the watercourse based on habitat characteristics. Of these reaches, two (2) are located within the study area. A summary figure (Figure B4)and table (Table B1) have been included in Appendix B for reference. It is likely that these reach breaks will be modified as part of the current study with further site reconnaissance and field work. Generally, the upper reach section (C9) is narrower and more sloped, with more online weir structures, than the lower reach section (C10) downstream of the existing Jaycees Park, which is much wider and stagnant, with cloudier/more turbid water.

Field Reconnaissance

Site reconnaissance was performed on December 22, 2015 by Matrix Solutions. The intent of the visit was to observe existing conditions in order to better guide the development of detailed field work and ultimately the conceptual channel design. A photographic inventory containing geomorphic observations has been compiled in Appendix A.

The section of Clythe Creek that is in the study area flows for approximately 950 m adjacent to the south-east side of York Road, between Industrial Avenue and Watson Parkway, before changing direction to flow south east to confluence with the Eramosa River. Based on the December 22 site reconnaissance, this section of channel can be sub-divided into two distinct channel reaches based on overall channel gradient and cross section dimensions. The reach divide is located at the Historical Stone Arch Bridge that acts as the main entryway to the Former Guelph Correctional Facility.

From York Road downstream to the Historical Stone Arch Bridge, the channel is 2 – 3 m wide and 0.5 m deep at bankfull. The gradient is low to moderate, and is controlled by a series of weir structures. Channel planform is sinuous and banks are protected with stone. Water within the channel is moderately turbid and multiple occurrences of water cress and cattails were observed growing. A groundwater fed tributary enters the channel approximately 140 m upstream from the historic bridge. A pool-riffle morphology was not apparent, and only one true riffle feature was observed immediately downstream from the York Road crossing.

Downstream from the historical stone arch bridge, the channel widens to 4 – 5 m at pinch points to 15 – 18 m at ponded sections. Multiple channel development, due to the introduction of aesthetic islands attributes in some instances to the widened channel. Bankfull depth was not able to be determined. The channel is generally straight, with low gradient and stone protection along the banks. Similarly with upstream, multiple weir structures are present along with the occurrence of pedestrian bridges and culvert crossings. Beaver activity was also observed between the Industrial Ponds and the confluence with the Eramosa River.

7.5. Fisheries and Aquatic Habitat

The habitat characteristics and fish communities of Clythe Creek and Hadati Creek within the study area were documented during the preparation of the environmental assessment for the widening of York Road (Natural Resource Solutions, 2006). The stream habitats have been extensively altered. The downstream portion of the study area, including the north ‘Reformatory’ pond, is accessible to fish from the Eramosa River. The weir upstream from the Innovation Lands driveway blocks upstream fish migration.

Electrofishing in Clythe Creek has resulted in the capture of warm water non-game species. Greenside Darter (Etheostoma blennioides) is considered a species of special concern under the Species at Risk Act, but was assessed to be not at risk in the last (November 2006) COSEWIC assessment (http://www.registrelep-sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=99; accessed January 4, 2016). Centrarchids are known to be present in the ponds.

There is a considerable amount of water temperature information for Clythe Creek including temperature surveys by Trout Unlimited in 2006 and 2007 and by H. Ashworth in 2011 and 2012 as part of her M.Sc. thesis work at the University of Guelph. Additional, more recent temperature data will be provided by Trout Unlimited Canada (J. Imhof, personal communication). The data reviewed to date indicate that summer water temperatures in Clythe Creek within and immediately upstream from the study area are in the range that is typically associated with warm water or warm-cool water fish communities.

Two cooler tributaries have been identified within the study area. One of these discharges directly to Clythe Creek upstream from the connection with the north Reformatory Pond and the second discharges to the pond itself. The latter, therefore, has little or no influence on the temperature of Clythe Creek.

7.6. Terrestrial Ecology

As part of the background review for this project, available information with respect to natural heritage information (as listed in Section 12 – references) have been reviewed for relevant information. In addition to those sources listed in Section 12, the project team has completed a Natural Heritage Information Centre (NHIC) database query, as well as consulting with the Guelph District Ministry of Natural Resources and Forestry (MNRF) for local species at risk (SAR) information, including the City of Guelph's Municipal List of SAR. Information gathered in this ongoing phase will provide surveyors with an initial understanding of the YREDS area, facilitate decision-making during the study, and be incorporated into reporting.

A preliminary review of the background documents indicates records for 22 vascular plant species and 67 wildlife species of significance locally, regionally, and/or provincially. It should be noted that the scale of these studies are often broader than the limits of the current study area and serve only to flag potential species during the forthcoming field investigations. Several Key species were recorded near or within the YREDS area; notably: Snapping Turtle (Chelydra serpentina) and Eastern Milksnake (Lampropeltis Triangulum). Both are included in the Guelph District OMNRF's Species at Risk Records accessed on October 27, 2015, as well as the City of Guelph Municipal List (2015), and Ontario Reptile and Amphibian Atlas (Ontario Nature, 2015). Since both of these species are considered Special Concern Provincially, turtle surveys and Eastern Milksnake surveys are necessary.

7.7. Integrated Summary

Based on the background review process, it is understood that there have been a number of studies completed previously for the current study area. These studies have assisted team members in gaining an initial understanding of the characteristics of the study area, and in identifying analyses and tasks that have been previously completed which do not need to be repeated. Conversely, the background review process will guide the development of the field work investigations (Section 8), by identifying those data and knowledge gaps that exist and should be addressed in order to ensure a fulsome environmental characterization. Proposed field work investigations are discussed in greater detail in Section 8.

8. STAGE 2 – FIELD WORK INVESTIGATIONS

8.1. Hydrogeology and Geology

Based on the scope of the current assessment, and the available background information and modelling, no hydrogeologic or geologic field work activities are proposed as part of the current EIS. A limited spot baseflow monitoring program is proposed in conjunction with the Fluvial Geomorphology field work program (Section 8.4). This monitoring program will be used to estimate groundwater discharge contributions to baseflow. A more detailed site specific assessment of groundwater levels and the potential for upward hydraulic gradients should be carried out as part of a future field program supporting detailed design (beyond the scope of the current assessment).

8.2. Hydrology and Hydraulics

Based on discussions with City staff and staff from the GRCA, no hydrologic field work activities are proposed as part of the current EIS. A flow monitoring program was originally envisioned by the City as part of this study, however it has been agreed that this program will not be conducted as part of this study, primarily due to constraints with respect to the project schedule, and the availability of City monitoring equipment. As such, hydrologic modelling will be validated using previously completed modelling (as noted in Section 7.2) and unitary flow comparisons to similar watersheds in other jurisdictions. It is considered that this approach is defensible and appropriate for the current study purposes.

Spot flow measurements are to be completed as part of the Hydrogeology and Geology program (Section 8.1) and Fluvial Geomorphology program (Section 8.4). This information will be used where feasible as part of the future hydrologic modelling validation work.

With respect to channel hydraulics, an updated topographic survey will be conducted for selected sections of Clythe Creek to support updated hydraulic modelling and design work. No additional topographic survey is proposed for Hadati Creek, as the channel geometry available within the existing hydraulic modelling is considered sufficient for study purposes. A topographic survey for the York Road right-of-way has been previously completed by the City of Guelph and will be used as part of this study.

8.3. Water Quality

No specific water quality testing or field work is proposed as part of the current EIS. It is not considered that additional sampling information would impact upon the likely mitigation strategy for the proposed roadway widening given the relatively minor contributing drainage area in this case. Water quality impacts associated with the proposed road widening will be addressed directly as part of the Environmental Design Study, specifically Stage 3 (Impact Assessment/Mitigation for Preferred Alternative).

8.4. Fluvial Geomorphology

In order to fill gaps in the fluvial geomorphic understanding of the study area, a detailed field program is required. Information gathered from the proposed fluvial geomorphic field program will provide quantitative data on channel processes which will be valuable in the development of a conceptual design; however, the data may or may not be sufficient to support a detailed design.

Rapid Field Assessments

To further confirm and refine results of the desktop analyses, rapid field assessments (i.e., the Rapid Geomorphic Assessment and Rapid Stream Assessment Technique) and additional field reconnaissance will be conducted to confirm the reach setting and the dominant geomorphic forces impacting Clythe Creek adjacent to York Road. During this evaluation, areas of active channel adjustments (e.g., erosion, deposition) will be confirmed. Measurements of pool depth (to provide insight on scour potential) and depth measurements to channel bed in the area of the weirs would be completed. An inventory of all weir structures will be compiled and crossing assessments completed for all bridges and culverts.

Detailed Field Data Collection

In order to better quantify channel dynamics, a detailed field assessment of the study reaches are required. The field work would follow standard field protocols and would include installation of 2 monitoring cross sections as well as 8 additional (non-monumented) bankfull cross-sections, a longitudinal profile survey from York Road to the Eramosa River confluence, characterization of the bed and banks and documentation of any other features that may be affecting flow and sediment movement (i.e., weir structures, tributaries, stormwater outflows). This survey would be co-ordinated with the overall topographic survey work described in Section 8.2 to avoid a duplication of effort.

A limited spot flow monitoring program will be carried out for two purposes; to measure baseflow (low flows) to help characterize groundwater and surface water interactions and existing aquatic habitat (as per Section 8.1), and to measure wet weather flows in Clythe Creek and through all connecting streams and channels. The spot baseflow monitoring program will be carried out during the summer months following a suitable period without precipitation. The wet weather flow monitoring will completed during the spring freshet if possible. Bankfull flow conditions will be targeted if possible.

Hadati Creek

While the primary focus of the fluvial geomorphology field work will be on Clythe Creek, given the direct impacts to York Road, additional field work will be conducted on Hadati Creek to support the proposed upstream flow diversion assessment (Elizabeth Street trunk storm sewer and upstream flow splitter).

The Hadati Creek Characterization will include a reach walk from Elizabeth Street and Industrial Avenue to the confluence with Clythe Creek. During the walk, both the Rapid Geomorphic Assessment and Rapid Stream Assessment Technique will be carried out in order to identify dominant factors contributing to existing channel form and function as well as overall channel health. Spotflow measurements will be conducted within the reach and a representative cross section measured in order to identify bankfull channel dimensions. This work will occur simultaneously with the Clythe Creek assessments.

8.5. Fisheries and Aquatic Habitat

Fish Habitat

The habitat in Clythe Creek will be characterized from the Eramosa River upstream to the railway crossing north of York Road. The habitat in Hadati Creek will be characterized from its confluence with Clythe Creek upstream to Elizabeth Street (i.e. 50 m +\- east of Industrial Street). Parameters documented will include channel form and dimensions, substrate, barriers to fish movement and indicators of groundwater discharge (i.e. seepage areas, watercress). The area characterized will include the Industrial Ponds, and the nearshore habitat along the north side of the north reformatory pond, adjacent to Clythe Creek. Existing information will be relied upon to characterize the two coolwater ‘tributaries’ that enter from the south and the other portions of the reformatory ponds.

Fish Community

No fish sampling is proposed in Clythe Creek or any of the ponds. The assessment will rely on existing information with respect to the fish species present in those areas. Electrofishing will be conducted in Hadati Creek between York Road and Elizabeth Street to characterize the fish community.

Northern Pike Spawning Survey

Northern Pike (Esox lucius) are known to spawn in a wetland area beside the Eramosa River a short distance upstream from its confluence with Clythe Creek. Based on our current knowledge of the study area, it is possible that Northern Pike spawning habitat also exists in the lower reaches of Clythe Creek, particularly in the Industrial ponds. Therefore a Northern Pike spawning survey (visual search) will be undertaken in the early spring (late March – early April) when spawning is occurring at the other known spawning site.

Water Temperature
No additional water temperature monitoring is proposed. The study will rely on existing information, which is considerable.

8.6. Terrestrial Ecology

Surveys will include a Vegetation Assessment including Ecological Land Classification (ELC) and a vegetation inventory, tree inventory and hazard assessment, breeding bird surveys, turtle surveys, Eastern Milksnake surveys, Significant Wildlife Habitat (SWH) screening, and Species at Risk (SAR) screening. Incidental wildlife observations will be recorded as part of all field surveys. A summary of all field surveys and their timing is presented in Table 10.1.

Vegetation Field Investigations
Prompt initiation of seasonal field studies will be essential for study timing. Site investigations will be conducted by skilled field staff and will, at a minimum, include: Species at Risk (SAR) surveys, floral, faunal & ELC surveys, and a tree inventory and hazard Assessment.

The following vegetation field surveys are recommended within the York Road Environmental Design Study (YREDS) area, which includes adjacent lands (to 120 metres as per the PPS (2014)):

- Ecological Land Classification (ELC) - Confirmation and refinement of previously identified (NRSI 2013) ELC communities within the YREDS area using Lee et al. (1998), including characterization of soils. Polygons contiguous with and, extending beyond, the YREDS area will be surveyed in entirety to ensure the accurate characterization.
- Vegetation Inventory – conduct spring, summer, and fall vegetation inventories for the YREDS area to update existing vegetation inventories and determine if locally or regionally significant species are present.
- Tree Inventory and hazard assessment – the existing tree inventory (NRSI 2006) will be reviewed and updated through field investigations to determine which trees should be retained based on their health and hazard potential, or appropriate mitigation and compensation measures. Where necessary, trees will be tagged and located using a high-accuracy Trimble GeoXH GPS unit.
- Species at Risk (SAR) – all habitats and observations will be screened against the City of Guelph Municipal List of Species at Risk provided by Guelph District MNRF (September 2015). Some SAR (Endangered and Threatened) have specialized survey protocols required to detect their presence. Therefore, for any SAR that are not identified in the background review or during 2016 field investigations but have potentially suitable habitat found within the YREDS sarea, specialized survey protocols for detection will be recommended for the future (refer to the Potential Additional Field Investigations discussion within this section).
- Significant Wildlife Habitat (SWH) screening – during field investigations, all habitats within the YREDS area will be screened against criteria outlined in the Significant Wildlife Habitat Technical Guide (OMNR 2000) and the Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E (OMNRF 2015) to determine if rare vegetation communities are present. This will include searching for any Special Concern species (not covered under the ESA (2007)) and those with provincial Sranks of S1 to S3.

Wildlife Field Investigations

The following wildlife field surveys are recommended for the YREDS area, which includes adjacent lands (to 120 metres as per the PPS (2014)). The field surveys are recommended owing to routine "due diligence" as well as from information gleaned from background sources (see above).

- Breeding bird surveys following protocols outlined in the Ontario Breeding Bird Atlas (OBBA 2001). These surveys would take place from May 24 to July 10, with a minimum of two surveys taking place at least seven days apart; they will occur between sunrise and approximately 10:00 a.m. and under suitable weather conditions (i.e. light winds, good visibility, and no heavy rain).
- Nocturnal Amphibian Surveys following protocols outlined in the Ontario Marsh Monitoring Program (BSC 2003). At least three surveys would take place from April to June, with at least two weeks between surveys. The surveys would be conducted between sunset and midnight, and under suitable weather conditions (i.e. light winds, no heavy rain, and minimum temperatures of 5℃, 10℃, and 17℃ for the April, May, and June surveys, respectively.
- Turtle surveys following general protocols from a number of sources; these would including basking surveys as well as nesting surveys and road mortality surveys. Basking turtles would occur from mid-April to mid-June, with at least three surveys undertaken; they would occur between mid-morning and late afternoon during warm, sunny weather. High quality optics would be used to scan basking sites (e.g. logs, rocks) for turtles, and the number, species, and locations would be documented. Nesting surveys would be undertaken in late May to early June between dawn and mid-morning, especially within 24 hours of rain when females are more likely to initiate nesting activities; these surveys would take place at any nesting sites (sand and gravel areas with a southerly aspect in proximity to the ponds and creek) that are identified in the YREDS area. Further nest checks could be undertaken in August and September to check for signs of the emergence of young turtles (e.g. eggs shells, signs of nest depredation). Road mortality surveys would be conducted concurrently with any basking or nesting surveys, and would involve checking both sides of York Road for any dead turtles.
- Eastern Milksnake surveys following protocols from the Guelph District MNRF (OMNR 2013). These surveys would involve active hand searches over the entire YREDS area, with at least three surveys done a minimum of two weeks apart from late April to mid-June; the surveys would be conducted under suitable weather conditions (e.g. sunny and temperatures of at least 8℃ (or, if overcast, at least 15℃). Note that this protocol does not recommend the use of cover boards unless they have been in place at least two years.
- Significant Wildlife Habitat (SWH) screening – during field investigations, all habitats within the YREDS area will be screened against criteria outlined in the Significant Wildlife Habitat Technical Guide (OMNR 2000) and the Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E (OMNRF 2015). This will include searching for any Special Concern species (not covered under the ESA (2007)) and those with provincial Sranks of S1 to S3.
- Species at Risk (SAR) screening – all habitats and observations will be screened against the City of Guelph Municipal List of Wildlife Species at Risk provided by Guelph District MNRF (September 2015). Some SAR (Endangered and Threatened) have specialized survey protocols required to detect their presence. Therefore, for any SAR that are not identified in the background review or during 2016 field investigations but have potentially suitable habitat found within the YREDS area, specialized survey protocols for detection will be recommended for the future (see provisional list below).

- Incidental wildlife – groups such as mammals and insects (especially butterflies and odonates) will be noted on an incidental basis during all field investigations.

Potential Additional Field Investigations

The following is a number of extra tasks outside the scope of the above TOR which may become necessary depending on the results of the recommended surveys, or if they were recommended by the earlier reports from the background review. These additional investigations would be beyond the currently agreed upon scope, and would require further discussions with the City of Guelph prior to proceeding.

- Butternut Health Assessment. If Butternut trees (Juglans cinerea) are found during botanical surveys, MNRF may request that a Butternut Health Assessment be carried out. Butternut is designated Endangered in Ontario (OMNRF, 2015) and Canada (COSEWIC, 2014).
- Common Nighthawk: the NRSI report (2013) recommended surveys for this species, which require surveys after dusk; if suitable habitat is identified during spring 2016 surveys, then these surveys will be undertaken in late May and June.
- Other SAR: which require specialized protocols and therefore would not be detected by the general survey protocols in the recommended list. If individuals or suitable habitat for the species are found in the YREDS area, this could include the following species: Least Bittern, Chimney Swift, Jefferson Salamander, Blanding's Turtle, three bat species (Tricolored Bat, Northern Myotis, and Little Brown Myotis), and West Virginia White. Based on habitat assessments in the YREDS area, these species were not recommended for future surveys by NRSI (2013).
- Butterfly surveys: there are a number of S1 to S3 species that could occur in the YREDS area, including two sedge specialists (Black Dash (S3) and Dion Skipper (S3)), Hickory Hairstreak (S3), and Common Sootywing (S3). Two locally significant species could also occur: Little Glassywing and Delaware Skipper. If required, butterfly surveys would be conducted in June and July to determine the status of these species, and others, in the YREDS area. Also, a habitat assessment for West Virginia White (Special Concern) would also be undertaken in early spring and surveys for this species in early May would be conducted if suitable habitat and hostplants are found. Any significant stands of Common Milkweed, the hostplant of Monarch (Special Concern), will be noted during all field investigations.
- Odonates: according to Table 6 of the 2013 NRSI report, there are eight species of dragonflies and damselflies with Sranks of S1 to S3 that could occur in the YREDS area; in addition, there are 11 species with local significance (i.e. within the City of Guelph) that could occur. Odonate surveys would be conducted in June and July, with a focus along Clythe Creek, the edges of the two ponds, and in any other wetlands within the YREDS area.
- Winter surveys for Bald Eagle: the NRSI report (2013) recommended surveys for this species along the Eramosa River, which is to the north and east of the present YREDS area. This species would not utilize areas along Clythe Creek during winter or the adjacent ponds (which freeze) so it is not likely to be impacted by proposed activities along York Road. Therefore, these surveys are not recommended. If undertaken, however, it would involve two surveys per month in January and February to check for the presence of this species within the YREDS area. Surveys for other winter raptors are not required as the habitat within and adjacent to the YREDS area does not fulfill size or ELC requirements for this Significant Wildlife Habitat category (Raptor Wintering Area).

8.7. Integrated Summary

All field work activities are intended to address the data gaps for the study area identified as part of the background review process discussed in Section 7. The additional data will ensure a full environmental characterization of the study area, and will support the Environmental Impact Study process by ensuring that all constraints, opportunities, and environmental considerations are understood. All of the sub-disciplines will work collaboratively to ensure that findings and results are shared and that inter-connected constraints and potential mitigation opportunities are understood. Field work activities are expected to commence in the spring (March) of 2016, and extend through to early fall (September); preliminary scheduling is discussed in Section 10 and presented in Table 10.1.

9. STAGE 3 - IMPACT ASSESSMENT/MITIGATION FOR PREFERRED ALTERNATIVE

9.1. Identification of a Preferred Alternative

As part of the overall Environmental Design Study work, a preferred alternative will be identified for the re-alignment of Clythe Creek. This process of developing this preferred alternative will necessarily take into account the environmental sensitivities assessed as part of both the Stage 1 (Characterization) and Stage 2 (Field Work Investigation) works.

9.2. Potential Impact and Mitigation Assessment

Although it is expected that the preferred alternative will necessarily take into account the environmental sensitivities of the study area, there is the potential that environmental impacts could result from the implementation of the preferred alternative. As such, all disciplines will necessarily need to assess the potential for environmental impacts, and generate suggested mitigation measures (if required) to reduce or eliminate these potential impacts. As in previous stages, these environmental disciplines would include:

- Hydrogeology and Geology
- Hydrology and Hydraulics
- Water Quality
- Fluvial Geomorphology
- Fisheries and Aquatic Habitat
- Terrestrial Ecology

An integrated impact assessment (including the generation of mitigation measures) would also be generated which would consider all of the above-noted disciplines holistically.

10. PROJECT TIMING AND SCHEDULE

Based on the expected EIS activities, a preliminary proposed schedule has been developed. Table 10.1 presents the expected commencement and completion dates for major activities, including required field work. It should be noted that the timelines presented in Table 10.1 may be subject to change; notwithstanding date sensitive field work activities will be taken into consideration by the project team to ensure that relevant and meaningful data is collected. Given the need for spring data collection for many field work activities, it is expected that the current TOR should be finalized by late February 2016.

Table 10.1. Preliminary Proposed Schedule of EIS Activities

Discipline	Task Number	Task and Number of Surveys	Expected Start Date	Expected Completion Date
All	1	Background Review	Nov 2015	Jan 2016
All	2	Development and Approval of TOR	Dec 2015	Feb 2016
Hydrogeology and Geology	3.1	Spot Baseflow Monitoring	Jun 2016	Aug 2016
Fluvial Geomorphology	4.1	Rapid Geomorphic Assessments	Mar 2016	Jun 2016
	4.2	Selected Detailed Geomorphic Assessments (Cross-Sections, Profile, and Structures)	Mar 2016	Jun 2016
	4.3	Spot Flow Monitoring (Higher Flows)	Mar 2016	Jun 2016
Fisheries	5.1	Fisheries Assessment	Mar 2016	Jun 2016
Terrestrial Ecology	6.1	Vegetation Assessment (3)	Mar 2016	Sep 2016
	6.2	Tree Inventory & Hazard Assessment (1)	Mar 2016	Sep 2016
	6.3	Breeding Bird Surveys (2)	May 24 2016	Jul 10 2016
	6.4	Nocturnal Amphibian Survey (3)	Apr 2016	Jun 2016
	6.5	Turtle Surveys – Basking Surveys (3)	Mid Apr 2016	Mid Jun 2016
	6.6	Turtle Surveys – Nesting Surveys (2)	Late May 2016	Sep 2016
	6.7	Turtle Surveys – Road Mortality Surveys	Concurrently with other Surveys	
	6.8	Eastern Milksnake Surveys (3)	Late Apr 2016	Mid Jun 2016
	6.9	Significant Wildlife Habitat (SWH) screening	Concurrently with all Surveys	
	610	Species at Risk (SAR) Screening	Concurrently with all Surveys	
	6.11	Incidental Wildlife	Concurrently with all Surveys	
All	7	Impact Assessment and Mitigation for Preferred Alternative and Completion of EIS	Jul 2016	Oct 2016

11. REPORTING AND DOCUMENTATION

Following the completion of field work activities and the associated environmental impact assessment and mitigation analysis with respect to the preferred alternative, the findings will be incorporated into a technical memorandum, which will in turn be incorporated into the overall project reporting. It is expected that this documentation will be circulated and presented to RSAC for review and comment once a draft is available. Input from RSAC will be documented and taken into consideration along with other stakeholder input as part of the process of revising and refining the project reporting.

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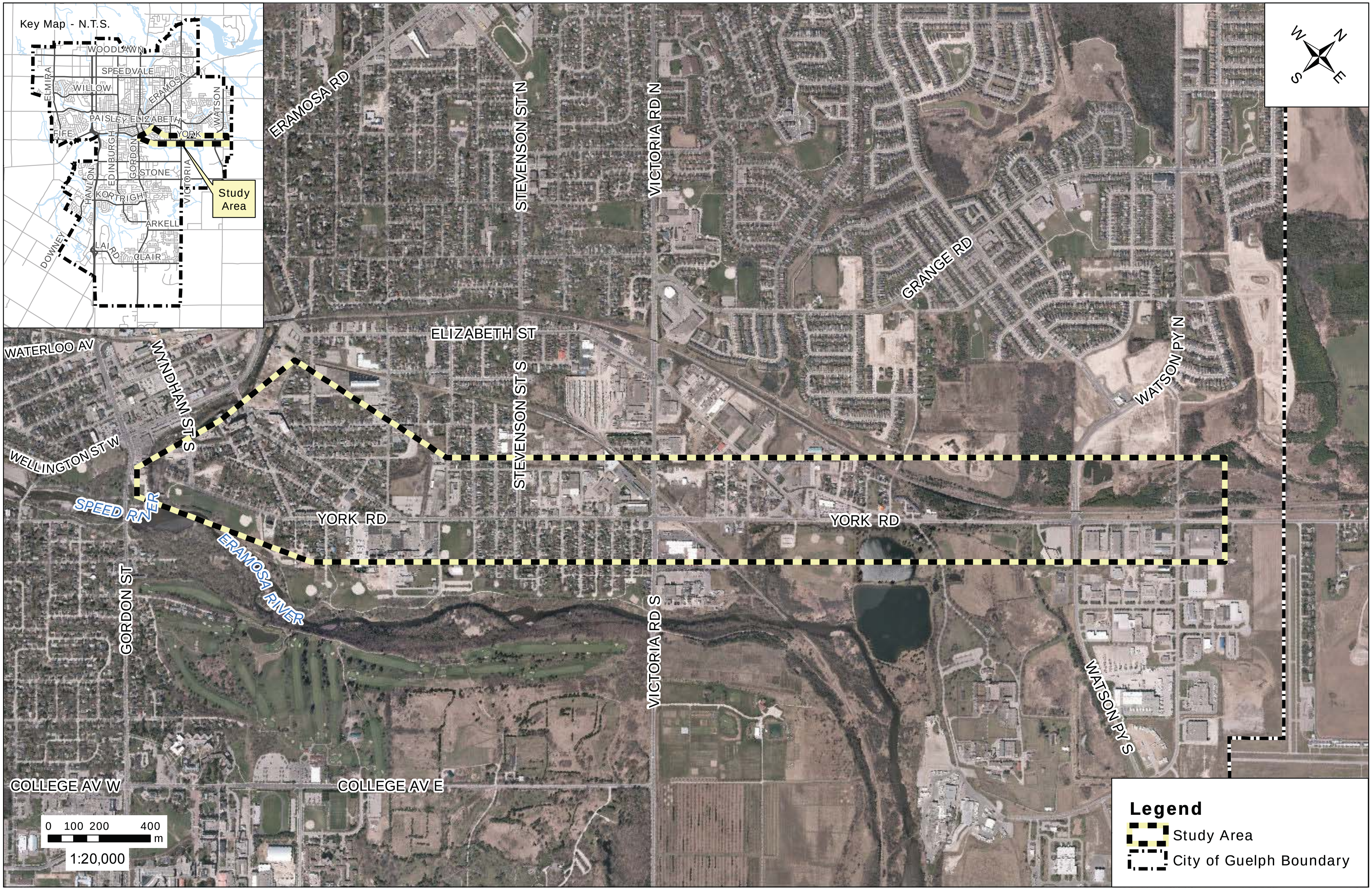

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Infrastructure, Development & Enterprise
Engineering Services
July 31, 2015

Figure 1
York Road from Wyndham Street to East City Limits
Study Area

CITY OF Guelph
Making a Difference

I:\gis_staging\Engineering\GIS Requests\15\024\GIS 15-024(01) York Road - Fig 01 - Study Area.mxd

Figure 2
York Road Environmental Design Study Area

Produced by the City of Guelph
Planning, Urban Design and Building Services, Development Planning
July 2015

Appendix A
Clythe Creek Site Photographs

Matrix Supplied
December 22, 2015

1. York Road crossing of Clythe Creek. Structure is a concrete box culvert , a pool has formed downstream from a transition riffle .

Matrix Supplied
December 22, 2015

2. Looking downstream along Clythe Creek; channel is straight with rock protection located along banks.

Matrix Supplied
December 22, 2015

3. Two clay pipes convey flow downstream from a grade control weir. Channel banks are protected by stone.

Matrix Supplied
December 22, 2015

4. Approximately 250m downstream from York Road, an approximate 1.2m stone weir grade control structure is present.

Matrix Supplied
December 22, 2015

5. Looking downstream along Clythe Creek channel; minor tributary enters the creek in the foreground.

Matrix Supplied
December 22, 2015

6. Looking downstream along Clythe Creek. Slow moving water appears to be just below bankfull height.

Matrix Supplied
December 22, 2015

7. Looking upstream along Clythe Creek from the historic stone bridge (access to institution lands); a grade control weir is present in the background.

Matrix Supplied
December 22, 2015

8. Historic stone bridge is main access to institution lands.

Matrix Supplied
December 22, 2015

9. Looking downstream along Clythe Creek from the historic stone bridge; aesthetic islands present in the background.

Matrix Supplied
December 22, 2015

10. Looking upstream along Clythe Creek; channel is over widened and stagnant, a CSP culvert contributes surface discharge from the north side of York Road, a sediment bar has formed downstream from the CSP.

Matrix Supplied
December 22, 2015

11. Looking upstream along the North Pond connection channel and pedestrian bridge.

Matrix Supplied
December 22, 2015

12. Looking upstream along Clythe Creek; channel is over widened and slow moving.

Matrix Supplied
December 22, 2015

13. Two CSP culverts convey flows downstream from a parklands access road; channel immediately regains width downstream before Hadati Creek Confluence (background, right bank).

Matrix Supplied
December 22, 2015

14. York Road crossing of Hadati Creek; structure is a concrete box culvert , gabion wing-walls protect the banks.

Matrix Supplied
December 22, 2015

15. Flow control structure downstream from Hadati Creek confluence.

Matrix Supplied
December 22, 2015

16. Channel remains wide and stagnant downstream from Hadati Creek. Water is turbid and woody debris is frequent.

Matrix Supplied
December 22, 2015

17. Beaver dam located approximately 250m upstream from the Eramosa River confluence.

Matrix Supplied
December 22, 2015

18. Clythe Creek flows immediately adjacent to railway embankment; embankment protection appears to be limited to vegetation. Water turbidity changes coulour to appear more beige.

Matrix Supplied
December 22, 2015

19. Looking downstream along the Eramosa River towards the Clythe Creek confluence located to the right. Railway embankment and bridge structure crossing the Eramosa River also present in background.

Matrix Supplied
December 22, 2015

20. Looking upstream along the Eramosa River; embankment separating the South Pond and Eramosa visible in the background left.

Matrix Supplied
December 22, 2015

21. South Pond connection to the Eramosa River through an CSP pipe elevated approximately 30cm; the pipe appears to be blocked and discharge is minimal.

Matrix Supplied
December 22, 2015

22. South pond breaches its banks at the ponds north-east corner; flow is contributed to a surface drainage tributary that flows adjacent to the pond and into the Eramosa River.

Matrix Supplied
December 22, 2015

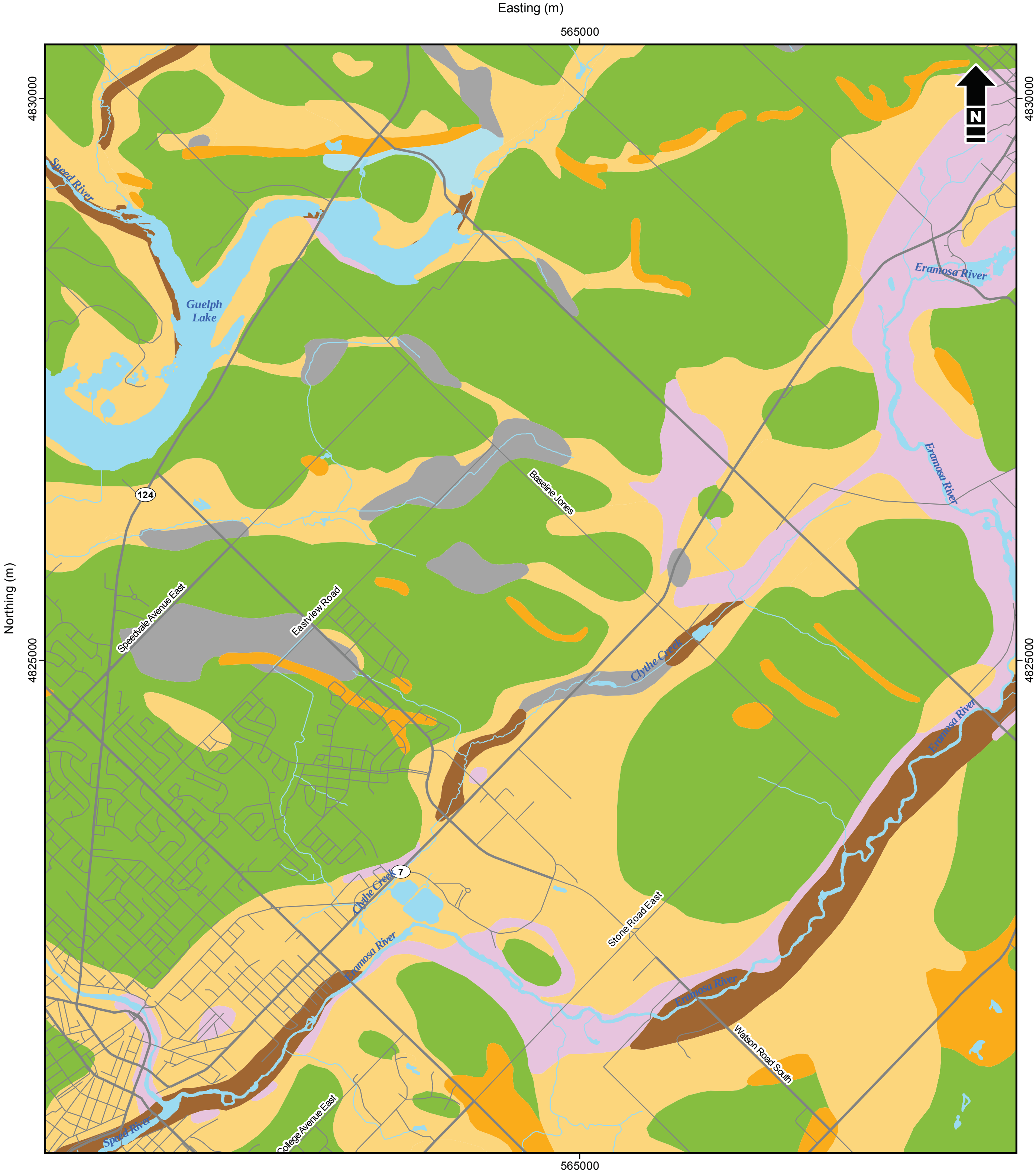
23. Drainage channel from decorative ponds discharges into the South Pond.

Matrix Supplied
December 22, 2015

24. Decorative pond, grade control feature.

TABLE B1: CLYTHE CREEK REACH BREAK CHARACTERISTICS

REACH CHARACTERISTICS		CLYTHE CREEK REACH BREAK IDENTIFIER									
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Bankfull Width	The width (m) of the channel at its fullest capacity	1.1	Not accessible	30	1.3	Ponded areas ~50 Channelized areas ~5	3	1.6	2.4	1 to 5	10 to 12
Depth of Channel	The depth (m) if the channel at its deepest point	0.10 – 0.12		<2	0.05 – 0.10	Ponded areas >2 Channelized Areas ~0.25	0.25	0.08 – 0.10	0.24	0.5	0.5
Substrate Type	The characteristics of the material found on the streambed	Organic		Organic	Organic	Silt/organic	Organic	Gravel/organ ic	Silt/organic	Gravel and rubble with thin organic layer	Silt/organic
Cover	The type and amount of vegetation found overhanging the stream	Dense jewelweed, cattails and occasional cedar		Mostly open water with cattails	Mainly cattails with scattered cedars	Herbaceous, lily pads around perimeter, red osier dogwood, cedars	Cattails, jewelweed, reed canary grass, areas of dense shrub	Herbaceous, open meadow with small poplar/cedar stand	Dense shrub understory with willow trees	Mowed lawn	Dense shrub species, mixed herbaceous and occasional willow trees
Width of Riparian Zone	The width (m) of the naturally vegetated areas adjacent to the creek	18 – 40	120	90	115	40	40 – 80	80	50	None	1 - 120
Channel Stability	Channel and bank characteristics which indicate stability of channel including erosion, bank failure, etc.	Stable		Stable	Stable, bank heights are low to nil	Stable	Stable	Stable	Stable, however some undercutting is evident	Stable	Generally stable but with some evidence of undercutting
Number of Bridge or Culvert Crossings	Number of “breaks” in channel continuity from bridges, culverts and dams	1	0	0	0	3	1	0	0	13 Culverts, artificial waterfalls and trickle-downs	3
Sinuosity	Length of channel compared to linear distance from upstream to downstream limits of reach	1.32	1.09	1.33	1.1	1.1	1.27	1.25	1.08	1.43	1.3
Other Comments		Cool, clear water		Scattered slumps present	Open marsh, creek becomes braided through marsh	Overflowing outlet in first pond, water very still, landscaped areas	Open marsh, channel is braided in areas	Meanders through open meadow	Good shading, water is cool as is crosses under CNR berm	Occasional landscaped areas, a few storm outfalls	Water very cloudy and slow flowing, lily pads and margins of confluence



Water Body
Watercourse
Highway
Road

Surficial Geology

- 3,4,4a: Paleozoic bedrock-drift complex
- 5b: Stone-poor, carbonate-derived silty to sandy till
- 6: Ice-contact stratified deposit
- 7,7a,7b: Glaciofluvial deposits-Sandy/Gravelly deposit
- 8,8a,8b: Fine-textured glaciolacustrine deposit
- 19: Modern alluvial deposit
- 20: Organic deposit

Reference: Data obtained from GeoBase® used under license. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 128 – Revised. Produced using information provided by the Ministry of Northern Development, Mines, and Forestry, Copyright © Queen's Printer, 2015

1:50,000
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NAD 1983 UTM Zone 17N

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City of Guelph
York Road Environmental Design

Quaternary Geology

Date:	Project:	Technical:	Reviewer:	Drawn:
15 Dec 2015	22257	J. Parish	P. Chin	C. Curry

Figure B1

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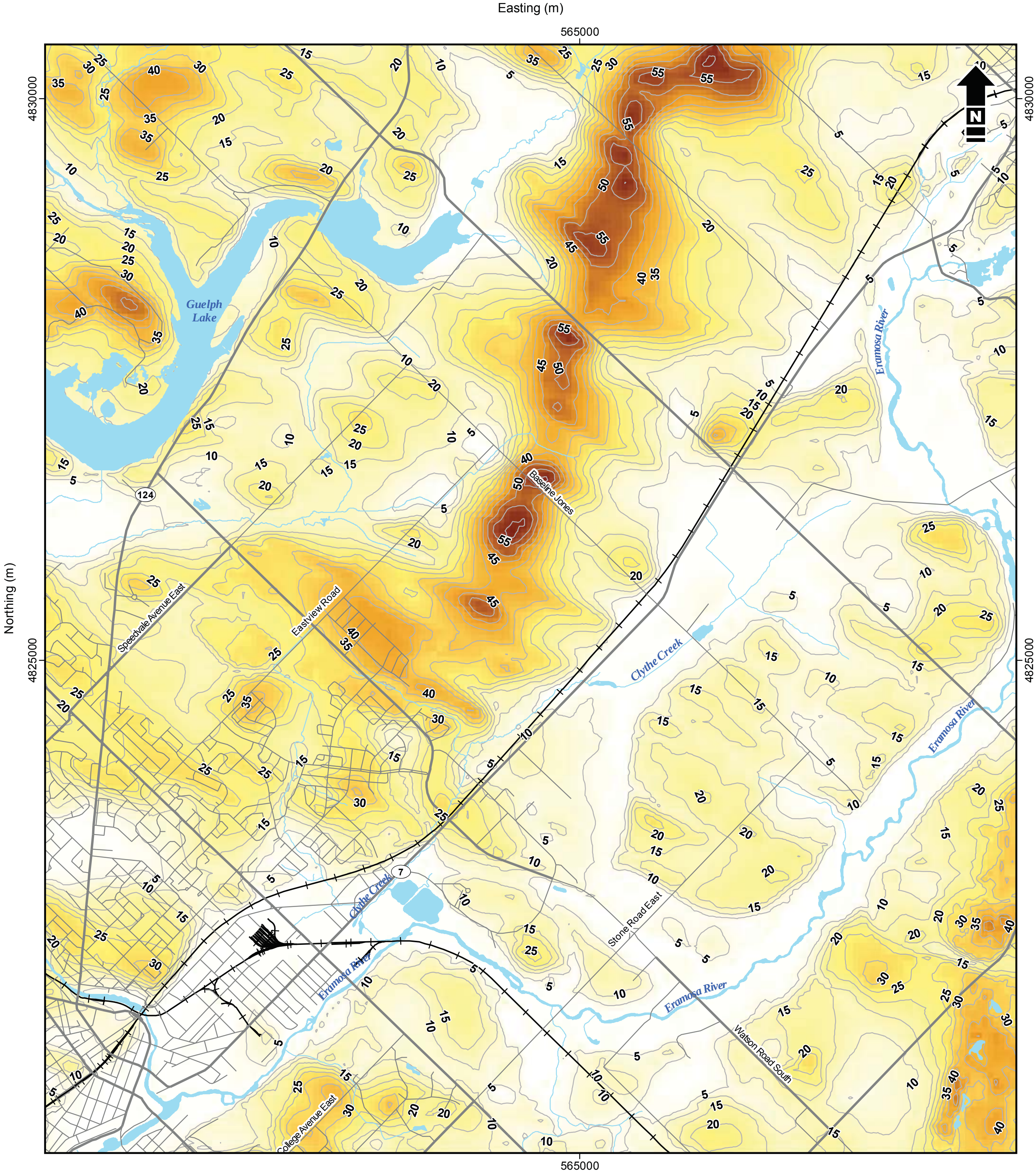

Water Body
Watercourse
Highway
Road
Railway
Contour Interval (5m)

Overburden Thickness
High : 65
Low : 0

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500 0 500 1,000 m
NAD 1983 UTM Zone 17N

Reference: Data obtained from GeoBase® used under license.

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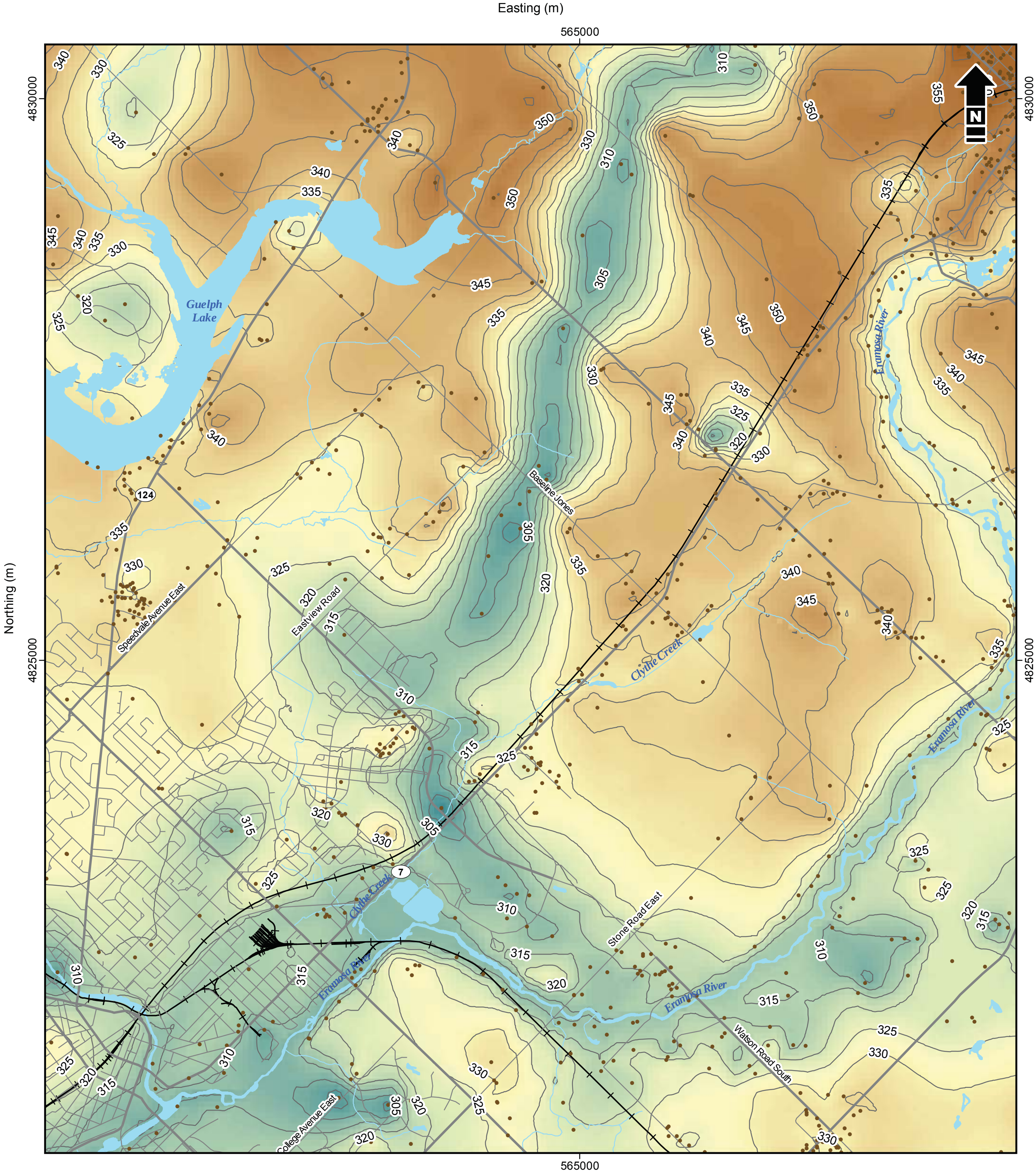
York Road Environmental Design

Overburden Thickness

Date:	Project:	Technical:	Reviewer:	Drawn:
04 Jan 2016	22257	J. Parish	P. Chin	C. Curry

Figure
B2



Water Body
Watercourse
Highway
Road
Railway
Contour Interval (5m)
Data Point

Elevation (m asl)
High : 365
Low : 290

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500 0 500 1,000 m
NAD 1983 UTM Zone 17N

Reference: Data obtained from GeoBase® used under license.

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City of Guelph
York Road Environmental Design

Bedrock Topography

Date:	Project:	Technical:	Reviewer:	Drawn:
04 Jan 2016	22257	J. Parish	P. Chin	C. Curry

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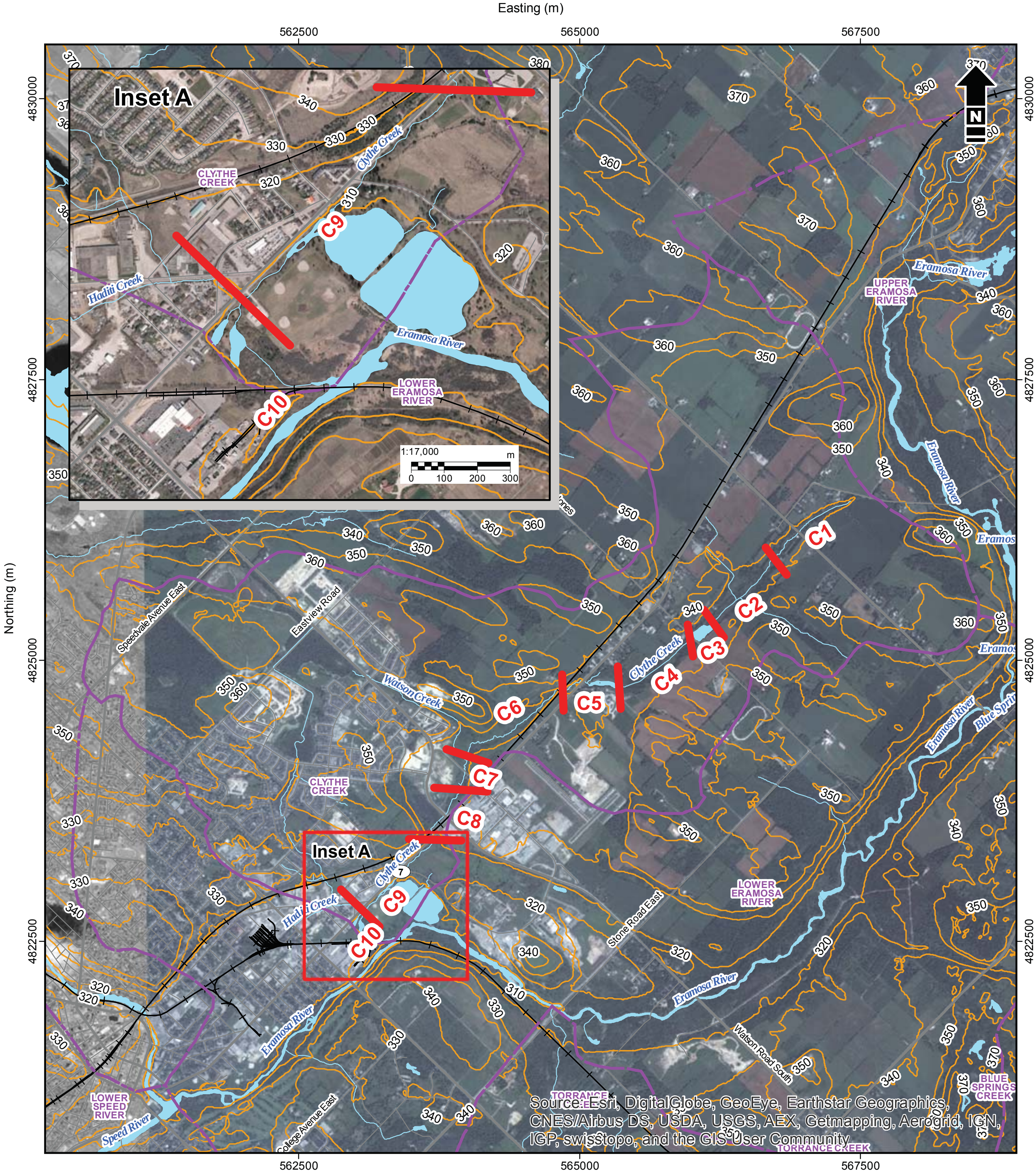
Figure
B3



- Subwatershed Boundary
- Water Body
- Watercourse
- Highway
- Road
- Railway
- Elevation Contour Interval (10m)
- Reach Break

Reference: Data obtained from GeoBase® used under license. This is version 1.0 of the Open Government Licence – Ontario. Contains Information made available under Grand River Conservation Authority's Open Data Licence v1.0
Imagery (2012) obtained from City of Guelph used under license.

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NAD 1983 UTM Zone 17N

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph
York Road Environmental Design

Clythe Creek Reach Breaks

Date:	Project:	Technical:	Reviewer:	Drawn:
17 Dec 2015	22257	J. Parish	P. Chin	C. Curry

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Figure
B4

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Appendix B

Clythe Creek Site Photographs

York Road Environmental Design Study
Environmental Impact Study (EIS) Appendix B

York Road east of Clythe Creek crossing

Upstream of York Road

Upstream face of Clythe Creek crossing

Looking upstream of York Road

York Road at Clythe Creek crossing

Downstream face of Clythe Creek

Clythe Creek culvert

Downstream of York Road crossing

Downstream of York Road crossing

Downstream of York Road crossing

Cultural heritage wall close to York Road culvert

Pool feature immediately downstream of culvert

Cultural heritage weird structure

Just west of York Road culvert

Cultural heritage wall in distance

Steep grading along north side of road

Cultural heritage wall south of creek

Pool downstream of culvert

Cultural heritage drop structure with side walls and pipes

Cultural heritage drop structure with side walls and pipes

Creek parallel to road

Cultural heritage drop structure

Cultural heritage drop structure

Cultural heritage drop structure

Gabion baskets next to roadway

Creek moves away from the road

Looking west along York Road

Cultural heritage drop structure

Creek in close proximity to road

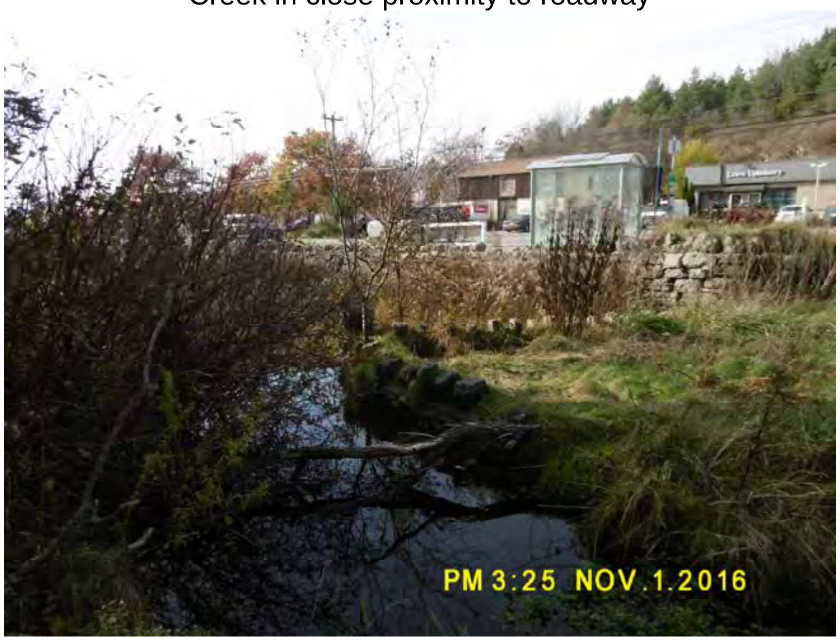
Relatively flat floodplain area

Drainage feature confluence with the creek

Creek in close proximity to the roadway

Creek in close proximity to roadway

Cultural heritage wall feature



Cultural heritage wall feature and bus stop in the background

Bus stop just west of former Reformatory driveway

Cultural heritage wall and drop structure just west of former Reformatory driveway

Former Reformatory driveway

Cultural heritage wall along York Road

Creek immediately upstream of former Reformatory driveway
Note creek is in a backwater condition

Creek immediately upstream of former Reformatory driveway
Note creek is in a backwater condition

Looking at Cultural Heritage wall upstream of former Reformatory driveway

Former Reformatory driveway crossing

Former Reformatory driveway crossing

Former Reformatory driveway crossing

Former Reformatory driveway crossing

Downstream of former Reformatory driveway crossing
Note drop structure

Lined channel downstream of former Reformatory driveway

Drop structure downstream of former Reformatory driveway crossing

Ponds adjacent to Clythe Creek

Ponds adjacent to Clythe Creek

Upstream of twin CSP crossing into park parking lot

Downstream of twin CSP culverts

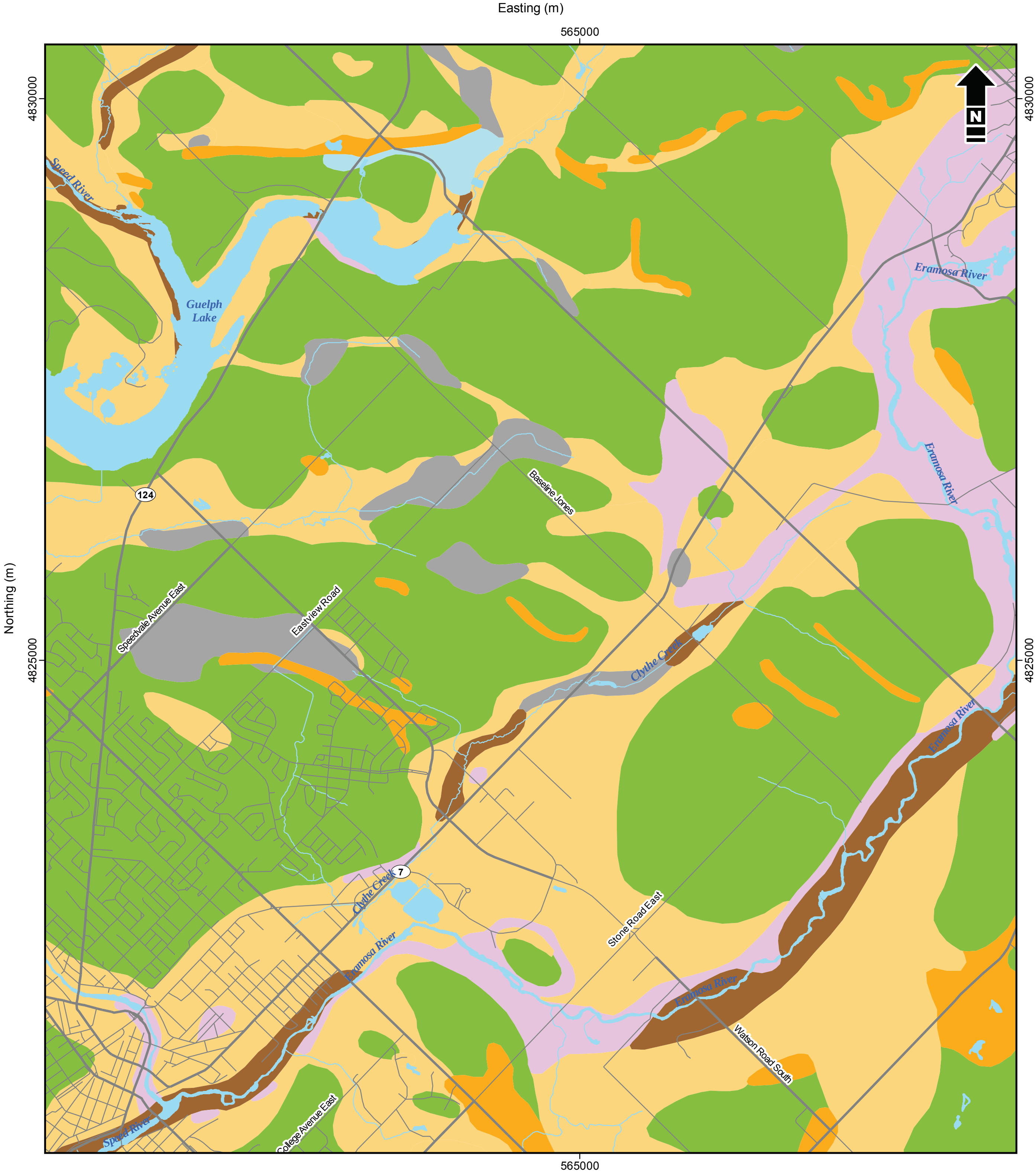
Driveway into park

Clythe Creek at meander downstream of park driveway

Damaged energy dissipation structure upstream of confluence with the Eramosa River

Appendix C

Hydrogeology and Geology



Water Body
Watercourse
Highway
Road

Surficial Geology

- 3,4,4a: Paleozoic bedrock-drift complex
- 5b: Stone-poor, carbonate-derived silty to sandy till
- 6: Ice-contact stratified deposit
- 7,7a,7b: Glaciofluvial deposits-Sandy/Gravelly deposit
- 8,8a,8b: Fine-textured glaciolacustrine deposit
- 19: Modern alluvial deposit
- 20: Organic deposit

Reference: Data obtained from GeoBase® used under license. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 128 – Revised. Produced using information provided by the Ministry of Northern Development, Mines, and Forestry, Copyright © Queen's Printer, 2015

1:50,000
500 0 500 1,000 m
NAD 1983 UTM Zone 17N

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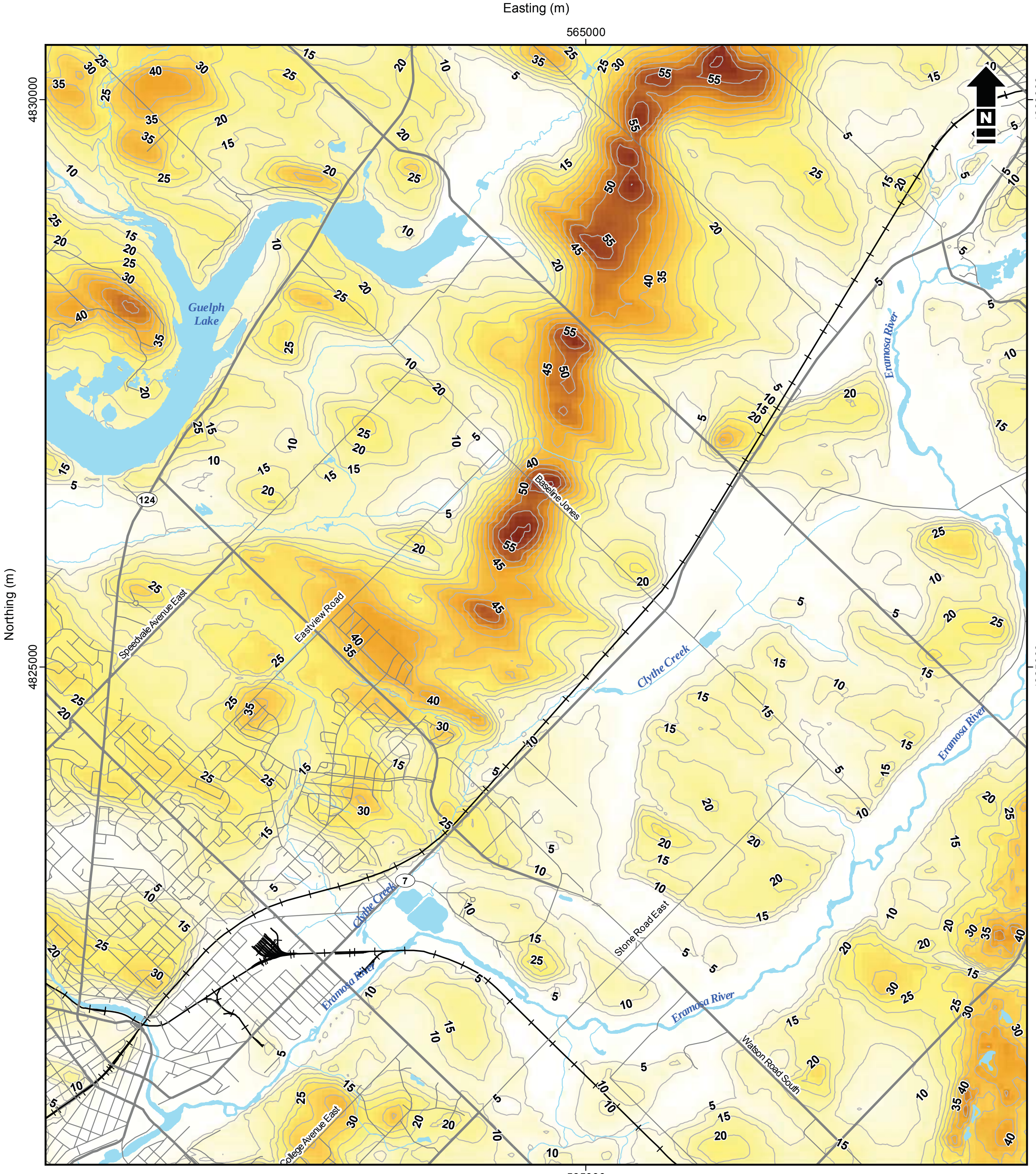
York Road Environmental Design

Quaternary Geology

Date:	Project:	Technical:	Reviewer:	Drawn:
15 Dec 2015	22257	J. Parish	P. Chin	C. Curry

Figure
B1

I:\AMEC\22257\FiguresandTables\SWM\2015\Report\Figure-5-Quaternary_Geology.mxd



Water Body
Watercourse
Highway
Road
Railway
Contour Interval (5m)

Overburden Thickness
High : 65
Low : 0

1:50,000
500 0 500 1,000 m
NAD 1983 UTM Zone 17N

Reference: Data obtained from GeoBase® used under license.

I:\AMEC\22257\FiguresandTables\SWM\2015\Report\Hydrogeology\Report\Figure-3-Overburden_Thickness.mxd

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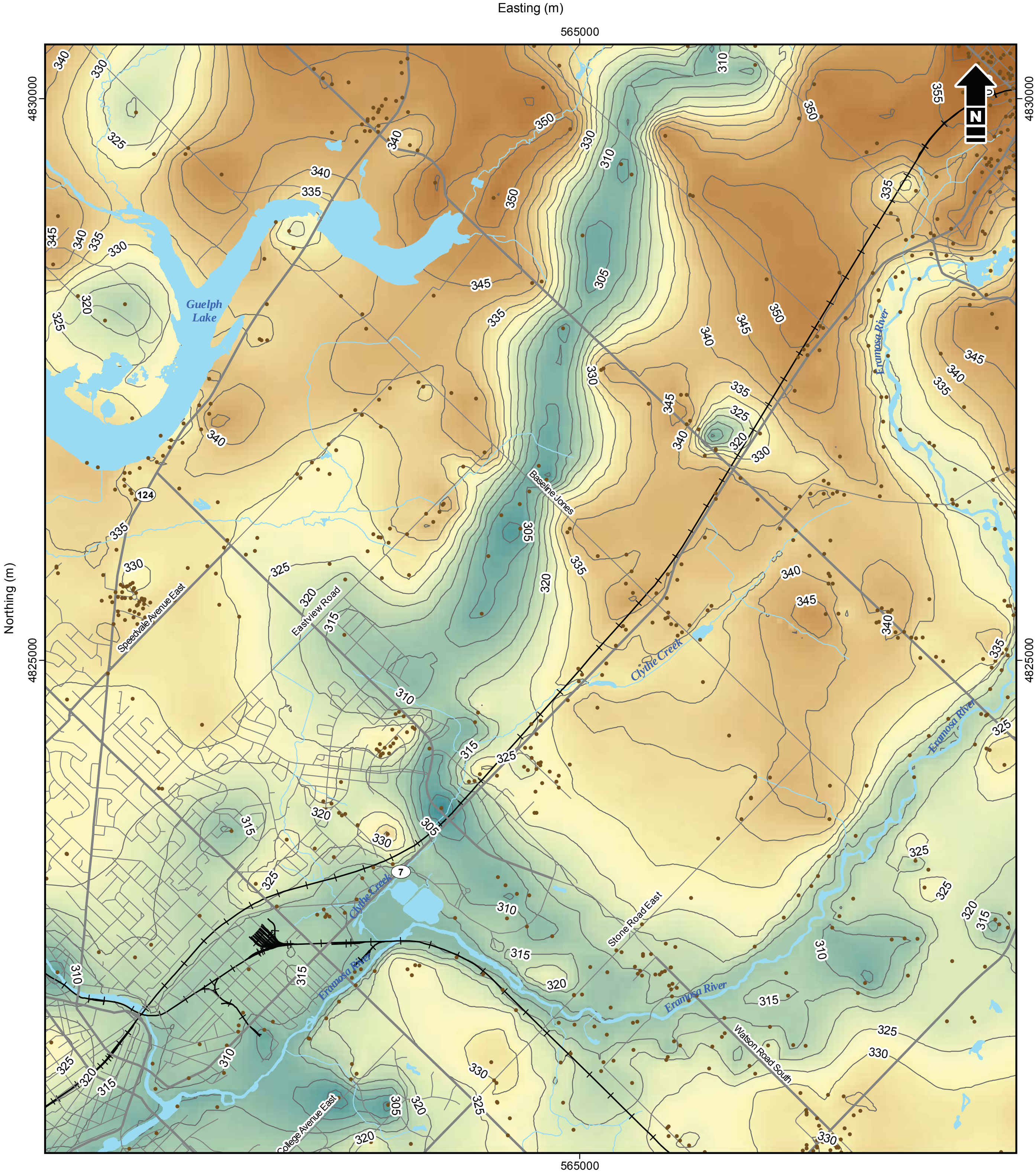
ENVIRONMENT & ENGINEERING

City of Guelph
York Road Environmental Design

Overburden Thickness

Date:	Project:	Technical:	Reviewer:	Drawn:
04 Jan 2016	22257	J. Parish	P. Chin	C. Curry

Figure
B2



Water Body
Watercourse
Highway
Road
Railway
Contour Interval (5m)
Data Point

Elevation (m asl)
High : 365
Low : 290

1:50,000
500 0 500 1,000 m
NAD 1983 UTM Zone 17N

Reference: Data obtained from GeoBase® used under license.

I:\AMEC\22257\FiguresandTables\SWM\2015\Report\Hydrogeology\Report\Figure-4-Bedrock_Topography.mxd

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City of Guelph
York Road Environmental Design

Bedrock Topography

Date:	Project:	Technical:	Reviewer:	Drawn:
04 Jan 2016	22257	J. Parish	P. Chin	C. Curry

Figure
B3

Appendix D

Hydrology and Hydraulics

TABLE C1: EXSITING CONDITIONS HYDROLOGIC MODELLING PARAMETERS

Sub-catchment	Area (ha)	Imperv. (%)	Width (m)	Length (m)	Average Slope (%)	Pervious Suction Head (mm)	Pervious Saturated Hydraulic Conductivity (mm/hr)	Overall Saturated Hydraulic Conductivity (mm/hr)
CC01-01	2.13	19.8	665	32	1.5	237.0	5.0	4.3
CC01-02	1.98	17.6	600	33	2.7	237.0	5.0	4.2
CC01-03	2.50	17.6	757	33	1.7	237.0	5.0	4.2
CC01-04	2.32	0.0	493	47	3.7	237.0	5.0	4.8
CC01-05	1.98	1.6	582	34	0.7	237.0	5.0	4.7
CC01-06	2.95	13.6	867	34	2.6	237.0	5.0	4.5
CC01-07	3.82	12.0	636	60	3.6	237.0	5.0	4.6
CC01-08	2.41	14.4	669	36	1.4	237.0	5.0	4.5
CC01-09	3.97	15.2	1134	35	2.2	237.0	5.0	4.4
CC01-10	4.35	12.0	1359	32	4.4	237.0	5.0	4.6
CC01-11	7.59	6.0	1686	45	1.5	237.0	5.0	4.6
CC01-12	0.46	15.2	230	20	0.9	237.0	5.0	4.4
CC01-13	1.67	15.2	491	34	3.0	237.0	5.0	4.4
CC01-14	0.83	40.4	244	34	4.0	237.0	5.0	4.1
CC01-15	1.17	13.6	344	34	0.9	237.0	5.0	4.5
CC01-16	1.64	15.2	455	36	0.7	237.0	5.0	4.4
CC01-17	2.92	0.4	1042	28	1.4	146.0	5.0	4.8
CC01-18	0.76	72.0	447	17	2.0	237.0	5.0	3.0
CC01-19	0.67	72.0	352	19	0.7	146.0	5.0	3.0
CC01-20	0.93	80.0	489	19	1.1	144.0	11.0	3.5
CC01-21	3.24	50.0	720	45	1.1	144.0	11.0	8.0
CC01-22	1.72	15.2	1011	17	1.2	237.0	5.0	4.4
CC01-23	1.38	15.2	445	31	4.3	237.0	5.0	4.4
CC01-24	8.80	22.4	2200	40	2	226.3	5.7	4.9
CC01-25	4.10	0.0	273	150	1	144.0	11.0	10.5
CC02-01	1.31	11.2	524	25	0.5	237.0	5.0	4.6
CC02-02	1.03	15.2	490	21	2.9	237.0	5.0	4.4
CC02-03	0.26	29.6	200	17	0.7	237.0	5.0	4.3
CC02-04	1.59	14.4	454	35	2.6	237.0	5.0	4.5
CC02-05	0.64	15.2	400	16	1.2	237.0	5.0	4.4
CC02-06	3.51	14.4	1350	26	1.3	237.0	5.0	4.5
CC02-07	0.33	15.2	194	17	0.6	237.0	5.0	4.4
CC02-09	1.74	14.4	497	35	2.9	237.0	5.0	4.5
CC02-10	2.06	13.6	447	46	0.6	237.0	5.0	4.5
CC02-11	0.09	49.6	69	15	3.1	237.0	5.0	4.0
CC02-12	2.36	10.0	715	33	1.1	237.0	5.0	4.7
CC02-13	2.20	8.4	785	28	2.5	237.0	5.0	4.7
CC02-14	1.15	11.2	348	33	1.0	237.0	5.0	4.6
CC02-15	2.74	5.6	1370	20	0.3	237.0	5.0	4.6
CC02-16	0.67	20.0	372	18	2.9	237.0	5.0	4.5
CC02-17	0.89	24.8	254	35	0.3	237.0	5.0	4.5
CC02-18	0.38	56.0	380	15	0.5	237.0	5.0	3.9
CC02-19	0.29	42.4	181	16	3.8	237.0	5.0	4.2
CC02-20	6.60	42.4	1100	60	1	214.6	5.0	4.2
CC04_EX	4.17	4.5	278	150	2.7	144.0	11.0	10.4
CC07_2	5.54	1.0	369	150	1	144.0	11.0	9.7
CC08_EX	4.34	64.1	678	64	0.1	144.0	11.0	7.4
CC08-05	4.46	18.8	719	62	2	181.0	8.6	6.9
CC08-06	5.57	18.8	1237	45	2	219.1	6.2	5.1

TABLE C1: EXSITING CONDITIONS HYDROLOGIC MODELLING PARAMETERS

Sub-catchment	Area (ha)	Imperv. (%)	Width (m)	Length (m)	Average Slope (%)	Pervious Suction Head (mm)	Pervious Saturated Hydraulic Conductivity (mm/hr)	Overall Saturated Hydraulic Conductivity (mm/hr)
CC08-07	3.32	18.8	948	35	2	151.7	10.5	8.4
CC09_EX	2.77	5.3	197	140	1.8	144.0	11.0	10.4
CC10_EX	5.14	6.5	342	150	3.1	144.0	11.0	10.4
CC11_EX	8.25	74.8	4125	20	0.2	144.2	10.4	5.1
CC12_EX	4.70	11.7	313	150	6.5	144.0	11.0	10.3
CC13_EX	2.92	0.0	194	150	2.0	144.0	11.0	10.5
CC14_EX	1.90	0.0	126	150	3.2	144.0	11.0	10.5
CC15_EX	0.74	10.2	123	60	6.5	144.0	11.0	10.3
CC16_EX	7.54	0.0	502	150	2.8	144.0	11.0	10.5
CC17_EX	8.62	6.1	574	150	3.4	144.0	11.0	9.5
CC18_EX	0.33	10.0	165	20	1.5	144.0	11.0	1.6
CC19_EX	0.72	10.0	360	20	0.7	144.0	11.0	1.6
CC20_EX	6.33	0.6	422	150	3.4	144.0	11.0	10.0
CC21_EX	2.99	3.6	199	150	3.4	144.0	11.0	9.5
CC22_EX	0.48	2.3	65	73	7.0	144.0	11.0	8.6
CC23_EX	0.37	10.0	185	20	0.9	144.0	11.0	1.6
CC24_EX	2.53	8.3	168	150	1.1	144.0	11.0	7.6
CC25_EX	1.85	15.3	123	150	0.6	144.0	11.0	10.2
CC26_EX	1.47	0.0	107	136	2.4	144.0	11.0	10.5
CC27_EX	1.05	4.9	70	150	2.4	144.1	11.0	6.3
CC28_EX	0.76	10.0	50	150	0.8	144.0	11.0	1.6
CC29_EX	3.70	7.2	246	150	6.5	144.0	11.0	10.3
CC30_EX	0.85	6.5	56	150	2.6	144.4	10.6	4.7
CC31_EX	2.72	3.2	181	150	1.3	144.0	11.0	10.4
CC32_EX	5.55	25.0	370	150	2.2	144.0	11.0	9.7
CC34_EX	3.65	37.5	133	274	1.6	144.0	11.0	9.0
CC35_EX	9.04	37.8	269	335	1.8	145.3	9.3	7.7
CC36_EX	1.33	0.0	99	134	0.6	144.0	11.0	10.5
CC37_EX	1.98	12.9	132	150	5.4	144.0	11.0	10.2
CC38_EX	7.46	0.0	497	150	3.0	144.0	11.0	10.5
CC39_EX	1.99	12.9	132	150	4.4	144.0	11.0	10.2
CC40_EX	3.00	1.3	200	150	5.7	144.0	11.0	9.5
CC41_EX	0.88	0.0	66	131.4	7.5	144.3	10.0	9.6
CC42_EX	0.38	80.0	36	104.62	3.0	144.8	8.6	2.9
CC43_EX	2.32	0.0	187	124	3.4	145.2	7.4	7.1
CC44_EX	1.24	10.0	82	150	1.5	144.9	8.4	1.4
CC45_EX	3.69	0.0	246	150	1.4	144.0	11.0	10.5
CC46_EX	11.06	6.3	737	150	1.5	144.8	8.7	8.2
CC47-EXT	214.74	0.5	14316	784	1	200.9	7.2	6.6
CCEXT	7.73	17.6	540	143	1	144.0	11.0	10.0
CCEXT_05	53.90	0.5	3593	190	1	203.5	7.2	6.6
CCEXT_06	26.54	0.0	1769	150	1	235.4	4.8	4.6
CCEXT_07	59.25	0.0	3950	255	1	237.0	5.0	4.8
CCEXT_08	21.98	3.0	1465	172	1	154.8	10.3	7.5
CCEXT_09	120.53	2.0	8035	649	1	194.8	7.7	6.3
CCEXT_10	77.75	0.0	5183	539	1	208.3	6.9	6.6
CCEXT_11	37.40	0.5	2493	431	1	197.5	7.5	6.9
CCEXT_12	24.75	0.5	1650	150	1	144.0	11.0	10.1
CCEXT_13	212.98	0.5	14198	709	1	171.1	9.2	8.5

TABLE C1: EXSITING CONDITIONS HYDROLOGIC MODELLING PARAMETERS

Sub-catchment	Area (ha)	Imperv. (%)	Width (m)	Length (m)	Average Slope (%)	Pervious Suction Head (mm)	Pervious Saturated Hydraulic Conductivity (mm/hr)	Overall Saturated Hydraulic Conductivity (mm/hr)
CCEXT_14	57.61	0.5	3840	294	1	234.1	5.2	4.8
CCEXT_15	293.65	0.0	19576	1246	1	152.6	10.0	9.6
CCEXT_3	8.28	47.4	552	150	1	144.0	11.0	8.3
CCEXT_4	29.10	17.1	1940	150	1	174.1	9.1	8.3
CCEXT_7	5.85	36.3	417	140	1	144.0	11.0	8.9
CCMB-01_1	0.60	11.4	120	50	2	144.0	11.0	3.0
CCMB-01_3	3.28	9.8	656	50	2	144.0	11.0	5.4
CCMB-05	18.65	0.0	1243	150	5	209.6	6.8	6.5
CCTRIB1_01	7.36	8.8	758	97	2	224.5	5.8	5.4
CCTRIB1-02	18.62	0.0	1241	150	2	193.7	5.0	4.8
ER01_EX	1.68	4.9	112	150	2.9	144.0	11.0	10.4
ER02_EX	20.90	7.4	1393	150	2.3	144.7	8.8	8.3
ER03_EX	1.04	16.9	86	120	1.8	146.0	5.0	4.7
ER04_EX	1.81	4.1	120	150	4.3	203.9	7.1	4.7
ER05_EX	0.87	6.6	58	150	4.4	187.7	8.2	3.8
ER06_EX	1.28	0.0	108	117.5	3.2	144.0	11.0	10.5
ER07_EX	1.57	15.8	116	134.75	4.3	145.6	6.1	5.7
ER08_EX	1.42	5.3	94	150	3.0	144.7	8.9	5.0
ER09_EX	9.63	0.8	379	254	3.0	145.0	7.6	7.3
ER10_EX	15.23	1.1	1015	150	4.7	200.9	6.6	6.3
ER11_EX	9.99	8.1	666	150	7.2	146.0	5.0	4.7
ER12_EX	4.81	0.5	176	272	6.8	145.9	5.6	5.2
ER13_EX	16.22	3.9	1081	150	4.4	219.9	5.1	4.9
ER14_EX	13.35	38.1	890	150	5.8	144.9	8.3	6.9
ER15_EX	30.58	3.2	2038	150	5.0	199.1	6.1	5.8
ER16_EX	23.24	22.1	1549	150	2.5	144.2	10.3	9.2
ER17_EX	11.39	6.8	759	150	7.0	175.7	7.2	6.8
ER18_EX	10.05	7.2	670	150	0.3	144.3	10.1	9.5
ER19_EX	10.13	2.4	675	150	10.0	154.5	9.8	9.3
ER20_EX	7.16	20.8	363	196.8	1.2	144.4	11.0	9.9
ER21_EX	4.17	9.6	278	150	5.0	144.0	11.0	10.3
ER22_EX	5.69	72.8	286	198.95	0.6	144.0	11.0	5.8
EXT01	8.60	3.0	573	150	2.1	144.4	9.7	9.2
EXT02	5.29	3.5	352	150	0.5	144.0	11.0	10.4
EXT03	53.29	12.2	3552	150	1.4	144.0	11.0	9.7
EXT04	3.25	0.0	300	108	1.0	144.0	11.0	10.5
EXT05	8.59	12.0	572	150	1.9	144.0	11.0	5.9
EXT06	7.70	10.0	526	146.2	1.6	144.0	11.0	4.3
EXT07	1.60	36.5	106	150	4.0	237.0	5.0	4.4
HD_LF	76.96	8.0	5130	150	5	186.1	5.2	4.9
HD01-01	2.79	17.3	558	50	1.5	237.0	5.0	4.9
HD01-02	2.05	23.6	394	52	0.7	237.0	5.0	4.8
HD01-03	1.10	23.6	200	55	1.1	237.0	5.0	4.8
HD01-04	0.65	58.4	216	30	0.7	237.0	5.0	3.6
HD01-05	0.57	36.8	150	38	1.1	237.0	5.0	4.2
HD01-06	0.37	50.0	112	33	3.7	237.0	5.0	3.8
HD02-001	0.81	20.0	245	33	0.6	149.2	10.7	9.8
HD02-002	1.14	21.2	207	55	0.9	184.9	8.4	7.1
HD02-003	0.75	20.0	277	27	3.1	148.6	10.7	9.8

TABLE C1: EXSITING CONDITIONS HYDROLOGIC MODELLING PARAMETERS

Sub-catchment	Area (ha)	Imperv. (%)	Width (m)	Length (m)	Average Slope (%)	Pervious Suction Head (mm)	Pervious Saturated Hydraulic Conductivity (mm/hr)	Overall Saturated Hydraulic Conductivity (mm/hr)
HD02-004	0.58	30.0	156	37	1.3	193.0	7.8	7.0
HD02-005	3.10	20.0	939	33	0.8	237.0	5.0	4.6
HD02-006	5.15	19.4	1716	30	3.9	237.0	5.0	4.6
HD02-007	0.71	36.8	355	20	5.1	235.1	5.1	4.2
HD02-008	0.77	42.4	385	20	5.2	227.7	5.6	5.0
HD02-009	3.75	31.3	1250	30	1.9	236.6	5.0	4.7
HD02-010	0.81	40.0	385	21	2.5	144.0	11.0	9.3
HD02-011	2.41	47.0	334	72	2.5	182.2	8.5	6.8
HD02-012	0.51	40.0	255	20	0.8	144.0	11.0	9.3
HD02-013	2.86	38.3	1430	20	0.6	144.0	11.0	9.8
HD02-014	11.86	26.9	3825	31	1.9	226.3	5.7	5.4
HD02-015	0.98	11.9	288	34	1.5	192.6	7.9	7.5
HD02-016	3.25	20.0	1083	30	2.0	181.2	8.6	8.1
HD02-017	1.31	23.6	436	30	3.7	175.8	8.9	8.5
HD02-018	3.20	21.9	969	33	2.6	167.1	9.5	9.1
HD02-019	1.12	23.6	311	36	0.8	144.0	11.0	10.5
HD02-020	2.55	23.6	772	33	0.4	144.0	11.0	10.5
HD02-021	1.09	23.6	545	20	2.1	144.0	11.0	10.5
HD02-022	1.10	23.6	354	31	1.5	144.0	11.0	10.5
HD02-023	4.75	8.0	791	60	1.2	144.0	11.0	10.3
HD02-024	2.56	10.6	581	44	0.9	144.0	11.0	10.4
HD02-025	2.64	23.6	880	30	0.9	144.0	11.0	10.5
HD02-026	1.23	40.0	384	32	0.9	144.0	11.0	9.3
HD02-027	0.73	40.0	228	32	0.8	144.0	11.0	9.3
HD02-028	1.16	40.0	580	20	0.6	144.0	11.0	9.3
HD02-029	7.41	15.0	435	170	0.6	144.0	11.0	9.2
HD02-030	1.86	20.3	600	31	0.8	144.0	11.0	10.3
HD02-031	1.46	40.0	339	43	1.3	144.0	11.0	9.3
HD02-032A	0.82	15.2	146	56	2.3	237.0	5.0	4.4
HD02-032B	1.33	15.2	282	47	0.5	156.4	10.2	8.9
HD02-032C	0.41	15.2	107	38	1.1	237.0	5.0	4.4
HD02-033	8.40	7.2	1647	51	1.9	237.0	5.0	4.6
HD02-034	1.42	15.2	373	38	5.4	237.0	5.0	4.4
HD02-035	7.80	15.2	1950	40	3.5	237.0	5.0	4.4
HD02-036	4.71	5.3	1272	37	3.3	225.5	5.7	5.4
HD02-037	1.22	23.6	338	36	2.1	216.6	6.3	6.0
HD02-038	11.36	15.3	3917	29	3.0	237.0	5.0	4.5
HD02-039	4.07	8.0	969	42	0.8	237.0	5.0	4.6
HD02-040	1.67	15.2	463	36	0.9	237.0	5.0	4.4
HD02-041	2.53	21.3	744	34	1.1	237.0	5.0	4.6
HD02-042	2.17	23.6	723	30	1.9	222.2	6.0	5.7
HD02-043	0.92	50.0	164	56	1.4	237.0	5.0	3.8
HD02-044	1.58	12.0	246	64	1.4	237.0	5.0	4.6
HD02-045	5.76	15.5	1645	35	2.4	237.0	5.0	4.4
HD02-046	1.67	19.4	556	30	0.7	237.0	5.0	4.4
HD02-047	2.04	15.2	497	41	1.0	211.6	6.6	5.8
HD02-048	12.09	14.4	2948	41	4.8	197.4	7.6	6.7
HD02-049	6.32	15.2	1708	37	0.6	183.3	8.5	7.4
HD02-050	4.71	17.6	1121	42	4.6	190.1	8.0	7.2

TABLE C1: EXSITING CONDITIONS HYDROLOGIC MODELLING PARAMETERS

Sub-catchment	Area (ha)	Imperv. (%)	Width (m)	Length (m)	Average Slope (%)	Pervious Suction Head (mm)	Pervious Saturated Hydraulic Conductivity (mm/hr)	Overall Saturated Hydraulic Conductivity (mm/hr)
HD02-051	2.12	14.4	572	37	5.7	237.0	5.0	4.5
HD02-052	1.14	15.2	380	30	3.3	237.0	5.0	4.4
HD02-053	0.91	15.2	293	31	1.1	237.0	5.0	4.4
HD02-054	1.92	12.8	304	63	0.6	237.0	5.0	4.4
HD02-055	2.40	4.0	252	95	0.9	237.0	5.0	4.8
HD02-056	1.98	15.2	582	34	5.5	237.0	5.0	4.4
HD02-057	0.46	15.2	170	27	2.8	237.0	5.0	4.4
HD02-058	0.60	13.6	222	27	5.0	237.0	5.0	4.5
HD02-059	1.75	12.8	564	31	4.1	237.0	5.0	4.5
HD02-060	0.81	15.2	231	35	1.3	237.0	5.0	4.4
HD02-061	2.66	15.2	831	32	3.6	237.0	5.0	4.4
HD02-062	13.51	15.9	3002	45	2.0	237.0	5.0	4.4
HD02-063	6.11	15.2	1651	37	1.1	237.0	5.0	4.4
HD02-064	4.36	8.4	822	53	0.6	154.7	10.3	9.2
HD02-065	4.57	17.6	1235	37	4.7	209.1	6.8	6.1
HD02-066	1.50	17.6	405	37	0.3	144.0	11.0	9.8
HD02-067	1.09	15.2	294	37	0.8	145.2	10.9	9.5
HD02-068	2.16	23.6	304	71	3.4	153.7	10.4	9.9
HD02-069	1.09	9.6	151	72	4.8	160.3	9.9	9.2
HD02-070	1.11	14.4	336	33	4.3	181.7	8.6	7.6
HD02-071	1.78	0.4	809	22	1.1	144.0	11.0	10.5
HD02-072	1.17	19.4	292	40	0.7	147.6	10.8	9.8
HD02-073	3.41	20.0	974	35	2.2	145.7	10.9	10.0
HD02-074	8.72	23.6	2180	40	3.5	151.6	10.5	10.0
HD02-075	1.67	23.6	439	38	0.5	144.0	11.0	10.5
HD02-076	2.19	80.0	251	87	0.8	144.0	11.0	3.5
HD02-077	2.66	26.0	682	39	0.4	156.2	10.2	8.6
HD02-078	1.68	16.2	480	35	1.7	144.0	11.0	10.1
HD02-079	6.74	29.9	1821	37	1.7	144.0	11.0	9.1
HD02-080	1.19	15.2	371	32	0.6	144.0	11.0	9.5
HD02-081	0.81	15.2	324	25	2.0	144.0	11.0	9.5
HD02-082	3.26	14.4	1051	31	0.9	144.0	11.0	9.6
HD02-083	1.16	6.8	116	100	0.7	145.5	10.9	10.1
HD02-084	0.48	15.2	129	37	0.7	237.0	5.0	4.4
HD02-085	1.51	8.0	251	60	5.5	237.0	5.0	4.7
HD02-086	0.86	36.8	252	34	2.7	237.0	5.0	4.2
HD02-087	2.99	14.0	854	35	0.9	237.0	5.0	4.5
HD02-088	0.93	15.2	211	44	3.4	237.0	5.0	4.4
HD02-089	2.88	38.0	240	120	0.3	233.3	5.2	4.4
HD02-090	1.08	15.2	300	36	0.3	235.6	5.1	4.5
HD02-091	1.30	11.6	250	52	1.6	237.0	5.0	4.5
HD02-092	1.90	72.0	158	120	1.9	237.0	5.0	3.0
HD02-093	3.66	80.0	228	160	0.6	237.0	5.0	2.0
HD02-094	1.28	65.6	228	56	0.7	149.7	10.6	6.6
HD02-095	1.58	80.0	385	41	0.7	235.9	5.1	2.0
HD02-096	1.26	14.0	406	31	0.9	237.0	5.0	4.5
HD02-097	2.06	8.0	219	94	0.9	237.0	5.0	4.7
HD02-098	4.37	17.0	291	150	0.5	173.5	9.1	7.9
HD02-099	0.54	15.2	142	38	1.0	237.0	5.0	4.4

TABLE C1: EXSITING CONDITIONS HYDROLOGIC MODELLING PARAMETERS

Sub-catchment	Area (ha)	Imperv. (%)	Width (m)	Length (m)	Average Slope (%)	Pervious Suction Head (mm)	Pervious Saturated Hydraulic Conductivity (mm/hr)	Overall Saturated Hydraulic Conductivity (mm/hr)
HD02-100	0.64	15.2	177	36	1.3	237.0	5.0	4.4
HD02-101	2.16	23.6	540	40	0.7	144.0	11.0	10.5
HD02-102	0.44	15.2	110	40	1.3	144.0	11.0	9.5
HD02-103	0.75	15.2	187	40	1.4	144.0	11.0	9.5
HD02-104	2.22	8.4	462	48	0.6	144.0	11.0	10.0
HD02-105	1.23	15.2	307	40	0.4	144.0	11.0	9.5
HD02-106	1.21	15.2	295	41	0.9	218.9	6.2	5.4
HD02-107	0.93	15.2	226	41	2.4	220.5	6.1	5.4
HD02-108	0.35	72.0	48	72	0.5	144.0	11.0	6.0
HD02-109	2.50	16.8	245	102	10.0	226.2	5.7	5.3
HD02-110	0.85	32.0	197	43	10.0	225.7	5.7	5.1
HD02-111	0.93	47.0	232	40	2.6	237.0	5.0	4.0
HD02-112	2.65	44.5	441	60	0.6	192.5	6.9	5.5
HD02-113	0.67	56.0	223	30	2.3	168.8	8.5	6.5
HD02-114	2.13	48.5	266	80	0.5	146.0	5.0	2.4
HD02-115	1.30	44.7	154	84	0.5	145.9	5.3	3.1
HD02-116	0.33	7.5	47	70	0.5	146.0	5.0	3.2
HD02-117	0.84	33.4	520	35	1.4	144.0	11.0	9.6
HD02-118A	6.55	9.8	935	70	0.5	144.9	8.4	4.2
HD02-118B	1.14	50.0	95	120	0.5	148.7	10.2	7.4
HD02-119	0.23	69.5	92	25	0.5	146.0	5.0	2.2
HD02-120	2.13	26.0	229	93	0.9	151.5	9.1	6.5
HD02-121	0.43	6.5	71	60	0.5	146.0	5.0	3.4
HD02-122	1.71	17.0	131	130	1.5	144.8	8.7	4.8
HD02-123	0.56	56.0	186	30	0.5	146.0	5.0	3.9
HD02-124	2.51	10.0	167	150	1.2	144.9	8.4	3.9
HD02-125	0.27	48.0	135	20	2.5	146.0	5.0	4.2
HD02-126	3.08	9.9	293	105	0.5	145.8	5.5	2.9
HD02-127	1.81	8.0	235	77	0.5	146.0	5.0	3.0
HD02-128	0.47	15.2	223	21	0.6	144.5	9.6	8.4
HD02-129	0.40	47.6	200	20	1.1	144.6	9.1	7.0
HD02-130	0.17	65.6	77	22	1.4	144.0	11.0	6.8
HD02-131	0.23	12.0	20	110	1.0	144.0	11.0	10.3
HD02-132	0.76	44.0	82	92	0.8	144.0	11.0	9.1
HD02-133	0.55	60.0	76	72	0.5	146.0	5.0	3.8
HD02-136	1.77	10.0	126	140	0.8	145.4	6.7	3.2
HD02-137	6.18	18.8	1545	40	2	151.4	10.5	8.4
HD03-01	2.77	15.2	692	40	2.5	237.0	5.0	4.4
HD03-02	1.14	15.2	345	33	2.8	237.0	5.0	4.4
HD03-03	1.17	15.2	377	31	3.3	237.0	5.0	4.4
HD03-04	1.98	15.2	495	40	0.6	237.0	5.0	4.4
HD03-05	1.48	15.2	435	34	2.4	237.0	5.0	4.4
HD03-06	6.48	4.4	648	100	1.3	237.0	5.0	4.8
HD03-07	1.28	15.2	441	29	1.3	237.0	5.0	4.4
HD03-08	0.73	15.2	173	42	5.5	237.0	5.0	4.4
HD03-09	1.51	15.2	359	42	2.1	237.0	5.0	4.4
HD03-10	1.35	21.0	675	20	3.3	237.0	5.0	3.9
HD04-01	2.28	11.6	616	37	1.6	237.0	5.0	4.6
HD04-02	1.61	8.0	805	20	2.8	237.0	5.0	4.7

TABLE C1: EXSITING CONDITIONS HYDROLOGIC MODELLING PARAMETERS

Sub-catchment	Area (ha)	Imperv. (%)	Width (m)	Length (m)	Average Slope (%)	Pervious Suction Head (mm)	Pervious Saturated Hydraulic Conductivity (mm/hr)	Overall Saturated Hydraulic Conductivity (mm/hr)
HD04-03	1.93	20.0	772	25	0.4	237.0	5.0	3.5
HD04-04	2.08	15.2	520	40	0.6	237.0	5.0	4.4
HD04-05	1.66	15.2	638	26	0.7	237.0	5.0	4.4
HD04-06	1.96	13.6	384	51	4.1	237.0	5.0	4.5
HD04-07	1.66	26.0	664	25	0.4	237.0	5.0	3.5
HD05-01	1.10	15.2	323	34	0.6	237.0	5.0	4.4
HD05-02	1.34	14.4	372	36	0.3	237.0	5.0	4.5
HD05-03	2.45	14.4	700	35	0.5	237.0	5.0	4.5
HD05-04	0.40	18.8	235	17	1.2	237.0	5.0	4.4
HD05-05	0.52	18.0	200	26	0.8	237.0	5.0	4.4
HD05-06	0.57	18.8	154	37	0.6	237.0	5.0	4.4
HD05-07	0.48	10.4	154	31	0.1	237.0	5.0	4.5
HD05-08	0.96	14.0	436	22	0.5	237.0	5.0	4.5
HD05-09	3.43	9.2	1039	33	0.4	237.0	5.0	4.7
HD05-10	1.24	14.4	375	33	0.6	237.0	5.0	4.5
HD05-11	2.54	35.3	1587	16	0.6	237.0	5.0	4.0
HD05-12	1.39	14.0	631	22	0.7	237.0	5.0	4.5
HD05-13	0.63	26.0	262	24	0.6	237.0	5.0	3.5
HD05-14	2.68	34.4	893	30	0.4	237.0	5.0	3.9
HD05-15	1.32	26.0	733	18	0.5	237.0	5.0	3.5
HD05-16	0.73	44.0	214	34	0.7	237.0	5.0	3.3
HD05-17	2.90	26.0	906	32	1.1	237.0	5.0	3.5
HD05-18	1.13	14.8	332	34	0.8	237.0	5.0	4.4
HD05-19	9.05	20.0	2262	40	2	237.0	5.0	4.0
HD05-20	0.55	25.6	1375	40	2	237.0	5.0	4.5
HD06-01	3.01	30.6	885	34	3.7	237.0	5.0	3.8
HD06-02	3.68	20.0	968	38	1.9	237.0	5.0	4.6
HD06-03	0.69	36.8	431	16	2.3	144.0	11.0	8.9
HD06-04	3.83	10.4	1235	31	1.9	146.0	5.0	4.6
HD06-05	1.15	8.8	370	31	0.5	146.0	5.0	4.7
HD06-06	1.84	11.6	593	31	2.1	237.0	5.0	4.5
HD06-07	0.74	29.6	493	15	1.9	144.0	11.0	9.2
HD06-08	3.69	9.4	1190	31	1.2	146.0	5.0	4.6
HD06-09	0.68	36.8	377	18	5.8	146.0	5.0	4.2
HD06-11	1.21	15.2	345	35	4.3	146.0	5.0	4.4
HD06-12	2.22	15.2	616	36	2.8	144.0	11.0	9.5
HD06-13	0.49	18.8	163	30	2.0	144.0	11.0	9.5
HD06-14	0.30	22.4	142	21	1.1	144.0	11.0	9.4
HD06-15	0.24	18.8	133	18	1.5	144.0	11.0	9.5
HD06-16	0.32	56.0	168	19	5.8	146.0	5.0	3.9
HD06-17	1.20	14.4	387	31	3.0	144.0	11.0	9.6
HD06-18	6.09	0.0	1791	34	4.1	144.0	11.0	10.5
HD06-19	26.05	7.7	1736	150	3	201.9	7.3	6.8
HD07-01	10.82	15.2	2705	40	1	237.0	5.0	4.4
HD07-02	4.84	20.0	806	60	1	237.0	5.0	4.5
HD08-01	13.24	21.6	3310	40	1	237.0	5.0	4.4
HD08-02	2.99	22.4	747	40	1	181.1	8.6	7.4
HD08-03	25.55	23.2	6387	40	2	237.0	5.0	4.3
HD08-04	11.46	24.4	2865	40	2	237.0	5.0	4.2

TABLE C1: EXSITING CONDITIONS HYDROLOGIC MODELLING PARAMETERS

Sub-catchment	Area (ha)	Imperv. (%)	Width (m)	Length (m)	Average Slope (%)	Pervious Suction Head (mm)	Pervious Saturated Hydraulic Conductivity (mm/hr)	Overall Saturated Hydraulic Conductivity (mm/hr)
HD08-05	24.17	22.8	6042	40	2	230.1	5.0	4.3
HDMB_03	9.22	33.0	614	150	1	169.0	9.4	7.6
HDMB_04	1.71	11.2	114	150	1	144.0	11.0	10.0
HDMB_05	4.10	3.2	1025	40	1	202.6	7.2	6.7
HDMB_06	10.26	0.8	684	150	1	237.0	5.0	4.8
HDMB_07	11.85	1.2	790	150	1	232.9	5.0	4.8
HDMB_2	10.31	56.8	1288	80	2	144.4	9.7	6.7
HDMB_3	8.36	47.7	1393	60	2	144.8	8.7	6.8
HDMB-08	68.23	6.9	2274	300	1	205.4	4.5	4.3
HDMB-09	12.61	14.6	840	150	2	211.3	5.0	4.6
HDMB-10	9.87	13.6	1645	60	2	237.0	5.0	4.5
TC01_EX	7.85	3.3	523	150	2.9	145.8	5.6	5.3
TC02_EX	7.07	4.7	471	150	3.5	145.5	6.5	6.2
TC03_EX	6.93	8.0	462	150	1.4	144.0	11.0	10.3
TC04_EX	7.56	0.1	504	150	2.3	156.2	9.9	9.5
TC05_EX	11.88	0.0	792	150	2.2	192.1	6.2	5.9
TC06_EX	6.31	13.9	420	150	0.8	237.0	5.0	4.6
VR01_EX	2.01	4.6	227	88.4	4.4	237.0	5.0	4.8
VR02_EX	0.52	15.9	81	63.5	3.5	237.0	5.0	4.2
VR03_EX	4.35	9.9	290	150	1.6	237.0	5.0	4.7
VR04_EX	8.09	14.4	539	150	1.5	237.0	5.0	4.7
VR05_EX	13.17	2.7	878	150	2.4	236.6	5.0	4.8
VR06_EX	30.09	3.2	2006	150	2.9	205.4	6.2	5.9
YRK-2-02	1.53	43.3	766	20	2	144.0	11.0	7.7
YRK-EXT01_1	2.37	16.1	236	100	2	144.0	11.0	9.5
YRK-EXT01_3	1.25	17.3	313	40	2	193.6	7.8	6.8
YRK-EXT01_4	1.16	14.6	290	40	2	144.0	11.0	10.2
YRK-EXT02	1.54	80.0	205	75	2	144.0	11.0	1.6
YRK-EXT03	0.62	60.0	311	20	2	144.0	11.0	1.6
YRK-N-01	0.18	88.8	88	20	2	144.0	11.0	4.0
YRK-N-02	0.53	82.2	262	20	2	144.0	11.0	4.4
YRK-N-03	0.18	73.1	91	20	2	144.0	11.0	2.1
YRK-N-04	0.24	67.1	120	20	2	144.0	11.0	1.6
YRK-N-05	0.11	63.2	54	20	2	144.0	11.0	1.6
YRK-N-06	0.32	69.0	161	20	2	144.0	11.0	1.6
YRK-N-07	0.60	39.2	298	20	2	188.8	8.1	1.4
YRK-N-08	0.75	56.1	377	20	2	144.0	11.0	1.8
YRK-N-09	0.13	60.1	63	20	2	144.0	11.0	1.9
YRK-N-10	0.66	48.4	327	20	2	144.0	11.0	1.6
YRK-S-01	0.19	86.1	92	20	2	144.0	11.0	4.0
YRK-S-03	1.59	19.3	793	20	2	144.0	11.0	8.6
YRK-S-04	0.76	13.3	378	20	2	144.0	11.0	8.1
YRK-S-05	0.43	15.6	213	20	2	144.2	10.5	7.8
YRK-S-06	0.50	21.6	251	20	2	144.0	11.0	8.2
YRK-S-07	1.14	9.7	571	20	2	144.0	11.0	8.8
YRK-S-08	1.48	17.6	742	20	2	147.0	10.8	7.1
YRK-S-09	0.91	58.2	454	20	2	144.0	11.0	1.7
YRK-S-10	0.87	50.4	433	20	2	144.0	11.0	1.6

TABLE C3: FUTURE CONDITIONS HYDROLOGIC MODELLING PARAMETERS

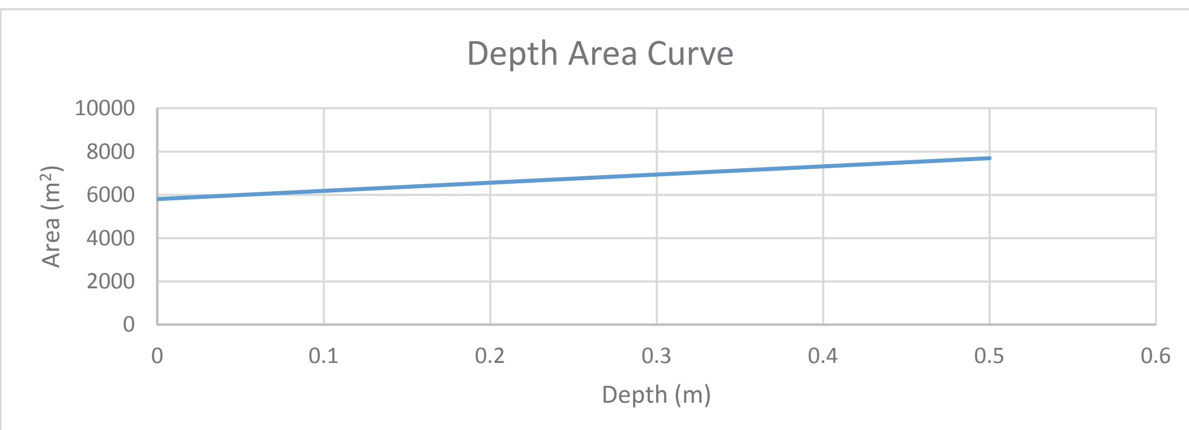
Sub-catchment	Area (ha)	Imperv. (%)	Width (m)	Length (m)	Average Slope (%)	Pervious Suction Head (mm)	Pervious Saturated Hydraulic Conductivity (mm/hr)	Overall Saturated Hydraulic Conductivity (mm/hr)
YRK-EXT04	1.08	0.0	241	45	2	147.0	11.0	10.4
YRK-EXT05	0.97	0.0	194	50	2	144.0	11.0	8.8
YRK-EXT06	0.35	0.0	174	20	2	144.0	11.0	8.2
YRK-EXT07	0.32	0.0	160	20	2	144.2	11.0	7.8
YRK-EXT08	0.60	0.0	171	35	2	144.0	11.0	8.1
YRK-EXT09	1.39	0.0	199	70	2	144.0	11.0	8.6
YRK-EXT10	0.95	34.2	316	30	2	144.0	11.0	7.7
YRK-N-01-FUT	0.20	87.5	98	20	2	144.0	4.0	4.0
YRK-N-02A-FUT	0.34	77.9	171	20	2	144.0	4.4	4.4
YRK-N-02B-FUT	0.23	82.0	113	20	3	144.0	4.4	4.4
YRK-N-03-FUT	0.13	97.5	63	20	2	144.0	2.1	2.1
YRK-N-04-FUT	0.33	96.0	164	20	2	144.0	1.6	1.6
YRK-N-05A-FUT	0.28	91.4	194	20	2	144.0	1.6	1.6
YRK-N-05B-FUT	0.11	100.0	55	20	2	144.0	1.6	1.6
YRK-N-06-FUT	0.62	57.1	310	20	2	188.0	1.4	1.4
YRK-N-07-FUT	1.08	75.5	538	20	2	144.0	1.8	1.8
YRK-N-08-FUT	0.54	73.2	271	20	2	144.0	1.6	1.6
YRK-S-01-FUT	0.17	78.6	83	20	2	144.0	4.0	4.0
YRK-S-02A-FUT	0.32	81.8	160	20	2	144.0	4.4	4.4
YRK-S-02B-FUT	0.22	68.6	110	20	2	144.0	4.4	4.4
YRK-S-03-FUT	0.13	73.8	65	20	2	144.0	1.6	1.6
YRK-S-04-FUT	0.29	79.2	147	20	2	144.0	1.6	1.6
YRK-S-05A-FUT	0.28	71.6	141	20	2	144.0	1.6	1.6
YRK-S-05B-FUT	0.10	66.5	52	20	2	144.0	1.6	1.6
YRK-S-06-FUT	0.44	76.2	221	20	2	188.0	1.4	1.4
YRK-S-07-FUT	1.06	79.5	529	20	2	144.0	1.8	1.8
YRK-S-08-FUT	0.58	67.1	288	20	2	144.0	1.6	1.6

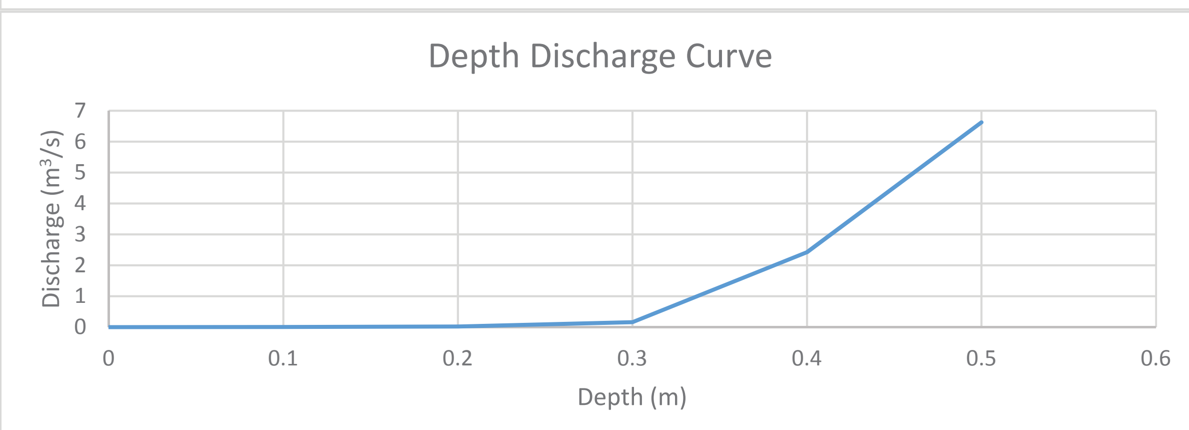
City Pond #31

Grangehill Estates Subdivision Phase 4
Stantec Consulting Ltd. June 2005
MIDUSS Outputs - December 15, 2004

Depth	Area
(m)	(m^2)
0	5806
0.1	6184
0.2	6562
0.3	6939
0.4	7317
0.5	7695

Depth	Outflow
(m)	(m^3/s)
0	0
0.1	0.0075
0.2	0.0195
0.3	0.161
0.4	2.424
0.5	6.624



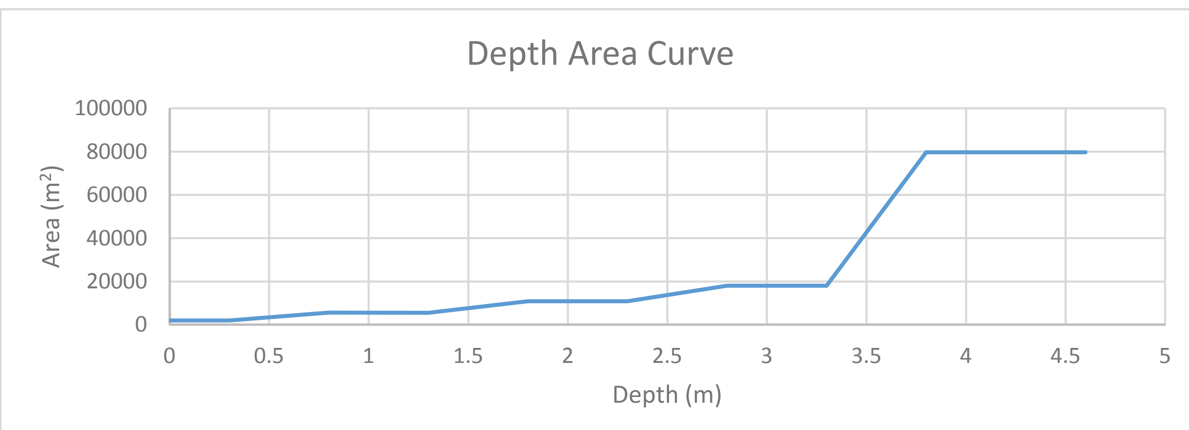


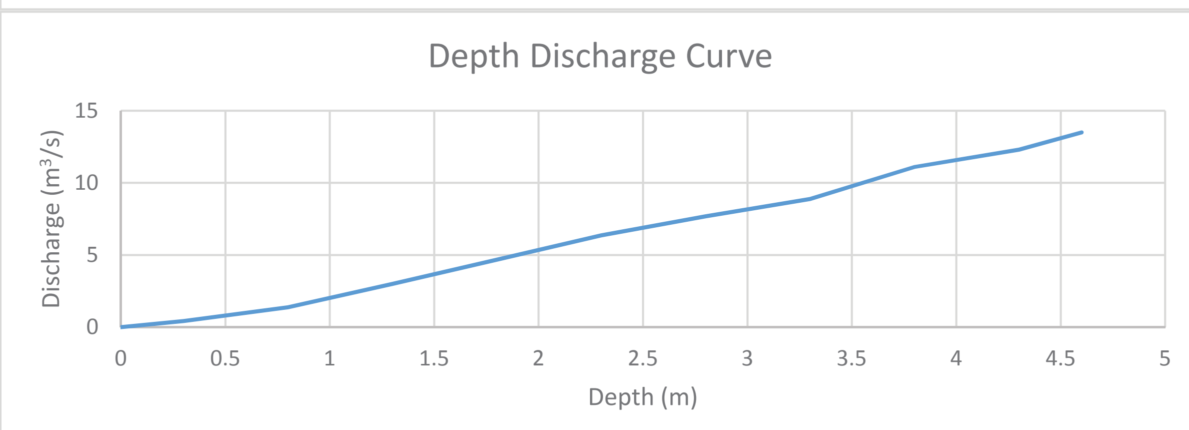
City Pond #35

Box Culvert Extension Under CN Tracks
Schaeffers May 1997

Depth	Area
(m)	(m^2)
0	2000
0.3	2000
0.8	5600
1.3	5560
1.8	10900
2.3	10880
2.8	18080
3.3	18080
3.8	79700
4.3	79700
4.6	79700

Depth	Outflow
(m)	(m^3/s)
0	0
0.3	0.42
0.8	1.38
1.3	3
1.8	4.68
2.3	6.36
2.8	7.68
3.3	8.88
3.8	11.1
4.3	12.3
4.6	13.5



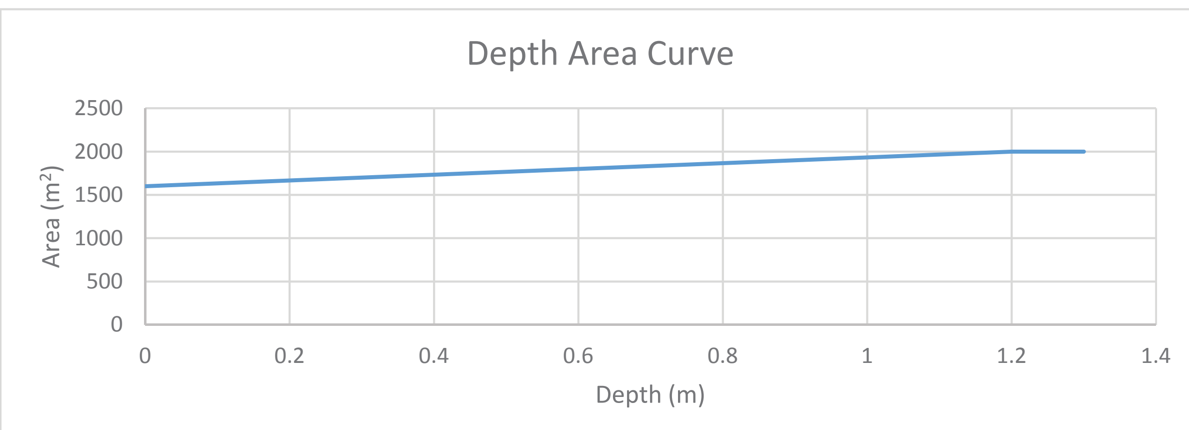


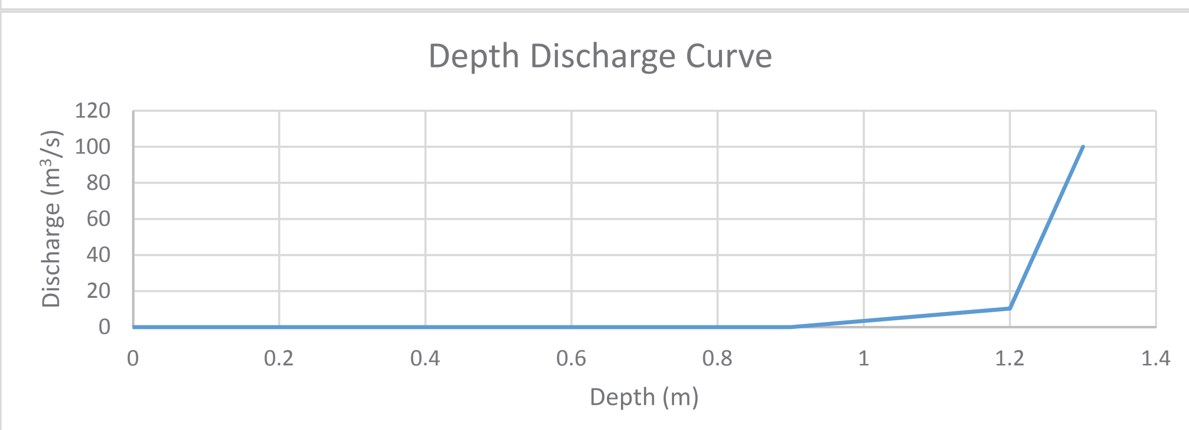
City Pond #37

Grangehill Subdivision Phase 2
Buckthorn Crescent to Pond
DWG Y-10

Depth	Area
(m)	(m^2)
0	1600
1.2	2000
1.3	2000

Depth	Outflow
(m)	(m^3/s)
0	0
0.07	0.002
0.9	0.01
1.2	10.284
1.3	100



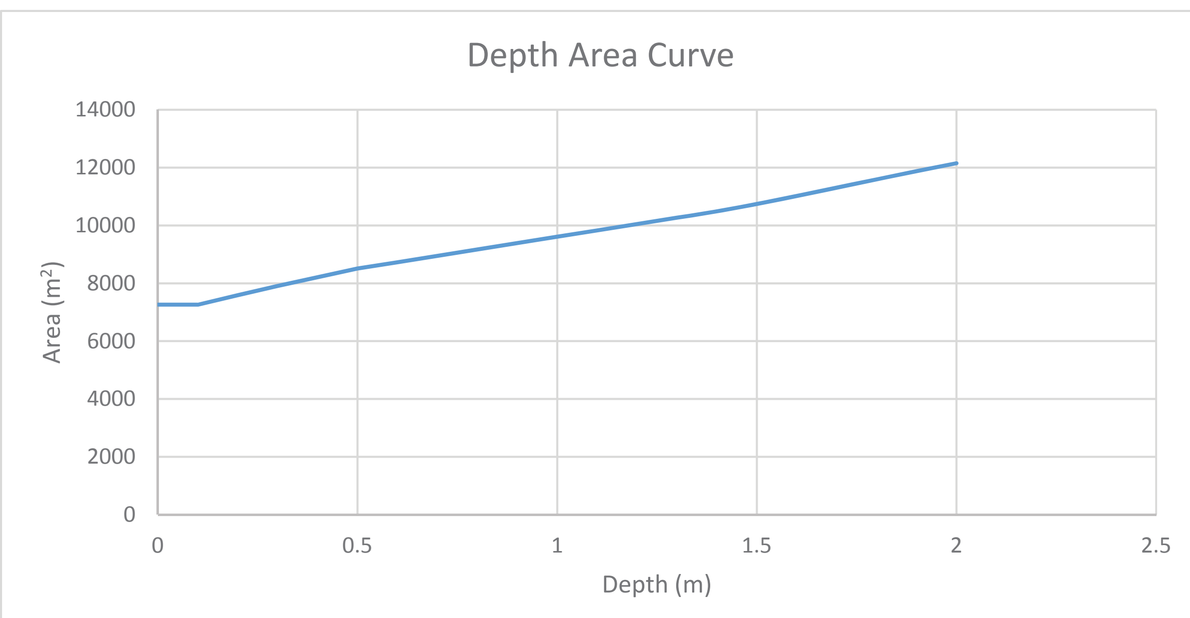


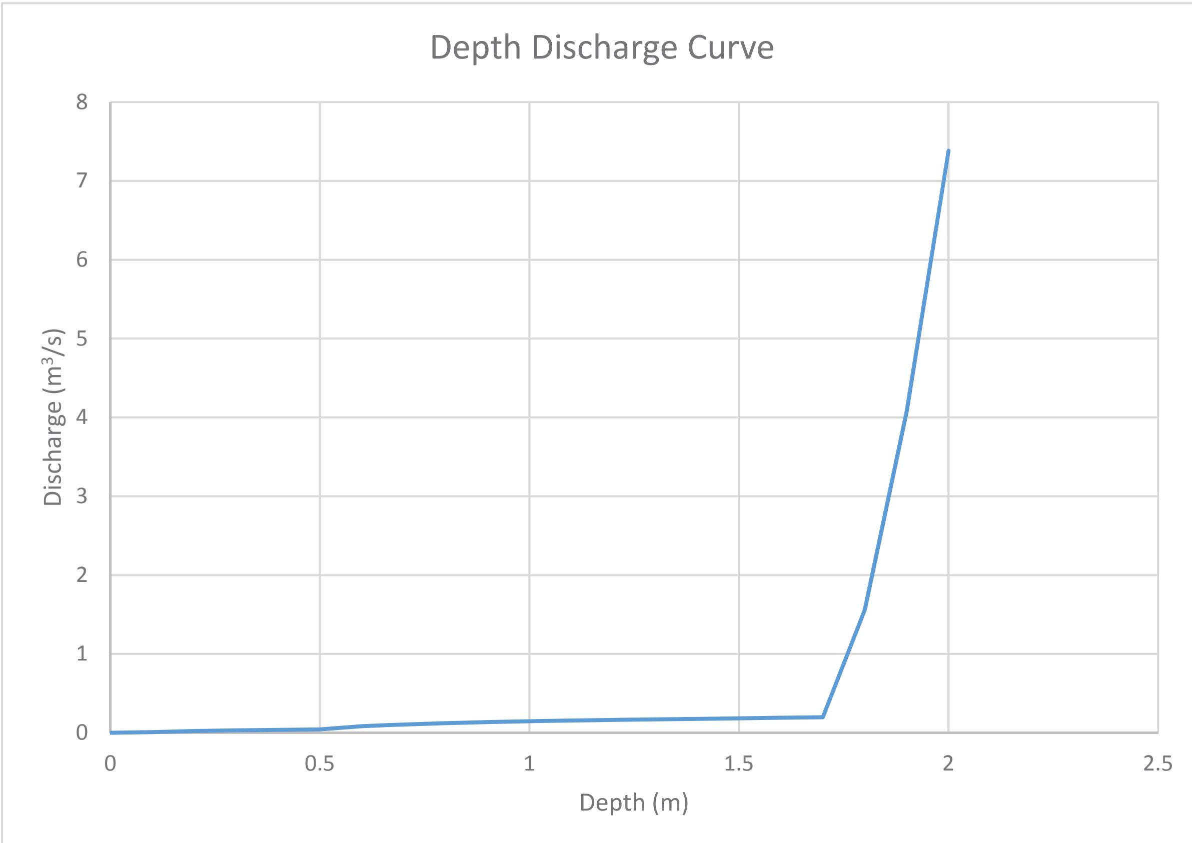
City Pond #53

Grangehill Estates SWM Design Brief
Stanley Consulting October 1998
8787 - Grangehill Subdivision SWM Facility (Appendix B)

Depth	Area
(m)	(m^2)
0	7260
0.1	7260
0.2	7590
0.3	7910
0.5	8510
0.6	8730
0.7	8950
0.8	9170
0.9	9390
1	9610
1.1	9830
1.2	10050
1.3	10270
1.4	10490
1.5	10740
1.6	11020
1.7	11310
1.8	11590
1.9	11880
2	12150

Depth	Outflow
(m)	(m^3/s)
0	0
0.1	0.007
0.2	0.022
0.3	0.031
0.4	0.037
0.5	0.043
0.6	0.083
0.7	0.106
0.8	0.124
0.9	0.135
1	0.145
1.1	0.154
1.2	0.162
1.3	0.17
1.4	0.177
1.5	0.184
1.6	0.19
1.7	0.196
1.8	1.558
1.9	4.077
2	7.384





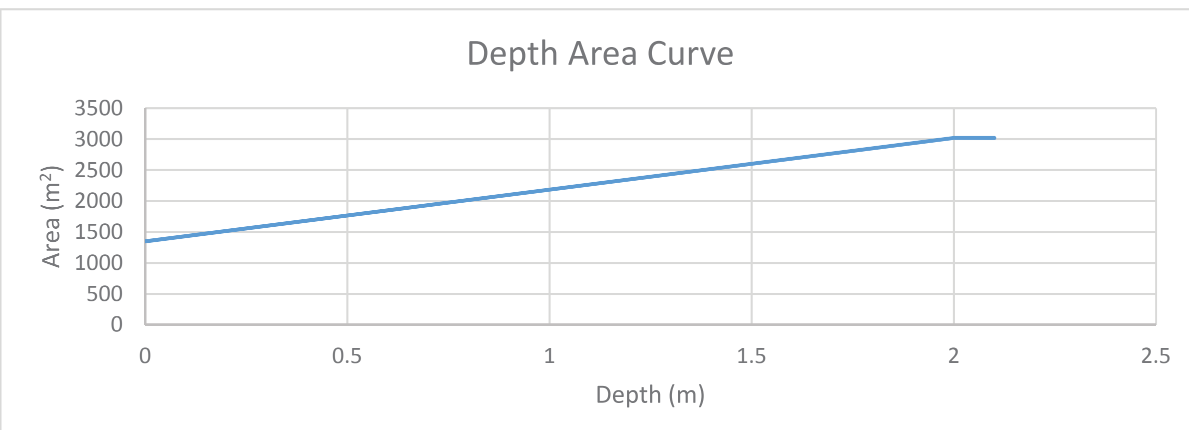
Depth Discharge Curve
Discharge (m³/s)
Depth (m)
0
1
2
3
4
5
6
7
8
0
0.5
1
1.5
2
2.5

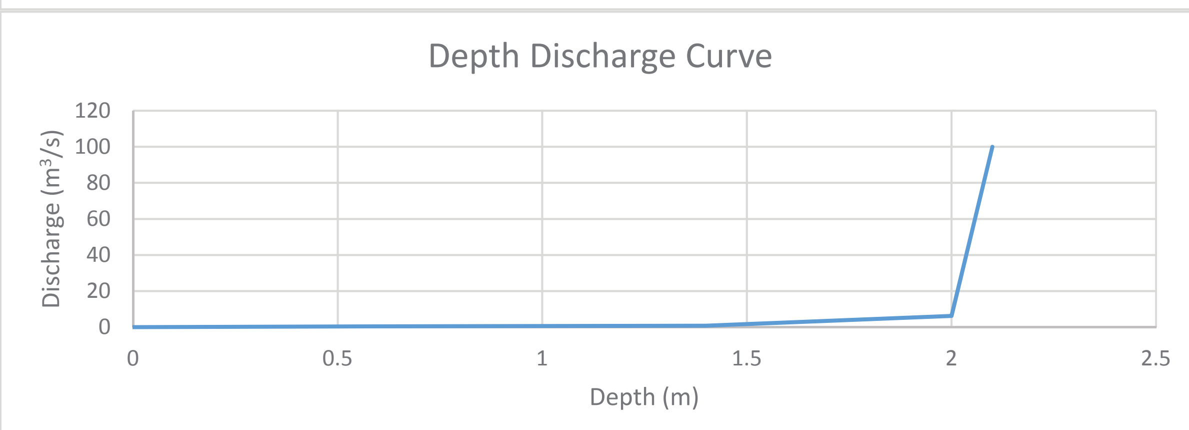
City Pond #54

CheltonWood Subdivision
S.W.M. Pond Detail
DWG SWM-6

Depth	Area
(m)	(m^2)
0	1350
2	3020
2.1	3020

Depth	Outflow
(m)	(m^3/s)
0	0
0.6	0.412
1.4	0.788
2	6.263
2.1	100



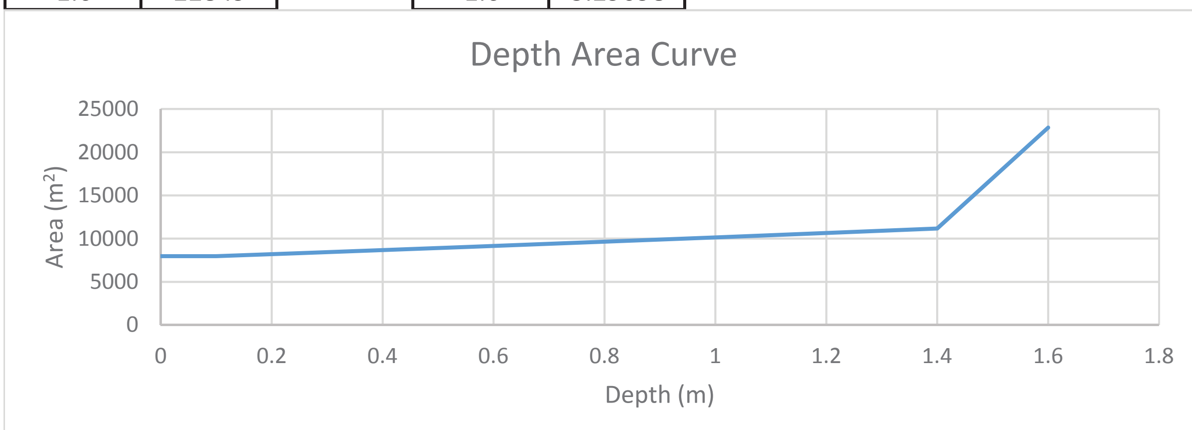


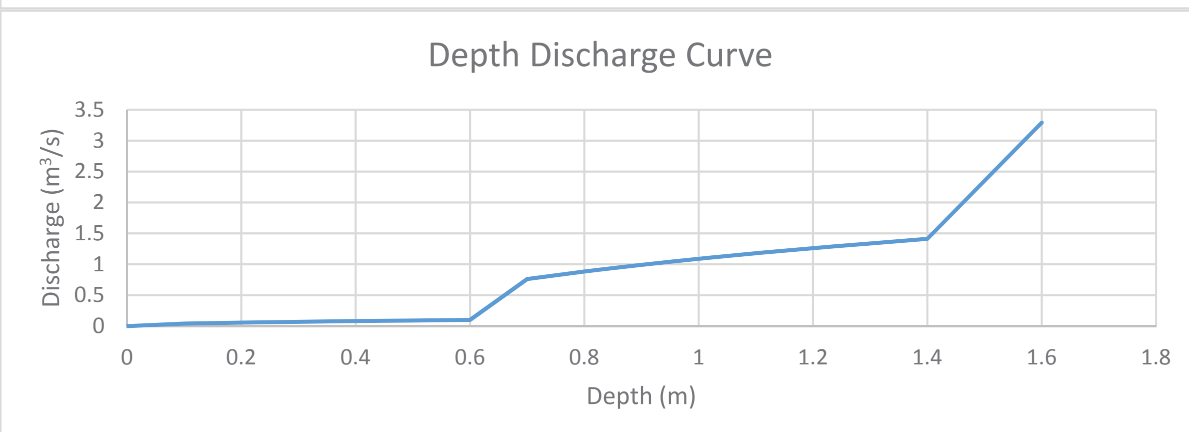
City Pond #86

Watson Pond 2001
excel design calcs date modified 2005

Depth (m)	Area (m^2)
0	7963
0.1	7963
0.2	8197.5
0.3	8433.5
0.4	8672
0.5	8912.5
0.6	9154.5
0.7	9399
0.8	9645.5
0.9	9893.5
1	10143.5
1.1	10396
1.2	10650
1.3	10906
1.4	11164.5
1.6	22849

Depth (m)	Outflow (m^3/s)
0	0
0.1	0.041192
0.2	0.058254
0.3	0.071346
0.4	0.082383
0.5	0.092107
0.6	0.100899
0.7	0.761759
0.8	0.884371
0.9	0.991941
1	1.088936
1.1	1.177972
1.2	1.260735
1.3	1.33839
1.4	1.41178
1.6	3.29098



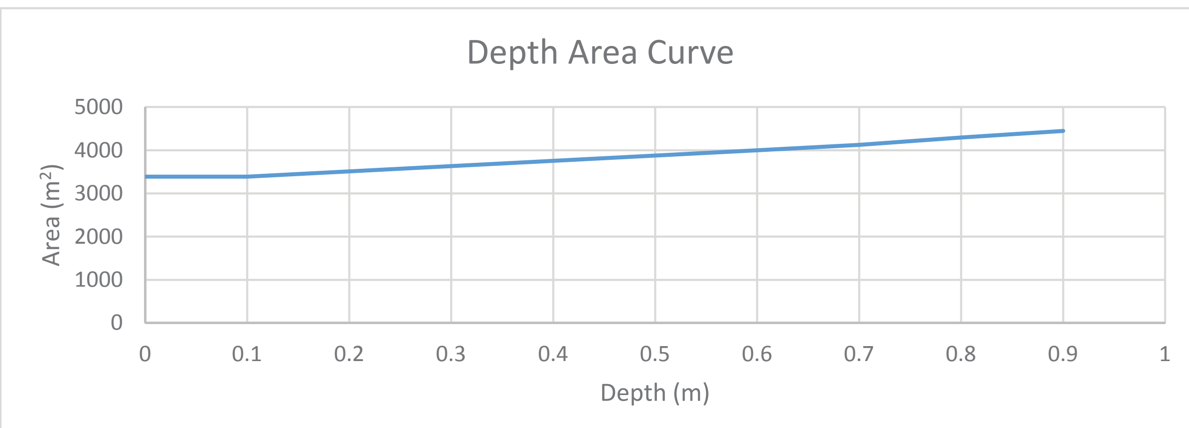


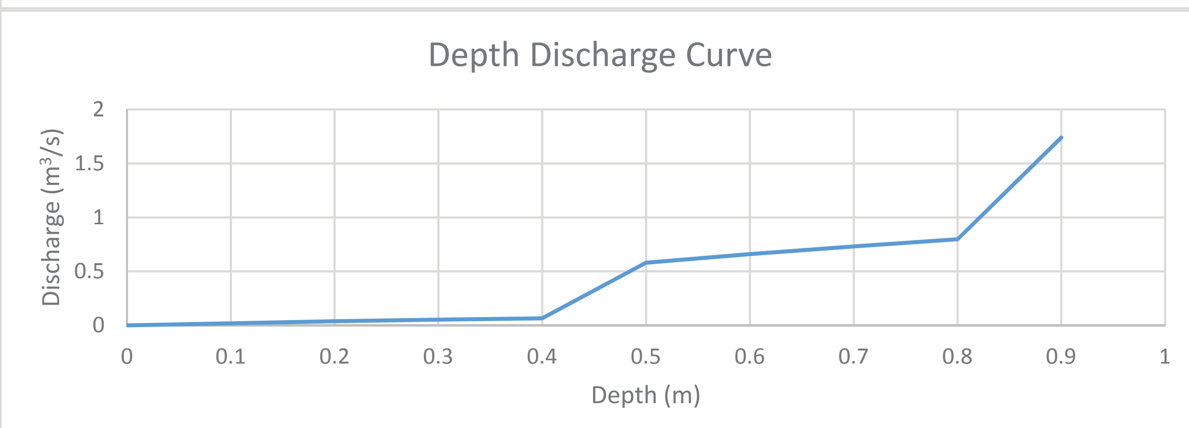
City Pond #87

Watson Pond 1001
excel design calcs dated 2007

Depth	Area
(m)	(m^2)
0	3388
0.1	3388
0.2	3509
0.3	3631
0.4	3754
0.5	3876
0.6	3999
0.7	4124
0.8	4295
0.9	4447

Depth	Outflow
(m)	(m^3/s)
0	0
0.1	0.02
0.2	0.039
0.3	0.054
0.4	0.065
0.5	0.58
0.6	0.661
0.7	0.732
0.8	0.798
0.9	1.74



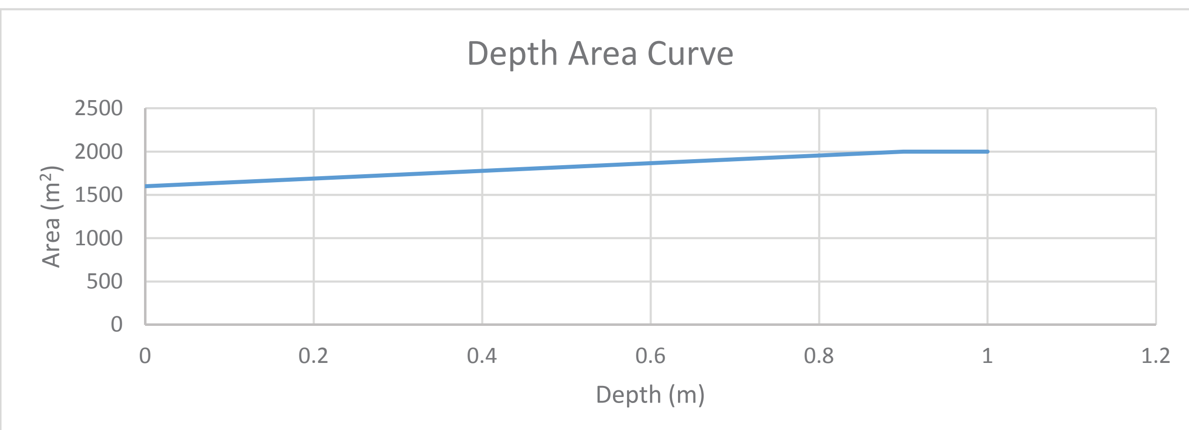


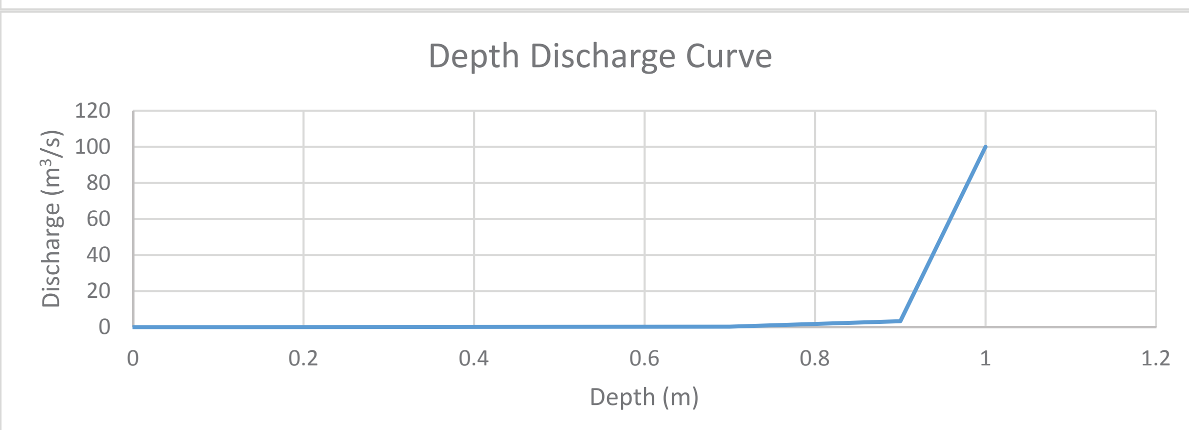
City Pond #88

Watson Creek Subdivision Phase II
SWM Pond 7001
DWG 13

Depth	Area
(m)	(m^2)
0	1600
0.9	2000
1	2000

Depth	Outflow
(m)	(m^3/s)
0	0
0.125	0.008
0.4	0.196
0.7	0.317
0.9	3.275
1	100



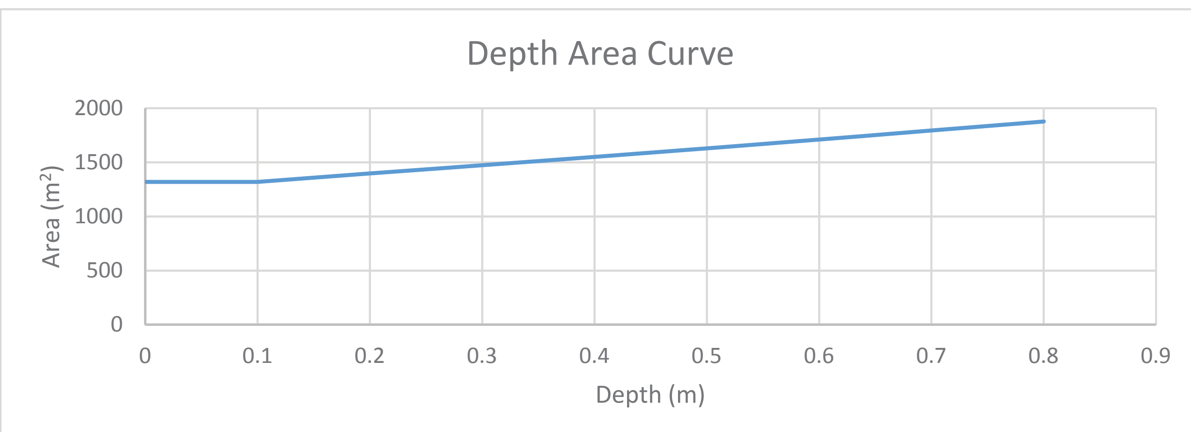


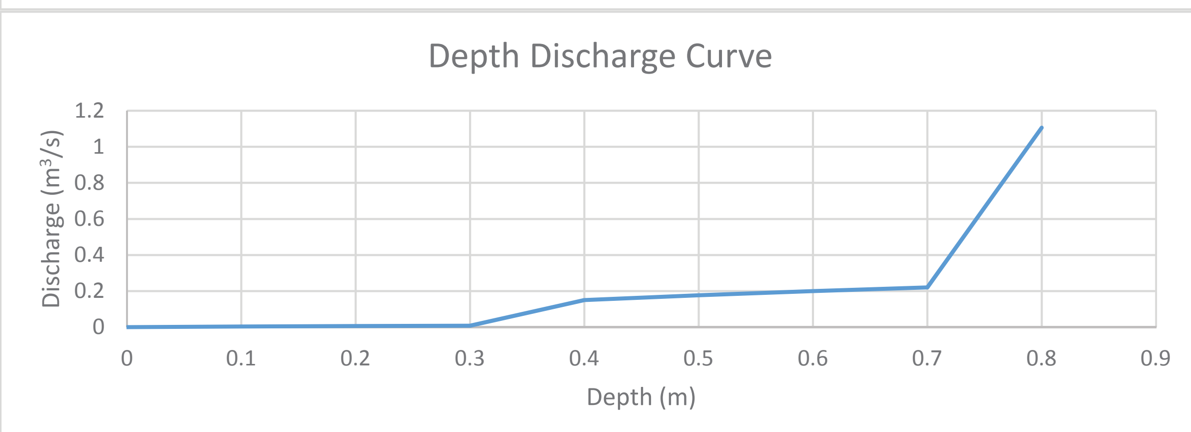
City Pond #111

Watson Pond 4001
excel design calcs dated 2007

Depth	Area
(m)	(m^2)
0	1320
0.1	1320
0.2	1398
0.3	1473
0.4	1551
0.5	1631
0.6	1711
0.7	1794
0.8	1878

Depth	Outflow
(m)	(m^3/s)
0	0
0.1	0.004
0.2	0.006
0.3	0.008
0.4	0.15
0.5	0.177
0.6	0.2
0.7	0.22
0.8	1.106



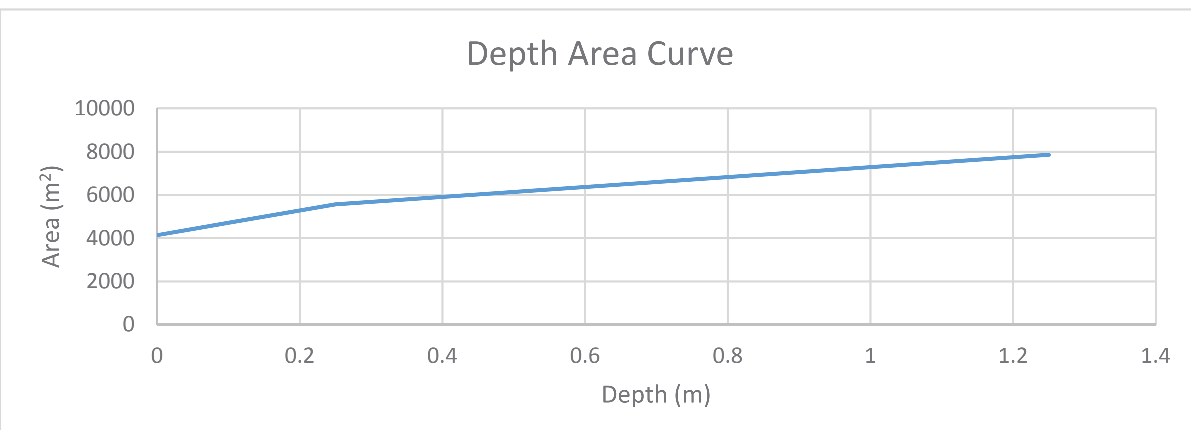


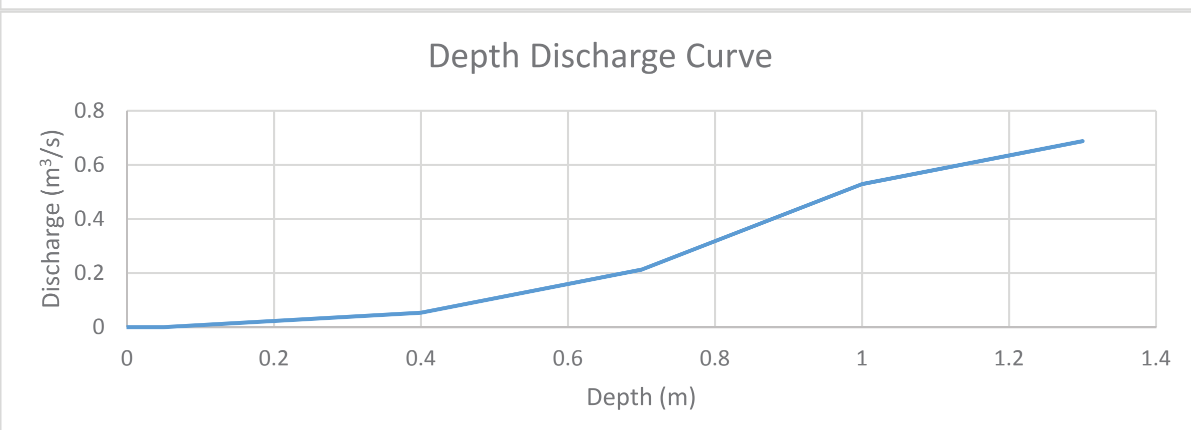
City Pond #115

Grangehill Estates Phase 7 SWM Report
exp February 2012
Design Calcs February 2012

Depth	Area
(m)	(m^2)
0	4140
0.05	4424.6
0.1	4715.74
0.25	5563
0.35	5792.2
0.45	6021.4
0.55	6250.6
0.65	6479.8
0.75	6709
0.85	6938.2
0.95	7167.4
1.05	7396.6
1.25	7855

Depth	Outflow
(m)	(m^3/s)
0	0
0.05	1E-07
0.4	0.05345
0.7	0.2126
1	0.5291
1.3	0.6876



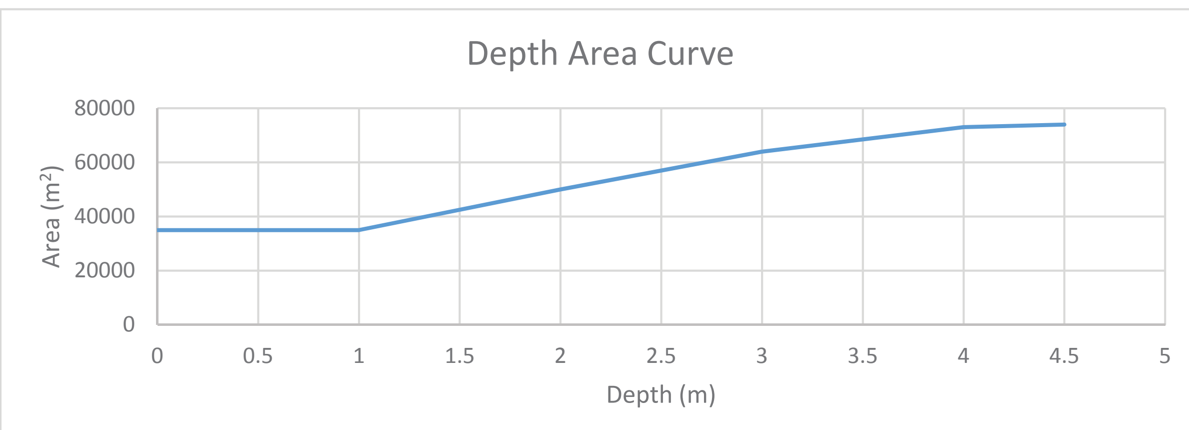


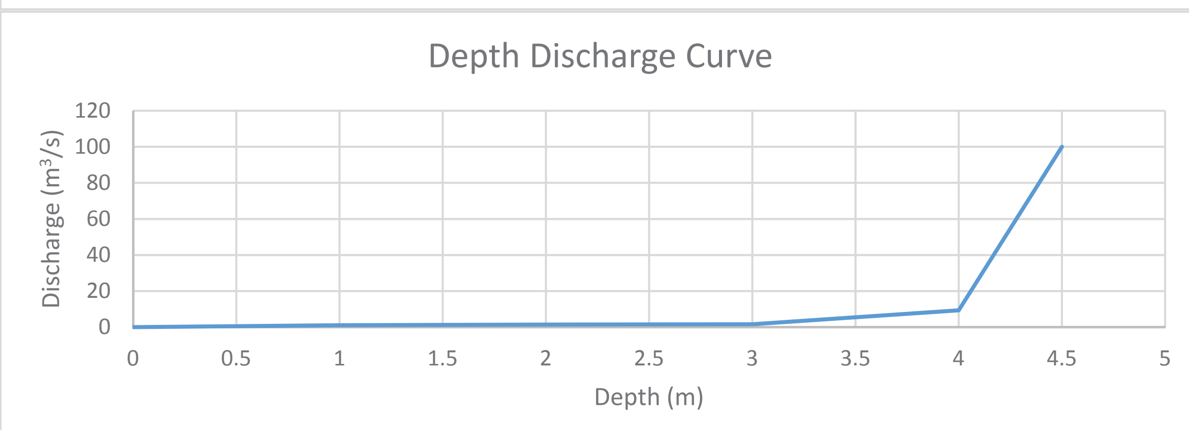
Starwood Drive Online

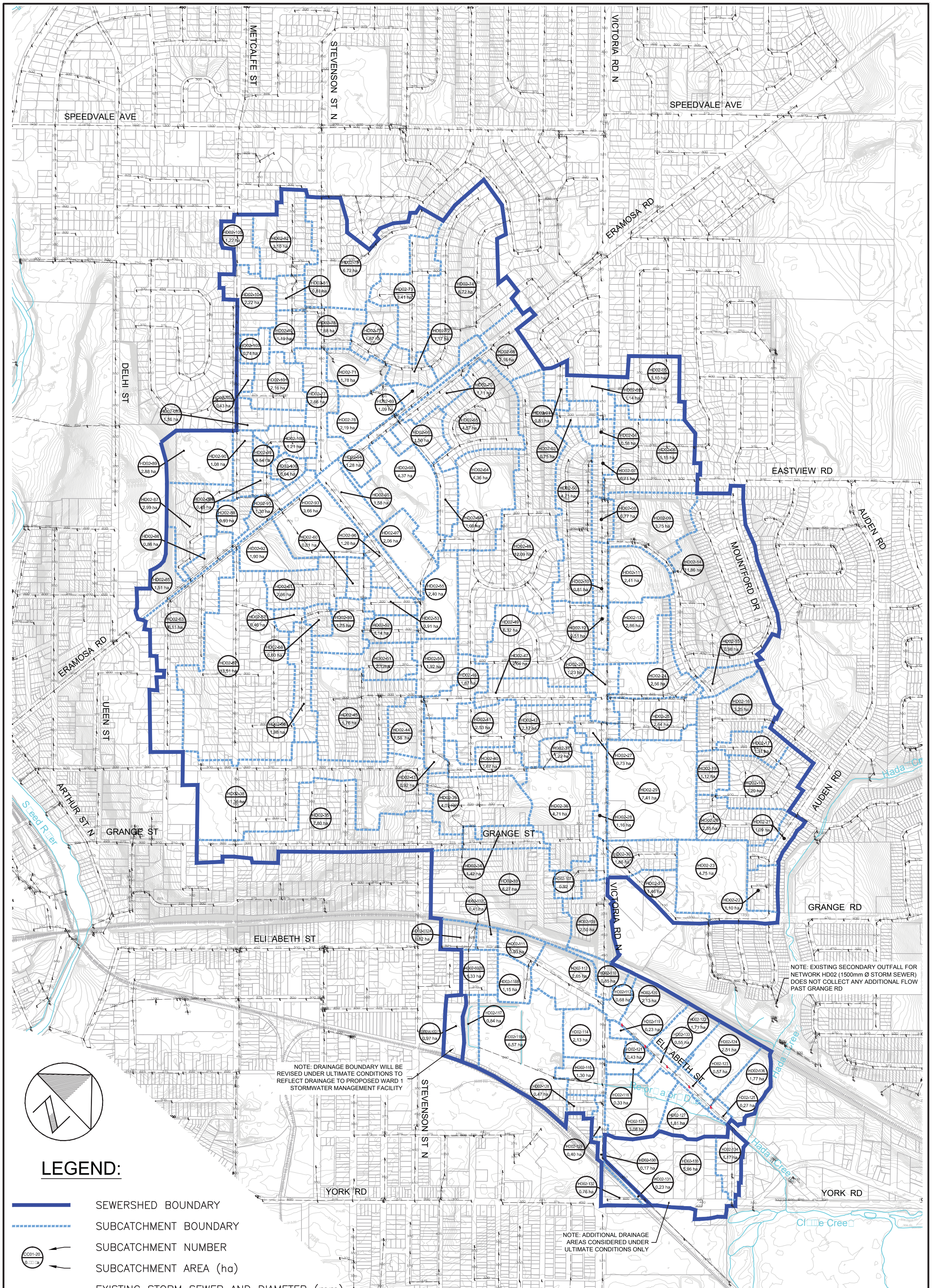
Grangehill Estates Phase 4 SWM RPT
Stantec June 2005

Depth	Area
(m)	(m^2)
0	35000
1	35000
2	50000
3	64000
4	73000
4.5	74000

Depth	Outflow
(m)	(m^3/s)
0	0
1	1.1
2	1.4
3	1.6
4	9.3
4.5	100







SCALE VALID ONLY FOR 24"x36" VERSION

ELIZABETH STREET RECONSTRUCTION VICTORIA ROAD TO INDUSTIAL AVENUE CITY OF GUELPH	SUB-CATCHMENT BOUNDARY PLAN NETWORK HD02	amec foster wheeler	Scale 1:5000 (0 50 100 200) Consultant File No. TP112088 Drawing No. SHEET 1 OF 2

Path: P:\Work\TP112088\water\dwg\Fig-1.dwg
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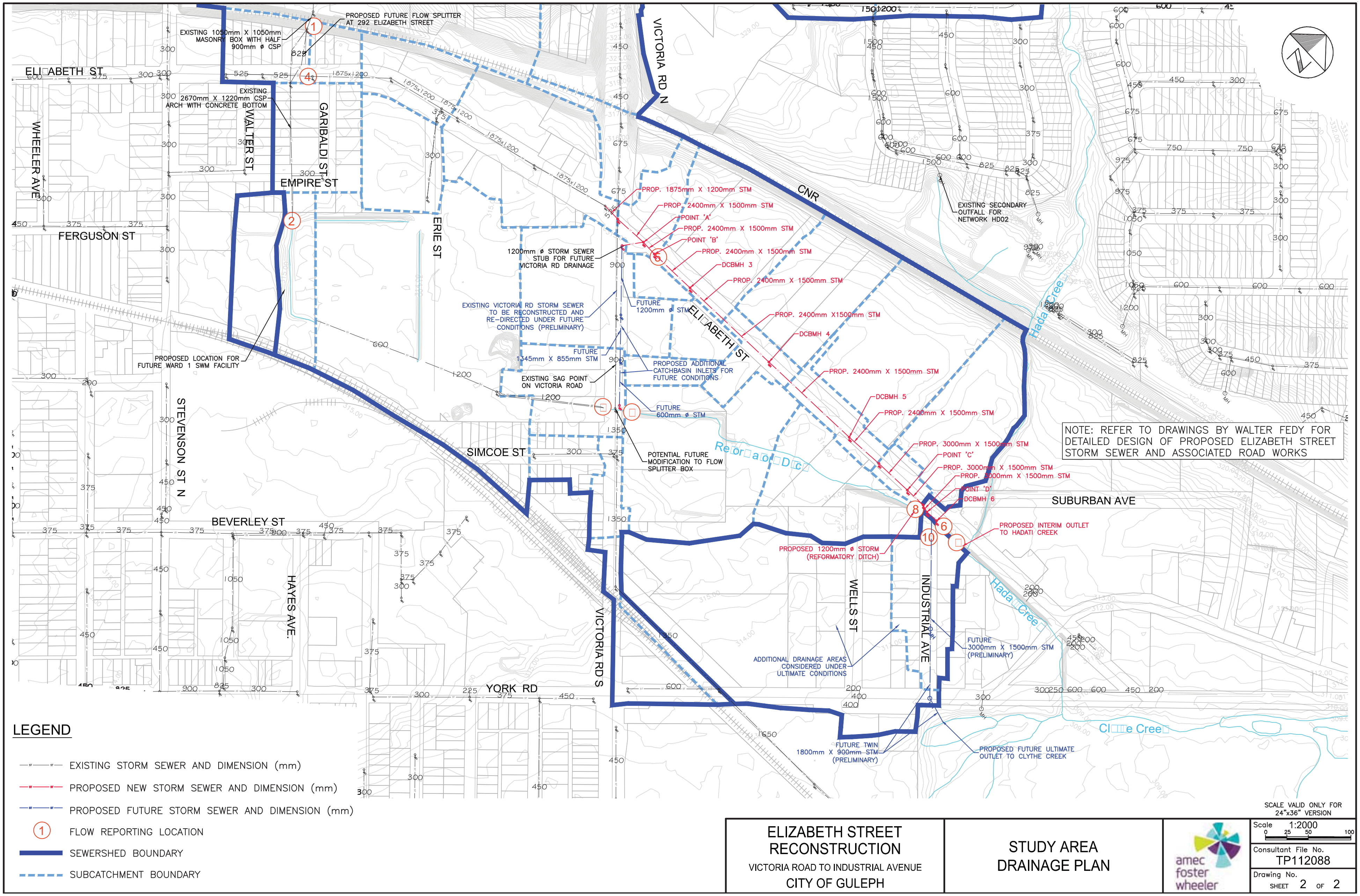
Last Saved By: josh.seraj Last Saved: 2014-12-05



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Last Saved: 2014-12-04 Last Saved By: josh.seraj

ELIZABETH STREET RECONSTRUCTION
VICTORIA ROAD TO INDUSTRIAL AVENUE

CITY OF GUELPH

Submitted to:

Grand River Conservation Authority

Submitted by:

Amec Foster Wheeler Environment & Infrastructure
3215 North Service Road
Burlington, ON L7N 3G2

Tel: 905-335-2353
Fax: 905-335-1414

March 2015

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1. INTRODUCTION

Elizabeth Street from Victoria Road to Industrial Avenue is a 2 lane collector road (non-urbanized) with sidewalk along the north side of Elizabeth, with no curb and roadside ditches in certain areas. The underground storm sewer infrastructure along Elizabeth Street in this location ranges in diameter from 300 mm to 750 mm at Industrial Avenue, where the storm sewer outlets to an existing ditch at the confluence with a minor drainage feature known as the reformatory ditch. This ditch then confluences with Hadati Creek some 50 m +\- downstream (ref. Drawing 2).

The City of Guelph has proposed to reconstruct this section of roadway, including the construction of a new trunk storm sewer, which under interim conditions, would continue to outlet to the section of ditch upstream of Hadati Creek. This outlet would be maintained until such time as the proposed ultimate outlet (along Industrial Avenue to Clythe Creek) can be constructed. The detailed design of the proposed trunk storm sewer (as well as the roadway and other underground infrastructure) is being conducted by WalterFedy, based on the preliminary design as generated by Amec Foster Wheeler in 2012 and 2013. Given Amec Foster Wheeler's previous experience with the design of the trunk storm sewer, and the complexity of the drainage system in this area, Amec Foster Wheeler has been retained to prepare the documentation and supporting analyses for the trunk storm sewer in parallel with the detailed design work and supporting documentation being undertaken for the balance of the proposed works by WalterFedy.

This design brief has been generated to summarize the various analyses and modelling conducted in support of the design of the trunk storm sewer, and to demonstrate that the storm sewer has been properly designed to the satisfaction of the City of Guelph, the Grand River Conservation Authority (GRCA), and the Ministry of the Environment and Climate Change (MOECC). The proposed works also lie partly within the area regulated by the GRCA (floodplain from the reformatory ditch and Hadati Creek); accordingly, a permit application has been submitted in conjunction with this design brief.

2. BACKGROUND REVIEW

2.1. Project History

It is understood that there has been a long history of flooding issues and drainage system constraints within the lower Ward One area, generally consisting of the area south of the GJR tracks and east of Stevenson Street, within the City of Guelph. These issues impact upon adjacent residential and commercial properties, in particular the lands owned by PDI at 351 Elizabeth Street, through which flow from a large trunk storm sewer drains.

Accordingly, in 2007, EarthTech (now AECOM) completed the “Stormwater Management Study – Class Environmental Assessment – Ward One – City of Guelph”. This report assessed drainage within the study area (hydrologic/hydraulic modelling using XP-SWMM) and undertook an alternative assessment, ultimately recommending Alternative “C”, which consisted of:

- A flow splitter at 292 Elizabeth Street to split flows between the existing CSP arch storm sewer outlet and a new relief sewer on Elizabeth Street
- A new relief sewer (1.8 x 1.2 m box) along Elizabeth Street easterly to Victoria Road, then south along Victoria Road, outletting to the existing reformatory ditch
- A new stormwater management (SWM) facility west of the lands owned by PDI at the location of the existing CSP arch storm sewer outlet, incorporating water quality treatment
- Channel and other conveyance improvements through the PDI lands
- Channel re-alignment and channel improvements for the reformatory ditch east of Victoria Road, including an enclosure for the downstream section at Wells Street

Excerpts of the report detailing Alternative “C” have been included in Appendix A.

In 2009, the City of Guelph completed the reconstruction of Elizabeth Street from Stevenson Street to Victoria Road. The reconstruction also included the installation of a 1875 mm x 1200 mm box culvert from 294 Elizabeth Street to Victoria Road, consistent with the recommendations of the Ward One EA. This design was conducted in conjunction with a preliminary design for the extension of this trunk storm sewer south-east along Victoria Road towards the reformatory ditch, generally consistent with the recommended alternative in the original EA. It was then proposed to continue the trunk storm sewer along the path of the existing reformatory ditch, ultimately outletting to the existing open ditch at Elizabeth Street and Industrial Avenue, approximately 50 m +\- upstream of the confluence with Hadati Creek. This is contrasted to the EA, which recommended open channel improvements along the reformatory ditch, rather than an enclosure. The design also included the preliminary design of a flow splitter box at 292 Elizabeth Street, which was necessary to split inflows (from the trunk sewer beneath the GJR tracks) between the existing drainage system outlet (through the PDI lands) and the new trunk storm sewer along Elizabeth Street. A copy of all associated drawings (as completed by AECOM) has been included in Appendix A.

In 2012, Amec Foster Wheeler was retained by the City of Guelph to undertake the detailed design for the proposed reconstruction of Victoria Road (Elizabeth Street to the reformatory ditch), including the detailed design of the continuation of the trunk storm sewer along this path and through the reformatory ditch lands. In order to undertake this process, the globally calibrated PCSWMM hydrologic/hydraulic modelling developed by Amec Foster Wheeler as part of the City of Guelph's Stormwater Management Master Plan (Network HD02) was updated and upgraded to reflect 2012 conditions. Amec Foster Wheeler then used this updated modelling to assess the preliminary design generated by AECOM. The results of this assessment were detailed in a memorandum to City staff (October 2, 2012); a copy has been included in Appendix A for reference.

As noted in the memorandum, the updated modelling and supporting review found a number of issues with the proposed preliminary design, including extensive simulated surface flooding and surcharge for the 100 year storm event, and minimal use of storage within the proposed Ward One SWM facility (i.e. excessive flows being directed towards the Elizabeth Street storm sewer). Of particular concern were the high simulated tailwater levels from Hadati Creek, with the proposed outlet being more than 50% submerged for a 2 year storm event, and completely submerged for the 25 year storm event and above. The high tailwater levels were found to have a significant impact upon the performance of the proposed trunk storm sewer system. From a logistical perspective, the process of obtaining easements along the path of the reformatory ditch was also considered highly problematic (given the significant degree of private ownership). An alternative assessment was conducted; the preferred alternative solution consisted of:

- Altering the path of the proposed trunk storm sewer to remain on Elizabeth Street from Victoria Road to Industrial Avenue (which avoided the need for easements, and also reduced the total required length of storm sewer and preserved grade)
- Directing the trunk storm sewer south along Industrial Avenue and across York Road towards Clythe Creek and away from Hadati Creek (which significantly lowered tailwater levels; 100 year tailwater levels are some 2.57 m lower for Clythe Creek, despite the additional required length of storm sewer)

A meeting (November 6, 2012) with staff from the GRCA was held to discuss the recommended alternative, particularly given the proposed revised outlet. GRCA staff indicated that they had no engineering objectives to the proposed solution, but indicated that further assessment of ecological concerns and water quality would likely be required; in particular, an Environmental Impact Study (EIS) would likely be required. A copy of the meeting minutes has been included in Appendix A.

Amec Foster Wheeler subsequently completed the preliminary design of the proposed reconstruction of Elizabeth Street, including the trunk storm sewer, with an interim outlet to Hadati Creek (as it was considered appropriate to address the proposed construction along Industrial Avenue and the proposed outlet to Clythe Creek separately as future works due to the need to obtain funding, and due to future construction considerations along York Road, in particular the York Road trunk sanitary sewer). A preliminary design was however completed for the proposed ultimate storm sewer outlet along Industrial Avenue to Clythe Creek (a copy has been included in Appendix A). A revised design was also included for the proposed upstream flow splitter at 292 Elizabeth Street; a copy has also been included in Appendix A.

In 2013, WalterFedy was retained by the City of Guelph to undertake the detailed design of the reconstruction of Elizabeth Street, including the proposed trunk storm sewer (and interim outlet to Hadati Creek). The proposed flow splitter at 292 Elizabeth Street was not included as part of the contract; it is understood these works will be addressed separately by the City of Guelph.

As noted previously, given Amec Foster Wheeler’s previous experience with the design of the trunk storm sewer, and the complexity of the drainage system in this area, Amec Foster Wheeler has been retained to prepare the documentation and supporting analyses for the trunk storm sewer along Elizabeth Street in parallel with the detailed design work and supporting documentation being undertaken for the balance of the proposed works by WalterFedy. The current design brief should therefore be reviewed in conjunction with the current drawing set as prepared by WalterFedy.

2.2. Information Sources

The following information and data has been reviewed in the preparation of this design brief:

Mapping and Base Data

- Aerial Photography (2008) of the study area and surrounding area (as provided by the City of Guelph as part of the SWM MP)
- 0.5 m elevation contours (2008) of the study area and surrounding area (as provided by the City of Guelph as part of the SWM MP)
- Storm sewer and storm manhole mapping (2008) of the study area and surrounding area (as provided by the City of Guelph as part of the SWM MP)
- Soil Mapping Reports from Agriculture Canada (Report Number 35 – Soil Survey of Wellington County)

Background Reports and Studies

- Design Report – Hadati Creek Channel Improvements – City of Guelph. Gamsby and Mannerow Limited, June 2003.
- Stormwater Management Study – Class Environmental Assessment – Ward One – City of Guelph. EarthTech, September 2007.
- City of Guelph Stormwater Management Master Plan. AMEC Environment & Infrastructure (now Amec Foster Wheeler), February 2012.
- Victoria Road Storm Sewer and Elizabeth Street Flow Splitter Design - City of Guelph. Memorandum to Andrew Janes, City of Guelph, from AMEC Environment & Infrastructure, October 16, 2012.

Design Drawings

- Various plan and profile drawings for the study area (as provided by the City of Guelph)
- Elizabeth Street Reconstruction drawing set, AECOM, 2009. Drawings P101 to P112.
- City of Guelph – Storm Sewer Easement – Property Requirements – Site Plan, AECOM, No date. Drawing C-101.
- City of Guelph – Storm Splitter, AMEC Environment & Infrastructure, No Date. Sheet 7/5.
- City of Guelph – Industrial Street STA 0+000 to STA 0+270, AMEC Environment & Infrastructure, No Date. Sheets 5/5 and 6/5.
- Elizabeth Street Reconstruction – Victoria Road to Industrial Avenue (Issued for GRCA Approval), WalterFedy, February 20, 2015. Drawings 1-19.

Relevant findings and direction from the previously noted reports and studies are referenced as required in subsequent sections of this design brief.

In addition to the foregoing, two drawings have been generated by Amec Foster Wheeler in support of this design brief. The following drawings should be read in conjunction with this report:

- Drawing 1 (Sub-Catchment Boundary Plan – Network HD02)
- Drawing 2 (Study Area Drainage Plan)

3. HYDROLOGIC/HYDRAULIC MODELLING

3.1. Modelling Setup

Hydrologic and hydraulic modelling have been completed using PCSWMM. PCSWMM is capable of combining both hydrologic and hydraulic modelling requirements, and is capable of addressing complex hydraulics (including pressure flow, reverse and looped flow, minor/major drainage system interactions, etcetera). PCSWMM was also applied as part of Amec Foster Wheeler's work on the City of Guelph's Stormwater Management Master Plan (SWM MP).

The PCSWMM modelling developed as part of the SWM MP was employed as the basis for modelling; specifically drainage network HD02. The dual drainage version of the model has been employed, which includes representation of both the minor system (storm sewers) as well as the major system (roadways and open channels). The dual drainage model is capable of simulating flows under more formative storm events (such as the 100 year storm) and was thus considered to be a more appropriate option.

The base dual drainage model for network HD02 has been updated to reflect existing conditions as an initial basis of comparison; to summarize the associated model updates:

- Inlet functions (which simulate the interaction between the minor and major drainage systems) have been revised from the approach applied in the SWM MP. While the SWM MP employed stage-discharge rating curves based on the appropriate number of catchbasins, the updated modelling has employed equivalent orifices instead. Based on Amec Foster Wheeler's experience, orifices are better able to represent the interaction between the minor and major system under surcharge conditions.
- The SWM MP modelling terminated downstream of the GJR (at Elizabeth Street); the updated modelling has been expanded to include the entire contributing downstream area to Hadati Creek, as well as to the existing trunk storm sewer (1650 mm diameter) to Clythe Creek. This has included:
    - Additional subcatchments (which have been discretized based on available topographic mapping, and parameterized consistent with the approach employed in the SWM MP; refer to Appendix C for details). Drawing 1 (attached) indicates the overall updated sub-catchment boundary plan for Network HD02.
    - Additional hydraulic conduits (both storm sewers, roadways, and open channels) which have been inputted based on the most currently available information from the City of Guelph, including the 2009 construction along

Elizabeth Street west of Victoria Road. Inlet functions have been included based on the associated number of catchbasins.

- Boundary conditions have been incorporated into the modelling based on the storm return period being simulated. Simulated peak water levels along both Hadati Creek (at Industrial Avenue) and the Eramosa River (at Clythe Creek) have been obtained from the currently approved HEC-RAS hydraulic modelling, as supplied by the GRCA. Note that there is no currently available hydraulic model for the downstream limits of Clythe Creek, thus tailwater conditions have been assumed to be governed by the Eramosa River. The resulting tailwater levels/boundary conditions are summarized in Table 3.1.

Table 3.1: Simulated Tailwater/Boundary Conditions for Hadati Creek and Clythe Creek

Location Reference	HEC-2 Model XS	Storm Return Period (Years)					
		2	5	10	25	50	100
Hadati Creek (Downstream side of Elizabeth St)	235	311.61	311.86	312.07	312.35	312.53	312.72
Eramosa River (At Clythe Creek)	102858	309.24	309.57	309.73	309.86	310.04	310.15

Where the water levels presented in Table 3.1. are below the invert of the outlet (as is the case for the existing 1650 mm trunk storm sewer which outlets to Clythe Creek), a normal depth boundary condition has been applied.

Note that with respect to Hadati Creek, the supplied HEC-2 modelling only included a simulation of the 5, 25, and 100 year storm events. Accordingly, simulated water levels for other return periods have been estimated using a logarithmic fit line (refer to Appendix C).

It should be noted that the simulated boundary conditions provided in Table 3.1 do not account for the impact of any additional flows resulting from proposed flow diversions, since additional flows would be expected to increase downstream water surface elevations. In those cases, the original HEC-2 models have been updated to estimate the resulting boundary condition; this is discussed further within those associated sections (Section 3.4 and 3.5). Additional scenario-specific model modifications are also discussed further within those associated sections.

3.2. Rainfall and Design Storms

Consistent with the approach applied within the SWM MP and previous modelling efforts for the study area, design storm methodology has been employed. The City of Guelph's standard design storms are approximately 3-Hour Chicago distributions. Given the need to incorporate a preliminary assessment of the proposed/planned Ward 1 SWM Facility (adjacent to the PDI lands), and the magnitude of the drainage area under consideration (321 ha +\- total, of which 260 ha +\- drains primarily through the study area), the lower overall rainfall depths associated with a 3-hour duration were considered inappropriate. The proposed 24-hour design storms are considered more appropriate to allow for saturation of the entire contributing watershed and more consistent peak flow generation and timing; as well as a more conservative assessment of storage volume usage within both existing SWM facilities (the Bullfrog Mall SWM facility) and proposed facilities (such as the Ward 1 SWM Facility).

Accordingly, as documented within previous correspondence (refer to Appendix A) 24-hour Chicago design storms (10-minute time step) have been generated based on the City of Guelph's current intensity-duration-frequency (IDF) parameters. The current and re-generated design storms are summarized within Appendix B.

As per previous discussion with GRCA staff (refer to Appendix A) it has not been considered necessary to simulate the Regional Storm Event. The design of the proposed trunk sewer is to be based both on the City of Guelph's standard for storm sewer design (the 5 year storm event) as well as the performance under the 100 year storm event. Other return periods have also been simulated for reference purposes.

3.3. Hydrologic/Hydraulic Modelling Results – Existing Conditions

Drawing 1 (attached) indicates the overall drainage boundaries considered, while Drawing 2 (attached) provides a more detailed view of the specific drainage patterns within the lower Ward 1 area. As evident from Drawing 2, the majority of the drainage to the study area is via a trunk storm sewer beneath the GJR tracks from William Street on the north side. The trunk sewer in this case is a half 900 mm diameter CSP, with a 1.05 m x 1.05 m masonry box above. The sewer serves as a flow constraint, limiting how much flow can drain into the lower Ward 1 area from upstream areas (as the GJR tracks are sufficiently elevated to block any overland flow). From this point, the sewer drains across 292 Elizabeth Street (which has been recently purchased by the City of Guelph), across Elizabeth Street and then between a number of private properties (as a CSP arch with a concrete bottom), before discharging to the PDI lands. From that point flow is drained towards Victoria Road and an existing storm culvert which allows for some flow interaction between this drainage and the existing storm sewer on Victoria Road (refer to Appendix A for the associated drawing). Flow at this location is split between the reformatory ditch and a trunk storm sewer which drains south along Victoria Road towards Clythe Creek. There is an existing local storm sewer along Elizabeth Street (300 mm to 750 mm in diameter) which drains the street easterly towards Hadati Creek, where the storm sewer combines with flow from the reformatory ditch.

The updated existing conditions modelling described within the previous sections has been executed using the previously noted 24-hour Chicago design storms. The resulting simulated peak flows are presented in Table 3.2 at key locations of interest; refer to Drawing 2 for specific locations. Although the currently proposed works extend only along Elizabeth Street (Victoria Road to Industrial Avenue), given that the proposed works involve a flow diversion and the number of interconnected future drainage projects, it was considered appropriate to present flows at key locations throughout the Ward One area.

Table 3.2: Simulated Peak Flow Summary (m^3/s) - Existing Conditions

Location Reference	Node	24-Hour Chicago Distribution					
		2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
1	Trunk storm sewer at GJR	4.51	4.97	5.32	5.61	5.98	6.36
2	Inflow to PDI Lands	4.59	5.17	5.44	5.81	5.83	5.86
3	Outflow from PDI Lands	4.05	4.09	4.36	4.41	4.45	4.49
4	Elizabeth Street Trunk at Upstream limit	0.04 (0.01)	0.09 (0.03)	0.17 (0.04)	0.19 (0.06)	0.17 (0.08)	0.24 (0.11)
5	Elizabeth Street Trunk east of Victoria Road	0.03 (0.04)	0.05 (0.08)	0.06 (0.14)	0.10 (0.26)	0.14 (0.54)	0.16 (0.75)
6	Outflow from Elizabeth Street to Hadati Creek (not including Reformatory Ditch)	0.49 (0.03)	0.79 (0.06)	1.07 (0.11)	1.14 (0.22)	1.19 (0.39)	1.21 (0.56)
7	Inflow to Reformatory Ditch	1.38	2.35	2.98	3.48	3.82	4.24
8	Outflow from Reformatory Ditch	1.31	2.05	2.82	3.49	4.00	4.57
9	Total Discharge to Hadati Creek at Elizabeth Street and Industrial Avenue	1.40	2.43	3.39	4.42	5.06	5.66
10	Flow to Industrial Avenue (Clythe Creek)	0 (0.04)	0 (0.09)	0 (0.17)	0 (0.36)	0 (0.63)	0 (0.91)
11	Discharge to Clythe Creek from Existing 1650 mm Storm Sewer	3.07	3.09	3.10	3.11	3.11	3.12

1. Where relevant, bracketed values indicate major system (overland) flows, preceding values are minor system flows (storm sewer).

The peak flows presented in Table 3.2 will serve as a basis of comparison to the hydrologic/hydraulic modelling completed for both interim conditions (Section 3.4) and ultimate conditions (Section 3.5).

3.4. Hydrologic/Hydraulic Modelling Results – Interim Conditions

3.4.1 Modelling results (Current boundary conditions)

An interim conditions scenario has been assessed, which would reflect conditions with the proposed reconstruction works along Elizabeth Street (including the proposed trunk storm sewer with the interim outlet to Hadati Creek) in place, as shown in the detailed design drawing set generated by WalterFedy (refer to those drawings, as well as Amec Foster Wheeler's Drawing 2 for details of the proposed works).

To summarize the changes considered within the updated hydrologic/hydraulic modelling under interim conditions:

- New trunk storm sewer along Elizabeth Street from Victoria Road (connecting in to the existing trunk sewer) to Industrial Avenue, with an interim outlet to Hadati Creek (as per the detailed design completed by WalterFedy)
- Roadway re-grading along Elizabeth Street for the same extents, including the proposed modifications to the number and locations of all inlets/catchbasins (as per the detailed design completed by WalterFedy)
- The flow splitter box constructed at 292 Elizabeth Street, as per the preliminary design completed by Amec Foster Wheeler (refer to Appendix A)

It is understood that the flow splitter box is not part of the current detailed design works being undertaken by WalterFedy; these works will be undertaken as a separate project. It has been considered necessary however to include this feature as part of the assessment of interim conditions however, since without the flow splitter box, inflows to the trunk storm sewer would be minimal (from local drainage only), and would not be representative of expected flows. As noted, the preliminary design as completed by Amec Foster Wheeler has been incorporated for this purpose; the supporting drawing and correspondence have been included in Appendix A. A 900 mm equivalent pipe (1145x735 horizontal elliptical pipe) has been selected for the direction of low flows towards the PDI lands (and future Ward One SWM facility) given capacity constraints in this location. The balance of the flows within the splitter box would be directed towards the trunk storm sewer system along Elizabeth Street. Future detailed design work will be necessary, however the current preliminary design is considered to be effective in achieving the required flow split.

The resulting interim condition modelling has been executed using the previously noted 24-hour Chicago design storms. The resulting simulated peak flows are presented in Table 3.3 at key locations of interest. Note that for the initial modelling assessment, the boundary conditions presented previously in Table 3.1 have been applied. The impact of additional flows to tailwater conditions is assessed further in Section 3.4.2.

Table 3.3: Simulated Peak Flow Summary (m^3/s) - Interim Conditions

Location Reference	Node	24-Hour Chicago Distribution					
		2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
1	Trunk storm sewer at GJR	4.51	4.97	5.31	5.69	6.05	6.43
2	Inflow to PDI Lands	2.45	2.59	2.68	2.78	2.86	2.95
3	Outflow from PDI Lands	2.47	2.69	2.82	3.03	3.27	3.50
4	Elizabeth Street Trunk at Upstream limit	2.21 (0.01)	2.55 (0.03)	2.89 (0.04)	3.29 (0.06)	3.65 (0.08)	4.06 (0.10)
5	Elizabeth Street Trunk east of Victoria Road	2.80 (0.02)	3.82 (0.03)	4.42 (0.03)	4.92 (0.12)	5.07 (0.22)	5.02 (0.34)
6	Outflow from Elizabeth Street to Hadati Creek (not including reformatory ditch)	3.24 (0.01)	4.53 (0.02)	5.51 (0.03)	6.34 (0.05)	6.91 (0.06)	7.27 (0.08)
7	Inflow to Reformatory Ditch	0.33	0.52	0.67	1.10	1.54	2.13
8	Outflow from Reformatory Ditch	0.34	0.63	0.95	1.37	1.77	2.03[2.]
9	Total Discharge to Hadati Creek at Elizabeth Street and Industrial Avenue	3.52	4.86	5.91	7.09	7.86	8.33
10	Flow to Industrial Avenue (Clythe Creek)	0 (0.02)	0 (0.03)	0 (0.05)	0 (0.08)	0 (0.10)	0 (0.13)
11	Discharge to Clythe Creek from Existing 1650 mm Storm Sewer	2.50	2.74	2.88	2.98	3.03	3.05

1. Where relevant, bracketed values indicate major system (overland) flows, preceding values are minor system flows (storm sewer).
2. Decrease in simulated peak flows (as compared to upstream) is considered attributable to backwater influence of trunk storm sewer and Hadati Creek.

In order to better assess the changes in flows due to the proposed construction, difference between the simulated peak flows presented in Table 3.3 (Interim Conditions) and Table 3.2 (Existing Conditions) have been calculated; the results are presented in Table 3.4. Negative values indicate decreases in peak flows (as compared to existing conditions), while positive values indicate increases in peak flows (as compared to existing conditions).

Table 3.4: Simulated Difference in Peak Flows (m^3/s) between Existing and Interim Conditions

Location Reference	Node	24-Hour Chicago Distribution					
		2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
1	Trunk storm sewer at GJR	0	0	-0.01	+0.08	+0.07	+0.07
2	Inflow to PDI Lands	-2.14	-2.58	-2.76	-3.03	-2.97	-2.91
3	Outflow from PDI Lands	-1.58	-1.40	-1.54	-1.38	-1.18	-0.99
4	Elizabeth Street Trunk at Upstream limit	+2.17 (0)	+2.46 (0)	+2.72 (0)	+3.10 (0)	+3.48 (0)	+3.82 (-0.01)
5	Elizabeth Street Trunk east of Victoria Road	+2.77 (-0.02)	+3.77 (-0.05)	+4.36 (-0.11)	+4.81 (-0.14)	+4.93 (-0.32)	+4.86 (-0.41)
6	Outflow from Elizabeth Street to Hadati Creek	+2.75 (-0.02)	+3.74 (-0.04)	+4.44 (-0.08)	+5.20 (-0.17)	+5.72 (-0.33)	+6.06 (-0.48)
7	Inflow to Reformatory Ditch	-1.05	-1.83	-2.31	-2.38	-2.28	-2.09
8	Outflow from Reformatory Ditch	-0.97	-1.42	-1.87	-2.12	-2.23	-2.54
9	Total Discharge to Hadati Creek at Elizabeth Street and Industrial Avenue	+2.12	+2.43	+2.52	+2.67	+2.80	+2.67
10	Flow to Industrial Avenue (Clythe Creek)	0 (-0.02)	0 (-0.06)	0 (-0.12)	0 (-0.28)	0 (-0.53)	0 (-0.78)
11	Discharge to Clythe Creek from Existing 1650 mm Storm Sewer	-0.57	-0.35	-0.22	-0.13	-0.08	-0.07

1. Where relevant, bracketed values indicate major system (overland) flows, preceding values are minor system flows (storm sewer).

As evident from the results presented in Table 3.4, under interim conditions, simulated peak flows would be decreased both to the PDI lands, and also to the reformatory ditch. This is considered attributable to the proposed splitter box (which would divert a large part of the simulated inflow into the existing trunk sewer on Elizabeth Street), and the proposed continuation of the storm sewer along Elizabeth Street east of Victoria Street, which would intercept storm flows from Victoria Road to the north of Elizabeth Street. Discharges from the PDI lands would be largely reduced to the capacity of the receiving 1200 mm storm sewer (full flow capacity of approximately 3 m^3/s), although some surcharging would be expected under the 100 year storm event.

By contrast, simulated peak flows would be increased to the proposed Elizabeth Street storm sewer system (as per the intended design), which would also increase discharges to Hadati Creek as compared to existing conditions. It should be clearly noted however that the trunk sewer outlet to Hadati Creek (at Elizabeth Street and Industrial Avenue) is intended as an interim outlet only; under ultimate conditions, the storm sewer is proposed to be re-directed south on Industrial Avenue to a new outlet to Clythe Creek (as discussed in Section 3.5). The section of channel between the proposed outfall and the confluence is being re-designed as part of the works being undertaken by WalterFedy; refer to the design drawings for these details.

In order to confirm that the proposed storm sewer design is adequate, two different design checks have been undertaken:

- Standard storm sewer design sheets, using the peak flow rates simulated using PCSWMM and Manning's equation for estimated hydraulic capacity
- Hydraulic grade line (HGL) plots directly from PCSWMM, which better accounts for the dynamic nature of the storm system conveyance, and additional factors (entry/exit losses, boundary conditions, etcetera)

Both these methodologies have been employed under both the 5 year storm event (City of Guelph design standard for storm sewers) and the 100 year storm event (design basis in this case, given the lack of a major overland flow route). Results are presented in Appendix D.

As evident from the results in Appendix D, using standard storm sewer design sheets, the entire length of proposed trunk sewer would remain unsurcharged for the 5 year storm event, with an average of only 48% of the available capacity used. This is reasonably consistent with the results of the HGL analysis within PCSWMM, which indicates the trunk sewer would be expected to be approximately 50% +\- full, with higher simulated water levels at the downstream limits (up to 76% full) due to tailwater levels from Hadati Creek (5 year peak water level of 311.86 m, which represents 64% of the opening height at the proposed trunk storm sewer outlet.

Under a simulated 100 year storm event using standard storm sewer design sheets, surcharge is indicated at only one section of the proposed trunk storm sewer (at the upstream limits at Victoria Road, where the proposed trunk storm sewer will connect into the existing section of trunk storm sewer). The simulated surcharge at this location is considered slight (12% above capacity), and is considered acceptable given that this surcharge only occurs for the 100 year storm event. The sizing of this section of storm sewer (1875 mm x 1200 mm box) is also consistent with the upstream sizing. The results from the HGL analysis using PCSWMM show a much more extensive and complete surcharge, with a maximum simulated depth of some 0.6 m +\- above the obvert. This is considered to be primarily attributable to the high simulated tailwater levels from Hadati Creek. The 100 year peak water level in this case is 312.72 m; which is some 0.32 m above the obvert of the proposed interim storm sewer outfall, which means the outlet would be expected to be completely submerged for the 100 year event. These observations reinforce the need to relocate the outlet under ultimate conditions to the proposed outfall to Clythe Creek (along Industrial Avenue), where tailwater levels would be expected to be significantly lower. This is discussed in greater detail in Section 3.5. The timing of these proposed works is currently uncertain.

In addition to the foregoing, the sizing of a storm sewer outlet from the reformatory ditch has been confirmed. Based on the standard storm sewer design sheet approach, a 975 mm diameter storm sewer (at 1.00%) should provide sufficient capacity to convey the 100 year flow rate under interim conditions. In order to be conservative, a 1200 mm diameter storm sewer has been specified. As evident from the HGL analysis using PCSWMM, this outlet would be expected to be surcharged under the 100 year storm event, due to the tailwater conditions from Hadati Creek. Reference is also made in the design spreadsheets to a 1200 mm diameter storm sewer stub at Victoria Road; however this storm sewer is applicable under ultimate conditions only. Under interim conditions, there would be minimal flow to the sewer (two connected catchbasins); model results in fact suggest that there would in fact be negative flow to this conduit under the 100 year event, due to the level of surcharge within the connected trunk storm sewer along Elizabeth Street. This results in a reduction in simulated peak flows to the trunk sewer, as evident from the storm sewer design sheets included in Appendix ‘D’.

100 year overland flow depths along Elizabeth Street due to the proposed works have also been assessed. Based on the simulated HGL results, the maximum simulated 100 year depths would be expected at the sag points as would be expected. Maximum simulated depths of 0.23 m, 0.24 m, and 0.22 m relative to the gutter are indicated at Point A, DCBMH3, and DCBMH4 respectively (refer to Drawing 2 for locations). Lower depths are indicated further to the east along Elizabeth Street. These simulated depths represent depths of 0.12 m, 0.13 m, and 0.11 m above the crown, which is within acceptable City standards for 100 year roadway ponding (typical maximum 100 year depth of 0.15 m above the roadway crown).

3.4.2 Assessment of Hadati Creek under interim conditions

As noted in Section 3.1, applied tailwater conditions (as obtained from the currently approved HEC-2 modelling) do not account for the impact of any proposed additional diverted flows. Any additional flow would be expected to further raise downstream water levels. This is a particular concern for Hadati Creek, given its proposed use as an interim outlet for the Elizabeth Street trunk storm sewer. The increased flows would be expected to have some impact on downstream water levels, which may impact both upon the performance of the proposed storm sewer (elevated HGL) as well as cause impacts to downstream properties.

To further assess the impact both to and from Hadati Creek from the proposed interim storm sewer outlet, the currently approved HEC2 modelling has been applied. This model was generated as part of the "Hadati Creek Channel Improvements" report (Gamsby and Mannerow Limited, June 2003) and reflects (then) proposed channel improvements along the lower reaches of Hadati Creek downstream of Elizabeth Street, as well as additional upstream flow attenuation through over-control of flows within an upstream online SWM facility. This model is also the basis for the applied base tailwater levels for the current assessment, as presented in Table 3.1. As detailed within the 2003 report, it is understood that the previously proposed drainage improvements should serve to contain the 100 year storm event within the Hadati Creek channel, i.e. no overtopping of the banks (refer to the associated figure from that report included in Appendix A).

For the purposes of a simplified assessment, the simulated proposed interim peak flows increases to Hadati Creek presented in Table 3.4 have been added to the current simulated peak flow values within the approved HEC-2 modelling (the original peak flows from the 2003 report are included in Appendix A). This is considered to be a conservative methodology, as it does not account for any potential peak flow reductions due to hydrograph timing. It would be necessary to combine the current modelling with modelling for the entire Hadati Creek watershed to assess this; this has not been considered warranted for the purposes of the current assessment.

The proposed interim peak flow additions would impact three flow change locations within the modelling, beginning with the section downstream of Elizabeth Street, where the proposed interim storm sewer outlet would generate the additional simulated peak flows. The resulting revised peak flows are presented in Table 3.5. Note that only flows for the 5, 25, and 100 year storm events have been assessed, consistent with the 2003 report. The Regional storm event has not been simulated, consistent with direction from the GRCA. Note that a total of four flow change locations are presented in Table 3.5; however since the simulated peak flows downstream of York Road and at the outlet to Clythe Creek (i.e. at the Eramosa River) are identical, there are only three flow change locations within the HEC-2 modelling.

Table 3.5: Revised Estimated Peak Flows (m^3/s) for Hadati Creek under Interim Conditions						
Location	**Simulated Peak Flow (m^3/s) for specified land use**					
	5 year		**25 year**		**100 year**	
	Existing	Interim	Existing	Interim	Existing	Interim
D/S of Elizabeth Street	10.5	12.9	15.7	18.4	18.4	21.1
D/S of Beaumont Crescent	12.8	15.2	18.5	21.2	22.6	25.3
D/S of York Road	12.9	15.3	18.7	21.4	22.9	25.6
Outflow to Clythe Creek (Eramosa River)	12.9	15.3	18.7	21.4	22.9	25.6

The flows presented in Table 3.5 have been inputted into the revised HEC-2 model and the revised water surface elevations simulated. Table 3.6 presents the resulting simulated water surface elevations under both existing and interim conditions; Table 3.7 presents the corresponding simulated top width (i.e. floodplain extents) under the same conditions. Refer to the original floodplain mapping drawing included in Appendix A for cross-section locations. Stations range from 0 (outlet to Clythe Creek) to 495 (downstream side of railway tracks). Station 235 represents the downstream side of Elizabeth Street where the additional flows would be added (and which was used as the location for the applied PCSWMM model boundary conditions as presented in Table 3.1).

Table 3.6: Simulated Peak Water Surface Elevation under Existing and Interim Conditions									
Cross-Section	**Simulated Peak Water Surface Elevation (m)**								
	5 year			**25 year**			**100 year**		
	Exist	Interim	Diff	Exist	Interim	Diff	Exist	Interim	Diff
0	309.54	309.54	0	309.87	309.87	0	310.12	310.12	0
26	309.62	309.72	+0.10	309.90	309.96	+0.06	310.14	310.15	+0.01
40	309.98	310.10	+0.12	310.19	310.37	+0.18	310.38	310.56	+0.18
110	310.32	310.44	+0.12	310.59	310.68	+0.09	310.75	310.89	+0.14
120	310.51	310.71	+0.20	310.99	311.31	+0.32	310.59	311.05	+0.46
130	310.84	311.07	+0.23	311.37	311.53	+0.16	311.74	311.70	-0.04
215	311.65	311.84	+0.19	312.11	312.31	+0.20	312.44	312.59	+0.15
235	311.88	312.08	+0.20	312.35	312.54	+0.19	312.72	312.89	+0.17
250	311.88	312.07	+0.19	313.13	313.47	+0.34	313.53	313.57	+0.04
275	312.33	312.56	+0.23	313.35	313.71	+0.36	313.76	313.87	+0.11
300	312.32	312.56	+0.24	313.34	313.71	+0.37	313.75	313.86	+0.11
311	312.32	312.56	+0.24	313.34	313.78	+0.44	313.83	313.90	+0.07
320	313.23	313.23	0	313.81	313.81	0	313.87	313.87	0
360	313.86	313.86	0	314.26	314.26	0	314.33	314.33	0
430	315.38	315.38	0	315.75	315.75	0	315.79	315.79	0
485	316.69	316.69	0	316.97	316.97	0	317.03	317.03	0
495	318.59	318.59	0	319.28	319.28	0	319.45	319.45	0

Table 3.7: Simulated Top (Floodplain) Width under Existing and Interim Conditions									
Cross-Section	**Simulated Top (Floodplain) Width (m)**								
	5 year			**25 year**			**100 year**		
	Exist	Interim	Diff	Exist	Interim	Diff	Exist	Interim	Diff
0	5.30	5.30	0	5.30	5.30	0	5.30	5.30	0
26	5.58	5.59	+0.01	5.60	5.61	+0.01	5.63	5.63	0
40	5.15	5.40	+0.25	6.38	8.38	+2.00	8.56	10.48	+1.92
110	3.22	3.23	+0.01	3.24	3.25	+0.01	3.26	3.27	+0.01
120	3.11	3.12	+0.01	3.15	3.17	+0.02	3.12	3.15	+0.03
130	3.62	3.64	+0.02	3.67	3.68	+0.01	3.70	3.69	-0.01
215	3.62	3.64	+0.02	3.66	3.68	+0.02	3.69	3.70	+0.01
235	3.64	3.65	+0.01	3.67	3.68	+0.01	3.69	3.69	0
250	3.09	3.10	+0.01	3.17	3.20	+0.03	7.28	13.51	+6.23
275	5.97	6.69	+0.72	25.19	42.51	+17.32	44.81	88.21	+43.40
300	3.70	3.70	0	3.70	92.54	+88.84	100.52	119.49	+18.97
311	3.70	3.70	0	3.70	76.05	+72.35	81.03	90.23	+9.20
320	3.09	3.08	-0.01	38.83	38.87	+0.04	48.08	48.08	0
360	3.77	3.77	0	14.16	14.16	0	16.74	16.74	0
430	5.02	5.02	0	69.39	69.41	+0.02	85.21	85.21	0
485	4.68	4.68	0	5.17	5.17	0	5.28	5.28	0
495	1.14	1.14	0	1.20	1.20	0	1.20	1.20	0

As evident from the results in Table 3.6, water surface elevations would be expected to increase under interim conditions (as compared to existing conditions). The amount of simulated increase varies by storm event, with the 25 year storm event demonstrating the highest relative increase. Under the 5 year storm event, the average simulated increase over the entire section is 0.12 m (0.18 m between cross-sections 26 and 311 only), to a maximum increase of 0.24 m. Under the 100 year storm event, the average simulated increase is only 0.08 m (0.13 m between cross-sections 26 and 311 only), to a maximum increase of 0.46 m (one cross-section only – thus possibly due to an oscillation or localized issue within the modelling).

The results presented in Table 3.7 indicate that in general, these simulated increases in water surface elevations would be expected to be contained within the channel, given the nominal increases in simulated top (floodplain) width. No impacts are expected under the 5 year event, given the presented results; the proposed additional flows would be expected to be fully contained within the existing channel (maximum increase of 0.72 m). For the 25 and 100 year storm events, significant floodplain width increases are limited to three cross-sections (cross-sections 275 to 311 – between Suburban Avenue and

Elizabeth Street to the upstream side of Suburban Avenue). In this location, floodplain width increases ranging between 9.20 and 89.84 m are indicated. The largest simulated increases are for the 25 year storm event, where flow was previously contained within the channel under existing conditions, but is not under proposed interim conditions. Under the 100 year storm event, simulated floodplain width increases are less, to a maximum of 43.40 m at one cross-section (cross-section 275 – between Suburban Avenue and Elizabeth Street). Based on a review of the previously completed hydraulic modelling, and the cross-section geometry at this cross-section, this additional floodplain width would be expected to extend to the west, across an existing parking lot area; no direct impact to buildings would be expected at this location, beyond the slight increase in 100 year floodplain depth (0.11 m). This could potentially have a minor impact on the existing industrial building on the east side of Hadati Creek; details regarding door sill elevations would be required to confirm whether or not any potential impact would be expected.

It should be clearly noted however that the foregoing is an interim condition; the City of Guelph is expected to plan for the proposed ultimate works (storm sewer extension along Industrial Avenue to Clythe Creek) which would ultimately reduce floodplain elevations and extents within Hadati Creek as compared to existing conditions. As demonstrated previously, additional impacts would be expected for the 25 and 100 year storm events only (the 5 year storm event would continue to be contained within the channel), and these impacts are considered to be generally minor. Given the minor nature of the simulated impacts, the infrequent nature of these storm events (1-4% annual chance of occurrence), and the assumed brief time frame under which interim conditions will occur, the simulated impacts to Hadati Creek from the interim storm sewer outlet are considered to be acceptable; however further consultation with GRCA staff is considered warranted.

It should be further noted that the preceding analysis is based on HEC-2 hydraulic modelling; which is considered to be a dated hydraulic modelling platform. A more current analysis (i.e. HEC-RAS) may be warranted to further assess hydraulic conditions in this area, depending on input from the GRCA.

Based on the revised tailwater levels presented in Table 3.6, the previously discussed HGL analysis for the proposed Elizabeth Street trunk storm sewer has been re-checked for the 5 year and 100 year storm events. The results are included in Appendix D. As evident from those figures, the increased tailwater levels would slightly increase the expected HGL, however not significantly enough to impact the overall conclusion that the proposed storm sewer design is acceptable under interim conditions.

3.5. Hydrologic/Hydraulic Modelling Results – Ultimate Conditions

In addition to the previously noted interim conditions scenario (which reflect the proposed construction works along Elizabeth Street as well as the proposed flow splitter at 292 Elizabeth Street), an ultimate conditions scenario has also been assessed. This scenario would reflect a full build-out of all currently considered or proposed works within the Ward One area. To summarize the additional changes considered within the updated hydrologic/hydraulic modelling under ultimate conditions (in addition to those discussed previously under interim conditions):

- Construction of the proposed Ward One SWM facility adjacent to the PDI lands
- Re-construction of Victoria Road between Elizabeth Street and the reformatory ditch to include a new storm sewer (against grade) which will connect in to the 1200 mm storm sewer stub at Victoria Road and Elizabeth Street constructed as part of the currently proposed works; additional inlet capacity improvements (catchbasins) at the existing sag point along Victoria Road (refer to Drawing 2 for details)
- Re-direction of the trunk storm sewer along Elizabeth Street from its interim outlet to Hadati Creek to a new outlet to Clythe Creek, via Industrial Avenue

Ward One SWM Facility

A simplified rating curve function for the proposed Future Ward One SWM facility has been incorporated into the modelling, generally consistent with the conceptual plan and initial design as undertaken by EarthTech and as shown within the Ward One Class EA (2007). Additional modifications have been necessary to optimize the proposed SWM facility based on the modelling results; these modifications were previously summarized in correspondence with the City of Guelph (refer to the October 2, 2012 memorandum to City of Guelph; a copy is included in Appendix A). The contributing subcatchment to the facility has also been revised to reflect the additional drainage area and imperviousness associated with the permanent pool.

It is understood that the facility is primarily intended for water quality treatment only (i.e. provide only extended detention storage and incidental secondary quantity control), although the recommendations of the Master Plan (Tables 5.18 & 7.1) note that a quantity control function would likely be required. Given that the facility would be a retrofit, the facility also may not be able to achieve MOE-specified targets with respect to permanent pool and extended detention; however any water quality treatment would be beneficial, given the lack of existing treatment within the watershed. These issues would need to be addressed at the detailed design stage.

A permanent pool surface area of 7,600 m^2 has been included at an elevation of 313.6 m. 3:1 side slopes have been assumed (although a section of 5:1 would likely be required adjacent to the permanent pool), to a maximum active storage depth of 1.5 m (to 315.1 m), which is equivalent to the obvert of the CSP arch storm sewer inlet, as well as approximately equal to the grade along the property line of adjacent residential properties. The existing 600 mm storm sewer outlet would be used as the primary outlet; based on the initial modelling results, a secondary 600 mm outlet (to the existing PDI lands channel) was found to be necessary to accommodate the magnitude of the simulated incoming flows. A 5 m wide overflow weir would be set at 314.3 m to allow for spills of higher flows to the exiting PDI lands channel.

It should again be noted that the function included within the modelling is preliminary only, for the purposes of obtaining reasonably representative outflows under ultimate conditions. The SWM facility function would clearly need to be re-addressed as part of future detailed design to optimize the performance of the facility. The timing for these works is currently unknown.

Victoria Road

It is understood that the existing sag point along Victoria Road (approximately 50 m +\- north of the reformatory ditch) is prone to flooding, given the large amount of roadway that drains to this location, the lack of an overflow spillway, and limited inlet capacity. Previous modelling completed by Amec Foster Wheeler (refer to the October 2, 2012 memorandum included in Appendix A) indicated that this sag point would be expected to flood under the 100 year storm event (simulated flood depths well beyond the limits of the road right-of-way).

As part of its preliminary design work for the trunk storm sewer, AECOM undertook a preliminary design for the reconstruction of Victoria Road (a copy is included in Appendix A). This preliminary road surface grading has been incorporated into the Ultimate conditions modelling. The preliminary AECOM design also included an increased number of inlets at the sag point (8 standard catchbasins). Based on previous modelling results, this was determined to be insufficient to reduce simulated 100 year overland flow depths at the sag point below 0.30 m. Based on previous modelling results 8 modified catchbasins with a combination of both side and bottom inlets would be sufficient, in combination with an additional 4 modified catchbasins located approximately 50 m +\- to the north along Victoria Road.

In order to minimize discharges to the reformatory ditch (private property), and utilize available capacity within the proposed trunk storm sewer along Elizabeth Street, it has been proposed that any future storm sewer along Victoria Road be directed against the surface grade, i.e. draining to the north towards Elizabeth Street. A preliminary design for such a storm sewer system has been incorporated into the ultimate conditions modelling, with storm sewers ranging in size from 600 mm at the upstream end to 1200 mm at the downstream end (refer to Drawing 2 for details). As noted previously, a 1200 mm stub has been included as part of the proposed design for the Elizabeth Street trunk storm sewer to accommodate this future connection. Horizontal elliptical pipe has been employed for one section to increase ground cover, given that the storm sewer system would be against grade; preliminary ground cover at the lowest points using the preliminary design would be approximately 0.8 m +\-, which is less than the typical minimum of 1.2 m. However, further optimization is likely possible as part of detailed design, including further use of horizontal elliptical pipe, revised storm sewer inverts, raised road grades, etcetera. Concrete encasement or distribution plates could also be considered if required cover could not be achieved.

It has been assumed that the connection to the existing reformatory ditch would be completely severed in conjunction with the proposed re-directed storm sewer on Victoria Road, however this drainage feature could be potentially maintained as an overflow. This would also need to be assessed as part of future detailed design work.

It is understood that the City of Guelph has retained a consultant to undertake the detailed design work for the reconstruction of Victoria Road. The proposed preliminary storm sewer design outlined herein should be taken into account as part of the detailed design work.

Re-direction of Trunk Storm Sewer (Industrial Avenue/Clythe Creek)

As noted in previous correspondence (refer to Appendix A) and the current design brief, tailwater conditions from Hadati Creek have a significant impact upon surcharging within the proposed trunk storm sewer system. Accordingly, it was determined that the most effective solution would be to outlet the proposed storm sewer to Clythe Creek at York Road, via Industrial Avenue. As indicated in Table 3.1, simulated tailwater conditions in Clythe Creek (based on levels within the Eramosa River) would be significantly lower, up to 2.57 m lower for the 100 year storm event. This approach was previously discussed with GRCA staff, who indicated no objections to the premise, subject to an Environmental Impact Study for the receiving watercourse.

A preliminary design for the proposed ultimate storm sewer outlet was previously completed by Amec Foster Wheeler; a copy is included in Appendix A for reference. This preliminary design has been incorporated into the ultimate conditions modelling. The updated ultimate conditions modelling has also included additional expected drainage areas from Industrial Avenue, as well as from areas to the west along York Road (refer to Drawings 1 and 2, attached). Due to the need for sufficient cover, and the presence of a trunk sanitary sewer at York Road which must be crossed to reach Clythe Creek, the downstream limits of the proposed trunk sewer transition from a 3000 mm x 1500 mm box to twin 1800 mm x 900 mm boxes (refer to drawings in Appendix A).

It is unclear when the detailed design and construction of the proposed works along Industrial Avenue to Clythe Creek will be undertaken by the City of Guelph. It is understood that re-construction of York Road is planned for the future (tentatively planned for 2017), which could impact upon the alignment of Clythe Creek. Thus it is considered likely that the proposed works along Industrial Avenue would be delayed until such time as the detailed design for York Road (and potentially Clythe Creek) are undertaken. As noted previously, it may be possible to incorporate water quality treatment for the outlet in the form of a wet pond; this would need to be assessed further at the detailed design stage.

The resulting ultimate condition modelling (incorporating all of the above-noted modifications) has been executed using the previously noted 24-hour Chicago design storms. The resulting simulated peak flows are presented in Table 3.8 at key locations of interest.

Table 3.8: Simulated Peak Flow Summary (m^3/s) – Ultimate Conditions							
Location Reference	**Node**	**24-Hour Chicago Distribution**					
		2 Year	**5 Year**	**10 Year**	**25 Year**	**50 Year**	**100 Year**
1	Trunk storm sewer at GJR	4.51	4.97	5.31	5.69	6.05	6.43
2	Inflow to PDI Lands	2.51	2.61	2.70	2.79	2.86	2.95
3	Outflow from PDI Lands	1.92	2.25	2.34	2.44	2.53	2.64
4	Elizabeth Street Trunk at Upstream limit	2.15 (0.01)	2.50 (0.03)	2.86 (0.04)	3.27 (0.06)	3.64 (0.08)	4.05 (0.10)
5	Elizabeth Street Trunk east of Victoria Road	2.99 (0.02)	4.36 (0.03)	5.27 (0.03)	6.17 (0.12)	6.88 (0.22)	7.60 (0.34)
6	Outflow from Elizabeth Street to Hadati Creek	0 (0.02)	0 (0.05)	0 (0.08)	0 (0.12)	0 (0.15)	0 (0.19)
7	Inflow to Reformatory Ditch	0	0	0	0	0	0
8	Outflow from Reformatory Ditch	0.10	0.22	0.33	0.51	0.76	1.01
9	Total Discharge to Hadati Creek at Elizabeth Street and Industrial Avenue	0	0	0	0	0	0
10	Flow to Industrial Avenue (Clythe Creek)	3.61 [3.83] (0)	5.21 [5.54] (0)	6.43 [6.85] (0)	7.65 [8.05] (0)	8.51 [9.04] (0)	9.17 [9.83] (0)
11	Discharge to Clythe Creek from Existing 1650 mm Storm Sewer	1.93	2.25	2.34	2.45	2.55	2.68

1. Where relevant, bracketed values indicate major system (overland) flows, preceding values are minor system flows (storm sewer).
2. Values in square brackets indicate the total flow within the minor system at the downstream limits of the proposed ultimate storm sewer (i.e. the outlet to Clythe Creek) as compared to the upstream limits of Industrial Avenue.

In order to better assess the changes in flows due to the proposed construction, difference between the simulated peak flows presented in Table 3.5 (Ultimate Conditions) and both Table 3.2 (Existing Conditions) and Table 3.3 (Interim Conditions) have been calculated; the results are presented in Table 3.9. Negative values indicate decreases in peak flows (as compared to existing conditions), while positive values indicate increases in peak flows (as compared to existing conditions).

Table 3.9: Simulated Difference in Peak Flows (m^3/s) between various Scenarios

Location Reference	Node	Scenario Comparison	24-Hour Chicago Distribution					
			2Year	5 Year	10 Year	25 Year	50 Year	100 Year
1	Trunk storm sewer at GJR	Existing	0	0	-0.01	+0.08	+0.07	+0.07
		Interim	0	0	0	0	0	0
2	Inflow to PDI Lands	Existing	-2.08	-2.56	-2.74	-3.02	-2.97	-2.91
		Interim	+0.06	+0.02	+0.02	+0.01	0	0
3	Outflow from PDI Lands	Existing	-2.13	-1.84	-2.02	-1.97	-1.92	-1.85
		Interim	-0.55	-0.44	-0.48	-0.59	-0.74	-0.86
4	Elizabeth Street Trunk at Upstream limit	Existing	+2.11 (0)	+2.41 (0)	+2.69 (0)	+3.08 (0)	+3.47 (0)	+3.81 (-0.01)
		Interim	-0.06 (0)	-0.05 (0)	-0.03 (0)	-0.02 (0)	-0.01 (0)	-0.01 (0)
5	Elizabeth Street Trunk east of Victoria Road	Existing	+2.96 (-0.02)	+4.31 (-0.05)	+5.21 (-0.11)	+6.07 (-0.14)	+6.74 (-0.32)	+7.44 (-0.41)
		Interim	+0.19 (0)	+0.52 (0)	+0.85 (0)	+1.24 (0)	+1.81 (0)	+2.57 (0)
6	Outflow from Elizabeth Street to Hadati Creek	Existing	-0.49 (-0.01)	-0.79 (-0.01)	-1.07 (-0.03)	-1.14 (-0.10)	-1.19 (-0.24)	-1.21 (-0.37)
		Interim	-3.24 (+0.01)	-4.53 (+0.03)	-5.51 (+0.05)	-6.34 (+0.07)	-6.91 (+0.09)	-7.27 (+0.11)
7	Inflow to Reformatory Ditch	Existing	-1.38	-2.35	-2.98	-3.48	-3.82	-4.24
		Interim	-0.33	-0.60	-0.67	-1.09	-1.54	-2.14
8	Outflow from Reformatory Ditch	Existing	-1.21	-1.83	-2.49	-2.98	-3.24	-3.56
		Interim	-0.24	-0.41	-0.62	-0.86	-1.01	-1.02
9	Total Discharge to Hadati Creek at Elizabeth Street and Industrial Avenue	Existing	-1.40	-2.43	-3.39	-4.42	-5.06	-5.66
		Interim	-3.53	-4.86	-5.91	-7.09	-7.86	-8.34
10	Flow to Industrial Avenue (Clythe Creek)	Existing	+3.61 (-0.04)	+5.21 (-0.09)	+6.43 (-0.17)	+7.65 (-0.36)	+8.51 (-0.63)	+9.17 (-0.91)
		Interim	+3.61 (-0.02)	+5.21 (-0.03)	+6.43 (-0.05)	+7.65 (-0.08)	+8.51 (-0.10)	+9.17 (-0.13)
11	Discharge to Clythe Creek from Existing 1650 mm Storm Sewer	Existing	-1.14	-0.84	-0.76	-0.66	-0.56	-0.44
		Interim	-0.57	-0.49	-0.54	-0.53	-0.48	-0.37

1. Where relevant, bracketed values indicate major system (overland) flows, preceding values are minor system flows (storm sewer).

Under ultimate conditions, discharges to the PDI lands and towards Elizabeth Street would remain essentially unchanged from interim conditions, as the proposed flow splitter was considered in the interim land use scenario. Discharges from the PDI lands would be further reduced as compared to interim conditions, due to the inclusion of the proposed Ward One SWM facility. The 100 year discharge from the PDI lands would be reduced to 2.64 m^3/s, which ensures that the 1200 mm storm sewer outlet from the PDI lands should remain within capacity for all storm events. This would also ensure no spill towards the reformatory ditch from the existing storm overflow culvert on Victoria Road, and would result in a minor reduction in flows to the existing 1650 mm storm sewer outlet to Clythe Creek. It should be noted however that the ultimate discharge from the PDI lands would be dependent on the final design of the Ward One SWM facility.

Simulated peak flows within the proposed Elizabeth Street trunk storm sewer to the east of Victoria Road would increase under ultimate conditions as compared to interim conditions, due to the re-direction of storm flows from Victoria Road to the proposed 1200 mm storm sewer stub. This re-direction would also further reduce discharges to and from the reformatory ditch; flows within the reformatory ditch would be due to local drainage only under ultimate conditions (all storm sewer inputs would be re-directed).

Discharges to Hadati Creek would be eliminated under ultimate conditions, resulting in a significant reduction in flows as compared to both existing conditions and in particular, interim conditions. This would be offset by a corresponding increase in simulated peak flows to Clythe Creek via Industrial Avenue. As noted, detailed design will be necessary to ensure that these flows are conveyed appropriately.

In order to confirm that the proposed storm sewer design is adequate, the same design checks as were undertaken for interim conditions have been completed, namely:

- Standard storm sewer design sheets, using the peak flow rates simulated using PCSWMM and Manning's equation for estimated hydraulic capacity
- Hydraulic grade line (HGL) plots directly from PCSWMM, which better accounts for the dynamic nature of the storm system conveyance, and additional factors (entry/exit losses, boundary conditions, etcetera)

Both these methodologies have been employed under both the 5 year storm event (City of Guelph design standard for storm sewers) and the 100 year storm event (design basis in this case, given the lack of a major overland flow route). Results are presented in Appendix D.

As evident from the results in Appendix D, using standard storm sewer design sheets, the entire length of proposed trunk sewer would remain unsurcharged for the 5 year storm event under ultimate conditions, with an average of only 52% of the available capacity used along Elizabeth Street. This is reasonably consistent with the results of the HGL analysis within PCSWMM, which indicates the trunk sewer would be expected to be approximately 50% +\- full.

Under a simulated 100 year storm event using standard storm sewer design sheets, surcharge is indicated at three sections of the proposed trunk storm sewer along Elizabeth Street:

- Similar to the results under interim conditions, surcharge is indicated at the upstream limits at Victoria Road, where the proposed trunk storm sewer will connect into the existing section of trunk storm sewer). The simulated surcharge at this location is considered slight (13% above capacity), and is considered acceptable given that this surcharge only occurs for the 100 year storm event. The sizing of this section of storm sewer (1875 mm x 1200 mm box) is also consistent with the upstream sizing.
- Some surcharge is indicated between DCBMH4 and Point ‘C’ (where a 600 mm storm sewer from 420 Elizabeth Street connects in). The simulated surcharge at this location is again considered to be slight (2 to 6% above capacity) and is considered acceptable given that this surcharge only occurs for the 100 year storm event.

The results from the HGL analysis using PCSWMM show similar results, however slightly lower simulated water levels. A minor surcharge is indicated for the section between DCBMH3 and DCBMH5 (maximum of 0.08 m above the obvert). Likewise, an extremely slight surcharge continues to be indicated for the section at the upstream limits of Victoria Road (maximum 0.07 m above the obvert). In both cases, the simulated surcharge is considered to be acceptable, given the slight magnitude, and that this occurs only for the 100 year storm event.

Surcharge is also indicated using both methods for the downstream section of storm sewer along Industrial Avenue to Clythe Creek, however this is considered to be unavoidable due to the need to reduce the height of the proposed storm sewer to achieve sufficient cover and cross the existing trunk sanitary sewer. This may be revisited as part of the future detailed design work. The impact of the reduced tailwater levels is clearly evident in the updated HGL plot for ultimate conditions, with generally free flow conditions simulated under ultimate conditions despite higher simulated flows than interim conditions (which indicated a surcharge condition for the 100 year storm event).

Under ultimate conditions, flows to the reformatory ditch would be further reduced, thus the 1200 mm diameter storm sewer proposed under interim conditions would continue to be valid (albeit further oversized). The HGL analysis for this pipe indicates however that under peak conditions the downstream section would be surcharged, due simply to the tailwater levels from the trunk storm sewer. The simulation results actually indicate that this storm sewer would experience negative flow for a period of time (i.e. outflow from the trunk storm sewer back to the reformatory ditch). This is evident from the attached storm sewer design sheets (100 year storm event) which show a slight decrease in simulated peak flow at Point 'D' (i.e. where the reformatory ditch is connected).

As included in the attached, a 1200 mm storm sewer stub has been included at Victoria Road and Elizabeth Street, to account for future drainage from Victoria Road. As evident in the attached storm sewer design sheet, the proposed 1200 mm diameter storm sewer stub should have sufficient capacity to convey the 100 year storm flow under ultimate conditions without surcharging. The results of the PCSWMM HGL analysis however indicate that this section of storm sewer would be expected to be surcharged under a 100 year storm event. Similar to the proposed storm sewer for the reformatory ditch, this is considered attributable to tailwater levels from the trunk storm sewer.

100 year overland flow depths along Elizabeth Street due to the proposed works have also been assessed. Based on the simulated HGL results, the maximum simulated 100 year depths would be expected at the sag points as would be expected. Maximum simulated depths of 0.23 m, 0.24 m, and 0.23 m relative to the gutter are indicated at Point A, DCBMH3, and DCBMH4 respectively (refer to Drawing 2 for locations). Lower depths are indicated further to the east along Elizabeth Street. These simulated depths represent depths of 0.12 m, 0.13 m, and 0.12 m above the crown, which is within acceptable City standards for 100 year roadway ponding (typical maximum 100 year depth of 0.15 m above the roadway crown). These depths are also identical to those simulated under interim conditions.

Under ultimate conditions, there would clearly be a reduction in peak flows to Hadati Creek; as evident from Table 3.9, the 100 year discharge to Hadati Creek would be reduced by some 5.66 m^3/s as compared to existing conditions (since all flow other than overland would be directed towards Clythe Creek via Industrial Avenue). Although not assessed in detail, this would clearly be beneficial in further reducing flood risk to downstream properties adjacent to Hadati Creek.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the foregoing, we would conclude that:

- The proposed Elizabeth Street trunk storm sewer design is satisfactory under both interim and ultimate conditions for the 100 year storm event.
- 100 year overland flow depths along Elizabeth Street are considered to be acceptable and within City standards.
- The proposed trunk storm sewer and associated works (Elizabeth Street flow splitter in particular) should assist in greatly reducing inflows to the PDI lands and associated flooding impacts.
- The proposed interim outlet for the Elizabeth Street trunk storm sewer will result in temporary peak flow increases to the lower sections of Hadati Creek; the results of the initial hydraulic assessment indicate that additional flooding would only be expected for the 25 and 100 year storm events, and that the associated impact is minor (would likely not impact upon any buildings). Further discussion with GRCA staff is however considered warranted.

We would recommend that:

- Construction of the proposed Elizabeth Street works proceed, subject to additional input from the City of Guelph, GRCA, and MOECC
- The City of Guelph proceed with the detailed design and construction of the proposed flow splitter at 292 Elizabeth Street in parallel with the works along Elizabeth Street (flow splitter should only be implemented once all works along Elizabeth Street are in place).
- The City of Guelph should also proceed with the detailed design of the additional works to be considered under ultimate conditions, including:
    - Ward One SWM Facility
    - Victoria Road reconstruction (including new storm sewer and additional inlet capacity)
    - Re-directed trunk storm sewer along Industrial Avenue to new outlet to Clythe Creek (which may potentially include water quality treatment at the outlet)

We trust the foregoing to be satisfactory. Please do not hesitate to contact our office should you wish to discuss further.

Yours truly,

Amec Foster Wheeler Environment & Infrastructure
a division of Amec Foster Wheeler Americas Limited

Per: Matthew Senior, M.A.Sc., P.Eng.
Project Engineer

Per: Steve Chipps, P.Eng.
Associate

MJS/SC/ll

Appendix A

Background Information

Appendix B

Rainfall and Design Storm Data

Appendix C

Hydrologic and Hydraulic Modelling Data

Appendix D

Storm Sewer Design Sheets and HGL Plots

E-mailed: jwagler@grandriver.ca
April 17, 2015
Our file: TP112088

Grand River Conservation Authority
400 Clyde Road
Cambridge, ON N1R 5W6

ATTENTION: Mr. Jason Wagler, MCIP, RPP

Dear Sir:

RE: Elizabeth Street Reconstruction – Hydrologic and Hydraulic Analysis

1. Introduction

Further to the Grand River Conservation Authority's (GRCA) letter of March 24 2015 and subsequent e-mail correspondence of April 15 2015, we have completed an additional assessment of the simulated impacts to Hadati Creek from the construction of the proposed trunk storm sewer along Elizabeth Street in the City of Guelph.

As documented in our March 2015 report submission, Amec Foster Wheeler originally considered three land use scenarios: existing conditions, interim conditions, and ultimate conditions. Interim conditions included the proposed trunk storm sewer construction on Elizabeth Street (which would intercept the existing storm sewer on Victoria Road north of Elizabeth Street, and the existing storm sewer on Elizabeth Street west of Victoria Road, which both currently outlet to the Reformatory Ditch via Victoria Road) with an interim outlet to Hadati Creek just east of Industrial Avenue. In addition, interim conditions also included the proposed construction of a flow splitter at 292 Elizabeth Street, to divert a portion of the flows from the existing trunk storm sewer north of 292 Elizabeth Street (which currently drains through the PDI lands and ultimately into the trunk storm sewer on Victoria Road which drains south to Clythe Creek) into the new trunk storm sewer on Elizabeth Street (and ultimately into Hadati Creek). The implementation of the flow splitter is intended to address the ongoing flooding concerns within the PDI lands; however the re-direction of flows from the splitter box understandably results in a simulated increase in flows to Hadati Creek.

As per the GRCA's letter of March 24 2015, and subsequent e-mail correspondence, it is understood that while GRCA's engineering staff have no concerns with this scenario, ecology staff have expressed concerns with respect to the potential impact of this interim flow increase to the downstream fisheries community within Hadati Creek (and potentially Clythe Creek). GRCA staff had requested an Environmental Impact Study (EIS) to specifically address this concern, prior to issuing a permit for the proposed reconstruction of Elizabeth Street.

3215 North Service Road
Burlington, ON L7N 3G2 Canada
Tel +1(905) 335-2353
Fax +1(905) 335-1414
amecfw.com

Amec Foster Wheeler Environment & Infrastructure
A division of Amec Foster Wheeler Americas Limited

In order to facilitate the reconstruction of Elizabeth Street and to address the GRCA's concern of increased flows to Hadati Creek (and potentially Clythe Creek), it has been recommended that the implementation of the proposed flow splitter at 292 Elizabeth Street be delayed. Under this revised interim scenario, flows would be expected to be largely consistent with existing conditions. The main difference would be that the trunk storm sewer on Victoria north of Elizabeth street would now be collected by the Elizabeth Street storm sewer, rather than draining through the reformatory ditch (although the ultimate outlet, Hadati Creek, would remain unchanged). Nonetheless, additional modelling of this revised interim scenario has been undertaken (as documented within this correspondence) to confirm the simulated potential impact.

As part of the City's forthcoming York Road Class Environmental Assessment (EA) Update, the City is proposing to address all of the potential impacts to Clythe Creek and Hadati Creek due to the future reconstruction of York Road (as well as the proposed ultimate re-direction of the Elizabeth Street storm sewer down Industrial Avenue to Clythe Creek). This work is scheduled to commence in 2015. As part of this study, the City has suggested including the impact of the flow splitter at 292 Elizabeth Street to the fisheries community along Hadati Creek and Clythe Creek. This would then satisfy the GRCA's request for further study of the impact of the proposed flow splitter; this study would need to be completed and approved by the GRCA before the City proceeds with the detailed design and construction of the flow splitter. However, this should allow the proposed reconstruction of Elizabeth Street to proceed in the meantime, assuming that the simulated impact to Hadati Creek under the revised interim scenario is minimal, as is expected.

The GRCA has confirmed that they are satisfied with this proposed course of action, and with deferring the additional analyses of the impact of the proposed flow splitter to the York Road Class EA update (ref. personal communication Wagler-Senior, April 15 2015), subject to undertaking a review of the revised analyses.

2. Revised Hydrologic/Hydraulic Modelling Results

The hydrologic/hydraulic modelling (PCSWMM) developed as part of our March 2015 report submission, has again been used. The originally developed interim conditions scenario has been modified as previously described; namely the proposed flow splitter at 292 Elizabeth Street has been removed from the modelling, and the existing storm sewer layout in this area re-instated into the modelling. This revised interim conditions scenario model has been executed for the 2 through 100-year storm events, using the previously developed 24-hour Chicago design storms. The resulting simulated peak flows are presented in Table 1, for the same locations of interest referenced in our March 2015 report submission.

Table 1: Simulated Peak Flow Summary (m^3/s) Revised interim Conditions (Elizabeth Street Reconstruction in place, no flow splitter at 292 Elizabeth Street)							
Location Reference	**Node**	**24-Hour Chicago Distribution**					
		2 Year	**5 Year**	**10 Year**	**25 Year**	**50 Year**	**100 Year**
1	Trunk storm sewer at GJR	4.51	4.97	5.31	5.61	5.98	6.36
2	Inflow to PDI Lands	4.59	5.05	5.43	5.81	5.83	5.86
3	Outflow from PDI Lands	4.03	4.20	4.31	4.38	4.41	4.47
4	Elizabeth Street Trunk at Upstream limit	0.06 (0.01)	0.12 (0.03)	0.18 (0.04)	0.25 (0.06)	0.31 (0.08)	0.37 (0.10)
5	Elizabeth Street Trunk east of Victoria Road	0.87 (0.02)	1.38 (0.03)	1.77 (0.03)	2.09 (0.12)	2.46 (0.22)	3.04 (0.34)
6	Outflow from Elizabeth Street to Hadati Creek (not including reformatory ditch)	1.31 (0.01)	2.14 (0.02)	2.91 (0.03)	3.57 (0.05)	4.17 (0.06)	4.78 (0.08)
7	Inflow to Reformatory Ditch	1.11	1.46	1.73	2.16	2.20	2.49
8	Outflow from Reformatory Ditch	1.03[2.]	1.43[2.]	1.73	2.05[2].	2.17[2.]	2.22[2.]
9	Total Discharge to Hadati Creek at Elizabeth Street and Industrial Avenue	1.52	2.59	3.59	4.90	5.74	6.73
10	Flow to Industrial Avenue (Clythe Creek)	0 (0.02)	0 (0.03)	0 (0.05)	0 (0.08)	0 (0.10)	0 (0.13)
11	Discharge to Clythe Creek from Existing 1650 mm Storm Sewer	3.07	3.09	3.09	3.11	3.11	3.11

1. Where relevant, bracketed values indicate major system (overland) flows, preceding values are minor system flows (storm sewer).
2. Decrease in simulated peak flows (as compared to upstream) is considered attributable to flow routing effects, as well as backwater influence of trunk storm sewer and Hadati Creek.

In order to better assess the changes in flows due to the proposed reconstruction along Elizabeth Street, the differences between the simulated peak flows under the modified interim conditions (Table 1), and existing conditions (Table 3.2 from the March 2015 report submission) have been calculated; the results are presented in Table 2. Negative values indicate decreases in peak flows (as compared to existing conditions), while positive values indicate increases in peak flows (as compared to existing conditions).

Table 2: Simulated Difference in Peak Flows (m^3/s) between Existing and Revised interim Conditions							
Location Reference	Node	24-Hour Chicago Distribution					
		2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
1	Trunk storm sewer at GJR	0	0	-0.01	0	0	0
2	Inflow to PDI Lands	0	-0.12	-0.01	0	0	0
3	Outflow from PDI Lands	-0.02	+0.11	-0.05	-0.03	-0.04	-0.02
4	Elizabeth Street Trunk at Upstream limit	+0.02 (0)	+0.03 (0)	+0.01 (0)	+0.06 (0)	+0.14 (0)	+0.13 (-0.01)
5	Elizabeth Street Trunk east of Victoria Road	+0.84 (-0.02)	+1.33 (-0.05)	+1.71 (-0.11)	+1.99 (-0.14)	+2.32 (-0.32)	+2.88 (-0.41)
6	Outflow from Elizabeth Street to Hadati Creek	+0.82 (-0.02)	+1.35 (-0.04)	+1.84 (-0.08)	+2.43 (-0.17)	+2.98 (-0.33)	+3.57 (-0.48)
7	Inflow to Reformatory Ditch	-0.27	-0.89	-1.25	-1.32	-1.62	-1.75
8	Outflow from Reformatory Ditch	-0.28	-0.62	-1.09	-1.44	-1.83	-2.35
9	Total Discharge to Hadati Creek at Elizabeth Street and Industrial Avenue	+0.12	+0.16	+0.20	+0.48	+0.68	+1.07
10	Flow to Industrial Avenue (Clythe Creek)	0 (-0.02)	0 (-0.06)	0 (-0.12)	0 (-0.28)	0 (-0.53)	0 (-0.78)
11	Discharge to Clythe Creek from Existing 1650 mm Storm Sewer	0	0	-0.01	0	0	-0.01

1. Where relevant, bracketed values indicate major system (overland) flows, preceding values are minor system flows (storm sewer).

As evident from the results presented in Table 2, peak flows would be expected to increase along Elizabeth Street, due to the re-direction of the existing storm sewers along Elizabeth Street (west of Victoria Road) and Victoria Road (north of Elizabeth Street) into the proposed trunk storm sewer. In parallel with this, peak flows would be expected to decrease to the reformatory ditch due to the proposed re-direction. The net impact of the proposed re-construction along Elizabeth Street is evident at location 9 (total discharge to Hadati Creek). Minor peak flow increases are evident, between 0.12 m^3/s for the 2-year event, to 1.07 m^3/s for the 100-year event. Although all flows are still being directed to the same location under proposed interim conditions (i.e. to Hadati Creek), flow routing patterns are changed. It is considered that this simulated peak flow increase is due primarily to the re-direction of flows away from the reformatory ditch (with a longer flow path, and higher channel roughness) to the proposed Elizabeth Street storm sewer (shorter flow path, lower conduit roughness). The simulated peak flow increases vary by return period with more minor increases (between 5.9 and 8.6%) indicated for less formative more frequent storm events (2 through 10-year storm events). Larger simulated increases are indicated for more formative, less frequent storm events, with increases of between 10.9% and 18.9% for the 25 through 100-year storm events. However given the GRCA's particular concern with respect to impacts to the fisheries community, it is considered the impact to more frequent storm events would be of greater concern. As noted, under more frequent storm events, the simulated impact to peak flows is considered nominal (less than 10%). The duration of the simulated increase would also be considered nominal. From an engineering perspective, it should again be noted that GRCA engineering staff expressed no concerns with the previous summation of interim conditions, which included much more substantial simulated flow increases to Hadati Creek, due to the implementation of the proposed flow splitter box at 292 Elizabeth Street.

3. Updated Assessment of Potential Hydraulic Impact to Hadati Creek

In order to assess the impact of the nominal simulated peak flow increases presented in the previous section, an updated hydraulic assessment has also been conducted. The approach summarized in the March 2015 report has again been employed. Namely, the simulated peak flow increases to Hadati Creek under revised interim conditions (as presented in Table 2) have been added to the current simulated peak flow values within the approved HEC-2 hydraulic modelling for Hadati Creek. This is considered to be a conservative approach, as this does not account for the influences of hydrologic timing (i.e. peak flow timing from the upstream section of Hadati Creek as compared to the peak flow timing from the proposed trunk storm sewer along Elizabeth Street and the reformatory ditch). The resulting revised peak flow rates using this conservative approach are presented in Table 3. Note that due to the storm events simulated as part of the original HEC-2 modelling, results are only possible for the 5, 25, and 100-year storm events (i.e. the 2, 10, and 50-year storm events were not originally included in the hydraulic modelling).

Table 3: Revised Interim Conditions Estimated Peak Flows (m^3/s) for Hadati Creek

Location	Simulated Peak Flow (m^3/s) for Specified Land Use					
	5 year		25 year		100 year	
	Existing	Revised Interim	Existing	Revised Interim	Existing	Revised Interim
D/S of Elizabeth Street	10.5	10.7	15.7	16.2	18.4	19.5
D/S of Beaumont Crescent	12.8	13.0	18.5	19.0	22.6	22.7
D/S of York Road	12.9	13.1	18.7	19.2	22.9	24.0
Outflow to Clythe Creek (Eramosa River)	12.9	13.1	18.7	19.2	22.9	24.0

The flows presented in Table 3 have been inputted into the revised HEC-2 model, and the revised water surface elevations simulated. Table 4 presents the resulting simulated water surface elevations under both existing and revised interim conditions; Table 5 presents the corresponding simulated top width (i.e. floodplain extents) under the same conditions. Refer to the March 2015 report (Appendix A) for the original cross-section locations. Stations range from 0 (outlet to Clythe Creek) to 495 (downstream side of the GJR tracks). Station 235 represents the downstream side of Elizabeth Street where the additional flows would be added.

Table 4: Simulated Peak Water Surface Elevation under Existing and Revised interim Conditions									
Cross-Section	**Simulated Peak Water Surface Elevation (m)**								
	5 year			**25 year**			**100 year**		
	Exist	Revised Interim	Diff	Exist	Revised Interim	Diff	Exist	Revised Interim	Diff
0	309.54	309.54	0	309.87	309.87	0	310.12	310.12	0
26	309.62	309.63	+0.01	309.90	309.90	0	310.14	310.14	0
40	309.98	309.99	+0.01	310.19	310.24	+0.05	310.38	310.48	+0.10
110	310.32	310.33	+0.01	310.59	310.60	+0.01	310.75	310.81	+0.06
120	310.51	310.53	+0.02	310.99	311.00	+0.01	310.59	311.23	+0.64
130	310.84	310.86	+0.02	311.37	311.40	+0.03	311.74	311.56	-0.18
215	311.65	311.66	+0.01	312.11	312.14	+0.03	312.44	312.40	-0.04
235	311.88	311.90	+0.02	312.35	312.38	+0.03	312.72	312.66	-0.06
250	311.88	311.89	+0.01	313.13	313.22	+0.09	313.53	313.52	-0.01
275	312.33	312.35	+0.02	313.35	313.45	+0.10	313.76	313.78	+0.02
300	312.32	312.34	+0.02	313.34	313.43	+0.09	313.75	313.78	+0.03
311	312.32	312.34	+0.02	313.34	313.43	+0.09	313.83	313.85	+0.02
320	313.23	313.23	0	313.81	313.81	0	313.87	313.87	0
360	313.86	313.86	0	314.26	314.26	0	314.33	314.33	0
430	315.38	315.38	0	315.75	315.75	0	315.79	315.79	0
485	316.69	316.69	0	316.97	316.97	0	317.03	317.03	0
495	318.59	318.59	0	319.28	319.28	0	319.45	319.45	0

As evident from the results in Table 4, water surface elevations would be expected to increase by a marginal amount under revised interim conditions (as compared to existing conditions). The amount of simulated increase varies by storm event, with the 100-year storm event demonstrating the highest relative increase. Under the 5-year storm event (the lowest storm event assessed, and thus likely the best indicator of the potential impacts to the fisheries community), the average simulated increase over the entire section is 0.015 m, to a maximum increase of 0.02 m. This simulated increase is considered to be nominal. A slightly larger simulated increase is indicated under the 25-year storm event, with an average increase of 0.05 m, to a maximum increase of 0.10 m. Under the 100-year storm event, the average simulated increase is 0.06 m, to a maximum increase of 0.64 m at a single cross-section (120). This simulated increase is considered to be a model oscillation or possibly a sensitive location with near critical flow, given the corresponding simulated decrease of 0.18 m at the next upstream cross-section (130). If these two cross-sections are omitted, the average simulated increase is only 0.015 m (maximum increase of 0.10 m), which is considered attributable to the slight decreases in the simulated peak water surface elevation between cross-sections 215 and 250. In general, the results suggest that under revised interim conditions (i.e. with the proposed Elizabeth Street reconstruction only), there would be only a nominal impact to peak water surface elevations within Hadati Creek, particularly for less formative, more frequent storm events.

Table 5: Simulated Top (Floodplain) Width under Existing and Revised interim Conditions									
Cross-Section	Simulated Top (Floodplain) Width (m)								
	5 year			25 year			100 year		
	Exist	Revised Interim	Diff	Exist	Revised Interim	Diff	Exist	Revised Interim	Diff
0	5.30	5.30	0	5.30	5.30	0	5.30	5.30	0
26	5.58	5.58	0	5.60	5.61	+0.01	5.63	5.63	0
40	5.15	5.16	+0.01	6.38	6.90	+0.52	8.56	9.72	+1.16
110	3.22	3.22	0	3.24	3.25	+0.01	3.26	3.26	0
120	3.11	3.11	0	3.15	3.15	0	3.12	3.16	+0.04
130	3.62	3.62	0	3.67	3.67	0	3.70	3.68	-0.02
215	3.62	3.62	0	3.66	3.66	0	3.69	3.68	-0.01
235	3.64	3.64	0	3.67	3.67	0	3.69	3.68	-0.01
250	3.09	3.09	0	3.17	3.18	+0.01	7.28	6.10	-1.18
275	5.97	6.03	+0.06	25.19	29.75	+4.56	44.81	45.87	+1.06
300	3.70	3.70	0	3.70	3.70	0	100.52	104.33	+3.81
311	3.70	3.70	0	3.70	3.70	0	81.03	82.74	+1.71
320	3.09	3.09	0	38.83	38.41	-0.42	48.08	48.15	+0.07
360	3.77	3.77	0	14.16	14.17	+0.01	16.74	16.74	0
430	5.02	5.02	0	69.39	69.44	+0.05	85.21	85.23	+0.02
485	4.68	4.68	0	5.17	5.17	0	5.28	5.28	0
495	1.14	1.14	0	1.20	1.20	0	1.20	1.20	0

The results presented in Table 5 further confirm that the minor simulated increases in water surface elevation, would be expected to have a negligible impact on floodplain width, with all of the simulated increases being contained by the channel. For the 5-year storm event (which is likely the best indicator of the potential impact to the fisheries community), channel width increases are nominal, with an increase of 0.01 m indicated at one cross, section, and 0.06 m at another, with no other simulated increases. For the 25-year and 100-year storm events, floodplain width increases are again considered to be nominal, and appear to be contained within the channel. The largest increases are all less than 5 m, with a simulated increase of 4.56 m indicated for one cross-section for the 25-year storm event, and a simulated increase of 3.81 m indicated for one cross-section for the 100-year storm event. Other simulated increases are typically less than 1 m, which is considered to be nominal.

As a further verification, potential changes in the simulated maximum channel velocities under the 5-year storm event have also been assessed. The 5-year storm event is considered to be the best available indicator of the potential impact to the fisheries community, given that the 2-year storm event was not included as part of the currently approved hydraulic modelling for Hadati Creek. The results of this supplemental analysis are presented in Table 6.

Table 6: Simulated Maximum Channel Velocity under Existing and Revised interim Conditions For the 5-Year Storm Event			
Cross-Section	**Existing Conditions**	**Revised Interim Conditions**	**Difference**
0	2.34	2.38	+0.04
26	2.87	2.89	+0.02
40	2.56	2.57	+0.01
110	3.07	3.10	+0.03
120	3.07	3.09	+0.02
130	2.48	2.48	0
215	2.49	2.50	+0.01
235	1.96	1.98	+0.02
250	2.69	2.71	+0.02
275	0.59	0.58	-0.01
300	0.94	0.92	-0.02
311	0.95	0.93	-0.02
320	2.17	2.17	0
360	2.03	2.03	0
430	1.68	1.68	0
485	1.89	1.89	0
495	3.03	3.03	0

As evident from the results presented in Table 6, only extremely minor increases in channel velocity are indicated under revised interim conditions (maximum simulated increase of 0.04 m/s at one cross-section, which represents an increase of approximately 1.7%). As such, the results again indicate that the impacts of the proposed reconstruction of Elizabeth Street to Hadati Creek are nominal.

4. Summary

Based on the foregoing, we would conclude that the overall impact of the proposed reconstruction of Elizabeth Street is nominal. As noted previously, it is understood that the GRCA's primary concern is with respect to the potential impact to the downstream fisheries community; where the particular concern would be expected to be more frequent storm events. The simulated increases in peak flows under less formative, more frequent storm events (2-10 year storm events) are considered minor. Similarly, the simulated hydraulic impact to Hadati Creek under the 5-year storm event is also considered to be minor, with an average water surface elevation increase of 0.015 m, and a maximum simulated increase in channel velocity of 0.04 m/s, both of which are considered to be nominal. Based on the foregoing analyses, we recommend that the proposed reconstruction of Elizabeth Street proceed, subject to GRCA review and approval.

As summarized previously, an additional assessment of the potential impact of the simulated peak flow increases due to the proposed flow splitter box at 292 Elizabeth Street to the downstream fisheries community will be incorporated into the City of Guelph's forthcoming York Road EA Update study. This study will assess all of the potential impacts to Hadati Creek and Clythe Creek from potential future works along York Road and within this area, including the proposed flow splitter box, as well as the recommended ultimate re-direction of the Elizabeth Street trunk storm sewer south on Industrial Avenue to Clythe Creek, and the potential retrofit of the existing pond feature to provide stormwater quality treatment.

We trust the foregoing satisfies the GRCA's requirements. Please do not hesitate to contact the undersigned should you have any further questions or concerns.

Yours truly,

Amec Foster Wheeler Environment & Infrastructure
a division of Amec Foster Wheeler Americas Limited

Per: Matthew Senior, M.A.Sc., P.Eng.
Project Engineer

Per: Steve Chipps, P.Eng.
Associate

Cc: Andrew Janes, City of Guelph
Robert Messier, Grand River Conservation Authority
John Palmer, Grand River Conservation Authority
Mark Christensen, WalterFedy

MJS/SC

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Existing Conditions HEC-RAS Model Results												
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach1	1486.058	2 Year	3.5	316.96	317.7	317.7	317.8	0.006044	1.48	4.83	34.7	0.68
Reach1	1486.058	5 Year	5.3	316.96	317.78	317.78	317.88	0.006422	1.68	7.41	37.21	0.72
Reach1	1486.058	10 Year	8.3	316.96	318.22	317.86	318.24	0.000676	0.81	29.17	56.36	0.26
Reach1	1486.058	25 Year	15.5	316.96	318.99	318	318.99	0.000145	0.55	78.55	70.34	0.13
Reach1	1486.058	50 Year	22.8	316.96	320.46	318.14	320.46	0.000023	0.33	203.7	105.04	0.06
Reach1	1486.058	100 Year	32.6	316.96	320.57	318.24	320.57	0.00004	0.44	215.64	106.34	0.08
Reach1	1486.058	Regional	80.7	316.96	320.9	318.61	320.91	0.000158	0.93	251.44	110.17	0.16
Reach1	1477.037	2 Year	3.5	316.47	317.48	317.27	317.57	0.00301	1.45	3.16	10.29	0.52
Reach1	1477.037	5 Year	5.3	316.47	317.73	317.41	317.84	0.002484	1.58	4.41	11.18	0.5
Reach1	1477.037	10 Year	8.3	316.47	318.09	317.6	318.22	0.002082	1.77	6.19	12.09	0.48
Reach1	1477.037	25 Year	15.5	316.47	318.8	317.97	318.97	0.001693	2.1	9.73	50.05	0.46
Reach1	1477.037	50 Year	22.8	316.47	320.42	318.29	320.45	0.000243	1.16	79.99	144.29	0.19
Reach1	1477.037	100 Year	32.6	316.47	320.52	318.67	320.57	0.000346	1.41	95.01	147.56	0.23
Reach1	1477.037	Regional	80.7	316.47	320.8	320.55	320.9	0.000929	2.43	140.24	177.49	0.38
Reach1	1463.072		Bridge									
Reach1	1452.487	2 Year	3.5	316.44	317.03	317.03	317.24	0.011975	2.07	1.73	4.7	0.98
Reach1	1452.487	5 Year	5.3	316.44	317.17	317.17	317.45	0.010868	2.36	2.37	6.06	0.98
Reach1	1452.487	10 Year	8.3	316.44	317.38	317.38	317.73	0.009447	2.69	3.38	8.06	0.96
Reach1	1452.487	25 Year	15.5	316.44	317.75	317.75	318.28	0.008683	3.32	5.24	11.65	0.98
Reach1	1452.487	50 Year	22.8	316.44	318.07	318.07	318.74	0.008188	3.78	6.83	17.06	0.99
Reach1	1452.487	100 Year	32.6	316.44	318.43	318.43	319.29	0.00789	4.29	8.65	27.34	1
Reach1	1452.487	Regional	80.7	316.44	319.32	319.32	319.67	0.003441	3.68	55	49.8	0.71
Reach1	1429.623	2 Year	3.5	316.32	316.72	316.72	316.84	0.009269	1.71	3.15	14.66	0.87
Reach1	1429.623	5 Year	5.3	316.32	316.8	316.8	316.94	0.009445	1.96	4.41	16.96	0.91
Reach1	1429.623	10 Year	8.3	316.32	316.91	316.91	317.08	0.009313	2.23	6.42	20.19	0.93
Reach1	1429.623	25 Year	15.5	316.32	317.1	317.1	317.3	0.009105	2.65	10.65	24.58	0.97
Reach1	1429.623	50 Year	22.8	316.32	317.22	317.22	317.48	0.009666	3.03	13.9	26.36	1.02
Reach1	1429.623	100 Year	32.6	316.32	317.37	317.37	317.67	0.009816	3.38	18.01	28.5	1.06
Reach1	1429.623	Regional	80.7	316.32	318.03	317.89	318.38	0.006947	3.94	39.86	37.64	0.96
Reach1	1428.749	2 Year	3.5	315.53	316.16	316.16	316.37	0.012173	2.05	1.74	4.97	0.99
Reach1	1428.749	5 Year	5.3	315.53	316.33	316.33	316.54	0.008251	2.09	3.1	9.22	0.86
Reach1	1428.749	10 Year	8.3	315.53	316.49	316.49	316.74	0.007802	2.38	4.69	10.66	0.87
Reach1	1428.749	25 Year	15.5	315.53	316.74	316.74	317.1	0.008487	2.99	7.61	12.81	0.95
Reach1	1428.749	50 Year	22.8	315.53	317.02	317.02	317.37	0.006636	3.1	12.2	20.64	0.87
Reach1	1428.749	100 Year	32.6	315.53	317.27	317.27	317.62	0.005754	3.26	18.43	27.83	0.84
Reach1	1428.749	Regional	80.7	315.53	317.87	317.87	318.36	0.00658	4.33	37.53	36.14	0.94
Reach1	1356.024	2 Year	3.7	315.32	315.81	315.81	315.81	0.000671	0.4	17.94	124.48	0.23
Reach1	1356.024	5 Year	6.1	315.32	315.81	315.81	315.82	0.001822	0.67	17.95	124.48	0.37
Reach1	1356.024	10 Year	8.5	315.32	315.81	315.81	315.83	0.003538	0.93	17.95	124.48	0.52
Reach1	1356.024	25 Year	15.5	315.32	315.81	315.81	315.86	0.011765	1.69	17.95	124.48	0.95
Reach1	1356.024	50 Year	22.8	315.32	315.82	315.82	315.93	0.020963	2.32	19.08	124.78	1.27
Reach1	1356.024	100 Year	32.4	315.32	315.88	315.88	316.01	0.022087	2.62	23.42	125.93	1.34
Reach1	1356.024	Regional	81.1	315.32	316	316	316.06	0.005555	1.58	75.77	128.66	0.7
Reach1	1311.56	2 Year	3.7	315.2	315.6	315.6	315.6	0.000006	0.04	86.82	113.8	0.02
Reach1	1311.56	5 Year	6.1	315.2	315.6	315.6	315.6	0.000018	0.06	86.82	113.8	0.03
Reach1	1311.56	10 Year	8.5	315.2	315.6	315.6	315.6	0.000034	0.09	86.82	113.8	0.05
Reach1	1311.56	25 Year	15.5	315.2	315.6	315.6	315.6	0.000113	0.16	86.82	113.8	0.09
Reach1	1311.56	50 Year	22.8	315.2	315.6	315.6	315.6	0.000245	0.24	86.82	113.8	0.13
Reach1	1311.56	100 Year	32.4	315.2	315.6	315.6	315.61	0.000495	0.34	86.82	113.8	0.18
Reach1	1311.56	Regional	81.1	315.2	315.6	315.6	315.64	0.003103	0.86	86.82	113.8	0.46
Reach1	1310.373	2 Year	3.7	314.13	314.7	314.7	314.91	0.012749	1.98	1.86	4.64	1
Reach1	1310.373	5 Year	6.1	314.13	314.88	314.88	315.13	0.011783	2.21	2.76	5.5	0.99
Reach1	1310.373	10 Year	8.5	314.13	314.99	314.99	315	0.001449	0.84	25.03	113.85	0.36
Reach1	1310.373	25 Year	15.5	314.13	314.99	314.99	315.04	0.004816	1.54	25.04	113.85	0.65
Reach1	1310.373	50 Year	22.8	314.13	315.01	315.01	315.09	0.008415	2.06	27.07	114.87	0.86
Reach1	1310.373	100 Year	32.4	314.13	315.06	315.06	315.16	0.009871	2.33	32.61	114.98	0.94
Reach1	1310.373	Regional	81.1	314.13	315.22	315.22	315.41	0.014658	3.32	51.92	115.18	1.19
Reach1	1281.832	2 Year	3.7	314.49	314.8	314.8	314.8	0.000005	0.03	89.07	101.63	0.02
Reach1	1281.832	5 Year	6.1	314.49	314.8	314.8	314.8	0.000014	0.05	89.07	101.63	0.03
Reach1	1281.832	10 Year	8.5	314.49	314.8	314.8	314.8	0.000026	0.07	89.07	101.63	0.04
Reach1	1281.832	25 Year	15.5	314.49	314.8	314.8	314.8	0.000087	0.13	89.07	101.63	0.08
Reach1	1281.832	50 Year	22.8	314.49	314.8	314.8	314.8	0.000189	0.19	89.07	101.63	0.12
Reach1	1281.832	100 Year	32.4	314.49	314.8	314.8	314.81	0.000382	0.26	89.07	101.63	0.16
Reach1	1281.832	Regional	81.1	314.49	314.8	314.8	314.84	0.002393	0.66	89.07	101.63	0.41
Reach1	1280.724	2 Year	3.7	313.6	314.21	314.21	314.42	0.012625	2.01	1.84	4.42	0.99
Reach1	1280.724	5 Year	6.1	313.6	314.39	314.39	314.65	0.010855	2.25	2.78	6.56	0.96
Reach1	1280.724	10 Year	8.5	313.6	314.51	314.51	314.51	0.000073	0.21	65.04	101.69	0.08
Reach1	1280.724	25 Year	15.5	313.6	314.51	314.51	314.51	0.000243	0.38	65.05	101.69	0.15
Reach1	1280.724	50 Year	22.8	313.6	314.51	314.51	314.52	0.000525	0.56	65.05	101.69	0.22
Reach1	1280.724	100 Year	32.4	313.6	314.51	314.51	314.52	0.00106	0.8	65.05	101.69	0.31
Reach1	1280.724	Regional	81.1	313.6	314.54	314.51	314.62	0.00563	1.9	68.36	101.69	0.72

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach1	1245.863	2 Year	3.7	314	314.34	314.34	314.34	0.000011	0.05	63.17	77.78	0.03
Reach1	1245.863	5 Year	6.1	314	314.34	314.34	314.34	0.000029	0.08	63.17	77.78	0.05
Reach1	1245.863	10 Year	8.5	314	314.34	314.34	314.34	0.000057	0.11	63.17	77.78	0.06
Reach1	1245.863	25 Year	15.5	314	314.34	314.34	314.34	0.00019	0.19	63.17	77.78	0.12
Reach1	1245.863	50 Year	22.8	314	314.34	314.34	314.35	0.000411	0.29	63.17	77.78	0.17
Reach1	1245.863	100 Year	32.4	314	314.34	314.34	314.35	0.00083	0.41	63.17	77.78	0.24
Reach1	1245.863	Regional	81.1	314	314.36	314.34	314.44	0.004771	1.02	64.97	78.18	0.59
Reach1	1244.83	2 Year	3.7	313.02	313.63	313.63	313.84	0.012559	2.01	1.84	4.42	0.99
Reach1	1244.83	5 Year	6.1	313.02	313.86	313.86	314.06	0.008062	2.03	3.54	14.2	0.84
Reach1	1244.83	10 Year	8.5	313.02	313.9	313.9	313.9	0.000239	0.37	38.99	71.42	0.15
Reach1	1244.83	25 Year	15.5	313.02	313.9	313.9	313.91	0.000796	0.67	39	71.42	0.27
Reach1	1244.83	50 Year	22.8	313.02	313.9	313.9	313.92	0.001721	0.99	39	71.42	0.39
Reach1	1244.83	100 Year	32.4	313.02	313.9	313.9	313.94	0.003476	1.4	39	71.42	0.56
Reach1	1244.83	Regional	81.1	313.02	314.37	313.9	314.44	0.002968	1.86	74.06	79.34	0.57
Reach1	1176.299	2 Year	3.7	313.22	313.33	313.33	313.33	0.000151	0.09	20.03	35.36	0.09
Reach1	1176.299	5 Year	6.1	313.22	313.33	313.33	313.34	0.000409	0.15	20.03	35.36	0.15
Reach1	1176.299	10 Year	8.5	313.22	313.33	313.33	313.34	0.000795	0.21	20.03	35.36	0.21
Reach1	1176.299	25 Year	15.5	313.22	313.33	313.33	313.36	0.002644	0.39	20.03	35.36	0.38
Reach1	1176.299	50 Year	22.8	313.22	313.33	313.33	313.4	0.005721	0.57	20.03	35.36	0.55
Reach1	1176.299	100 Year	32.4	313.22	313.34	313.33	313.47	0.011093	0.83	20.32	35.65	0.78
Reach1	1176.299	Regional	81.1	313.22	314.06	313.62	314.19	0.005239	2.14	54.84	58.76	0.74
Reach1	1175.274	2 Year	3.7	311.79	312.42	312.32	312.51	0.005204	1.36	2.93	9.17	0.66
Reach1	1175.274	5 Year	6.1	311.79	312.51	312.46	312.67	0.007055	1.8	3.85	10.58	0.79
Reach1	1175.274	10 Year	8.5	311.79	312.58	312.58	312.81	0.008878	2.19	4.59	11.66	0.91
Reach1	1175.274	25 Year	15.5	311.79	312.84	312.84	313.13	0.00747	2.55	8.16	15.29	0.88
Reach1	1175.274	50 Year	22.8	311.79	313.19	313.02	313.25	0.001544	1.46	29.68	43.57	0.43
Reach1	1175.274	100 Year	32.4	311.79	313.38	313.15	313.45	0.001542	1.61	38.26	45.86	0.44
Reach1	1175.274	Regional	81.1	311.79	314.07	313.42	314.18	0.001737	2.24	72.79	59.23	0.49
Reach1	1137.794	2 Year	3.7	311.42	312.4	312.14	312.42	0.000962	0.79	10.18	39.39	0.29
Reach1	1137.794	5 Year	6.1	311.42	312.55	312.3	312.56	0.000827	0.82	15.97	41.05	0.28
Reach1	1137.794	10 Year	8.5	311.42	312.66	312.39	312.68	0.000773	0.86	20.8	42.36	0.27
Reach1	1137.794	25 Year	15.5	311.42	312.93	312.51	312.94	0.000727	0.97	32.31	45.3	0.27
Reach1	1137.794	50 Year	22.8	311.42	313.19	312.59	313.21	0.00062	1.02	44.51	48.24	0.26
Reach1	1137.794	100 Year	32.4	311.42	313.38	312.7	313.4	0.000722	1.18	54.01	51.1	0.29
Reach1	1137.794	Regional	81.1	311.42	314.06	313.05	314.12	0.001119	1.84	94.37	71.71	0.38
Reach1	1109.979	2 Year	3.7	311.75	312.31	312.18	312.37	0.003384	1.29	4.6	13.88	0.55
Reach1	1109.979	5 Year	6.1	311.75	312.42	312.31	312.51	0.004432	1.66	6.17	15.89	0.65
Reach1	1109.979	10 Year	8.5	311.75	312.5	312.4	312.63	0.005174	1.95	7.57	17.49	0.72
Reach1	1109.979	25 Year	15.5	311.75	312.65	312.63	312.88	0.007878	2.72	10.49	21.05	0.92
Reach1	1109.979	50 Year	22.8	311.75	313.02	312.8	313.16	0.003655	2.33	19.62	28.88	0.66
Reach1	1109.979	100 Year	32.4	311.75	313.15	312.98	313.35	0.004722	2.82	23.5	31.62	0.76
Reach1	1109.979	Regional	81.1	311.75	313.57	313.57	314.02	0.008515	4.52	38.58	40.19	1.07
Reach1	1108.705	2 Year	3.7	311.29	312.33	312	312.36	0.00108	0.94	6.71	18.87	0.32
Reach1	1108.705	5 Year	6.1	311.29	312.45	312.19	312.5	0.001513	1.21	9.03	20.63	0.39
Reach1	1108.705	10 Year	8.5	311.29	312.54	312.31	312.61	0.00183	1.41	11.02	21.92	0.44
Reach1	1108.705	25 Year	15.5	311.29	312.73	312.52	312.84	0.002712	1.92	15.48	25.56	0.55
Reach1	1108.705	50 Year	22.8	311.29	313.05	312.65	313.14	0.001857	1.85	24.7	31.23	0.47
Reach1	1108.705	100 Year	32.4	311.29	313.19	312.85	313.32	0.00245	2.25	29.28	33.67	0.55
Reach1	1108.705	Regional	81.1	311.29	313.57	313.42	313.92	0.005858	3.97	42.98	40.28	0.88
Reach1	1088.885	2 Year	3.7	311.42	312.31	312.14	312.33	0.00181	0.84	7.02	21.87	0.37
Reach1	1088.885	5 Year	6.1	311.42	312.42	312.24	312.46	0.001999	0.99	9.84	27.01	0.4
Reach1	1088.885	10 Year	8.5	311.42	312.52	312.3	312.56	0.002053	1.1	12.62	32.09	0.42
Reach1	1088.885	25 Year	15.5	311.42	312.72	312.43	312.77	0.002244	1.36	20.16	44.03	0.46
Reach1	1088.885	50 Year	22.8	311.42	313.06	312.56	313.1	0.001086	1.17	35.93	48.1	0.33
Reach1	1088.885	100 Year	32.4	311.42	313.22	312.71	313.26	0.001315	1.39	43.39	50.26	0.38
Reach1	1088.885	Regional	81.1	311.42	313.66	313.12	313.77	0.002526	2.32	67.21	58.16	0.54
Reach1	1033.914	2 Year	3.7	311.77	312.02	312.02	312.11	0.014463	1.56	3.01	16.14	1.01
Reach1	1033.914	5 Year	6.1	311.77	312.09	312.09	312.23	0.013152	1.79	4.3	17.21	1.01
Reach1	1033.914	10 Year	8.5	311.77	312.16	312.16	312.33	0.012419	1.97	5.46	18.04	1.01
Reach1	1033.914	25 Year	15.5	311.77	312.39	312.33	312.57	0.006827	2	10.08	21.24	0.81
Reach1	1033.914	50 Year	22.8	311.77	312.96	312.47	313.02	0.001676	1.53	24.12	33.07	0.45
Reach1	1033.914	100 Year	32.4	311.77	313.07	312.64	313.16	0.002427	1.94	27.93	37.69	0.54
Reach1	1033.914	Regional	81.1	311.77	313.47	313.26	313.62	0.003139	2.65	53.91	67.53	0.65
Reach1	1033.308	2 Year	3.7	310.61	311.43	311.3	311.54	0.004499	1.56	2.75	9.19	0.63
Reach1	1033.308	5 Year	6.1	310.61	311.62	311.52	311.73	0.003407	1.62	4.59	10.67	0.57
Reach1	1033.308	10 Year	8.5	310.61	311.77	311.62	311.89	0.002832	1.66	6.4	12.55	0.54
Reach1	1033.308	25 Year	15.5	310.61	312.48	311.85	312.53	0.000707	1.19	18.35	21.76	0.29
Reach1	1033.308	50 Year	22.8	310.61	312.97	312.03	313.02	0.000564	1.26	31.03	33.61	0.27
Reach1	1033.308	100 Year	32.4	310.61	313.08	312.24	313.16	0.000947	1.69	34.94	38.51	0.36
Reach1	1033.308	Regional	81.1	310.61	313.46	312.98	313.62	0.001906	2.66	60.15	67.37	0.52

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach1	1010.387	2 Year	3.7	310.42	311.47	310.91	311.49	0.00046	0.63	6.45	10.8	0.22
Reach1	1010.387	5 Year	6.1	310.42	311.65	311.06	311.68	0.000612	0.82	8.56	13.19	0.26
Reach1	1010.387	10 Year	8.5	310.42	311.8	311.19	311.84	0.000691	0.96	10.68	15.31	0.28
Reach1	1010.387	25 Year	15.5	310.42	312.48	311.47	312.51	0.00032	0.89	24.24	25.34	0.21
Reach1	1010.387	50 Year	22.8	310.42	312.98	311.71	313	0.00022	0.86	45.14	60.11	0.18
Reach1	1010.387	100 Year	32.4	310.42	313.1	311.97	313.13	0.000319	1.07	52.69	67.68	0.22
Reach1	1010.387	Regional	81.1	310.42	313.49	312.71	313.57	0.000704	1.75	83.53	88.96	0.33
Reach1	998.545	2 Year	3.7	310.34	311.47	310.69	311.49	0.000231	0.54	6.87	9.26	0.16
Reach1	998.545	5 Year	6.1	310.34	311.64	310.83	311.67	0.000388	0.77	7.94	9.58	0.22
Reach1	998.545	10 Year	8.5	310.34	311.78	310.94	311.83	0.000533	0.97	8.8	9.84	0.26
Reach1	998.545	25 Year	15.5	310.34	312.43	311.22	312.5	0.000508	1.21	12.82	11.05	0.27
Reach1	998.545	50 Year	22.8	310.34	312.97	311.47	313	0.000215	0.9	36.66	54.64	0.18
Reach1	998.545	100 Year	32.4	310.34	313.09	311.77	313.13	0.000275	1.04	48.51	82.92	0.2
Reach1	998.545	Regional	81.1	310.34	313.48	312.97	313.56	0.000554	1.62	84.92	99.63	0.3
Reach1	993.3976		Bridge									
Reach1	987.5314	2 Year	3.7	310.49	311.44	310.85	311.46	0.000437	0.65	5.68	9.8	0.22
Reach1	987.5314	5 Year	6.1	310.49	311.56	310.98	311.61	0.000767	0.94	6.47	10.4	0.29
Reach1	987.5314	10 Year	8.5	310.49	311.63	311.1	311.71	0.001204	1.23	6.9	10.72	0.37
Reach1	987.5314	25 Year	15.5	310.49	311.66	311.38	311.9	0.00371	2.19	7.06	10.85	0.66
Reach1	987.5314	50 Year	22.8	310.49	311.63	311.63	312.19	0.008614	3.3	6.91	10.73	1
Reach1	987.5314	100 Year	32.4	310.49	311.93	311.93	312.63	0.007942	3.7	8.75	12.12	1
Reach1	987.5314	Regional	81.1	310.49	312.81	312.81	313.14	0.002925	3.01	39.77	54.6	0.65
Reach1	982.615	2 Year	5.1	310.87	311.33	311.33	311.44	0.008491	1.74	4.2	18.13	0.84
Reach1	982.615	5 Year	9	310.87	311.44	311.44	311.58	0.0087	2.05	6.39	20.26	0.88
Reach1	982.615	10 Year	12.2	310.87	311.51	311.51	311.68	0.009003	2.26	7.85	21.18	0.92
Reach1	982.615	25 Year	19.2	310.87	311.64	311.64	311.86	0.009447	2.62	10.63	22.68	0.97
Reach1	982.615	50 Year	26.7	310.87	311.75	311.75	312.02	0.009753	2.92	13.24	23.97	1.01
Reach1	982.615	100 Year	36.5	310.87	311.88	311.88	312.19	0.009521	3.18	16.51	24.92	1.02
Reach1	982.615	Regional	86.6	310.87	312.25	312.25	312.96	0.015524	5	26.25	30.87	1.37
Reach1	980.8696	2 Year	5.1	309.8	310.58	310.43	310.75	0.006505	1.83	2.78	4.15	0.72
Reach1	980.8696	5 Year	9	309.8	310.7	310.7	311.08	0.012358	2.72	3.3	4.34	1
Reach1	980.8696	10 Year	12.2	309.8	310.93	310.93	311.33	0.009873	2.8	4.53	8.57	0.91
Reach1	980.8696	25 Year	19.2	309.8	311.31	311.31	311.59	0.005347	2.57	10.35	19.41	0.71
Reach1	980.8696	50 Year	26.7	309.8	311.47	311.47	311.78	0.005566	2.83	13.66	21.47	0.74
Reach1	980.8696	100 Year	36.5	309.8	311.63	311.63	311.99	0.005903	3.12	17.36	23.57	0.78
Reach1	980.8696	Regional	86.6	309.8	312.12	312.12	312.73	0.008306	4.4	30.26	29.69	0.96
Reach1	947.0903	2 Year	5.1	309.94	310.4	310.4	310.5	0.007342	1.65	4.67	22.27	0.79
Reach1	947.0903	5 Year	9	309.94	310.5	310.5	310.58	0.005861	1.68	8.94	36.38	0.73
Reach1	947.0903	10 Year	12.2	309.94	310.53	310.53	310.64	0.007885	2.02	10	36.93	0.85
Reach1	947.0903	25 Year	19.2	309.94	310.61	310.61	310.76	0.008943	2.35	13.16	38.51	0.93
Reach1	947.0903	50 Year	26.7	309.94	310.69	310.69	310.87	0.0096	2.62	16.12	39.94	0.98
Reach1	947.0903	100 Year	36.5	309.94	310.77	310.77	310.99	0.009994	2.88	19.64	41.24	1.02
Reach1	947.0903	Regional	86.6	309.94	312.06	310.82	312.06	0.000007	0.14	627.3	263.78	0.03
Reach1	943.9661	2 Year	5.1	309.16	310.11	309.81	310.16	0.001283	1.05	6.72	16.28	0.36
Reach1	943.9661	5 Year	9	309.16	310.25	310.03	310.33	0.001944	1.42	9.2	19.57	0.45
Reach1	943.9661	10 Year	12.2	309.16	310.34	310.14	310.44	0.002353	1.66	11.01	21.65	0.51
Reach1	943.9661	25 Year	19.2	309.16	310.49	310.33	310.63	0.002997	2.04	14.57	25.27	0.58
Reach1	943.9661	50 Year	26.7	309.16	310.53	310.48	310.67	0.003363	2.2	20.53	37.14	0.62
Reach1	943.9661	100 Year	36.5	309.16	310.55	310.55	310.79	0.005801	2.92	21.16	37.43	0.82
Reach1	943.9661	Regional	86.6	309.16	312.06	310.81	312.06	0.000006	0.16	641.23	264.59	0.03
Reach1	914.451	2 Year	5.1	309.62	309.97	309.97	310.07	0.011939	1.79	3.95	17.51	0.97
Reach1	914.451	5 Year	9	309.62	310.07	310.07	310.21	0.011864	2.13	5.9	19.77	1.01
Reach1	914.451	10 Year	12.2	309.62	310.14	310.14	310.31	0.011614	2.32	7.36	21.24	1.02
Reach1	914.451	25 Year	19.2	309.62	310.27	310.27	310.48	0.011258	2.65	10.28	23.89	1.05
Reach1	914.451	50 Year	26.7	309.62	310.63	310.39	310.63	0.000004	0.07	349.05	234.36	0.02
Reach1	914.451	100 Year	36.5	309.62	310.47	310.47	310.47	0.000011	0.1	312.31	232.8	0.03
Reach1	914.451	Regional	86.6	309.62	312.06	310.47	312.06	0.000005	0.13	700.5	267.11	0.03
Reach1	913.6924	2 Year	5.1	309.02	309.76	309.76	309.93	0.00686	1.89	3.26	11.68	0.75
Reach1	913.6924	5 Year	9	309.02	309.97	309.97	310.14	0.005721	2.07	6.18	17.76	0.71
Reach1	913.6924	10 Year	12.2	309.02	310.06	310.06	310.25	0.006038	2.28	7.9	19.83	0.75
Reach1	913.6924	25 Year	19.2	309.02	310.21	310.21	310.44	0.006417	2.6	11.24	23.04	0.79
Reach1	913.6924	50 Year	26.7	309.02	310.34	310.34	310.6	0.006751	2.87	14.37	25.67	0.82
Reach1	913.6924	100 Year	36.5	309.02	310.46	310.46	310.46	0.000011	0.12	313.82	233.08	0.03
Reach1	913.6924	Regional	86.6	309.02	312.06	310.46	312.06	0.000005	0.13	704.61	267.24	0.02
Reach1	847.8298	2 Year	5.1	308.3	309.71	308.71	309.71	0.000001	0.03	214.8	239.29	0.01
Reach1	847.8298	5 Year	9	308.3	309.83	308.86	309.83	0.000002	0.05	243.54	241.05	0.01
Reach1	847.8298	10 Year	12.2	308.3	309.9	308.97	309.9	0.000002	0.06	260.76	241.6	0.02
Reach1	847.8298	25 Year	19.2	308.3	310.02	309.22	310.02	0.000004	0.09	290.21	241.94	0.02
Reach1	847.8298	50 Year	26.7	308.3	310.17	309.31	310.17	0.000005	0.1	326.06	242.36	0.03
Reach1	847.8298	100 Year	36.5	308.3	310.29	309.31	310.29	0.000008	0.13	356.64	242.71	0.03
Reach1	847.8298	Regional	86.6	308.3	312.06	309.31	312.06	0.000003	0.13	808.95	282.71	0.02

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach1	826.0436	2 Year	5.1	308.34	309.71	308.72	309.71	0.000001	0.03	210.2	234.98	0.01
Reach1	826.0436	5 Year	9	308.34	309.83	308.88	309.83	0.000002	0.05	238.4	236.02	0.01
Reach1	826.0436	10 Year	12.2	308.34	309.9	309	309.9	0.000002	0.06	255.25	236.65	0.02
Reach1	826.0436	25 Year	19.2	308.34	310.02	309.21	310.02	0.000004	0.09	284.13	237.74	0.02
Reach1	826.0436	50 Year	26.7	308.34	310.17	309.46	310.17	0.000006	0.11	319.42	239.16	0.03
Reach1	826.0436	100 Year	36.5	308.34	310.29	309.46	310.29	0.000008	0.13	349.64	240.48	0.03
Reach1	826.0436	Regional	86.6	308.34	312.06	309.46	312.06	0.000003	0.14	807.05	279.17	0.02
Reach1	786.1621	2 Year	5.1	308.37	309.71	308.6	309.71	0.000001	0.03	216.17	257.6	0.01
Reach1	786.1621	5 Year	9	308.37	309.83	308.7	309.83	0.000002	0.05	247.74	269.74	0.01
Reach1	786.1621	10 Year	12.2	308.37	309.9	308.78	309.9	0.000002	0.06	267.22	276.95	0.02
Reach1	786.1621	25 Year	19.2	308.37	310.02	308.92	310.02	0.000004	0.09	301.66	288.18	0.02
Reach1	786.1621	50 Year	26.7	308.37	310.17	309.09	310.17	0.000005	0.11	344.75	294.2	0.03
Reach1	786.1621	100 Year	36.5	308.37	310.29	309.22	310.29	0.000007	0.13	382.14	299.34	0.03
Reach1	786.1621	Regional	86.6	308.37	312.06	309.57	312.06	0.000002	0.11	997.15	377.84	0.02
Reach1	729.9763	2 Year	5.1	308.12	309.7	308.32	309.71	0.000006	0.11	98.64	237.74	0.03
Reach1	729.9763	5 Year	9	308.12	309.82	308.41	309.83	0.000011	0.15	127.07	238.78	0.04
Reach1	729.9763	10 Year	12.2	308.12	309.9	308.47	309.9	0.000015	0.18	144.02	239.36	0.04
Reach1	729.9763	25 Year	19.2	308.12	310.02	308.6	310.02	0.000024	0.24	173.05	240.41	0.06
Reach1	729.9763	50 Year	26.7	308.12	310.16	308.71	310.17	0.000028	0.28	208.99	246.04	0.06
Reach1	729.9763	100 Year	36.5	308.12	310.29	308.86	310.29	0.000036	0.32	240.21	252.05	0.07
Reach1	729.9763	Regional	86.6	308.12	312.06	309.5	312.06	0.000007	0.22	726.57	295.98	0.04
Reach1	677.7048	2 Year	5.1	308.03	309.7	308.26	309.71	0.000004	0.09	146.47	272.05	0.02
Reach1	677.7048	5 Year	9	308.03	309.82	308.37	309.82	0.000007	0.12	178.96	272.9	0.03
Reach1	677.7048	10 Year	12.2	308.03	309.89	308.44	309.9	0.000009	0.15	198.32	273.61	0.03
Reach1	677.7048	25 Year	19.2	308.03	310.02	308.58	310.02	0.000015	0.19	231.49	275.49	0.04
Reach1	677.7048	50 Year	26.7	308.03	310.16	308.72	310.16	0.000017	0.22	272.27	277.3	0.05
Reach1	677.7048	100 Year	36.5	308.03	310.29	308.91	310.29	0.000023	0.26	307.08	278.83	0.06
Reach1	677.7048	Regional	86.6	308.03	312.06	309.52	312.06	0.000005	0.19	863.35	343.51	0.03
Reach1	607.9432	2 Year	5.1	308.04	309.7	308.53	309.7	0.000003	0.07	177.48	267.46	0.02
Reach1	607.9432	5 Year	9	308.04	309.82	308.72	309.82	0.000005	0.1	209.4	268.38	0.03
Reach1	607.9432	10 Year	12.2	308.04	309.89	308.86	309.89	0.000007	0.12	228.41	268.95	0.03
Reach1	607.9432	25 Year	19.2	308.04	310.02	309.07	310.02	0.000012	0.17	260.89	269.84	0.04
Reach1	607.9432	50 Year	26.7	308.04	310.16	309.22	310.16	0.000015	0.19	300.75	270.97	0.04
Reach1	607.9432	100 Year	36.5	308.04	310.29	309.27	310.29	0.00002	0.24	335.75	284.13	0.05
Reach1	607.9432	Regional	86.6	308.04	312.06	309.4	312.06	0.000005	0.17	919.52	360.4	0.03
Reach1	557.6347	2 Year	5.1	307.99	309.7	308.5	309.7	0.000004	0.08	156.66	238.69	0.02
Reach1	557.6347	5 Year	9	307.99	309.82	308.66	309.82	0.000007	0.11	185.13	240.4	0.03
Reach1	557.6347	10 Year	12.2	307.99	309.89	308.77	309.89	0.000009	0.14	202.12	240.69	0.03
Reach1	557.6347	25 Year	19.2	307.99	310.01	308.99	310.01	0.000015	0.18	231.09	241.15	0.04
Reach1	557.6347	50 Year	26.7	307.99	310.16	309.18	310.16	0.000019	0.22	266.86	245.04	0.05
Reach1	557.6347	100 Year	36.5	307.99	310.29	309.25	310.29	0.000025	0.26	297.57	248.67	0.06
Reach1	557.6347	Regional	86.6	307.99	312.06	309.43	312.06	0.000006	0.19	832.03	328.44	0.03
Reach1	523.273	2 Year	5.1	308.01	309.7	308.46	309.7	0.000004	0.08	155.19	236.49	0.02
Reach1	523.273	5 Year	9	308.01	309.82	308.62	309.82	0.000007	0.12	183.36	237.53	0.03
Reach1	523.273	10 Year	12.2	308.01	309.89	308.74	309.89	0.000009	0.14	200.12	238.01	0.03
Reach1	523.273	25 Year	19.2	308.01	310.01	308.97	310.01	0.000015	0.19	228.75	238.81	0.05
Reach1	523.273	50 Year	26.7	308.01	310.16	309.16	310.16	0.000019	0.22	263.93	239.76	0.05
Reach1	523.273	100 Year	36.5	308.01	310.29	309.32	310.29	0.000025	0.27	293.77	241.1	0.06
Reach1	523.273	Regional	86.6	308.01	312.06	309.44	312.06	0.000005	0.19	843.4	336.65	0.03
Reach1	490.7546	2 Year	5.1	308.37	309.68	308.83	309.7	0.000481	0.64	10.4	102.8	0.23
Reach1	490.7546	5 Year	9	308.37	309.79	309.02	309.82	0.000674	0.83	21.19	103.37	0.27
Reach1	490.7546	10 Year	12.2	308.37	309.86	309.16	309.89	0.000761	0.92	27.79	103.71	0.29
Reach1	490.7546	25 Year	19.2	308.37	309.97	309.79	310.01	0.000892	1.07	39.04	104.38	0.32
Reach1	490.7546	50 Year	26.7	308.37	310.13	309.87	310.16	0.000759	1.01	55.5	106.68	0.3
Reach1	490.7546	100 Year	36.5	308.37	310.25	309.94	310.28	0.000786	1.1	68.78	112.24	0.31
Reach1	490.7546	Regional	86.6	308.37	312.06	310.17	312.06	0.000028	0.37	393.78	224.87	0.07
Reach1	483.5387		Culvert									
Reach1	474.6852	2 Year	5.1	308.34	309.32	308.97	309.39	0.001586	1.16	4.59	13.93	0.41
Reach1	474.6852	5 Year	9	308.34	309.6	309.18	309.71	0.001845	1.52	6.23	51.7	0.46
Reach1	474.6852	10 Year	12.2	308.34	309.83	309.32	309.84	0.000257	0.62	37.87	99.05	0.18
Reach1	474.6852	25 Year	19.2	308.34	309.98	309.59	310	0.000288	0.71	54.25	106.42	0.19
Reach1	474.6852	50 Year	26.7	308.34	310.14	309.75	310.15	0.000269	0.74	70.63	106.9	0.19
Reach1	474.6852	100 Year	36.5	308.34	310.26	309.74	310.27	0.000315	0.84	83.64	109.71	0.2
Reach1	474.6852	Regional	86.6	308.34	312.05	310.04	312.05	0.000022	0.35	397.47	219.32	0.06
Reach1	441.3358	2 Year	7.9	308.45	309.32	309	309.34	0.000828	0.76	14.7	32.38	0.29
Reach1	441.3358	5 Year	14.6	308.45	309.63	309.14	309.65	0.000629	0.85	26.11	42.16	0.27
Reach1	441.3358	10 Year	21.9	308.45	309.79	309.26	309.82	0.000872	1.09	34.21	62.57	0.32
Reach1	441.3358	25 Year	30.7	308.45	309.93	309.38	309.98	0.001093	1.32	46.73	100.97	0.37
Reach1	441.3358	50 Year	37.5	308.45	310.1	309.46	310.14	0.000674	1.13	64.78	102.39	0.29
Reach1	441.3358	100 Year	47.8	308.45	310.23	309.57	310.26	0.000657	1.17	77.36	103.39	0.29
Reach1	441.3358	Regional	103.2	308.45	312.04	309.83	312.05	0.00005	0.53	333.1	178.74	0.09

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach1	380.4584	2 Year	7.9	308.64	309.29	308.94	309.3	0.000695	0.66	22.11	53.71	0.26
Reach1	380.4584	5 Year	14.6	308.64	309.61	309.05	309.62	0.000345	0.61	49.41	87.94	0.2
Reach1	380.4584	10 Year	21.9	308.64	309.77	309.14	309.78	0.000383	0.71	64.02	96.24	0.21
Reach1	380.4584	25 Year	30.7	308.64	309.91	309.23	309.93	0.000442	0.82	78.21	105.21	0.23
Reach1	380.4584	50 Year	37.5	308.64	310.09	309.32	310.1	0.000339	0.79	97.02	106.14	0.21
Reach1	380.4584	100 Year	47.8	308.64	310.21	309.4	310.23	0.000375	0.87	109.8	106.75	0.22
Reach1	380.4584	Regional	103.2	308.64	312.04	309.7	312.04	0.000068	0.62	334.52	148.98	0.11
Reach1	378.7204	2 Year	7.9	308.02	309.29	308.65	309.3	0.000241	0.53	27.26	56.51	0.16
Reach1	378.7204	5 Year	14.6	308.02	309.61	308.92	309.62	0.000183	0.56	56.12	91.89	0.15
Reach1	378.7204	10 Year	21.9	308.02	309.77	309.05	309.78	0.000229	0.67	71.39	100.95	0.17
Reach1	378.7204	25 Year	30.7	308.02	309.91	309.17	309.93	0.000274	0.77	86.04	105.66	0.19
Reach1	378.7204	50 Year	37.5	308.02	310.09	309.26	310.1	0.00023	0.76	104.93	106.6	0.18
Reach1	378.7204	100 Year	47.8	308.02	310.21	309.36	310.23	0.000265	0.85	117.73	107.22	0.19
Reach1	378.7204	Regional	103.2	308.02	312.04	309.71	312.04	0.000059	0.62	344.89	150.43	0.1
Reach1	294.9459	2 Year	7.9	308.05	309.26	308.58	309.27	0.000287	0.51	29.01	58.74	0.18
Reach1	294.9459	5 Year	14.6	308.05	309.6	308.8	309.61	0.000116	0.4	100.57	130.69	0.12
Reach1	294.9459	10 Year	21.9	308.05	309.76	308.95	309.77	0.000156	0.51	127.06	154.86	0.14
Reach1	294.9459	25 Year	30.7	308.05	309.9	309.1	309.91	0.000202	0.62	148.37	156.05	0.16
Reach1	294.9459	50 Year	37.5	308.05	310.08	309.21	310.08	0.000185	0.64	176.5	157.6	0.16
Reach1	294.9459	100 Year	47.8	308.05	310.19	309.3	310.2	0.000227	0.74	194.93	158.6	0.18
Reach1	294.9459	Regional	103.2	308.05	312.03	309.41	312.04	0.000068	0.64	510.97	199.16	0.11
Reach1	291.1832	2 Year	7.9	307.84	309.26	308.49	309.27	0.000229	0.55	29.91	61.41	0.16
Reach1	291.1832	5 Year	14.6	307.84	309.6	308.73	309.61	0.000111	0.45	106.42	155.26	0.12
Reach1	291.1832	10 Year	21.9	307.84	309.76	308.91	309.76	0.00015	0.56	130.59	156.62	0.14
Reach1	291.1832	25 Year	30.7	307.84	309.89	309.09	309.9	0.000197	0.68	152.07	157.82	0.16
Reach1	291.1832	50 Year	37.5	307.84	310.07	309.21	310.08	0.000184	0.7	180.57	159.4	0.16
Reach1	291.1832	100 Year	47.8	307.84	310.19	309.3	310.2	0.000228	0.81	199.15	160.42	0.18
Reach1	291.1832	Regional	103.2	307.84	312.03	309.49	312.04	0.000072	0.7	517.95	199.37	0.11
Reach1	211.9683	2 Year	7.9	307.86	309.25	308.36	309.26	0.0001	0.4	64.84	184.41	0.11
Reach1	211.9683	5 Year	14.6	307.86	309.6	308.57	309.6	0.000069	0.39	129.52	193.22	0.1
Reach1	211.9683	10 Year	21.9	307.86	309.75	308.75	309.75	0.00009	0.47	159.51	197.17	0.11
Reach1	211.9683	25 Year	30.7	307.86	309.89	308.98	309.89	0.000115	0.55	186.36	200.64	0.13
Reach1	211.9683	50 Year	37.5	307.86	310.07	309.1	310.07	0.000103	0.56	223.07	205	0.12
Reach1	211.9683	100 Year	47.8	307.86	310.18	309.27	310.19	0.000126	0.64	246.77	207.44	0.14
Reach1	211.9683	Regional	103.2	307.86	312.03	309.52	312.03	0.000034	0.49	686.98	297.33	0.08
Reach1	156.9333	2 Year	7.9	307.62	309.25	308.13	309.26	0.000026	0.23	128.77	166.69	0.06
Reach1	156.9333	5 Year	14.6	307.62	309.6	308.38	309.6	0.000031	0.29	188.34	180.31	0.07
Reach1	156.9333	10 Year	21.9	307.62	309.75	308.51	309.75	0.000048	0.37	216.07	182.8	0.08
Reach1	156.9333	25 Year	30.7	307.62	309.88	308.67	309.89	0.000069	0.47	240.68	184.99	0.1
Reach1	156.9333	50 Year	37.5	307.62	310.06	308.75	310.07	0.00007	0.5	274.33	187.15	0.1
Reach1	156.9333	100 Year	47.8	307.62	310.18	308.86	310.18	0.000092	0.58	295.65	187.59	0.12
Reach1	156.9333	Regional	103.2	307.62	312.03	309.13	312.03	0.000035	0.52	708.59	228.29	0.08
Reach1	107.5073	2 Year	10.5	307.38	309.25	308	309.25	0.000027	0.26	155.55	147.39	0.06
Reach1	107.5073	5 Year	17.7	307.38	309.59	308.14	309.6	0.000033	0.32	205.82	147.66	0.07
Reach1	107.5073	10 Year	25.1	307.38	309.75	308.26	309.75	0.000048	0.4	228.25	147.78	0.08
Reach1	107.5073	25 Year	33.9	307.38	309.88	308.46	309.88	0.000068	0.5	247.88	147.89	0.1
Reach1	107.5073	50 Year	40.6	307.38	310.06	308.55	310.06	0.000071	0.53	274.58	148.03	0.1
Reach1	107.5073	100 Year	50.2	307.38	310.17	308.59	310.18	0.00009	0.61	291.27	148.12	0.12
Reach1	107.5073	Regional	103.3	307.38	312.03	308.93	312.03	0.00004	0.58	640.52	191.85	0.09
Reach1	64.59046	2 Year	10.5	307.47	309.25	308.11	309.25	0.000035	0.28	143.97	133.98	0.07
Reach1	64.59046	5 Year	17.7	307.47	309.59	308.21	309.59	0.000042	0.34	189.62	134.18	0.08
Reach1	64.59046	10 Year	25.1	307.47	309.74	308.32	309.75	0.000061	0.43	209.89	134.26	0.09
Reach1	64.59046	25 Year	33.9	307.47	309.87	308.42	309.88	0.000086	0.54	227.58	134.34	0.11
Reach1	64.59046	50 Year	40.6	307.47	310.06	308.53	310.06	0.00009	0.57	251.81	134.44	0.12
Reach1	64.59046	100 Year	50.2	307.47	310.17	308.55	310.17	0.000114	0.67	266.83	134.51	0.13
Reach1	64.59046	Regional	103.3	307.47	312.02	308.9	312.03	0.00005	0.64	567.14	154.83	0.1
Reach1	0	2 Year	10.5	307.35	309.25	307.91	309.25	0.000018	0.21	146.79	114.67	0.05
Reach1	0	5 Year	17.7	307.35	309.59	308.03	309.59	0.000025	0.28	185.88	115.32	0.06
Reach1	0	10 Year	25.1	307.35	309.74	308.14	309.74	0.000038	0.36	203.19	115.61	0.08
Reach1	0	25 Year	33.9	307.35	309.87	308.24	309.87	0.000056	0.45	218.25	115.86	0.09
Reach1	0	50 Year	40.6	307.35	310.05	308.3	310.05	0.00006	0.49	239.12	116.34	0.1
Reach1	0	100 Year	50.2	307.35	310.16	308.39	310.17	0.000078	0.58	251.95	116.85	0.11
Reach1	0	Regional	103.3	307.35	312.02	308.72	312.03	0.00004	0.58	526.41	135.98	0.09

Future Conditions HEC-RAS Model Results

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach1	1486.058	2 Year	3.5	316.96	317.7	317.7	317.8	0.006044	1.48	4.83	34.7	0.68
Reach1	1486.058	5 Year	5.3	316.96	317.78	317.78	317.88	0.006422	1.68	7.41	37.21	0.72
Reach1	1486.058	10 Year	8.3	316.96	317.96	317.86	318.02	0.003371	1.47	14.86	44.15	0.55
Reach1	1486.058	25 Year	15.5	316.96	318.44	318	318.46	0.000875	1.05	41.69	61.25	0.3
Reach1	1486.058	50 Year	22.8	316.96	318.82	318.14	318.83	0.000501	0.95	66.84	68.9	0.24
Reach1	1486.058	100 Year	32.6	316.96	319.31	318.24	319.32	0.0003	0.88	102.09	74.96	0.19
Reach1	1486.058	Regional	80.7	316.96	321.12	318.61	321.13	0.000122	0.85	275.66	112.69	0.14
Reach1	1477.037	2 Year	3.5	316.47	317.47	317.28	317.54	0.002671	1.35	4.12	10.23	0.49
Reach1	1477.037	5 Year	5.3	316.47	317.61	317.42	317.71	0.002926	1.58	5.45	10.75	0.53
Reach1	1477.037	10 Year	8.3	316.47	317.9	317.57	317.99	0.002299	1.68	8.21	11.6	0.49
Reach1	1477.037	25 Year	15.5	316.47	318.29	317.85	318.43	0.002587	2.15	12.17	12.86	0.55
Reach1	1477.037	50 Year	22.8	316.47	318.62	318.08	318.81	0.002716	2.5	15.68	46.2	0.58
Reach1	1477.037	100 Year	32.6	316.47	319.04	318.34	319.29	0.002886	2.94	20.89	76.91	0.62
Reach1	1477.037	Regional	80.7	316.47	321.06	319.51	321.12	0.000604	2.04	175.47	204.71	0.31
Reach1	1463.072		Bridge									
Reach1	1452.487	2 Year	3.5	316.44	317.1	317.1	317.34	0.013131	2.15	1.62	3.42	1
Reach1	1452.487	5 Year	5.3	316.44	317.34	317.34	317.51	0.006351	1.93	4.03	22.43	0.74
Reach1	1452.487	10 Year	8.3	316.44	317.47	317.47	317.67	0.00668	2.23	6.02	23.13	0.78
Reach1	1452.487	25 Year	15.5	316.44	317.69	317.69	317.97	0.007963	2.83	9.19	23.13	0.88
Reach1	1452.487	50 Year	22.8	316.44	317.86	317.86	318.22	0.00858	3.26	11.78	23.13	0.94
Reach1	1452.487	100 Year	32.6	316.44	318.07	318.07	318.51	0.008992	3.7	14.79	23.13	0.99
Reach1	1452.487	Regional	80.7	316.44	318.81	318.81	319.6	0.009984	5.15	25.75	23.13	1.12
Reach1	1429.623	2 Year	3.5	315.16	316.43		316.47	0.00082	0.92	4.23	8.29	0.28
Reach1	1429.623	5 Year	5.3	315.16	316.37		316.48	0.002275	1.48	3.81	7.69	0.47
Reach1	1429.623	10 Year	8.3	315.16	316.34	316.19	316.63	0.006266	2.41	3.56	7.34	0.78
Reach1	1429.623	25 Year	15.5	315.16	316.79	316.79	317.09	0.004439	2.61	9.4	18.98	0.69
Reach1	1429.623	50 Year	22.8	315.16	317	317	317.33	0.004612	2.91	13.65	22.84	0.72
Reach1	1429.623	100 Year	32.6	315.16	317.21	317.21	317.57	0.004909	3.25	18.69	26.1	0.76
Reach1	1429.623	Regional	80.7	315.16	317.83	317.83	318.34	0.005957	4.34	37.79	34.83	0.88
Reach1	1428.749	2 Year	3.5	315.16	316.44		316.46	0.000423	0.67	8.22	14.52	0.2
Reach1	1428.749	5 Year	5.3	315.16	316.42		316.46	0.001071	1.05	7.88	14.28	0.32
Reach1	1428.749	10 Year	8.3	315.16	316.49		316.57	0.002	1.49	8.85	14.96	0.45
Reach1	1428.749	25 Year	15.5	315.16	316.6		316.81	0.004419	2.37	10.7	16.14	0.68
Reach1	1428.749	50 Year	22.8	315.16	316.68	316.68	317.03	0.007368	3.18	11.92	16.84	0.88
Reach1	1428.749	100 Year	32.6	315.16	316.93	316.93	317.32	0.006893	3.46	16.77	20.52	0.88
Reach1	1428.749	Regional	80.7	315.16	317.63	317.63	318.15	0.007045	4.46	35.45	32.82	0.94
Reach1	1398.044	2 Year	3.5	315.5	316.16	316.16	316.4	0.013116	2.15	1.63	3.42	1
Reach1	1398.044	5 Year	5.3	315.5	316.32	316.32	316.39	0.004308	1.48	8.29	50.45	0.6
Reach1	1398.044	10 Year	8.3	315.5	316.38	316.38	316.46	0.005319	1.74	11.17	51.4	0.67
Reach1	1398.044	25 Year	15.5	315.5	316.47	316.47	316.59	0.007378	2.23	15.93	52.94	0.81
Reach1	1398.044	50 Year	22.8	315.5	316.54	316.54	316.68	0.008753	2.57	19.78	54.13	0.89
Reach1	1398.044	100 Year	32.6	315.5	316.62	316.62	316.8	0.010144	2.94	24.13	55.43	0.98
Reach1	1398.044	Regional	80.7	315.5	316.92	316.92	317.21	0.01307	4.01	41.09	60.29	1.16
Reach1	1356.024	2 Year	3.7	314.8	315.48	315.48	315.72	0.013187	2.19	1.69	3.46	1
Reach1	1356.024	5 Year	6.1	314.8	315.63	315.63	315.63	0.000181	0.3	33.03	99.88	0.12
Reach1	1356.024	10 Year	8.5	314.8	315.63	315.63	315.63	0.000351	0.42	33.03	99.88	0.17
Reach1	1356.024	25 Year	15.5	314.8	315.63	315.63	315.64	0.001166	0.77	33.03	99.88	0.31
Reach1	1356.024	50 Year	22.8	314.8	315.63	315.63	315.66	0.002524	1.14	33.03	99.88	0.46
Reach1	1356.024	100 Year	32.4	314.8	315.63	315.63	315.68	0.005097	1.62	33.03	99.88	0.65
Reach1	1356.024	Regional	81.1	314.8	315.85	315.73	315.96	0.008553	2.55	59.46	125.29	0.88
Reach1	1311.56	2 Year	3.7	313.5	314.27	314.18	314.44	0.007648	1.85	2.01	3.8	0.78
Reach1	1311.56	5 Year	6.1	313.5	314.47	314.38	314.72	0.007295	2.22	2.88	4.71	0.8
Reach1	1311.56	10 Year	8.5	313.5	314.57	314.56	314.94	0.009227	2.71	3.38	5.16	0.92
Reach1	1311.56	25 Year	15.5	313.5	315.51	314.93	315.51	0.000131	0.52	75.79	108.68	0.12
Reach1	1311.56	50 Year	22.8	313.5	315.07	315.07	315.19	0.003234	2.16	30.65	98.09	0.59
Reach1	1311.56	100 Year	32.4	313.5	315.14	315.14	315.27	0.003937	2.47	37.64	99.81	0.66
Reach1	1311.56	Regional	81.1	313.5	315.37	315.37	315.58	0.006622	3.53	61.19	105.37	0.87
Reach1	1310.373	2 Year	3.7	313.5	314.18	314.18	314.42	0.013069	2.19	1.69	3.46	1
Reach1	1310.373	5 Year	6.1	313.5	314.39	314.39	314.7	0.010738	2.5	2.54	4.74	0.96
Reach1	1310.373	10 Year	8.5	313.5	314.57	314.57	314.93	0.00918	2.69	3.5	5.92	0.92
Reach1	1310.373	25 Year	15.5	313.5	314.81	314.81	315.45	0.012368	3.67	5.11	7.49	1.11
Reach1	1310.373	50 Year	22.8	313.5	315.04	315.04	315.15	0.003107	2.09	33.44	114.95	0.58
Reach1	1310.373	100 Year	32.4	313.5	315.11	315.11	315.22	0.00386	2.4	40.5	115.04	0.65
Reach1	1310.373	Regional	81.1	313.5	315.31	315.31	315.5	0.006631	3.45	64.2	115.28	0.87
Reach1	1281.832	2 Year	3.7	313.34	314.29	314.02	314.29	0.000039	0.16	42.21	80.47	0.06
Reach1	1281.832	5 Year	6.1	313.34	314.1	314.1	314.1	0.000337	0.39	28.16	69.36	0.16
Reach1	1281.832	10 Year	8.5	313.34	314.1	314.1	314.11	0.000654	0.54	28.17	69.37	0.23
Reach1	1281.832	25 Year	15.5	313.34	314.1	314.1	314.12	0.002176	0.98	28.17	69.37	0.42
Reach1	1281.832	50 Year	22.8	313.34	314.1	314.1	314.14	0.004709	1.44	28.17	69.37	0.61
Reach1	1281.832	100 Year	32.4	313.34	314.1	314.1	314.18	0.009509	2.05	28.17	69.37	0.87
Reach1	1281.832	Regional	81.1	313.34	314.55	314.26	314.64	0.005359	2.27	65.41	93.58	0.72
Reach1	1280.724	2 Year	3.7	313.34	314.02	314.02	314.26	0.012874	2.18	1.7	3.46	0.99
Reach1	1280.724	5 Year	6.1	313.34	314.08	314.08	314.08	0.000371	0.39	27.27	69.94	0.17
Reach1	1280.724	10 Year	8.5	313.34	314.08	314.08	314.09	0.00072	0.55	27.27	69.94	0.24
Reach1	1280.724	25 Year	15.5	313.34	314.08	314.08	314.1	0.002395	1	27.27	69.94	0.43
Reach1	1280.724	50 Year	22.8	313.34	314.08	314.08	314.12	0.005182	1.47	27.27	69.94	0.64
Reach1	1280.724	100 Year	32.4	313.34	314.08	314.08	314.16	0.010464	2.1	27.27	69.94	0.91
Reach1	1280.724	Regional	81.1	313.34	314.55	314.25	314.63	0.004731	2.14	70.5	101.69	0.68

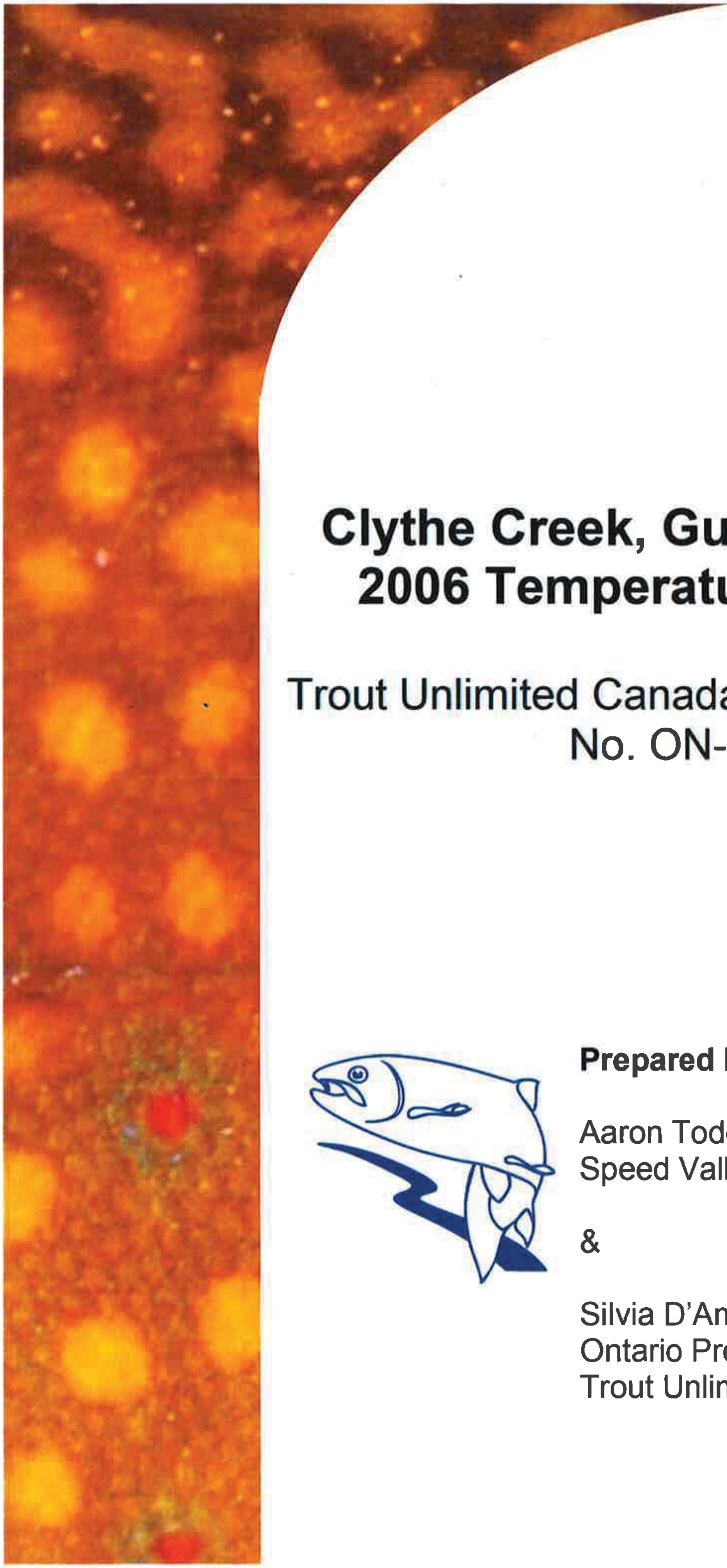
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach1	1245.863	2 Year	3.7	312.63	313.58	313.31	313.58	0.00015	0.31	20.3	39.33	0.11
Reach1	1245.863	5 Year	6.1	312.63	313.33	313.33	313.35	0.001849	0.84	11.84	29.29	0.38
Reach1	1245.863	10 Year	8.5	312.63	313.33	313.33	313.37	0.003551	1.16	11.88	29.37	0.52
Reach1	1245.863	25 Year	15.5	312.63	313.43	313.33	313.5	0.005912	1.7	15.12	33.96	0.69
Reach1	1245.863	50 Year	22.8	312.63	313.62	313.36	313.69	0.004552	1.78	22.09	41	0.64
Reach1	1245.863	100 Year	32.4	312.63	313.81	313.48	313.88	0.00399	1.92	30.33	48.6	0.62
Reach1	1245.863	Regional	81.1	312.63	314.38	313.93	314.49	0.003362	2.39	67.79	78.53	0.61
Reach1	1244.83	2 Year	3.7	312.63	313.31	313.31	313.55	0.013128	2.19	1.69	3.46	1
Reach1	1244.83	5 Year	6.1	312.63	313.33	313.33	313.35	0.001756	0.82	12.04	29.23	0.37
Reach1	1244.83	10 Year	8.5	312.63	313.33	313.33	313.36	0.00341	1.14	12.04	29.23	0.51
Reach1	1244.83	25 Year	15.5	312.63	313.43	313.33	313.5	0.005811	1.67	15.19	34.24	0.69
Reach1	1244.83	50 Year	22.8	312.63	313.62	313.34	313.69	0.004458	1.76	22.29	41.42	0.63
Reach1	1244.83	100 Year	32.4	312.63	313.8	313.47	313.88	0.003911	1.89	30.7	50.08	0.61
Reach1	1244.83	Regional	81.1	312.63	314.4	313.93	314.47	0.002424	2.05	77.96	79.97	0.52
Reach1	1176.299	2 Year	3.7	311.5	312.78	312.18	312.8	0.000549	0.76	8	17.75	0.23
Reach1	1176.299	5 Year	6.1	311.5	312.53	312.43	312.7	0.004866	1.9	4.32	11.82	0.66
Reach1	1176.299	10 Year	8.5	311.5	312.6	312.6	312.85	0.006586	2.34	5.23	13.56	0.78
Reach1	1176.299	25 Year	15.5	311.5	312.89	312.88	313.16	0.006076	2.69	10.05	20.31	0.79
Reach1	1176.299	50 Year	22.8	311.5	313.08	313.07	313.39	0.006187	3	14.41	24.93	0.82
Reach1	1176.299	100 Year	32.4	311.5	313.29	313.29	313.61	0.005856	3.21	20.1	28.64	0.81
Reach1	1176.299	Regional	81.1	311.5	313.88	313.88	314.25	0.006085	4.04	46.98	51.52	0.87
Reach1	1175.274	2 Year	3.7	311.5	312.78	312.18	312.8	0.000543	0.76	8.1	17.98	0.23
Reach1	1175.274	5 Year	6.1	311.5	312.52	312.43	312.69	0.004939	1.91	4.32	11.83	0.67
Reach1	1175.274	10 Year	8.5	311.5	312.59	312.59	312.84	0.006791	2.36	5.19	13.48	0.79
Reach1	1175.274	25 Year	15.5	311.5	312.88	312.88	313.16	0.006114	2.69	10.09	20.45	0.79
Reach1	1175.274	50 Year	22.8	311.5	313.08	313.08	313.38	0.006123	2.99	14.56	25.15	0.81
Reach1	1175.274	100 Year	32.4	311.5	313.28	313.15	313.37	0.002301	2.01	35.42	44.79	0.51
Reach1	1175.274	Regional	81.1	311.5	313.87	313.41	314.01	0.002721	2.69	64.03	52	0.58
Reach1	1137.794	2 Year	3.7	311.82	312.5	312.5	312.74	0.012972	2.18	1.7	3.46	0.99
Reach1	1137.794	5 Year	6.1	311.82	312.52	312.52	312.55	0.003547	1.16	10.91	37.84	0.52
Reach1	1137.794	10 Year	8.5	311.82	312.54	312.52	312.59	0.00538	1.47	11.84	38.16	0.65
Reach1	1137.794	25 Year	15.5	311.82	312.78	312.56	312.82	0.003004	1.41	21.27	41.29	0.51
Reach1	1137.794	50 Year	22.8	311.82	313.11	312.65	313.14	0.00139	1.21	35.38	45.59	0.37
Reach1	1137.794	100 Year	32.4	311.82	313.27	312.74	313.31	0.001596	1.43	42.99	48.48	0.41
Reach1	1137.794	Regional	81.1	311.82	313.85	313.11	313.93	0.002215	2.17	74.66	61.52	0.51
Reach1	1109.979	2 Year	3.7	311.42	312.14	312.06	312.19	0.003888	1.24	5.57	22.62	0.55
Reach1	1109.979	5 Year	6.1	311.42	312.37	312.16	312.4	0.001628	1.03	11.09	24.88	0.38
Reach1	1109.979	10 Year	8.5	311.42	312.41	312.22	312.46	0.002407	1.3	12.2	25.32	0.46
Reach1	1109.979	25 Year	15.5	311.42	312.66	312.36	312.72	0.002391	1.55	18.77	28.41	0.48
Reach1	1109.979	50 Year	22.8	311.42	313.04	312.48	313.08	0.001353	1.43	30.29	32.97	0.38
Reach1	1109.979	100 Year	32.4	311.42	313.17	312.62	313.24	0.001849	1.78	34.86	34.6	0.45
Reach1	1109.979	Regional	81.1	311.42	313.61	313.13	313.81	0.003974	3.08	51.46	40.63	0.69
Reach1	1108.705	2 Year	3.7	311.42	312.14	311.84	312.18	0.003212	1.13	5.53	16.66	0.5
Reach1	1108.705	5 Year	6.1	311.42	312.36	312.06	312.39	0.002071	1.15	10.15	25.08	0.43
Reach1	1108.705	10 Year	8.5	311.42	312.39	312.16	312.45	0.003153	1.46	11.07	25.41	0.53
Reach1	1108.705	25 Year	15.5	311.42	312.65	312.4	312.71	0.002767	1.65	17.76	27.97	0.52
Reach1	1108.705	50 Year	22.8	311.42	313.03	312.52	313.08	0.001474	1.49	29.56	33.26	0.4
Reach1	1108.705	100 Year	32.4	311.42	313.16	312.63	313.24	0.002005	1.84	34.08	34.92	0.47
Reach1	1108.705	Regional	81.1	311.42	313.59	313.17	313.8	0.004341	3.19	50.33	40.78	0.72
Reach1	1088.885	2 Year	3.7	311.12	311.8	311.8	312.04	0.012883	2.18	1.7	3.46	0.99
Reach1	1088.885	5 Year	6.1	311.12	312.1	312.1	312.31	0.006461	2.1	3.88	14.42	0.76
Reach1	1088.885	10 Year	8.5	311.12	312.28	312.2	312.38	0.003235	1.71	9.32	22.64	0.56
Reach1	1088.885	25 Year	15.5	311.12	312.49	312.39	312.64	0.004157	2.2	14.59	30.08	0.65
Reach1	1088.885	50 Year	22.8	311.12	313	312.57	313.05	0.001136	1.47	35.58	46.76	0.36
Reach1	1088.885	100 Year	32.4	311.12	313.13	312.79	313.2	0.001481	1.76	41.78	49.12	0.42
Reach1	1088.885	Regional	81.1	311.12	313.56	313.18	313.71	0.002806	2.8	64.33	55.86	0.6
Reach1	1033.914	2 Year	3.7	310.62	311.42	311.3	311.58	0.006348	1.75	2.12	3.58	0.72
Reach1	1033.914	5 Year	6.1	310.62	311.49	311.49	311.83	0.011703	2.57	2.38	3.63	1
Reach1	1033.914	10 Year	8.5	310.62	311.66	311.66	312.08	0.010794	2.86	3.01	3.76	0.99
Reach1	1033.914	25 Year	15.5	310.62	312.48	312.12	312.53	0.000738	1.17	17.09	22.5	0.29
Reach1	1033.914	50 Year	22.8	310.62	312.98	312.24	313.02	0.000425	1.06	29.79	33.36	0.23
Reach1	1033.914	100 Year	32.4	310.62	313.09	312.37	313.15	0.000625	1.33	33.66	35.15	0.28
Reach1	1033.914	Regional	81.1	310.62	313.48	312.88	313.61	0.001474	2.27	59.09	67.71	0.44
Reach1	1033.308	2 Year	3.7	310.62	311.51	311.1	311.53	0.000801	0.69	6	13.11	0.26
Reach1	1033.308	5 Year	6.1	310.62	311.7	311.24	311.72	0.000803	0.8	8.55	15.21	0.27
Reach1	1033.308	10 Year	8.5	310.62	311.85	311.37	311.88	0.000778	0.88	11	17.13	0.28
Reach1	1033.308	25 Year	15.5	310.62	312.5	311.59	312.52	0.000264	0.71	24.51	22.24	0.17
Reach1	1033.308	50 Year	22.8	310.62	312.99	311.76	313.01	0.000212	0.75	37.22	33.81	0.16
Reach1	1033.308	100 Year	32.4	310.62	313.11	311.94	313.14	0.000332	0.97	41.37	36.39	0.21
Reach1	1033.308	Regional	81.1	310.62	313.51	312.52	313.59	0.000916	1.8	68.41	68.38	0.35
Reach1	1010.387	2 Year	3.7	310.42	311.5	310.91	311.52	0.000405	0.61	6.77	11.21	0.21
Reach1	1010.387	5 Year	6.1	310.42	311.67	311.06	311.7	0.000553	0.8	8.91	13.56	0.25
Reach1	1010.387	10 Year	8.5	310.42	311.82	311.19	311.86	0.000639	0.93	11.03	15.63	0.27
Reach1	1010.387	25 Year	15.5	310.42	312.48	311.47	312.51	0.00032	0.89	24.24	25.34	0.21
Reach1	1010.387	50 Year	22.8	310.42	312.98	311.71	313	0.00022	0.86	45.14	60.11	0.18
Reach1	1010.387	100 Year	32.4	310.42	313.1	311.97	313.13	0.000319	1.07	52.69	67.68	0.22
Reach1	1010.387	Regional	81.1	310.42	313.49	312.71	313.57	0.000704	1.75	83.53	88.96	0.33
Reach1	998.545	2 Year	3.7	310.34	311.5	310.69	311.51	0.000212	0.52	7.05	9.32	0.16
Reach1	998.545	5 Year	6.1	310.34	311.67	310.83	311.7	0.000363	0.75	8.1	9.63	0.21
Reach1	998.545	10 Year	8.5	310.34	311.8	310.94	311.85	0.000507	0.95	8.94	9.88	0.25
Reach1	998.545	25 Year	15.5	310.34	312.43	311.22	312.5	0.000508	1.21	12.82	11.05	0.27
Reach1	998.545	50 Year	22.8	310.34	312.97	311.47	313	0.000215	0.9	36.66	54.64	0.18
Reach1	998.545	100 Year	32.4	310.34	313.09	311.77	313.13	0.000275	1.04	48.51	82.92	0.2
Reach1	998.545	Regional	81.1	310.34	313.48	312.97	313.56	0.000554	1.62	84.92	99.63	0.3

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach1	993.3976		Bridge									
Reach1	987.5314	2 Year	3.7	310.49	311.47	310.85	311.49	0.00039	0.63	5.88	9.95	0.21
Reach1	987.5314	5 Year	6.1	310.49	311.6	310.98	311.64	0.000696	0.91	6.67	10.55	0.28
Reach1	987.5314	10 Year	8.5	310.49	311.66	311.1	311.74	0.001098	1.2	7.1	10.87	0.36
Reach1	987.5314	25 Year	15.5	310.49	311.69	311.38	311.93	0.003349	2.13	7.28	11.01	0.63
Reach1	987.5314	50 Year	22.8	310.49	311.65	311.63	312.19	0.008258	3.26	7	10.8	0.98
Reach1	987.5314	100 Year	32.4	310.49	311.93	311.93	312.63	0.007942	3.7	8.75	12.12	1
Reach1	987.5314	Regional	81.1	310.49	312.81	312.81	313.14	0.002925	3.01	39.77	54.6	0.65
Reach1	982.615	2 Year	5.1	310.87	311.36	311.36	311.47	0.007388	1.68	4.4	18.92	0.78
Reach1	982.615	5 Year	9	310.87	311.47	311.47	311.61	0.008264	2.03	6.52	20.72	0.85
Reach1	982.615	10 Year	12.2	310.87	311.54	311.54	311.71	0.008702	2.25	7.98	21.5	0.89
Reach1	982.615	25 Year	19.2	310.87	311.66	311.66	311.88	0.009287	2.61	10.76	23	0.95
Reach1	982.615	50 Year	26.7	310.87	311.78	311.78	312.04	0.00927	2.87	13.57	24.26	0.97
Reach1	982.615	100 Year	36.5	310.87	311.91	311.91	312.22	0.009418	3.16	16.69	25.09	1
Reach1	982.615	Regional	86.6	310.87	312.25	312.25	312.99	0.016785	5.11	25.71	30.85	1.4
Reach1	947.0903	2 Year	5.1	310.12	310.54	310.4	310.56	0.002755	0.7	7.89	28.28	0.44
Reach1	947.0903	5 Year	9	310.12	310.61	310.5	310.66	0.004132	0.97	9.97	29.29	0.55
Reach1	947.0903	10 Year	12.2	310.12	310.71	310.53	310.76	0.003361	1.01	12.96	30.57	0.51
Reach1	947.0903	25 Year	19.2	310.12	310.91	310.63	310.96	0.002513	1.06	19.1	32.71	0.45
Reach1	947.0903	50 Year	26.7	310.12	310.72	310.72	310.93	0.015636	2.19	13.08	30.61	1.1
Reach1	947.0903	100 Year	36.5	310.12	310.82	310.82	311.08	0.014887	2.38	16.26	31.74	1.09
Reach1	947.0903	Regional	86.6	310.12	312.05	310.92	312.05	0.000007	0.12	618.33	259.36	0.03
Reach1	914.451	2 Year	5.1	309.83	310.49	310.11	310.52	0.001231	0.66	7.75	14.34	0.31
Reach1	914.451	5 Year	9	309.83	310.26	310.26	310.45	0.015525	1.69	4.7	12.05	1.04
Reach1	914.451	10 Year	12.2	309.83	310.35	310.35	310.58	0.015557	1.98	5.84	12.95	1.07
Reach1	914.451	25 Year	19.2	309.83	310.53	310.53	310.8	0.01482	2.37	8.22	14.66	1.09
Reach1	914.451	50 Year	26.7	309.83	310.63	310.63	310.63	0.000004	0.05	340.57	234.39	0.02
Reach1	914.451	100 Year	36.5	309.83	310.63	310.63	310.63	0.000008	0.06	340.57	234.39	0.03
Reach1	914.451	Regional	86.6	309.83	312.05	310.63	312.05	0.000005	0.11	687.42	266.58	0.03
Reach1	847.8298	2 Year	5.1	309.3	310.04	310.04	310.3	0.012279	2.25	2.27	4.38	1
Reach1	847.8298	5 Year	9	309.3	310.1	310.1	310.1	0.000001	0.02	291.24	242.11	0.01
Reach1	847.8298	10 Year	12.2	309.3	310.1	310.1	310.1	0.000002	0.03	291.25	242.11	0.01
Reach1	847.8298	25 Year	19.2	309.3	310.1	310.1	310.1	0.000004	0.04	291.25	242.11	0.02
Reach1	847.8298	50 Year	26.7	309.3	310.17	310.1	310.17	0.000006	0.06	309.19	242.33	0.02
Reach1	847.8298	100 Year	36.5	309.3	310.3	310.1	310.3	0.000009	0.08	339.31	242.71	0.03
Reach1	847.8298	Regional	86.6	309.3	312.05	310.1	312.05	0.000003	0.11	785.25	282.35	0.02
Reach1	786.1621	2 Year	5.1	308.9	309.56	309.29	309.58	0.001297	0.68	9.57	28.08	0.32
Reach1	786.1621	5 Year	9	308.9	309.71	309.39	309.71	0.000003	0.04	195.46	237.99	0.02
Reach1	786.1621	10 Year	12.2	308.9	309.89	309.46	309.89	0.000003	0.05	237.22	239.04	0.02
Reach1	786.1621	25 Year	19.2	308.9	310.03	309.57	310.03	0.000005	0.06	272.61	239.89	0.02
Reach1	786.1621	50 Year	26.7	308.9	310.17	309.57	310.17	0.000007	0.08	306.18	240.7	0.03
Reach1	786.1621	100 Year	36.5	308.9	310.3	309.57	310.3	0.000009	0.1	336.08	241.43	0.03
Reach1	786.1621	Regional	86.6	308.9	312.05	309.57	312.05	0.000002	0.09	970.86	377.75	0.02
Reach1	729.9763	2 Year	5.1	308.75	309.5	309.24	309.56	0.002278	1.08	4.92	15.63	0.45
Reach1	729.9763	5 Year	9	308.75	309.71	309.41	309.71	0.000159	0.35	68.31	237.77	0.12
Reach1	729.9763	10 Year	12.2	308.75	309.88	309.55	309.89	0.000066	0.26	110.35	239.27	0.08
Reach1	729.9763	25 Year	19.2	308.75	310.03	309.55	310.03	0.000068	0.29	145.72	240.69	0.09
Reach1	729.9763	50 Year	26.7	308.75	310.17	309.55	310.17	0.000067	0.31	179.5	242.94	0.09
Reach1	729.9763	100 Year	36.5	308.75	310.3	309.57	310.3	0.000076	0.35	209.75	246.79	0.09
Reach1	729.9763	Regional	86.6	308.75	312.05	309.76	312.05	0.00001	0.21	690.18	295.73	0.04
Reach1	677.7048	2 Year	5.1	308.66	309.32	309.15	309.41	0.003743	1.28	3.99	7.73	0.57
Reach1	677.7048	5 Year	9	308.66	309.71	309.33	309.71	0.000036	0.18	118.78	272.06	0.06
Reach1	677.7048	10 Year	12.2	308.66	309.88	309.45	309.88	0.000022	0.16	167.09	273.43	0.05
Reach1	677.7048	25 Year	19.2	308.66	310.03	309.46	310.03	0.000027	0.19	207.52	275.67	0.05
Reach1	677.7048	50 Year	26.7	308.66	310.17	309.46	310.17	0.00003	0.21	246.05	277.38	0.06
Reach1	677.7048	100 Year	36.5	308.66	310.29	309.46	310.29	0.000036	0.25	280.31	278.89	0.07
Reach1	677.7048	Regional	86.6	308.66	312.05	309.57	312.05	0.000006	0.18	831.32	343.15	0.03
Reach1	607.9432	2 Year	5.1	308.35	309.37	308.92	309.38	0.000031	0.15	85.75	264.96	0.06
Reach1	607.9432	5 Year	9	308.35	309.71	309.09	309.71	0.00001	0.11	173.64	267.46	0.03
Reach1	607.9432	10 Year	12.2	308.35	309.88	309.26	309.88	0.000009	0.11	221.22	268.88	0.03
Reach1	607.9432	25 Year	19.2	308.35	310.03	309.3	310.03	0.000012	0.14	260.81	269.95	0.04
Reach1	607.9432	50 Year	26.7	308.35	310.17	309.3	310.17	0.000015	0.17	298.45	271.01	0.04
Reach1	607.9432	100 Year	36.5	308.35	310.29	309.3	310.29	0.000021	0.21	332.94	283.64	0.05
Reach1	607.9432	Regional	86.6	308.35	312.05	309.36	312.05	0.000005	0.16	910.46	359.97	0.03
Reach1	557.6347	2 Year	5.1	308.45	309.37	308.94	309.37	0.000054	0.2	68.69	237.05	0.07
Reach1	557.6347	5 Year	9	308.45	309.7	309.11	309.7	0.000015	0.13	147.6	238.69	0.04
Reach1	557.6347	10 Year	12.2	308.45	309.88	309.28	309.88	0.000012	0.13	190.17	240.65	0.04
Reach1	557.6347	25 Year	19.2	308.45	310.03	309.28	310.03	0.000018	0.17	225.51	241.53	0.05
Reach1	557.6347	50 Year	26.7	308.45	310.17	309.28	310.17	0.000022	0.2	259.32	245.23	0.05
Reach1	557.6347	100 Year	36.5	308.45	310.29	309.3	310.29	0.000029	0.24	289.44	246.73	0.06
Reach1	557.6347	Regional	86.6	308.45	312.05	309.41	312.05	0.000006	0.18	818.88	328.02	0.03
Reach1	523.273	2 Year	5.1	308.36	309.37	308.85	309.37	0.000052	0.21	67.65	233.37	0.07
Reach1	523.273	5 Year	9	308.36	309.7	309.03	309.7	0.000015	0.14	145.93	236.49	0.04
Reach1	523.273	10 Year	12.2	308.36	309.88	309.32	309.88	0.000012	0.14	188.08	237.93	0.04
Reach1	523.273	25 Year	19.2	308.36	310.03	309.32	310.03	0.000018	0.18	223.01	238.91	0.05
Reach1	523.273	50 Year	26.7	308.36	310.17	309.32	310.17	0.000022	0.21	256.22	239.8	0.05
Reach1	523.273	100 Year	36.5	308.36	310.29	309.32	310.29	0.000029	0.25	285.58	241.26	0.06
Reach1	523.273	Regional	86.6	308.36	312.05	309.43	312.05	0.000006	0.18	830.33	336.33	0.03
Reach1	490.7546	2 Year	5.1	308.26	309.34	308.75	309.37	0.000495	0.68	7.95	11.79	0.23
Reach1	490.7546	5 Year	9	308.26	309.67	308.93	309.7	0.000413	0.76	19.89	102.76	0.22
Reach1	490.7546	10 Year	12.2	308.26	309.86	309.05	309.88	0.000262	0.66	39.13	103.74	0.18
Reach1	490.7546	25 Year	19.2	308.26	310.01	309.3	310.03	0.000321	0.78	53.64	105.02	0.2
Reach1	490.7546	50 Year	26.7	308.26	310.14	309.73	310.16	0.000365	0.88	68.01	106.9	0.22
Reach1	490.7546	100 Year	36.5	308.26	310.26	309.82	310.29	0.000437	1.01	80.92	112.38	0.24
Reach1	490.7546	Regional	86.6	308.26	312.04	310.12	312.05	0.000026	0.39	401.33	224.73	0.07

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach1	483.5387		Bridge									
Reach1	474.6852	2 Year	5.1	308.23	309.33	308.72	309.35	0.000476	0.67	8.06	12.06	0.22
Reach1	474.6852	5 Year	9	308.23	309.63	308.9	309.66	0.000518	0.84	12	51.79	0.24
Reach1	474.6852	10 Year	12.2	308.23	309.82	309.01	309.83	0.000256	0.65	36.08	89.84	0.17
Reach1	474.6852	25 Year	19.2	308.23	309.97	309.26	309.99	0.000296	0.75	52.56	105.95	0.19
Reach1	474.6852	50 Year	26.7	308.23	310.12	309.49	310.14	0.000287	0.79	68.42	106.71	0.19
Reach1	474.6852	100 Year	36.5	308.23	310.24	309.71	310.26	0.000337	0.89	81.06	109.17	0.21
Reach1	474.6852	Regional	86.6	308.23	312.04	310.05	312.05	0.000022	0.36	395.47	219.28	0.06
Reach1	441.3358	2 Year	7.9	308.2	309.28	308.8	309.32	0.001171	1.01	9.97	30.8	0.34
Reach1	441.3358	5 Year	14.6	308.2	309.6	309.06	309.64	0.000833	1.05	21.55	41.1	0.3
Reach1	441.3358	10 Year	21.9	308.2	309.75	309.39	309.81	0.00109	1.3	28.69	56.86	0.35
Reach1	441.3358	25 Year	30.7	308.2	309.87	309.52	309.96	0.001504	1.61	38.18	100.57	0.42
Reach1	441.3358	50 Year	37.5	308.2	310.07	309.6	310.12	0.000821	1.3	58.45	102.15	0.32
Reach1	441.3358	100 Year	47.8	308.2	310.2	309.65	310.24	0.000797	1.34	70.91	103.12	0.32
Reach1	441.3358	Regional	103.2	308.2	312.04	310.15	312.04	0.000053	0.55	328.61	178.58	0.09
Reach1	380.4584	2 Year	7.9	308.08	309.28	308.68	309.29	0.000221	0.48	30.84	63.47	0.15
Reach1	380.4584	5 Year	14.6	308.08	309.6	308.94	309.61	0.000191	0.54	55.2	87.47	0.15
Reach1	380.4584	10 Year	21.9	308.08	309.76	309.08	309.77	0.000235	0.64	69.4	95.35	0.17
Reach1	380.4584	25 Year	30.7	308.08	309.9	309.15	309.91	0.000289	0.75	83.11	105.11	0.19
Reach1	380.4584	50 Year	37.5	308.08	310.08	309.21	310.09	0.000244	0.74	102.09	106.05	0.17
Reach1	380.4584	100 Year	47.8	308.08	310.19	309.29	310.21	0.000285	0.83	114.53	106.65	0.19
Reach1	380.4584	Regional	103.2	308.08	312.03	309.5	312.04	0.000066	0.62	340.78	148.85	0.1
Reach1	378.7204	2 Year	7.9	308.08	309.28	308.68	309.29	0.000155	0.4	36.28	67.35	0.13
Reach1	378.7204	5 Year	14.6	308.08	309.6	308.94	309.61	0.000147	0.47	61.97	91.42	0.13
Reach1	378.7204	10 Year	21.9	308.08	309.76	309.08	309.77	0.000186	0.57	76.89	100.24	0.15
Reach1	378.7204	25 Year	30.7	308.08	309.9	309.08	309.91	0.000231	0.67	91.16	105.59	0.17
Reach1	378.7204	50 Year	37.5	308.08	310.08	309.1	310.09	0.000201	0.67	110.18	106.54	0.16
Reach1	378.7204	100 Year	47.8	308.08	310.19	309.18	310.21	0.000238	0.76	122.7	107.14	0.17
Reach1	378.7204	Regional	103.2	308.08	312.04	309.5	312.04	0.000061	0.6	351.15	150.34	0.1
Reach1	294.9459	2 Year	7.9	307.92	309.25	308.42	309.27	0.000336	0.66	12.65	14.49	0.19
Reach1	294.9459	5 Year	14.6	307.92	309.6	308.64	309.6	0.000089	0.4	116.53	131.84	0.1
Reach1	294.9459	10 Year	21.9	307.92	309.75	308.84	309.76	0.000124	0.51	142.68	154.81	0.12
Reach1	294.9459	25 Year	30.7	307.92	309.89	309.05	309.9	0.000167	0.62	163.66	155.97	0.15
Reach1	294.9459	50 Year	37.5	307.92	310.07	309.2	310.08	0.00016	0.64	191.88	157.53	0.15
Reach1	294.9459	100 Year	47.8	307.92	310.18	309.38	310.19	0.000201	0.75	210.01	158.52	0.16
Reach1	294.9459	Regional	103.2	307.92	312.03	309.4	312.04	0.000071	0.68	527.35	198.99	0.11
Reach1	291.1832	2 Year	7.9	307.92	309.25	308.42	309.27	0.000337	0.66	12.71	14.96	0.19
Reach1	291.1832	5 Year	14.6	307.92	309.6	308.64	309.6	0.000087	0.4	117.91	135.33	0.1
Reach1	291.1832	10 Year	21.9	307.92	309.75	308.84	309.76	0.00012	0.5	145.72	156.57	0.12
Reach1	291.1832	25 Year	30.7	307.92	309.89	309.05	309.89	0.000162	0.61	166.93	157.76	0.14
Reach1	291.1832	50 Year	37.5	307.92	310.07	309.2	310.07	0.000155	0.63	195.47	159.34	0.14
Reach1	291.1832	100 Year	47.8	307.92	310.18	309.33	310.19	0.000195	0.74	213.8	160.35	0.16
Reach1	291.1832	Regional	103.2	307.92	312.03	309.42	312.04	0.000069	0.67	533.65	199.22	0.11
Reach1	211.9683	2 Year	7.9	307.76	309.25	308.22	309.26	0.00006	0.31	83.56	184.37	0.08
Reach1	211.9683	5 Year	14.6	307.76	309.59	308.43	309.6	0.000053	0.34	147.99	193.15	0.08
Reach1	211.9683	10 Year	21.9	307.76	309.75	308.62	309.75	0.000074	0.42	177.67	197.06	0.1
Reach1	211.9683	25 Year	30.7	307.76	309.88	308.82	309.88	0.0001	0.51	204.12	200.48	0.11
Reach1	211.9683	50 Year	37.5	307.76	310.06	309	310.06	0.000094	0.52	240.77	204.86	0.11
Reach1	211.9683	100 Year	47.8	307.76	310.17	309.08	310.18	0.000117	0.6	264.06	207.26	0.13
Reach1	211.9683	Regional	103.2	307.76	312.03	309.41	312.03	0.000038	0.51	705.32	297.11	0.08
Reach1	107.5073	2 Year	10.5	307.6	309.25	308.11	309.25	0.00002	0.19	164.98	147.39	0.05
Reach1	107.5073	5 Year	17.7	307.6	309.59	308.3	309.59	0.000025	0.24	215.21	147.66	0.06
Reach1	107.5073	10 Year	25.1	307.6	309.74	308.47	309.75	0.000037	0.31	237.55	147.78	0.07
Reach1	107.5073	25 Year	33.9	307.6	309.88	308.6	309.88	0.000052	0.39	257.03	147.88	0.08
Reach1	107.5073	50 Year	40.6	307.6	310.06	308.6	310.06	0.000055	0.42	283.92	153.3	0.09
Reach1	107.5073	100 Year	50.2	307.6	310.17	308.6	310.17	0.00007	0.49	301.4	159.35	0.1
Reach1	107.5073	Regional	103.3	307.6	312.03	308.72	312.03	0.000035	0.51	649.92	191.85	0.08
Reach1	0	2 Year	10.5	307.3	309.25	307.81	309.25	0.000014	0.18	163.71	126.02	0.04
Reach1	0	5 Year	17.7	307.3	309.59	308	309.59	0.00002	0.24	206.75	127.29	0.05
Reach1	0	10 Year	25.1	307.3	309.74	308.17	309.74	0.000031	0.32	225.88	127.85	0.07
Reach1	0	25 Year	33.9	307.3	309.87	308.3	309.87	0.000046	0.4	242.55	128.33	0.08
Reach1	0	50 Year	40.6	307.3	310.05	308.3	310.05	0.00005	0.44	265.69	129.13	0.09
Reach1	0	100 Year	50.2	307.3	310.16	308.3	310.17	0.000066	0.51	279.94	129.84	0.1
Reach1	0	Regional	103.3	307.3	312.02	308.6	312.03	0.000039	0.56	531.17	135.98	0.08

Appendix E

Water Quality and Temperature



Clythe Creek, Guelph, Ontario
2006 Temperature Report

Trout Unlimited Canada Technical Report No. ON-019

Prepared by:

Aaron Todd, Member
Speed Valley Chapter

&

Silvia D'Amelio
Ontario Provincial Biologist
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List of Figures

Background

Clythe Creek is a small watershed (21 km^2) that drains to the Eramosa River on the east side of the City of Guelph. The Eramosa River and its tributaries (including Blue Springs Creek) have some of the highest quality water and stream habitat in southern Ontario.

Historical monitoring studies found coldwater species in Clythe Creek, including brook trout. A 1952 field survey of fish communities in the Speed Valley found brook trout in Clythe Creek at Highway 7 (York Road) and Watson Road North (*GRCA 1953*). The Ontario Ministry of Natural Resources currently classifies Clythe Creek as coldwater habitat.

Land use in the Clythe Creek watershed is dominated by agriculture; however, urban development is expanding in the lower portion of the watershed. The Eramosa-Blue Springs Watershed Study identified Clythe Creek as the most impacted tributary of the Eramosa River due to channel alteration and erosion, removal of riparian vegetation and online ponds and weirs (*Beak International et al. 1999*). These changes typically result in the degradation of water quality including temperature which in turn impacts the aquatic communities within the creek.

Salmonids, especially brook trout, are considered indicators of good water quality. Data collected in this study have been compared to the thermal preferences of brook trout. Though the upper thermal tolerance of brook trout is commonly known to be approximately 24°C (*Power 1980*, *Grande and Andersen 1991*), the optimal range for physical activity, growth and metabolism is 10-19 °C (*Power 1980* and references therein). Critical temperatures further limit available brook trout habitat at particular life history stages. Summer temperatures should not exceed 16 °C and spawning maximums should not exceed 12 °C with the optimum below 9 °C.

This study investigates the temperature profiles of Clythe Creek to assess its current temperature regimes. Information derived from the temperature profiles will be used in the identification of potential rehabilitation projects and stewardship activities to restore and improve coldwater habitat in Clythe Creek.

Methods

Water temperature monitoring was initiated at four sites (Sites 1-4) in the Clythe Creek watershed in June 2006. Two additional sites (Sites 5 and 6) were added in July 2006 to enhance the spatial resolution of the monitoring. Temperature data were collected at each site until the end of October 2006. The locations of the monitoring sites are illustrated in Figure 1. Photos of the watershed are presented Appendix B.

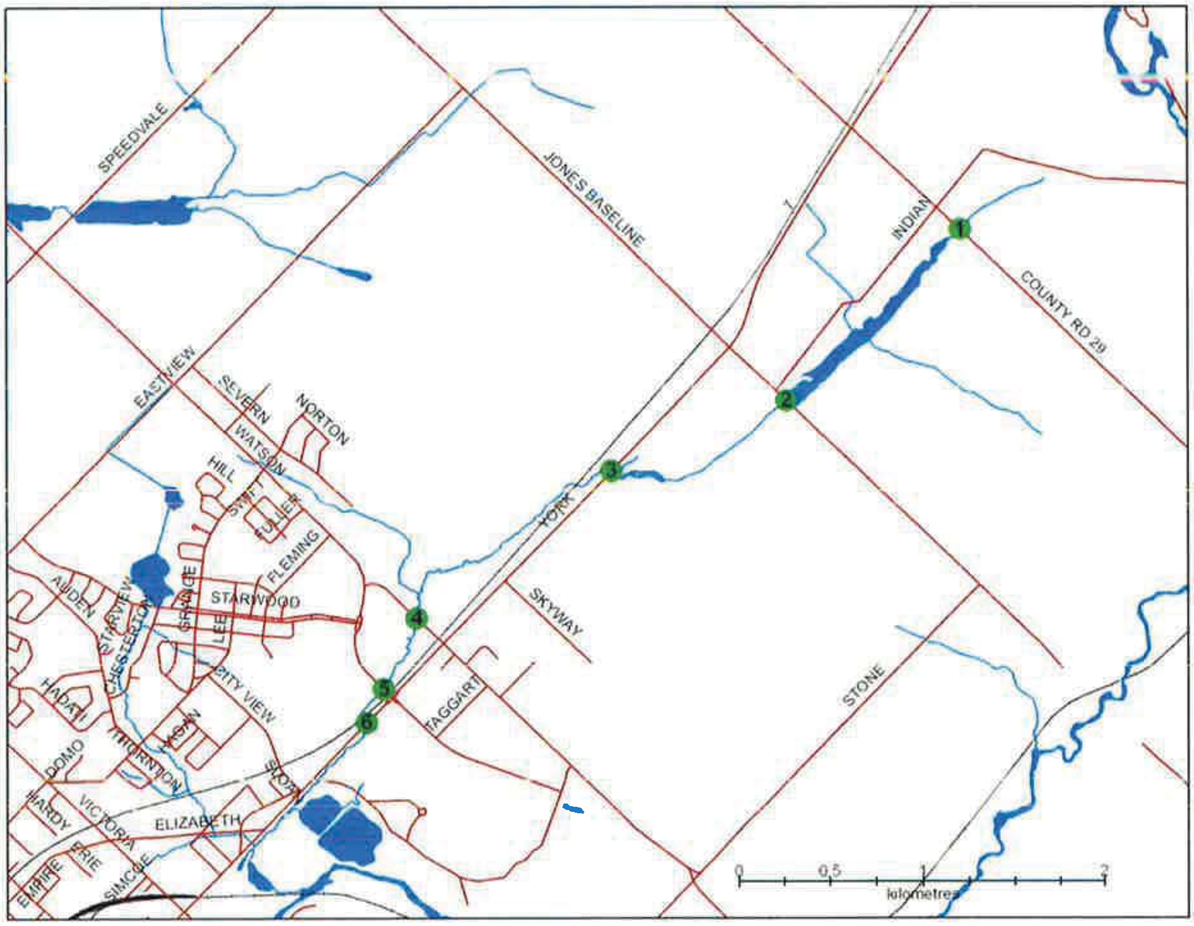


Figure 1: Map of Clythe Creek showing the locations of the sites (number 1 to 6) where water temperatures were monitored in 2006.

Water temperature data were collected at 30 minute intervals using Hobo Water Temp Pro loggers (Onset Computer Corporation). The loggers were periodically retrieved and redeployed throughout the study period to download the data. Logger malfunction resulted in the loss of some data at Site 3. The loggers were attached to a brick or cinder block using cable ties and placed in the centre of the stream channel. Efforts were made to eliminate direct warming from sunlight by placing the loggers in culverts beneath road crossings.

Temperature data were compiled using Microsoft Excel to create a seamless seasonal temperature plot for each location within the Creek. Erroneous data were removed where justification existed (e.g. where the logger was exposed to air due to low water levels, or following removal and before downloading). Daily averages, maximums, minimums and temperature ranges were plotted for each sampling location and compared among sampling sites. Trimean average and maximum temperatures were calculated weekly to identify potential sustained temperature trends. These trends account for the degree of temperature variability during the course of a week and may be indicative of the temperature stress felt by aquatic organisms within the Creek.

Data and Results

Water temperature monitoring results are shown in Figure 2. Monthly minimum, maximum and average water temperatures are shown in Table 1.

Table 1. Monthly minimum (min), maximum (max) and average (avg) water temperatures (°C) for monitoring sites in the Clythe Creek watershed.

	JULY			AUGUST			SEPTEMBER		
SITE	min	max	avg	min	max	avg	min	max	avg
1	9.7	17.1	13.4	9.8	18.1	13.1	8.1	15.2	11.9
2	16.1	29.8	23.1	15.7	32.4	22.1	8.6	23.9	16.1
3				17.2	27.0	21.2	11.1	20.8	16.1
4	15.0	27.1	21.0	13.3	28.3	19.4	8.4	19.7	14.5
5				13.1	28.3	19.2	9.6	19.1	14.7
6				13.1	26.4	18.3	9.5	17.5	14.3

Water temperatures in the headwaters of the Creek (Site 1 - Wellington Road 29) reached a maximum of 18.1 °C on August 3, 2006. Average water temperatures in the headwaters of the Creek for the months of July and August were 13.4 and 13.1 °C, respectively (Figure 2).

Water temperatures increased significantly between Wellington Road 29 (Site 1) and Jones Baseline (Site 2) which is located 1.3 km downstream (Figure 2, 3, 5, 8, 9 and 10). A maximum temperature of 32.4 °C was reached at Site 2 on August 1 (Figure 3). Average temperatures for the months of July and August at Site 2 were 23.1 and 22.1 °C, respectively (Figure 5).

Daily ranges and hourly rates of change are greatest at Site 2 (Figure 6 and 7). Trimean maximum and average temperatures illustrate that all sites except Site 1 reach lethal temperatures for brook trout (Figure 9 and 10).

All sites downstream of Site 1 are classified as warm or warm/cool water habitats, whereas Site 1 is clearly a coldwater section (Figure 11).

Site 2 displays an extremely high frequency of days of sustained high temperatures, but the frequency decreases with downstream sites (Figure 12).

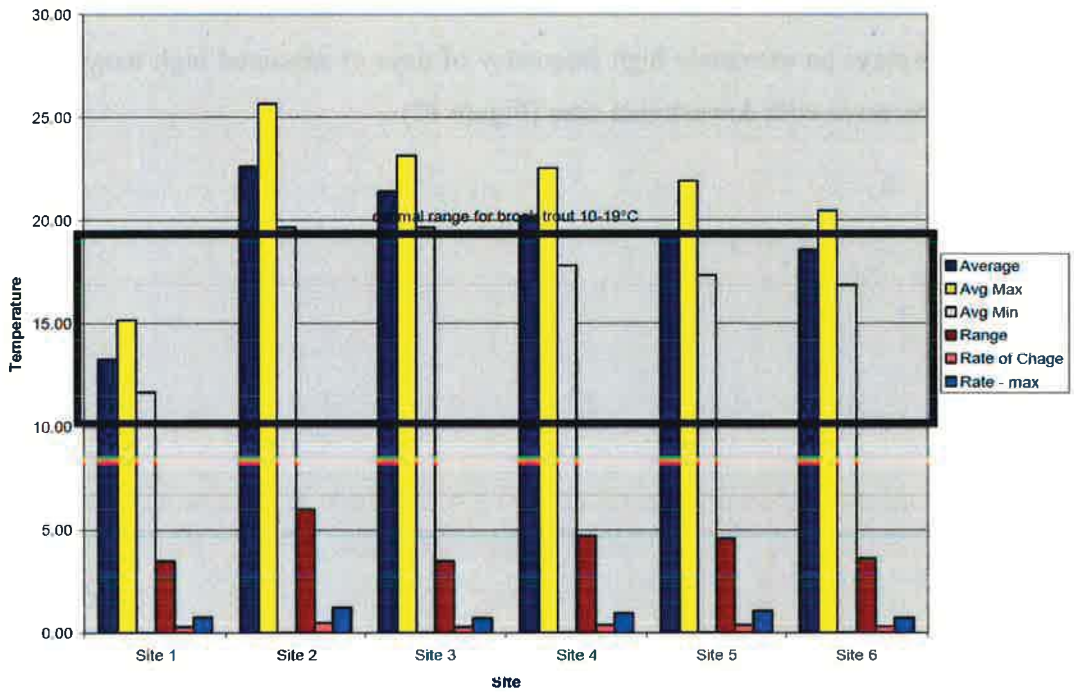


Figure 2: Summary of summer data from all sites. Average daily temperature, average maximum and minimum temperature, average daily range, average daily rate of change and absolute maximum rate of change were calculated for July and August.

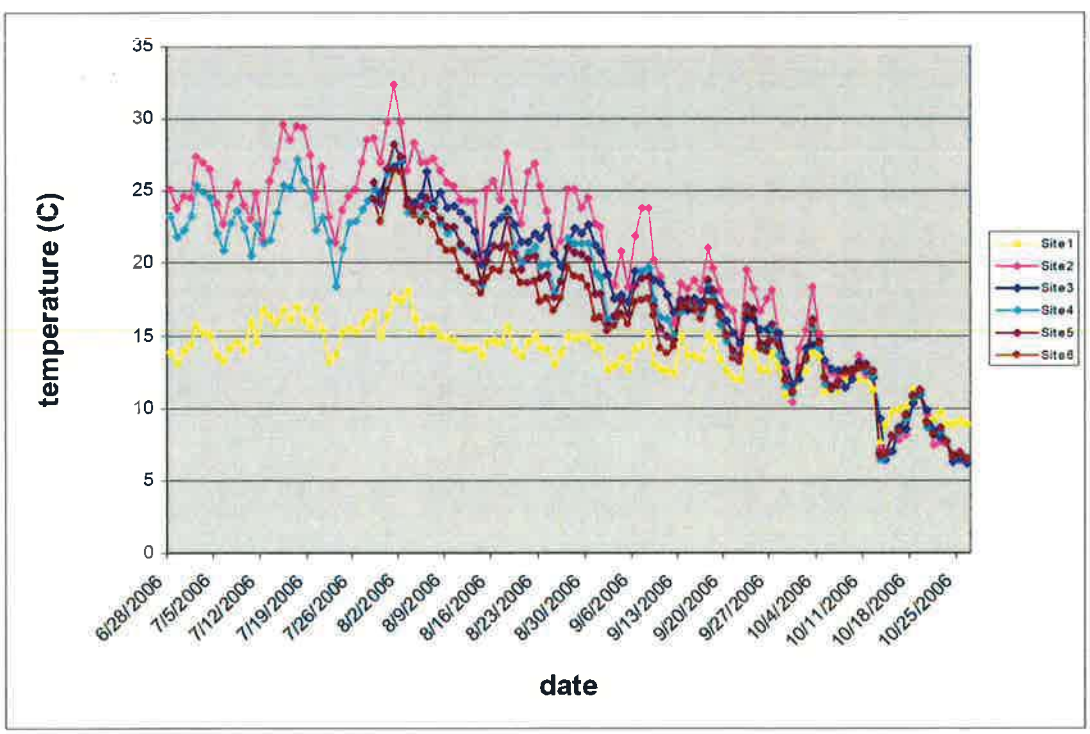


Figure 3: Maximum daily temperature. Sites are listed upstream (Site 1) to downstream (Site 6).

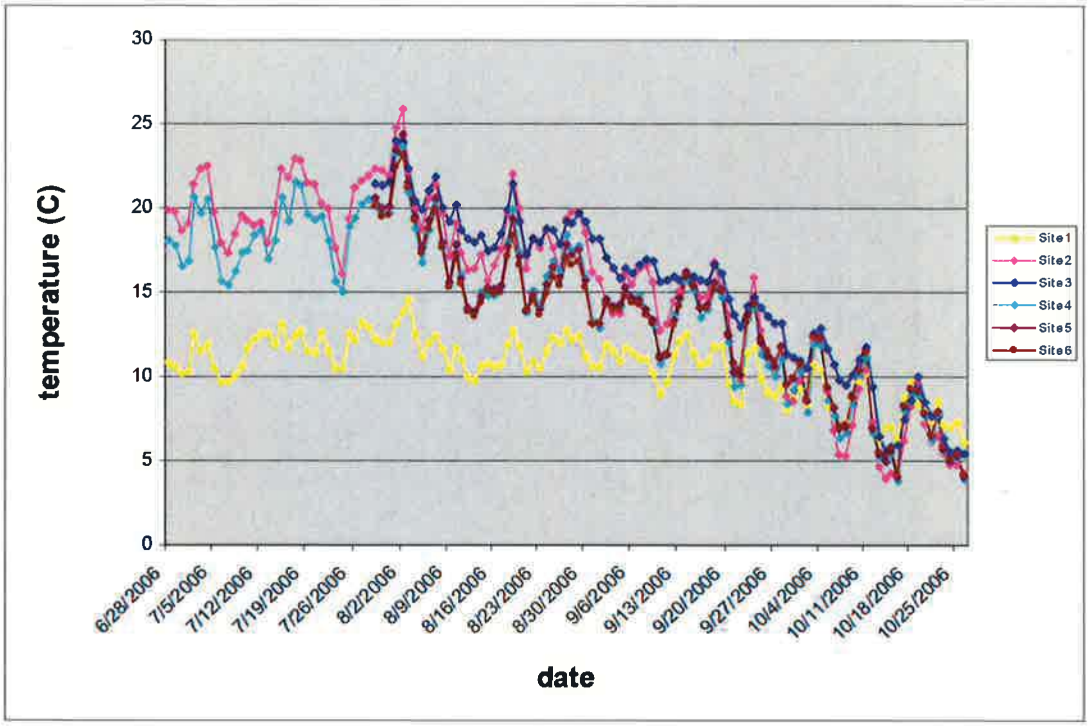


Figure 4: Minimum daily temperature.

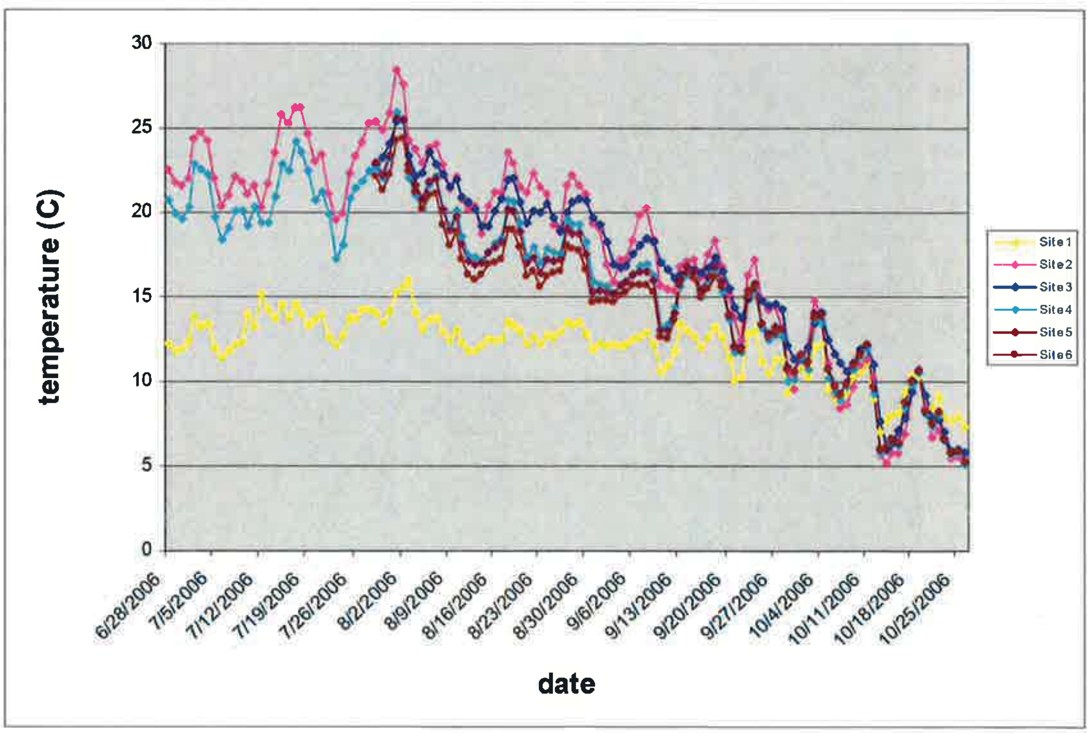


Figure 5: Average daily temperature.

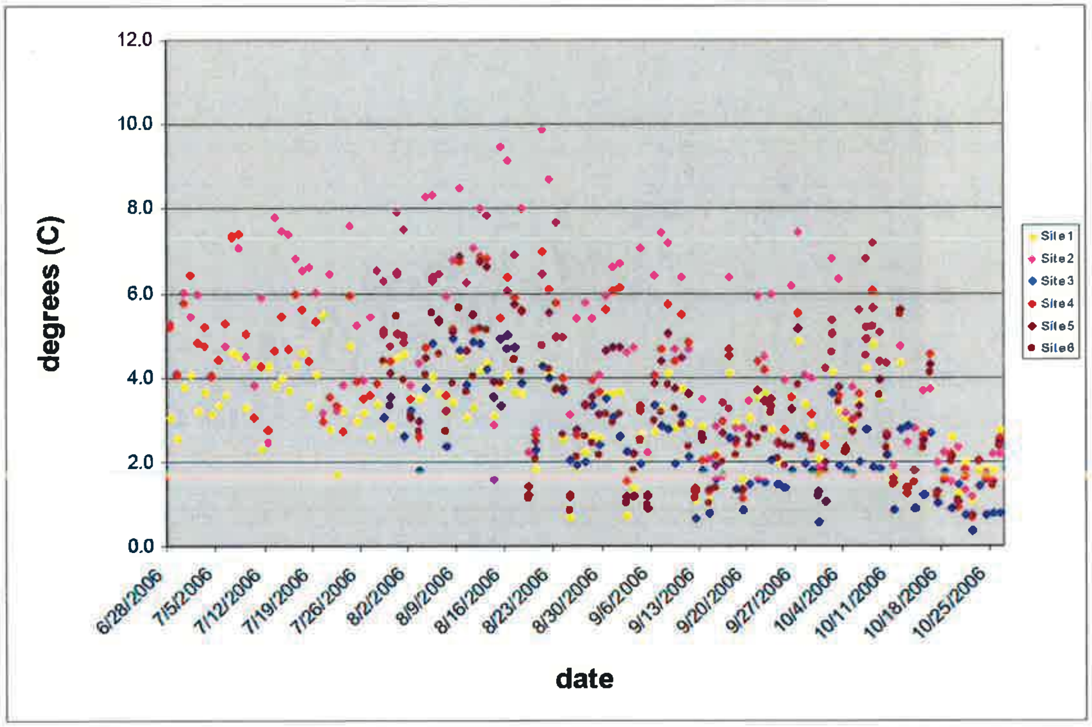


Figure 6: Daily range in temperature.

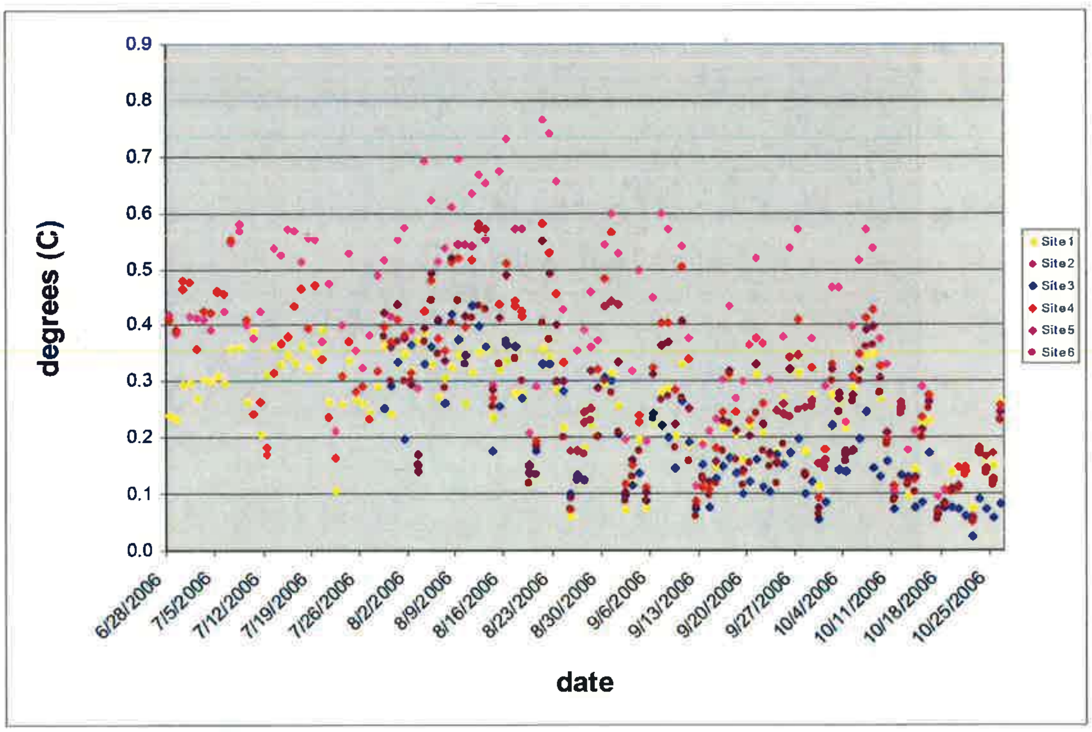


Figure 7: Daily average hourly rate of change in temperature.

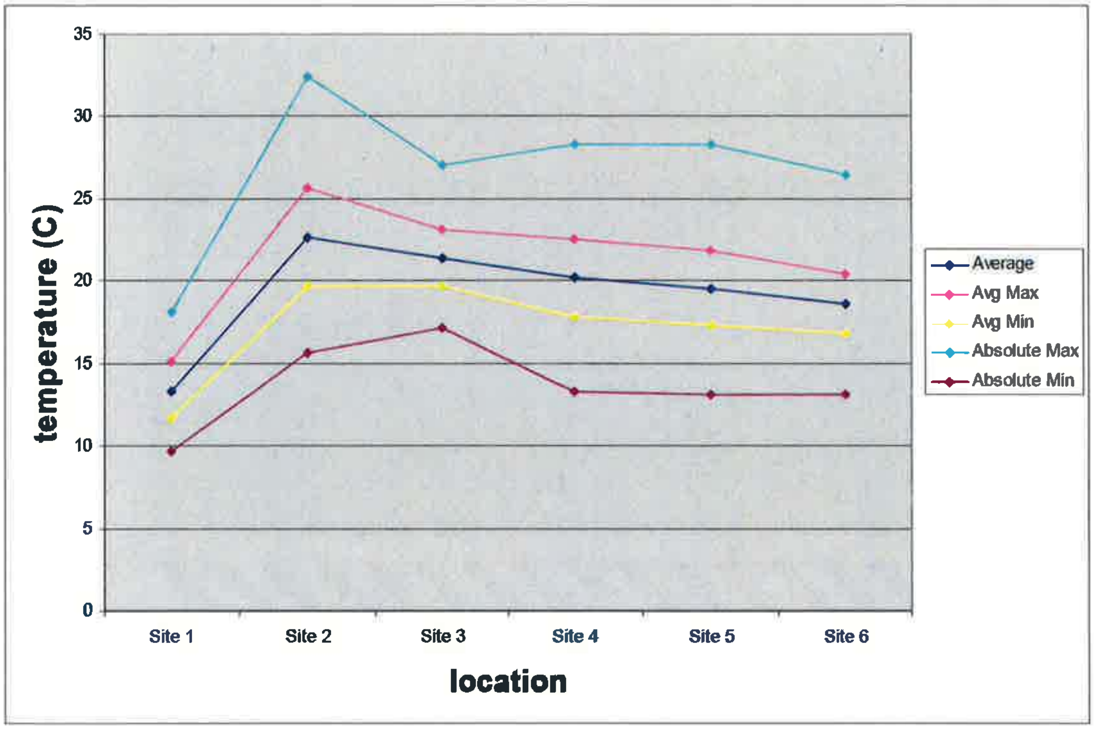


Figure 8: Longitudinal chart showing change in temperature from upstream to downstream during the summer months (July and August).

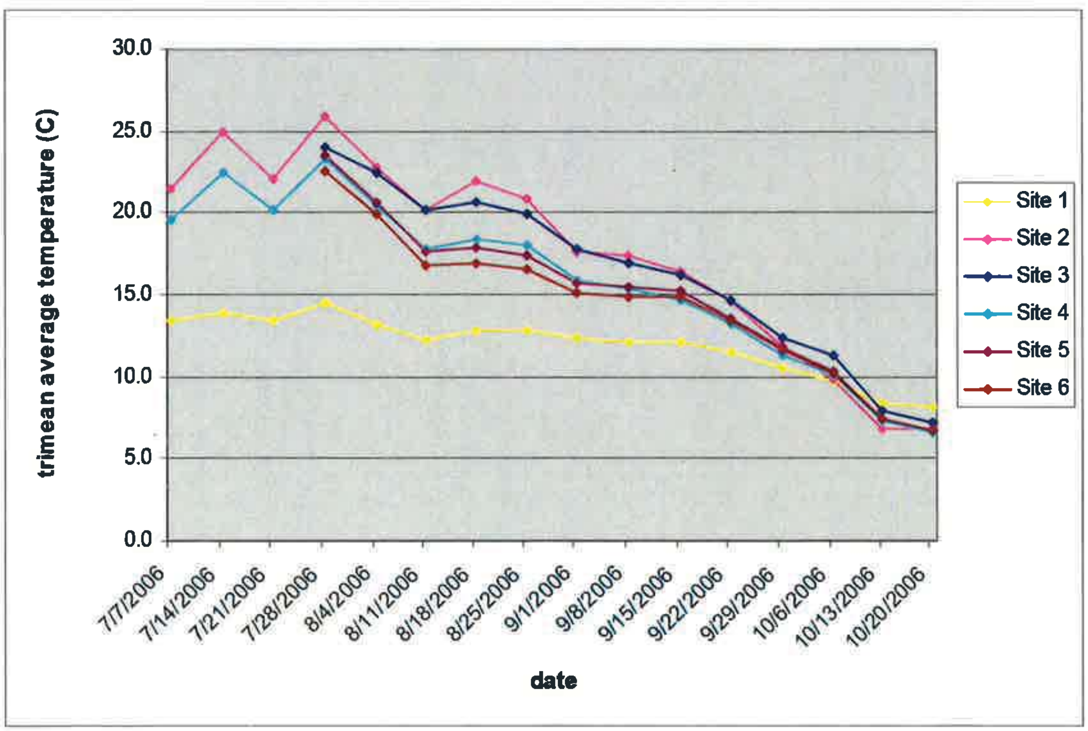


Figure 9: Trimean weekly average temperatures by site.

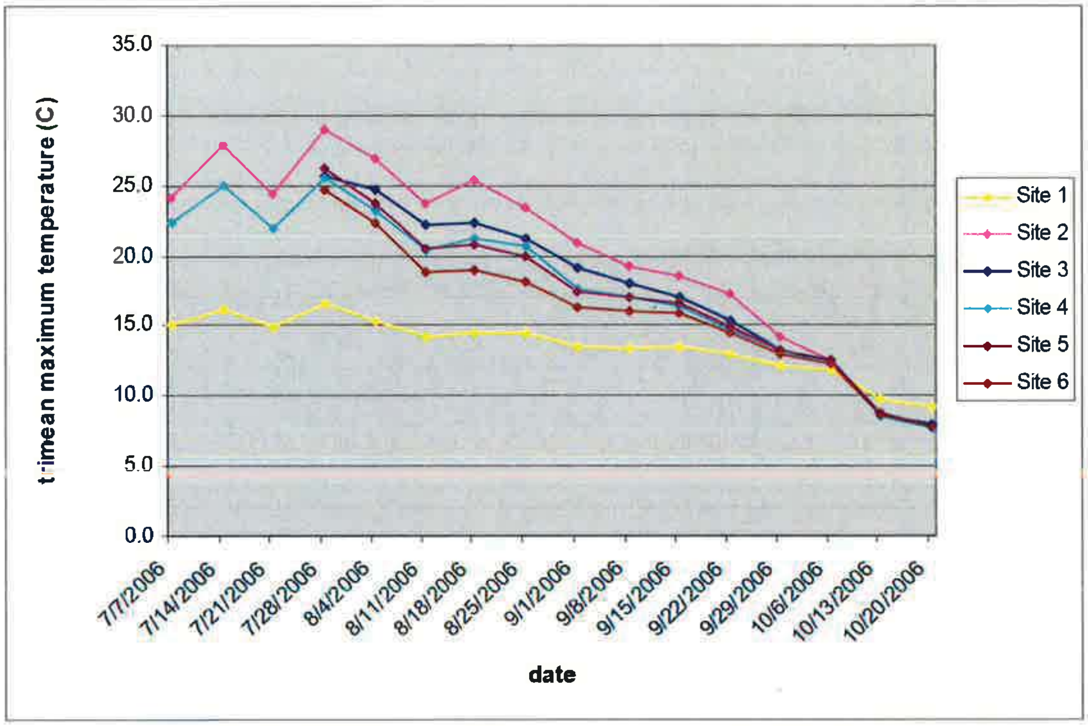


Figure 10: Trimean weekly maximum temperatures by site.

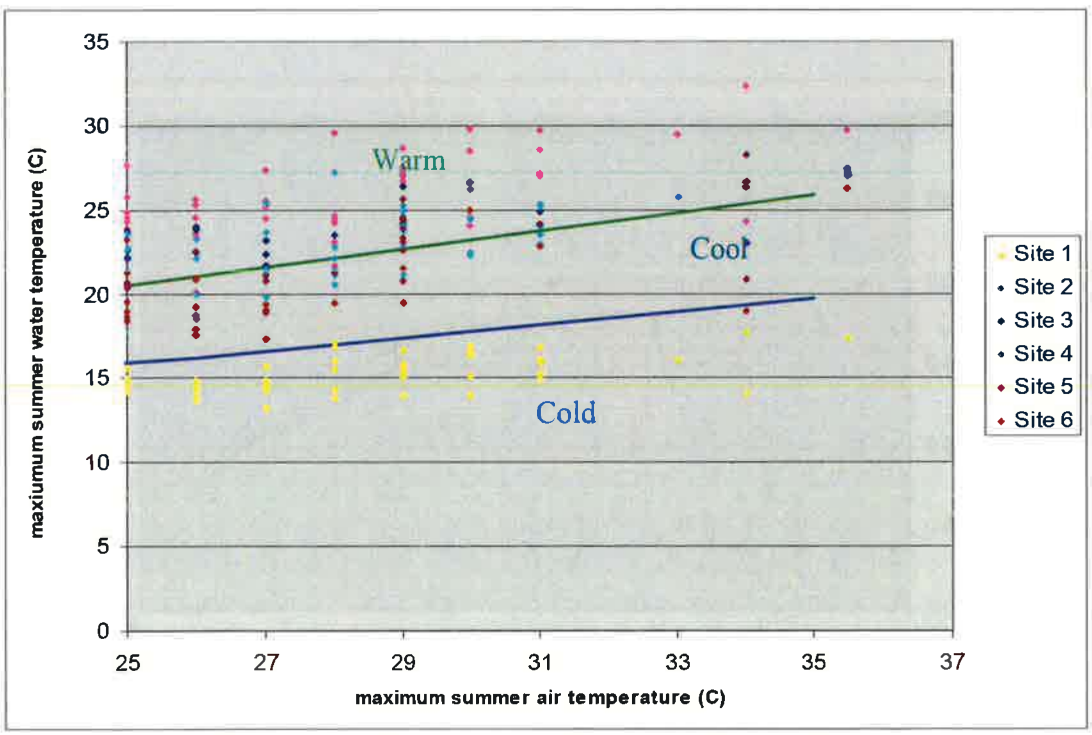


Figure 11: Stream classification of all sites (format from Stoneman and Jones 1996). Sites plotted below blue line classify as cold water, between blue and green classified as cool water and above green classified as warm water sites.

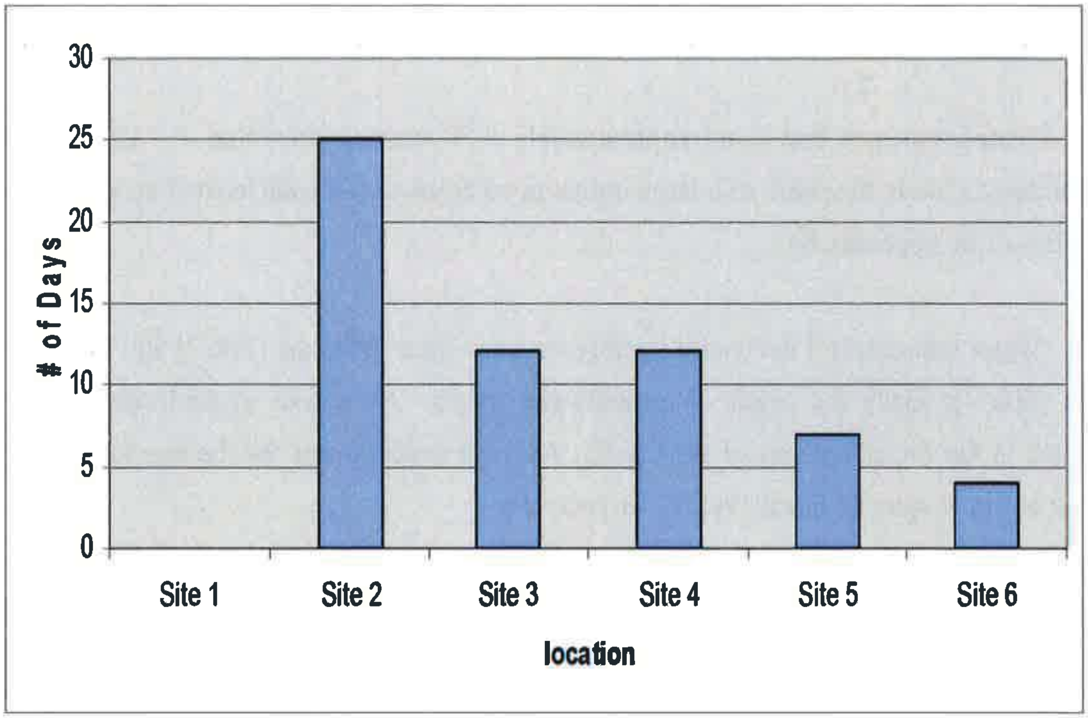


Figure 12: Number of days by site where temperatures ≥ 20°C were sustained for a 24h period.

Implications

Temperatures at Site 2 are approximately 9 °C warmer than Site 1. The increase in temperature is likely the result of a large online pond created by a weir located at Jones Baseline (see Photo 1 in Appendix B).

Water temperatures decreased slightly between Jones Baseline (Site 2) and Watson Road North (Site 4); likely the result of groundwater inputs. Numerous groundwater seeps were observed in the lower sections of the Creek. Average temperatures for the months of July and August at Site 4 were 21.0 and 19.4 °C, respectively.

The combination of cold headwaters at Site 1 and the cooling of the creek due to coldwater inputs downstream of Site 2 illustrate significant potential for coldwater restoration. The removal of the barrier and associated impoundment just upstream of Site 2 would allow for the movement of coldwater further down the system. The coldwater inputs may mitigate general warming of the system allowing this creek to be cooled from top to bottom.

Additional potential thermal inputs have been identified downstream of Site 2. The effects of these inputs will be much better understood with the mitigation of Site 2. For example the slight increase in temperatures between Sites 3 and 4 can be investigated more clearly when the confounded effects of the upstream impoundment are removed.

It is recommended that the temperature loggers are redeployed in 2007 to collect another season of data and to enhance spatial resolution to assess specifically the impact of online ponds. In addition, the collection of water quality (chemistry) information at strategic locations would be beneficial in the assessment of the influence of land use activities; specifically the impacts of storm water management ponds in the developing lower portion of the watershed.

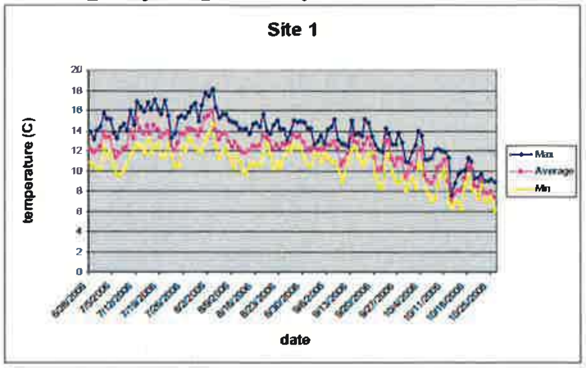
Based on these data it would be beneficial to survey the fish community composition in selected sections of the Creek to identify remnant coldwater communities. Sections sampled should include upstream of Wellington Road 29 (Site 1) and between Highway 7 (Site 3) and Watson Road North (Site 4). These are the most likely areas to support remnant populations of coldwater species. The results should be compared to historical surveys to assess changes in community composition.

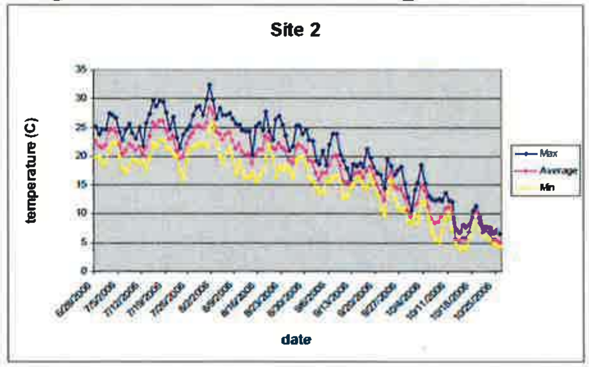
Acknowledgements

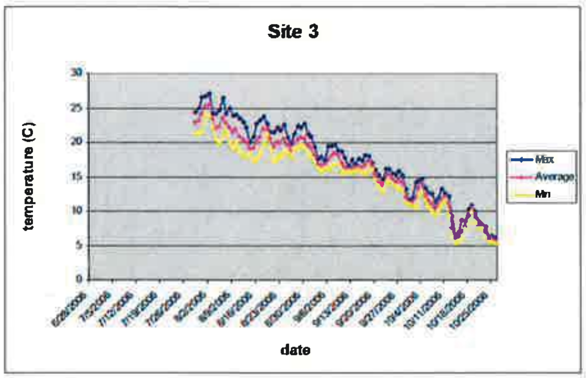
The late Walt Crawford provided the inspiration for this study.

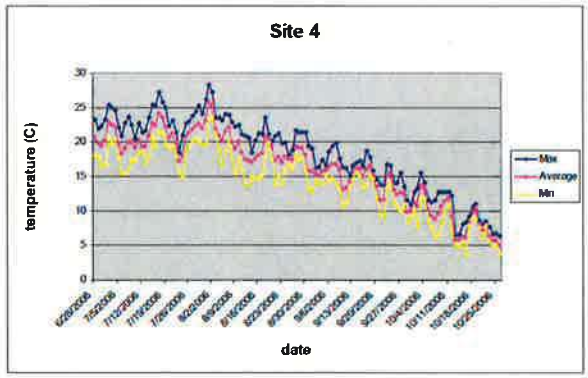
The Environmental Monitoring and Reporting Branch of the Ontario Ministry of the Environment provided the water temperature loggers used in this study.

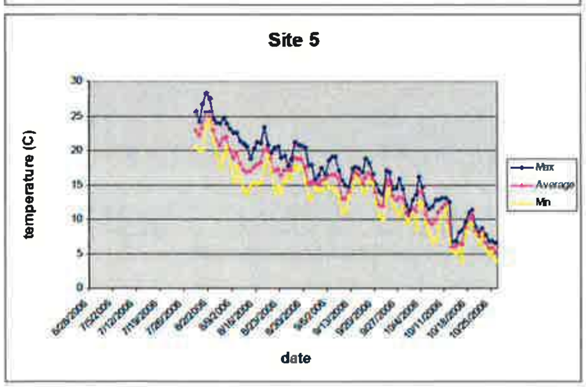
Appendix A: Individual Site Data
Displaying Daily Maximum, Average & Minimum Temperatures

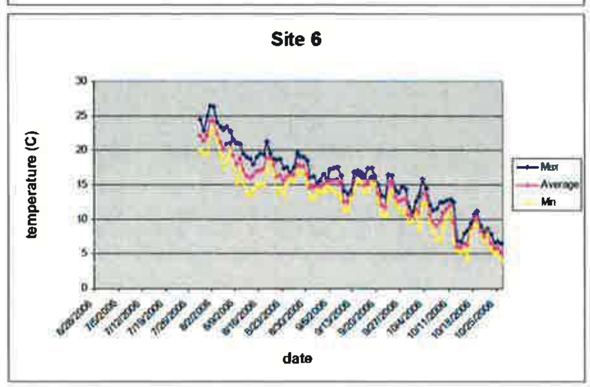












Appendix B: Site Photographs

Photo 1: Large online pond created by a weir at Jones Baseline. The pond is located downstream of Site 1 and immediately upstream of Site 2. The pond is likely the primary cause of the observed increase in water temperature.

Photo 2: Dense vegetation downstream of Jones Baseline (Site 2) presents a challenge to exploring the Creek. A pump used for taking water for the irrigation of a garden was observed in the Creek just downstream of Site 2.

Photo 3: Dense riparian vegetation typical of the Creek between Highway 7 (Site 3) and Watson Road North (Site 4). Groundwater seeps were observed in this section of Creek and watercress was observed in the channel.

Photo 4: The Creek meanders through a wetland immediately upstream of Watson Road North (Site 4). Hills to the north of the Creek have been cleared for development (construction in progress) and storm water ponds have been constructed.

Photo 5: Perched culvert at Watson Road North (Site 4) presents a significant barrier to fish migration. Large schools of minnows (and minnow traps) can usually be observed in the pool below the culvert.

Photo 6: Sections of the Creek between Watson Road North (Site 4) and Watson Parkway (Site 5) have been channelized; however, the Creek is relatively narrow with areas of gravel streambed and some riparian cedar trees.

Photo 7: Damselfly observed in the section of Creek between Watson Road North (Site 4) and Watson Parkway (Site 5). Various insects hatches were observed over the summer in this section of the Creek.

Photo 8: Storm water management pond collects runoff from the developing portion of the watershed near Starwood Drive and Grange Road. The pond discharges to the Creek just upstream of Watson Parkway (Site 5).

Photo 9: Discharge from the storm water pond was consistently turbid throughout the summer. Water quality in Clythe Creek was noticeably impacted and sedimentation of the Creek channel downstream of the pond outlet was observed.

Photo 10: The Creek flows through a small patch of dense cedar forest between Watson Parkway (Site 5) and Highway 7 (Site 6). Numerous groundwater seeps can be found in this area. Sedimentation of the Creek channel is evident.

Photo 11: A long, dual-channelled, concrete culvert diverts the Creek from the north to the south side of the railway line.

Photo 12: The Creek passes under Highway 7 (Site 6) and flows along the north side of the highway toward its confluence with the Eramosa River. This section of the Creek is highly altered with numerous dams, weirs and ponds.

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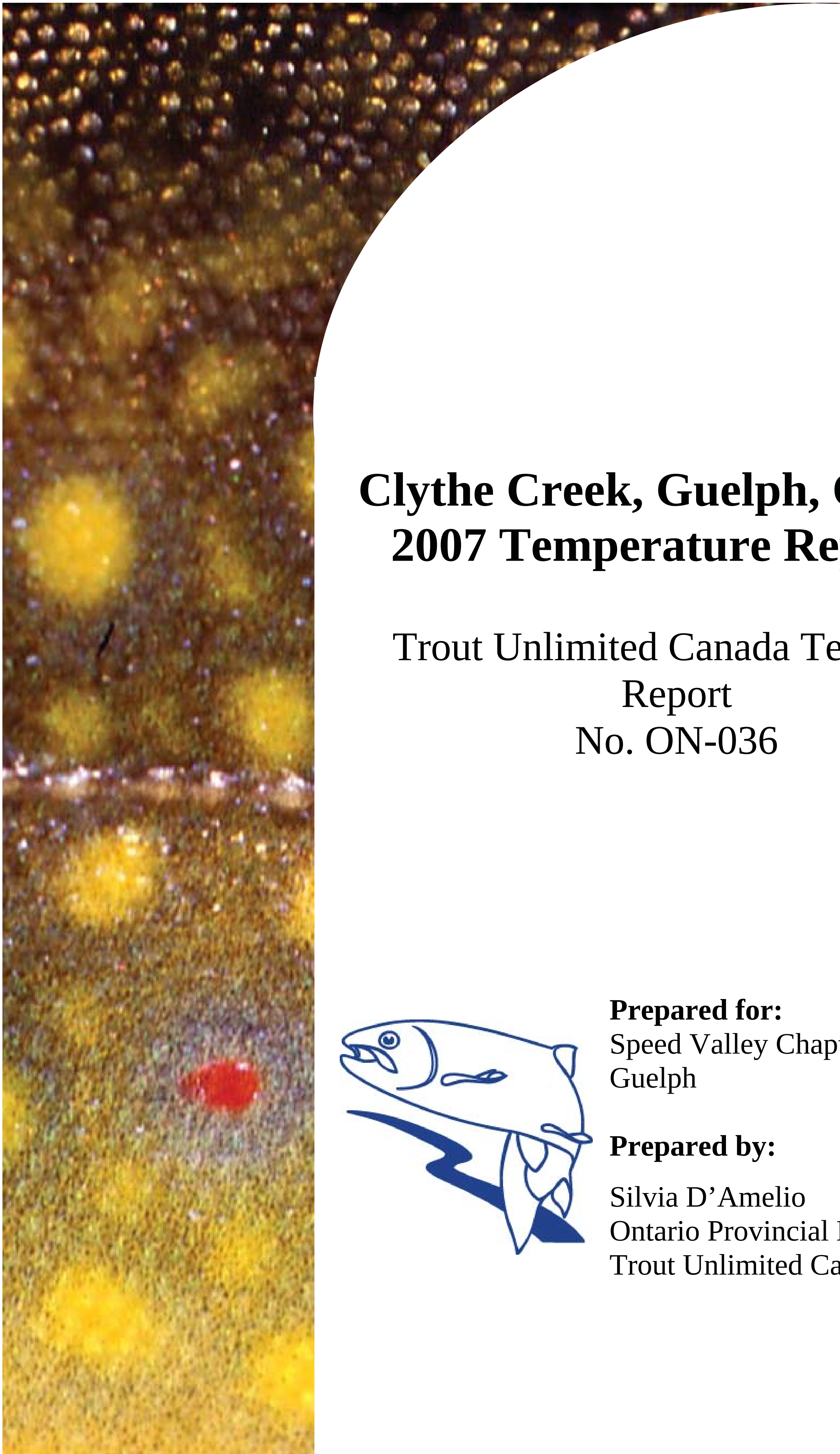

Clythe Creek, Guelph, Ontario 2007 Temperature Report

Trout Unlimited Canada Technical Report
No. ON-036

Prepared for:
Speed Valley Chapter
Guelph

Prepared by:

Silvia D'Amelio
Ontario Provincial Biologist
Trout Unlimited Canada

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List of Tables and Figures

Background

Clythe Creek is a small watershed (21 km^2) that drains to the Eramosa River on the east side of the City of Guelph. The Eramosa River and its tributaries (e.g. Blue Springs Creek) have some of the highest quality water and stream habitat in southern Ontario.

Historical monitoring studies found cold water species in Clythe Creek. A 1952 field survey of fish communities in the Speed Valley found brook trout in Clythe Creek at Highway 7 (York Road) and Watson Road North (GRCA 1953). As a result, the Ontario Ministry of Natural Resources has classified Clythe Creek as coldwater habitat.

Land use in the Clythe Creek watershed is dominated by agriculture. However, urban development is expanding in the lower portion of the watershed. As a result, the Eramosa-Blue Springs Watershed Study identified Clythe Creek as the most impacted tributary of the Eramosa River. This is mainly due to channel alteration and erosion, removal of riparian vegetation and online ponds and weirs (Beak International et al. 1999). These types of changes typically result in the degradation of water quality, including temperature, which has negative impacts on aquatic communities in the creek.

Salmonids, especially brook trout, are often considered indicators of good water quality. Therefore the data collected from this study will be compared to the thermal preferences of brook trout documented in scientific literature. Although the upper thermal tolerance of brook trout is commonly known to be approximately 24°C (Ricker 1934, Power 1980, Grande and Andersen 1991), it has been well documented that their preferred range is 4°C to 20°C (Power 1980 and references therein). In order to better understand a brook trout's ability to fully and efficiently utilize its environment, it is necessary to understand that neither of these temperature ranges illustrates optimums for specific life stages. The optimal range for physical activity, growth and metabolism is 10°C to 19°C (Baldwin 1948, Graham 1949, MacCrimmon and Campbell 1969, Power 1980 and references therein, Dwyer et al 1983) with trout selecting a preferred range of 15°C to 17°C (Cherry et al. 1975). Optimal maximum temperatures to sustain a healthy brook trout population are 18°C to 19°C (Powers

1929, Creaser 1930, Ferguson 1958) and they actively avoid areas where temperatures approach 24°C (Meisner 1990). Critical temperatures further limit available brook trout habitat at particular life history stages. During the summer season, temperatures should not exceed 19°C and spawning maximums should not exceed 12°C with the optimum range of 6°C to 8°C (Hokanson 1973, Witzel and MacCrimmon 1983). It is well documented that temperature affects swimming performance and the overall cost of swimming. As a result, increases in temperature lead to increases in critical swimming velocity (Heggenes and Traaen 1988, Tang and Boisclair 1995).

This study investigates the temperature profiles of Clythe Creek to assess its current temperature regimes. In addition, the temperature profiles derived from the data will be utilized to identify future rehabilitation projects. The goal of this study is expand the monitoring program initiated in 2006 and to provide information for the restoration and maintenance of cold water habitats in Clythe Creek.

Methods

Temperature data loggers (Hobo Water Temp Pro loggers produced by Onset Computer Corporation) were launched at 17 sites in Clythe Creek, Blue Springs Creek and the Eramosa River. The locations of the monitoring sites are illustrated in Figure 1. For data analysis, sites are labelled by their stream and site number (C = Clythe Creek, E = Eramosa, BS = Blue Springs). Site C18 was located in the outflow of a stormwater management pond which drains directly into Clythe Creek.

Water temperature data were collected at 30 minute intervals. These data were compiled using Microsoft Excel to create seamless seasonal temperature plots for each location within the tributary. Data were summarized and daily averages, maximums, minimums and temperature ranges were plotted for each sampling location and compared among sampling sites. Additionally, longitudinal trends were compared among years and stream classification was identified using a method outlined by Stoneman and Jones (1996). Trimean average and maximum temperatures were calculated weekly to identify potential sustained temperature trends. These trends account for the degree of temperature variability within the system during the course of a week and may be more indicative of the actual temperature stress felt by aquatic organisms within the system. Baldwin (Hansen 2001) showed that a Trimean maximum of 22°C correlates to an overall maximum of 25.6°C, well over brook and brown trout tolerances.

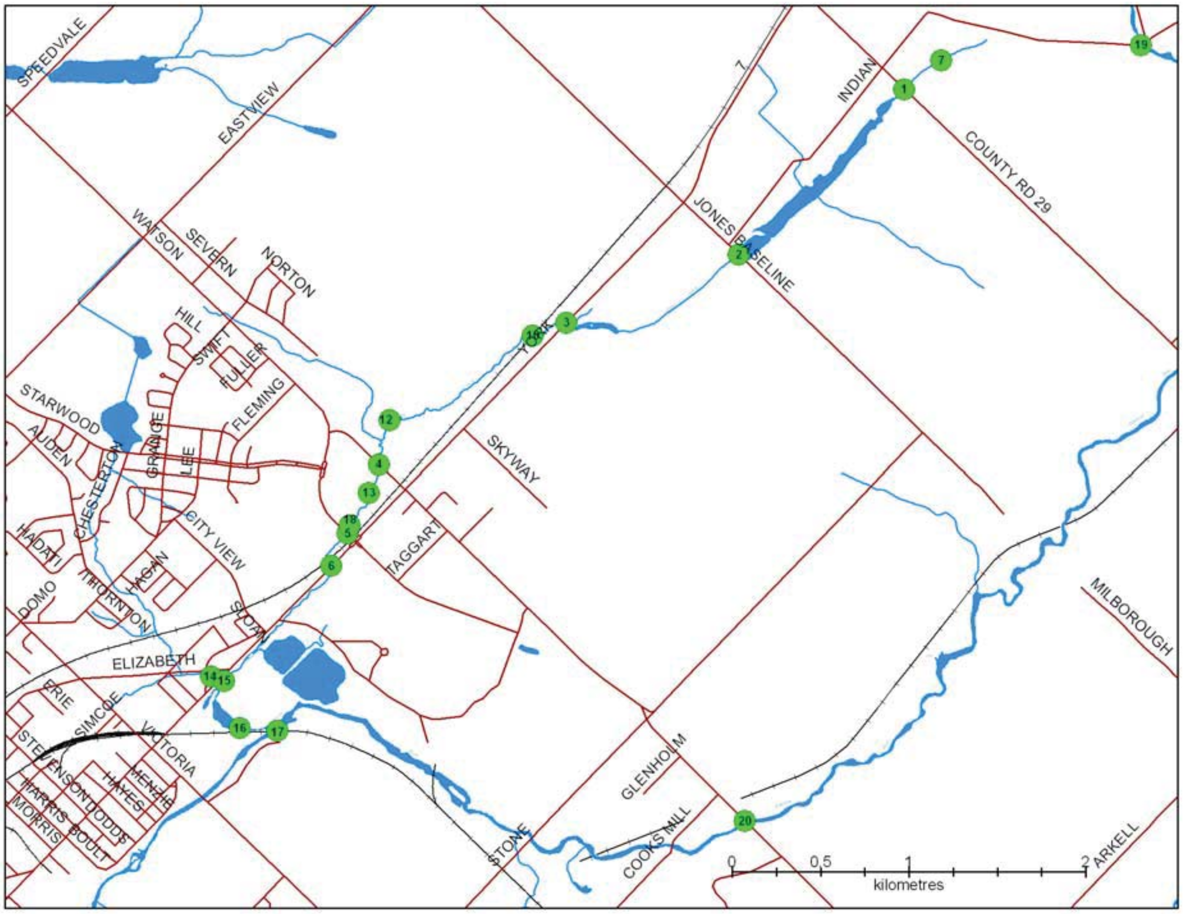


Figure 1: Study Site – Clythe Creek temperature monitoring locations (locations are approximate).

Data and Results

Of the 17 logger launched, 14 were retrieved and successfully downloaded. Water temperatures were captured from May 30 to November 21, 2007. Sites 14, 6 and 20 were either lost or were not retrievable due to water level changes. A cursory review of data collected revealed profiles consistent with air and not water temperatures for a portion of the monitoring period, at some sites. As a result data from sites C13, C18, C5, C15 and BS21 was removed prior to analysis.

For the period spanning July and August, summary data for Clythe Creek display optimal average, maximum and minimum temperatures for trout in its upper reaches, sites C7 and C1 (Figure 2). Sites C2 through E20 display average maximum temperatures above optimum, but most C2, C12, C4, C13, C18, C5 and C16, display minimum temperatures with the optimum range (Figure 2). Interestingly, temperatures generally rise from site C7 to C13 but fall at site C12 and again at C5 before rising significantly at site C15 (Figure 2). Sites in the Eramosa River (E17 and E20) display relatively high temperatures outside of the optimal range for brook trout. The most significant temperature difference exists between sites C1 and C2 (Figure 2). The single site in Blue Springs Creek (BS21) displays temperatures well within the optimum for brook trout (Figure 2).

Detailed daily temperatures reveal the highest maximum daily temperature recorded in Clythe Creek surpassed 30ºC at site C2 at the end of June and at sites C4 and C13 at the beginning of August (Figure 3). Sites C15 and E16 also showed high daily temperatures and peaked at 29ºC and 28ºC respectively (Figure 4). Sites Site C7 maintained maximum daily temperatures below 16ºC for the entire sampling period (Figure 3). Sites C7, C1 and BS21 were the only sites that did not reach lethal temperatures for book trout (Figures 3 and 4). All sites, except for C7 and C1, maintained maximum daily temperatures between 15º and 32º C from May to the beginning of October, with most surpassing 25 ºC frequently (Figures 3 and 4).

Minimum daily temperatures for sites C3, C18, C16, E17 and E20 are often at or above 20ºC (Figures 5 and 6). Sites C2, C12, C4, C13 and C5 display minimum daily temperatures that reach 20ºC but do not sustain these high temperatures (Figures 5 and 6). Sites C7, C1 and BS2 never reach a minimum temperature of 20ºC.

The average daily temperatures for sites C7, C1 and BS21 are consistently below 20ºC for the entire sampling period (Figures 7 and 8). All other sites exceed 20ºC, with sites C2, C18, C16 and E17 reaching or exceeding 25ºC for short periods of time (Figures 7 and 8). Maximum, minimum and average daily temperatures show a decreasing trend for all sites from mid-September to the end of November (Figures 3, 4, 5, 6, 7, and 8). The single most significant difference in temperature between neighbouring sites was observed between C1 and C2 (Figures 3, 5, and 7). Site C18 (stormwater management pond outflow) displays the greatest degree of variability, relatively hot in June and August, but cooler in July (Figures 4, 6 and 8).

The highest daily range and daily average hourly rate of change in temperature was recorded at sites C4, C13 and C18 (Figures 9 and 10). Sites C7 and C3 showed consistently the least amount of variation in daily average hourly rate of change in temperature (Figures 9 and 10). The greatest variability in range and rate of change was observed at C18 (Figures 9 and 10).

According to the stream classification developed by Stoneman and Jones (1996), Figure 14 shows that sites C1 and C7 are classified as cold water. However, the remaining temperature monitoring sites show that Clythe Creek is classified as cool to warm water due to overlap between warm and cool water classifications for most sites (Figure 11). E17 displays a warm water classification, while E20 is mixed warm-cool (Figure 11). BS21 displays a cool to cold water classification (Figure 11).

The longitudinal profile for Clythe Creek indicates that water temperatures generally increase from C7 to C3 but minimum temperatures decrease from C7 to C1 (Figure 12). Average, minimum and absolute minimum temperatures also decrease from C3 to C4, while maximums and absolute maximums increase (Figure 12). An increase from C4 to C13 is followed by a decrease to C18 and a narrowing of range to C5 (Figure 12). Temperature increases again to C15 before one final decrease to C16 (Figure 12). The most significant increase in temperature is between sites is between C1 and C2 (Figure 12). Data from 2006 (Todd and D'Amelio 2006) show that average, minimum and absolute minimums are lower in 2007, whereas maximums and absolute maximums show no consistent trends in comparison with 2007 (Figure 12).

Trimean averages at C2, C3, C18, C15, C16 and E17 surpass the 22ºC maximum for brief periods (Figure 13). All other sites remain below the maximum (Figure 13). Trimean maximums above 22ºC were observed at all sites with the exception of C7, C1 and BS21 (Figure 14).

Sites C3, C18 and C2 showed the greatest numbers of days where temperatures were greater than or equal to 20ºC for a 24h period with a total of 14, 13 and 9 days respectively (Figure 15). Sites C1, C7 and BS21 did not experience any days where temperatures were greater than or equal to 20ºC for a 24h period (Figure 15).

Summary Plots

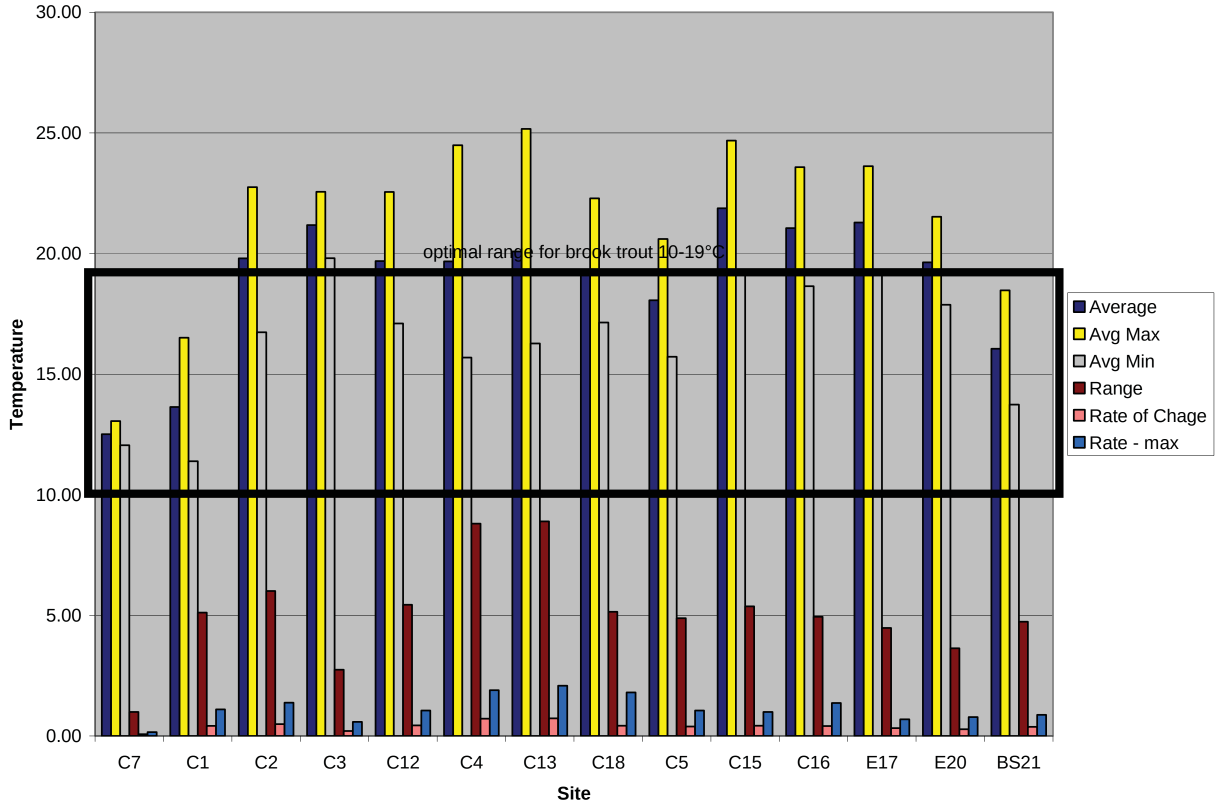


Figure 2: Summary of summer data from all sites. Average daily temperatures, average maximum and minimum temperatures, average daily range, average daily rate of change and absolute maximum rate of change were calculated for July and August.

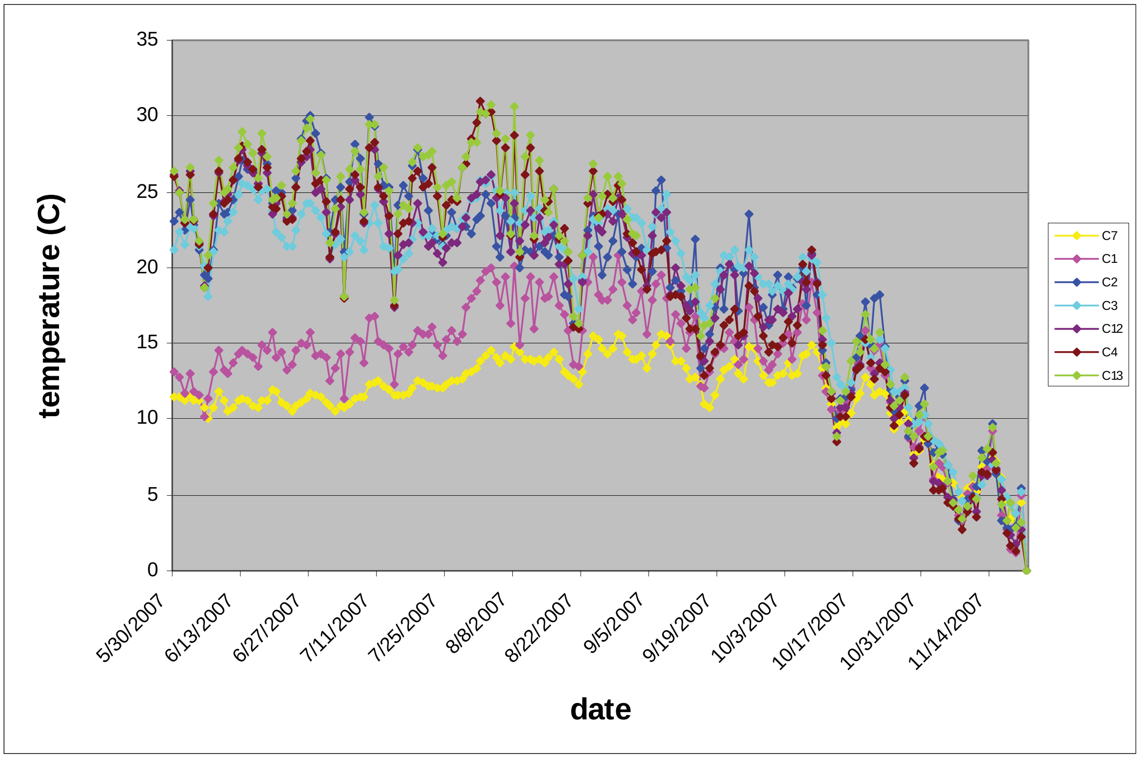


Figure 3: Maximum daily temperature for Clythe Creek (sites C7 to C13 are listed upstream to downstream).

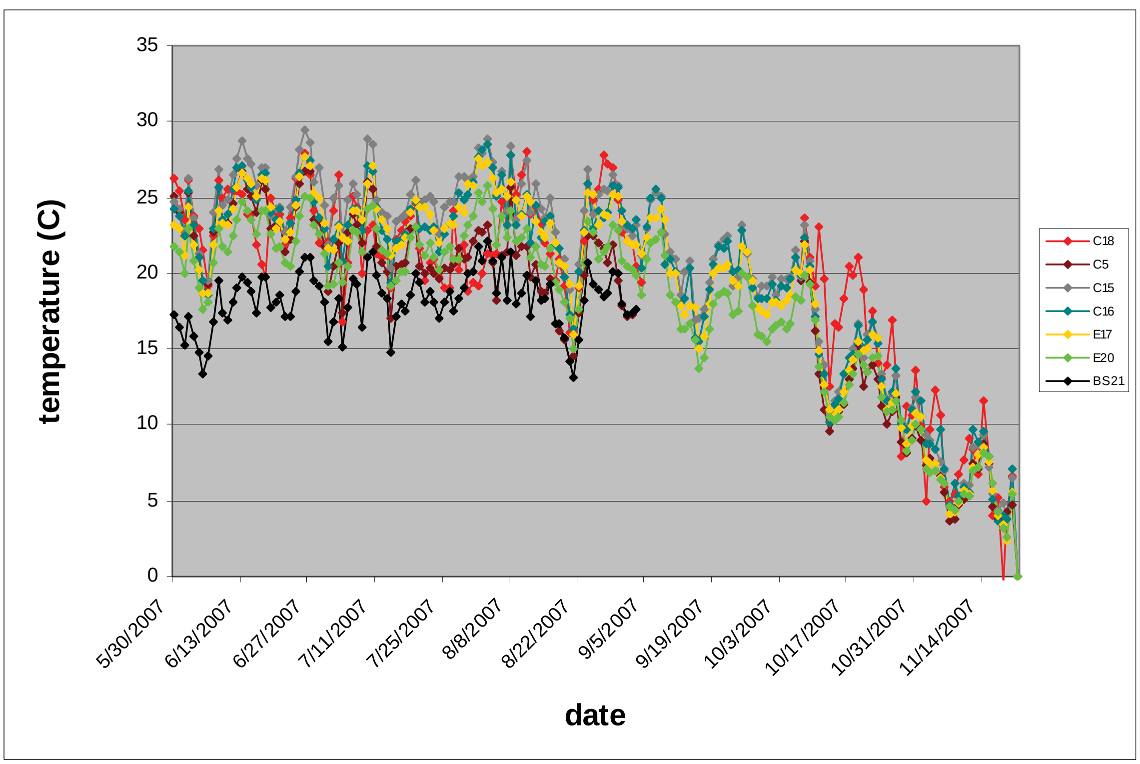


Figure 4: Maximum daily temperature for Clythe Creek (sites C18 to BS21 are listed upstream to downstream).

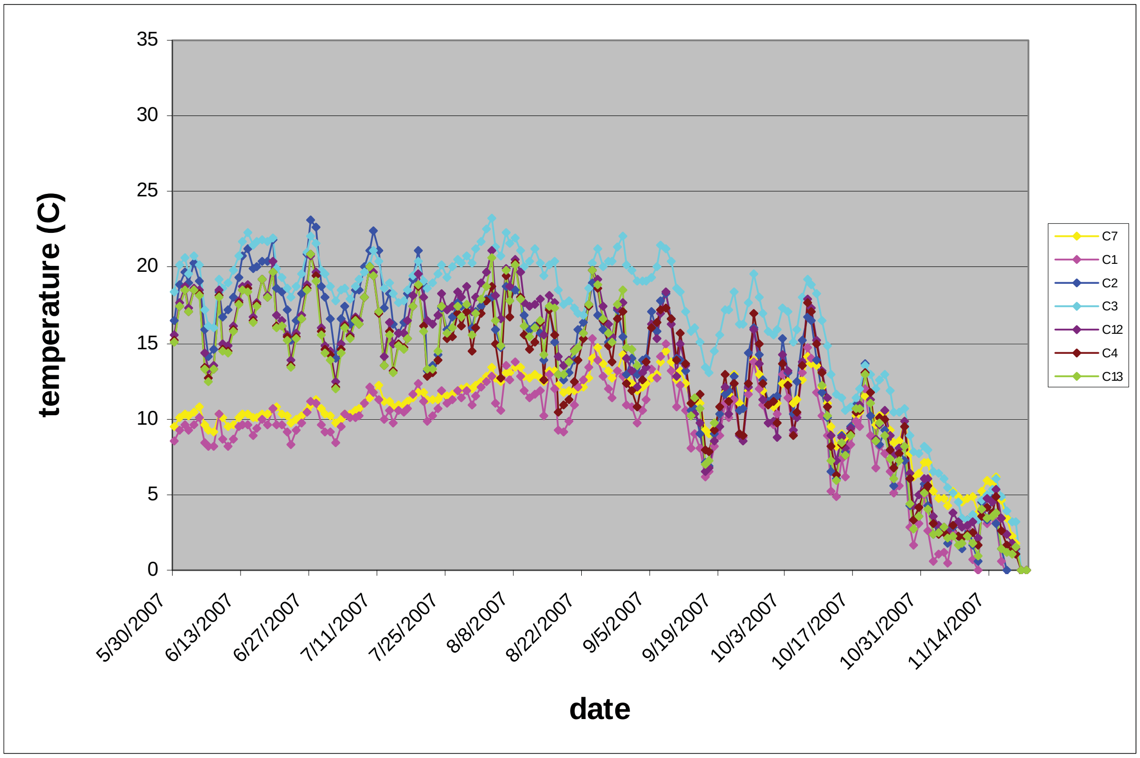


Figure 5: Minimum daily temperature for Clythe Creek (sites C7 to C13 are listed upstream to downstream).

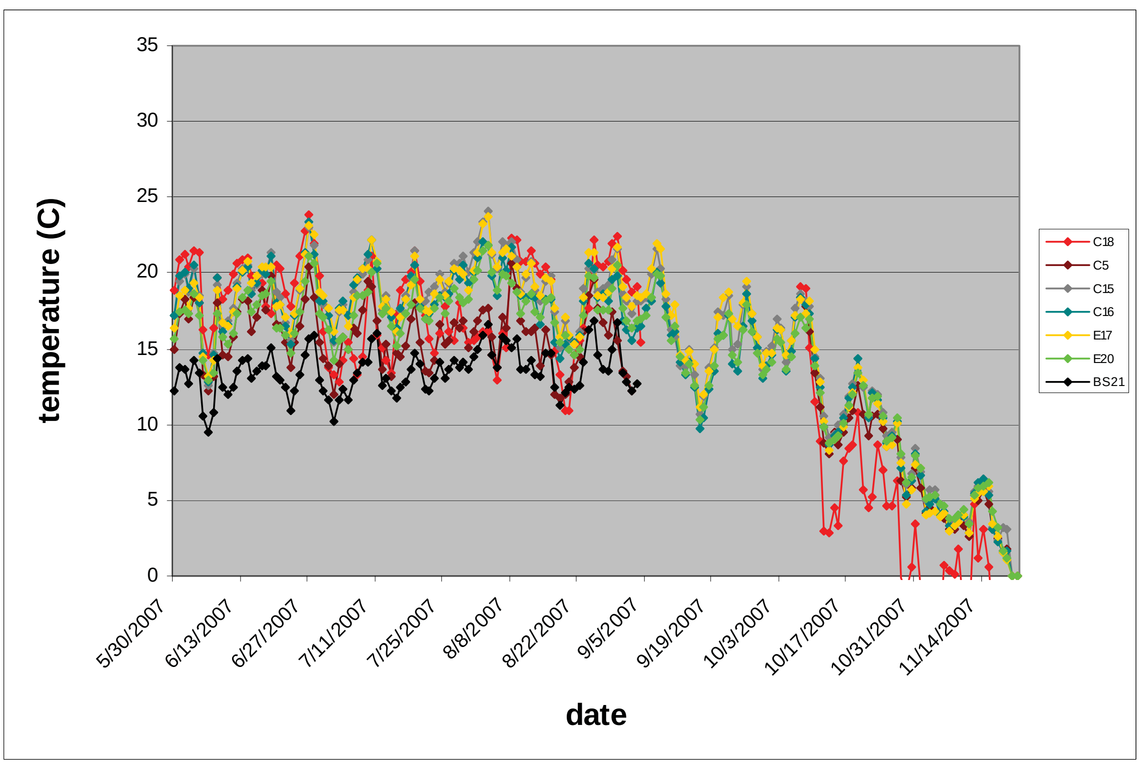


Figure 6: Minimum daily temperature for Clythe Creek (sites C18 to BS21 are listed upstream to downstream).

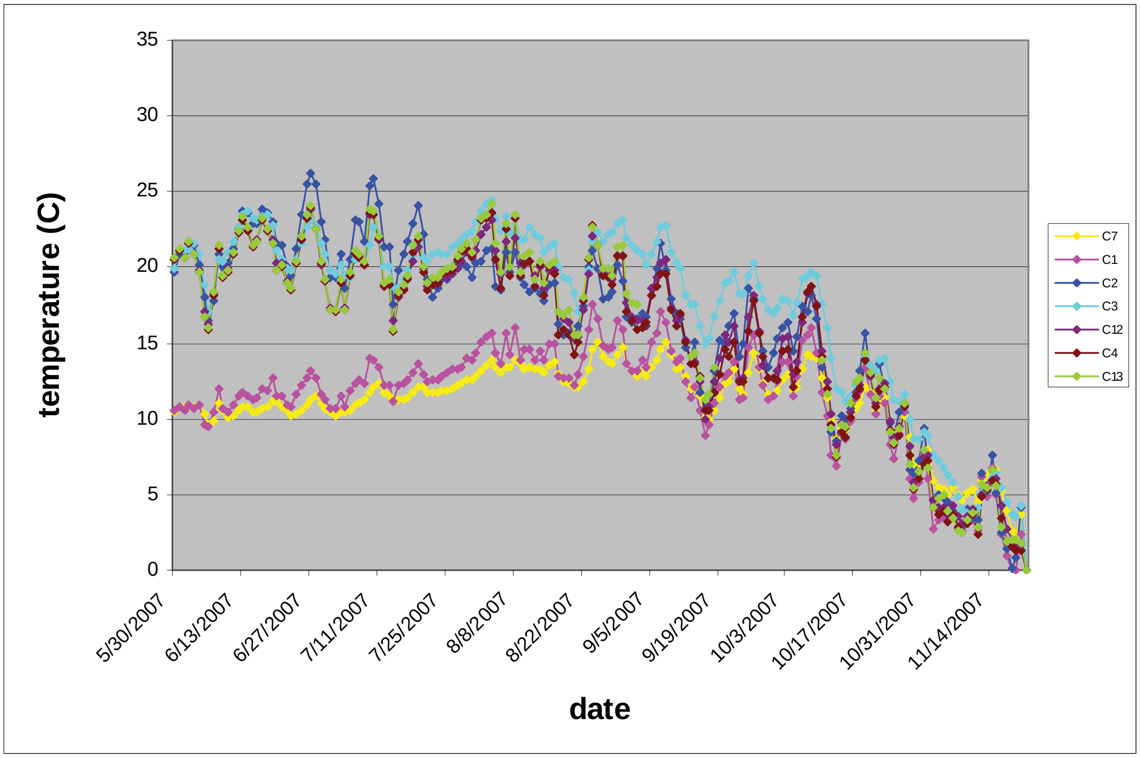


Figure 7: Average daily temperature for Clythe Creek (sites C7 to C13 are listed upstream to downstream).

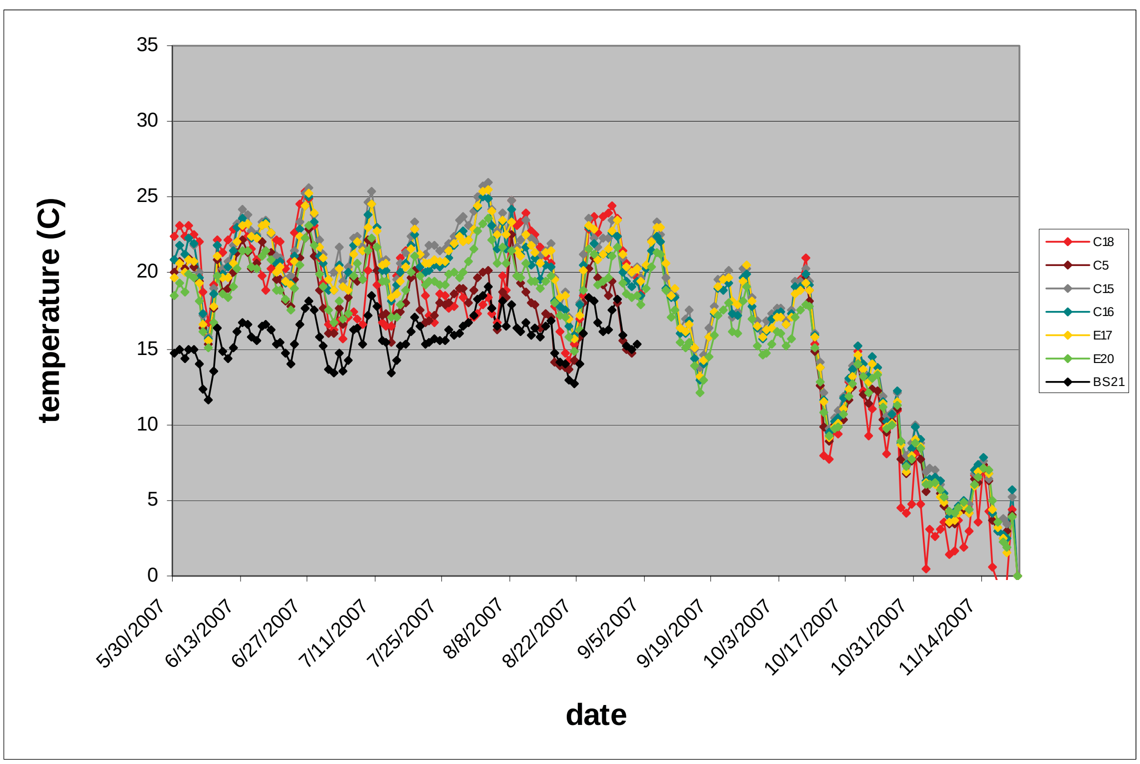


Figure 8: Average daily temperature for Clythe Creek (sites C18 to BS21 are listed upstream to downstream).

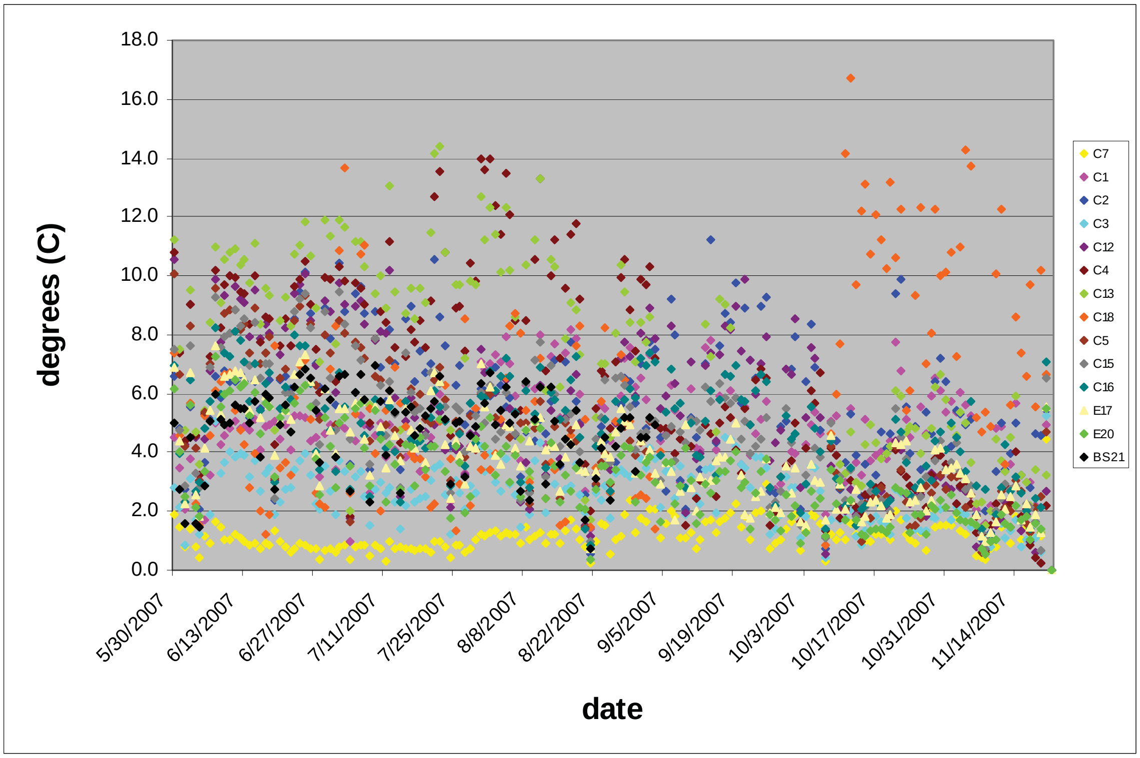


Figure 9: Daily range in temperature at all sites.

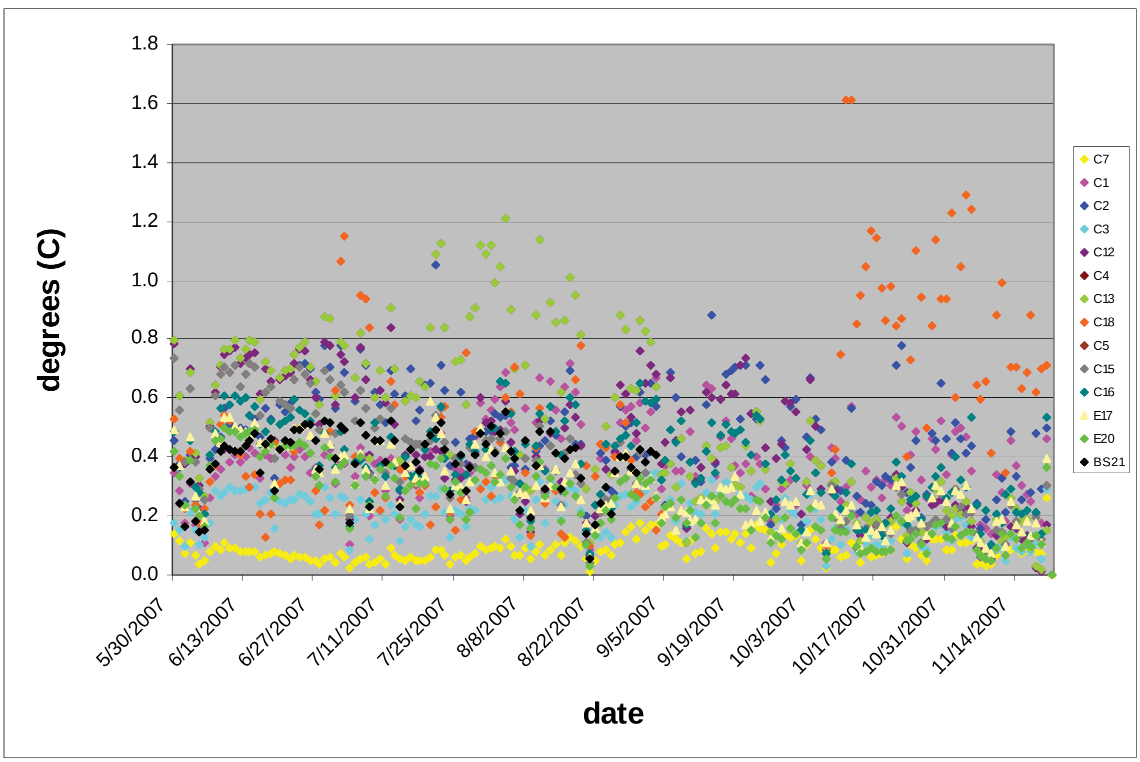


Figure 10: Average hourly rate of change in temperature per day at all sites

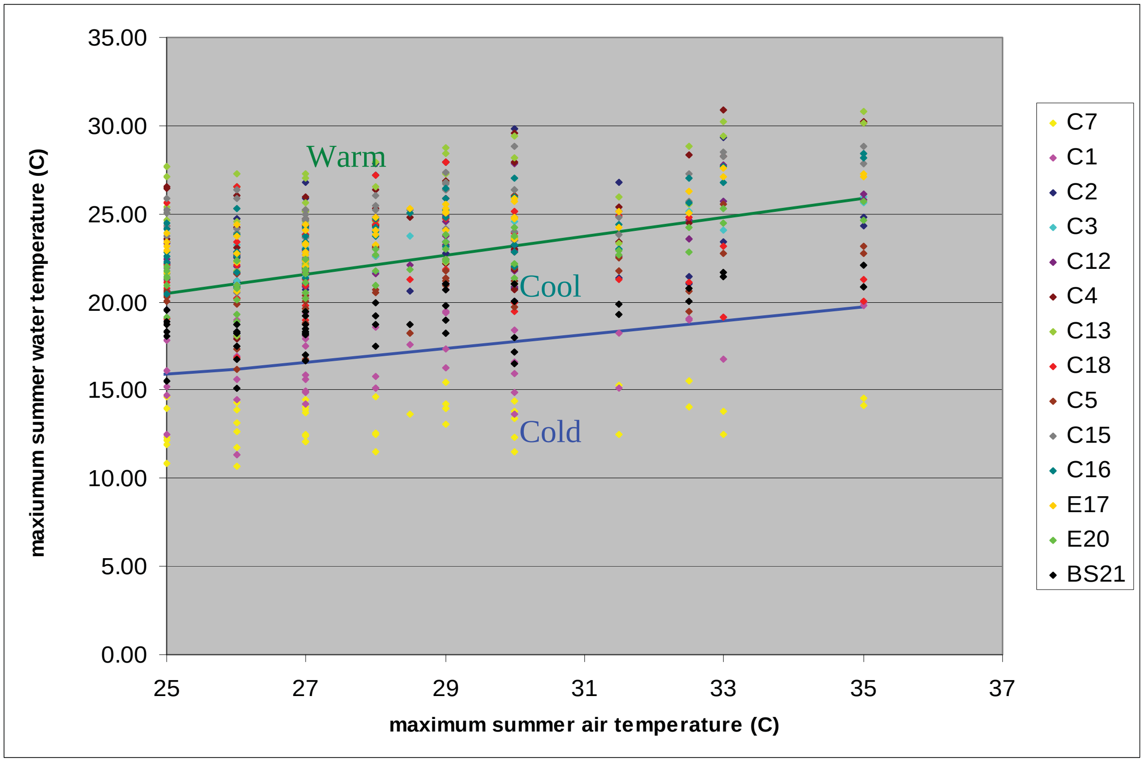


Figure 11: Stream classification of all sites (format from Stoneman and Jones 1996). Sites plotted below blue line classify as cold water, between blue and green classified as cool water and above green classified as warm water sites.

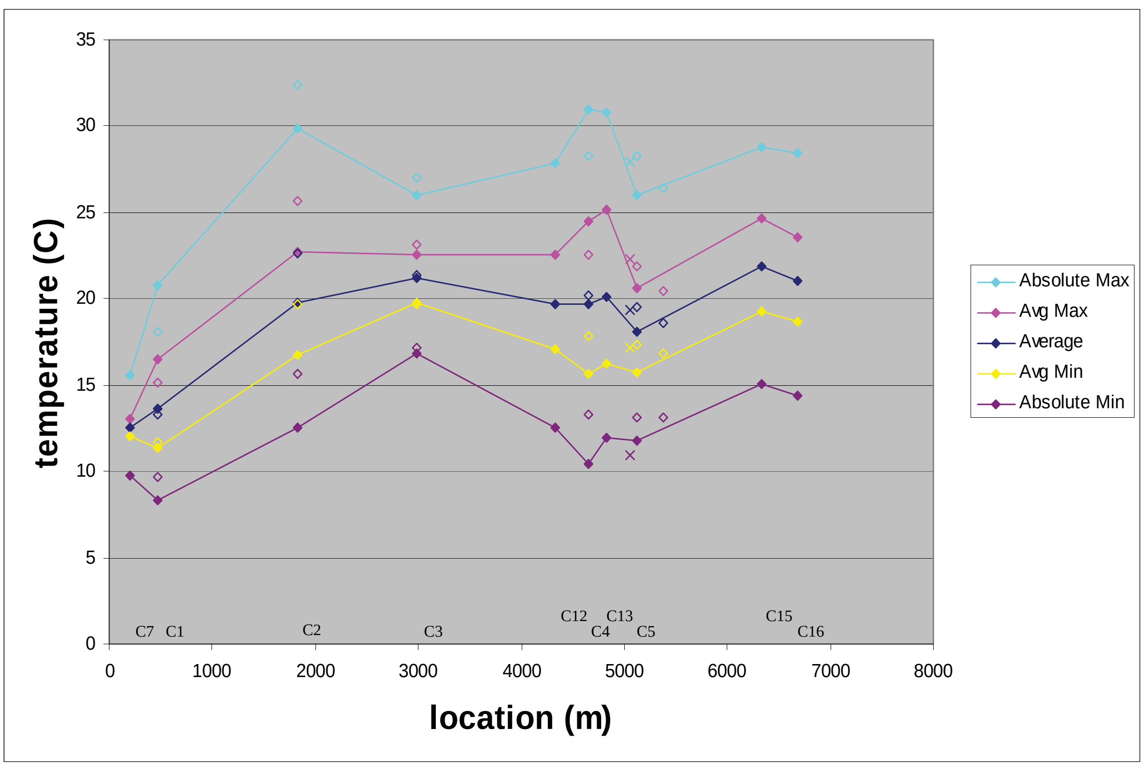


Figure 12: Longitudinal chart showing change in temperature from upstream to downstream during peak summer months (July and August). Solid points represent 2007 data, hollow points represent 2006, 'X' represent the stormwater outflow (C18).

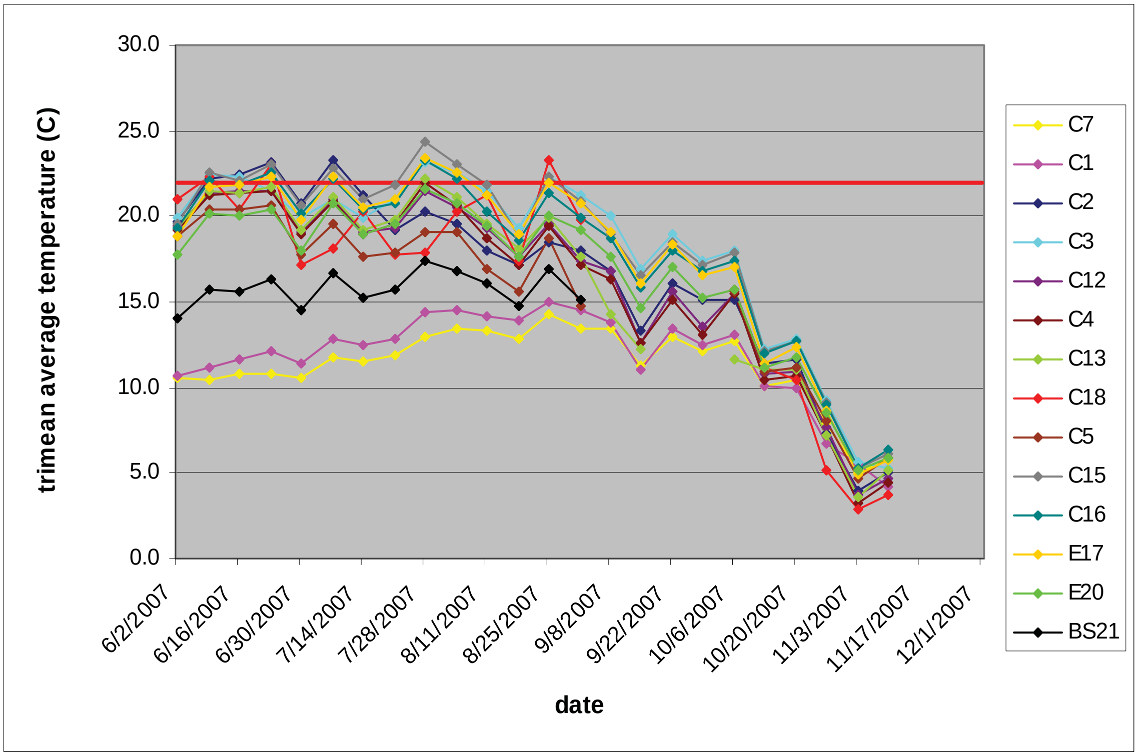


Figure 13: Trimean average temperature for Clythe Creek (sites are listed upstream to downstream). The red line marks 22ºC.

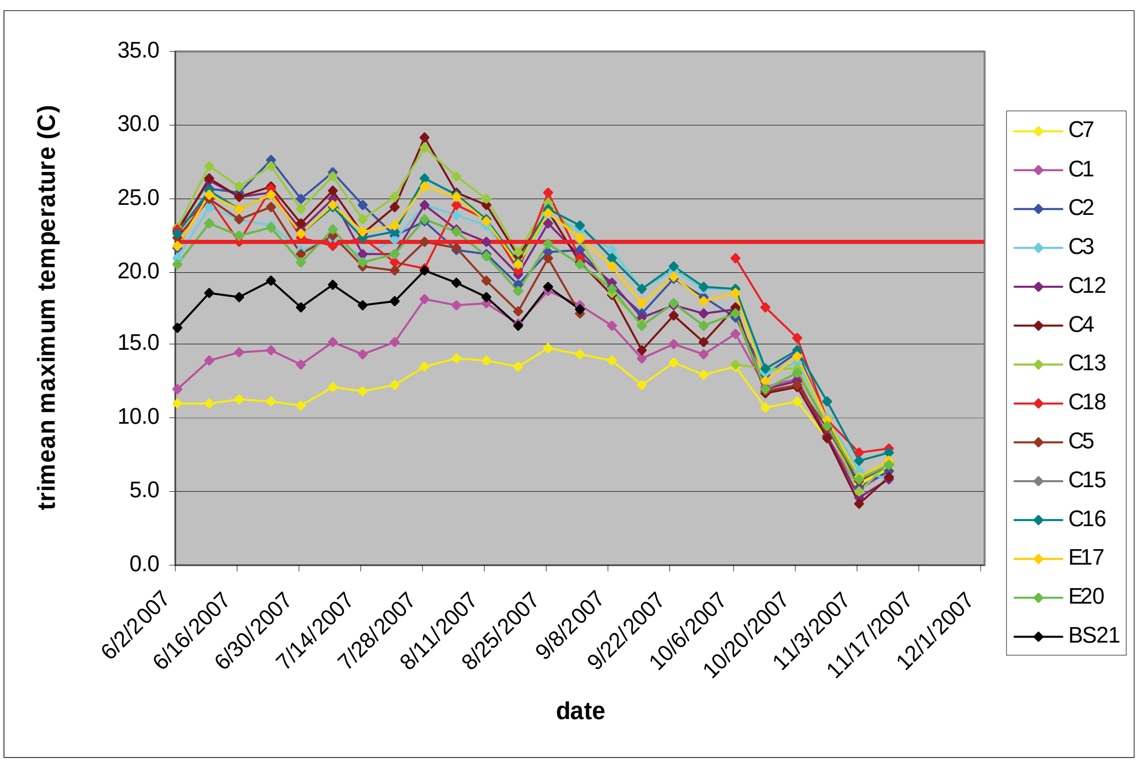


Figure 14: Trimean maximum temperature for Clythe Creek (sites are listed upstream to downstream). The red line marks 22ºC.

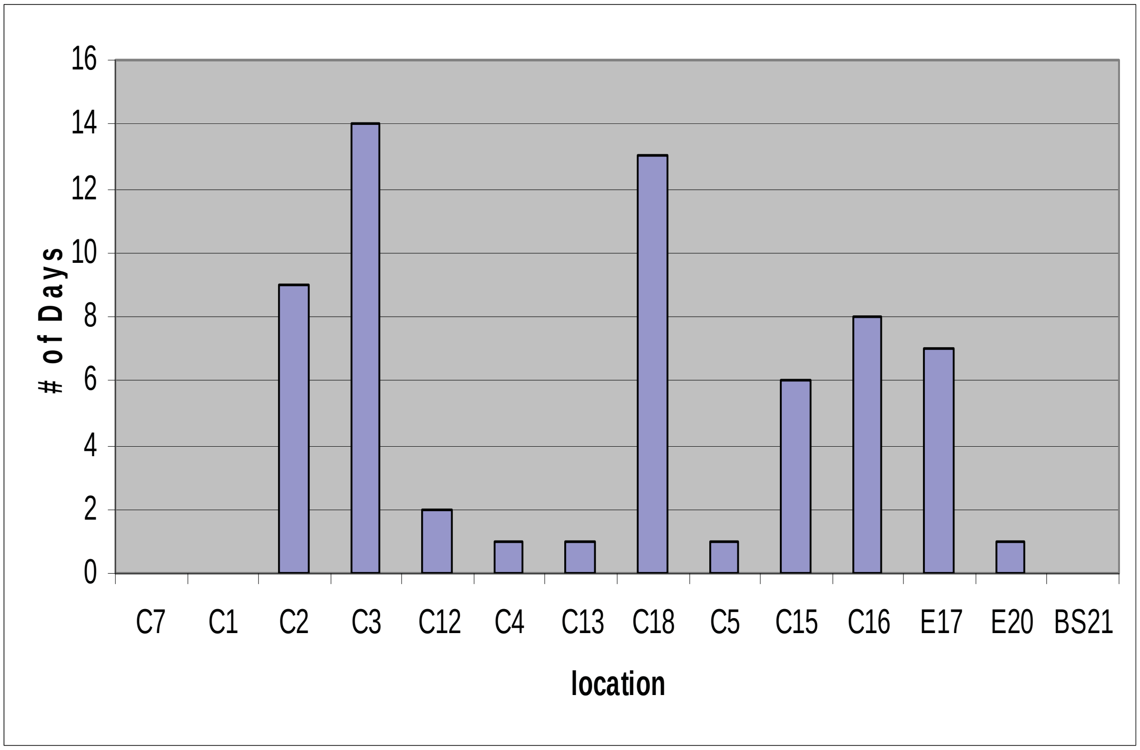


Figure 15: Number of days where temperatures were sustained over 19ºC for a 24h period.

Implications

There is a great deal of variability in temperature trends throughout the length of Clythe Creek. This is likely due to the large number of online ponds combined with multiple areas of groundwater seepage. The most significant increase in water temperatures is between site C1 to site C2. This is likely due to the online pond created by a weir located at Jones Baseline. Water temperatures decrease between Jones Baseline (C2) and Watson Road North (C4), likely as a result of groundwater inputs, which is consistent with observations of numerous groundwater seeps in this reach of the creek in 2006. The effects of the warm water from the storm water management pond (C18) on minimum temperatures of the creek is seasonal. However, the degree of cooling in this area (between C13 and C5) could be greater if not for the effects of the stormwater management pond.

The presence of groundwater inputs in the upper reaches of Clythe Creek provide great potential for coldwater restoration. With the removal of the impoundment upstream of Jones Baseline, the increase in water flow combined with coldwater inputs will likely mitigate general warming of the system allowing this creek to be cooled from top to bottom. This mitigation could potentially return this creek to a coldwater classification capable of sustaining brook trout.

It is strongly recommended that an attempt is made to contact landowners and neighbours of Clythe Creek and discuss the implications of online ponds and the benefits of removal. Mitigation of these impoundments should be prioritized with impoundments further upstream holding the highest priority. Monitoring of any physical changes to the creek will aid in our understanding of the degree of benefit to this system and will further aid in the understanding of temperature regimes downstream.

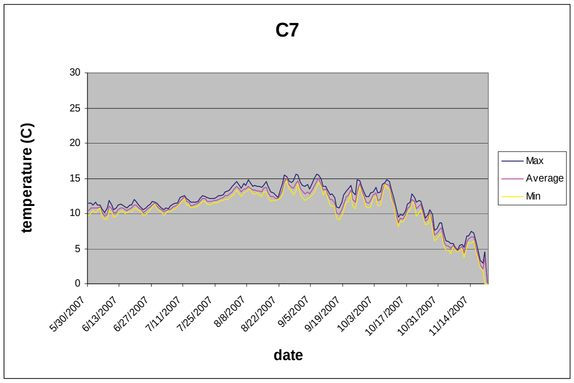
It is recommended that water quality (chemistry) information at strategic locations be collected to help assess the influence of land use activities, specifically, the impacts of storm water management ponds in the developing lower portion of the watershed. Measurements should include variables such as turbidity, conductivity, pH and dissolved oxygen.

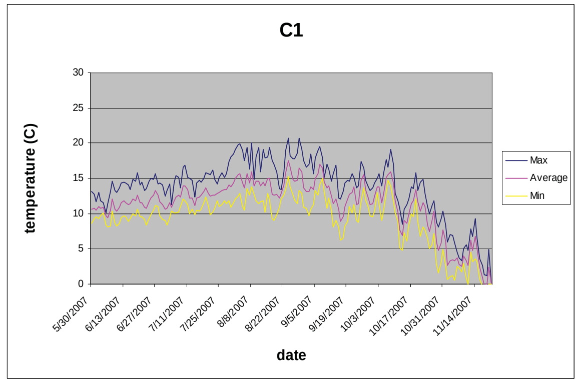
Based on these data it would be beneficial to survey the fish community composition in selected sections of the creek to identify any remnant coldwater communities. Anicdotal evidence from preliminary surveying by the Speed Valley Chapter of Trout Unlimited Canada in 2007 revealed the presence of central mudminnow, pearl dace, brook stickleback, northern redbelly dace and sculpin in Clythe Creek. Brook stickleback and sculpin are commonly found in the same habitats as brook trout and can be considered indicators of aquatic health. Future surveys should include reaches upstream of Wellington Road 29 and between Highway 7 and Watson Road North. These are the most likely areas to support remnant populations of coldwater species such as brook trout and these results should be compared to historical surveys to assess changes in community composition.

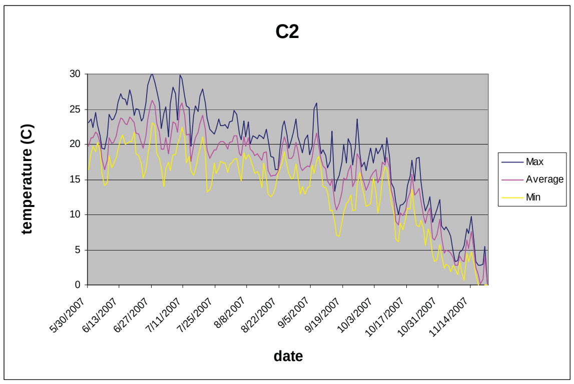
Clythe Creek holds great potential for restoration. The available groundwater and gradient allow for cooling downstream which will mitigate some of the warming caused by impoundments. Increasing water flow by removing impoundments will increase this mitigation potentially creating coldwater habitats.

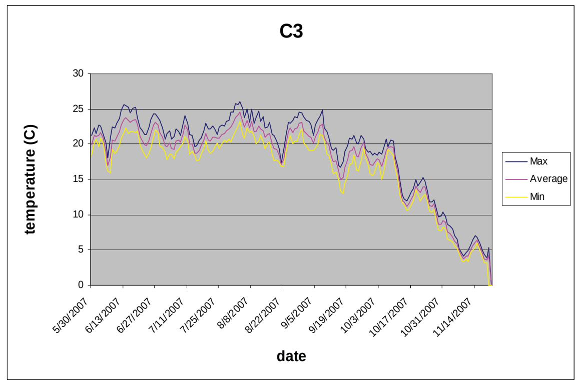
Appendix A Individual Site Data

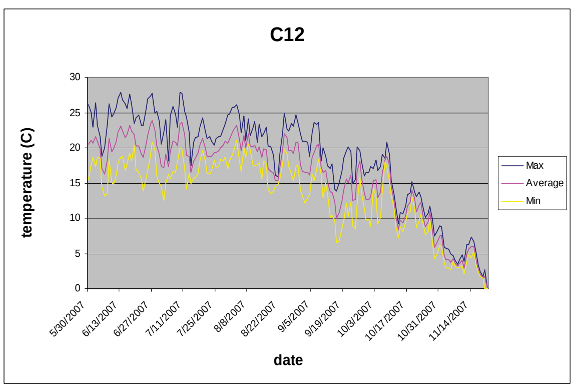
Displaying Daily Average & Minimum/Maximum Temperatures

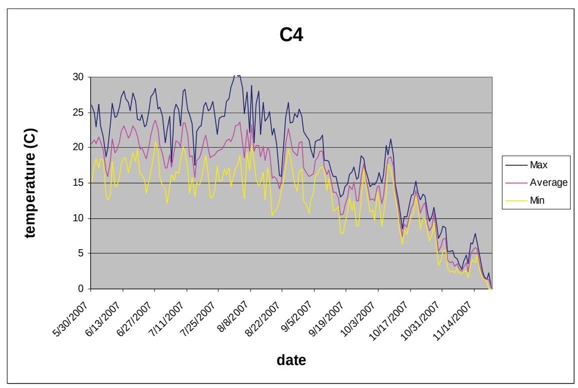


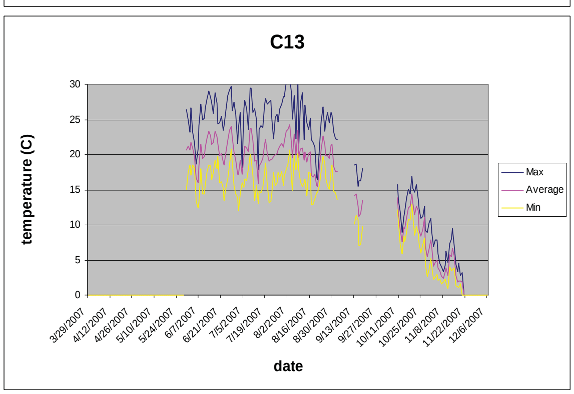


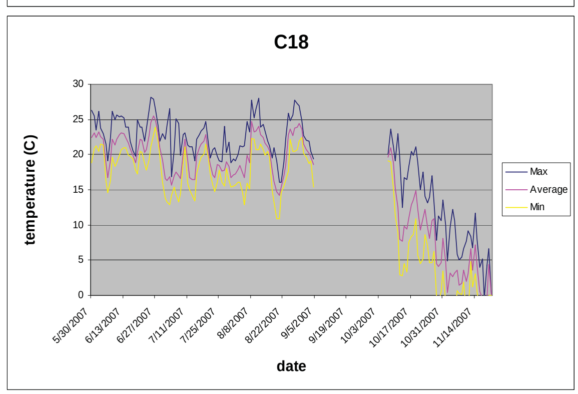


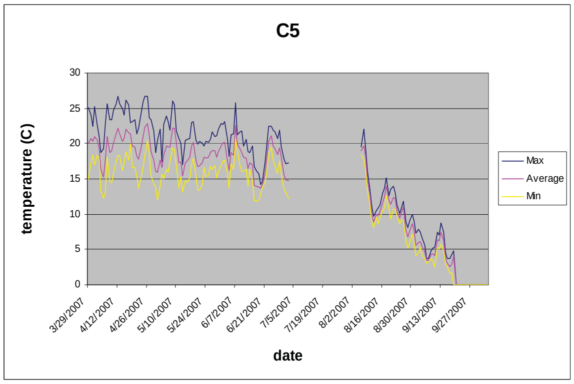








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30
25
20
15
10
5
0
3/29/2007
4/12/2007
4/26/2007
5/10/2007
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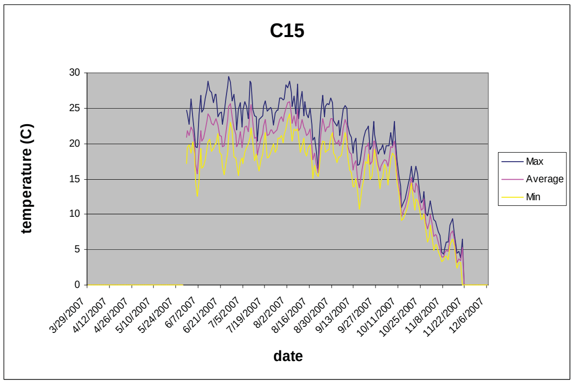
6/7/2007
6/21/2007
7/5/2007
7/19/2007
8/2/2007
8/16/2007
8/30/2007
9/13/2007
9/27/2007
date
Max
Average
Min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4/12/2007
4/26/2007
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7/5/2007
7/19/2007
8/2/2007
8/16/2007
8/30/2007
9/13/2007
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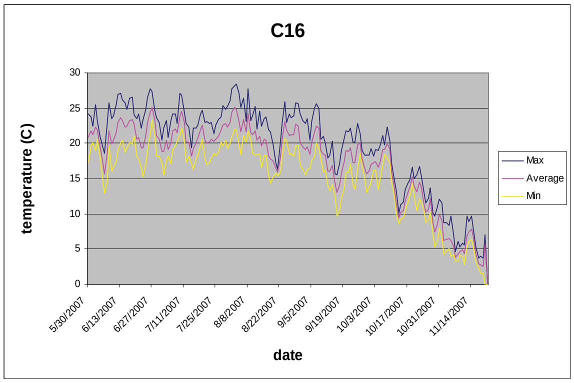
10/11/2007
10/25/2007
11/8/2007
11/22/2007
12/6/2007
date
Max
Average
Min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20
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6/27/2007
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8/8/2007
8/22/2007
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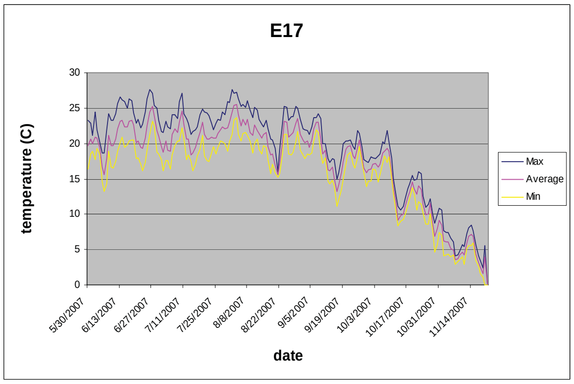
9/19/2007
10/3/2007
10/17/2007
10/31/2007
11/14/2007
date
Max
Average
Min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6/27/2007
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8/8/2007
8/22/2007
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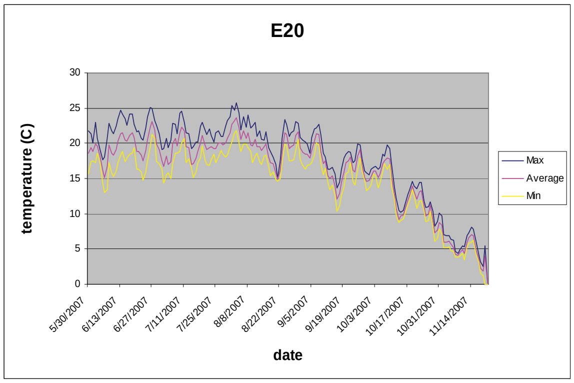
9/19/2007
10/3/2007
10/17/2007
10/31/2007
11/14/2007
date
Max
Average
Min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8/8/2007
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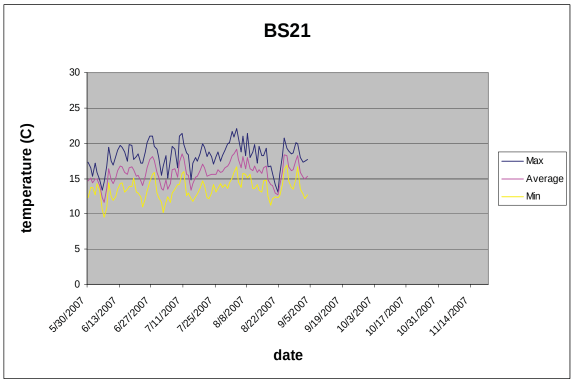
date
Max
Average
Min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10/3/2007
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11/14/2007
date
Max
Average
Min

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Appendix F

Fluvial Geomorphology

YORK ROAD ENVIRONMENTAL DESIGN STUDY: FLUVIAL GEOMORPHIC EXISTING CONDITIONS AND DESIGN OPTIONS

Report Prepared for:
WOOD

Prepared by:
MATRIX SOLUTIONS INC.

Version 1.0
March 2019
Mississauga, Ontario

Suite 200, 2500 Meadowpine Boulevard
Mississauga, ON, Canada L5N 6C4
Phone: 905.877.9531 Fax: 905.877.4143
www.matrix-solutions.com

YORK ROAD ENVIRONMENTAL DESIGN STUDY:

FLUVIAL GEOMORPHIC EXISTING CONDITIONS AND DESIGN OPTIONS

Report prepared for Wood, March 2019

Mark Wojda, M.Sc.E., P.Eng.
Water Resources Engineer

Dave Van Vliet, M.A.Sc., P.Eng.
Vice President Operations, East

DISCLAIMER

VERSION CONTROL

Version	Date	Authors	Issue Type	Filename	Description
V0.1	07-Mar-2017	JH, JP	Draft	22257-514 York Road Geomorphology 2017-03-07 draft.docx	Issued to client for review
V0.2	20-Nov-2018	MW	Draft Revised	22257-514 Geomorph R 2018-11-20 draft V0.2.docx	Updates throughout. Issued to client for review.
V1.0	21-Mar-2019	MW, DVV	Final	22257-514 Geomorph R 2019-03-21 final V1.0.docx	Issued to client

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APPENDICES

1 INTRODUCTION

Matrix Solutions Inc. has been retained by Wood to provide fluvial geomorphic guidance with regards to the York Road Environmental Design Study initiated by the City of Guelph. The project objectives are intended to assist with the implementation of recommendations identified in the 2007 York Road Improvements Class Environmental Assessment (EA). Specifically, the 2007 EA recommended that York Road be widened from Victoria Road to the East City Limits from its existing 2-lane footprint to a 4-lane roadway with a 1.5 m bicycle lane in each direction and associated curbs, sidewalks, and gutters (NRSI 2006). As a result of the proposed road widening, there will be impacts to Clythe Creek which flows adjacent to York Road between Watson Parkway and Industrial Avenue. Due to these impacts, recommendations for the channel included the following:

- extension of the existing Clythe Creek culvert crossing of York Road
- relocation of approximately 135 m of Clythe Creek to accommodate the proposed road widening
- implementation of riparian plantings to separate the widened roadway from the relocated Clythe Creek channel

This assessment documents existing fluvial geomorphic conditions and identifies and evaluates alternative solutions that conform to the 2007 EA recommendations while taking into consideration the overall form and function of Clythe Creek. The optimal outcome is one in which Clythe Creek is able to maintain long-term stability and natural fluvial form and function is promoted (i.e., sediment transport processes). As part of the overall Environmental Design Study work, a preferred alternative for the realignment of Clythe Creek was identified for the March 2017 draft environmental impact study (EIS) submission. The current report provides an update to the draft submission and includes further detail regarding originally-contemplated alternatives and discussion of creek impacts with regards to refined road alternatives that were evaluated in 2018.

2 BACKGROUND REVIEW

The background review of Clythe Creek focused on a desktop analysis of existing conditions. The review organized the available information in order to identify any significant data gaps and to scope future fluvial geomorphic field work initiatives. Data obtained and reviewed included existing subwatershed study reports, stormwater management and drainage studies, geographic information, and aerial photography.

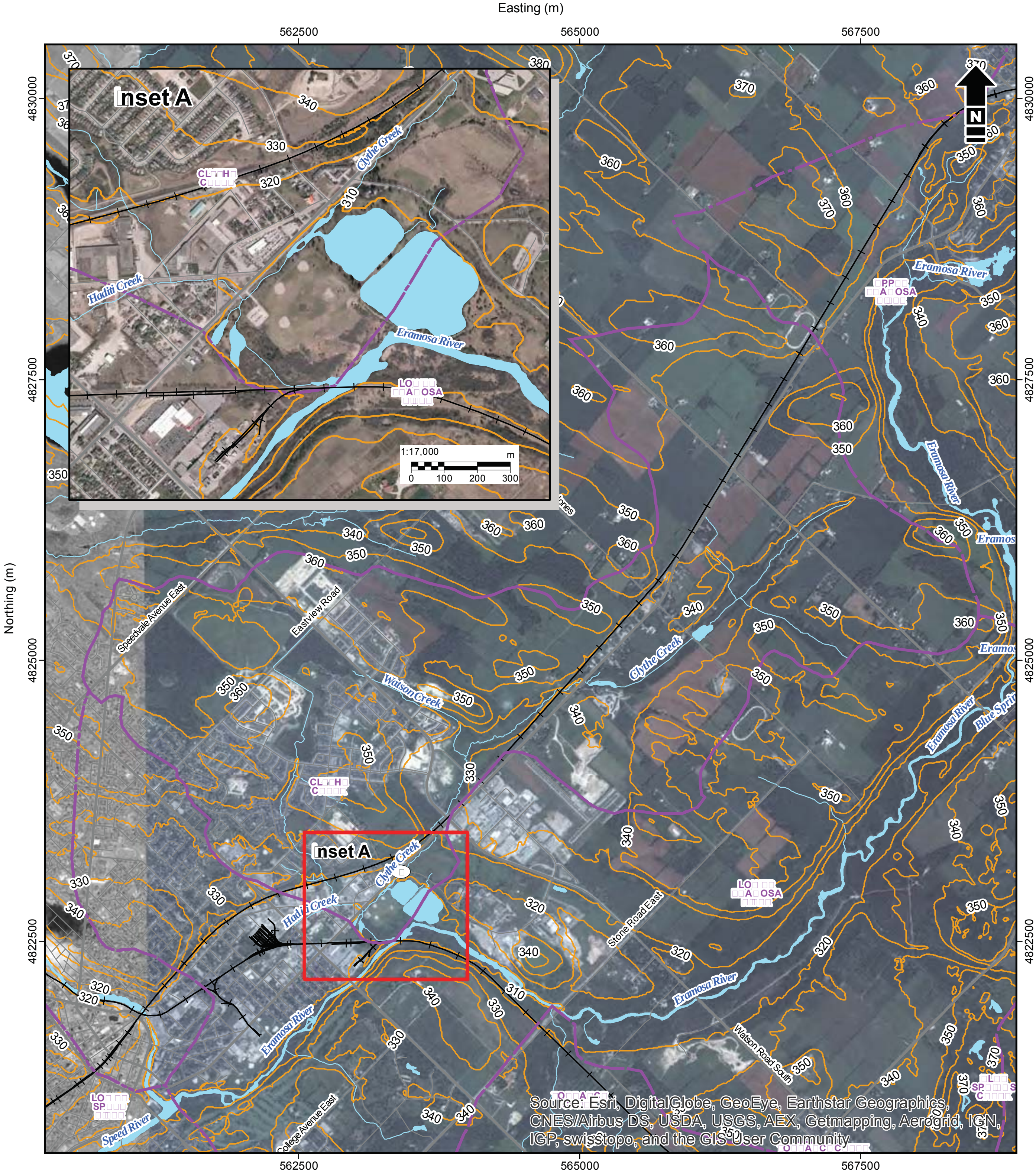
2.1 Study Area

Located within the City of Guelph, the study area discharges into Clythe Creek which flows southwesterly, parallel to the south side of York Road between Watson Parkway and Industrial Avenue. At Industrial Avenue, the channel changes direction to flow southeasterly and confluence with the

Eramosa River immediately upstream from a rail line. Figure 2.1 depicts the Clythe Creek subwatershed and the study area.

The Clythe Creek subwatershed is composed of Clythe Creek and its two tributaries, Watson Creek, and Hadati Creek. The Clythe Creek subwatershed has an approximate drainage area of 21 km^2, and is dominated by both agricultural and urban land uses. Clythe Creek is considered a cold water stream with a band of wetland vegetation found along its length. The abundance of groundwater near or at the ground surface in this watershed plays a key role in influencing the composition and distribution of vegetation within the watershed.

The study area of Clythe Creek is located within lands associated with the former Guelph Correctional Centre (GCC; the Reformatory) which was in operation from 1910 to 2001, and is currently owned by Infrastructure Ontario. The close proximity to the Reformatory buildings has had a large impact on the overall fluvial form and functioning of Clythe Creek within the study area, as numerous culverts, bridges, dams, and weirs have been installed along the channel by inmates of the facility. Additionally, two online ponds (the Reformatory Ponds) have been created which drainage directly into Clythe Creek, as well as the Eramosa River. The channel also flows through additional ponds (the Industrial Ponds) at the western extent of the study area before the channel changes direction to confluence with the Eramosa River.



Subwatershed Boundary
Water Body
Watercourse
Highway
Road
Railway
Elevation Contour Interval (10m)

Reference: Data obtained from GeoBase® used under license. This is version 1.0 of the Open Government Licence – Ontario. Contains Information made available under Grand River Conservation Authority's Open Data Licence v1.0
Imagery (2012) obtained from City of Guelph used under license.

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Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph
York Road Environmental Design

Clythe Cree□ Su□□atershed

Date:	Project:	Technical:	Reviewer:	Drawn:
17 Dec 2015	22257	J. Parish	P. Chin	C. Curry

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2.2 Historical Assessment

A historical aerial image from 1930 (Figure 2.2) was obtained for the study area and was used to infer past and present land uses within the area. Within the image, several features that are consistent with current land use are present, including the Reformatory (buildings and access roads), York Road, railway alignments, and the Clythe Creek confluence with Eramosa River.

Two aesthetic ponds are located on opposite sides of the correctional facility main driveway, and several small drainage features, originating to the west of the Reformatory, are present that discharge directly into the Eramosa River. Clythe Creek flows adjacent to York Road along its current alignment, becoming noticeably more pronounced (i.e., wider) with multiple flow pathways in the downstream direction. Both of the Reformatory Ponds are absent from the image. The pronounced change in direction of the Eramosa River as it passed the Reformatory is more abrupt in 1930, indicating channel realignment when the south Reformatory Pond was created.

FIGURE 2.2 1930 Historical Aerial Image for the Study Area

2.3 Previous Studies

Matrix reviewed available background information pertaining to the fluvial geomorphic aspects of Clythe Creek. The review identified watercourse reaches that have been delineated and studied by others that will be adopted by Matrix for use in this assessment. While watershed based studies (e.g., for the Eramosa River and Clythe Creek) related to the overall state of the watercourses' health have been completed during the last few decades, no study was able to provide a detailed characterization of the entire subwatershed; however, site specific information on channel dimensions and characteristics were obtained for several locations along the channel and within the current study area adjacent to York Road. Several conceptual channel designs have also been considered for Clythe Creek as part of the proposed York Road widening. A full list and overview of the background reports reviewed can be found in the Geomorphic Background Review Report (Technical Memo #1; Matrix, 2016).

3 METHODOLOGY

The fluvial geomorphology of Clythe Creek was assessed through a combination of desktop and field investigations. Matrix personnel were required to comply with legislated, Matrix, and Wood health and safety standards.

3.1 Reach Delineation

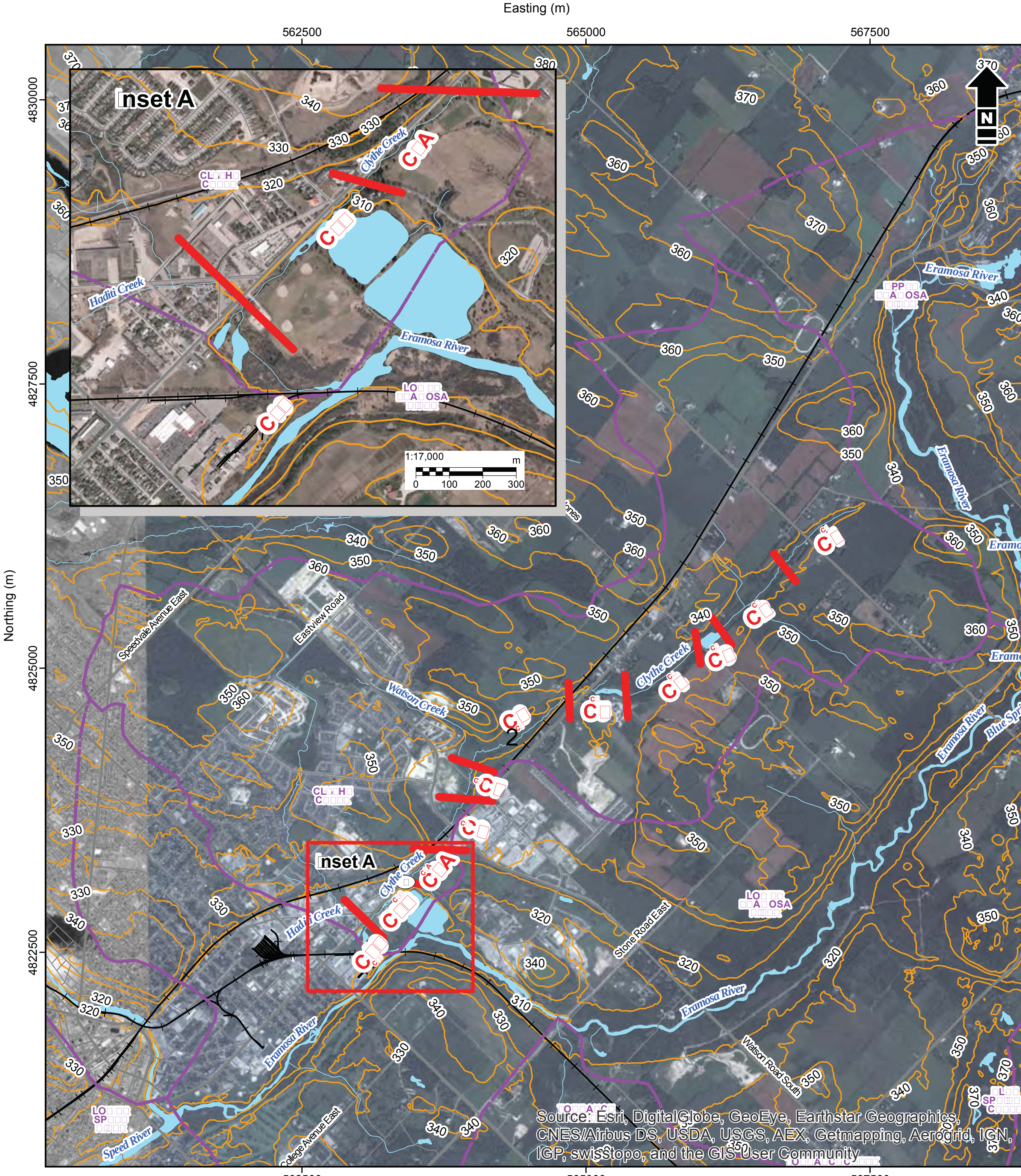
Reaches are lengths of channel that display similarity with respect to valley setting, planform, floodplain materials, and land use/cover. Reach length will vary with channel scale since the morphology of low order watercourses will vary over a smaller distance than those of higher order watercourses. At the reach scale, characteristics of the stream corridor exert a direct influence on channel form, function, and processes.

Within the Clythe Creek subwatershed study reviewed as part of the background review assessment (Ecologistics 1997), ten reaches were identified along the Clythe Creek based on habitat characteristics. The reaches are named based on position along the watercourse chainage; with Reach C-1 located furthest upstream within the headwaters and Reach C-10 located furthest downstream extending to the confluence with the Eramosa River. The Clythe Creek reach delineation is displayed on Figure 3.1.

The study area is located within Reach C-9 and C-10. Reach C-9 corresponds with the Clythe Creek channel corridor downstream from York Road to the confluence with Hadati Creek. The 1997 subwatershed study describes this reach as having a bankfull width of 1 to 5 m and average bankfull depth of 0.5 m. Channel substrate is described as gravel and rubble with a thin organic layer. Riparian cover is mowed lawn with landscaping, numerous artificial waterfalls and weirs to control channel gradient, and several culverts and storm outfalls adding discharge. Reach C-10 extends from the Hadati Creek confluence downstream to the Eramosa River. This reach is described as having bankfull widths ranging from 10 to 12 m and an average bankfull depth of 0.5 m, with silty organic material composing the bed substrate. Riparian cover consists of dense cedar forest with mixed herbaceous an occasional willow trees (Ecologistics 1997).

Further refinement of this previous delineation is warranted for the current study due to differences in channel morphology and planform that exist. For the purposes of the existing study, Reach C-9A represents the upstream segment of Clythe Creek Reach C-9; extending for approximately 445 m downstream from York Road to the historical stone arch bridge at the Reformatory driveway. Reach C-9B represents the downstream segment, extending from the Reformatory driveway, 500 m downstream to the confluence with Hadati Creek. Reach C-10 continues to represent the channel downstream from Hadati Creek to the Eramosa River.

A 280 m long reach of Hadati Creek, Reach HC-1, which extends upstream from the Clythe Creek confluence to Suburban Avenue, was also included in the field reconnaissance to ensure existing conditions along the channel are properly documented and that proposed design options along Clythe Creek will not produce negative effects upstream within Hadati Creek.



Subwatershed Boundary
Water Body
Watercourse
Highway
Road
Railway
Elevation Contour Interval (10m)
Reach Break

Reference: Data obtained from GeoBase® used under license. This is version 1.0 of the Open Government Licence – Canada. Contains Information made available under Grand River Conservation Authority's Open Data Licence v1.0
Imagery (2012) obtained from City of Guelph used under license.

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Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph
York Road Environmental Design

Clythe Cree□ □each □rea□s

Date:	Project:	Technical:	Reviewer:	Drawn:
29 Jan 2016	22257	J. Parish	P. Chin	C. Curry

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3.2 Field Reconnaissance

In order to provide insight regarding existing geomorphic conditions and document any evidence of active erosion, an initial site visit was conducted on December 22, 2015. The purpose of the visit was to observe channel conditions, examine patterns and processes of local erosion and sediment transport, and to verify aerial imagery-based interpretations. During the visit, channel conditions along the study reaches were also evaluated using two established synoptic surveys: the Rapid Geomorphic Assessment (RGA) and the Rapid Stream Assessment Technique (RSAT).

3.2.1 Rapid Geomorphic Assessment

The RGA was designed by the Ontario Ministry of Environment (MOE 2003) 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 is 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 that can be interpreted to represent the relative degree of channel adjustment and/or sensitivity to altered sediment and flow regimes (Table 3.1).

TABLE 3.1 Rapid Geomorphic Assessment Classification

Index	Classification	Interpretation
≤0.20	In Regime or Stable (Least Sensitive)	The channel morphology is within a range of variance for streams of similar hydrographic characteristics - evidence of instability is isolated or associated with normal river meander propagation processes
0.21 to 0.40	Transitional/Stressed (Moderately Sensitive)	Channel morphology is within the range of variance for streams of similar hydrographic characteristics but the evidence of instability is frequent
≥0.41	In Adjustment (Most Sensitive)	Channel morphology is not within the range of variance and evidence of instability is wide spread

3.2.2 Rapid Stream Assessment Technique

The RSAT (Galli 1996) 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:

1. Channel Stability
2. Erosion and Deposition
3. Instream Habitat
4. Water Quality
5. Riparian Conditions
6. 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 final value is then categorized into one of three classes: low (poor health), moderate (moderate health), and high (good health).

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

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.).

3.3 Detailed Assessment Survey

Subsequent field reconnaissance was completed by Matrix fluvial geomorphology specialists on May 2, 2016 following spring freshet conditions to complete a detailed geomorphic assessment survey of Clythe Creek. The survey was conducted to support preliminary design recommendations and included bankfull cross-sections and a longitudinal profile surveyed with Total Station survey equipment along with substrate characterization and characterization of bank properties. The surveys were used to determine channel bankfull dimensions and provide indications of bed morphology and local energy gradient.

4 FLUVIAL GEOMORPHIC EXISTING CONDITIONS

4.1 Rapid Assessment Results

General observations of channel dimensions, such as bankfull width and depth, substrate size, bank height, in-channel and riparian cover, channel hardening, and other disturbances (e.g., excessive erosion) were documented as part of the overall geomorphic assessment on Clythe Creek and Hadati Creek. The following section provides results of the rapid assessments for Clythe Creek (Reaches C-9A, C-9B, and C-10) and Hadati Creek (Reach HC-1) within the study area.

In natural, stable streams the “bankfull” channel area generally represents the maximum capacity of the channel before flow spills into the floodplain, and is associated with the channel-forming discharge (bankfull discharge). Field indicators include obvious breaks or inflections in the cross-section profile, top elevation of point bars, and changes in vegetation. However, given the impacts of channelization and backwatering, bankfull indicators are often difficult to discern and field identifiers can be unreliable in urban settings.

4.1.1 Reach C-9A

Reach C-9A extends downstream from York Road (approximately 175 m west of Watson Parkway) following a generally sinuous planform. The downstream reach break is located at the historical stone arch bridge that serves as entrance to the former GCC. The overall reach length is approximately 445 m. Within the reach, eight historical instream structures have been identified, as well as two outfalls and one tributary confluence. Due to the extent of instream structures which control flow within the reach, the majority of the channel is backwatered into pools. Only two riffle features were observed, comprising of cobble and gravel substrate. Substrate in the pools was predominantly unconsolidated silts and sands. Bankfull width within the reach was measured at 3 m, with bankfull depth at 0.5 m. Due to backwatering effects, water levels throughout the reach were at or near bankfull during the time of the onsite assessments, leading to oversaturated bank material with observed fracture lines along the top of bank. Bank undercutting was also observed at a few locations toward the downstream extent of the reach; however boulder stone placement along the bank toe throughout the majority of the reach prevents substantial erosion. The RGA score for Reach C-9A is 0.33 indicating a channel in transition, with evidence of aggradation being the dominant geomorphic factor influencing channel function. The RSAT score of 25 indicated the channel in generally in moderate health, however major limiting factors in the reach include water quality, riparian conditions, and biological indicators.

4.1.2 Reach C-9B

Reach C-9B extends downstream from the historical stone arch ridge to the confluence with Hadati Creek. The overall reach length is approximately 500 m. Within the reach is the outlet to the Reformatory Ponds. Active wetted width ranges from 2 m at pinch points to 20 m, with water depth ranging from 0.2 to 0.4 m. Riffle-pool morphology was not observed and the overall channel gradient is low with extensive aggradation of unconsolidated fine silts. Unconsolidated sediment was measured along the bed and ranged from 0.5 to over 1 m in depth downstream from the Reformatory Ponds outlet. The extensive aggradation observed within the reach is likely a result of the low gradient and stagnant flow throughout the reach. Apart from local increases in velocity at drop-structures, flow was barely observed as moving until the downstream reach break. Several mature willow trees are located along the channel banks; however, there are broad gaps in cover over the channel. Channel banks have been hardened with boulder placement similar to the upstream reach. In total, four bridges, three drop-structures, and one corrugated steel pipe (CSP) outlet were observed within the reach. Each of the bridges and drop-structures are found at pinch points along the channel. An additional bridge is located over the Reformatory Ponds outlet channel. The RGA score for Reach C-9B is 0.32 indicating a channel in transition with evidence of aggradation being the dominant geomorphic factor influencing channel function. The RSAT score of 19 indicates that the channel is in poor health. Limiting factors are found in nearly all factor value categories including extensive deposition, lack of suitable instream habitat, water quality issues, riparian conditions, and biological indicators.

4.1.3 Reach C-10

Reach C-10 extends downstream from the Hadati Creek confluence to the confluence with the Eramosa River adjacent to the CP Rail bridge over the Eramosa at the confluence. Channel planform within the reach is typically straight; however the channel changes direction due to historical alteration of the Industrial Ponds and influences of the CP Rail line embankment. Downstream from the Hadati Creek confluence the channel branches into a north and south alignment, each flowing though one of the Industrial Ponds, forming islands. A single channel connects the two ponds at the western property extent. At the outlet from the southern Industrial Pond, the reach follows a straight planform to the southeast before flowing along the CP Rail embankment until the Eramosa River confluence. Total reach length is approximately 450 m along the dominant flow path through the southern Industrial Pond. Bankfull channel dimensions were measured at 8.5 m wide and 1 m deep. Riparian corridor is composed of a cedar forest with beaver activity present along the banks. A beaver dam is located along the channel 150 m upstream from the Eramosa River confluence. Due to the beaver dam, as well as the Industrial Ponds, flow velocities through this reach are slow and sediment accumulation along the bed is extensive. The depth of unconsolidated silt and sand deposition along the bed ranges from 0.1 to 0.2 m throughout the reach. The RGA score for Reach C-10 is 0.32 indicating a channel in transition, with evidence of aggradation being the dominant geomorphic factor influencing channel function. The RSAT score of 24 indicates the channel reach in generally in moderate health, however major limiting factors include extensive deposition, lack of diverse instream habitat, water quality, and biological indicators.

4.1.4 Reach HC-1

Hadati Creek was walked for approximately 280 m upstream from the Clythe Creek confluence. For the first 75 m upstream from Clythe Creek, Hadati Creek is partially channelized with the right bank lined with eroding cement cushions. Few trees are growing out of the banks, and have exposed, elevated roots. Bank heights are approximately 1.5 to 2.0 m tall and are near vertical. At several locations along the outer meander bends the cement cushions are undermined. Bankfull width was measured at approximately 3.0 m and bankfull depth at 1.0 m. Bankfull measurements were determined by the height of exposed tree roots and an inflection in the exposed soil profile. At Beaumont Crescent, the channel becomes briefly concrete lined as is flows through a box culvert. Upstream from Beaumont Crescent the channel is heavily entrenched within the roadside ditch with bank heights over 2.0 m and vertical. The exaggerated entrenchment of the channel upstream from Beaumont Crescent is likely a result of historical trenching. Approximately 120 m upstream from Beaumont Crescent, the main Hadati Creek Channel and a tributary converge. The RGA score for Reach HC-1 is 0.3 indicating a channel in transition, with evidence of degradation being the dominant geomorphic factor influencing channel function. The RSAT score of 22 indicates the channel reach in generally in moderate health; however, major limiting factors include lack of riparian corridor, lack of instream habitat, water quality, and biological indicators.

Observed erosion and failing bank stabilization treatments along Hadati Creek between York Road and Suburban Avenue are not anticipated to be worsened as part of currently proposed channel work along Clythe Creek. Restoration efforts along Hadati Creek are not addressed as part of the current scope of work.

4.1.5 Summary of Rapid Assessment Results

A summary of channel characteristics describing the reaches is provided in Table 4.1. The RGA scores are summarized in Table 4.2, and the RSAT scores are presented in Table 4.3. Additionally, a photographic record of each Reach at the time of the field evaluation is included in Appendix A.

TABLE 4.1 General Channel Characteristics based on Rapid Assessments

Channel Characteristic	C-9A	C-9B	C-10	HC-1
Bankfull Width (m)*	3.5	10 to 19	8.5	3.0
Bankfull Depth (m)*	0.5	0.4 to 0.5	1.0	1.0
Width: Depth Ratio	6.0	20 to 47.5	8.5	3.0
Bank Height (m)	0.4	0.4	0.6	1.5 to 2.0
Bed Substrate	Silts and sands with few cobbles	Silts	Silts	Cobbles with some gravels and pebbles
Riparian Vegetation	Some mature willow and cedar	Some mature willows	Mature cedar forest	-
Evidence of Hardening	Stone boulders along banks	Stone boulders along banks	-	Concrete lined

*Bankfull widths and depths were measured with metre stick.

TABLE 4.2 Summary of the 2015 RGA Scores for Clythe Creek and Hadati Creek

Reach	Factor Value				Stability Index	Condition
	Aggradation	Degradation	Widening	Planimetric Adjustment		
C-9A	0.43	0.2	0.4	0.29	0.33	Transitional
C-9B	0.7	0.2	0.1	0.29	0.32	Transitional
C-10	0.57	0.1	0.3	0.29	0.32	Transitional
HC-1	0.29	0.5	0.3	0.14	0.30	Transitional

TABLE 4.3 Summary of the 2015 RSAT Scores for Clythe Creek and Hadati Creek

Reach	Factor Value						Overall Score	Condition
	Channel Stability	Scour / Deposition	Instream Habitat	Water Quality	Riparian Condition	Biological Indicators		
Max. Score	**11**	**8**	**8**	**8**	**7**	**8**	**50**	
C-9A	6	5	5	3	4	2	25	Moderate
C-9B	6	2	3	2	3	3	19	Low
C-10	6	4	3	3	6	2	24	Moderate
HC-1	5	5	3	4	2	3	22	Moderate

4.2 Detailed Channel Characterization

A geomorphic survey was conducted within Reach C-9A, C-9B, and C-10 of the York Road study area in order to gain an understanding of the existing channel function and stability. Approximately 1.4 km of channel was surveyed from the upstream York Road reach break to the Eramosa River confluence.

The collection of more complete field data to also aids in defining current channel geometry and hydraulics. Detailed field data collection included the following tasks:

- measurement of bankfull channel geometries via cross-section surveys at nine locations
- characterization of bank parameters, such as height, angle, sediment composition, degree of vegetative cover, and other metrics
- identification of the median sediment size along the bed and a description of clast size distributions at the nine cross-section survey sites
- determination of local energy gradients through a survey of channel bottom and bankfull elevations, including top-of-riffle and bottom-of-riffle (where applicable), maximum depth, and any obstructions to flow

4.2.1 Bankfull Geometry

Bankfull geometry was recorded at nine cross-sections: five within Reach C-9A and four within Reach C-9B. Table 4.4 contains a summary of the bankfull parameters, including mean values for all cross-section sites in the study reaches. Figure 4.1 and Figure 4.2 provide a typical channel cross-section for each reach and Figure 4.3 depicts the overall longitudinal profile from York Road to the Eramosa River confluence. Cross-sections were not surveyed within Reach C-10.

The typical cross-section for Reach C-9A (Figure 4.1) depicts generally consistent bank heights and a U-shaped channel bed. Due to the U-shape cross-section, the thalweg through the reach is typically located in the center of the channel. Bankfull channel width ranged from 3 to 4 m, with an average of 3.39 m. Bankfull hydraulic depths (i.e., average depth across the cross-section) varied between 0.29 and

0.42 m, averaging 0.36 m. The average maximum depth was 0.64 m. These recorded channel widths and depths form cross-sections with areas between 0.93 and 1.75 m^2 and an average width to depth ratio of 9.67. The long profile (Figure 4.3) shows that the gradient along through Reach C-9A from York Road to the historic stone arch bridge is low-moderate, with an average slope of 0.012 m/m.

The typical cross-section for Reach C-9B (Figure 4.2) is drastically different from what is observed upstream. Bankfull channel widths range from 9 to 11 m, with an average of 10.19 m. Bankfull hydraulic depths varied between 0.31 and 0.53 m, averaging 0.44 m. The average maximum depth was 0.8 m. The recorded channel widths and depths form cross-sections with areas averaging 6 m^2 and an average width to depth ratio of 23.8. The long profile shows that the gradient through this reach is low, with an average slope of 0.0049 m/m. Although the gradient throughout the reach is predominantly flat, several weir structures controlling the gradient are located within the upstream quarter of the reach near the historic bridge. A reverse gradient is observed within the reach upstream from the Hadati Creek confluence, contributing to the observed standing water downstream from the pond outlet.

TABLE 4.4 Channel Geometry Data for Clythe Creek

Cross-section Parameter	Minimum	Maximum	C-9A Avg.	Minimum	Maximum	C-9B Avg.
Bankfull Width (m)	3.04	4.0	**3.39**	9.03	11.08	**10.19**
Average Bankfull Depth (m)	0.29	0.42	**0.36**	0.31	0.53	**0.44**
Maximum Bankfull Depth (m)	0.44	0.75	**0.64**	0.61	0.96	**0.8**
Bankfull Width: Depth	9.02	11.59	**9.67**	19.61	28.77	**23.83**
Cross-sectional Area (m^2)	0.93	1.75	**1.51**	3.75	7.19	**6.0**
Wetted Perimeter (m)	3.4	4.73	**3.98**	9.21	11.43	**10.62**
Hydraulic Radius (m)	0.27	0.45	**0.38**	0.41	0.65	**0.56**

Bankfull width was determined in the field by identifying grade inflections that are associated with the start of the floodplain, as well as changes in vegetation growth and exposed roots. The bankfull elevation of the channel is typically associated with the point at which overbank flooding occurs if overtopped. Within the study reaches, water level was frequently observed at or near bankfull level. Oversaturated banks and hummocky terrain in close proximity to the channel indicates that the channel is frequently overtopped, that the channel is undersized, or that there are barriers preventing the downstream movement of water.

Width to depth ratio is defined as the ratio of the bankfull surface width to the average depth of the bankfull channel and is a ratio that helps to interpret prevailing energy distributions within a channel and the ability of various discharges to move sediment downstream through the reach. Channels with a high width to depth ratio, such as Reach C-9B, are characteristically wide and shallow. Deposition in channels with a high width to depth ratio is common, as the over-widened nature reduces the channels ability to transport sediment.

The presence of bedrock observed near the surface of the existing bed profile, as seen on the original York Road Reconstruction and Trunk Watermain engineering drawings (Guelph 1988a and b) may have an influence on the overall gradient of the channel. Several bedrock inflections are recorded in the vicinity of significant instream structures, particularly near the historic stone arch bridge. The potential for bedrock outcropping being the basis for structure placement or that the structures were intentionally built on top of bedrock, could lead to further understanding of exiting conditions and downstream channel morphology. Within Reach C-9B, where the channel is dominated by aggradation processes, channel widening can then be associated with downstream adjustments to the degradation process and particularly changes in bed slope. The containment of flows within a degrading channel increases available energy and typically leads to erosion of one or both banks where the bed material is more resistant to erosion (i.e., bedrock material) than bank materials. Coupled with a sharp decrease in slope, there is expected to be a natural widening of the channel.

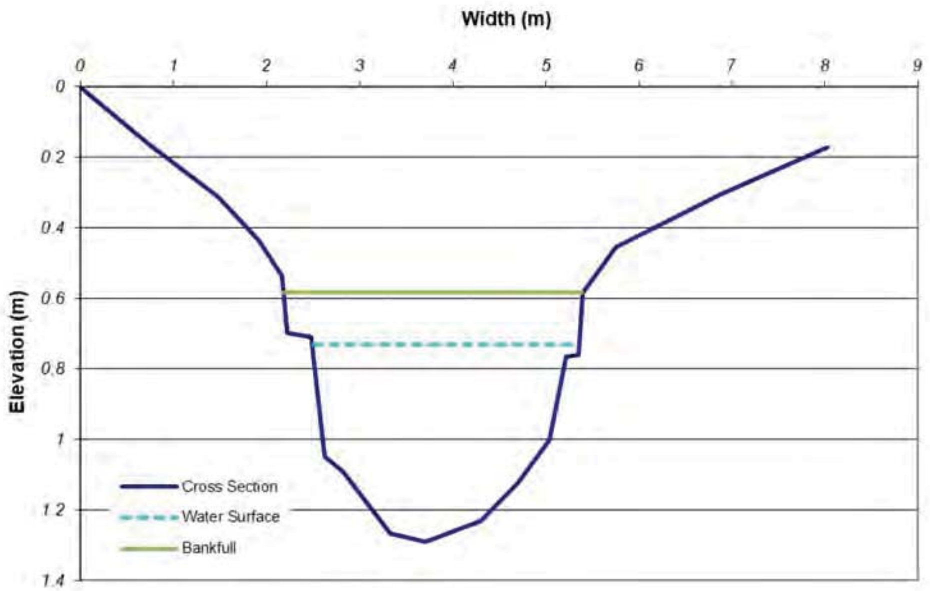

FIGURE 4.1 Typical Cross-Section within Reach C-9A

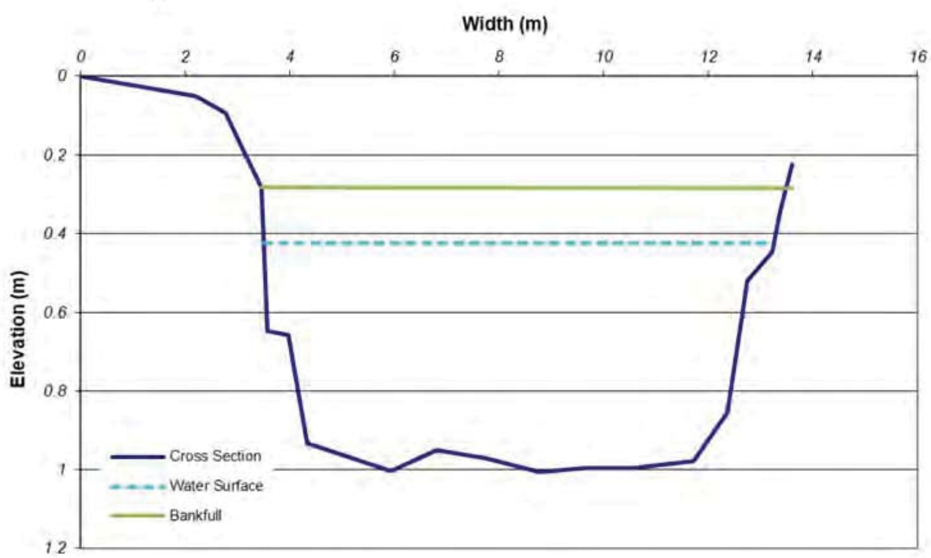

FIGURE 4.2 Typical Cross-Section within Reach C-9B

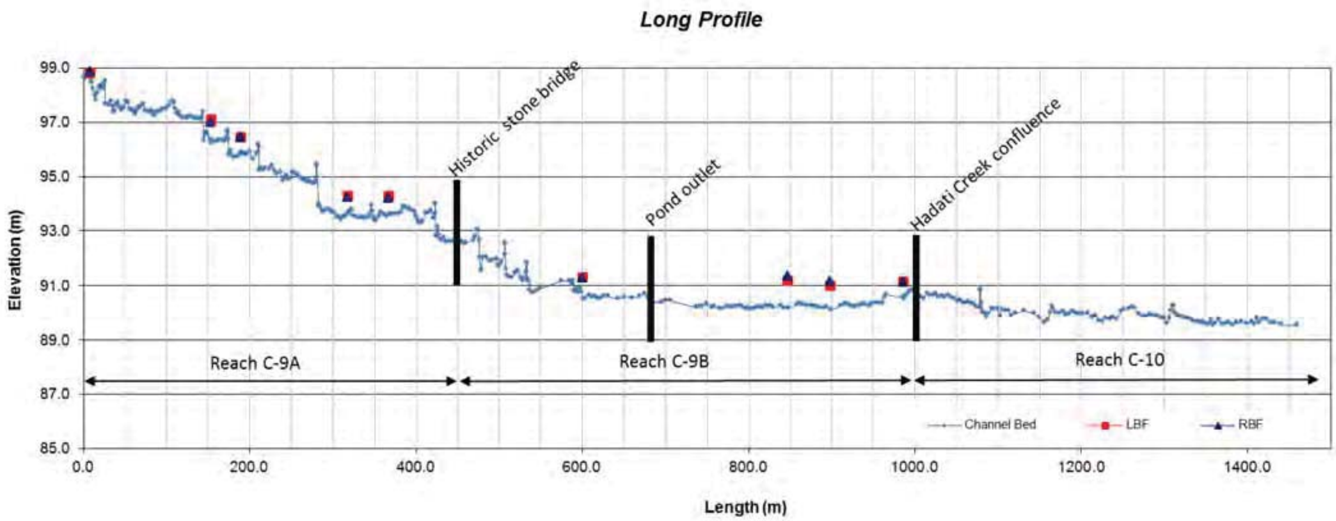

FIGURE 4.3 Long Profile Survey of Clythe Creek; Elevation Relative to Local Datum

4.2.2 Instream Structures

During the detailed field assessments, an inventory of all instream structures, bridges, and outlets was completed and information regarding location, type, drop height, and influences to the stream system were recorded.

In total, nine instream structures of a cultural heritage nature were observed as having direct contact with flow within Reach C-9A and seven structures within Reach C-9B, which are present within the first 125 m of the reach. Additionally, there are three pedestrian bridges that have limited cultural heritage value and a double CSP culvert crossing with no cultural heritage value within Reach C-9B. A detailed inventory of these structures is included in Appendix B. These structures need to be considered with regards to proposed recommended channel realignments through the study area.

4.2.3 Interpretation of Fluvial Processes

From a fluvial geomorphological stand point, a natural watercourse is considered stable, and in a state of 'dynamic equilibrium', when flow and sediment supply are balanced and over time. Channel cross-sectional dimensions, planform and profile are maintained with no indicators of pronounced erosion or deposition. This stable state allows for minor adjustments to occur over long time periods (i.e., meander bend migration). The Lane Balance Equation (Lane 1955) states that sediment load (Q_s) and size (D_{50}) should be proportional to water discharge (Q_w) and channel slope (S). By altering any one of these variables, the balance would shift and one or more of the other variables must compensate.

Anthropogenic influences, such as land use changes and stormwater management practices or the introduction of instream barriers such as weirs and dams, can alter the variables, disrupting the ability of the channel to balance flow and sediment supply, and shift the overall characterization of the channel from 'stable' to 'transitional' or 'in adjustment'.

Based on the geomorphic characterization assessment completed for Clythe Creek, a variety of disturbances were identified that have altered natural fluvial processes in the system. In particular, alterations in channel slope and discharge have occurred due to the introduction of instream barriers and change in drainage patterns. It is possible that anthropogenic disturbances locally, such as slope and cross-sectional alterations (over widening), and within the wider watershed have also resulted in changes to sediment load and size delivered to the creek. Overall, an imbalance between flow, sediment, and slope has pushed the channel to a transitional state that is adjusting to return to a state of dynamic equilibrium.

5 CHANNEL REALIGNMENT – ALTERNATIVE DESIGN OPTIONS

5.1 Development and Evaluation of Alternative Options

Several creek design options, in addition to the Do Nothing Option, were developed for consideration. Due to the altered and degraded channel form characterized during the field study, opportunities to improve channel conditions beyond the minimum requirements to accommodate road grading were contemplated. The primary focus of creek improvements is optimizing channel form and function by addressing the imbalance of creek elements (i.e. discharge, sediment load, and slope) that currently exists. The is achieved through the establishment of a graded stream, described by Mackin (1948) as "one in which, over a period of years, slope is delicately adjusted to provide, with available discharge and with prevailing channel characteristics, just the velocity required for the transport of the load supplied from the drainage basin". This is particularly applicable within the lower reaches of the study area (i.e., Reaches C-9B and C-10) where Clythe Creek is of low gradient, typically over-widened, and experiencing excessive deposition. Concurrently, considerations of in-stream structures of cultural importance that were installed in the past as well as possible improvements to aquatic habitat (e.g. fish passage) are factored into the designs. It is important to consider a range of options comprising various levels of intervention and assess how each would ultimately impact the channel. The creek options include:

- Option 1: Do Nothing
- Option 2: Improved Form and Function
- Option 3: Ultimate Channel Configuration

In addition to the above noted alternatives, a broader range of alternatives was considered based on input received during consultation and review activities, including potential creek realignment of Clythe Creek to disconnect the channel from Hadati Creek. It is possible for this separation of the creeks to occur in the future following monitoring of the impacts to Clythe Creek that result from realignment in the study area. This option was not selected for advancement as a preliminary design alternative.

5.1.1 Option 1 – Do Nothing

Minimal channel works (Do Nothing) are considered as Option 1 (Refer to Clythe Creek Option 1 Figures 1 to 8 in Appendix C). Only general maintenance following road widening works will occur and it does not entail channel realignment or any significant enhancement works. Resultantly, the existing fish passage issues and impaired fluvial form and function of the channel are not addressed. Minor encroachment into the existing floodplain is necessary at certain locations to accommodate road widening. Within Reach C-9A, local works will be required to restore the channel following a culvert extension or replacement at York Road. There will be no impact associated with this option with regard to cultural heritage features located within the channel. In order to maintain the features, a retaining wall will be constructed adjacent to features 9 and 10 in order to accommodate grading requirements of the road widening.

5.1.2 Option 2 - Improved Form and Function

Option 2 channel works would be considered the minimum required in order to improve channel function (Refer to Clythe Creek Option 2 Figures 1 to 8 in Appendix C). For Option 2, works within Reach C-9A will include a channel realignment that will bring the creek well away from the York Road right-of-way (RoW) and utilize more of the floodplain. The realignment will also utilize the existing groundwater tributary planform. The realignment for Reach C-9A has an optional fish passage channel that would split flow around a significant cultural heritage feature. As a result of this channel realignment, the majority of the cultural heritage features will be taken offline but remain within the landscape. In order to improve the functioning of Reaches C-9B and C-10, significant grading works are proposed in order to narrow the channel and create a consistent bed profile. The outlet of the northern Reformatory Pond will also be narrowed in an effort to limit interactions between the pond and creek channel. The bed and bank grading will continue downstream to the existing flow splitter which will be removed.

5.1.3 Option 3 - Ultimate Channel Configuration

For Option 3, works within Reach C-9A will correspond to works proposed under Option 2. Channel realignment will separate the creek from the York Road RoW and utilize more of the existing floodplain. The realignment will also utilize the existing groundwater tributary planform. The realignment for Reach C-9A has an optional fish passage channel that would split flow around a significant cultural heritage feature. As a result of this channel realignment, the majority of the cultural heritage features will be taken offline but remain within the landscape. In order to improve the functioning of Reach C-9B, significant grading work is proposed along both the bed and the banks in order to narrow the channel and create a steeper bed profile. The outlet of the northern Reformatory Pond will also be narrowed in addition to the outlet elevation being raised in an effort to limit interactions between the pond and creek channel. The bed and bank grading will continue downstream within Reach C-10 where full channel realignment will occur downstream from the Hadati Creek confluence. As a result, the existing flow splitter will be taken offline. The existing channel extends downstream from the realignment will be repurposed as necessary to accommodate stormwater management practices.

5.2 Discussion of Preferred Option

Based on the graded stream concept (Mackin 1984), the goal of the design is to establish a channel that displays dynamic stability, involving a balance between erosion and deposition over a long period with variations in average conditions over short-term timescales, with considerations of local constraints.

Implementation of Option 3 - Ultimate Channel Configuration will reduce sedimentation and channel instability and maximize restoration potential within Clythe Creek. The detailed channel surveys revealed that the low gradients, backwatered conditions, and widened out cross-section in the downstream reaches have resulted in extensive deposition of fine material along Clythe Creek in the study area. The realignment design establishes a stable and functioning channel planform with a narrowed channel and increased bed gradient which has a greater capacity to transport flow and sediment, thereby reducing deposition trends. The improved channel stability and natural fluvial processes are expected in turn to improve overall aquatic habitat quality and quantity via removal of barriers to fish passage and establishment of stable habitat (e.g. riffle-pool profile).

5.3 Option 3 - Ultimate Channel Configuration - Further Consideration

For the March 2017 draft EIS, creek realignment options were assessed in context of the proposed multiuse pathway (MUP) being constructed on the south side of Clythe Creek. Option 3 - Ultimate Channel Configuration was subsequently short-listed as the preferred creek alignment option. However, following submission of the March 2017 draft EIS it was requested that alternatives with the MUP set within the RoW, on the north side of the creek, be assessed. Resultantly, the preferred creek realignment option (Option 3) was evaluated in conjunction with March 2017 draft EIS-preferred road section alternatives 20A/ 20B (20) and 23 that incorporate the MUP within the RoW.

Overall, four additional road configurations were assessed (Alternatives 1 to 4). Two functional channel designs were created by Matrix (Refer to Appendix D). The creek alignment evaluated in conjunction with Road Widening Option 1 is applicable to Alternative 1. The creek alignment evaluated in conjunction with Road Widening Option 2 is applicable to Alternatives 2, 3, and 4. The assessments were presented in a Memo submitted to the City on December 19, 2017 and are summarized below.

5.3.1 Road Widening Alternative 1

The grading slopes (i.e., either 2:1 or 3:1 H:V) that are required to accommodate the MUP alongside York Road and adjacent to Clythe Creek extend further south into the floodplain area than the previously-established preferred alternative in the March 2017 draft EIS. The new grading limit overlaps with the preferred channel alignment at two separate locations. Refer to Clythe Creek - Road Widening Option 1 in Appendix D.

The first location where the revised grading slope intersects with the march 2017 draft EIS-preferred channel alignment is within Reach C-9A, upstream of the Reformatory driveway (approximate chainage 0+425 m, Sheet 01). Within this reach, the existing planform of Clythe Creek flows over a stone weir (Cultural Feature '14'). The preferred channel alignment option realigns the primary flow pathway further south around the stone weir, reconnecting to the existing channel at a pool immediately downstream of the weir. From this location, the creek then flows under the Reformatory Bridge. At the stone weir, the preferred alignment incorporated a channel that directs flows exceeding bankfull toward and through the existing channel at the weir. This approach supports fish passage through the primary channel but also allows for the weir to be activated at flows greater than bankfull, partially mitigating its disconnection from the main channel. However, to accommodate the 3:1 H:V road grading associated with Alternative 1, it is not possible to re-connect the channel at the pool immediately downstream of the weir as the pool must be infilled to achieve the desired road slope grading. As this pool becomes unusable, the proposed channel alignment must tie-in to the existing channel further downstream. Further, this new configuration eliminates any continued flow through the weir as the grading and fill would cut off the connection location.

The second location requiring adjustment is in the vicinity of the Hadati Creek confluence (approximate chainage 0+850 to 1+050 m, Sheet 03). The grading to accommodate the MUP necessitates shifting the design planform south. The shifted planform aligns with the concrete box culvert that is proposed to replace the existing CSPs at this location. Downstream of the crossing, Hadati Creek flows south through a box culvert under York Road where it enters Clythe Creek at the outlet. The box culvert is to be extended on the south side, facilitated by the shift south of the Clythe Creek planform. Whereas the March 2017 draft EIS-preferred channel alignment utilized the existing creek planform for approximately 40 m west of the culvert, the revised creek planform bend begins further upstream. The existing length of creek that was previously intended as part of the design channel will be filled.

5.3.2 Road Widening Alternatives 2, 3, and 4

A second channel design was prepared for consideration based on the grading required to accommodate Road Alternatives 2, 3, and 4. Refer to Clythe Creek - Road Widening Option 2 in Appendix D.

The creek design is similar to Alternative 1 aside from at the weir location (approximate chainage 0+375 to 0+425 m, Sheet 04). The grading does not encroach on the channel to the extent of Alternative 1 and, as a result, it is possible to incorporate the channel that conveys bankfull and greater flows over the weir structure. This design involves the establishment of an island-type feature downstream of the weir that separates the newly constructed primary channel and the existing length of channel that will be maintained to convey flows passing over the weir. The two channels connect further downstream toward the Reformatory driveway at approximate chainage 0+430 m, same as the previously-identified preferred alignment. The design at this location is differentiated from the preferred channel alignment based on the absence of a crossing for the MUP, which is considered a benefit from a corridor connectivity and natural function standpoint.

The second location requiring adjustment (approximate chainage 0+850 to 1+050 m, Sheet 06) is the same as Alternative 1. The associated implications to the planform and proposed design refinements discussed for Alternative 1 are consistent between the Alternatives.

Road Alternatives 3 and 4 utilize the same creek design as Alternative 2. For Road Alternative 4, minor modifications are proposed to the heritage fieldstone entrance walls (Features #15 and #16) to position the walls a greater distance from the roadway. On the upstream (east) side of the entrance bridge, at Feature #15, the stone wall is to be reassembled and extended east such that the end treatment does not conflict with the instream weir Feature #24. There should not be any implications for the connection of the weir feature to flows at bankfull flow and as the proposed new creek planform is situated south of the weir, there will not be any disruption of natural channel function. Downstream of the bridge, Feature #16 is to be reconstructed south of the existing wall location. Minor infilling toward the creek on the south side of the road is required in order to establish a level base upon which to reconstruct the wall. From the edge of the reconstructed wall, the fill slopes down to existing grade at approximately 2:1 H:V. At the narrowest location, the fill will abut the existing in-water heritage feature (stone wall comprising the creek bank) for a short length; however, there is not any direct encroachment into the existing creek. Similar to upstream, the proposed Alternative 2 planform is pulled south, away from the existing planform and the minor amount of fill placed in the upper floodplain should not have a negative implications for the natural function of the primary channel of the creek design.

5.3.3 Discussion of Alternatives

The creek designs for Alternatives 1 and 2, with Alternative 2 also representing the creek design for Road Alternatives 3 and 4, do not represent substantial change to the channel form and function of the preferred channel alignment as identified in the March 2018 draft EIS (Option 3). For Alternative 1, it will not be possible to maintain any connection with the weir feature (Cultural Feature ‘14’) located upstream of the Reformatory driveway. From a channel design perspective, this is not considered detrimental. Alternative 2, 3, and 4 would allow for the development of the high flow channel that conveys flows greater than bankfull over the weir structure. In either scenario, the barrier to fish passage is mitigated.

With all alternatives, the planform must be shifted south near the confluence with Hadati Creek. Less existing channel length is utilized than was possible with the draft EIS-preferred alignment as the planforms begin to bend at a point further upstream, directing the planform south toward the Eramosa River. This is equally advantageous for both Alternatives as there is increased buffer between the roadway/culvert and the channel at this location; however additional cut and fill is subsequently required during construction.

Beyond the minor changes noted above, the benefits of creek realignment as outlined in Section 5.2 are provided by the refined alternatives and are considered an improvement to natural channel function and habitat compared to existing conditions.

5.4 Detailed Design

The realignment options were developed to functional designs at a detail level sufficient for comparative assessment of high-level impacts and improvements. At this stage, basic channel geometry (i.e., planforms, profiles, and cross-sections) was developed to assess the feasibility of different channel/corridor configurations with respect to the design constraints.

The realigned channel cross-sections are sized based on the main channel or "bankfull channel" conveying the 2-year return discharge prior to the channel banks being overtopped. The planform was subsequently developed based on a balance between the introduction of some sinuosity (channel meandering) commensurate with channel size, channel profiles (energy gradients), utilization of existing natural features, and accommodation of built constraints such as crossings and cultural features.

At the detailed design stage, design parameters can be finalized through an iterative process that optimizes the channel design from multiple perspectives. The hydraulic modelling is advanced based on detailed channel/topographic and soil survey information and confirmation of key elevations (tie-in points, crossing inverts, etc.) and design conditions. The hydraulic analyses will be instrumental in confirming that the proposed configuration promotes project objectives (i.e. natural sediment transport processes and reduction of deposition trends).

Hydraulic modelling results provide insight into the velocity, depth, and stress conditions which will inform the selection of appropriate restoration treatment (e.g., bed and bank treatments) and material types and sizes. Identification of key water level elevations would help to plan appropriate floodplain elevation, height of bank treatments. A proposed conditions model will enable the design team to evaluate the hydraulic effects and benefits of the detailed design. The data will facilitate fish passage and aquatic habitat assessments.

Several characteristics of low flows and high flows are informative for channel design and understanding flood plain coverage by flood flows and in-channel habitat hydraulics, including assessment of flows beyond the typical return periods such as bankfull flow, baseflow, etc. Results of hydraulic conditions of the proposed channel design should be used to ensure that fish passage, especially during typical critical stage flows, can occur. The fish passage assessment should consider the ability of target and community fish to negotiate the flow velocity over the length of riffles. The sizing of substrate material and their long-term stability is a key design parameter used to ensure that riffle materials provide the ecological function for fish habitat while being stable at the designed hydraulic and flow conditions.

Design parameters to be further refined at the detailed design stage include:

- Design discharge and cross-section dimensions - The 2-year flow was used as a preliminary estimate of bankfull flow for the current assignment. Further analysis of the bankfull discharge and other flow events will be completed to optimize channel function at all flow stages. Differentiation in cross-sectional characteristics by feature type (pools, riffles, shoals, etc.) will ensure the channel functions as intended and features are suitable for target species.

- Planform - The general alignment of the planform must remain relatively consistent through to the detailed design based on the lateral constraints at the site, however further refinement of planform geometry (meander wavelength and amplitude, radius of curvature, etc.) may be possible and may be supported through application of a reference reach or regional relationships. Note that the planform cannot be developed independently of the profile as bed features are typically placed as per their natural analogues (i.e. pools on bends and riffles at straight sections). Utilization of the existing groundwater tributary planform will require confirmation of soil conditions and groundwater inputs such that a stable channel form can be constructed at that location.

- Profile - Currently the profiles provide a general indication of where a varied bed (i.e. riffle-pool profile) can be introduced and where run-type morphology may be more suitable. At the detailed design, the positioning/spacing of riffle-pool features can be optimized to ensure that the features provide intended functions (i.e. riffles that provide grade control, backwater the pool upstream and scour out the pool downstream to maintain depths). With bed slopes confirmed, further detail regarding cross-sections and channel substrate (stone sizing) will be provided with a heterogeneous composition of materials incorporated into the design. As proposed conditions hydraulics modelling is advanced, it can be confirmed that instream flow conditions (velocities) are appropriate for aquatic organism passage.

- Bed and Bank Treatments - The selection of appropriate bed and bank treatments requires consideration of in-channel velocities and/or shear stresses, the resistance of the boundary materials, and the level of acceptable morphological adjustment in the context of infrastructure and other constraints. Channel hardening where necessary, including bank treatments (e.g. vegetated sod blocks, brush mattress, brush layering, vegetated riprap, armourstone revetment, etc.), will be confirmed as proposed conditions hydraulics are advanced. At locations where the channel must remain essentially static (e.g. adjacent to infrastructure), the channel is designed to be stable under the design flow. In segments where risk is not as high, more flexibility is provided. Vegetated treatments can be used that offer the stability of a hard approach while incorporating plantings which contribute to the aesthetic, self-maintaining, long-term stability of the protection.

- Habitat Elements - Instream and riparian habitat elements can be introduced such as large woody debris (LWD) to mimic natural woody debris in streams and on banks. LWD including trees, logs, stumps, rootwads, and large tree branches can provide cover for aquatic species and create aquatic habitat, maintain pool depths, or promote fine sediment accumulation in marginal areas. Appropriate securement ensures that the wood material is not dislodged and does not block culverts.

- Floodplain - The establishment of a stable floodplain through the use of suitable fill material allows for connection of the main channel with the overbank at appropriate flows, ensuring a healthy terrestrial system and also providing energy dissipation. Currently, the water level in the Reformatory Ponds and Clythe Creek are identical. Modification to the pond connection may be required if the channel bed is raised and backflow into the ponds is not desired. By closing off the pond connection it is also anticipated that some thermal mitigation will be provided.

- Vegetation - Enhanced planting of vegetation along the creek corridor can provide stability to the creek banks as the plant roots give structure to the soil matrix. Only native, locally present trees, shrubs, and grasses should be used to restore the site. A restoration planting plan will be required to address the following components:

  - vegetative erosion control of the banks and floodplain
  - erosion and sediment control of the banks and disturbed overbank area
  - provision of terrestrial habitat
  - provision of shading of the creek water to enhance aquatic habitat
  - establishing a self-sustaining vegetated system in the riparian area
  - bioengineering techniques including live staking, live fascines, and bio-logs

- Crossings - Watercourse crossing structures ideally accommodate channel planform morphology and promote natural fluvial processes (i.e. sediment transport) to occur. From a geomorphic standpoint, crossing spans should be a minimum of 3 times the bankfull width of the channel. Ecological considerations, including terrestrial and aquatic organism passage, will be incorporated into the design of the channel through crossing structures to the extent possible.

5.5 Construction Considerations

5.5.1 General Phasing

When evaluating the creek realignment construction works, implementation of the preferred alternative will benefit from the ability to construct a portion of the proposed new channel offline. In other words, where the proposed planform is outside of the footprint of the current creek, the new channel can be constructed largely without disrupting flow in the existing channel. If timing allows, this also provides the opportunity for vegetation to establish along the channel margins and in the floodplain prior to connecting flow through the new channel (i.e. grow in period).

In locations where constructing offline is not possible, the realignments may be accomplished using a "dam and pump" system. The work area is isolated by blocking the flow upstream and downstream with stone and impermeable sheeting, pea gravel bags, or aqua dam. A flume (e.g., CSP culvert) may be used in combination with a pumping system to assist in conveying flow, if necessary. The bypass will depend on the volume of flow expected at the time of construction, and coffer dam dimensions will need to be designed in accordance with the serviceability requirements. During stream bypass operation, fish relocation will be required in order to limit the number of stranded fish during each phase of construction.

Ideally construction would take place during seasons of low flow to reduce the risk of nuisance flood and erosion susceptibility. Available timing is therefore the summer and winter months. The advantages of winter construction can include that frozen conditions generally facilitate access through traversing across fill areas with little damage and restoration required. Consideration in the timing should be given to restoring areas at a time when bioengineering material (live cuttings) are dormant (November to March) and can be applied so that growth occurs in the following spring. Planting, adjustments, warrantee work, and final restoration can occur in the spring of the following year.

5.5.2 Mitigation Measures

The major mitigation activities will be associated with the implementation of Best Management Practices (BMPs), particularly for erosion and sediment control measures, tree protection, and timely site restoration designed to address specific requirements for vegetation establishment as a function of season. Environmental protection and sediment and erosion control systems will need to be in place prior to commencement of construction activity to prevent deleterious substances from entering the creek. Silt fence, erosion control blanket, and site fencing are required where construction disturbs surface cover or where susceptibility to erosion is high.

5.5.3 Contractor Selection and Construction Supervision

Contractors should be evaluated on the basis of their previous creek rehabilitation and erosion control experience, with particular emphasis on in-water channel restoration work experience, to help contribute to the quality and effectiveness of implementation.

To ensure that the objectives of the channel design are realized, it is important that someone with experience in channel design and channel construction perform regular construction supervision. Onsite supervision by experienced staff should include the following:

- provide input for construction sequencing, methods and equipment
- provide field direction for layout details
- materials inspection
- enforcement / inspection of erosion and sediment control plans
- construction access and egress

- ensure environmental protection during construction
- document construction proceedings in a daily construction log of contractor's progress, personnel and equipment onsite, material shipments, relevant discussions with the contractor, relevant construction proceedings, climatic conditions, and flow conditions
- identify any and all deficiencies in the construction works and advise the contractor to take appropriate corrective measures, follow up on corrective measure, confirm and report the results
- substantiate the quality and quantity of completed work
- photographic record of construction proceedings including detailed pre-construction log and chronologic progress pictures

5.6 Pre- and Post-Construction Monitoring

Effective monitoring along Clythe Creek study area will be essential to ensure constructed design elements are functioning as desired. As proposed channel restoration works may be completed in phases, holistic monitoring of the study area, and within each reach, should take place each year regardless of whether or not restoration activities have taken place. Although proposed channel restoration activities are reach specific, the intent of the monitoring plan is to maintaining overall connectivity through the entire study area. By monitoring the study area holistically, changes within downstream reaches can be identified and future restoration activities can be planned accordingly. The following monitoring initiatives are recommended:

5.6.1 Pre-Construction

Prior to the implementation of channel restoration measures, each individual study reach should undergo fluvial geomorphic monitoring at pre-determined locations to monitor change over time and as a result of any upstream channel works. Pre-construction monitoring within reach should include:

- monumented bankfull cross-section survey
- longitudinal profile survey extending for 5 to 7 times the bankfull width
- Wolman style pebble count
- photographic inventory from known vantages

5.6.2 Immediate Post-Construction

An as-built assessment of the entire restored reach should be completed immediately post-construction. This assessment and survey which will compare designed parameters with constructed results. The assessment should be composed of the following:

- A comprehensive topographic survey (as-built) should be undertaken of the entire study reach. This survey will determine the constructed channel dimensions for comparison with those specified on design drawings. The survey should include a longitudinal profile surveyed along the channel thalweg and cross-section profiles measured perpendicular to the channel within each selected riffle or pool and extend out onto the floodplain in sufficient detail to define cross-sections for undertaking hydraulic analysis.

- A photographic inventory from known vantages.
- Bed substrate will be surveyed for all three reaches using a Wolman style pebble count.
- A review of mitigation practices including sediment and erosion control measures, appropriate material storage, and working in contained / dry conditions will be summarized for the length of the construction. Of which a photographic inventory should be provided.
- A summary table of vegetation works should be provided, recording the species present, the number of plantings, and the species health/survival.
- The functioning of channel conditions and flow conveyance should be assessed by a qualified fluvial geomorphologist and will include the assessment of; floodplain connectivity, low-flow concentration along riffles to enable fish passage, pools maintaining habitat and resting areas for aquatic species, and placement of herbaceous and woody vegetation adjacent to the channel. Photographic evidence illustrating the channel functionality will be provided.

5.6.3 End of Year, Post-Construction 3 Year Monitoring

An assessment of the restored stream channel should be completed for three (3) years (years 1, 2, and 3) following the completion of the construction. At the end of each year, a report should be compiled. These reports will document the conditions and success of the restoration, review the status of aforementioned deficiencies, and make recommendations for additional works as required. Yearly monitoring will include the following;

- The success of vegetated plantings should be assessed by a certified botanist. If the health of the plantings is in poor condition, recommendations to reduce the risk of failure will be made.
- Success of groundcover (Terraseeding or erosion control blankets) will be assessed. If areas are observed where bare and loose soil may be exposed to creek flow, additional seeding or planting may be recommended.
- The stability of constructed riffle features and banks will be assessed through photographic comparisons of chosen vantage points.
- The monitoring of the stream channel morphology will be completed by a qualified fluvial geomorphologist for channel stability and long-term viability. The report will include field assessment of channel form including: planform, bank stability and treatments, profile, (riffle/step placement and hydraulics), cross-section (flow concentration and width adjustments), photographic inventory, and map to document observations. Recommendations for any required mitigation measures should be made as necessary.

6 CONCLUSIONS AND RECOMMENDATIONS

A fluvial geomorphic assessment has been completed for Clythe Creek to support the selection of a preferred design alternative for road widening along York Road. This assessment reviewed background information, which included past documents, aerial photos, and contour mapping. Watercourse reaches were identified along the study corridor using desktop analyses and were further assessed in the field. Rapid assessments and detailed channel surveys were undertaken to gain an understanding of the existing channel function and stability. During the field investigation, indicators of active geomorphic processes were noted, channel dimensions were measured and a stability index (RGA score) was provided for each reach.

Based on the fluvial geomorphic characterization assessment completed for Clythe Creek, the system was identified to be in a transitional or stressed state due to past alterations and a variety of disturbances that have disrupted natural fluvial processes in the system. In particular, alterations in channel slope and discharge have occurred due to the introduction of instream barriers and changes in drainage patterns. Significant deposition in downstream channel reaches due to low gradients, backwatered conditions, and a widened out cross-section has resulted in degraded fluvial geomorphic conditions.

As a result of proposed widening of York Road, it is necessary to consider the impact these works will have on Clythe Creek which flows parallel to the roadway. Several creek design options, in addition to the Do Nothing Option, were developed for consideration. Due to the altered and degraded channel form characterized during the field study, opportunities to improve channel conditions beyond the minimum requirements to accommodate road grading were contemplated. The Creek Alternatives include:

- Option 1: Do Nothing
- Option 2: Improved Form and Function
- Option 3: Ultimate Channel Configuration

As part of the overall Environmental Design Study work, Option 3: Ultimate Channel Configuration was identified as the preferred creek alternative in the March 2017 draft EIS submission. The realignment design establishes a stable and functioning channel planform with a narrowed channel, reduced occurrence of in-stream structures, and increased bed gradient which resultantly has a greater capacity to transport flow and sediment, thereby reducing deposition trends. The improved channel stability and natural fluvial processes are expected in turn to improve overall aquatic habitat quality and quantity via removal of barriers to fish passage and establishment of stable habitat (e.g. riffle-pool profile).

Following review of the March 2017 draft EIS, Option 3 was re-evaluated in context of revised roadway cross-sections (Alternatives 1 to 4). Two additional functional channel designs were developed, incorporating minor changes to Option 3: Ultimate Channel Configuration. The benefits of creek realignment as previously outlined are applicable to both alternatives. The creek alignment evaluated in conjunction with Road Widening Option 2 allows for connection with a cultural heritage weir feature at flows greater than bankfull and as such is recommended. At the detailed design stage, channel realignment design parameters should be advanced to greater detail based on confirmation of site information (channel tie-ins and topographic surveys) and further fluvial geomorphic analyses and hydraulic modelling.

7 REFERENCES

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APPENDIX A
Site Photographs

Matrix Solutions Inc.
May 5, 2016

1. Reach C-9A: Clythe Creek culvert inlet at York Road. Gabion protection along road embankment and rip rap placement along the channel banks. Channel approaches culvert at a 45 degree angle; rip rap protection limits bank scour at inlet.

Matrix Solutions Inc.
May 5, 2016

2. Reach C-9A: Substrate inside York Road culvert. Wetted channel width occupies the entire culvert width.

Matrix Solutions Inc.
May 5, 2016

3. Reach C-9A: Looking downstream from York Road culvert outlet.

Matrix Solutions Inc.
May 5, 2016

4. Reach C-9A: Typical cross section within the reach. Water level site near bankfull, banks are oversaturated and slumping causing hummocky terrain.

Matrix Solutions Inc.
May 5, 2016

5. Reach C-9A: Banks are typically lines with small boulders.

Matrix Solutions Inc.
May 5, 2016

6. Reach C-9A: Channel outflanks in-stream weir structure.

Matrix Solutions Inc.
May 5, 2016

7. Reach C-9A: Section of over widened channel upstream from weir where water is ponded. Sediment deposition occurs and cat tail growth observed.

Matrix Solutions Inc.
May 5, 2016

8. Reach C-9A: Channel is locally widened downstream from weir structure that spans approximately 2x bankfull width. Deposition and infill occurs to compensate.

Matrix Solutions Inc.
May 5, 2016

9. Reach C-9A: Tributary channel through ornamental grounds that confluences' with Clythe Creek.

Matrix Solutions Inc.
May 5, 2016

10. Reach C-9A: Minor debris upstream from wier.

Matrix Solutions Inc.
May 5, 2016

11. Reach C-9B: Looking upstream towards man-made island and main correctional facility entrance.

Matrix Solutions Inc.
May 5, 2016

12. Reach C-9B: CSP outlet and sediment deposition plume upstream from pedestrian bridge.

Matrix Solutions Inc.
May 5, 2016

13. Reach C-9B: Looking upstream along Clythe Creek adjacent to Jaycee Park.

Matrix Solutions Inc.
May 5, 2016

14. Reach C-9B: Looking downstream along Clythe Creek adjacent to Jaycee Park.

Matrix Solutions Inc.
May 5, 2016

15. Reach C-9B: Double CSP culvert at entrance to Jaycee Park.

Matrix Solutions Inc.
May 5, 2016

16. Reach C-10: Clythe Creek downstream from Hadati Creek confluence; flow is ponded upstream from flow splitter.

Matrix Solutions Inc.
May 5, 2016

17. Reach C-10: Flow splitter structure installed along Clythe Creek.

Matrix Solutions Inc.
May 5, 2016

18. Reach C-10: Beaver dam towards the downstream extent of the reach contributing to ponding water.

Matrix Solutions Inc.
May 5, 2016

19. Reach C-10: Channel flows adjacent to CNRL embankment at the Eramosa River confluence.

Matrix Solutions Inc.
May 5, 2016

20. Reach C-10: Confluence with the Eramosa.

Matrix Solutions Inc.
May 5, 2016

21. Reach HC-1: Looking downstream towards York Road culvert crossing.

Matrix Solutions Inc.
May 5, 2016

22. Reach HC-1: Looking upstream along Hadati Creek.

Matrix Solutions Inc.
May 5, 2016

23. Reach HC-1: Concrete cushion bank protection installed along the west bank is failing.

Matrix Solutions Inc.
May 5, 2016

24. Reach HC-1: Concrete block wall at channel bend is undermined.

Matrix Solutions Inc.
May 5, 2016

25. Reach HC-1: Channel immediately downstream form Beaumont Cres. Both banks are lines with concrete and shale bricks. Bank protection is undermined along meander bend.

Matrix Solutions Inc.
May 5, 2016

26. Reach HC-1: Looking upstream towards Beaumont Cres culvert crossing.

Matrix Solutions Inc.
May 5, 2016

27. Reach HC-1: Beaumont Cres culvert inlet.

Matrix Solutions Inc.
May 5, 2016

28. Reach HC-1: Looking upstream from Beaumont Cres crossing. Channel is lined with concrete for approximately 18 m.

Matrix Solutions Inc.
May 5, 2016

29. Reach HC-1: Channel occupies roadside ditch and has been historically altered.

Matrix Solutions Inc.
May 5, 2016

30. Reach HC-1: Culvert crossing at Industrial Ave. Channel has been buried for approximately 60 m upstream from Industrial Ave.

Matrix Solutions Inc.
May 5, 2016

31. Reach HC-1: Inlet 60 m upstream from Industrial Ave. Channel was dry at the time of field inspection.

Matrix Solutions Inc.
May 5, 2016

32. Reach HC-1: Elizabeth Street culvert crossing

Matrix Solutions Inc.
May 5, 2016

33. Reach HC-1: Upstream from Elizabeth Street the channel is confined through private property.

Matrix Solutions Inc.
May 5, 2016

34. Reach HC-1: Bedrock influence along the channel bed upstream from Suburban Ave.

APPENDIX B
Cultural Heritage Features

Matrix Solutions Inc.
May 5, 2016

1. Feature #1: Ashlar stone culvert (potential significance) north of York Road. Culvert is 25 m upstream from York Road and conveys Clythe Creek flow underneath the CNR line. The double box culvert has approximate dimensions of 1.2 m wide by 1.4 m high. Substrate is present along the bed of the culvert however, natural light does not penetrate and the upstream inlet is not visible.

City of Guelph
n/a

2. Feature #2: Reinforced concrete road bridge railing (potential significance) north of York Road. Railing has been reinforce with gabion and rip-rap.

Matrix Solutions Inc.
May 5, 2016

3. Feature #3: Fieldstone weir with steps and sentinel stones (listed, non-designated significant feature). Structure height is 0.5 m above water level with an additional 0.45 m scour pool (total height above bed 0.95 m). At the time of survey, flow depth over the structure was 0.08 m and 1.6 m wide. Backwatering upstream from the structure had a depth of 0.45 m. Channel has scoured out downstream from the weir, over-widening the channel to 4m

City of Guelph
n/a

4. Feature #4: Fieldstone garden wall with sentinels (listed, non-designated significant feature). Feature extends for 110 m south-east across the floodplain.

Matrix Solutions Inc.
May 5, 2016

5. Feature #5: Fieldstone weir with clay pipes (listed, non-designated significant feature). Two clay pipes are imbedded into concrete and fieldstone weir structure. The feature is 2m wide and has a total height of 1.1 m; 0.5 m above existing water level plus 0.6 m scour depth. Feature imposes a significant barrier to downstream flow movement and has trapped woody debris at its crest.

City of Guelph
n/a

6. Feature #6: Fieldstone steps (listed, non-designated significant feature). Feature is located on the floodplain north of Clythe Creek and south of York Road.

City of Guelph
n/a

7. Feature #7: Large boulder or bedrock outcrop (potential significance). Feature is located on the floodplain north of Clythe Creek and south of York Road.

Matrix Solutions Inc.
May 5, 2016

8. Feature #8: Fieldstone weir (listed, non-designated significant feature). This feature is made from fieldstone and concrete with decorated stones placed along the banks. The feature is 1m high; 0.55 m above existing water level plus 0.45 m scour pool. The upstream pool created by backwater is 0.4 m deep with a flow depth of 0.04 m over the crest of the feature. Width of the feature is 2m conforming to the bankfull channel.

Matrix Solutions Inc.
May 5, 2016

9. Feature #9: Fieldstone weir (listed, non-designated significant feature). This feature is located within a group of cedar trees and the feature and been outflanked to the south. Channel banks are lined with decorative stone and gabion baskets are in place along the road embankment to the north. The feature is 0.9 m high with a downstream scour pool

Matrix Solutions Inc.
May 5, 2016

10. Feature #10: Fieldstone weir (listed, non-designated significant feature). No in-stream structure is visible, however banks are lines with decorative stone. Bankfull width is 2m and wetted depth is 0.15 m.

Matrix Solutions Inc.
May 5, 2016

11. Feature #11: Fieldstone weir with steps and ashlar stone terrace wall (listed, non-designated significant feature). This feature is 4m wide and 1.4 m high from the channel bed to crest. Stone placement along the channel bed downstream from the feature limits scour. Decorative stone placement line the banks of the channel.

City of Guelph
n/a

12. Feature #12: Ashlar limestone wall (listed, non-designated significant feature). The feature is approximately 10m in length and extends south across the floodplain adjacent to Feature #11.

Matrix Solutions Inc.
May 5, 2016

13. Feature #13: Confluence of Clythe Creek and intermittent stream (potential significance). The intermittent stream flows through the southern floodplain and typically conveys groundwater flows. There is a small CSP culvert crossing immediately upstream from the confluence that allows for pedestrian crossing.

Matrix Solutions Inc.
May 5, 2016

14. Feature #14: Fieldstone weir with cut stone terrace wall (listed, non-designated significant feature). The crest of this feature is 1.5 m wide between the two main sentinel stones and is 1.45 m high from the base of the downstream scour pool. The backwater pool upstream from the feature is 0.55 m deep. Noticeable sedimentation is occurring behind the structure, with unconsolidated material measuring 10-15 cm.

City of Guelph
n/a

15. Feature #15: Fieldstone east entrance wall with sentinel stones (listed, non-designated significant feature). This feature is located to the north of the channel adjacent to York Road. The feature is 42 m long.

City of Guelph
n/a

16. Fieldstone west entrance wall with sentinel stones (listed, non-designated significant feature). This feature is located to the north of the channel adjacent to York Road. The feature is 50 m long.

Matrix Solutions Inc.
May 5, 2016

17. Feature #17: Stone and concrete road bridge (listed, non-designated significant feature). The bridge and wing-wall structure is approximately 14 m wide. The inlet to convey Clythe Creek is 4m wide and is considered to be undersized from a geomorphic perspective as the channel has widened and pooled on either side of the inlet.

Matrix Solutions Inc.
May 5, 2016

18. Feature #18: Fieldstone steps to the south of road bridge (listed, non-designated significant feature). The steps lead from the driveway entrance, down to Clythe Creek south of the bridge.

City of Guelph
n/a

19. Feature #19: Entrance sign, ashlar stone with jack arch (potential significance). The sign is located south of the creek channel and east of the main entrance drive way.

City of Guelph
n/a

20. Feature #20: Ashlar dry stone wall (listed, non-designated significant feature). The wall is 160 m long and runs parallel to the main entrance driveway south of the creek channel.

Google Earth
December 21, 2016

21. Feature #21: Willowbank Hall (listed, non-designated significant feature). The building structure is located to the south-west of the main entrance driveway and is a prominent landscape feature when visitors enter the property.

Matrix Solutions Inc.
May 5, 2016

22. Feature #22: Fieldstone weir (listed, non-designated significant feature). The feature is located 6m downstream from Feature #17, and is made from concrete with small boulders protruding which emphasizes the "rushing" waterfall effect. Structure width is 2.5 m along the crest and is 1.5 m height from the downstream bed elevation. The downstream water depth within the associated scour pool is 0.8 m.

Matrix Solutions Inc.
May 5, 2016

23. Feature #23: Fieldstone weir (listed, non-designated significant feature). This feature is located to the south of a man-made island downstream from the main entrance. The feature is 2m wide and is made out of concrete with small boulders protruding which emphasizes the “rushing” waterfall effect. Channel banks are lined with decorative stone and there is visual evidence of the structure detaching from the bank.

Matrix Solutions Inc.
May 5, 2016

24. Feature #24: Fieldstone weir (listed, non-designated significant feature). This feature is located to the north of a man-made island downstream from the main entrance. The feature is 2.1 m wide and is made out of concrete with small boulders protruding which emphasizes the “rushing” waterfall effect. Channel banks are lined with decorative stone. There are fracture lines present along the northern bank adjacent to the downstream stone wall. The structure is 0.7 m high, with the downstream bank heights/stone wall 1m high. Stone placement along the channel bed limits scour.

Matrix Solutions Inc.
May 5, 2016

25. Feature #25: Fieldstone weir (listed, non-designated significant feature). This feature is located downstream from the man-made island and 60m downstream from Feature #17 (main bridge). The feature is 5.5 m wide, however active flow width is only 4m over the crest. Height of the structure is 0.8 m from the downstream channel bed, with maximum scour depth of 0.5 m. Water depth upstream from the structure is 0.45 m, and the channel is heavily silted with deposition.

Matrix Solutions Inc.
May 5, 2016

26. Feature #26: Fieldstone weir (listed, non-designated significant feature). The feature height is 1m from the crest to the downstream channel bed, scour depth is 0.4 m. The feature is spanned by Feature #27 and decorative stone is places along the banks.

Matrix Solutions Inc.
May 5, 2016

27. Feature #27: Arched concrete and metal pedestrian bridge with stone abutments (potential significance). The bridge is 6.5 m long, and 2.5 m wide, the opening between footings allowing for channel flow is 3.5 m wide.

City of Guelph
n/a

28. Feature #28 and #29: Limestone pillars with wood board fencing leading to main entrance (potential significance). This feature runs parallel to York Road north of Clythe Creek, and extends for 630 m along the edge of the property.

City of Guelph
n/a

29. Feature #30: Limestone pillars (potential significance). This feature runs parallel to York Road north of Clythe Creek, and extends for 630 m along the edge of the property.

Matrix Solutions Inc.
May 5, 2016

30. Feature #31: metal and wooden pedestrian bridge (potential significance). The bridge is 7m long and 1.8 m wide, with a metal railing and concrete block footings. Water depth under the bridge is 0.65 m with 0.8 m freeboard between the water surface and the bridge deck. Minimum width of the outlet channel is 6.5 m indicating that the bridge is likely undersized.

City of Guelph
n/a

31. Feature #32: Metal and wood pedestrian bridge (potential significance). This pedestrian bridge leads from the south floodplain downstream from Feature #31 to a small island feature within Clythe Creek. The bridge is 9m long and 1.1 m wide sitting on concrete block footings. Wetted depth under the bridge is 0.28 m. Significant sedimentation has occurred within the vicinity of the bridge, with a depth of approximately 0.55 m of soft unconsolidated material present.

City of Guelph
n/a

32. Feature #33: Metal and wood pedestrian bridge (potential significance). The bridge spans Clythe Creek 120 m east of the driveway to Jacees Park. The Bridge is 7m long and 1.15 m wide, the deck sits 0.75 m above water level.

Matrix Solutions Inc.
May 5, 2016

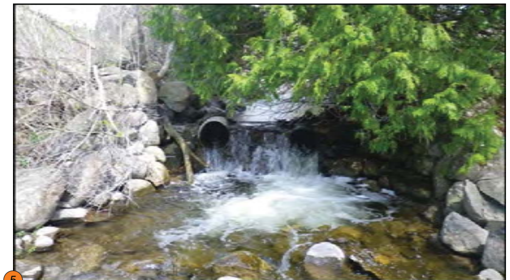
33. Feature #34: Confluence of Clythe Creek and Hadati Creek (potential significance). Hadati Creek flows south-east, crossing perpendicular to York Road through a concrete box culvert.

Matrix Solutions Inc.
May 5, 2016

34. Feature #35: Concrete and stone weir (potential significance). Total height of the feature is 0.7 m, with 0.35 m downstream water depth. The structure is 5.5 m wide and is constructed with concrete and decorative limestone blocks along the banks.

APPENDIX C
Clythe Creek Channel Alignment Options 1 to 3

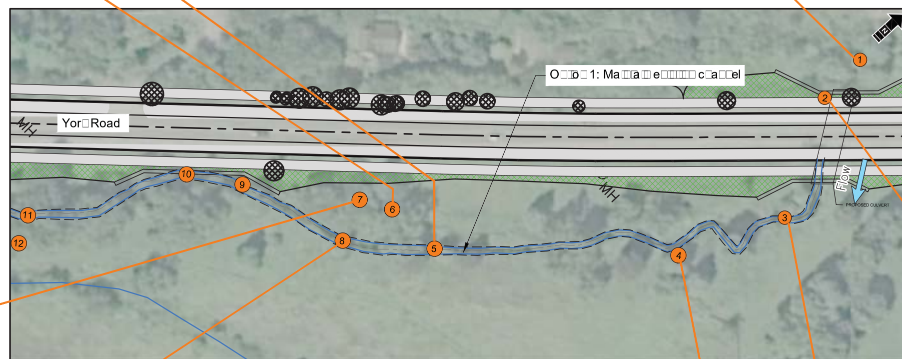
Feature 6: Fieldstone [illegible] lined, non-designated historical feature. No impact to feature anticipated.



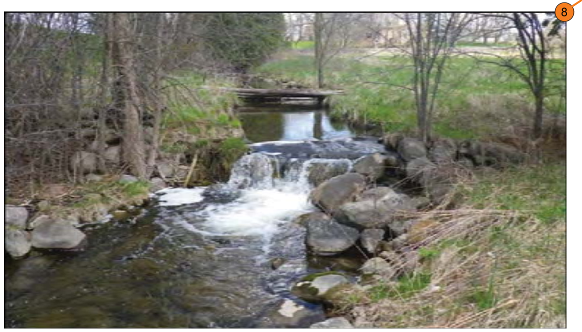
Feature 5: Fieldstone retaining walls and culvert lined, non-designated historical feature. No impact to feature anticipated.

Feature 1: Ashlar stone culvert - potential significance. No impact to feature anticipated.

Feature 7: Large boulder or bedrock outcrop - potential significance. No impact to feature anticipated.

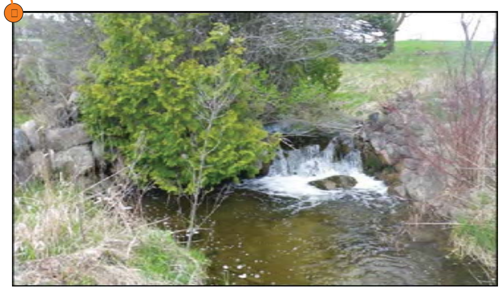


Feature 2: Reinforced concrete road bridge railing - potential significance. Feature to be modified to accommodate road widening.



Feature 8: Fieldstone weir lined, non-designated historical feature. No impact to feature anticipated.

Feature 4: Fieldstone garden wall and tree channel lined, non-designated historical feature. No impact to feature anticipated.



Feature 3: Fieldstone weir and weir lined and tree channel lined, non-designated historical feature. No impact to feature anticipated.

1:1500 Metres
15 0 15 30
Datum

Notes:

1. Refer to Figure 02 for photos of features 9, 10, 11 and 12.
2. For full plan and profile detail drawings for all options of Option 1, refer to Figure 03-08.

REVISION					
00	01 1 201	Issued for client review	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

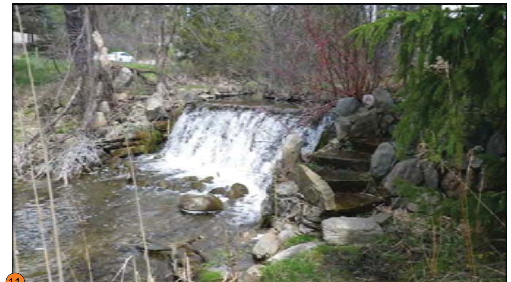
AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option 1 - Upstream Reach
Cultural Heritage Feature Impacts

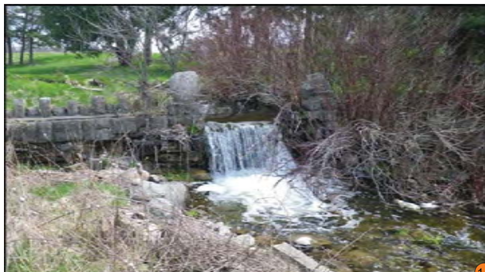
Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
01 1 201	2225 York Road	J. Henshaw	J. Parks	E. Dro	01

Feature 15: Fieldstone head/entrance wall with sentinel stones. Listed, non-designated cultural heritage feature.

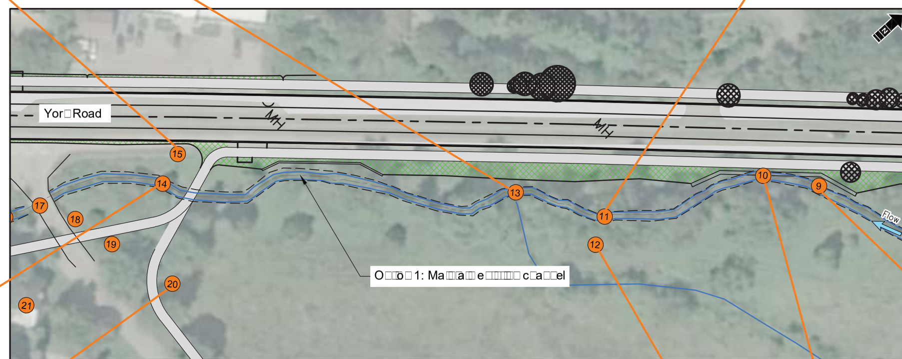
Feature 16: Confluence of Clythe Creek and Eramosa tributary. Potential cultural significance. No impacts to feature anticipated.

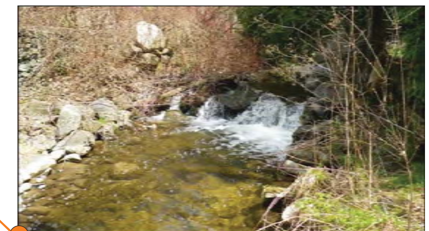


Feature 11: Fieldstone weir with steps and ashlar stone terrace wall. Listed, non-designated cultural heritage feature. No impacts to feature anticipated.



Feature 14: Fieldstone weir with cut stone terrace wall. Listed, non-designated cultural heritage feature.





Feature 9: Fieldstone weir. Listed, non-designated cultural heritage feature. No impacts to feature anticipated. Retaining wall required to be built to protect/maintain feature from anticipated road and grading limits.

Feature 20: Ashlar dry stone wall. Listed, non-designated cultural heritage feature. No impacts to feature anticipated.

Feature 12: Ashlar limestone wall. Listed, non-designated cultural heritage feature. No impacts to feature anticipated.

Feature 10: Fieldstone weir. Listed, non-designated cultural heritage feature. Retaining wall required to be built to protect/maintain feature from anticipated road and grading limits. Part of ashlar stone to be removed to accommodate retaining wall.

1:1500 Metres
15 0 15 30
Datum

Notes:
1. For full plan and profile details for each option of Option 1, refer to Figures 05-08.
2. Refer to Figure 03 for photos of features 16, 18, 19 and 21.

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No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option 1 - Upstream Reach
Cultural Heritage Feature Impacts

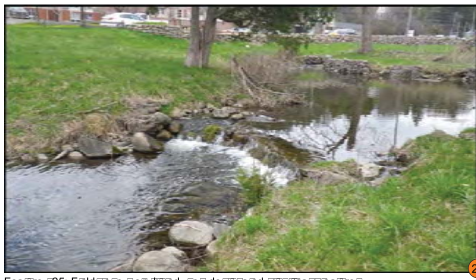
Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
01 1_ 201_	2225_ York Road	J. Hemingway	J. Par_	E. Dro_	02

Feature 16: Fieldstone decorative fence wall with decorative stones lined, non-designated cultural heritage feature. Potential for feature to be modified as a result of road and grading requirements.

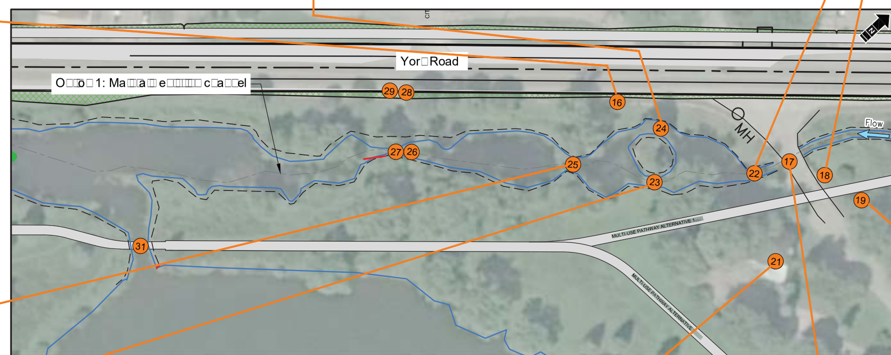
Feature 24: Fieldstone weir lined, non-designated cultural heritage feature. No impact to feature anticipated.

Feature 22: Fieldstone weir lined, non-designated cultural heritage feature. No impact to feature anticipated.

Feature 18: Fieldstone steps to the York Road bridge lined, non-designated cultural heritage feature. No impact to feature anticipated. No impact to feature anticipated.



Feature 25: Fieldstone weir lined, non-designated cultural heritage feature.



Feature 19: Entrance sign, a pillar stone with a plaque, potential cultural heritage significance. No impact to feature anticipated.

Feature 23: Fieldstone weir lined, non-designated cultural heritage feature. No impact to feature anticipated.

Feature 21: Willow □□ Hall lined, non-designated cultural heritage feature. No impact to feature anticipated.

Feature 17: Stone and concrete road bridge lined, non-designated cultural heritage feature. No impact to feature anticipated. No impact to feature anticipated.

1:1500 Meters
15 0 15 30
Datum

Notes:
1. For full plan and profile design information for Option 1, refer to Figures 05-08.
2. Refer to Figure 04 for location of features 2□, 2□ and □1.

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No.	DATE	DESCRIPTION	BY	CHK.	DRN.
00	01 1□ 201□	Issued for client review	JH	JP	ED

Matrix Solutions Inc. ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option 1 - Middle Reach
Cultural Heritage Feature Impacts

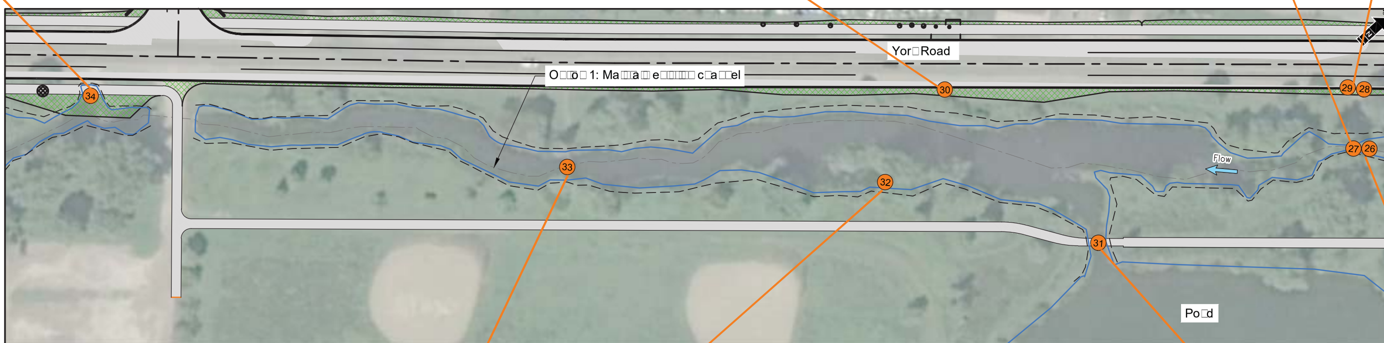
Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
01 1□ 201□	2225□ York Road	J. He□□□an	J. Par□□	E. Dro□□	0□

Feature 34 is considered cultural heritage feature: Box culvert at confluence of Clythe Creek and Hadati Creek. Potential culvert extension to accommodate road and grading requirements and CSP replacement.

Feature 30: Limestone pillar. Potential significance. Potential for feature to be modified as a result of road and grading requirements.

Feature 29: Arched concrete and metal pedestrian bridge with stone abutments. Potential significance. No impact to feature anticipated.

Features 28 and 29: Limestone pillars with wood board fencing leading to a path entrance. Potential significance. Potential for feature to be modified as a result of road and grading requirements.



Feature 2[illegible]: Fieldstone weir lined, non-designated significant feature. No impact to feature anticipated.

Feature 33: Metal and wood pedestrian bridge. Potential significance. No impact to feature anticipated.

Feature 32: Metal and wood pedestrian bridge. Potential significance. No impact to feature anticipated.

Feature 31: Metal and wooden pedestrian bridge. Potential significance. Potential for feature to be modified to accommodate pedestrian traffic and utilities in area.

1:1500

15 0 15 30

Metres

Datum

Notes:

1. For full plan and profile details for all alternatives of Option 1, refer to Figures 04-08.

REVISION					
00	01 1[illegible] 201[illegible]	Issued for client review	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option 1 - Middle Reach
Cultural Heritage Feature Impacts

Date:	Project:	Technical:	Reviewer:	Drawn:
01 1[illegible] 201[illegible]	2225[illegible] York Road	J. He[illegible]	J. Par[illegible]	E. Dro[illegible]

Figure 0[illegible]

Feature CH5: Concrete and stone weir. Potential significance. No impact to feature anticipated.

Feature CH8: GJR railway bridge. Potential significance. No impact to feature anticipated.

1:1500
15 0 15 30
Meters
Datum

Notes:
1. For full plan and profile details for Option 1, refer to Figures 05-08.

REVISION					
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No.	DATE	DESCRIPTION	BY	CHK.	DRN.

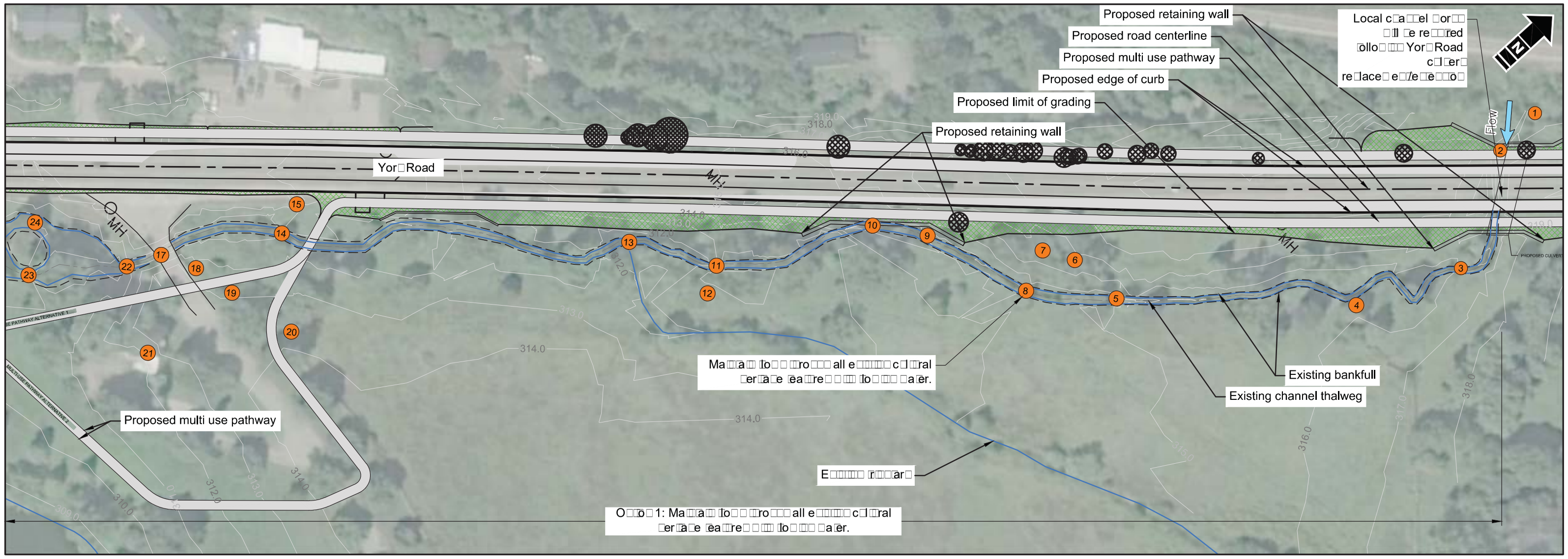
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

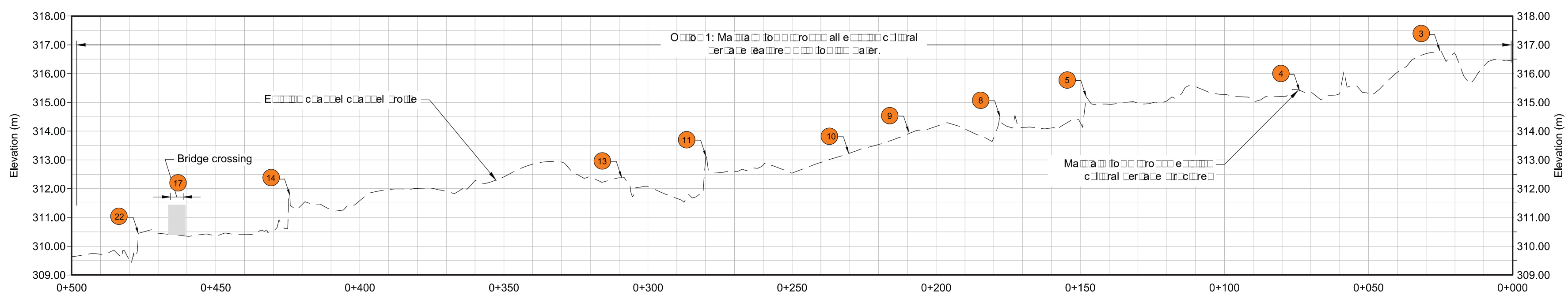
York Road Improvements
Clythe Creek Option 1 - Downstream Reach
Cultural Heritage Feature Impacts

Date:	Project:	Technical:	Reviewer:	Drawn:
01 1□ 201□	2225□ York Road	J. He□□□a□	J. Par□□	E. Dro□□

Figure
05



1:1500 Metres



Legend	
	Surveyed channel thalweg
	Surveyed edge of water
	Surveyed bankfull
	Toe of road grading
	Fill/grading area
2	Cultural heritage feature/structure

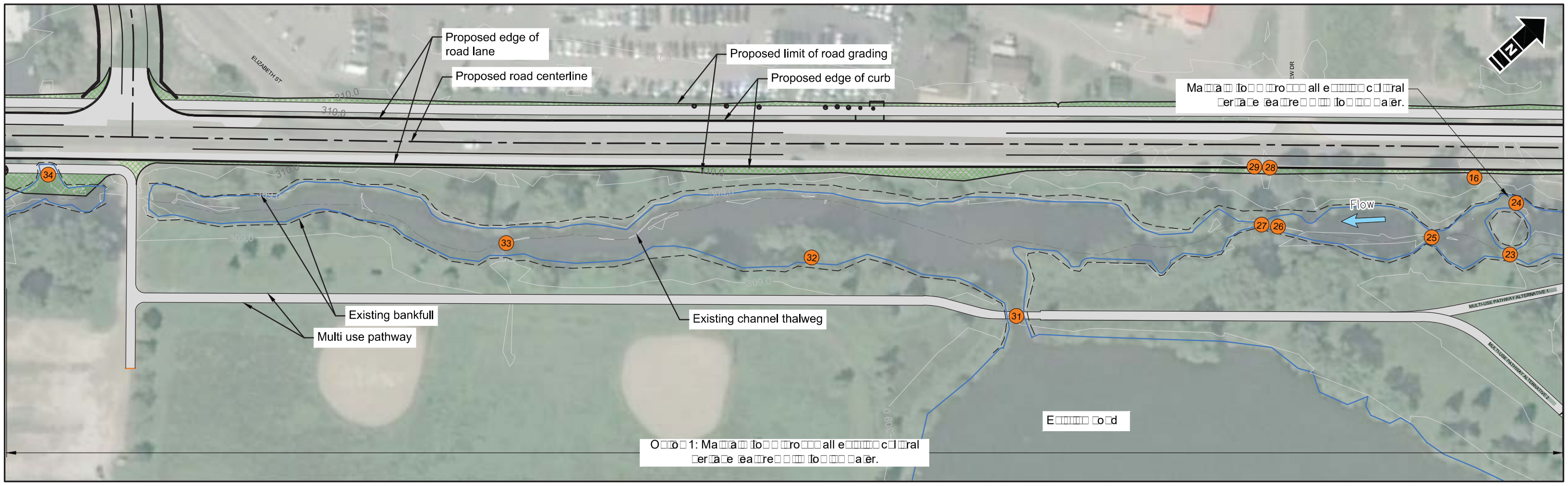
Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

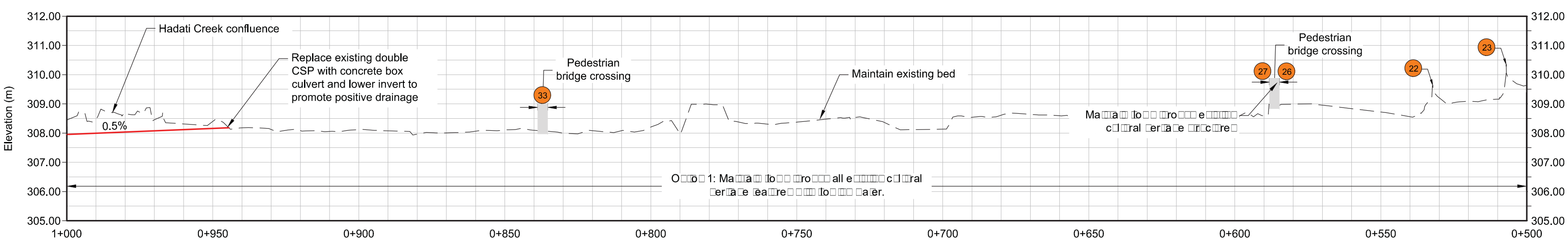
REVISION					
02	01 1□ 201□		JH	JP	ED
01	12 0□ 201□		JH	JP	ED
00	0□ 15 201□		JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

York Road Improvements
Clythe Creek - Option 1
Preliminary Plan and Profile 0+000-0+500m

Figure 06





Channel Profile

Hor[illegible]al Scale 1:1500
Ver[illegible]al Scale 1:150

Legend	
	Surveyed channel thalweg
	Surveyed edge of water
	Surveyed bankfull
	Toe of road grading
	Fill/grading area
2	Cultural heritage feature/structure

No[illegible]

1. C[illegible] Mat[illegible] Sol[illegible] I[illegible]c. o[illegible] Ma[illegible] 2, [illegible] a[illegible]d 5, 201[illegible]
2. Road a[illegible]d [illegible] co[illegible]
3. A[illegible]
4. Fea[illegible] are [illegible] UTM Nad 8[illegible] [illegible]
5. Her[illegible]
6. Ba[illegible]

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00	0[illegible] 15 201[illegible]	Dra[illegible]	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Fo[illegible]er W[illegible]eeler
Yor[illegible] Road W[illegible]de[illegible]

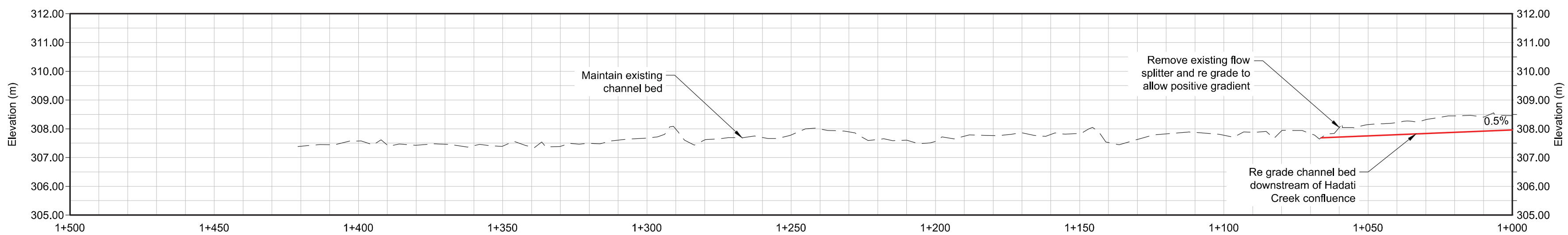
York Road Improvements
Clythe Creek - Option 1
Preliminary Plan and Profile 0+500-1+000m

Date:	Project:	Technical:	Reviewer:	Drawn:
01 1[illegible] 201[illegible]	2225[illegible] Yor[illegible] Road	J. He[illegible]	J. Par[illegible]	E. Dro[illegible]

Figure 0[illegible]

Legend	
(dash-dot line)	Surveyed channel thalweg
(blue line)	Surveyed edge of water
(dashed line)	Surveyed bankfull
(solid line)	Toe of road grading
(hatched area)	Fill/grading area
(2)	Cultural heritage feature/structure

Notes:
1. Channel survey completed by Matrix Solutions Inc. on May 2, [illegible], and 5, 201[illegible].
2. Road and property survey completed by others.
3. [illegible] provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinates.
5. Heritage feature locations and information provided by others.
6. Bankfull features to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
02	01 1[illegible] 201[illegible]	Revised based on client comments	JH	JP	ED
01	12 0[illegible] 201[illegible]	Revised based on client comments	JH	JP	ED
00	0[illegible] 15 201[illegible]	Draft for client review	JH	JP	ED

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

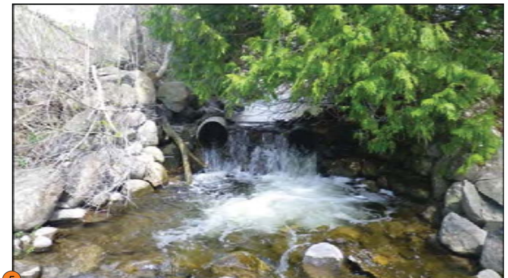
AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Option 1
Preliminary Plan and Profile 1+000-1+500m

Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
01 1[illegible] 201[illegible]	2225[illegible] York Road	J. Hes[illegible]	J. Par[illegible]	E. Dro[illegible]	0[illegible]

N:\PROJECTS\2225[illegible] - York Road ... AMEC ... 2018 1:12:2[illegible] PM

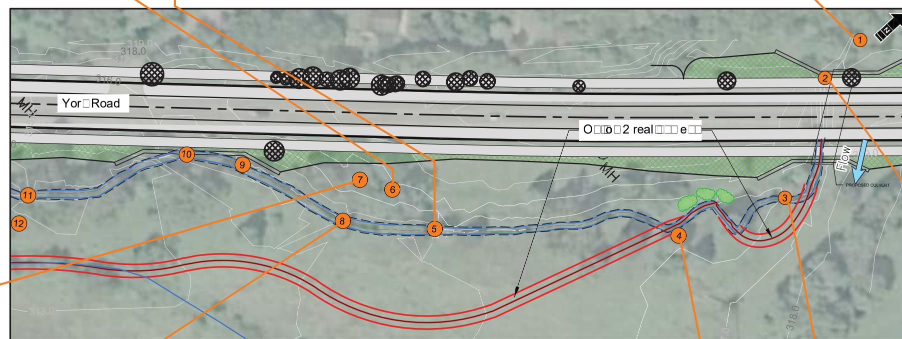
Feature 06: Fieldstone pile identified, non-designated historical feature. No impact to feature anticipated.



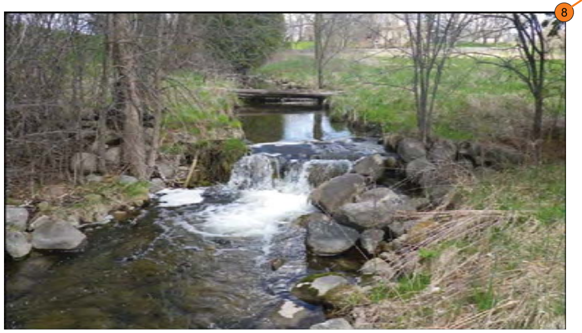
Feature 05: Fieldstone weir with clay tile identified, non-designated historical feature. No impact to feature anticipated. Feature is a substantial barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken off-line/disconnected from active flow as a result of local channel realignment. Feature will be maintained in landscape [illegible].

Feature 01: Ashlar stone culvert, potential significance. No impact to feature anticipated.

Feature 07: Large boulder or bedrock outcrop, potential significance. No impact to feature anticipated.

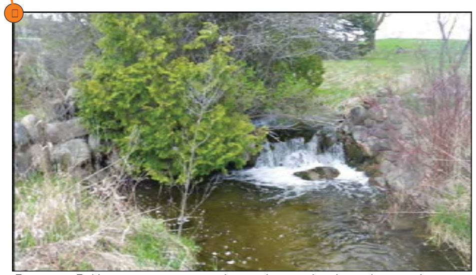


Feature 02: Reinforced concrete road bridge railing, potential significance. Feature to be modified to accommodate road widening works.



Feature 08: Fieldstone weir identified, non-designated historical feature. No impact to feature anticipated. Feature is a substantial barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken off-line/disconnected from active flow as a result of local channel realignment. Feature will be maintained in landscape [illegible].

Feature 04: Fieldstone garden wall [illegible] identified, non-designated historical feature. No impact to feature anticipated.



Feature 03: Fieldstone weir with headwall and culvert identified, non-designated historical feature. Feature is a substantial barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken off-line/disconnected from active flow as a result of channel realignment. Feature will be maintained in landscape [illegible].

1:1500 Metres 15 0 15 30 Datum

Notes:
1. Refer to Figure 02 for photos of features 9, 10, 11 and 12.
2. For full plan and profile design drawings of Option 2, refer to Figures 05-08.

REVISION					
00	01 1 201	Issued for client review	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc. ENVIRONMENT & ENGINEERING

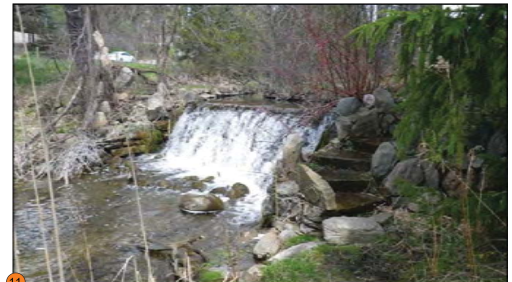
AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option 2 - Upstream Reach Cultural Heritage Feature Impacts

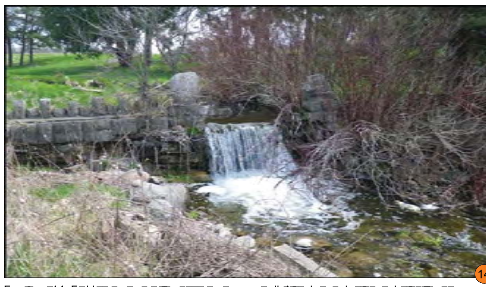
Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
01 1 201	22251 York Road	J. Herman	J. Parish	E. Drost	01

Feature 15: Fieldstone entrance wall with wheel stone lined, non-designated cultural heritage feature. No impact to feature anticipated.

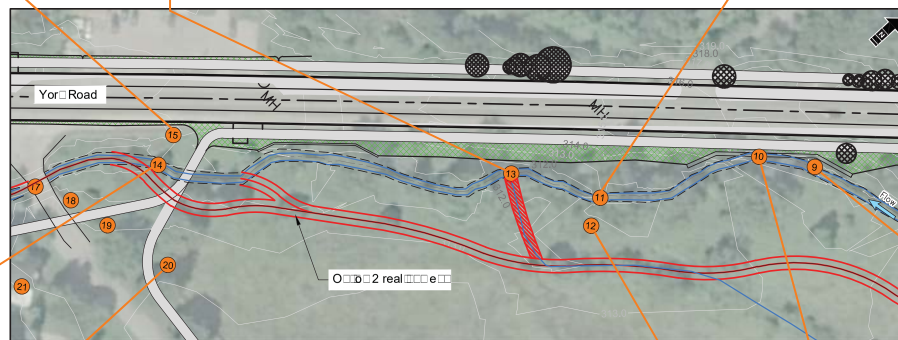
Feature 13: Confluence of Clythe Creek and other tributary. Potential significance: Feature to be isolated/disconnected from active flow as a result of channel realignment. Tributary connection to Existing Clythe Creek will be filled. Existing proposed water drain to be incorporated and attached to proposed re-alignment.

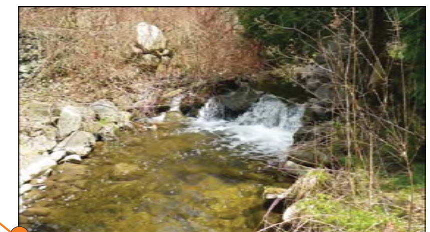


Feature 11: Fieldstone weir with stone and a similar stone terrace wall lined, non-designated cultural heritage feature. Feature is a structural barrier to fish passage and limits factor to overall channel function and health. Feature to be isolated/disconnected from active flow as a result of channel realignment. Feature will be maintained in landscape but will be isolated from flow.



Feature 14: Fieldstone weir with concrete stone terrace wall lined, non-designated cultural heritage feature. Feature is a structural barrier to fish passage and limits factor to overall channel function and health. Feature to be isolated/disconnected from active flow as a result of channel realignment and maintained in landscape. Potential for overflow channel to reconnect feature during times of high-flow.





Feature 9: Fieldstone weir lined, non-designated cultural heritage feature. No impact to feature anticipated. Feature is a structural barrier to fish passage and limits factor to overall channel function and health. Feature to be isolated/disconnected from active flow as a result of channel realignment. Feature will be maintained in landscape but will be isolated from flow.

Feature 20: Ashlar dry stone wall lined, non-designated cultural heritage feature. No impact to feature anticipated.

Feature 12: Ashlar limestone wall lined, non-designated cultural heritage feature. Part of feature impacted by proposed creek realignment.

Feature 10: Fieldstone weir lined, non-designated cultural heritage feature. No impact to feature anticipated. Feature is a structural barrier to fish passage and limits factor to overall channel function and health. Feature to be isolated/disconnected from active flow as a result of channel realignment. Feature will be maintained in landscape but will be isolated from flow.

1:1500
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Metres
Datum

Notes:
1. For full plan and profile details for Option 2, refer to Figure [illegible]-08.
2. Refer to Figure 0[illegible] for photos of features 16, 17, 18, 19 and 21.

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
00	01 [illegible] 201[illegible]	Issued for client review	JH	JP	ED

REVISION

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option 2 - Upstream Reach Cultural Heritage Feature Impacts

Date:	Project:	Technical:	Reviewer:	Drawn:
01 [illegible] 201[illegible]	2225[illegible] York Road	J. Hen[illegible]	J. Par[illegible]	E. Dro[illegible]

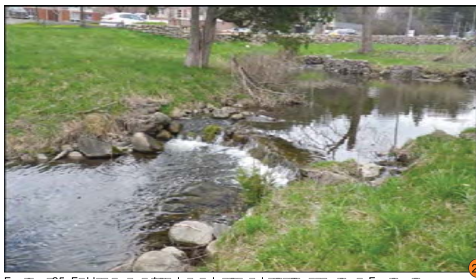
Figure 02

Feature 16: Fieldstone entrance wall with central posts listed, non-designated cultural heritage feature. Potential for feature to be modified as a result of road and grading requirements.

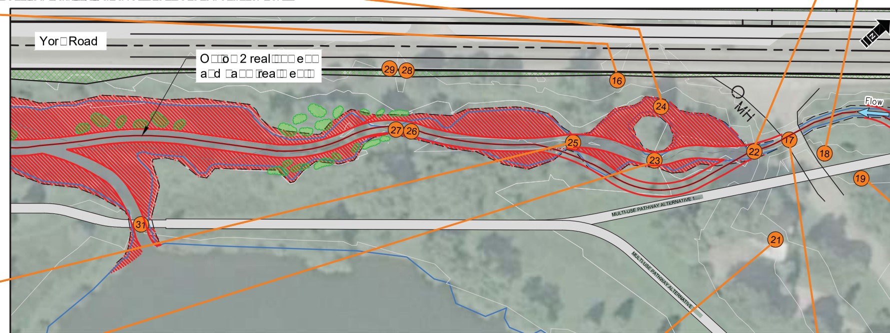
Feature 24: Fieldstone weir listed, non-designated cultural heritage feature. Feature is a substantial barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken off-line/disconnected from active flow as a result of proposed channel works. Potential for feature to be impacted as a result of required grading/fill as a result of proposed channel works.

Feature 22: Fieldstone weir listed, non-designated cultural heritage feature. No impact to feature anticipated.

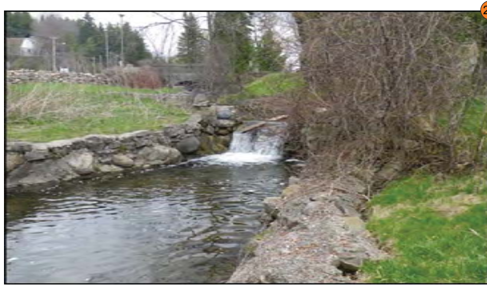
Feature 18: Fieldstone steps to the south of road bridge listed, non-designated cultural heritage feature. No impact to feature anticipated. No impact to feature anticipated.



Feature 25: Fieldstone weir listed, non-designated cultural heritage feature. Feature is a substantial barrier to fish passage and limiting factor to overall channel function and health. Feature will require modification or removal (confirmed during detailed design) as a result of channel works.



Feature 19: Entrance sign, ashlar stone with backarch, potential significance. No impact to feature anticipated.



Feature 20: Fieldstone weir listed, non-designated cultural heritage feature. Feature is a substantial barrier to fish passage and limiting factor to overall channel function and health. Feature will require modification or removal (confirmed during detailed design) as a result of channel works.

Feature 21: Willow Hall listed, non-designated cultural heritage feature. No impact to feature anticipated.

Feature 17: Stone and concrete road bridge listed, non-designated cultural heritage feature. No impact to feature anticipated, existing hydraulic capacity to be maintained.

1:1500
15 0 15 30 Metres

Notes:
1. For full plan and profile details for alignment option 2, refer to Figures 01-08.
2. Refer to Figure 04 for location of features 2[illegible], 2[illegible] and [illegible]1.

REVISION					
00	01 1[illegible] 2018	Issued for client review	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option 2 - Middle Reach
Cultural Heritage Feature Impacts

Date:	Project:	Technical:	Reviewer:	Drawn:
01 1[illegible] 2018	2225[illegible] York Road	J. He[illegible]	J. Par[illegible]	E. Dro[illegible]

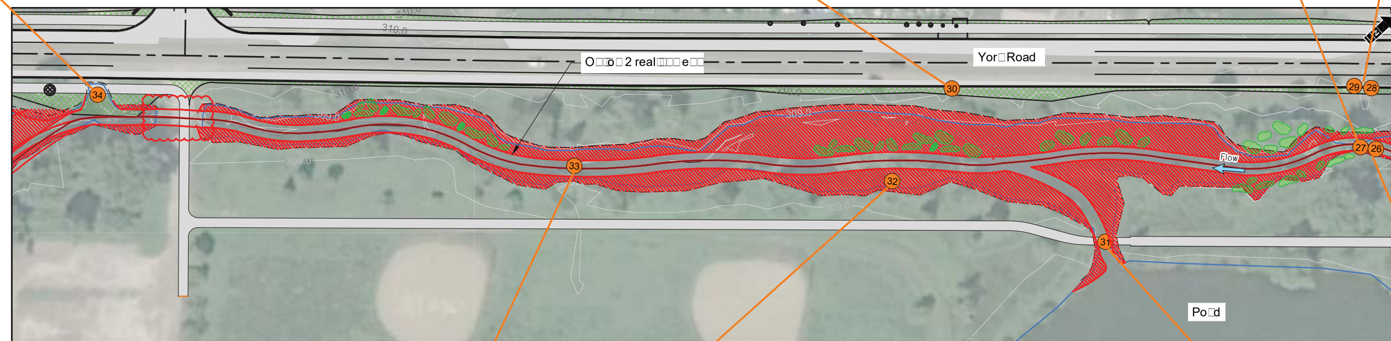
Figure 0[illegible]

Feature 34 is considered cultural heritage feature. Boundary marker at confluence of Clythe Creek and Hadati Creek. Potential cultural heritage value to accommodate road and grading requirements and CSP replacement.

Feature 30: Limestone pillar. Potential significance. Potential for feature to be modified as a result of road and grading requirements.

Feature 29: Arched concrete and metal pedestrian bridge with stone abutments. Potential significance. Potential for feature to be modified to accommodate pedestrian traffic and climate change.

Features 28 and 29: Limestone pillars with wood board fencing leading to an entrance. Potential significance. Potential for feature to be modified as a result of road and grading requirements.



Feature 27: Fieldstone weir lined, cast-in-place concrete feature. Feature is a structural barrier to fish passage and limits factor to overall channel function and health. Feature will require modification or removal, confirmed during detailed design as a result of channel works.

Feature 33: Metal and wood pedestrian bridge. Potential significance. No impact to feature anticipated. Potential for feature to be modified to accommodate pedestrian traffic and climate change.

Feature 32: Metal and wood pedestrian bridge. Potential significance. Feature to be removed as a result of proposed channel works.

Feature 31: Metal and wooden pedestrian bridge. Potential significance. Potential for feature to be modified to accommodate pedestrian traffic and climate change.

1:1500 — Metres — 15 0 15 30 — Datum

Notes:

1. For full plan and profile details for portion of Option 2, refer to Figures 0-08.

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
00	01 1 201	Issued for client review	JH	JP	ED

Matrix Solutions Inc. ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option 2 - Middle Reach
Cultural Heritage Feature Impacts

Date:	Project:	Technical:	Reviewer:	Drawn:
01 1 201	2225 York Road	J. Hemmings	J. Parish	E. Drost

Figure 0

Feature 5: Concrete and stone weir potential significance. Feature to be removed and replaced with proposed channel works.

Feature 8: GJR railway bridge potential significance. No impact to feature anticipated.

Notes:
1. For full plan and profile design information of Option 2, refer to Figures 0…-08.

1:1500
Metres

REVISION				
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00	01 1 201	Issued for client review	JH	JP	ED

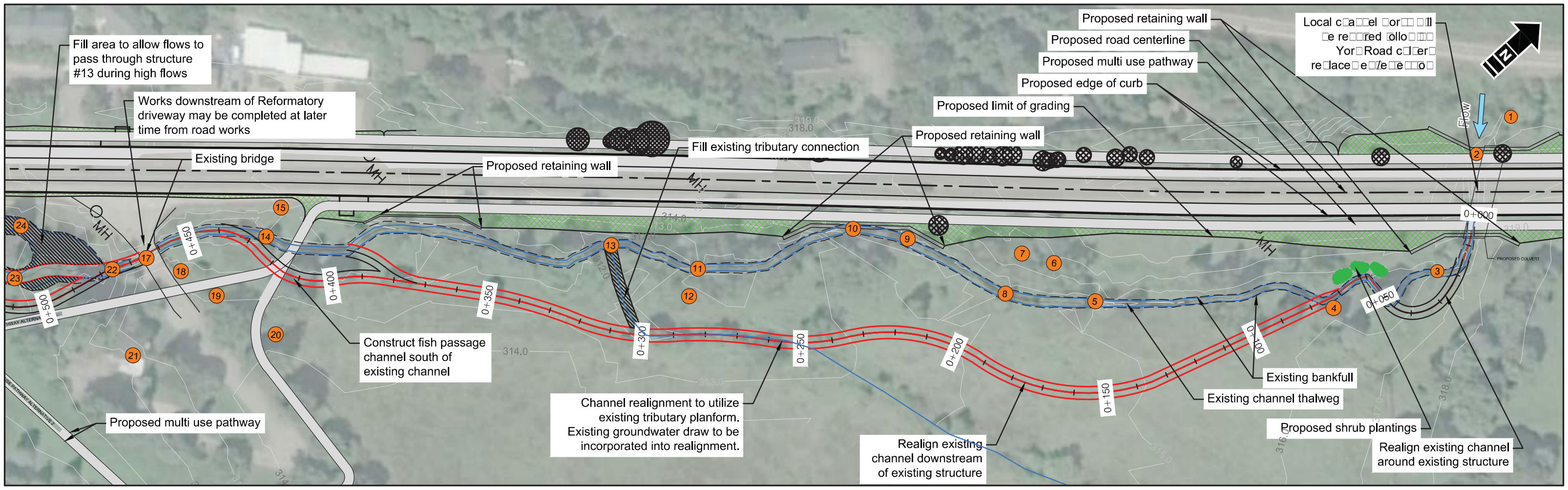
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option 2 - Downstream Reach Cultural Heritage Feature Impacts

Date: 01 1 201 | Project: 2225 York Road | Technical: J. Heath | Reviewer: J. Parish | Drawn: E. Dro

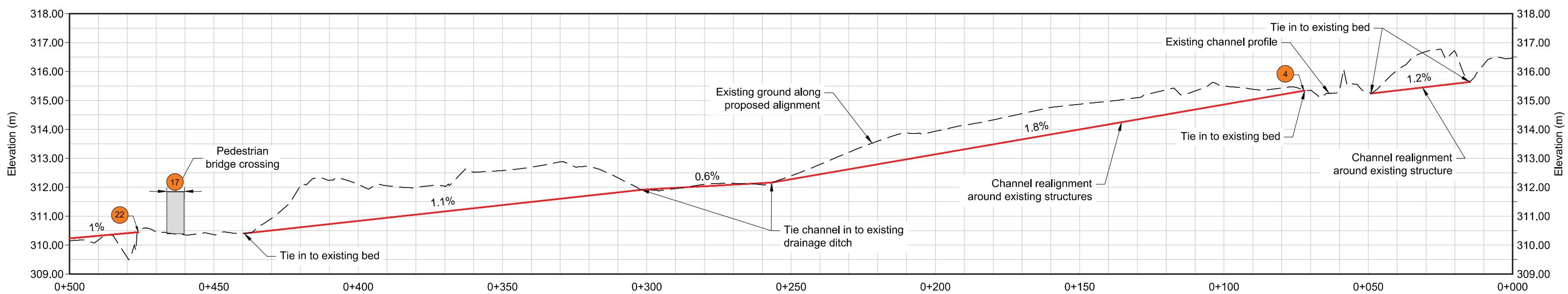
Figure 05



Legend	
(blue line)	Surveyed edge of water
(dashed line)	Surveyed bankfull
(black line)	Toe of road grading
(red line)	Proposed realignment
(hatched)	Proposed fill/bank treatment
(green)	Proposed shrubs and plantings
(2)	Cultural heritage feature/structure

Notes:
1. Channel survey completed by Matrix Solutions Inc. on May 2, 3 and 5, 2017.
2. Road and property survey completed by others.
3. Air photo provided by others.
4. Features displayed are in UTM Nad 83 zone 17 coordinate system.
5. Heritage feature locations and information provided by others.
6. Bank treatments to be confirmed in detailed design.

1:1500 Metres



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

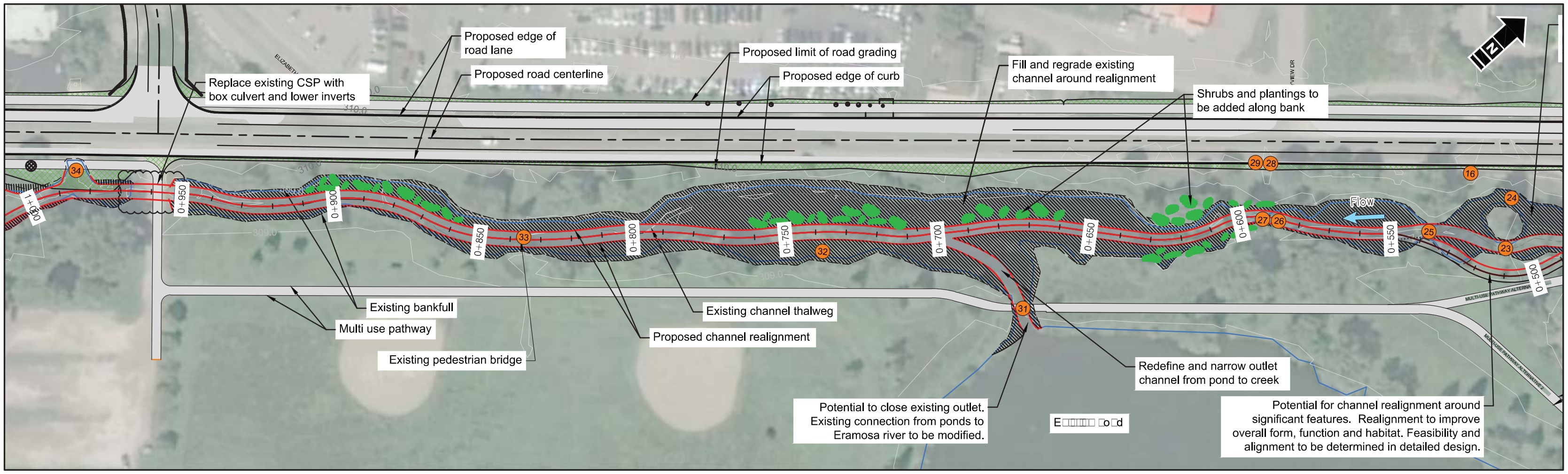
REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
02	01 1 2017	Revised based on client comments	JH	JP	ED
01	12 0 2017	Revised based on client comments	JH	JP	ED
00	0 15 2017	Draft for client review	JH	JP	ED

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Option 2
Preliminary Plan and Profile 0+000-0+500m

Date: 01 1 2017 | Project: 2225 York Road | Technical: J. Heyman | Reviewer: J. Parish | Drawn: E. Dro | Figure 06



Legend	
(blue line)	Surveyed edge of water
(dashed line)	Surveyed bankfull
(black line)	Toe of road grading
(red line)	Proposed realignment
(hatched)	Proposed fill/bank treatment
(green)	Proposed shrubs and plantings
2	Cultural heritage feature/structure

No□e□:
1. C□a□□el □□r□e□ co□□le□ed □□ Ma□r□ Sol□□o□□ I□c. o□ Ma□ 2, □, a□d 5, 201□.
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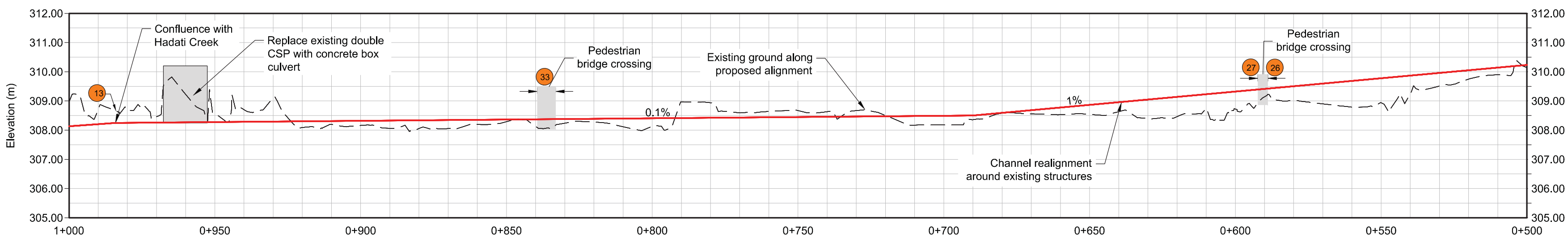

Channel Profile
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REVISION

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Fo□□er W□eeler
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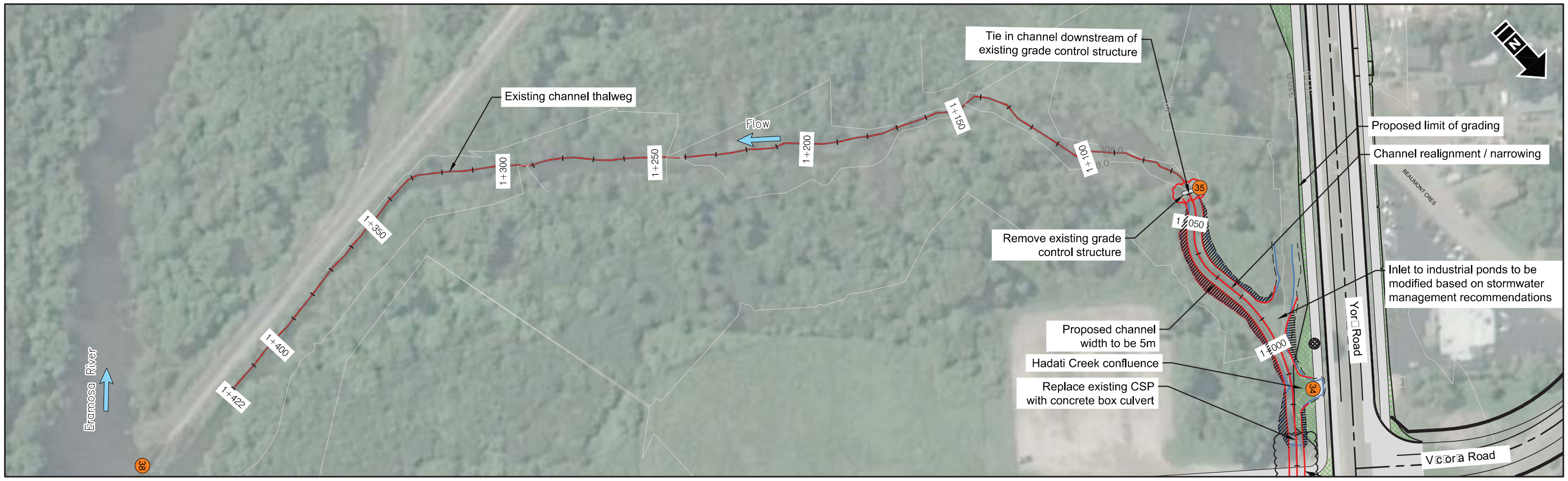
York Road Improvements
Clythe Creek - Option 2
Preliminary Plan and Profile 0+500-1+000m

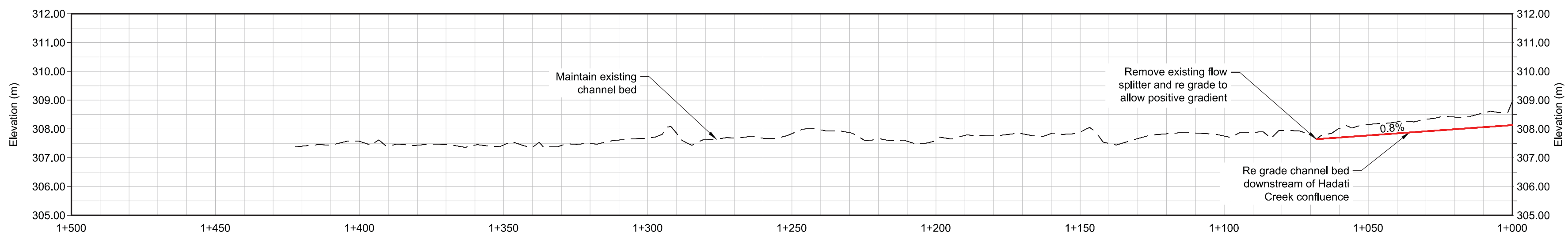
Da□e: 01 1□ 201□	Pro□ec□: 2225□ Yor□ Road	Tec□□□cal: J. He□□□a□	Re□□e□er: J. Par□□□	Dra□□: E. Dro□□	Figure 0□



Legend	
(blue line)	Surveyed edge of water
(dashed line)	Surveyed bankfull
(black line)	Toe of road grading
(red line)	Proposed realignment
(red hatching)	Proposed fill/bank treatment
(2)	Cultural heritage feature/structure

Notes:

1. Channel [illegible] completed by Matrix Solutions Inc. on May 2, [illegible] and 5, 201[illegible]
2. Road and [illegible] completed [illegible]
3. Air [illegible] provided [illegible]
4. Features [illegible] are [illegible] UTM Nad 8[illegible] Zone 1[illegible] coordinate [illegible]
5. Heritage feature locations and [illegible] provided [illegible]
6. Bank treatments to be confirmed [illegible] detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
02	01 1[illegible] 201[illegible]	Re[illegible]ed [illegible]	JH	JP	ED
01	12 0[illegible] 201[illegible]	Re[illegible]ed [illegible]	JH	JP	ED
00	0[illegible] 15 201[illegible]	Draft for c[illegible]	JH	JP	ED

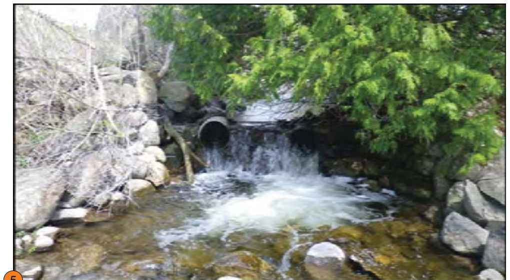
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Option 2
Preliminary Plan and Profile 1+000-1+500m

Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
01 1[illegible] 201[illegible]	2225[illegible] York Road	J. He[illegible]	J. Par[illegible]	E. Dro[illegible]	0[illegible]

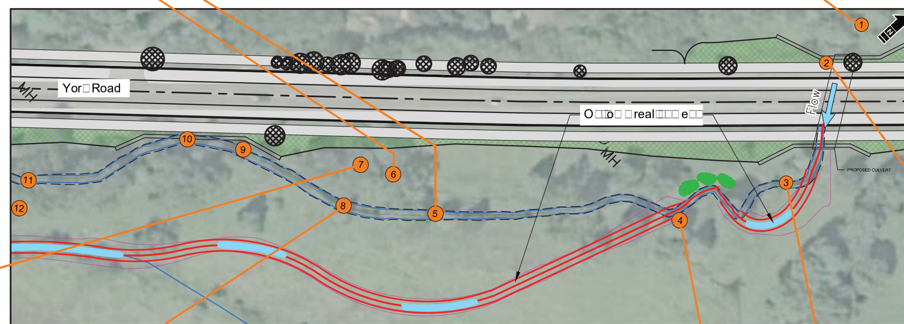
Feature 06: Fieldstone pile lined, non-designated potential heritage feature. Feature is located within the floodplain and will not be impacted by proposed channel works.



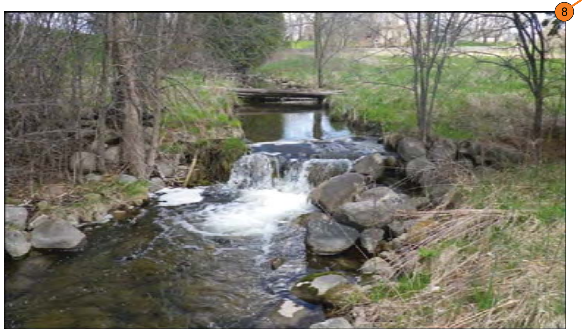
Feature 05: Fieldstone weir with clay tile-lined, non-designated potential heritage feature. Feature is a potential barrier to fish passage and limiting factor to overall channel morphology and health. Feature to be taken off-line and disconnected from active flow as a result of channel realignment. Feature will be maintained in the landscape.

Feature 01: Arch stone culvert - potential heritage significance. Channel works are proposed downstream from York Road therefore the feature will not be impacted by proposed channel works.

Feature 07: Large boulder or bedrock outcrop - potential heritage significance. Feature is located within the floodplain and will not be impacted by proposed channel works.

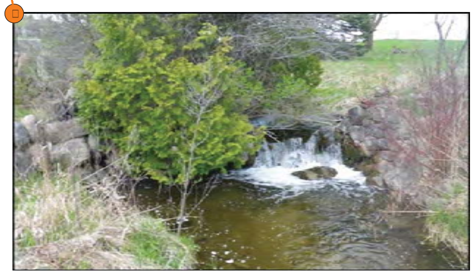


Feature 02: Reinforced concrete road bridge railing - potential heritage significance. No impacts to feature anticipated as a result of proposed channel works.



Feature 08: Fieldstone weir lined, non-designated potential heritage feature. Feature is a potential barrier to fish passage and limiting factor to overall channel morphology and health. Feature to be taken off-line and disconnected from active flow as a result of channel realignment. Feature will be maintained in the landscape.

Feature 04: Fieldstone garden wall [illegible] lined, non-designated potential heritage feature. In order to maintain the feature, the existing channel planform will be utilized. All the feature is within the floodplain and will not be impacted by proposed channel works.



Feature 03: Fieldstone weir [illegible] lined, non-designated potential heritage feature. Feature is a potential barrier to fish passage and limiting factor to overall channel morphology and health. Feature to be taken off-line and disconnected from active flow as a result of channel realignment. Feature will be maintained in the landscape.

1:1500 Metres
15 0 15 30
Datum

Notes
1. Refer to Figure 02 for photos of features 9, 10, 11 and 12.
2. For full plan and profile details for Option [illegible], refer to Figures 03-08.

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
01	0[illegible] 08 201[illegible]	Revised based on client comments	JH	JP	ED
00	01 1[illegible] 201[illegible]	Issued for client review	JH	JP	ED

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

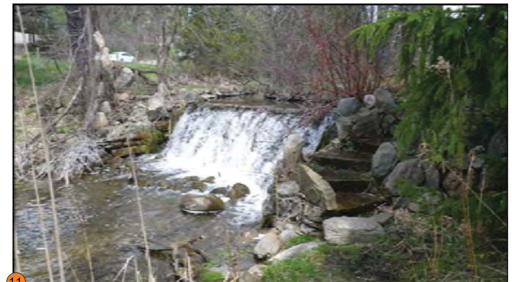
AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option [illegible] - Upstream Reach
Cultural Heritage Feature Impacts

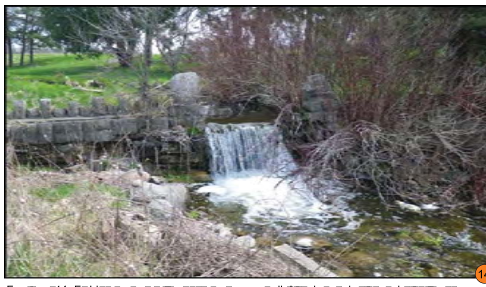
Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
0[illegible] 08 201[illegible]	2225[illegible] York Road	J. He[illegible]	J. Par[illegible]	E. Dro[illegible]	01

Feature #15: Fieldstone entrance wall with metal stone lined, non-designated cultural heritage feature. No impact to feature anticipated as a result of proposed channel works.

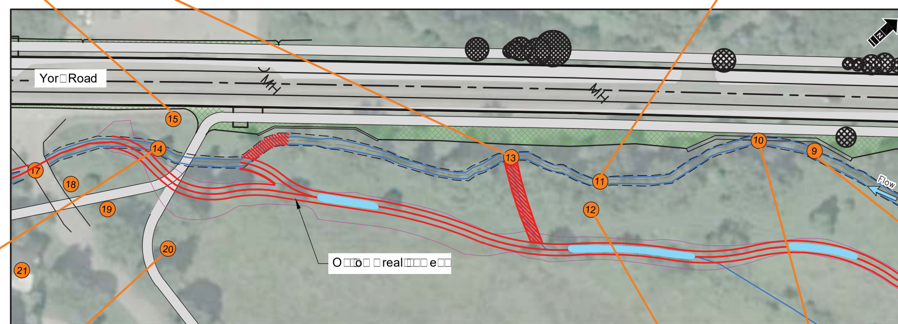
Feature #1[illegible]: Confluence of Clythe Creek and [illegible]. Potential significance. Feature will be 'filled' and the floodplain restored to [illegible] elevation. The proposed channel alignment will be a local section of the [illegible], as a result the existing groundwater draw will be maintained during proposed re-alignment.

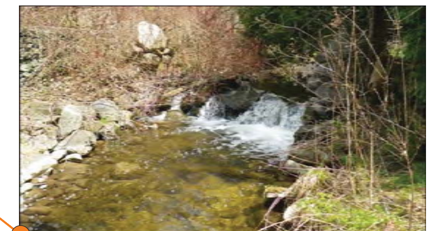


Feature #11: Fieldstone weir with stone and ashlar stone terrace wall lined, non-designated cultural heritage feature. Feature is a potential barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken offline and disconnected from active flow as a result of channel realignment. Feature will be maintained in the landscape.



Feature #14: Fieldstone weir with concrete stone terrace wall lined, non-designated cultural heritage feature. Feature is a potential barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken offline and disconnected during low-flow stages. An overflow channel will be incorporated so that the feature will be reconnected during flows greater than the 2 yr discharge.





Feature #[illegible]: Fieldstone weir lined, non-designated cultural heritage feature. Feature is a potential barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken offline and disconnected from active flow as a result of channel realignment. A retaining wall will be installed in order for the feature to be maintained in the landscape.

Feature #20: Ashlar dry stone wall lined, non-designated cultural heritage feature. Feature is located within the floodplain and will not be impacted by proposed channel works.

Feature #12: Ashlar limestone wall lined, non-designated cultural heritage feature. Feature is located within the floodplain and will not be impacted by proposed channel works.

Feature #10: Fieldstone weir lined, non-designated cultural heritage feature. Feature is a potential barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken offline and disconnected from active flow as a result of channel realignment. A retaining wall will be installed in order for the feature to be maintained in the landscape.

1:1500 — Metres — Datum

Notes:
1. For full plan and profile design information of Option [illegible], refer to Figure 0[illegible]-08.
2. Refer to Figure 01 for location of features 1[illegible], 18, 1[illegible] and 21.

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
01	0[illegible].08.201[illegible]	Revised based on client comments	JH	JP	ED
00	01.1[illegible].201[illegible]	Issued for client review	JH	JP	ED

REVISION

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option [illegible] - Upstream Reach
Cultural Heritage Feature Impacts

Date: 0[illegible].08.201[illegible] | Project: 2225 York Road | Technical: J. He[illegible] | Reviewer: J. Par[illegible] | Drawn: E. Dro[illegible] | Figure 02

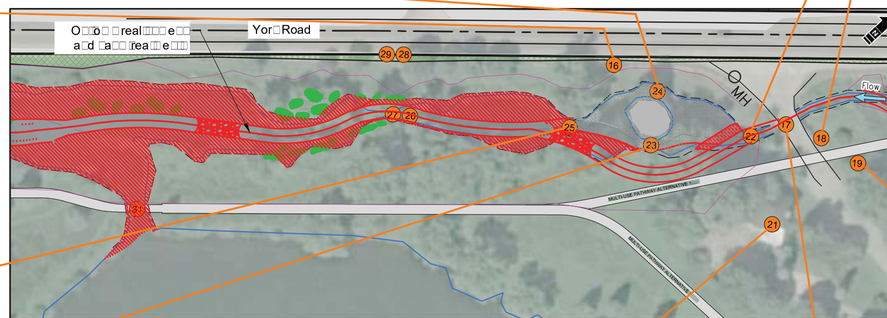
Feature 16: Fieldstone decorative wall with rubble stone lined, non-designated cultural heritage feature. No impact to feature anticipated as a result of proposed channel works.

Feature 24: Fieldstone weir lined, non-designated cultural heritage feature. Feature is a structural barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken offline and disconnected during low-flow diversion as a result of proposed channel realignment. A new low-flow channel will be incorporated to maintain the feature, which will be reconnected during high flows greater than the 2-yr discharge.

Feature 22: Fieldstone weir lined, non-designated cultural heritage feature. Feature will require modification as a result of proposed channel realignment. Proposed channel realignment will require a tie-in location immediately downstream from Feature 17. Full extent of proposed modifications to be confirmed during detailed design.

Feature 18: Fieldstone steps to the south of road bridge lined, non-designated cultural heritage feature. Feature is located within the floodplain and will not be impacted by proposed channel works.

Feature 25: Fieldstone weir lined, non-designated cultural heritage feature. Feature is a structural barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken offline and disconnected during low-flow diversion as a result of proposed channel realignment. A new low-flow channel will be incorporated to maintain the feature, which will be reconnected during high flows greater than the 2-yr discharge.



Feature 19: Entrance sign, pillar stone with back arch, potential significance. Feature is located within the floodplain and will not be impacted by proposed channel works.

Feature 20: Fieldstone weir lined, non-designated cultural heritage feature. Feature is a structural barrier to fish passage and limiting factor to overall channel function and health. Feature to be taken offline and disconnected during low-flow diversion as a result of proposed channel realignment. A new low-flow channel will be incorporated to maintain the feature, which will be reconnected during high flows greater than the 2-yr discharge.

Feature 21: Willow Hall listed, non-designated cultural heritage feature. Feature is located within the floodplain and will not be impacted by proposed channel works.

Feature 17: Stone and concrete road bridge listed, non-designated cultural heritage feature. No impact to feature anticipated as a result of proposed channel works, existing capacity determined to be adequate.

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Notes:

1. For full plan and profile details of works along Option [illegible], refer to Figures [illegible]-08.
2. Refer to Figure 04 for photos of features [illegible], [illegible] and [illegible].

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
01	[illegible] 08 201[illegible]	Revised based on client comments	JH	JP	ED
00	01 1[illegible] 201[illegible]	Issued for client review	JH	JP	ED

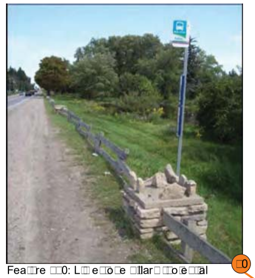
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option [illegible] - Middle Reach
Cultural Heritage Feature Impacts

Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
[illegible] 08 201[illegible]	22251 York Road	J. Hemsworth	J. Parish	E. Drost	0[illegible]

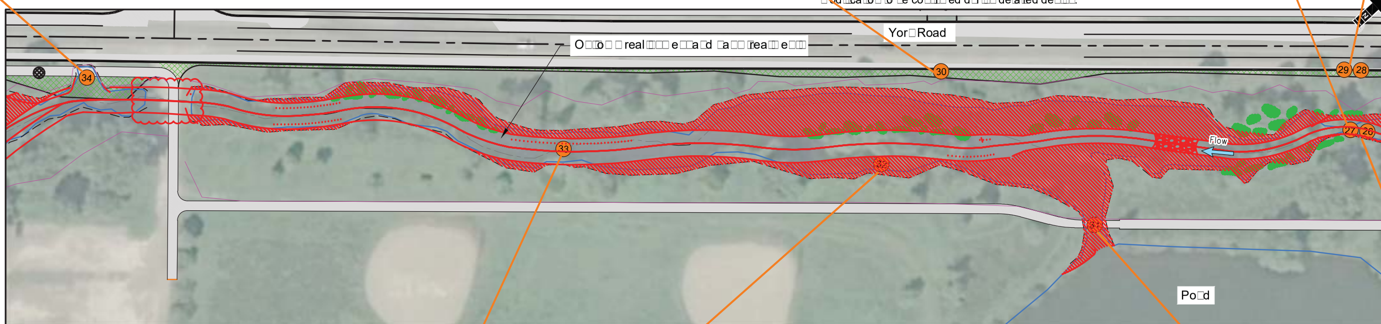
Feature 34: Confluence of Clythe Creek and Hadati Creek. Potential significance. Potential impacts to culvert to be upgraded to accommodate road and grading requirements and CSP replacement.



Feature 30: Limestone pillar. Potential significance. No impacts to feature anticipated as a result of proposed channel works.

Feature 27: Arched concrete and metal pedestrian bridge with stone abutments. Potential significance. Potential for feature abutments to be modified as a result of proposed channel work. The proposed channel will require a tie-in location at the confluence of the two watercourses: upstream and downstream. Full extent of proposed modifications to be confirmed during detailed design.

Feature 28 and 29: Limestone pillars with wood board fencing leading to a pedestrian entrance. Potential significance. No impacts to feature anticipated as a result of proposed channel works.



Feature 26: Fieldstone weir lined, non-designated significant feature. Feature is a potential barrier to fish passage and limits factor to overall channel function and health. As a result of proposed channel works it is anticipated that the feature will be reconfigured, decreasing or eliminating the existing fish passage barrier.

Feature 33: Metal and wood pedestrian bridge. Potential significance. Potential for feature to be modified or removed as a result of proposed channel works.

Feature 32: Metal and wood pedestrian bridge. Potential significance. Feature is likely to be modified or removed as a result of proposed channel works.

Feature 31: Metal and wooden pedestrian bridge. Potential significance. Feature is likely to be modified or removed as a result of proposed channel works.

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Notes:
1. For full plan and profile design information of Option 4, refer to Figure 04-08.

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
01	04/08/2019	Revised based on client comments	JH	JP	ED
00	01/11/2019	Issued for client review	JH	JP	ED

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek Option 4 - Middle Reach
Cultural Heritage Feature Impacts

Date:	Project:	Technical:	Reviewer:	Drawn:
04/08/2019	22254 York Road	J. Henshaw	J. Parish	E. Drost

Figure 0

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Plot 1:1 Tabloid 11x17

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York Road Improvements
Clythe Creek Option □ - □o□nstream Rea□h
Cultural □eritage Feature Impa□ts

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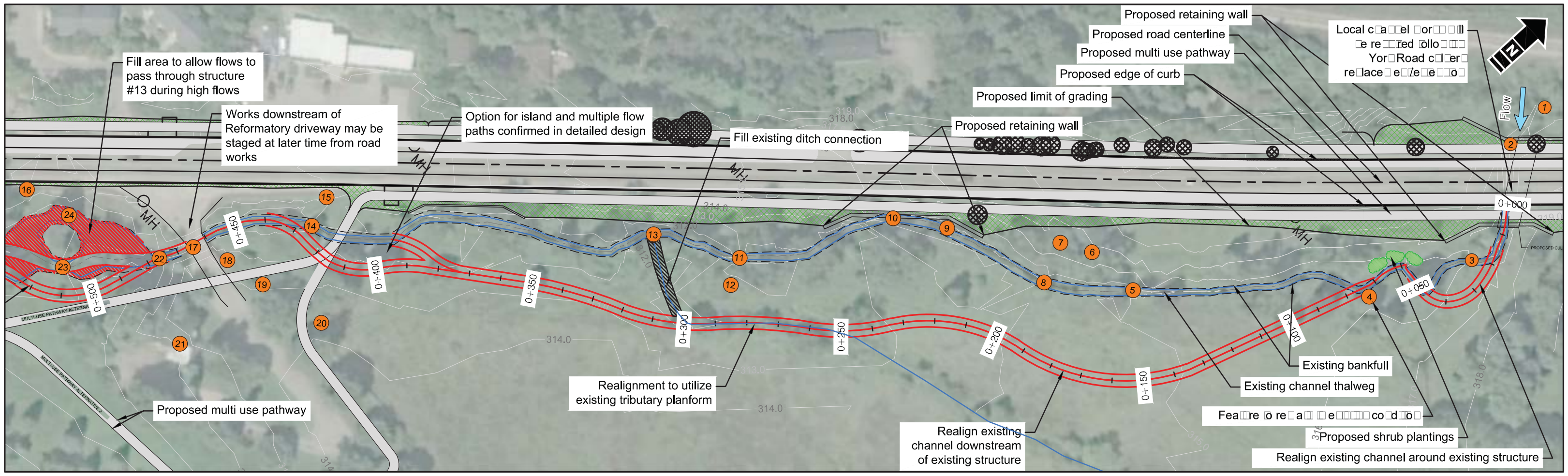

Legend

- Surveyed edge of water
- Surveyed bankfull
- Toe of road grading
- Proposed realignment
- Proposed fill/bank treatment
- Proposed shrubs and plantings
- Cultural heritage feature/structure

Notes:

4. Features displayed are in UTM Nad 83 Zone 17 coordinates.

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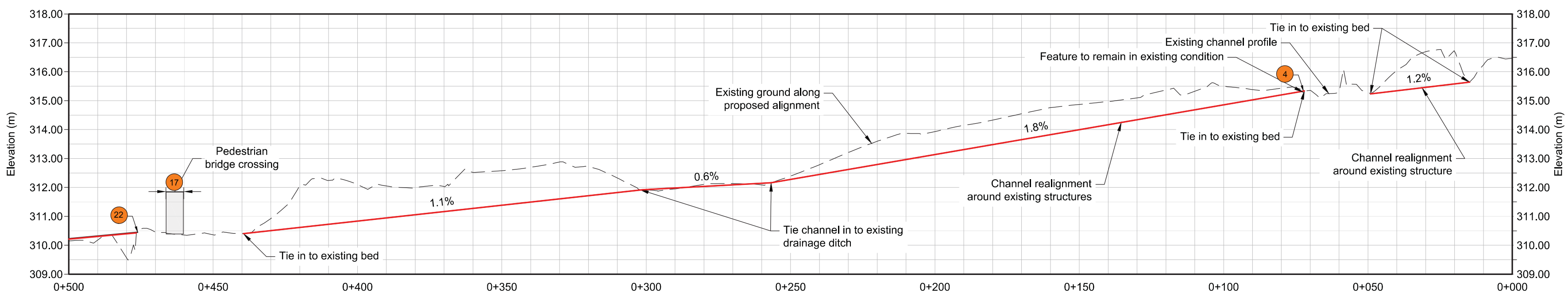

Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

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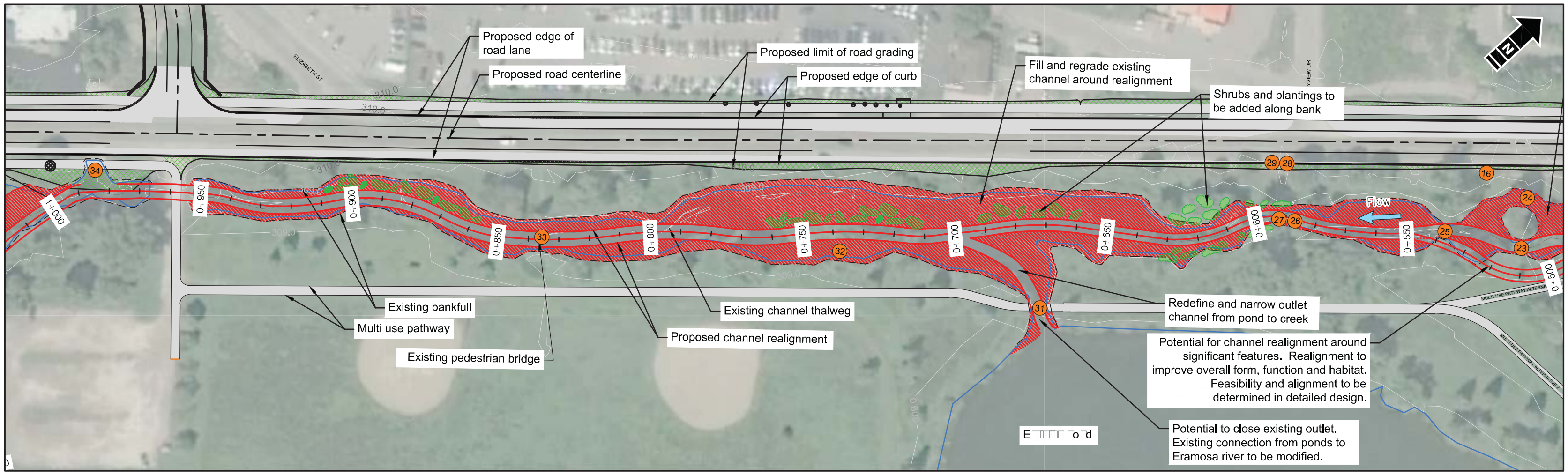
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Option
Preliminary Plan and Profile 0+000-0+500m

Project: 2225 York Road
Technical: J. He
Reviewer: J. Par
Drawn: E. Dro
Figure 06



Legend	
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	Toe of road grading
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	Proposed fill/bank treatment
	Proposed shrubs and plantings
2	Cultural heritage feature/structure

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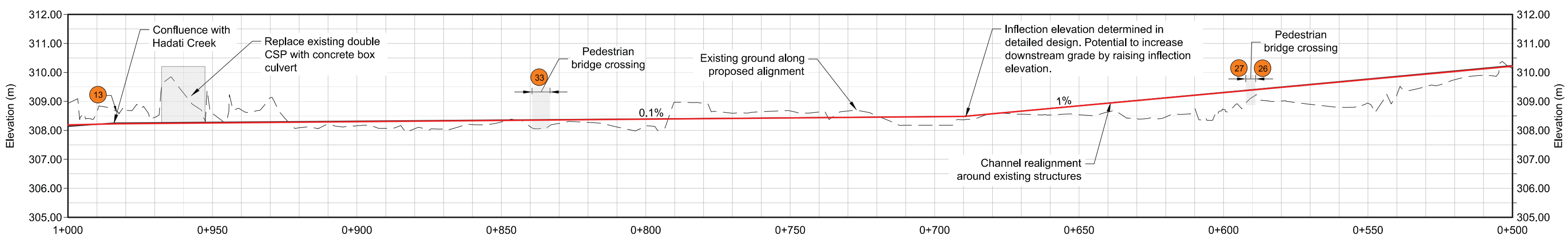

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York Road Improvements
Clythe Creek - Option □
Preliminary Plan and Profile 0+500-1+000m

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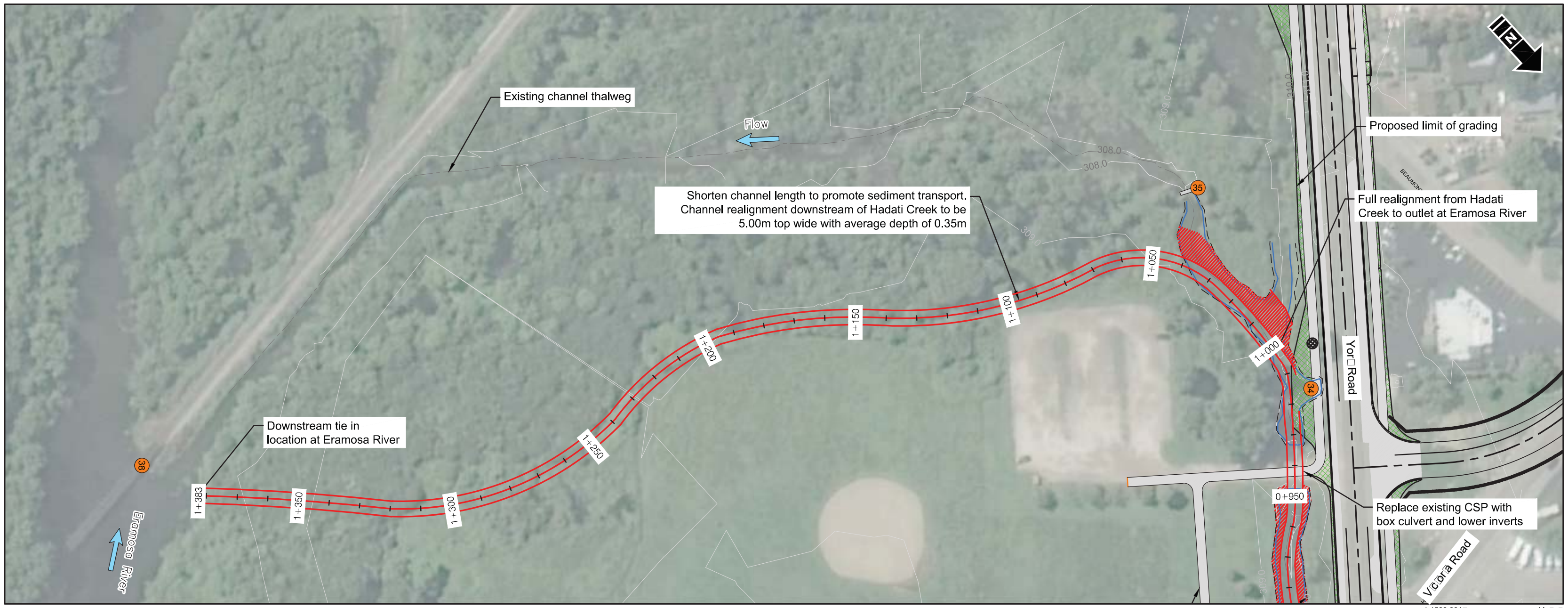

Legend	
(blue line)	Surveyed edge of water
(dashed line)	Surveyed bankfull
(black line)	Toe of road grading
(red line)	Proposed realignment
(red hatching)	Proposed fill/bank treatment
(2)	Cultural heritage feature/structure

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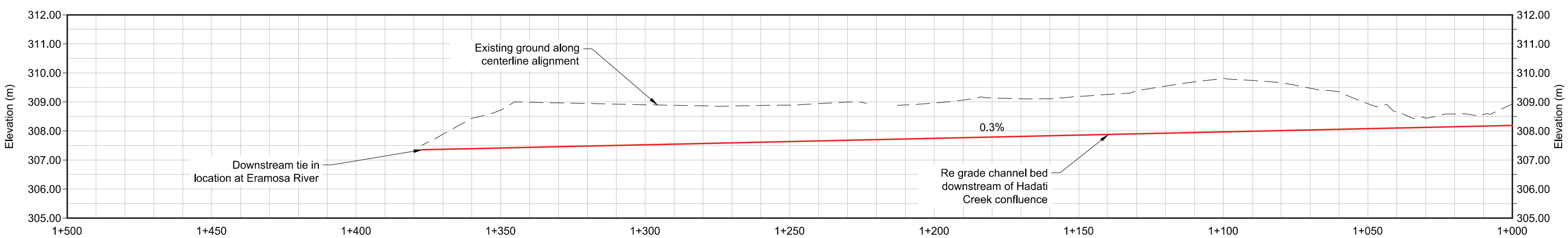

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York Road Improvements
Clythe Creek - Option □
Preliminary Plan and Profile 1+000-1+500m

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Figure 0□

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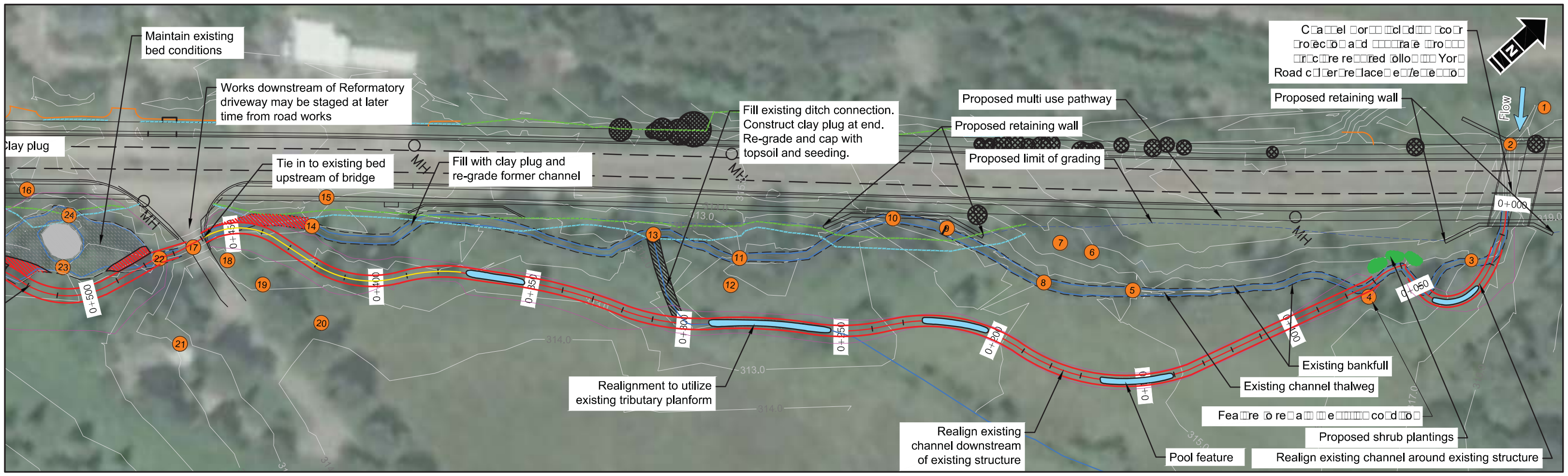
APPENDIX D
Clythe Creek Road Widening Option 1 and 2



Legend	
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	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
	Proposed shrubs and plantings
2	Cultural heritage feature/structure
	Maintain existing bed
	Proposed pool
	Approximate grading limit

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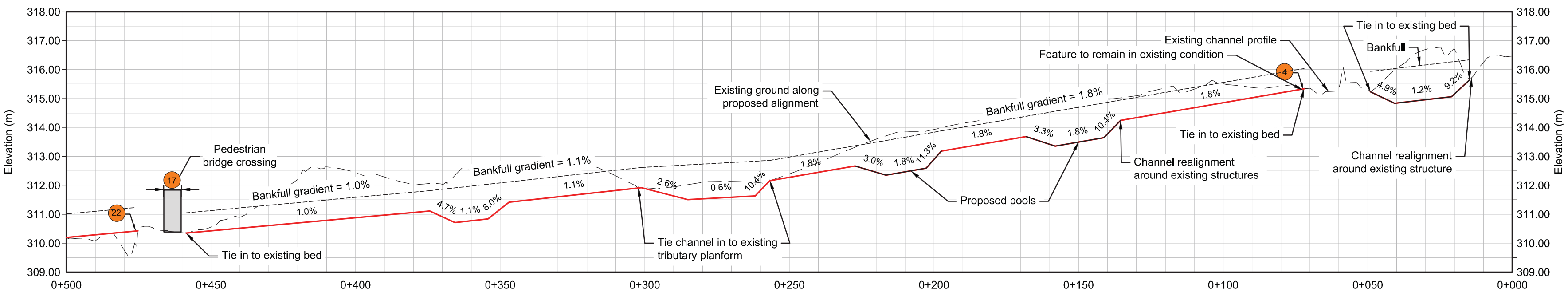

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REVISION

Matrix Solutions Inc.
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Yor□ Road W□de□□□□

York Road Improvements
Clythe Creek - Road Widening Option 1
Preliminary Plan and Profile 0+000-0+500m

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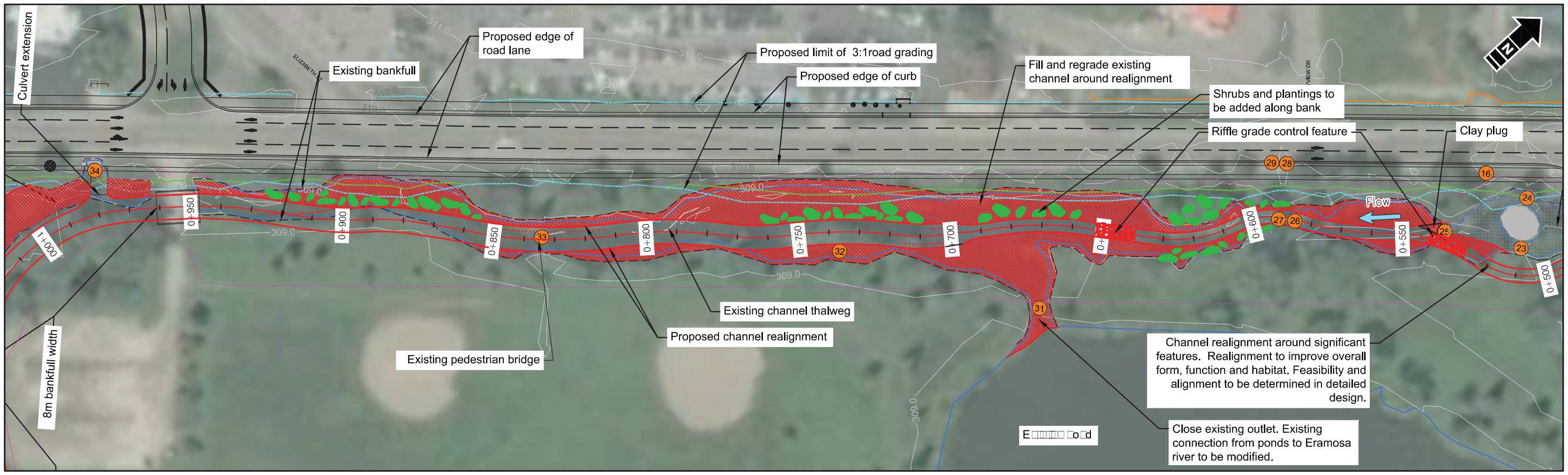
Figure 01



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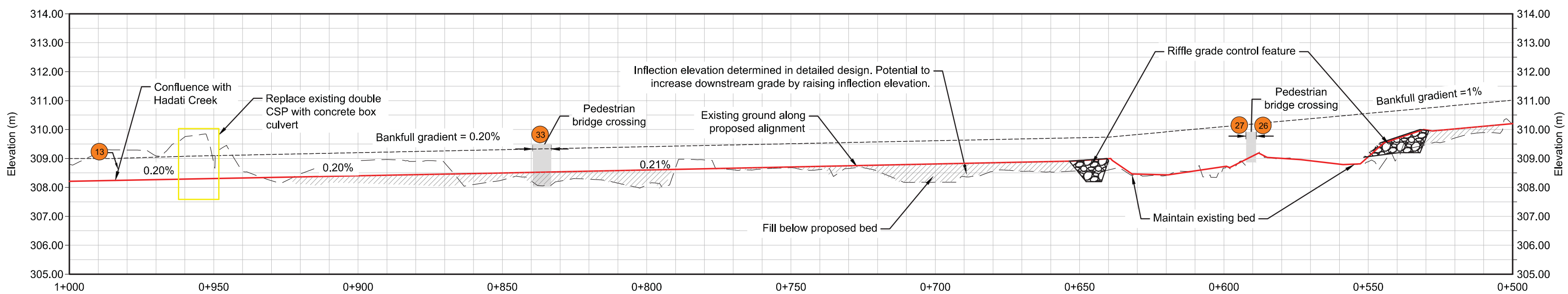

Channel Profile
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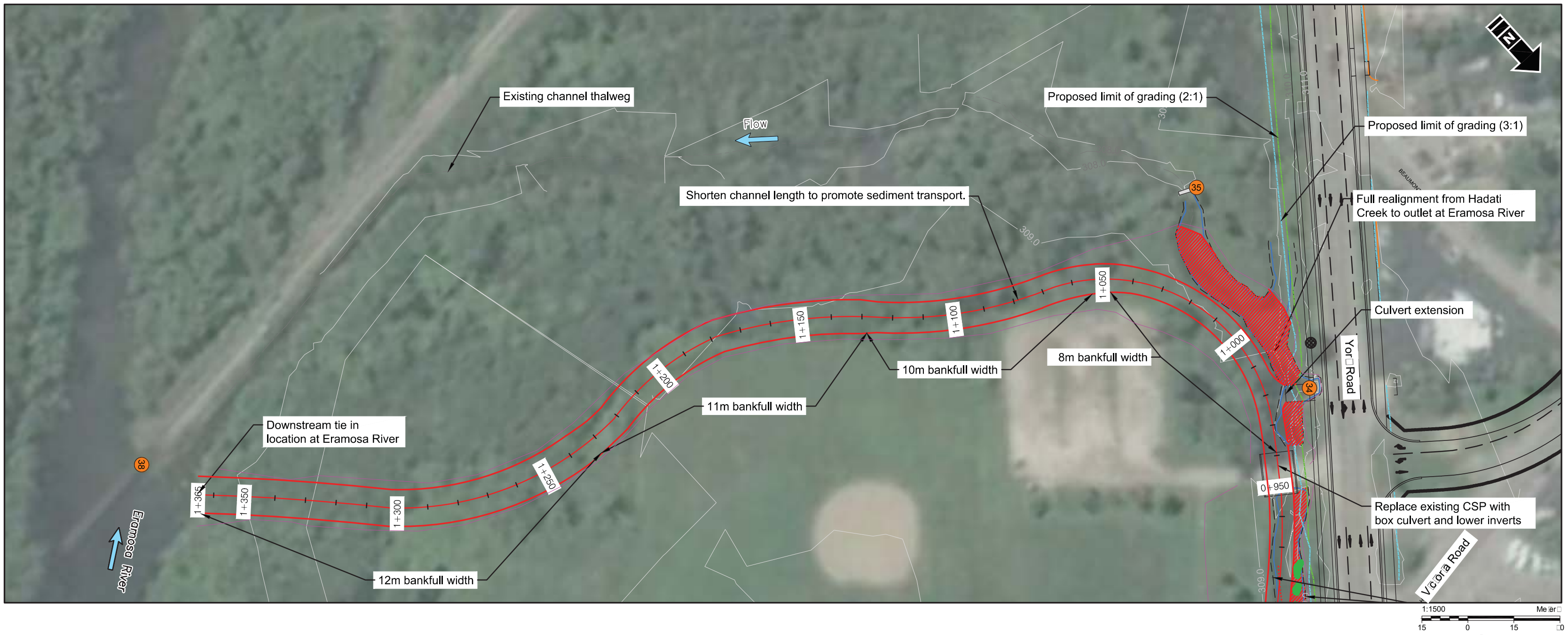
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Fo□□er W□eeler
Yor□ Road W□de□□□□

York Road Improvements
Clythe Creek - Road Widening Option 1
Preliminary Plan and Profile 0+500-1+000m

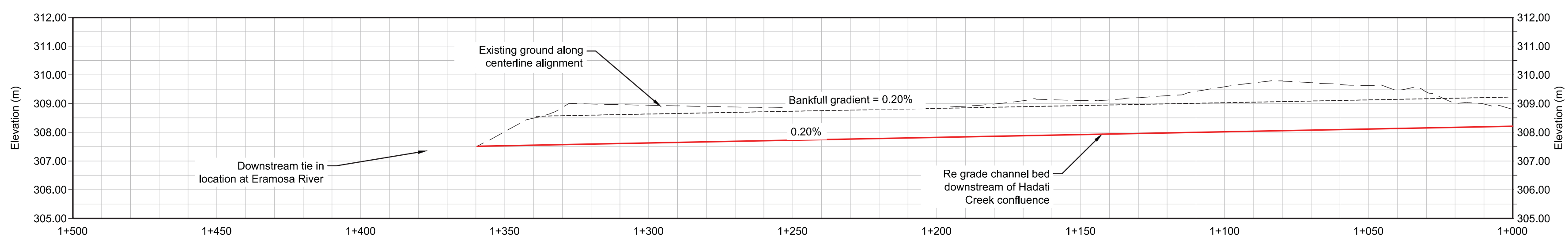
Da□e: 11 22 201□ | Pro□ec□: 2225□ Yor□ Road | Tec□□□cal: J. He□□□a□ | Re□□e□er: J. Par□□□ | Dra□□: E. Dro□□

Figure 02



Legend	
	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
2	Cultural heritage feature/structure
	Approximate grading limit

Notes:
1. Channel features collected by Matrix Solutions Inc. on May 2, □ and 5, 201□.
2. Road and property features collected by others.
□ Air photo provided by others.
4. Features displayed are in UTM Nad 83 zone 17 coordinates.
5. Heritage feature locations and information provided by others.
□ Bank treatments to be confirmed at detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

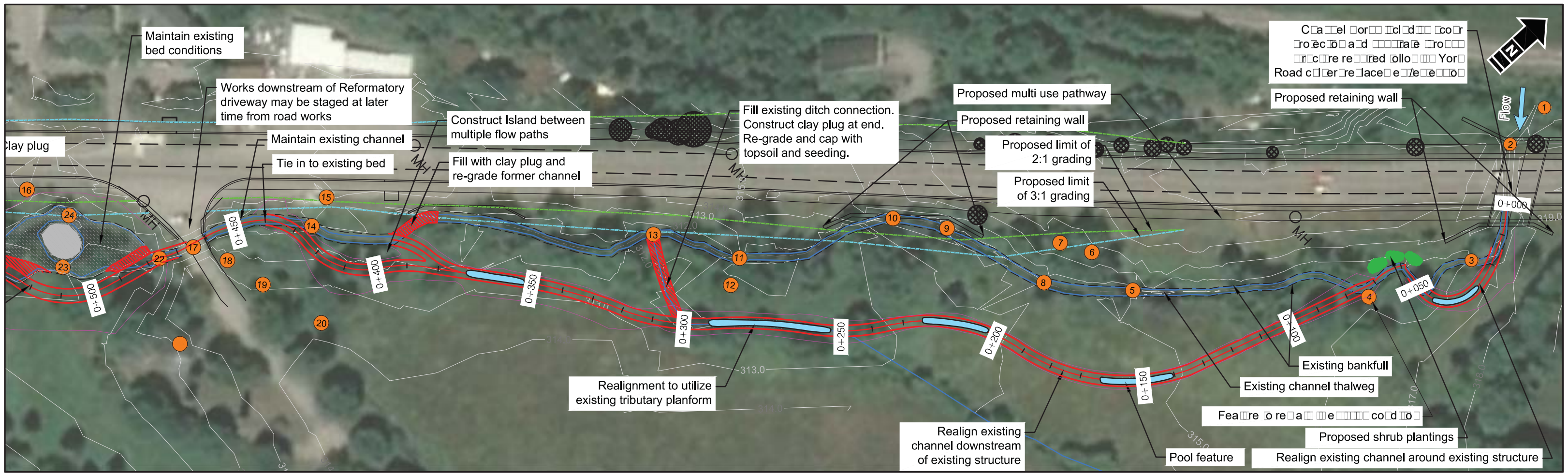
REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
04	11 22 201□	Revised design based on updated road grading	JH	JP	ED
0□	0□ 08 201□	Revised based on client comments	JH	JP	ED
02	01 1□ 201□	Revised based on client comments	JH	JP	ED
01	12 0□ 201□	Revised based on client comments	JH	JP	ED
00	0□ 15 201□	Draft for client review	JH	JP	ED

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 1
Preliminary Plan and Profile 1+000-1+500m

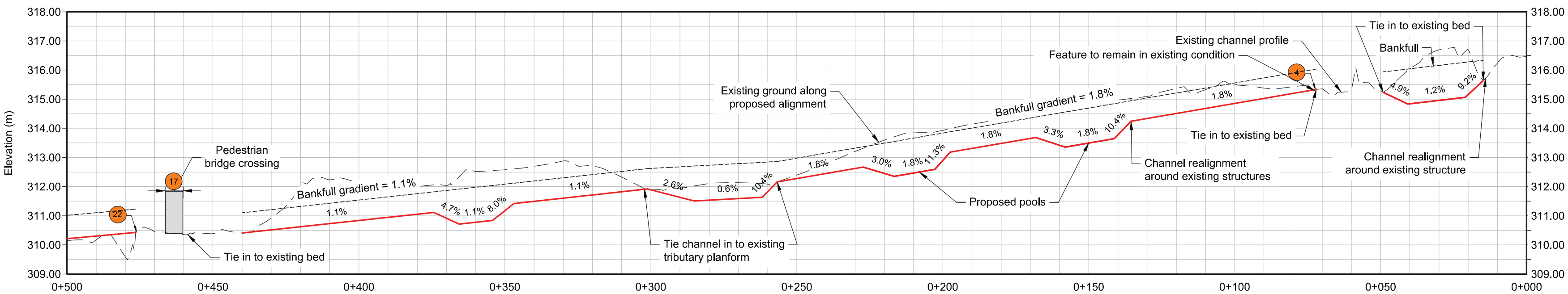
Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
11 22 201□	2225□ York Road	J. He□□□a□	J. Par□□	E. Dro□□	0□



Legend

Symbol	Description
	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
	Proposed shrubs and plantings
2	Cultural heritage feature/structure
	Maintain existing bed
	Proposed pool
	Approximate grading limit

No□e□:
1. C□a□□el □□r□e□co□ □le□ed □□Ma□r□ Sol□□o□□I□c. o□Ma□2, □, a□d 5, 201□.
2. Road a□d □ro□er□□ □□r□e□co□ □le□ed □□ o□□er□.
3. A□□ a□er□ □ro□ded □□o□□er□.
4. Fea□re□d□□la□ed are □□UTM Nad 8□ □o□e 1□ coord□□a□e □□□e□.
5. Her□a□e □ea□re loca□o□a□d □□or□a□o□ □ro□ded □□o□□er□.
6. Ba□□ □rea□ e□□□o □e co□□r□ed □□ de□a□led de□□□.



Channel Profile
Hor□o□al Scale 1:1500
Ver□cal Scale 1:150

REVISION					
04	11 22 201□	Re□□ed de□□□ □a□ed o□ □□da□ed road □rad□□	JH	JP	ED
0□	0□08 201□	Re□□ed □a□ed o□ cl□e□□co□□e□□	JH	JP	ED
02	01 1□ 201□	Re□□ed □a□ed o□ cl□e□□co□□e□□	JH	JP	ED
01	12 0□ 201□	Re□□ed □a□ed o□ cl□e□□co□□e□□	JH	JP	ED
00	0□15 201□	Dra□□or cl□e□□re□e□	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

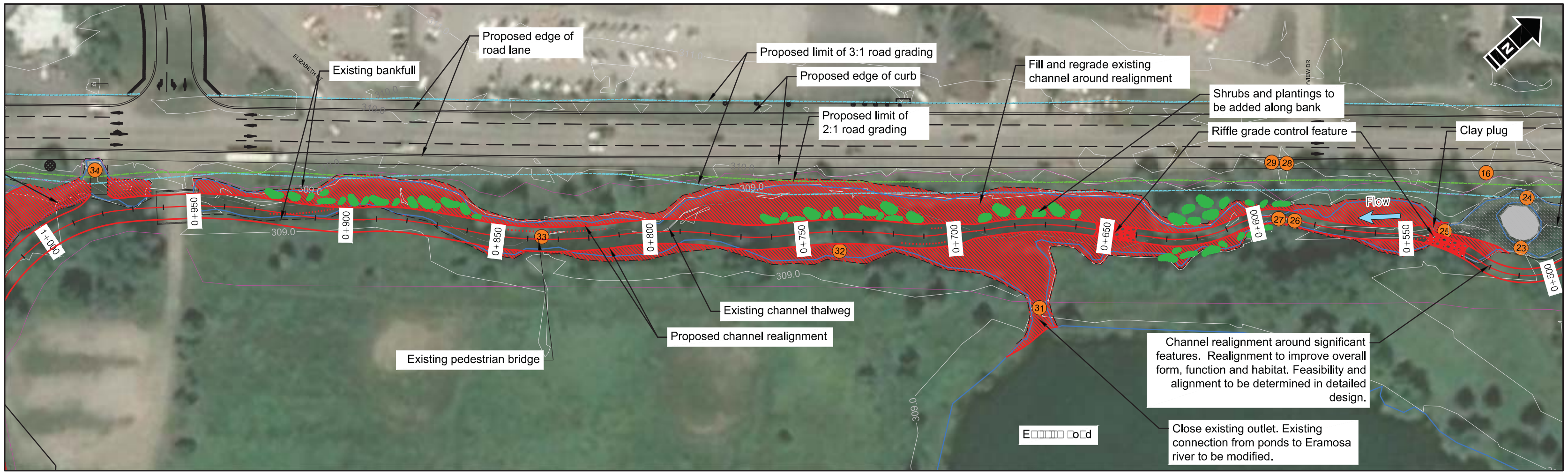
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Fo□□er W□eeler
Yor□Road W□de□□□

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 0+000-0+500m

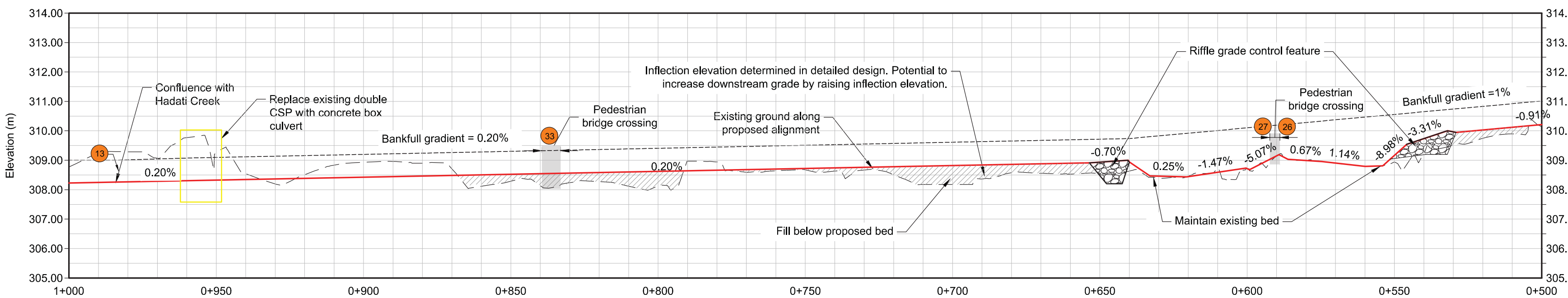
Da□e:	Pro□ec□:	Tec□□cal:	Re□□e□er:	Dra□□:
11 22 201□	2225□Yor□Road	J. He□□□a□	J. Par□□	E. Dro□□

Figure 0□



Legend
- Surveyed edge of water
- Surveyed bankfull
- Toe of 2:1 road grading
- Toe of 3:1 road grading
- Proposed realignment
- Proposed fill/cut area
- Proposed shrubs and plantings
- Cultural heritage feature/structure
- Maintain existing bed
- Proposed pool
- Approximate grading limit

Notes:
1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air photo provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
04	11 22 2016	Revised design based on updated road grading	JH	JP	ED
03	08 2016	Revised based on client comments	JH	JP	ED
02	01 1 2016	Revised based on client comments	JH	JP	ED
01	12 0 2016	Revised based on client comments	JH	JP	ED
00	0 15 2016	Draft for client review	JH	JP	ED

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 0+500-1+000m

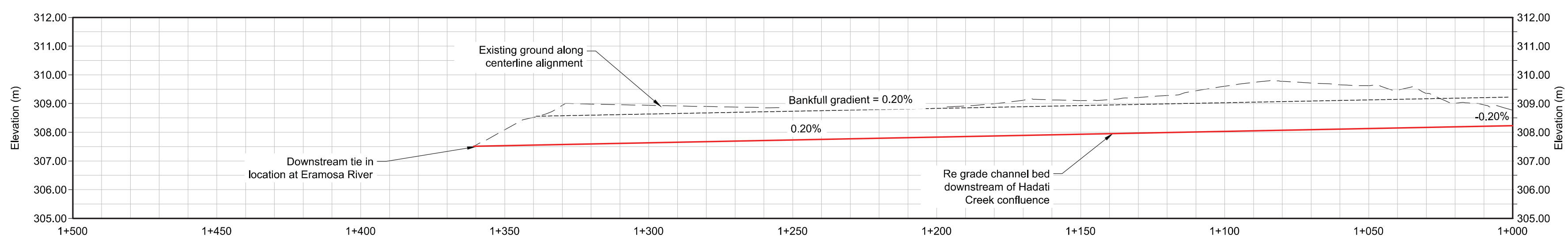
Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
11 22 2016	22252 York Road	J. Herman	J. Parish	E. Drost	05

Legend

Symbol	Description
(blue line)	Surveyed edge of water
(grey dashed line)	Surveyed bankfull
(green dashed line)	Toe of 2:1 road grading
(cyan dashed line)	Toe of 3:1 road grading
(red line)	Proposed realignment
(red hatching)	Proposed fill/bank treatment
2 (orange circle)	Cultural heritage feature/structure
(purple line)	Approximate grading limit

Notes:

1. Channel [illegible] collected by Matrix Solutions Inc. on May 2, [illegible] and 5, 201[illegible].
2. Road and [illegible] collected by others.
3. Air [illegible] provided by others.
4. Features [illegible] are in UTM Nad 83 Zone 1[illegible] coordinates.
5. Heritage feature locations and [illegible] provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
04	11 22 201[illegible]	Revised design based on updated road grading	JH	JP	ED
0[illegible]	0[illegible] 08 201[illegible]	Revised based on client comments	JH	JP	ED
02	01 1[illegible] 201[illegible]	Revised based on client comments	JH	JP	ED
01	12 0[illegible] 201[illegible]	Revised based on client comments	JH	JP	ED
00	0[illegible] 15 201[illegible]	Draft for client review	JH	JP	ED

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 1+000-1+500m

Date:	Project:	Technical:	Reviewer:	Drafter:
11 22 201[illegible]	2225[illegible] York Road	J. He[illegible]	J. Par[illegible]	E. Dro[illegible]

Figure 06

N:\PROJECTS\2225[illegible] - York Road [illegible] - AMEC - York Road [illegible] 2018 10:[illegible]:01 AM
Plot: 1:1 [illegible]

Appendix G

Fisheries and Aquatic Habitat

From: Arun.Hindupur@guelph.ca
Sent: December-01-15 10:33 AM
To: Senior, Matt; Chipps, Steve
Subject: FW: York Road Environmental Design Study
Attachments: Clythe Creek.jpg

From: McKenna, Tara (MNRF) [mailto:Tara.McKenna@ontario.ca]
Sent: December 1, 2015 10:22 AM
To: Arun Hindupur
Cc: Thompson, Melinda (MNRF); Timmerman, Art (MNRF)
Subject: RE: York Road Environmental Design Study

Hi Arun,

The previous figure provided by Art Timmerman was his interpretation of where the weirs appear to be from the aerial imagery. We do not have a shape file associated with that information.

I have attached an additional figure with this email, and the green dots represent locations where fish and/or fish habitat information has been collected in the past. The consultant or yourself can make arrangements with Art (copied on this email) to look at the data in more detail in our office at 1 Stone Road West in Guelph.

Art informed me that the Speed River chapter of Trout Unlimited Canada has also collected a lot of data from the area recently and we recommend that you consult with them to request that information.

Kind regards,

Tara

Tara McKenna, M.Pl.
District Planner
Ministry of Natural Resources and Forestry, Guelph District
1 Stone Road West
Guelph ON, N1G 4Y2
(P) 519-826-4912
(F) 519-826-4929
email: tara.mckenna@ontario.ca

From: Arun.Hindupur@guelph.ca [mailto:Arun.Hindupur@guelph.ca]
Sent: November-30-15 12:57 PM
To: Thompson, Melinda (MNRF); McKenna, Tara (MNRF)
Cc: steve.chipps@amecfw.com; matt.senior@amecfw.com
Subject: RE: York Road Environmental Design Study

Hi Melinda,

Thanks for the information you had previously sent. In discussions with the GRCA, it appears they have a copy of a 2001 Inspection report from Guelph MNRF on various reaches of the Clythe Creek. Would you happen to provide us with a copy of that report as well?

Also, the attached figure which was previously sent by MNRF appears to show weirs/fish barriers. Would you be able to provide this information in shapefile format?

Thanks,
Arun

From: Thompson, Melinda (MNRF) [mailto:Melinda.Thompson@ontario.ca]
Sent: November 25, 2015 1:51 PM
To: Arun Hindupur; McKenna, Tara (MNRF)
Cc: steve.chipps@amecfw.com; matt.senior@amecfw.com
Subject: RE: York Road Environmental Design Study

Please see the attached.

Melinda

MELINDA J. THOMPSON ❀ ❀ ❀ ❀ ❀

MANAGEMENT BIOLOGIST | ONTARIO MINISTRY of NATURAL RESOURCES and FORESTRY | GUELPH DISTRICT OFFICE
1 Stone Road West, Guelph, Ontario, N1G 4Y2 | ☎ 519.826.6543 | melinda.thompson@ontario.ca

Learn more about Ontario's Species at Risk

From: Arun.Hindupur@guelph.ca [mailto:Arun.Hindupur@guelph.ca]
Sent: November 25, 2015 1:49 PM
To: McKenna, Tara (MNRF)
Cc: Thompson, Melinda (MNRF); steve.chipps@amecfw.com; matt.senior@amecfw.com
Subject: RE: York Road Environmental Design Study

Thanks Tara. That would be great.

From: McKenna, Tara (MNRF) [mailto:Tara.McKenna@ontario.ca]
Sent: November 25, 2015 1:17 PM
To: Arun Hindupur
Cc: Thompson, Melinda (MNRF)
Subject: RE: York Road Environmental Design Study

Hi Arun,

MNRF staff received a similar information request for this project from Dougan and Associates, and a response was provided to them this morning. If you would like, we can send you a copy of the letter.

Regards,

Tara

Tara McKenna, M.Pl.
District Planner
Ministry of Natural Resources and Forestry, Guelph District
1 Stone Road West

Guelph ON, N1G 4Y2
(P) 519-826-4912
(F) 519-826-4929
email: tara.mckenna@ontario.ca

From: Arun.Hindupur@guelph.ca [mailto:Arun.Hindupur@guelph.ca]
Sent: November-25-15 9:30 AM
To: McKenna, Tara (MNRF)
Cc: steve.chipps@amecfw.com; matt.senior@amecfw.com
Subject: RE: York Road Environmental Design Study

Hi Tara,

In addition to the jpg file you provided, would you happen to have any more information which may be relevant to this study area? Was something along the lines of ecological mapping for the area or perhaps field monitoring, including temperature data collection or electrofishing?

Thanks,
Arun

From: Arun Hindupur
Sent: November 10, 2015 8:49 AM
To: 'McKenna, Tara (MNRF)'
Cc: Chipps, Steve (steve.chipps@amecfw.com); Senior, Matt (matt.senior@amecfw.com)
Subject: RE: York Road Environmental Design Study

Hi Tara,

Thanks for your comments. The project team will take them into consideration and be in touch if there are any additional questions.

Regards,
Arun

Arun Hindupur, M.Sc., P.Eng. | Infrastructure Planning Engineer
Engineering Services | **Engineering and Capital Infrastructure Services**
City of Guelph

T 519-822-1260 x 2282 | F 519-822-6194
E arun.hindupur@guelph.ca

guelph.ca

From: McKenna, Tara (MNRF) [mailto:Tara.McKenna@ontario.ca]
Sent: November 9, 2015 4:13 PM
To: Arun Hindupur
Cc: Timmerman, Art (MNRF); Whalen, Rose (MNRF)
Subject: RE: York Road Environmental Design Study

Hi Arun,

MNRF staff have reviewed the York Road Class Environmental Assessment Report and Terms of Reference for the environmental design study. Please find MNRF comments below:

- Where the dam/weir decommissioning or partial decommissioning is being proposed, Lands and Rivers Improvement Act (LRIA) approval may be required. MNRF staff require more detailed information on the proposal to provide specific direction in this regard.
- The relocation or channelization of the creek does not require LRIA approval as this is the jurisdiction of the Grand River Conservation Authority for approvals at this location.
- The following bullet points come directly from the Grand River Fisheries management plan:
    - "The *fish community objective* for Clythe Creek is a coldwater fish community in areas where geological and biophysical characteristics are present and habitat exists or has been rehabilitated." (Pg. 78)
    - "Management Strategies for Clythe Creek include: work with owners of dams and impoundments to eliminate or reduce the impacts of these features on downstream fish populations and fish habitat, consider modifications to remove existing barriers to fish passage, rehabilitate degraded habitat to restore functional system" (Pg. 78-79)

  MNRF staff recommend incorporating these objectives and management strategies into the relocation design for Clythe Creek.
- Based on information in the Terms of Reference, MNRF staff have marked on the attached map the approximate location of the 135m stretch of the Clythe Creek which is recommended to be relocated for the proposed road widening.
    - MNRF staff note that there appears to be 3 weirs within the 135m stretch of creek to be relocated, whereas only 2 weirs are proposed to be removed for the relocation of the creek. MNRF would appreciate clarification on whether or not the 3rd weir is being considered for removal to improve fish passage.
    - Also within this stretch of Clythe Creek is a tributary that enters from the east (see attached map). This tributary discharges cold water to the creek, and MNRF recommends that this tributary be considered in the relocation design for Clythe Creek.
    - Downstream (to the southwest) of this reach all the way to Hadati Creek, Clythe Creek appears to be just as close to the existing York Road as the creek is within the 135m stretch. Will this downstream area be impacted by the proposed widening of York Road? This section contains additional weirs that not only impact fish movement in the creek but they also impound the creek, causing widening which in turn elevates the water temperature of the creek.
        - Within this downstream reach there is a lack of riparian vegetation, and as such, MNRF staff recommend considering opportunities for riparian planting in this area to improve fish habitat.

Should you have any questions or require any clarification on the above comments, please do not hesitate to contact me.

Kind regards,

Tara

Tara McKenna, M.Pl.
District Planner
Ministry of Natural Resources and Forestry, Guelph District
1 Stone Road West
Guelph ON, N1G 4Y2
(P) 519-826-4912
(F) 519-826-4929

email: tara.mckenna@ontario.ca

From: Arun.Hindupur@guelph.ca [mailto:Arun.Hindupur@guelph.ca]
Sent: October-28-15 9:52 AM
To: McKenna, Tara (MNRF)
Cc: steve.chipps@amecfw.com; matt.senior@amecfw.com
Subject: RE: York Road Environmental Design Study

Hi Tara,

The main objective of the current study is to determine a creek design/realignment in order to accommodate the widening of York Rd. from 2 to 4 lanes. We are aware of the weir structures along different reaches of the creek and that they pose a barrier to fish passage. However, these weir features have cultural heritage significance so it's not necessarily as simple as removing them completely. The ultimate creek/channel design as to balance hydrology and hydraulic considerations as well as natural heritage features (groundwater/surface water interactions, fish passage, etc.) and cultural heritage aspects (weirs).

Nothing has been proposed as of yet as we have just started the study. The project team is planning on engaging all affected stakeholders (GRCA, MOECC, Infrastructure Ontario, etc.) including the MNRF at the beginning of the study in order to determine what considerations should be taken into account when considering a new channel design/realignment. Once that information is provided, the project team will evaluate various design alternatives and ask the impacted stakeholders to provide input in order to inform the preferred final design.

Please feel free to contact me if you have any questions.

Thanks,
Arun

Arun Hindupur, M.Sc., P.Eng. | Infrastructure Planning Engineer
Engineering Services | **Engineering and Capital Infrastructure Services**
City of Guelph

T 519-822-1260 x 2282 | F 519-822-6194
E arun.hindupur@guelph.ca

guelph.ca

From: McKenna, Tara (MNRF) [mailto:Tara.McKenna@ontario.ca]
Sent: October 27, 2015 4:26 PM
To: Arun Hindupur
Subject: RE: York Road Environmental Design Study

Hi Arun,

I have a some areas for clarification based on the information you sent me previously. On page 16 of the EA report, Section 5.7 notes the removal of two weirs which are a barrier to fish passage. Is the proposal still to remove only the 2 weirs? It is MNRF's understanding that there are 10+ weirs along Clythe Creek in this area, and staff would appreciate a better understanding of the number and location of the weirs proposed in the relocation of the creek.

Would you be able to send any preliminary figures, maps, or images of the potential relocation options for Clythe Creek? This would help give MNRF staff a better understanding of the works proposed, and potential impacts to the creek.

How will the flow of the creek be controlled with the removal of the weirs?

Looking forward to your response. Thank you kindly,

Tara

Tara McKenna, M.Pl.
District Planner
Ministry of Natural Resources and Forestry, Guelph District
1 Stone Road West
Guelph ON, N1G 4Y2
(P) 519-826-4912
(F) 519-826-4929
email: tara.mckenna@ontario.ca

From: Arun.Hindupur@guelph.ca [mailto:Arun.Hindupur@guelph.ca]
Sent: October-21-15 1:28 PM
To: McKenna, Tara (MNRF)
Subject: RE: York Road Environmental Design Study

Hi Tara,

Hope all is well. We will be having a project meeting next Friday morning here at the City with our consultants. If you're available Friday afternoon, perhaps we can come to your office and discuss any of the MNRF's concerns with respect to this study?

Thanks,
Arun

From: Arun Hindupur
Sent: October 19, 2015 11:13 AM
To: 'tara.mckenna@ontario.ca'
Cc: Chipps, Steve (steve.chipps@amecfw.com); Senior, Matt (matt.senior@amecfw.com)
Subject: York Road Environmental Design Study

Hi Tara,

Further to our discussion, please see attached original 2007 York Rd. EA. Once, you've had a chance to review, it would be good to have a chat with yourself and our consulting team (cc'd on this email) to discuss any considerations from the MNRs perspective.

Please feel free to contact me if you have any questions.

Thanks,
Arun

Arun Hindupur, M.Sc., P.Eng. | Infrastructure Planning Engineer

Engineering Services | **Engineering and Capital Infrastructure Services**
City of Guelph

T 519-822-1260 x 2282 | F 519-822-6194
E arun.hindupur@guelph.ca

guelph.ca

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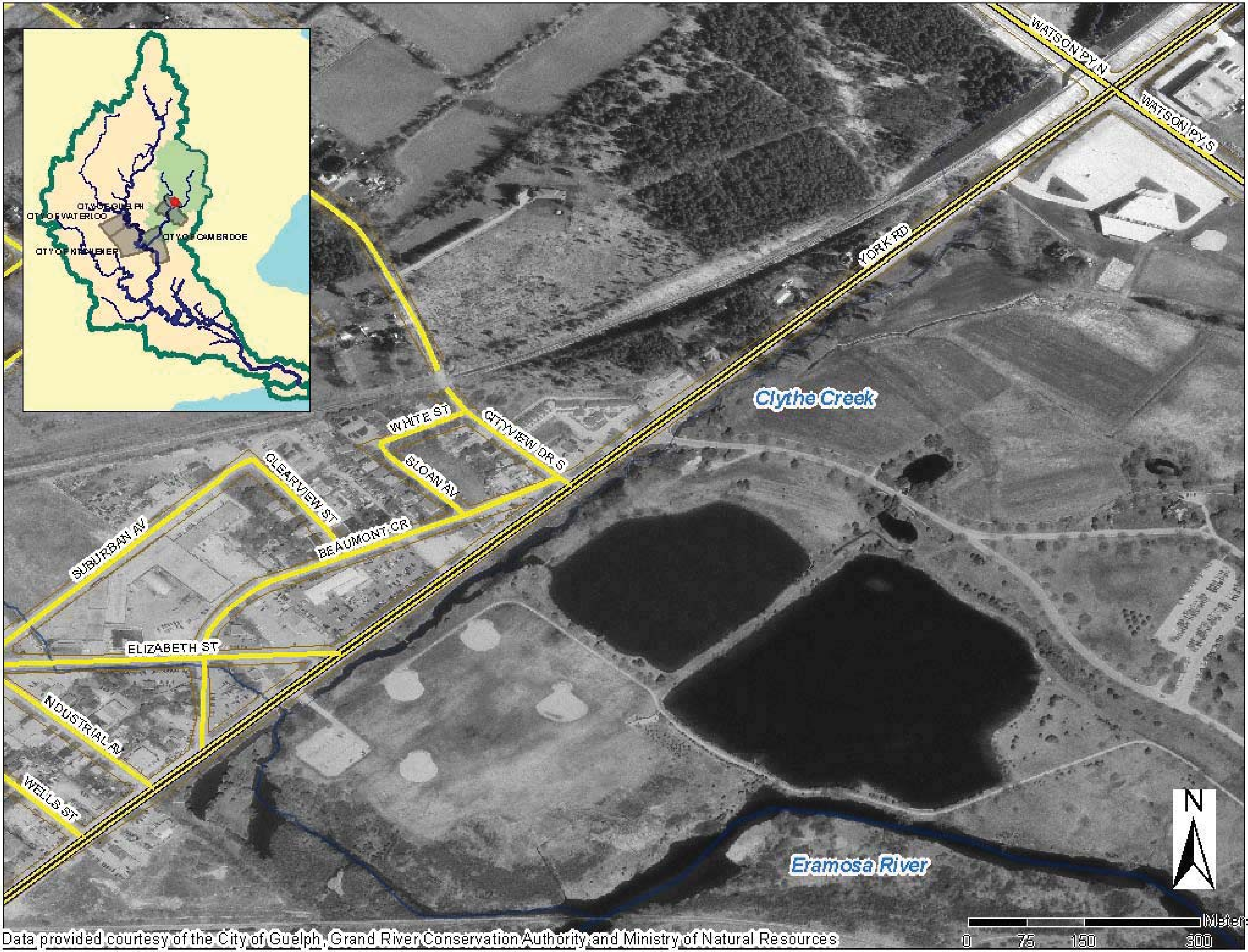
Assessment of
Clythe Creek Remediation
Alternatives, Guelph, ON
UW 4th year Engineering Students
November 23, 2007



WATSON PY N
WATSON PY S
YORK RD
Clythe Creek
Eramosa River
WHITE ST
CITYVIEW DR S
SLOAN AV
CLEARVIEW ST
BEAUMONT CR
SUBURBAN AV
ELIZABETH ST
INDUSTRIAL AV
WELLS ST
CITY OF GUELPH
CITY OF WATERLOO
CITY OF CAMBRIDGE
CITY OF KITCHENER
N
Meters
0
75
150
300
Data provided courtesy of the City of Guelph, Grand River Conservation Authority and Ministry of Natural Resources

Project Objectives

- Accommodate for the widening of York Road
- Improve cold water aquatic life habitat
- Improve the stream thermal regime

Project Scope

- Assess the current state of the study area
- Determine alternative solutions for remediation
- Present final detailed design for the preferred alternative

Current Site Conditions

- Only crude base flow estimate available (17.7 L/s)
- No average or peak discharge values available
- Creek classified as cool water stream
- Stream is located in sensitive groundwater recharge/discharge area
- Land currently classified as institutional; proposed use as greenlands

Hydrology

- Three method were used to estimate stream discharge
  - Rational Method
  - Regional Analysis
  - SCS Triangular Method

	2 Year	20 Year	25 Year	50 Year	100 Year
Rational Method					
tc = 4 hrs	14.06	-	26.21	29.21	32.20
tc = 6 hrs	10.16	-	18.02	19.99	21.93
Regional Analysis					
Region 7	3.76	8.85	-	-	11.81
Region 8	3.05	6.00	-	-	7.93
SCS Triangular Method					
D = 4hr	0.1044		2.89	4.02	5.28
D = 6hr	0.0942		2.60	3.63	4.77

All flows are in m^3/s

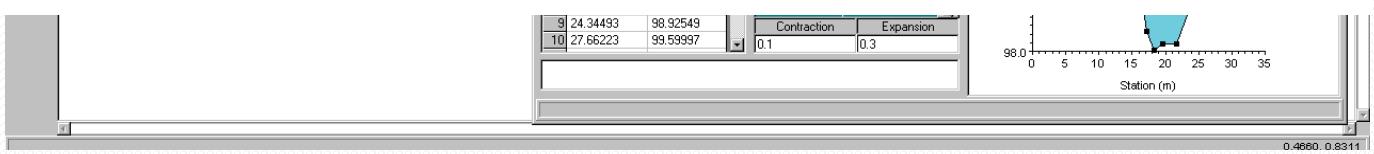
Problems/Issues

- Rational Method: assumes small watershed area and uniform rainfall
- Regional Analysis: study area near boundary of two regions
- SCS Triangular Method: assumes uniform rainfall

- Recharge/discharge play significant role in the study reach
- Wetlands and storm detention ponds upstream

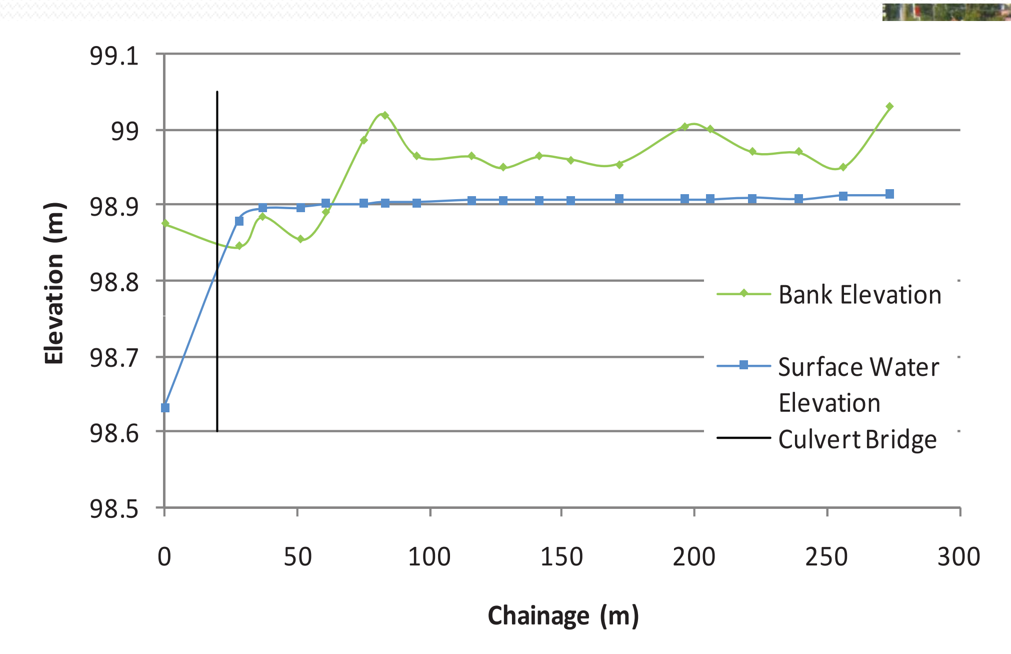
HEC- RAS Model Creation

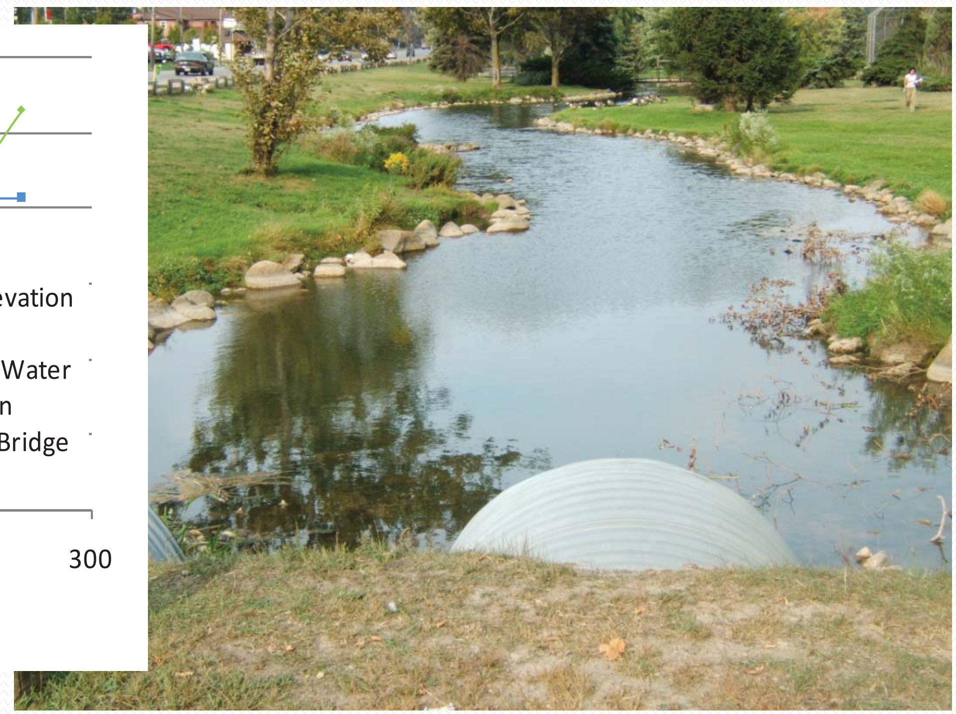
- Current site conditions modeled using topographical survey data
- 84 cross sections, 10 weirs, 2 vehicle bridges, and 3 pedestrian bridges over a stream length of 1 km
- Created to identify:
  - bank-full discharge
  - low flow water elevations and water velocity
  - Basis for creating future designs
- Base flow and bank-full discharge scenarios run



Bank-Full Conditions

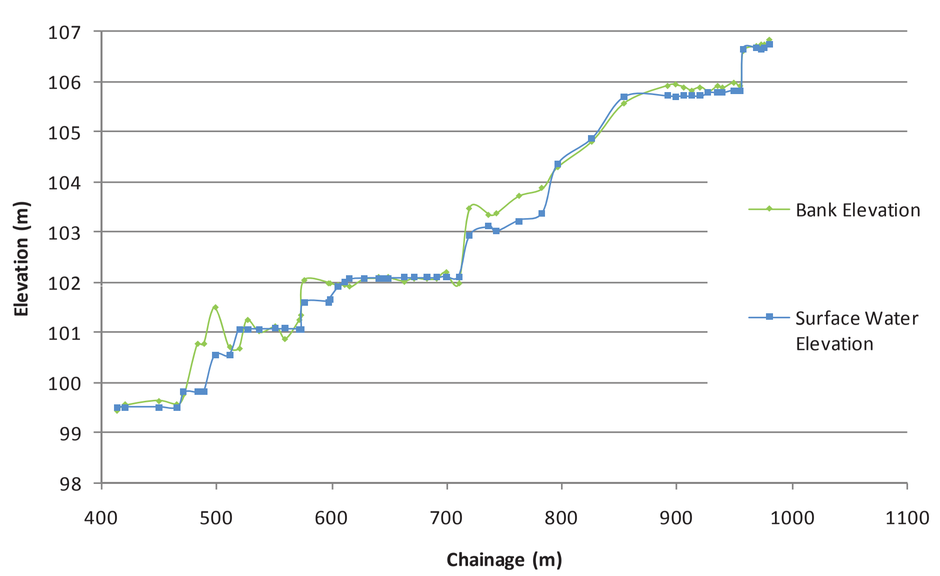
- Lower reach max discharge = $1.3 m^3/s$



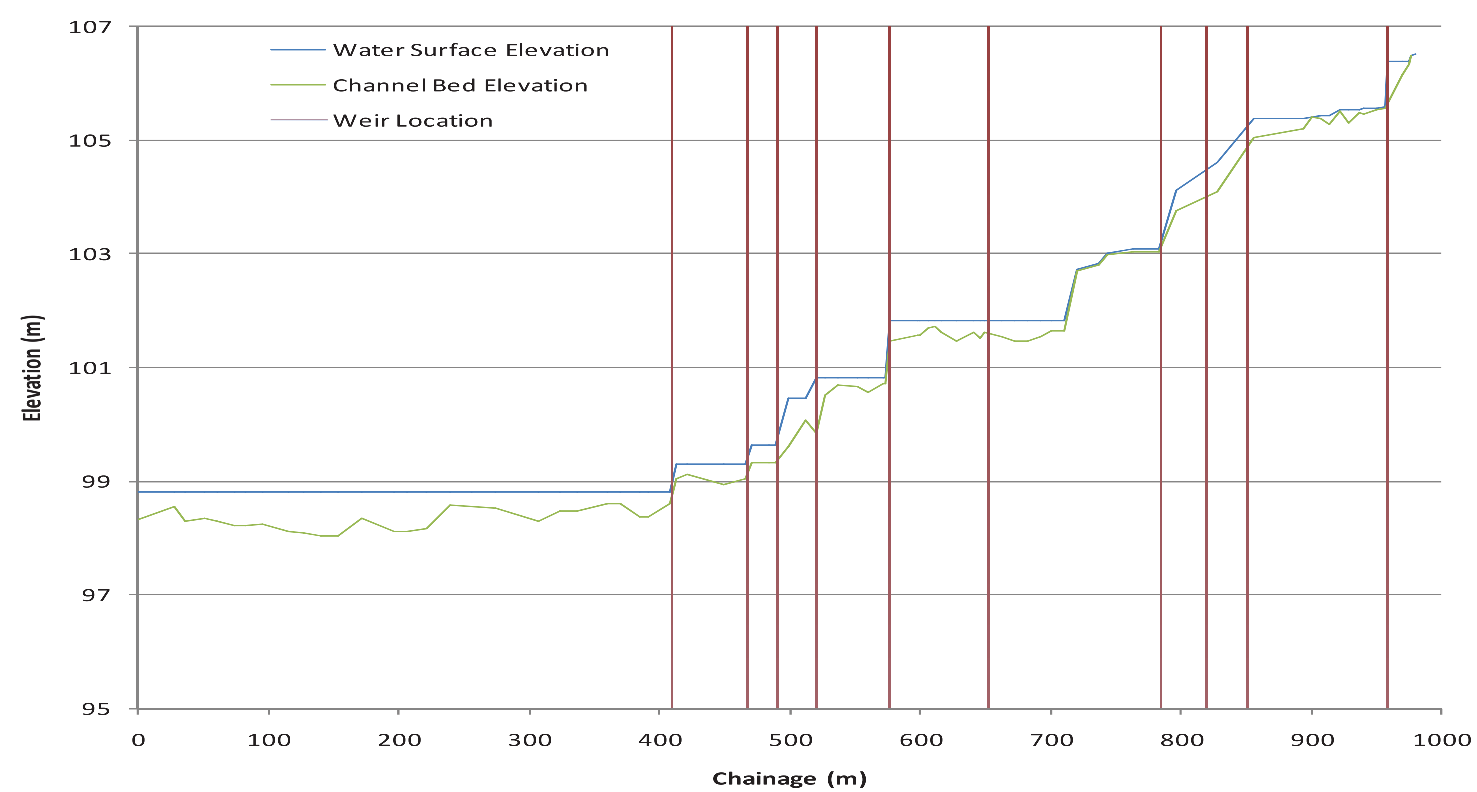


Bank-Full Conditions

- Upper reach max discharge = 0.6 m^3/s



Base Flow Conditions



- Water velocities during base flow approximately 0.005m/s

Current Site Conditions
Water Quality

- Nitrates, phosphates, DO – below PWQO
- Temperature satisfies cold water habitat conditions (might not in the summer)
- pH of the downstream is high (9.2)
- BOD generally increases from upstream to downstream

Alternatives

1. Do not change the current alignment of Clythe Creek
2. Construct a concrete channel parallel to York Rd to accommodate the water currently flowing through Clythe Creek
3. Realign sections of the creek which interfere with the scheduled road construction
4. Realign all or the majority of Clythe Creek running thought the Site

- Map and explain alternatives more

Regulatory Compliance

1. May or may not satisfy Canada Fisheries Act (CFA)
2. It does not satisfy CFA (destruction of fish habitat)
3. Satisfies the regulations
4. Satisfies the regulations

Thermal Regime and Aquatic Habitat Impacts

1. Ditch-like stream would not help to lower temperatures and will decrease the quality of habitat
2. Concrete channel would destroy the fish habitat
3. Partially re-naturalized stream would benefit the aquatic organisms and improve thermal regime
4. Completely re-naturalized stream would provide the largest environmental benefits

Social Impact

- 1: The stream would loose its aesthetic attractiveness
- 3 and 4: Re-naturalization of the creek would keep the area aesthetically pleasing and add to the educational value in the community

Costs

	Initial Costs	Maintenance	Present Worth
Alternative 1	$9,300	$1700	**$11,000**
Alternative 3	$112,500	0	**$112,500**
Alternative 4	$166,500	0	**$166,500**

Preferred Alternative

- Alternative 4 - Complete re-naturalization of the study reach

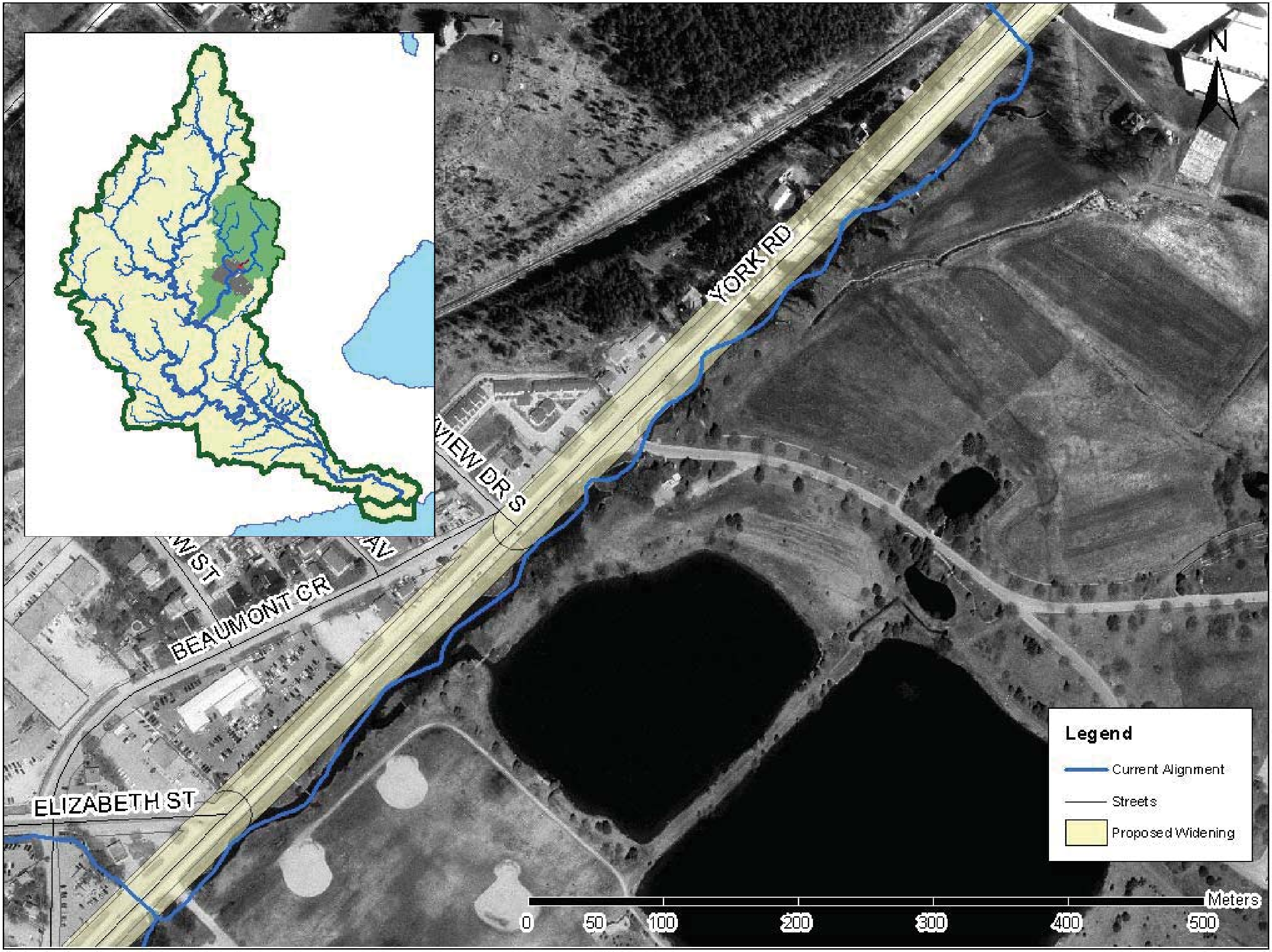
Recommendations

- Research remediation tools
- Use HEC-RAS model to design the new channel against erosion
- Investigate the cause of high pH
- Analyze temperature data (to be obtained from Trout Unlimited)

Questions?


SKYWAY DR
SHEEHY CRT
WATSON PKY S
DUNLOP DR
AIRPARK PL
WATSON RD S
TAGGART ST
WATSON RD N
WATSON PKY N
Eramosa River
CITYVIEW DR S
YORK RD
SLOAN AVE
KEATING ST


Tri-City Environmental Ltd.
March 28, 2008



YORK RD
VIEW DR S
AV
W ST
BEAUMONT CR
ELIZABETH ST
N
Legend
Current Alignment
Streets
Proposed Widening
Meters
0 50 100 200 300 400 500

Project Objectives

- Accommodate for the widening of York Road
- Increase stream velocity
- Improve the stream thermal regime
- Improve aquatic life habitat
- Maintain parkland athletics

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Phase I

- Background site assessment
- Modeling of existing conditions
- Selection of preferred alternative
  - Complete realignment of the study reach

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Phase II Scope

- Determine channel geometry and alignment
- Compare the current and proposed channel alignments
- Propose a construction schedule
- Prepare a cost estimation

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Design Parameters

- Split channel into upstream and downstream separated by the arch bridge
- Design bankull flow of 2 m^3/s (T_r=1.25 yr)
- Class C stream (Rosgen Classification)
  - defines ranges for width to depth ratio and sinuosity

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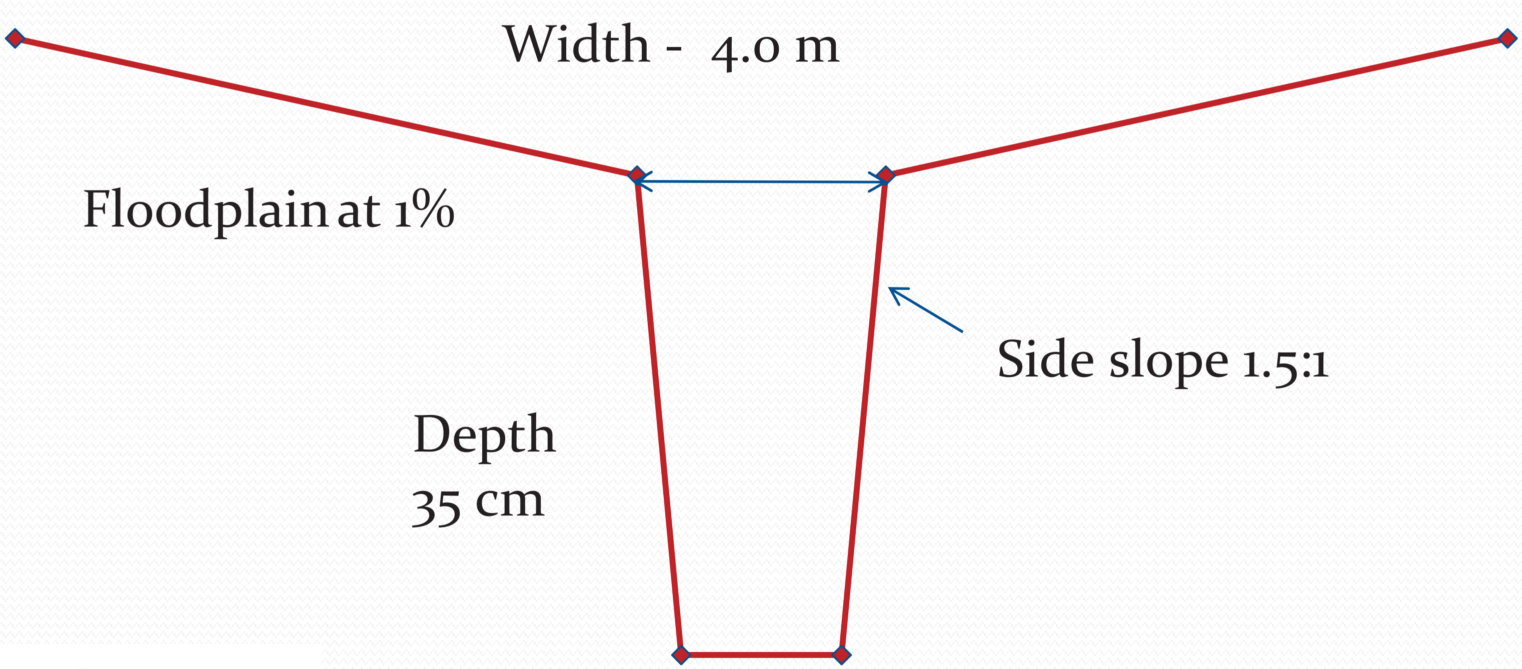
Proposed Alignment

Cross Sectional Geometry (at Riffles)



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Proposed Alignment

Meander Geometry

- Regional morphological relationships used to calculated amplitude, wavelength, and radius of curvature
- Radius of curvature/bankfull width >2.5 indicates lateral stream stability
- Target sinuosity for Upstream: 1.25; Downstream: 1.1
- Non-uniform meander pattern to create more natural look

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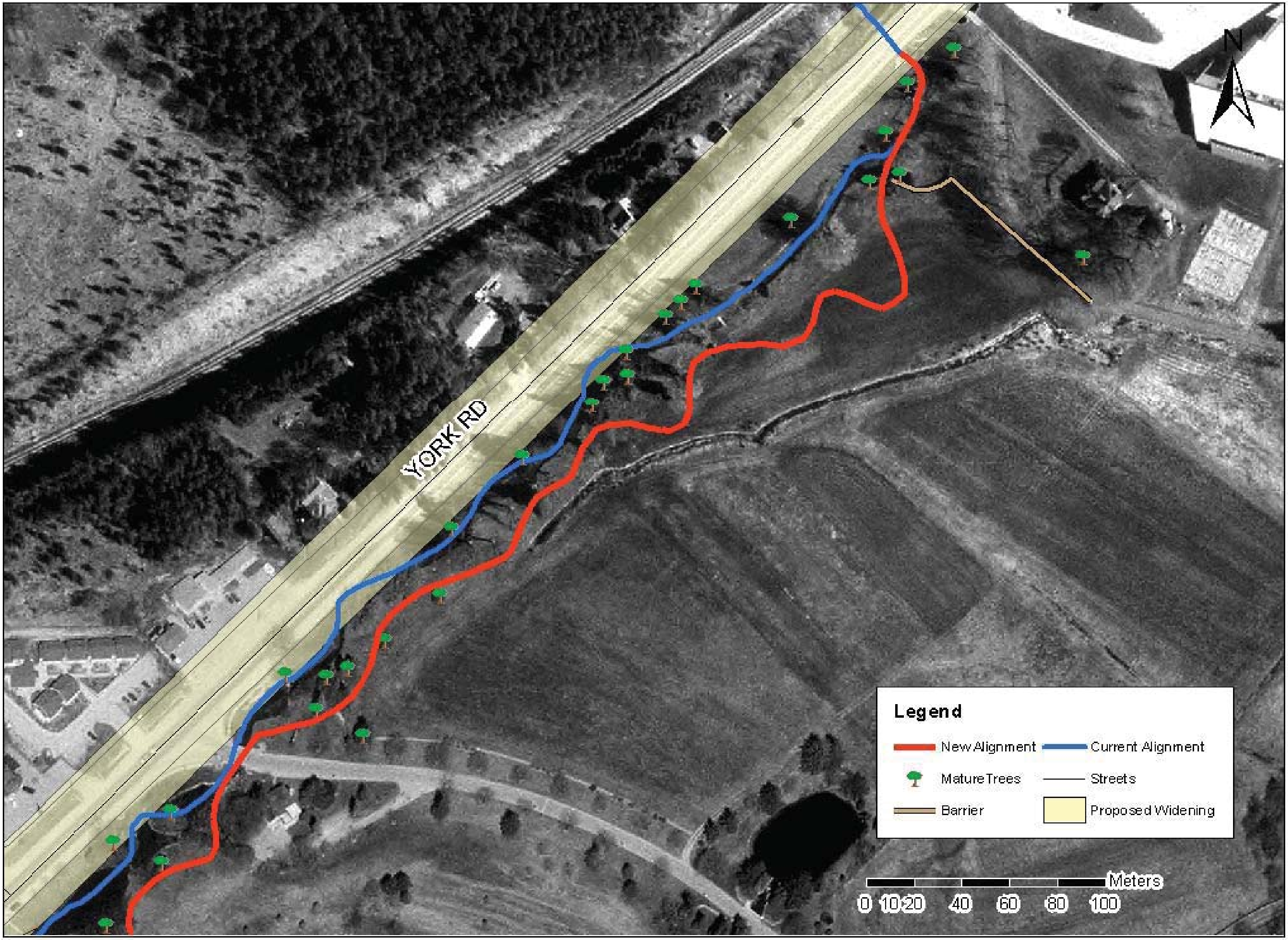
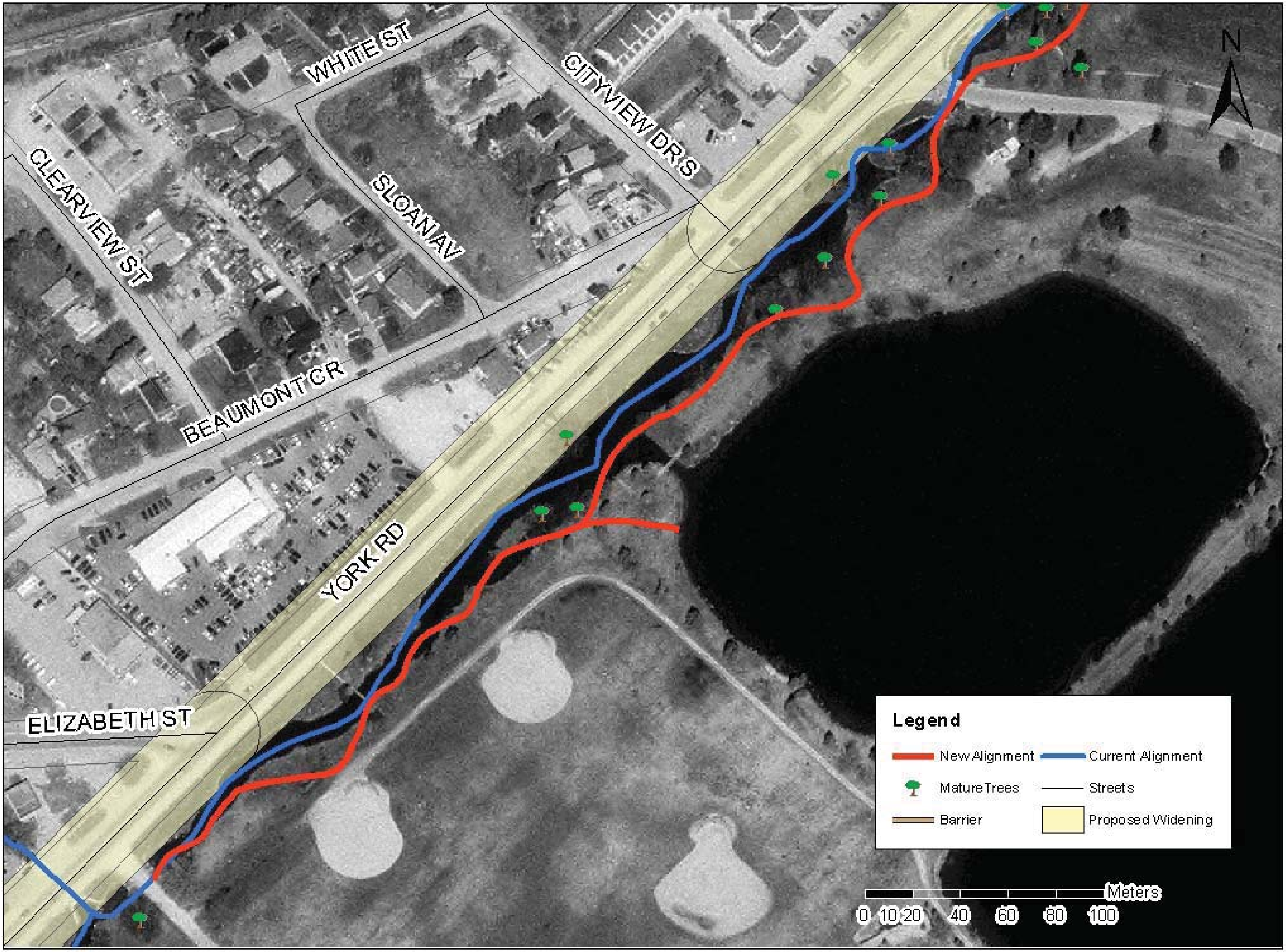
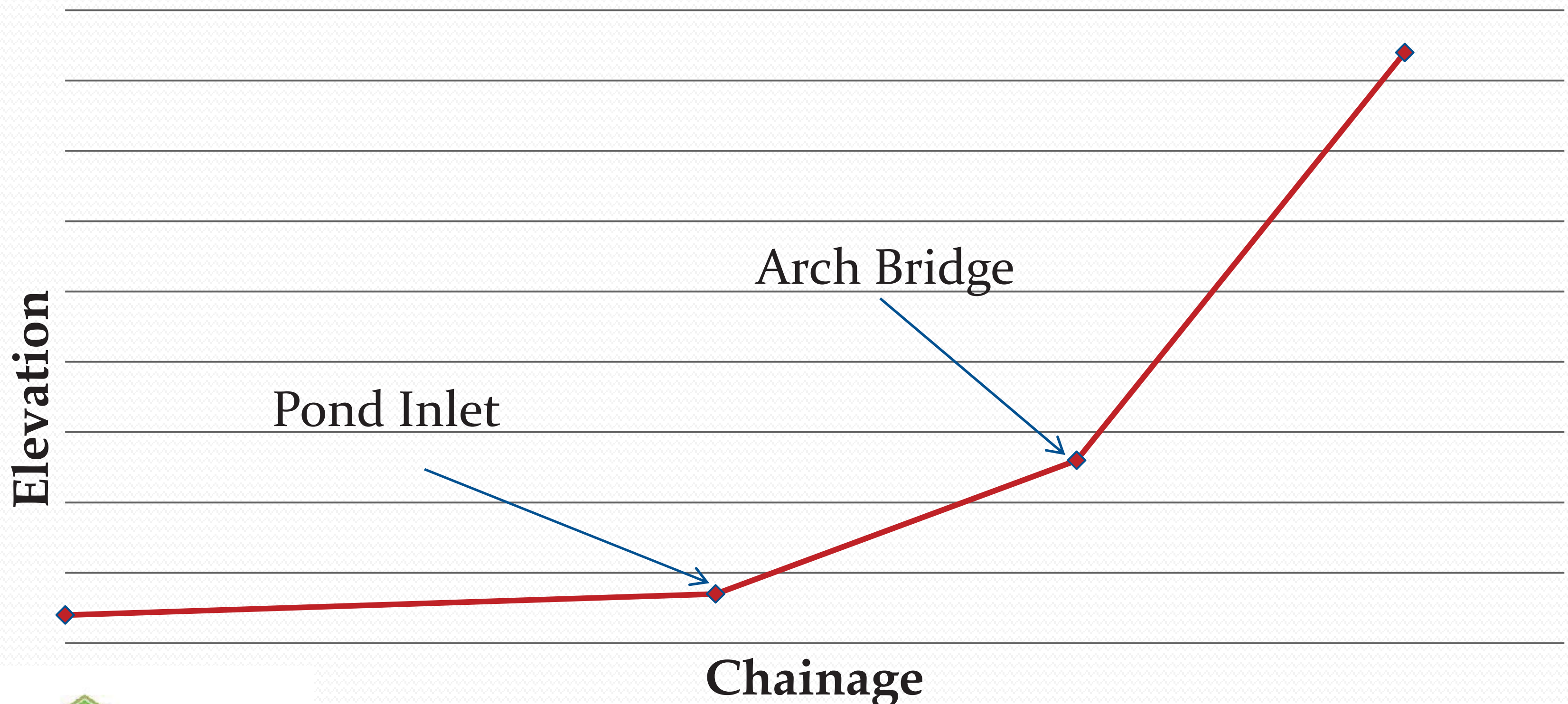

N
YORK RD
Legend
New Alignment
Current Alignment
Mature Trees
Streets
Barrier
Proposed Widening
Meters
0 10 20 40 60 80 100



WHITE ST
CITYVIEW DR S
CLEARVIEW ST
SLOAN AV
BEAUMONT CR
YORK RD
ELIZABETH ST
N
Legend
New Alignment
Current Alignment
Mature Trees
Streets
Barrier
Proposed Widening
Meters
0 10 20 40 60 80 100

Proposed Alignment
Channel Slope



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Vegetation and Buffer Strips

- Vegetated zones along the creek – 5 meters wide
- Benefits
  - Bank stabilization
  - Shading (reducing thermal pollution)
  - Cover (better habitat for fish)
  - Geese deterrence (reducing organic loading)
- Used the list of Ontario native species to pick a variety of species with different salt and moisture tolerance

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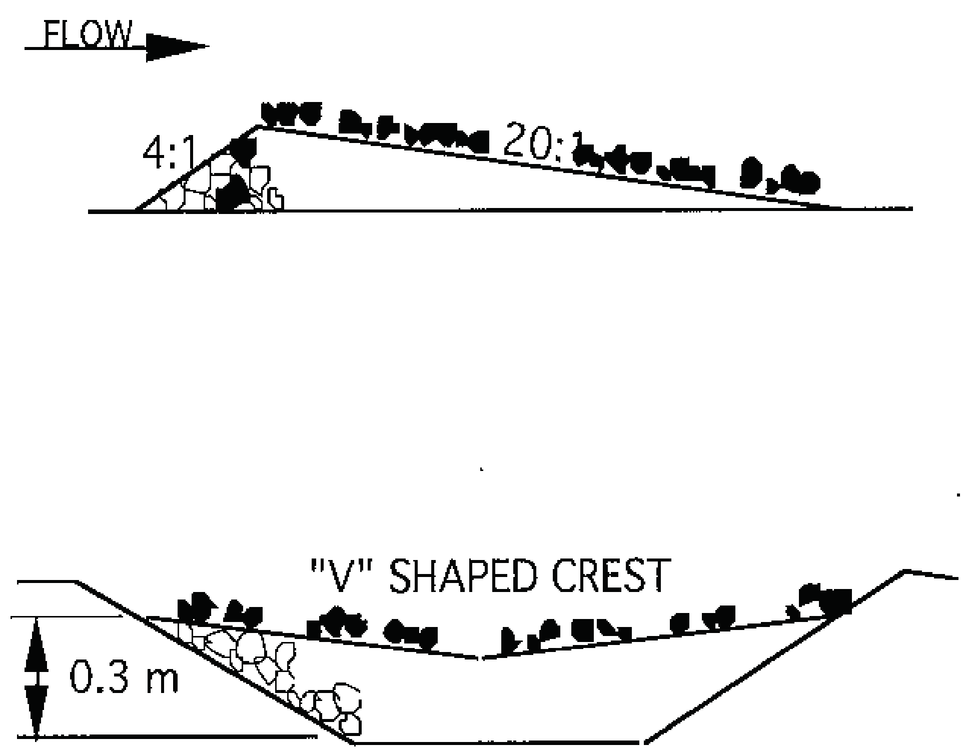
In-Stream Structures
Constructed Riffles

- Material size
  - US: 60 mm
  - DS: 18 mm

- 23 riffles to be constructed



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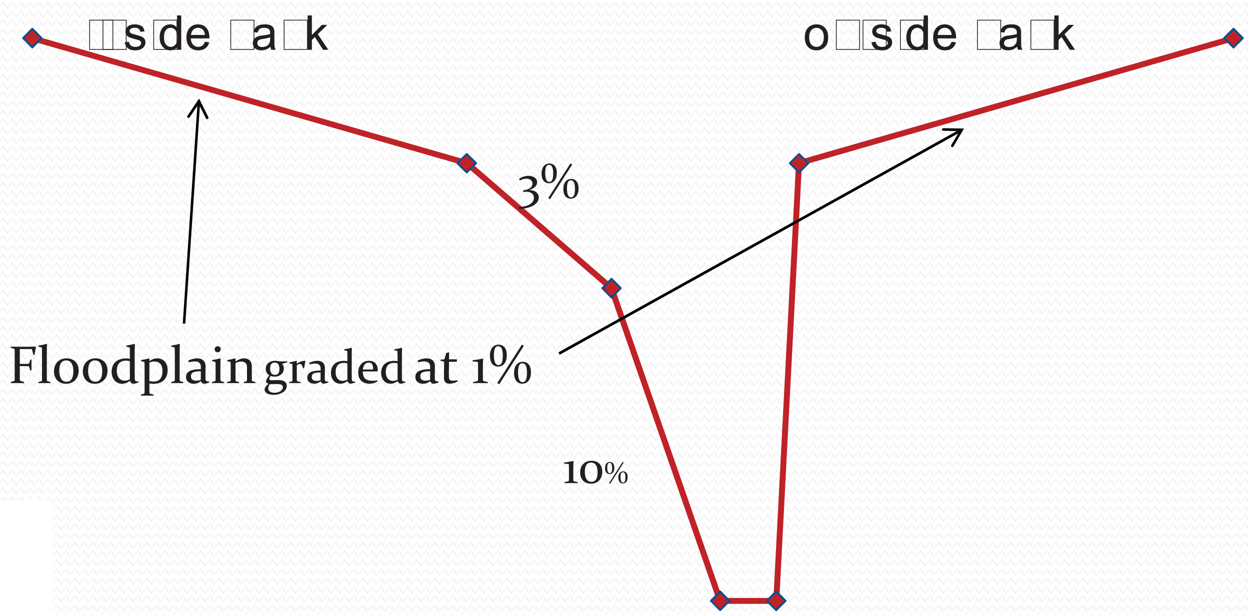
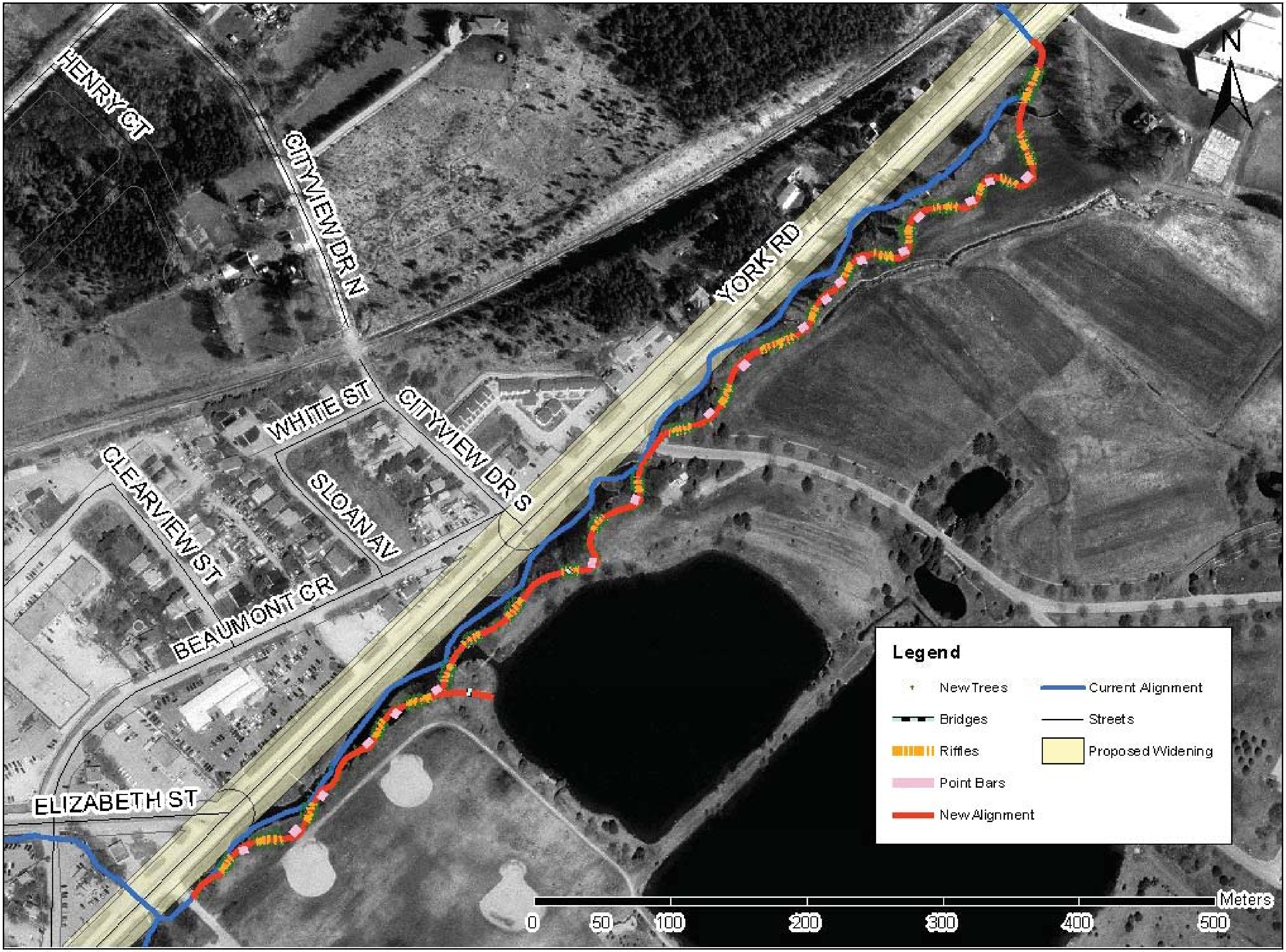
In-Stream Structures

Point Bars

- Total of 19 point bars




HENRY CT
CITYVIEW DR N
YORK RD
WHITE ST
CITYVIEW DR S
CLEARVIEW ST
SLOAN AV
BEAUMONT CR
ELIZABETH ST
N
Legend
New Trees
Bridges
Riffles
Point Bars
New Alignment
Current Alignment
Streets
Proposed Widening
0
50
100
200
300
400
500
Meters

Evaluation of Project Objectives

HEC-RAS Analysis

- 80 cross sections and an arch vehicle bridge
- Flow elevations were determined for the 1.25, 2, 20, and 100 year flows
- Velocities and elevations compared to current alignment model
  - New alignment results in increased velocities and similar surface water elevations

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Evaluation of Project Objectives

Temperature & Fish Habitat

- Increased velocities
  - Cooler stream temperatures
- Vegetation
  - Reduce thermal loading
  - Create fish habitat
- Riffles
  - Create zones of varied flow, preferred by fish

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Evaluation of Project Objectives

Aesthetics

- Clythe Creek runs through existing parkland
- Loss of waterfall structures, mixed opinion
- Re-vegetation will result in park like appearence
- Variation in stream alignment gives less “engineered” appearance

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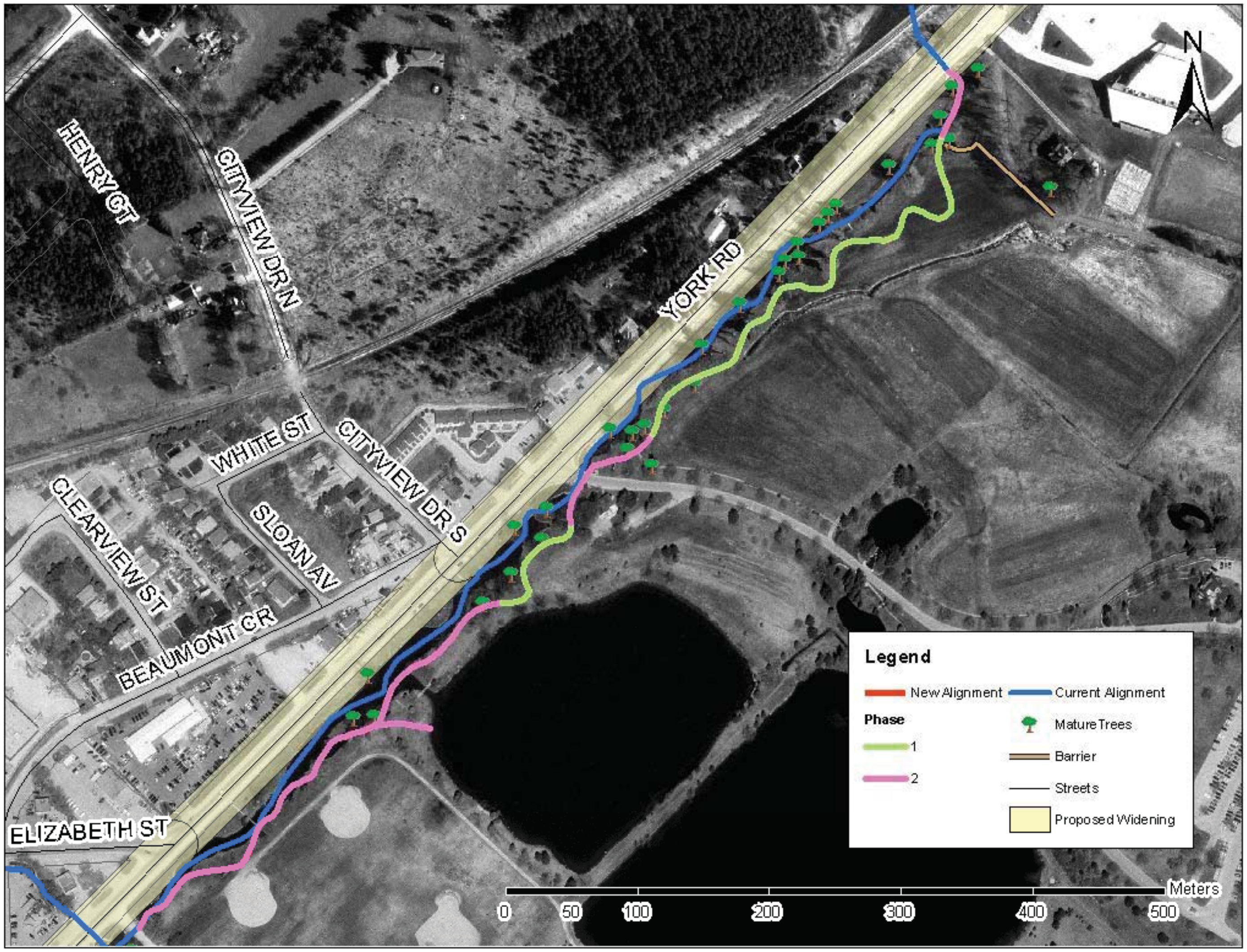
Construction Schedule



Cost Estimation

Current Stream	Maintenance
Backfill Current Cross Section	*Creek Features*
Removal of in-stream structures	*Monitoring buffer vegetation*

New Stream	Miscellaneous Construction
Construction of new channel alignment	*Safety*
Regrade new floodplain`	
Buffer Strips	
Creek Features	

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Cost Estimation (Continued)

Cost Summary Table

Phase I	**$113,900**
New Stream	
Miscellaneous Construction	
Phase II	**$134,800**
Current Stream	
New Stream	
Phase III	**$7,790**
Maintenance	
Subtotal (2006 dollars) =	$256,490
Inflation rate* =	3.33%
Total Costs =	**$274,000**

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Questions

APPENDIX A-2
Natural Environmental Report

Environmental Input to the EA for the Widening of York Road, Victoria Road to the East City Limit, Guelph, Ontario

Prepared for:
The City of Guelph, Ontario
c/o: Totten Sims Hubicki Associates
72 Victoria Street South
Kitchener, Ontario
N2G 4Y9

Project No. 658

Date: September 2006

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

Memo

Project No. 658

To: **Ernst Heinrichs – Totten Sims Hubicki Associates**

CC:

From: **Dave Green**

Date: **September 25, 2006**

Re: **Environmental Input to York Road Widening - Guelph**

The City of Guelph has proposed to widen York Road/Provincial Highway 7 in the section from Victoria Road eastward to the city limit. Natural Resource Solutions Inc. has provided the following information on the existing natural environment features within the project boundary as well as an assessment of impact for the preliminary design provided by TSH on September 13, 2006. Please refer to Drawings 5.1 to 5.4 in the main report by TSH for the preliminary design. A tree survey has also been completed for the York Road corridor. Information on the tree survey will be provided to TSH under a separate cover. Please refer to Figure 1, Key Map, for the location of the study area.

Methods

Information on the aquatic habitats was obtained by review of available background information and assessment of habitat in the field. Background information was obtained from the Ministry of Natural Resources Guelph District Office on June 8, 2006.

The aquatic habitat in the vicinity of York Road was assessed by an aquatic biologist from NRSI during two site visits, which occurred on June 5, 2006 and June 8, 2006.

A tree survey was carried out by a certified arborist from NRSI on June 5, June 16, and June 19, 2006

Figure 1

Environmental Input for the Widening of York Road, Guelph, Ontario

Key Map

September 26, 2006
Project NRSI-0658
NAD83 - UTM Zone 17
1:45,000 at 8.5 x 11

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

Layers:
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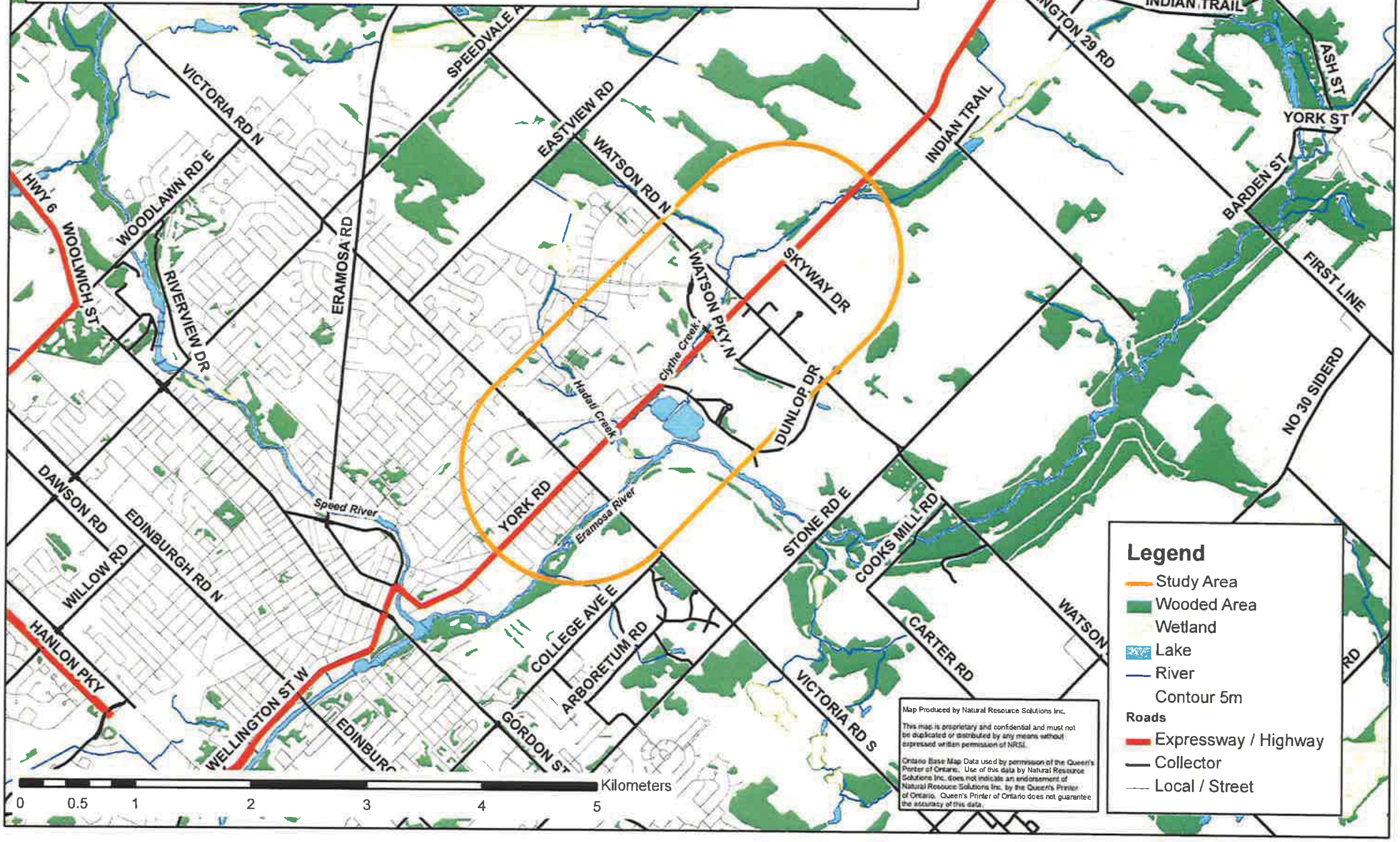
OLIW_0658_Waterseg_arc_CLIP_15Sep06
OLIW_0658_Waterseg_poly_CLIP_15Sep06
OLIW_0658_Wooded_area_CLIP_15Sep06



NRSI_0658_YorkRd_keymap_fig1_45k_26Sep08

EXISTING CONDITIONS

Aquatic Habitat – Clythe Creek

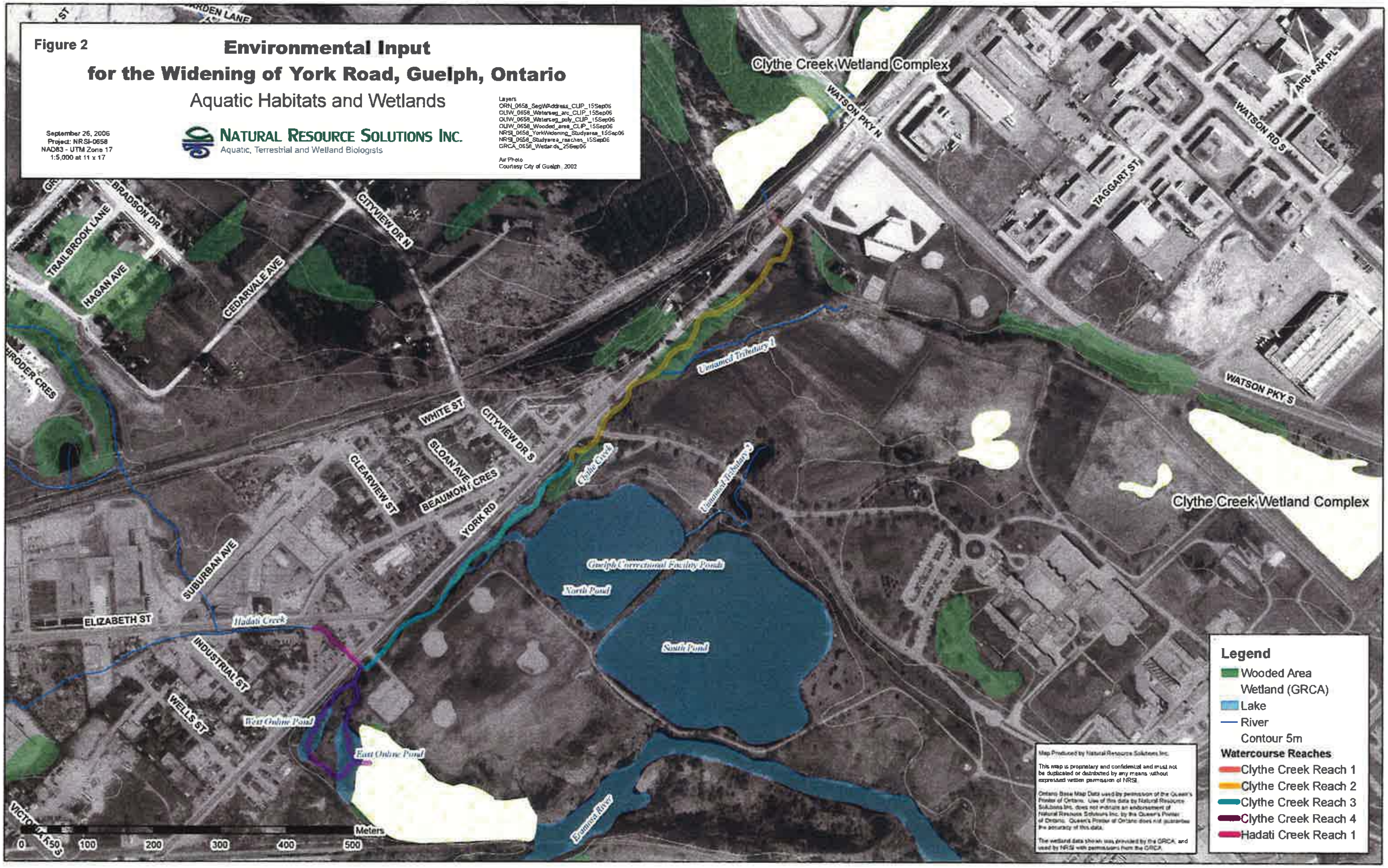
According to the Grand River Conservation Authority (GRCA), Clythe Creek is a coolwater stream (GRCA 2006). It originates in a lowland cedar swamp located approximately 6km upstream of its outlet to the Eramosa River, and the water is cold and clear in the upstream area near the swamp (Ecologistics et al 1998). The swamp is part of the Clythe Creek Provincially Significant Wetland (PSW) Complex. There are additional groundwater inputs to Clythe Creek between Watson Road and York Road (Ecologistics et al 1998). This section of the creek flows through another wetland in the Clythe Creek PSW Complex.

There are also 2 tributary streams that originate east of Clythe Creek (see Figure 2). One enters directly into Clythe Creek upstream of the ponds at the Guelph Correctional Centre (Unnamed Tributary 1), and the other flows into the south pond (Unnamed Tributary 2). Art Timmerman of the MNR indicated that both of these tributaries have cold water temperatures (MNR, 2006). The tributary that enters directly into Clythe Creek is currently providing a cooling influence. A survey by the MNR on August 30, 1994 found water temperatures at 2 locations in the tributary to be 11.6°C and 10.8°C while the air temperature was 19.7°C. In contrast, the other tributary flows into the south pond and does not have a meaningful cooling influence on Clythe Creek. Hadati Creek joins Clythe Creek from the north near Elizabeth Street, and is another coldwater tributary. It is described in detail in Section 3.3.

Within the study area, there are numerous weirs and dams on Clythe Creek that create barriers to fish movement (See Photo 1, Appendix I)

Clythe Creek – Reach 1

This short section of Clythe Creek is situated between the York Road crossing and a railway crossing (Figure 2). The vegetation on both sides of the creek is primarily long grasses along with other herbaceous plants and occasional shrubs. There are also several trees, including cedars, maples, and other deciduous species. The trees and shrubs create a canopy that provides approximately 70% shade to this reach.



NRSI_0658_YorkRd_Reaches_Fig2_5k_26Sep08

The bank vegetation is composed of grasses, other herbaceous plants, and shrubs. The high vegetation density affords good bank stability. Bank-full width ranged from approximately 3.1 to 3.5m. The channel substrate is dominated by coarse materials, consisting of approximately 10% boulder, 60% cobble, 10% pebble, 10% gravel, and 10% sand. Cover for fish includes pools (at the York Road culvert), boulders, and cobble. Most of this section is considered riffle habitat (See Photo 2, Appendix I).

On June 5, 2006, the measured wetted widths varied between 2.4 and 3.0m. Water depths ranged from 9 to 19cm. Water quality parameters were measured at 1:55pm. The water temperature was 18.8°C, and the air temperature was 25°C. The dissolved oxygen was 9.3ppm, or 99.8% saturation (at 18.8°C). The pH was 7.96, and the conductivity was 716μs/cm.

Clythe Creek – Reach 2

This reach of Clythe Creek is between the York Road crossing and the Ponds at the Guelph Correctional Centre (Figure 2). The lands surrounding this reach have a gently rolling topography. The vegetation in the riparian zone is manicured grass with some open-grown trees, including coniferous trees and willow trees (see Photo 3, Appendix I). Although the grass was mowed right up to the top-of-bank, the bank vegetation also included some trees, shrubs, and longer grass creating a high vegetation density on the banks.

Channel substrate in this reach is approximately 30% boulder, 20% cobble, 20% silt, 10%sand, 10% gravel, and 10% muck. Aquatic habitat features and cover include pools, riffles, backwater, undercut banks, woody debris, several types of aquatic vegetation, boulders, and cobble.

During site visits on June 5 and June 8, 2006, the measured wetted widths of the channel were as narrow as 1.8m in narrow sections of the channel, and up to 3.5m in wider locations. Measured depths at various locations along the middle of the channel varied between 8 and 72cm. The macrohabitats consisted mostly of runs, occasional pools, and a few riffles. Maximum pool depth was 72cm, and many runs were deeper than 30cm. The water temperature taken in the middle of this reach was 19.7°C at 3:40pm while the air temperature was 26°C. At the same location, dissolved oxygen was 9.5ppm (103.5% saturation at 26°C), pH was 7.99, and conductivity was 709µs/cm. Many small fish were observed.

Clythe Creek – Reach 3

This reach lies between the ponds at the Guelph Correctional Centre (Figure 2) and Hadati Creek. The lands surrounding this reach are relatively flat, and include baseball diamonds. The vegetation is dominated by manicured grass to the top-of-bank of Clythe Creek. Trees are distributed somewhat randomly in the vicinity of the creek. The vegetation density on the banks of Clythe Creek has been compromised due to feeding by the large numbers of geese that inhabit this area. This has contributed to bank instability, and boulders that were placed along the banks for aesthetic purposes are no longer integrated with the bank.

The bank height ranges from approximately 0.1 to 0.3m, and the bank-full channel width varies between 7 and 12m. This widened section of Clythe Creek has some meandering form, but intensive modifications have left it with a low gradient. As a result, the water becomes ponded during low flow (see Photo 4, Appendix I). The substrate reflects the depositional nature of the slow, diffused flows. It is approximately 50% silt, 30% boulder, and 20% muck.

On June 8, 2006, the water temperature in Clythe Creek immediately upstream of the Hadati Creek outlet was 23.5°C at 3:45pm while the air temperature was 24°C. The pH was 8.39, and the conductivity was 686µs/cm. Fish from the families Cyprinidae and Centrachidae (*Lepomis* sp.) were observed in this reach.

Clythe Creek – Reach 4

This reach lies between the outlet of Hadati Creek and the downstream limit of two online ponds (Figure 2) The flow diverges downstream of the Hadati Creek outlet to flow into the two ponds, which are located side-by-side (see Photo 5, Appendix I). The east online pond is at a lower elevation and is the larger of the two. The land on the east side of this pond is wooded. The land in between the two ponds and west of the ponds is manicured grass with occasional trees. Boulders were used as a landscaping feature along the banks, and there is abundant aquatic vegetation throughout both ponds.

The portion of flow that enters directly into the east pond passes over a weir and into a plunge pool at the upstream end of the pond. The west pond receives flow directly and as a result the water is at a higher elevation than that of the east pond. The flow leaves the pond through a channel that connects to the downstream end of the east pond. There is a pedestrian crossing over this channel that uses a corrugated steel pipe (CSP) to convey flow. A weir situated in this outlet channel keeps the west pond at its higher elevation.

On June 8, 2006, the water was relatively shallow (approximately 0.3m deep) throughout most of the area of the ponds. Water temperature was measured where the flow from the upper (west) pond joins the lower (east) pond. At 2:45pm, the water temperature was 23.5°C and the air temperature was 24°C. The pH at this location was 7.80 and the conductivity was 812µs/cm. The dissolved oxygen level was 9.3ppm, indicating supersaturated conditions (approximately 110% at 23.5°C). This was likely a result of the prolific growth of aquatic plants (see Photo 6, Appendix I). Fish from the families Centrarchidae (*Lepomis* sp.) and Cyprinidae were observed in the ponds.

Aquatic Habitat – Ponds at the Guelph Correctional Centre

The ponds at the Guelph Correctional Centre consist of two large ponds to the south of York Road and Clythe Creek (Figure 2). The north pond is closer to Clythe Creek, and is connected via a short channel approximately 10m long and 3 to 4m wide (see Photo 7, Appendix I). The flow of water moves slowly out of the pond as it joins the slow-moving water of this widened section of Clythe Creek. The south pond is not directly connected to Clythe Creek.

These constructed ponds are known to provide habitat for a variety of game fish and are used as a popular urban fishery (see Photo 8, Appendix I). Manicured grass surrounds much of their shorelines, and various trees and shrubs line the banks in some locations. The two ponds are separated by a narrow strip of land, and the south pond has a higher water level than the north pond (see Photo 9, Appendix I). The south pond is contained by a berm between it and the Eramosa River along its south shoreline. A formal trail has been established along the top of the berm on the south side.

Some water from the south pond seeps into the north pond. One location in particular was observed where the surface of the water in the north pond was turbulent due to flows entering from the south pond. Other less obvious seeps may also be present. As a result, this seepage flows through the north pond and subsequently into Clythe Creek. Therefore, there is a hydraulic connection between the south pond and Clythe Creek.

While this provides an input of flow, the potential for a cooling influence is lost as the water from the tributary entering the south pond is subject to warming while passing through the ponds. Furthermore, most of the flow leaves the south pond through a 45cm diameter CSP leading directly to the Eramosa River, which causes a large portion of the input from the tributary to be diverted directly to the Eramosa River instead of to Clythe Creek.

Aquatic Habitat – Hadati Creek

According to the GRCA, Hadati Creek is considered a coldwater stream (GRCA 2006). According to MNR, Guelph District file information, the gradient is higher upstream of Elizabeth Street, the substrate is primarily bedrock, and the stream is narrower than it is near the outlet to Clythe Creek (MNR 2001). A western tributary discharges to the main branch east of the Elizabeth Street/Industrial Street intersection. Upstream of Suburban Avenue, "...there is a bedrock shelf which probably prevents the upstream migration of fish (MNR 2001)."

Hadati Creek – Reach 1

Reach 1 of Hadati Creek is between Elizabeth Street and its outlet to Clythe Creek (Figure 2). Here, Hadati Creek passes between parking lots of the commercial lands that line York Road. The corridor is extremely narrow, with no more than one or two metres of vegetation on either side of the creek. The creek passes through a large box culvert under York Road. On the downstream side, grasses in the roadside ditch surround the short length of channel between the road and the outlet to Clythe Creek.

The channel in Reach 1 is approximately 3m wide, and is very entrenched. The bank height ranges from approximately 1.9 to 2.2m, and bank slopes are nearly vertical. Most of the banks are hardened with a concrete bag wall (see Photo 10, Appendix I). Elsewhere, vegetation consists of grasses and other herbaceous plants that provide a moderate vegetation density for bank stability. Some minor bank scour is occurring on the west bank immediately upstream of the York Road culvert, likely resulting from flow patterns at the culvert inlet. The varied channel substrate is the most important habitat feature. It consists of approximately 30% cobble, 20% pebble, 10% gravel, 20% sand, and 20% silt. A 2001 MNR report shows that the substrate downstream of Elizabeth Street is "...composed on fractured bedrock and bedrock (MNR 2001)." The difference in observations occurred either because of different observation locations, or because material from upstream of the site has been deposited in this reach since 2001.

On June 8, 2006, the measured wetted widths in Reach 1 were approximately 2.7 to 2.9m between York Road and Elizabeth Street. Measured water depths ranged from 8 to 20cm. Several water quality parameters were measured at 3:05pm approximately 5m upstream of the York Road culvert. At this time the air temperature was 23°C, the water temperature was 21.9°C, the pH was 8.27, and the conductivity was 989µs/cm. Many small fish were observed on the upstream side of York Road.

FISH COMMUNITY

Rare Fish Species

Records of greenside darter in the vicinity of the study area were found on the Natural Heritage Information Centre (NHIC) website using the geographic query function (NHIC 2006). There was one "element occurrence" square (1km by 1km) that included part of the study area. Observations were made at that location in 1991. They were also found during sampling by the University of Guelph in the Guelph Correctional Facility Ponds in 2005 (see Section 3.4.4 of this report). The greenside darter *(Etheostoma blennioides)* has an S-rank (subnational rank) of S4, which means it is apparently secure. Nevertheless, at the present time it remains listed as a species of "special concern" by both the MNR for Ontario and COSEWIC for Canada (NHIC 2006; Pers. Comm. with Donald Kirk, MNR 2006b).

According to the *Ontario Freshwater Fishes Life History Database (OFFLHD)*, greenside darters prefer "algae-covered rocky riffles of creeks and small to medium rivers with clear water and moderate to fast current" (Eakins 2005). Their preferred water temperature is 25.4°C. As phytophils, greenside darters deposit their eggs on vegetation and woody debris (Eakins 2005).

Brook Trout and Brown Trout

According to a MNR map of brook trout distributions (MNR Unknown Date), brook trout were known to inhabit Clythe Creek in 1952 (Figure 3). According to Art Timmerman (MNR 2006a), there are currently no brook trout but there are mottled sculpin *(Cottus bairdi)* which also require cool water temperatures. However, the Speed Valley chapter of Trout Unlimited is conducting a monitoring program throughout the Clythe Creek watershed to determine the suitability of the habitat for brook trout. Temperature monitoring is ongoing in 2006 and electrofishing will be conducted throughout Clythe Creek to determine if any populations are present (D'Amelio, 2006). In addition, brook trout and brown trout are known to inhabit the Eramosa River (Ecologistics Ltd. et al 1998).

Figure 3

Environmental Input for the Widening of York Road, Guelph, Ontario

Fish Record Locations

September 26, 2006
Project: NRSI-0658
NAD83 - UTM Zone 17
1:45,000 at 8.5 x 11

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

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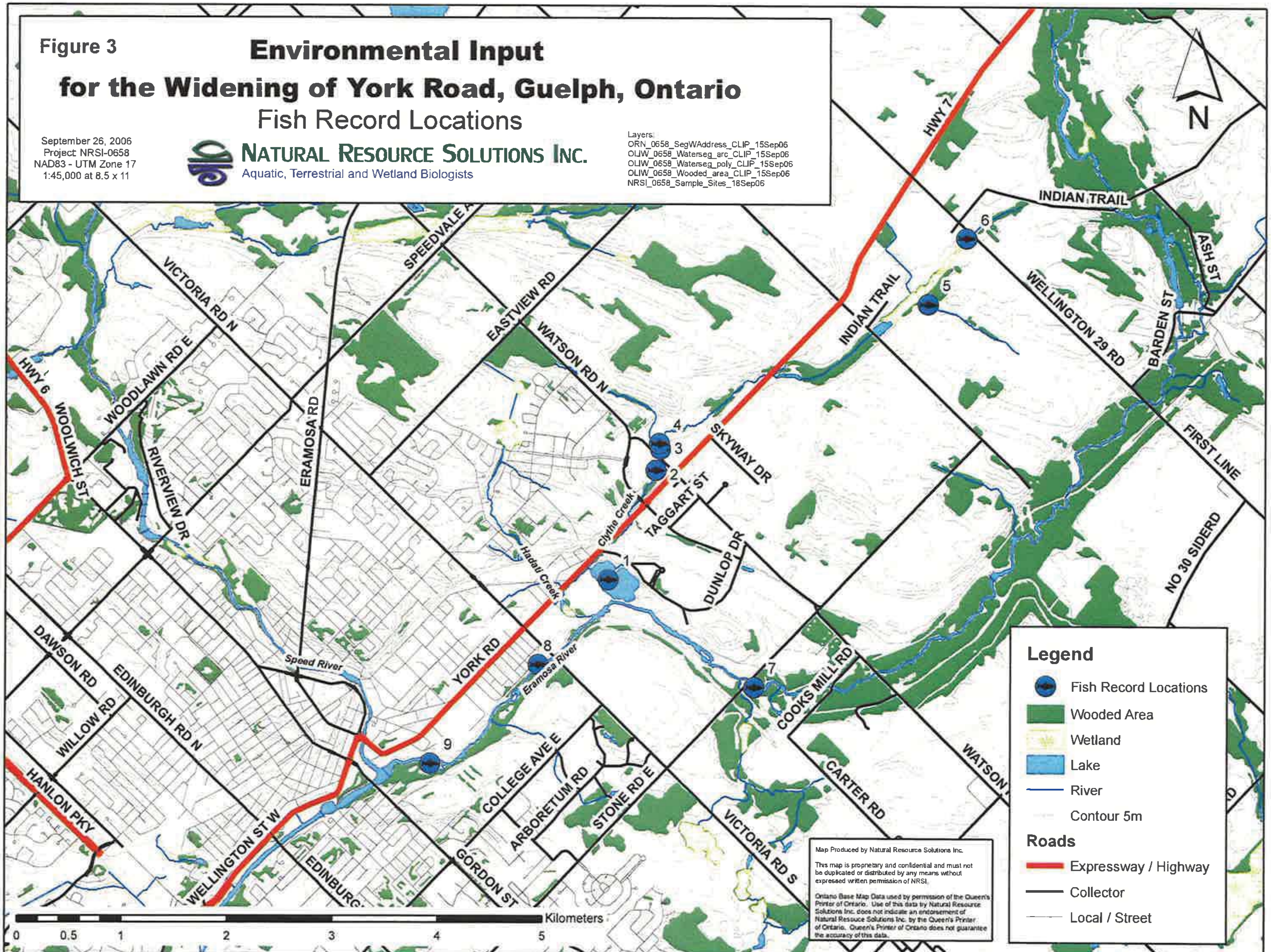

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Urban Fishery at the Guelph Correctional Centre Ponds

A report by Art Timmerman indicates information from anglers that the ponds at the Guelph Correctional Centre "...contain excellent populations of pike, smallmouth bass, crappie, bullheads and sunfish. Yellow perch and largemouth bass have also been caught in these ponds (MNR 2001)."

Other Fish Records

Unnamed Tributary 1, which enters Clythe Creek upstream of the ponds at the Guelph Correctional Centre, is known to contain fish near the outlet (Figure 2). A survey by the MNR on August 30, 1994 indicated that unidentified minnows were observed in the lower 10m of the tributary (MNR 1994).

The sampling results for a number of fish collection records from the MNR Guelph District Office files are given in Table 1. Descriptions are given below for the various sources of information for this list of fish species. Available specific fish sampling locations are shown on Figure 3.

In 2005, the University of Guelph sampled several watercourses in southern Ontario, including the Eramosa River. Sampling in the Eramosa River watershed occurred in the ponds at the Guelph Correctional Centre (Record Location 1, Figure 3).

In 2001, Fisheries and Oceans Canada (DFO) conducted fish sampling at a variety of locations with the purpose of monitoring culvert installations. This included Clythe Creek upstream of the York Road corridor, between York Road and Watson Road (see Record Location 2, Figure 3).

In 1998, a subwatershed study was conducted for the Clythe Creek subwatershed (Ecologistics et al 1998). The report included a list of species for the entire subwatershed.

In 1990, the GRCA conducted exploratory electrofishing at 4 sites on Clythe Creek upstream of Watson Road (see Record Locations 3, 4, 5, and 6, Figure 3).

In 1981, Gregory Humphreys (affiliation not noted) conducted sampling under scientific permit at various locations in the Grand River and Thames River Drainage. One site was located on the Eramosa River at the "Guelph Correctional Centre (bridge)".

In 1972, the GRCA published a report called "Water Quality Survey of the Speed and Eramosa Rivers." The report includes results of fish sampling for 13 sites, 3 of which are on the Eramosa River in relatively close proximity to the outlet of Clythe Creek (see Record Locations 7, 8, and 9).

Table 1. Fish Species Known from the Clythe Creek Subwatershed, and the Eramosa River near the Clythe Creek Outlet

Common Name	Scientific Name	Provincial Rank (S-Rank)	University of Guelph, Correctional Centre Ponds (2005)	DFO, Clythe Cr. between York Rd. and Watson Rd. (2001)	Ecologistics et al, Clythe Creek Subwatershed (1998)	GRCA, Clythe Cr. Upstream of Watson Rd. (1990)	Gregory Humphreys Eramosa River at Correctional Centre (1981)	GRCA Water Quality Survey, Eramosa River (1972)
Cyprinidae								
creek chub	*Semotilus atromaculatus*	S5	X		X	X		X
hornyhead chub	*Nocomis biguttatus*	S4						X
common shiner	*Luxilus cornutus*	S5			X	X		X
blacknose shiner	*Notropis heterolepis*	S5			X			
northern redbelly dace	*Phoxinus eos*	S5			X	X		
finescale dace	*Phoxinus neogaeus*	S5			X	X		
bluntnose minnow	*Pimephales notatus*	S5	X	X				X
fathead minnow	*Pimephales promelas*	S5			X	X		
blacknose dace	*Rhinichthys atratulus*	S5			X	X		
longnose dace	*Rhinichthys cataractae*	S5						X
Percidae								
greenside darter	*Etheostoma blennioides*	S4	X					
fantail darter	*Etheostoma flabellare*	S4	X	X	X			
barred fantail*								X
rainbow darter	*Etheostoma caeruleum*	S4	X					X
johnny darter	*Etheostoma nigrum*	S5	X				X	X
blackside darter	*Percina maculata*	S4					X	X
Centrarchidae								
smallmouth bass	*Micropteris dolomieu*	S5						X
largemouth bass	*Micropteris salmoides*	S5						X
pumpkinseed	*Lepomis gibbosus*	S5						X
rock bass	*Ambloplites rupestris*	S5						X
Catostomidae								
white sucker	*Catostomus commersoni*	S5			X	X		X
northern hog sucker	*Hypentelium nigricans*	S4			X			X
Other Families								
brook stickleback	*Culaea inconstans*	S5		X	X	X	X	
brown bullhead	*Ameiurus nebulosus*	S5		X				
central mudminnow	*Umbra limi*	S5		X	X	X		
mottled sculpin	*Cottus bairdi*	S5			X	X		X
brook trout	*Salvelinus fontinalis*	S5			X			

*The "barred fantail" is most likely the fantail darter *(Etheostoma flabellare)*

OPPORTUNITIES AND CONSTRAINTS

The aquatic habitat in the section of Clythe Creek along the south side of York Road is heavily impacted by numerous weirs, straightening, widening, and ongoing maintenance of manicured grass along its length. There is also ongoing impact by large goose populations that are contributing to bank erosion. As such, there are many opportunities to improve the condition of the creek.

Factors to consider in the design process include the current use of the area as an urban angling opportunity, the use of the habitat by many warmwater species of fish, the limited space or buffer between York Road and Clythe Creek, and the opportunity to restore this portion of the creek so it continues to provide coolwater or coldwater fish habitat.

Grand River Fisheries Management Plan

Opportunities and constraints can also be identified in the Grand River Fisheries Management Plan, which was completed in September 1998 by the Ontario Ministry of Natural Resources and the Grand River Conservation Authority. The management plan identifies Clythe Creek as a mixed water tributary to the Speed River. The fish community objectives for mixed water tributaries are to achieve a "...coldwater fish community in areas where geological and biophysical characteristics are present and habitat exists or has been rehabilitated..." and a "...warmwater fish community in reaches that cannot support coldwater fish (MNR & GRCA 1998)." Based on these objectives, the planning and design of any work affecting a mixed water tributary such as Clythe Creek should investigate the possibility of improving the habitat for a coldwater fish community.

Furthermore, the management plan identifies issues that exist for the Speed River's mixed water tributaries. Of relevance to the York Road widening project are the following:

1. water quality/quantity impacts from:
    a. nutrient and sediment inputs;
    b. riparian zone destruction and increased water temperatures; and
    c. stormwater discharge.
2. fish habitat impacts from:

   a. conflict between land use activities and use of flood plains as productive fish habitat;
   b. dams and impoundments on fish migration, downstream movements of stream bedload, water quality, and possibly increased water temperatures;
   c. loss of natural habitat due to channelization and stream bank hardening (urban encroachment); and
   d. perched culverts on fish movements.
3. fish population/community concerns:
   a. significant reduction in brook trout populations; and
   b. potentially incompatible fish species and/or communities (e.g. Eramosa River).

Finally, the Grand River Fisheries Management Plan identifies management strategies for the mixed water tributaries to the Speed River. From those listed in the management plan, the following strategies are relevant to this project:

1. Communication/Education/Partnerships:
   a. work with owners of dams and impoundments to eliminate or reduce the impacts of these features on downstream fish populations and fish habitat, and
   b. encourage tributary restoration program.
2. Data Collection/Assessment:
   a. assess habitat conditions and recommend candidates for rehabilitation,
   b. assess impacts of online ponds and develop strategies to mitigate such impacts (e.g. Eramosa River),
   c. assess value of ponds/dams to local communities and municipalities (consider removal of barriers if ponds are of little value),
   d. assess the social and economic benefits associated with the fish resource,
3. Habitat Management/Rehabilitation:
   a. rehabilitate fish habitat with the objective of extending the coldwater attributes downstream in each system,
   b. determine rehabilitation needs and prepare rehabilitation plans (instream and riparian zones),
   c. improve water quality, establish stable flows and restore riparian vegetation,
   d. consider modifications to/removal of existing barriers to fish passage,
   e. rehabilitate degraded habitat to restore functional system, and
   f. protect groundwater and riparian zones to maintain water quality/quantity.
4. Fish Population Management:
   a. use of structures (e.g. dams) for partitioning incompatible fish species/communities (e.g., Eramosa River).

IMPACT ASSESSMENT AND MITIGATION MEASURES

For details of the preliminary design provided to NRSI for the assessment of natural environment impacts, please refer to Drawings 5.1 to 5.4 in the main report by TSH.

Direct Impacts

The proposed road widening will cause a direct impact to Clythe Creek in 2 locations (described below). The impacts will result from the proposed additional traffic lanes and associated fill placement to create stable slopes along the south side of York Road.

Clythe Creek Culvert Extension or Replacement

The extension or replacement of the culvert for Clythe Creek (at chainage 13 + 280) may result in a Harmful Alteration, Disruption, or Destruction (HADD) of fish habitat, and will be subject to approval under the federal *Fisheries Act.* . It is possible that operational statements for culvert replacements and extensions prepared by DFO as part of the new risk management framework may allow the work to proceed without a full Authorization assuming that the criteria provided in the operational statement are met. The existing concrete headwall and stormwater pipe outlet adjacent to the south side of the culvert may also need to be modified in conjunction with the culvert replacement. In addition to direct impacts within the wetted area of the creek, attention must be given to fill placement adjacent to the creek as there are steep slopes in the vicinity of the crossing and a significant amount of fill may be required

Clythe Creek Channel Relocation

Mid-way between the Clythe Creek/York Road crossing and the main driveway to the Guelph Correctional Facility, the channel will need to be relocated to accommodate the widening of York Road. The section that would be impacted lies between chainage 13 + 055 and 13 + 135. In order to construct and a new section of channel that is stable and kept well away from the road, the channel realignment will affect at a minimum, approximately 90m of existing channel length. This will result in a HADD of fish habitat that will require mitigation and/or compensation. To compensate for the loss of existing habitat, a new channel that retains the same (or greater) channel length and area of habitat should suffice. It is recommended that the proposed channel realignment extend between the rock weirs located upstream and downstream of the area directly impacted by the York Road widening. This would result in reconstruction of approximately 135m of channel but would remove two barriers to fish movement and connect a larger section of Clythe Creek with the reaches upstream of York Road. Regardless of the specific design requirements, an authorization under the federal *Fisheries Act* will be required.

Indirect Impacts

Erosion and Sedimentation Potential Near Aquatic Habitats

The disturbance to the vegetation on lands immediately adjacent to Clythe Creek will cause indirect impact to the aquatic habitat due to elimination of existing vegetation and potential for sediment entering the water. Potential indirect impact will occur to some extent along the entire distance where Clythe Creek flows parallel to York Road. The impacts will need to be mitigated using erosion and sediment control measures, and the standard mitigation measures and operational constraints outlined in Section 5.4 of this report. It is strongly advised that the sediment and erosion control planning specifically address the areas where there is limited space between the proposed construction and Clythe Creek. Standard mitigation measures may not be sufficient in areas where there is less than 3.0m between the active construction of road slopes and the creek. Stockpiling and other construction practices should also be developed specifically for these pinch points along the York Road corridor.

Disturbance to soils on the north side of York Road also have potential to impact Clythe Creek. The ditch along the north side of York Road, and cross-drainage culverts that convey flow underneath York Road have potential to transport sediment across the road and into the creek. As such, the standard mitigation measures and operational constraints apply to all culvert inlets along York Road east of Victoria Street. A known 600mm diameter culvert crossing is found at chainage 12 + 950. Hadati Creek also flows under York Road from the north side, and must be protected from indirect impact by standard mitigation measures. Any other existing culverts will need to be identified in the detailed design, and standard mitigation measures will apply to them as well.

In some locations, grading will require slopes to be greater than 3:1 to allow a 1.5m or greater separation between fill placement and the top-of-bank of a creek. This separation will provide marginally sufficient space to install of erosion and sediment control fencing. In these locations of steeper slopes and close proximity of fill placement, stabilization techniques such as erosion matting and seeding must occur immediately after grading is finished. This applies at the following locations:

- On the northeast side of the Clythe Creek crossing (at chainage 13 + 290),
- west of the Clythe Creek crossing from chainage 13 + 260 to 13 + 280,
- from chainage 13 + 010 to 13 + 030,
- from chainage 12 + 940 to 12 + 980, and
- from chainage 12 + 880 to 12 +900.

Lastly, the crossing of Hadati Creek does not require replacement of the culvert. However, the widening of York Road and the realignment of Elizabeth Street will involve construction adjacent to Hadati Creek. Standard mitigation measures and operational constraints will apply to these construction activities.

Adjacent Vegetated Lands

The widening of the road will result in a reduction of the amount of vegetated land surface adjacent to Clythe Creek. The existing vegetated land along the north side of the creek includes manicured grass, and trees. The trees provide shade over the creek in some places, and the manicured grass has some limited benefit to the creek. The root mass stabilizes the soil, and the grass dissipates the energy of surface water runoff from the road as it flows overland to the creek. The loss of some of these functions will be considered a minor indirect impact.

The extent of this indirect impact can be described by comparing the distance between Clythe Creek and York Road before and after the widening. West of the outlet of Unnamed Tributary 1 (at chainage 13 + 000), there is currently a range of between 8 to 20m of land between Clythe Creek and the edge of the shoulder of York Road. In this section, the widening will bring the edge of the road at a minimum, approximately 2m closer to the creek, resulting in 6 to 18m of vegetated land. The preliminary design details provided to NRSI when compared to field investigations suggest there will be some sections that will have an even closer proximity to the creek

East of the outlet of Unnamed Tributary 1, there is currently a range of approximately 18 to 28m of land between Clythe Creek and the edge of the shoulder of York Road. In this section, the widening of York Road will bring the edge of the pavement approximately 6m closer to Clythe Creek. This will result in 12 to 22m of vegetated land between the creek and the road. Where Clythe Creek is to be relocated, it is anticipated that the resulting distance to the road will be similar to the rest of this section.

There is an opportunity to mitigate the loss of vegetated land adjacent to Clythe Creek by planting natural vegetation alongside the creek. Naturally vegetated lands adjacent to a watercourse have the following benefits:

- Vegetation provides shade over the watercourse to prevent water temperatures from rising due to solar energy inputs,
- Roots of larger and more varied vegetation improve stability of soils on the banks and adjacent land,
- The vegetation provides inputs of detritus that provides nutrients for aquatic organisms,
- The vegetation is a source of large woody material that provides important aquatic habitat structure,
- Abundant shrubs and trees along the creek deter geese and reduce their impacts to the creek banks,
- Floodplains are more effective for temporary floodwater storage, and
- The natural vegetation filters overland water runoff.

Stormwater Management

Currently, stormwater management details have not been presented in the provided information. Therefore it has been assumed that the increased amount of surface area of the road will increase the amount of stormwater that runs off the road in the direction of Clythe Creek. This will result in greater capacity to convey traffic-related contaminants in the direction of Clythe Creek. This impact should be mitigated on the south side of the road by installing native herbaceous plants, shrubs and trees to create a functional filter or buffer strip between Clythe Creek and York Road. A filter strip will enhance the capacity of the land between Clythe Creek and York Road to filter stormwater runoff. This will also serve as mitigation for the loss of adjacent vegetated land, which reduces the ability of the existing vegetation to filter stormwater runoff. This measure is consistent with management strategies 3a, 3c, 3e, and 3f of the Grand River Fisheries Management Plan (see paraphrased excerpts in this report).

To mitigate the increased stormwater runoff from the north side of the road, it is an option to install oil-grit separators to control the quality of the stormwater.

The number and locations of culverts that convey flow from the north side of York Road to the south side will not change. New culverts will replace the existing pipes, and the outlet locations will only change as a result of the required increased length to accommodate the wider road. As a result, no long-term impact is anticipated from changes in flow paths to the creek. In some cases, the replacement or extension of these culverts will increase the sedimentation potential and require active construction within close proximity to Clythe Creek.

SPECIAL CONSIDERATIONS FOR FISH COMMUNITIES

Populations of rare fish species are considered more sensitive because impacts can affect the viability of a species. The greenside darter, with an S-Rank of S4, and a status of Special Concern, is not expected to become extinct in the near future, and there is hope that it will recover. However, there is concern about the population of this fish species, which calls for diligent application of the mitigation measures and operational constraints recommended in this report. This diligence should be sufficient to ensure that the construction activities do not impact the aquatic habitat in the study area in any way that would be detrimental to a greenside darter population.

The interest by Trout Unlimited Canada in the brook trout potential of Clythe Creek confirms that it has potential to provide a valuable resource. This gives further reason to be diligent in applying the recommended mitigation measures and operational constraints.

Standard Mitigation Measures and Operational Constraints

During construction, standard mitigation measures and operational constraints will apply to protect the aquatic habitats against erosion and sedimentation, and other risks such as fuel and lubricants from equipment. They are as follows:

1. Sediment and erosion control measures should be installed and maintained throughout the construction period. Disturbed soils should be stabilized immediately with suitable plantings/seed/mat.
2. Stockpile and staging areas should be well removed from the watercourse and contained by appropriate sediment and erosion controls.
3. Dewatering of any excavations, pits or chambers must be done in a controlled manner so as not to discharge turbid water to watercourses or other aquatic features. Dewatering operations shall be directed to areas above ground and could include containment areas constructed with silt fence/strawbales and/or filter bag on existing vegetation. Where necessary, other techniques such as defractionation tanks or chemical flocculants shall be used. Suitable containment areas must be identified prior to any work commencing.

4. Where waterflow is to be pumped, screening shall be provided so as to prevent entry or damage fish at the intake, and discharge shall be directed so as to avoid erosion of the watercourse bed and banks at the water outlet. Water flow downstream must be maintained with a minimal amount of turbidity both from pumps and from associated construction activities.
5. For instream works, the area of disturbance within the channel and on the streambanks must be kept to a minimum. Heavy equipment traffic will be restricted to established travel pathways.
6. All timing restrictions, such as fisheries timing windows assigned by the MNR, must be adhered to.
7. Refueling activities should be conducted in an environmentally responsible manner. This includes a keeping the fueling operations 30 m setback from the waters edge, unless otherwise directed by the Environmental Monitor/Contract Administrator. Spill kits and sorbant material should be available on the fuel or service vehicles.
8. Any spills resulting from refueling operations, hydraulic leaks, maintenance etc. must be reported immediately to the Contact Administrator or Environmental Monitor who will then notify the Spills Action Centre if required.
9. Weather conditions should be monitored to adequately prepare the site for rain events.
10. Environmental monitoring must be conducted throughout the construction period. Post-construction monitoring should also be carried out to ensure that plantings become established and soils remain stabilized.

RECOMMENDATIONS

Based on the findings of this report, we make the following recommendations.

1. All mitigation measure provided in this report should be implemented.
2. Standard mitigation measures and operational constraints provided in this report should be employed as applicable throughout the construction period.
3. The section of channel to be realigned should be constructed using Natural Channel Design principles.
4. A *Fisheries Act* authorization will be required for the channel realignment, and possibly the culvert extension/replacement at the crossing of York Road and Clythe Creek.
5. Native herbaceous plants, shrubs and trees should be installed to create a filter strip between Clythe Creek and York Road, and to enhance the aquatic habitat in Clythe Creek. This will serve as mitigation for the loss of adjacent vegetated land and increased volume of stormwater runoff that will result from the road widening.

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Photo 1 – Clythe Creek, example of the many weirs in the study area

Photo 2 – Clythe Creek, Reach 1, looking downstream


Photo 3 – Clythe Creek, Reach 2, looking upstream toward York Road crossing

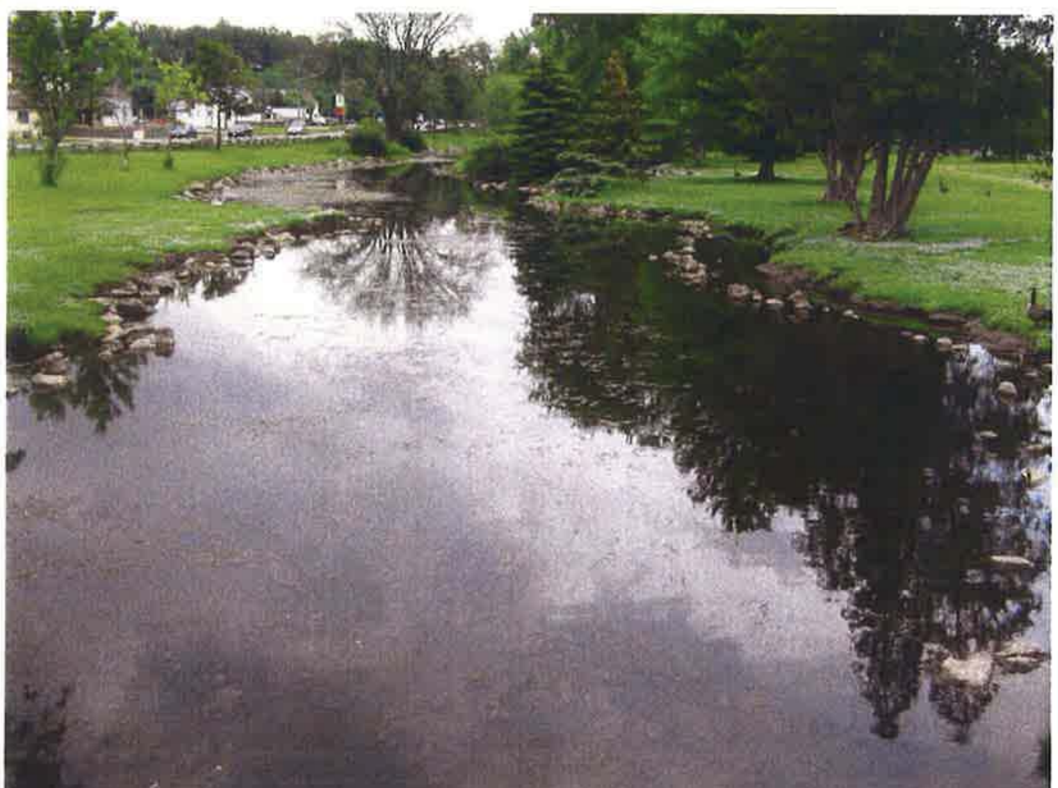
Photo 4 – Clythe Creek, Reach 3, looking upstream

Photo 5 – Clythe Creek, Reach 4, looking downstream toward Hadati Cr. outlet and ponds

Photo 6 – Clythe Creek, Reach 4, abundant aquatic plants in the online ponds

Photo 7 – Connection between the north pond and Reach 3 of Clythe Creek

Photo 8 – Fisherman at Guelph Correctional Facility Ponds, looking south from Clythe Cr.

Photo 9 – South Pond, looking southwest

Photo 10 – Hadati Creek, Reach 1, looking upstream

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October 26, 2006

Mr. Ernst Heinrichs
Totten Sims Hubicki Associates
72 Victoria Street South
Kitchener, Ontario
N2G 4Y9

Dear Mr. Heinrichs:

Re: Tree Management Plan –York Road, City of Guelph.

Natural Resource Solutions Inc. was retained to prepare a tree management plan consistent with the City of Guelph Tree Management Guidelines for the lands adjacent to a length of York Road, Guelph, Ontario. This work was undertaken as part of a Class Environmental Assessment for the proposed widening of a section of York Road. The original study area included both sides of York Road from Skyway Drive in the east to the western limit of York Road just west of Wyndham Street. It included Wyndham Street from York Road to Wellington Road. The initial assessment work was completed for this study area as depicted in the base survey provided by Totten Sims Hubicki Associates (TSH). Since that time, the study area has been reduced and consists of York Road from Victoria Street in the west to Skyway Drive in the east. This report only addresses this smaller study area, however the appended tree table shows all trees.

A Certified Arborist from Natural Resource Solutions Inc. visited the site on June 5, 16 and 19, 2006 to map and describe the trees in the proximity of the proposed undertakings. The following is a description of our findings.

A base survey was used to locate each of the surveyed trees. The attached copy of the plan shows the numbers and locations of the trees that were assessed. For each tree evaluated, species, diameter at breast height (dbh), crown radius and condition were recorded. Notes were also made on significant defects and other features of interest.

A table summarizing this information is appended to this letter. Those trees in the table that do not appear on the preliminary drawings are located on York Road west of Victoria Road and are not impacted by the recommended improvements.

Analysis of Potential Impacts to Trees

The preliminary design provided by TSH on September 13, 2006 was compared to the locations and characteristics of the trees within the study area. Trees were assessed individually using field measurements, a scale and the preliminary drawing. Please refer to Drawings 5.5 to 5.12 in the main report by TSH for the preliminary design.

A total of 204 trees comprising 20 species were evaluated within the smaller study area. No rare tree species were found in this area. The condition of the trees ranged from poor to good; some snags (standing dead trees) were also documented. Common defects in the trees with poor health included trunk wounds, weak forks, dead branches and past evidence of 'topping'. The trunk sizes ranged from less than 10cm dbh to 168cm dbh. The crown radii ranged from 1.5m to 12m.

The preliminary design proposes to widen York Road. This widening will require the removal of the trees within the construction footprint as well as those with significant portions of root zones extending into this construction area. This was assessed by comparing the actual tree crown radii to the proposed grading. Recommendations are provided below to minimize impacts to the trees to be retained.

Summary

The proposed widening of York Road between Skyway Drive and Victoria Street will result in the loss of 44 trees. An additional number of trees (2) were identified for removal due to their potential hazard condition and/or their poor condition. This included trees that will lose significant (> 25%) portions of their root systems. It should be noted however, that all trees have an inherent risk and warrant care and arboricultural management. A number of the trees to be retained along the construction edge may require some arboricultural attention. In a number of locations, limbs and roots were noted to overlap with the proposed road extension. These overlaps are not anticipated to result in significant impact to the retained trees if appropriate tree protection and care is implemented.

Tree protection measures should be installed prior to any clearing or other work. This will include but not be limited to the installation of tree protection and silt fencing along the proposed construction limit, inspection of the proposed fencing location before installation and after / before cutting, and installation of appropriate signage to mark the tree protection zones. As well, limbs and roots that are impacted by construction should be pruned and treated following standard arboricultural practices. Storage of materials and equipment must not occur within the dripline of trees to be retained.

Yours sincerely,
Natural Resource Solutions Inc.

Brett Woodman, M.E.S.
Certified Arborist / Terrestrial Biologist

TREE INVENTORY

Tree Number	Species	Scientific Name	dbh (cm)	Crown Radius (m)	Condition	Comments	Retain / Remove	Reason for action taken
1	Norway Maple	*Acer platanoides*	16	8	Good		retain	outside construction footprint
2	Norway Maple	*Acer platanoides*	60	7	Fair	frost cracks present	remove	in construction footprint
3	Norway Maple	*Acer platanoides*	75	7	Fair	forks with included bark	retain	outside construction footprint
4	Austrian Pine	*Pinus nigra*	27	5	Good		retain	outside construction footprint
5	Austrian Pine	*Pinus nigra*	17	4	Good		retain	outside construction footprint
6	Austrian Pine	*Pinus nigra*	26	5	Good		retain	outside construction footprint
7	Maple	*Acer sp.*	18	8	Poor	multi-stemmed clump; crown dieback; frost cracks	retain	outside construction footprint
8	Norway Maple	*Acer platanoides*	30	4	Good		retain	outside construction footprint
9	Austrian Pine	*Pinus nigra*	33	4	Fair	structure poor	retain	outside construction footprint
10	Austrian Pine	*Pinus nigra*	23	3.5	Good		retain	outside construction footprint
11	Scott's Pine	*Pinus sylvestris*	29	3.5	Good		retain	outside construction footprint
12	Norway Maple	*Acer platanoides*	27	4	Fair	some bark damage	retain	outside construction footprint
13	Austrian Pine	*Pinus nigra*	20	3.5	Good		retain	outside construction footprint
14	Austrian Pine	*Pinus nigra*	24	3.5	Good		retain	outside construction footprint
15	Honey Locust	*Gleditsi triacanthos var. inermis*	27	5	Fair	some crown dieback	retain	outside construction footprint
16	Honey Locust	*Gleditsi triacanthos var. inermis*	24	5	Fair	some crown dieback	retain	outside construction footprint
17	Norway Maple	*Acer platanoides*	26	4	Good		retain	outside construction footprint
18	Blue Spruce	*Picea pungens*	27	3	Good		retain	outside construction footprint
19	White Spruce	*Picea glauca*	26	2	Good		retain	outside construction footprint
20	Blue Spruce	*Picea pungens*	27	3	Good		retain	outside construction footprint
21	Blue Spruce	*Picea pungens*	20	3	Good		retain	outside construction footprint
22	Norway Maple	*Acer platanoides*	27	4	Fair	some crown dieback	retain	outside construction footprint
23	Blue Spruce	*Picea pungens*	31	4	Good		retain	outside construction footprint
24	Honey Locust	*Gleditsi triacanthos var. inermis*	30	5.5	Fair		retain	outside construction footprint
25	White Spruce	*Picea glauca*	20	3	Fair	some crown dieback	retain	outside construction footprint
26	Blue Spruce	*Picea pungens*	14	2.5	Good		retain	outside construction footprint
27	European Buckthorn	*Rhamnus cathartica*	10	3	Good		remove	in construction footprint
28	Scott's Pine	*Pinus sylvestris*	21	2.5	Good		retain	outside construction footprint
29	Norway Maple	*Acer platanoides*	31	3.5	Good	2 stems	retain	in construction footprint
30	Sugar Maple	*Acer saccharum*	24	4.5	Fair	epicormic branching	remove	in construction footprint
31	Norway Maple	*Acer platanoides*	45	5.5	Good	forking (< or = 30%)	remove	in construction footprint
32	Silver Maple	*Acer saccharinum*	65	7	Fair	some crown dieback	remove	in construction footprint
33	Norway Maple	*Acer platanoides*	70	7	Good	imbedded wire	remove	in construction footprint
34	Silver Maple	*Acer saccharinum*	80	9	Fair		remove	in construction footprint
35	Silver Maple	*Acer saccharinum*	64	9	Good		remove	in construction footprint
36	Silver Maple	*Acer saccharinum*	80	8	Fair	forking (< or = 30%)	remove	significant root loss
37	Norway Maple	*Acer platanoides*	10	1.5	Good		retain	outside construction footprint
38	Silver Maple	*Acer saccharinum*	64	8	Fair		remove	significant root loss
39	White Cedar	*Thuja occidentalis*	43	1	Fair	topped; significant bark damage;	retain	outside construction footprint
40	Norway Maple	*Acer platanoides*	10	0.5	Fair		retain	outside construction footprint
41	White Cedar	*Thuja occidentalis*	75	4	Good	forking (< or = 30%)	retain	outside construction footprint
42	White Elm	*Ulmus americana*	26	4.5	Good	forking (< or = 30%)	retain	outside construction footprint
43	White Cedar	*Thuja occidentalis*	30	2.5	Poor	crown dieback	retain	outside construction footprint

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44	Norway Maple	*Acer platanoides*	10	1	Fair	significant bark damage	retain	outside construction footprint
45	Little-leaved Linden	*Tilia cordata*	16	2.5	Good		retain	outside construction footprint
46	Little-leaved Linden	*Tilia cordata*	15	2	Good		retain	outside construction footprint
47	White Spruce	*Picea glauca*	19	2	Good		retain	outside construction footprint
48	White Spruce	*Picea glauca*	19	2	Good		retain	outside construction footprint
49	Honey Locust	*Gleditsi triacanthos var. inermis*	15	4.5	Fair		retain	outside construction footprint
50	Austrian Pine	*Pinus nigra*	20	2.5	Good		retain	outside construction footprint
51	Austrian Pine	*Pinus nigra*	21	2.5	Good		retain	outside construction footprint
52	Austrian Pine	*Pinus nigra*	19	2	Fair		retain	outside construction footprint
53	White Spruce	*Picea glauca*	17	2	Good		retain	outside construction footprint
54	Blue Spruce	*Picea pungens*	17	1.5	Good		retain	outside construction footprint
55	Norway Maple	*Acer platanoides*	17	3	Good		retain	outside construction footprint
56	White Spruce	*Picea glauca*	17	1	Good		retain	outside construction footprint
57	Blue Spruce	*Picea pungens*	16	1.5	Good		retain	outside construction footprint
58	Silver Maple	*Acer saccharinum*	59	7	Poor	crown dieback	remove	in construction footprint
59	Silver Maple	*Acer saccharinum*	67	8	Fair-Poor	cavities	remove	in construction footprint
60	Silver Maple	*Acer saccharinum*	64	7	Poor	crown dieback	remove	in construction footprint
61	Silver Maple	*Acer saccharinum*	64	8	Fair		remove	in construction footprint
62	Silver Maple	*Acer saccharinum*	62	8	Fair	some crown dieback	remove	significant root loss
63	Norway Maple	*Acer platanoides*	65	7	Fair	forking (< or = 30%); 15" leaner	remove	significant root loss
64	White Elm	*Ulmus americana*	15	3	Good	forking (< or = 30%)	retain	outside construction footprint
65	White Cedar	*Thuja occidentalis*	41	3	Good		retain	outside construction footprint
66	White Elm	*Ulmus americana*	36	7	Good	forking (< or = 30%)	remove	fill and grading in root zone
67	White Spruce	*Picea glauca*	42	3	Good		retain	outside construction footprint
68	Norway Maple	*Acer platanoides*	13	2.5	Good	2 stems	retain	outside construction footprint
69	White Cedar	*Thuja occidentalis*	15	15	Good	multi-stemmed clump	retain	outside construction footprint
70	White Elm	*Ulmus americana*			Snag		remove	existing hazard
71	Silver Maple	*Acer saccharinum*	22	4	Good	forking (< or =30%)	retain	outside construction footprint
72	Silver Maple	*Acer saccharinum*	23	4	Fair	significant bark damage	retain	outside construction footprint
73	European Buckthorn	*Rhamnus cathartica*	19	7	Good	forking (< or = 30%)	retain	outside construction footprint
74	White Cedar	*Thuja occidentalis*	36	5.5	Good	forking (< or = 30%)	retain	outside construction footprint
75	White Elm	*Ulmus americana*	21	3	Fair	major crook in trunk stem	retain	outside construction footprint
76	Blue Spruce	*Picea pungens*	31	3	Good		retain	outside construction footprint
77	White Elm	*Ulmus americana*	18	6	Good	multi-stemmed clump	retain	outside construction footprint
78	White Elm	*Ulmus americana*	18	5	Fair-Poor	multi-stemmed clump; primary fungal disease presen	retain	outside construction footprint
79	White Elm	*Ulmus americana*	44	9	Good		remove	significant root loss
80	Apple	*Malus sp*	30	5.5	Fair		retain	outside construction footprint
81	European Buckthorn	*Rhamnus cathartica*	11	3.5	Fair	poor structure	retain	outside construction footprint
82	White Cedar	*Thuja occidentalis*	13	1	Good		retain	outside construction footprint
83	White Cedar	*Thuja occidentalis*	17	2	Fair	under hydro-pruned	retain	outside construction footprint
84	White Cedar	*Thuja occidentalis*	16	2	Fair	under hydro-pruned	retain	outside construction footprint
85	White Cedar	*Thuja occidentalis*	15	1.5	Fair	under hydro-pruned	retain	outside construction footprint
86	White Cedar	*Thuja occidentalis*	12	1.5	Fair	under hydro-pruned	retain	outside construction footprint
87	White Cedar	*Thuja occidentalis*	19	2	Fair	by hydro - pruned	retain	outside construction footprint
88	White Cedar	*Thuja occidentalis*	12	1.5	Fair	by hydro - pruned	retain	outside construction footprint

Tree Number	Species	Scientific Name	dbh (cm)	Crown Radius (m)	Condition	Comments	Retain / Remove	Reason for action taken
89	White Cedar	*Thuja occidentalis*	24	2.5	Fair	by hydro - pruned	retain	outside construction footprint
90	White Cedar	*Thuja occidentalis*	16	3	Fair	2 stems; by hydro	retain	outside construction footprint
91	White Cedar	*Thuja occidentalis*	13/10	1	Good	2 stems	retain	outside construction footprint
92	White Cedar	*Thuja occidentalis*	22	1	Fair	2 stems; topped by hydro	retain	outside construction footprint
93	White Cedar	*Thuja occidentalis*	11	1	Fair	in hydro lines	retain	outside construction footprint
94	White Cedar	*Thuja occidentalis*	49	3	Good		retain	outside construction footprint
95	White Cedar	*Thuja occidentalis*	24	2	Good		retain	outside construction footprint
96	White Cedar	*Thuja occidentalis*	41	2.5	Poor	significant bark damage	retain	outside construction footprint
97	White Elm	*Ulmus americana*	22	3	Good	forking (< or = 30%)	retain	outside construction footprint
98	White Elm	*Ulmus americana*	14	3.5	Good	forking (< or = 30%)	retain	outside construction footprint
99	White Elm	*Ulmus americana*	10	1.5	Good	forking (< or = 30%)	retain	outside construction footprint
100	White Elm	*Ulmus americana*	11	1.5	Good	directly under hydro	retain	outside construction footprint
101	White Elm	*Ulmus americana*	28	1.5	Good		retain	outside construction footprint
102	White Elm	*Ulmus americana*	18	2	Good		retain	outside construction footprint
103	White Cedar	*Thuja occidentalis*	35	3.5	Poor	multi-stemmed clump; significant bark damage	retain	outside construction footprint
104	White Elm	*Ulmus americana*	12	1.5	Good		retain	outside construction footprint
105	White Elm	*Ulmus americana*	13	1.5	Good		retain	outside construction footprint
106	White Elm	*Ulmus americana*	19	1.5	Good		retain	outside construction footprint
107	White Elm	*Ulmus americana*	12	1	Good		retain	outside construction footprint
108	White Elm	*Ulmus americana*	12	1	Good		retain	outside construction footprint
109	White Elm	*Ulmus americana*	25	2	Good		retain	outside construction footprint
110	White Elm	*Ulmus americana*	16	1.5	Good	2 stems	retain	outside construction footprint
111	Pear	*Pyrus communis*	41	4	Good		retain	outside construction footprint
112	White Cedar	*Thuja occidentalis*	27	2.5	Fair	multi-stemmed clump; 1 stem top broken	retain	outside construction footprint
113	White Cedar	*Thuja occidentalis*	35	2.5	Poor	2 stems= snag @ 2.5m	retain	outside construction footprint
114	Blue Spruce	*Picea pungens*	24	1.5	Good		retain	outside construction footprint
115	Blue Spruce	*Picea pungens*	19	1.5	Good		retain	outside construction footprint
116	White Cedar	*Thuja occidentalis*	45	2	Poor	originally 4 stems now 1 remaining; bark damage	retain	outside construction footprint
117	Norway Spruce	*Picea abies*	45	3	Good		retain	outside construction footprint
118	European Buckthorn	*Rhamnus cathartica*	11	2.5	Good	multi-stemmed clump	retain	outside construction footprint
119	Norway Spruce	*Picea abies*	55	3.5	Good		retain	outside construction footprint
120	Norway Spruce	*Picea abies*	44	3	Good		retain	outside construction footprint
121	White Cedar	*Thuja occidentalis*	10	1	Good		retain	outside construction footprint
122	Norway Spruce	*Picea abies*	45	3.5	Good		retain	outside construction footprint
123	Norway Spruce	*Picea abies*	21	2	Good		retain	outside construction footprint
124	Norway Spruce	*Picea abies*	39	3	Good		retain	outside construction footprint
125	European Buckthorn	*Rhamnus cathartica*	15	3.5	Poor		remove	outside construction footprint
126	Norway Spruce	*Picea abies*	33	3	Good		retain	outside construction footprint
127	Manitoba Maple	*Acer negundo*	29	4.5	Poor		remove	outside construction footprint
128	Norway Spruce	*Picea abies*	39	4	Good		retain	outside construction footprint
129	Norway Spruce	*Picea abies*	28	3.5	Good		retain	outside construction footprint
130	White Elm	*Ulmus americana*	27	4	Fair	forking (< or = 30%)	retain	outside construction footprint
131	Norway Spruce	*Picea abies*	20	3.5	Good		retain	outside construction footprint
132	Norway Spruce	*Picea abies*	30	3.5	Good		retain	outside construction footprint
133	White Elm	*Ulmus americana*	11	2	Good		retain	outside construction footprint

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134	White Elm	*Ulmus americana*	54	3	Fair	forking (< or = 30%); canopy sparce	retain	outside construction footprint
135	Serviceberry	*Amelanchier*	19	1.5	Good		retain	outside construction footprint
136	Red Oak	*Quercus rubra*	20	4.5	Good		retain	outside construction footprint
137	Red Oak	*Quercus rubra*	17	4	Good	forking (< or = 30%)	retain	outside construction footprint
138	Red Oak	*Quercus rubra*	21	5	Fair	evidence of past biological infestation	retain	outside construction footprint
139	Red Oak	*Quercus rubra*	25	8	Good		retain	outside construction footprint
140	Red Oak	*Quercus rubra*	20	4	Good		retain	outside construction footprint
141	Red Oak	*Quercus rubra*	12	2	Good		retain	outside construction footprint
142	Siberian Elm	*Ulmus pumila*	20	3	Good	2 stems		
143	Siberian Elm	*Ulmus pumila*	12	2	Good			
144	Little-leaved Linden	*Tilia cordata*	37	5	Good	multi-stemmed clump		
145	Sugar Maple	*Acer saccharum*	59	6	Fair	imbedded wire		
146	Sugar Maple	*Acer saccharum*	65	9	Fair	cavities		
147	Norway Maple	*Acer platanoides*	37	4.5	Fair	directly under hydro;V-pruned		
148	Siberian Elm	*Ulmus pumila*	65	7.5	Poor			
149	Sugar Maple	*Acer saccharum*	55	4.5	Poor			
150	Norway Maple	*Acer platanoides*	28	3	Poor	poor structure; V-pruned		
151	Norway Maple	*Acer platanoides*	27	2	Poor	under hydro		
152	Norway Maple	*Acer platanoides*	14	1	Good			
153	Norway Maple	*Acer platanoides*	30	4	Good			
154	Norway Maple	*Acer platanoides*	62	5.5	Good			
155	Norway Maple	*Acer platanoides*	68	5	Fair	structure fair		
156	Silver Maple	*Acer saccharinum*	64	8	Fair	forking (< or = 30%); some canopy dieback		
157	White Elm	*Ulmus americana*	51	7	Fair-Poor	some canopy dieback		
158	Crab Apple	*Malus baccata*	25	4	Good			
159	Black Locust	*Robinia pseudoacacia*	24	3	Good			
160	Norway Maple	*Acer platanoides*	62	5	Fair	fair structure		
161	Crab Apple	*Malus baccata*	27	3	Good			
162	Norway Maple	*Acer platanoides*	44	5	Good			
163	Magnolia	*Magnoliaceae*	12	3.5	Good			
164	Silver Maple	*Acer saccharinum*	54	7	Fair-Good			
165	Honey Locust	*Gleditsi triacanthos var. inermis*	34	5	Good			
166	Red Ash	*Fraxinus pennsylvanica*	39	5	Good			
167	Honey Locust	*Gleditsi triacanthos var. inermis*	28	5	Good			
168	Honey Locust	*Gleditsi triacanthos var. inermis*	27	5	Fair	forking (< or = 30%); some canopy dieback		
169	White Cedar	*Thuja occidentalis*	15	1	Good	2 stems		
170	Siberian Elm	*Ulmus pumila*	15	3.5	Good	multi-stemmed clump		
171	Red Cedar	*Juniperus virginiana*	15	1	Good			
172	Honey Locust	*Gleditsi triacanthos var. inermis*	60	8	Poor	significant bark damage; cavities		
173	Sugar Maple	*Acer saccharum*	14	2.5	Fair	sparse canopy		
174	Japanese Horsechest	*Aescalus sp*	55	4	Fair	some dieback		
175	Norway Spruce	*Picea abies*	34	4	Poor	90% dead		
176	Silver Maple	*Acer saccharinum*	60	9	Fair			
177	Honey Locust	*Gleditsi triacanthos var. inermis*	35	5	Fair	sparse canopy		
178	Silver Maple	*Acer saccharinum*	107	9	Poor	crown dieback		

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179	Silver Maple	*Acer saccharinum*	34	6.5	Poor	crown dieback		
180	Silver Maple	*Acer saccharinum*	62	8	Good			
181	Silver Maple	*Acer saccharinum*	40	7	Good			
182	Silver Maple	*Acer saccharinum*	140	10	Fair	some canopy dieback		
183	Blue Spruce	*Picea pungens*	26	1	Fair	topped		
184	Silver Maple	*Acer saccharinum*	59	6	Good			
185	Silver Maple	*Acer saccharinum*	108	10	Good			
186	Norway Maple	*Acer platanoides*	21	4	Good			
187	White Elm	*Ulmus americana*	38	5	Fair			
188	White Elm	*Ulmus americana*	27	4	Poor			
189	White Cedar	*Thuja occidentalis*	15	1	Good			
190	Silver Maple	*Acer saccharinum*	80	8	Poor	crown dieback		
191	Crab Apple	*Malus baccata*	24	6	Good	3 stems		
192	Honey Locust	*Gleditsi triacanthos var. inermis*	28	5	Good			
193	Silver Maple	*Acer saccharinum*	61	8	Good			
194	Silver Maple	*Acer saccharinum*	89	8	Good			
195	Sugar Maple	*Acer saccharum*	66	6.5	Good			
196	Silver Maple	*Acer saccharinum*	88	8	Good			
197	White Birch	*Betula papyrifera*	20	3	Good	3 stems		
198	White Spruce	*Picea glauca*	22	2.5	Good			
199	Silver Maple	*Acer saccharinum*	119	10	Good			
200	Norway Maple	*Acer platanoides*	31	4	Good			
201	Norway Maple	*Acer platanoides*	37	5	Good			
202	Silver Maple	*Acer saccharinum*	101	9	Good			
203	Norway Maple	*Acer platanoides*	70	9	Good			
204	Norway Maple	*Acer platanoides*	64	8	Good			
205	Norway Maple	*Acer platanoides*	40	7	Fair	15 degree leaner		
206	Silver Maple	*Acer saccharinum*	59	8	Good			
207	Norway Maple	*Acer platanoides*	26	7	Good			
208	Silver Maple	*Acer saccharinum*	67	7	Fair	some canopy dieback		
209	Norway Maple	*Acer platanoides*	39	6	Good			
210	Silver Maple	*Acer saccharinum*	93	9.5	Good			
211	Silver Maple	*Acer saccharinum*	69	8	Good			
212	Norway Maple	*Acer platanoides*	33	5	Good			
213	Norway Maple	*Acer platanoides*	39	6	Good			
214	Cottonwood	*Populus sp*	28	4.5	Poor	60% dead		
215	Cottonwood	*Populus sp*	39	7	Fair	2-stem; leaner; some crown dieback		
216	Cottonwood	*Populus sp*	94	7	Fair			
217	Silver Maple	*Acer saccharinum*	109	7	Fair-Poor	crown dieback		
218	Silver Maple	*Acer saccharinum*	104	11	Good			
219	Silver Maple	*Acer saccharinum*	103	10	Good			
220	Silver Maple	*Acer saccharinum*	61	9	Good			
221	Silver Maple	*Acer saccharinum*	63	6.5	Good			
222	Silver Maple	*Acer saccharinum*	60	7.5	Good			
223	Silver Maple	*Acer saccharinum*	64	8	Good			

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224	Silver Maple	*Acer saccharinum*	87	8	Good			
225	Silver Maple	*Acer saccharinum*	91	10	Good			
226	Silver Maple	*Acer saccharinum*	99	8	Good			
227	Silver Maple	*Acer saccharinum*	94	7	Good			
228	Silver Maple	*Acer saccharinum*	130	9.5	Fair			
229	Silver Maple	*Acer saccharinum*	102	9.5	Good			
230	Silver Maple	*Acer saccharinum*	96	7	Good			
231	Silver Maple	*Acer saccharinum*	100	7	Good			
232	Silver Maple	*Acer saccharinum*	87	6	Good			
233	Silver Maple	*Acer saccharinum*	88	9	Fair			
234	Silver Maple	*Acer saccharinum*	73	9	Good			
235	Silver Maple	*Acer saccharinum*	79	8.5	Good			
236	Silver Maple	*Acer saccharinum*	84	8	Poor	crown dieback		
237	Silver Maple	*Acer saccharinum*	50	5.5	Good			
238	Silver Maple	*Acer saccharinum*	57	7	Good			
239	Silver Maple	*Acer saccharinum*	66	6.5	Good			
240	Norway Maple	*Acer platanoides*	39.5	3	Good			
241	Silver Maple	*Acer saccharinum*	23	2.5	Poor			
242	Silver Maple	*Acer saccharinum*	24	3	Fair	some crown dieback		
243	Silver Maple	*Acer saccharinum*	42	4.5	Good			
244	Silver Maple	*Acer saccharinum*	58	7	Good			
245	Norway Maple	*Acer platanoides*	67	7	Poor	hydro- Pruned-V		
246	Norway Maple	*Acer platanoides*	60	7	Poor	hydro- Pruned-V		
247	Norway Maple	*Acer platanoides*	24	4.5	Poor	crown damaged		
248	Honey Locust	*Gleditsi triacanthos var. inermis*	27	3.5	Good			
249	Honey Locust	*Gleditsi triacanthos var. inermis*	24	2.5	Good			
250	Honey Locust	*Gleditsi triacanthos var. inermis*	19.5	2.5	Good			
251	Honey Locust	*Gleditsi triacanthos var. inermis*	22.5	3.5	Good			
252	Honey Locust	*Gleditsi triacanthos var. inermis*	21	2	Good			
253	Crab Apple	*Malus baccata*	16.5	2.5	Good			
254	Crab Apple	*Malus baccata*	15	1	Good			
255	Honey Locust	*Gleditsi triacanthos var. inermis*	29	4	Good			
256	Honey Locust	*Gleditsi triacanthos var. inermis*	34	4.5	Good			
257	Crab Apple	*Malus baccata*	21	4	Good			
258	Honey Locust	*Gleditsi triacanthos var. inermis*	30	7	Good			
259	Honey Locust	*Gleditsi triacanthos var. inermis*	31	6	Good			
260	Crab Apple	*Malus baccata*	20.5	2.5	Good			
261	Norway Maple	*Acer platanoides*	34	5.5	Good			
262	Silver Maple	*Acer saccharinum*	16.5	2.5	Poor	crown dieback		
263	Blue Spruce	*Picea pungens*	24	1.5	Good			
264	Red Ash	*Fraxinus pennsylvanica*	19	3.5	Good			
265	Red Ash	*Fraxinus pennsylvanica*	36	5.2	Fair			
266	Honey Locust	*Gleditsi triacanthos var. inermis*	26	4.5	Good			
267	Blue Spruce	*Picea pungens*	22	1.5	Good			
268	Manitoba Maple	*Acer negundo*	37.5	6.5	Good			

Tree Number	Species	*Scientific Name*	dbh (cm)	Crown Radius (m)	Condition	Comments	Retain / Remove	Reason for action taken
269	Crab Apple	*Malus baccata*	25	3	Good			
270	Red Ash	*Fraxinus pennsylvanica*	26	6.5	Good			
271	Ornamental Cherry	*Prunus sp.*	12	1.5	Good			
272	Norway Maple	*Acer platanoides*	22	3	Good			
273	Silver Maple	*Acer saccharinum*	54	10	Poor	frost crack		
274	Crab Apple	*Malus baccata*	34.5	3.5	Good			
275	Crab Apple	*Malus baccata*	22.5	4.5	Good			
276	Honey Locust	*Gleditsi triacanthos var. inermis*	39.5	6.5	Good			
277	Honey Locust	*Gleditsi triacanthos var. inermis*	47	6.5	Good			
278	Norway Maple	*Acer platanoides*	23	7.5	Fair			
279	Norway Maple	*Acer platanoides*	52	7	Good			
280	Little-leaved Linden	*Tilia cordata*	57	8.5	Good			
281	Little-leaved Linden	*Tilia cordata*	79	5	Good			
282	Norway Maple	*Acer platanoides*	25	3	Good			
283	Norway Maple	*Acer platanoides*	56	6.5	Good			
284	Norway Maple	*Acer platanoides*	43	8	Good			
285	Crab Apple	*Malus baccata*	13	2	Good			
286	Norway Maple	*Acer platanoides*	12	0.5	Good			
287	Norway Maple	*Acer platanoides*	58.5	9	Good			
288	Norway Maple	*Acer platanoides*	34	7.5	Good			
289	Norway Maple	*Acer platanoides*	29	3	Good			
290	White Spruce	*Picea glauca*	27	2	Good			
291	Silver Maple	*Acer saccharinum*	66	8	Good			
292	Silver Maple	*Acer saccharinum*	63	9	Good			
293	Silver Maple	*Acer saccharinum*	54	10.5	Poor	broken crown (mechanical)		
294	Norway Maple	*Acer platanoides*	36	7	Fair			
295	Siberian Elm	*Ulmus pumila*	18	2	Fair	multi-stemmed clump		
296	Siberian Elm	*Ulmus pumila*	41	6.5	Fair	2 stems		
297	Norway Maple	*Acer platanoides*	30	5	Fair			
298	Norway Maple	*Acer platanoides*	33	6	Good			
299	Norway Maple	*Acer platanoides*	11.5	4	Good			
300	Siberian Elm	*Ulmus pumila*	13	1.5	Good	multi-stemmed clump		
301	Siberian Elm	*Ulmus pumila*	19.5	3.5	Good	multi-stemmed clump		
302	Siberian Elm	*Ulmus pumila*	22	3.5	Good	multi-stemmed clump	retain	outside construction footprint
303	Siberian Elm	*Ulmus pumila*	18.5	3.5	Good	multi-stemmed clump	retain	outside construction footprint
304	Siberian Elm	*Ulmus pumila*	21	3.5	Good		remove	in construction footprint
305	Siberian Elm	*Ulmus pumila*	13.5	2.5	Good		remove	in construction footprint
306	Norway Maple	*Acer platanoides*	25.5	4	Good		retain	outside construction footprint
307	Norway Maple	*Acer platanoides*	25.5	4	Good		retain	outside construction footprint
308	Norway Maple	*Acer platanoides*	24.5	4	Good		retain	outside construction footprint
309	Norway Maple	*Acer platanoides*	31	5	Good		retain	outside construction footprint
310	White Cedar	*Thuja occidentalis*	24.5	2.5	Good	multi-stemmed clump	retain	outside construction footprint
311	White Cedar	*Thuja occidentalis*	24.5	3	Good	multi-stemmed clump	retain	outside construction footprint
312	White Cedar	*Thuja occidentalis*	15.5	2	Good	multi-stemmed clump	retain	outside construction footprint
313	White Cedar	*Thuja occidentalis*	16	1.5	Poor	multi-stemmed clump; crown dieback; frost cracks	retain	outside construction footprint

Tree Number	Species	Scientific Name	dbh (cm)	Crown Radius (m)	Condition	Comments	Retain / Remove	Reason for action taken
314	White Cedar	*Thuja occidentalis*	12.5	0.5	Poor	clump; crown dieback	retain	outside construction footprint
315	White Cedar	*Thuja occidentalis*	28	3	Good	multi-stemmed clump	retain	outside construction footprint
316	White Cedar	*Thuja occidentalis*	28	4	Good	multi-stemmed clump	retain	outside construction footprint
317	European Buckthorn	*Rhamnus cathartica*	21	4	Good		retain	outside construction footprint
318	White Cedar	*Thuja occidentalis*	24	2	Poor		retain	outside construction footprint
319	Norway Maple	*Acer platanoides*	32	4.5	Good		remove	in construction footprint
320	Silver Maple	*Acer saccharinum*	26	6	Fair	sparse canopy	retain	outside construction footprint
321	Silver Maple	*Acer saccharinum*	14.5	3.5	Fair	sparse canopy	retain	outside construction footprint
322	Norway Maple	*Acer platanoides*	32	8	Poor		retain	outside construction footprint
323	Norway Maple	*Acer platanoides*	29	5	Fair		retain	outside construction footprint
324	Norway Maple	*Acer platanoides*	29	4.5	Poor		retain	outside construction footprint
325	Norway Maple	*Acer platanoides*	32	5	Good		retain	outside construction footprint
326	Blue Spruce	*Picea pungens*	28	3	Good		retain	outside construction footprint
327	Blue Spruce	*Picea pungens*	26	2	Fair		retain	outside construction footprint
328	Silver Maple	*Acer saccharinum*	61	11	Fair	some dieback	retain	outside construction footprint
329	Silver Maple	*Acer saccharinum*	10	3	fair		retain	outside construction footprint
330	Silver Maple	*Acer saccharinum*	14.5	3.5	Fair		retain	outside construction footprint
331	Norway Maple	*Acer platanoides*	19	4	Poor		remove	in construction footprint
332	White Elm	*Ulmus americana*	81	13	Poor	clump; crown dieback (90% dead)	remove	significant root loss
333	Norway Maple	*Acer platanoides*	26.5	5	Good		remove	in construction footprint
334	Silver Maple	*Acer saccharinum*	2	4	Good		retain	outside construction footprint
335	Silver Maple	*Acer saccharinum*	22.5	6	Good		retain	outside construction footprint
336	Silver Maple	*Acer saccharinum*	26	5	Good		retain	outside construction footprint
337	Norway Maple	*Acer platanoides*	16.5	5	Poor	significant bark damage	remove	in construction footprint
338	Norway Maple	*Acer platanoides*	20.5	5	Poor	crown dieback;significant bark damage	remove	in construction footprint
339	Norway Maple	*Acer platanoides*	31	5	Good		remove	in construction footprint
340	Norway Maple	*Acer platanoides*	23	4	Fair		remove	in construction footprint
341	Norway Maple	*Acer platanoides*	33	5	Good		remove	in construction footprint
342	Norway Maple	*Acer platanoides*	34	6.5	Good		remove	in construction footprint
343	White Cedar	*Thuja occidentalis*	24.5	1.5	Poor		remove	significant root loss
344	White Cedar	*Thuja occidentalis*	32	2.5	Poor		remove	significant root loss
345	Silver Maple	*Acer saccharinum*	99	12	Fair	some crown dieback	remove	significant root loss
346	White Cedar	*Thuja occidentalis*	24.5	2.5	Fair		retain	outside construction footprint
347	Silver Maple	*Acer saccharinum*	12	3	Good		retain	outside construction footprint
348	White Cedar	*Thuja occidentalis*	28	3	Poor		retain	outside construction footprint
349	White Cedar	*Thuja occidentalis*	32	3	Poor		retain	outside construction footprint
350	Red Pine	*Pinus resinosa*	74	9	Fair		remove	in construction footprint
351	White Cedar	*Thuja occidentalis*	10	1	Good	multi-stemmed clump	remove	fill and grading in root zone
352	Red Pine	*Pinus resinosa*	60.5	10	Fair		remove	fill and grading in root zone
353	White Spruce	*Picea glauca*	38	3	Fair	some crown dieback	remove	fill and grading in root zone
354	White Cedar	*Thuja occidentalis*	28	2.5	Fair		remove	in construction footprint
355	White Cedar	*Thuja occidentalis*	48	4	Good		remove	fill and grading in root zone
356	White Cedar	*Thuja occidentalis*	17	1	Good	multi-stemmed clump	remove	in construction footprint
357	White Elm	*Ulmus americana*	13	3	Good	multi-stemmed clump	retain	outside construction footprint
358	White Elm	*Ulmus americana*	12	1.5	Poor		retain	outside construction footprint

Tree Number	Species	*Scientific Name*	dbh (cm)	Crown Radius (m)	Condition	Comments	Retain / Remove	Reason for action taken
359	White Elm	*Ulmus americana*	11	2	Good		remove	fill and grading in root zone
360	White Elm	*Ulmus americana*	11.5	4	Fair	multi-stemmed clump	retain	outside construction footprint
361	Crack Willow	*Salix fragilis*	168	10	Poor	crown dieback	remove	fill and grading in root zone
362	Silver Maple	*Acer saccharinum*	59	8	Good		retain	outside construction footprint
363	Blue Spruce	*Picea pungens*	4	3	Good		remove	fill and grading in root zone
364	White Elm	*Ulmus americana*	14	2.5	Good		retain	outside construction footprint
365	Silver Maple	*Acer saccharinum*	67	10	Fair	some crown dieback	retain	outside construction footprint
366	White Elm	*Ulmus americana*	145	5	Good			
367	Manitoba Maple	*Acer negundo*	18	4	Good			
368	Manitoba Maple	*Acer negundo*	19	4	Good			
369	Manitoba Maple	*Acer negundo*	40	4	Good			
370	Manitoba Maple	*Acer negundo*	18.5	3	Good			
371	Manitoba Maple	*Acer negundo*	42	6	Good			
372	Manitoba Maple	*Acer negundo*	48	7	Good			
373	Crab Apple	*Malus baccata*	37	3.5	Poor	crown dieback		
374	Blue Spruce	*Picea pungens*	35.5	3	Good			
375	Blue Spruce	*Picea pungens*	36	3	Good			
376	White Spruce	*Picea glauca*	46	5	Good			
377	Manitoba Maple	*Acer negundo*	23	5	Good	multi-stemmed clump		
378	Manitoba Maple	*Acer negundo*	37	5	Good			
379	Manitoba Maple	*Acer negundo*	40	5	Good			
380	Manitoba Maple	*Acer negundo*	46	5	Good			
381	Red Ash	*Fraxinus pennsylvanica*	10.5	1	Good			
382	Red Ash	*Fraxinus pennsylvanica*	18	3	Good			
383	Bur Oak	*Quercus macrocarpa*	11	2	Good			
384	Honey Locust	*Gleditsi triacanthos var. inermis*	36	7	Good			
385	Norway Maple	*Acer platanoides*	38.5	4	Good			
386	Norway Maple	*Acer platanoides*	21.5	4	Good			

Appendix H

Terrestrial Ecology – Vascular Plants

Appendix H-1: Vascular Plant Species List from Available Background Resources.

Natural Heritage Information Centre (NHIC) Biodiversity Explorer query (NHIC 2015)	City of Guelph Municipal List of Species at Risk (SAR) (City of Guelph 2015)	Wellington Upper Tier SAR List (OMNRF 2013)	Clythe Creek Subwatershed Overview (Ecologistics Ltd. and Blackport and Associates 1998)	Eramosa - Blue Springs Watershed Study Report (Beak International Inc. and Aquafor Beech Ltd., 1999)	Eramosa River - Blue Springs Creek Linear Corridor Initiative (Proctor & Redfern Ltd. et al. 1995)	Guelph Correctional Centre Natural Heritage Assessment (Natural Resources Solutions Inc., 2013)	Scientific Name	Common Name	GRANK	COSEWIC	SARO STATUS	SRANK	City of Guelph	Wellington County	Native Status
		X					*Arnoglossum plantagineum*	Tuberous Indian-plantain	G4G5	SC	SC	S3			N
				X			*Asplenium platyneuron*	Ebony Spleenwort	G5			S4	LS	R1	N
				X			*Asplenium trichomanes*	Maidenhair Spleenwort	G5			S5	LS	R2	N
				X			*Botrychium simplex*	Least Moonwort	GNR			SU	LS	R1/R2	N
H				X			*Carex careyana*	Carey's Sedge	G4G5			S2		R1	N
				X			*Carex pallescens*	Pale Sedge	G5			S5	LS		N
		X					*Castanea dentata*	American Chestnut	G4	E	END	S2		R1	N
						P	*Celtis occidentalis*	Common Hackberry	G5			S4	LS		N
				H			*Epilobium strictum*	Downy Willowherb	G5?			S5	LS	R1	N
				X			*Equisetum pratense*	Meadow Horsetail	G5			S5	LS	R1	N
						P	*Euonymus atropurpureus*	Eastern Burning Bush	G5			S3		R1	N
					X		*Gentiana rubricaulis*	Closed Gentian	G4?			S4	LS	R1	N
	X	X		H		X	*Juglans cinerea*	Butternut	G4	E	END	S3?			N
					X		*Lobelia kalmii*	Kalm's Lobelia	G5			S5	LS		N
				H			*Lycopodium clavatum*	Running Clubmoss	G5			S5	LS		N
		X					*Panax quinquefolius*	American Ginseng	G3G4	E	END	S2		R2	N
				X			*Pellaea atropurpurea*	Purple-stemmed Cliffbrake	G5			S3		R1	N
		X					*Potamogeton hillii*	Hill's Pondweed	G3	SC	SC	S2		R2	N
				H			*Pyrola chlorantha*	Green-flowered Pyrola	G5			S4S5	LS	R1	N
				H			*Ribes hirtellum*	Smooth Gooseberry	G5			S5	LS	R1	N
				X			*Solidago arguta*	Cut-leaved Goldenrod	G5			S4	LS	R1	N
			X				*Vaccinium corymbosum*	Highbush Blueberry	G5			S4	LS	R1	N

X: Species was recorded in the document.
H: Species was recorded in the document but is considered historic
P: Species was recorded in the document and is known to be planted.

Appendix H-1: Vascular Plant Species List from Available Background Resources.

Parameter	Source	Legend
G Rank	NHIC (Natural Heritage Information Centre). 2011. Ontario Vascular Plant Species List. Biodiversity Explorer Online Database. Ontario Ministry of Natural Resources.	G1 critically imperiled on a global scale; G2 imperiled on a global scale; G3 vulnerable on a global scale; G4 apparently secure on a global scale; G5 secure on a global scale. (http://www.natureserve.org/explorer/ranking.htm)
COSEWIC	NHIC (Natural Heritage Information Centre). 2011. Ontario Vascular Plant Species List. Biodiversity Explorer Online Database. Ontario Ministry of Natural Resources.	NAR Not At Risk, a wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances; SC Special Concern, a wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats; T Threatened, a wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction; E Endangered, a wildlife species facing imminent extirpation or extinction; XT Extirpated, a wildlife species that no longer exists in the wild in Canada, but exists elsewhere; X Extinct, a wildlife species that no longer exists.
SARO Status	NHIC (Natural Heritage Information Centre). 2011. Ontario Vascular Plant Species List. Biodiversity Explorer Online Database. Ontario Ministry of Natural Resources.	NAR Not At Risk; SC Special Concern; THR Threatened; END Endangered; EXP Extirpated; END-R Endangered (Regulated)
S Rank	NHIC (Natural Heritage Information Centre). 2011. Ontario Vascular Plant Species List. Biodiversity Explorer Online Database. Ontario Ministry of Natural Resources.	SX Presumed Extirpated; SH Possibly Extirpated (Historical); S1 Critically Imperiled; S2Imperiled; S3 Vulnerable; S4 Apparently Secure; S5 Secure; SNR Unranked; SU Unrankable (conflicting information about status or trends); SNA Not Applicable (A conservation status rank is not applicable because the species is not a suitable target for conservation activities.); S#S# Range Rank (used to indicate any range of uncertainty about the status of the species or community). S? Not Ranked Yet; or if following a ranking, Rank Uncertain (e.g. S3?).
City of Guelph	City of Guelph. 2012. Locally Significant Species List, Significant Plant List. Official Plan Amendment # 42.	LS Locally Significant in the City of Guelph but not including species with higher level rarity status (COSEWIC, COSSARO, G1-G3, S1-S3)
Wellington County	Frank, R. and A. Anderson. 2009. The Flora of Wellington County. Wellington County Historical Society, Fergus Ontario. 145 pp.	Defined by the number of survey sites where the species was found. R1 1-3 sites; R2 4-6 sites; R3 6-10 sites.
Native Status	NHIC (Natural Heritage Information Centre). 2009. Ontario Vascular Plant Species List. Biodiversity Explorer Online Database. Ontario Ministry of Natural Resources.	N native; I introduced

Appendix I-1 - Species at Risk (SAR) Screening

SPECIES	SAR Designation	Status in City of Guelph (to September 29, 2015)	Key Habitats Used By Species	Status at York Road Environmental Design site and adjacent lands (within 120 metres)
AMPHIBIANS				
Jefferson Salamander (*Ambystoma jeffersonianum*)	Endangered	Known to Occur	Inhabits deciduous and mixed deciduous forests with suitable breeding areas which generally consist of ephemeral (temporary) bodies of water that are fed by spring runoff, groundwater, or springs.	**No suitable habitat present on site or on adjacent lands.**
BIRDS				
Bald Eagle (*Haliaeetus leucocephalus*)	Special Concern	Known to Occur		**No suitable breeding habitat present on site or on adjacent lands; may overwinter along stretches of the adjacent Eramosa River. Not detected during 2016 field investigations.**
Bank Swallow (*Riparia riparia*)	Threatened (federal only)	Known to Occur	Low areas along rivers, streams, coasts or reservoirs; nest in natural bluffs and eroding streamside banks, also sand and gravel quarries and road cuts	**No suitable habitat present on site or on adjacent lands. Not detected during 2016 breeding bird surveys.**
Barn Swallow (*Hirundo rustica*)	Threatened	Known to Occur	Prefers farmland, lake/river shorelines, wooded clearings, urban populated areas, rocky cliffs, and wetlands. They nest inside or outside buildings; under bridges and in road culverts; on rock faces and in caves, etc.	**Present at site foraging over open areas, such as the main ponds, the baseball fields on the west side, and fields at the east side. No nesting structures are present on site although they exist in adjacent areas.**
Bobolink (*Dolichonyx oryzivorus*)	Threatened	Known to Occur	Generally prefers open grasslands and hay fields. In migration and in winter uses freshwater marshes and grasslands.	**No suitable habitat present on site or on adjacent lands. Not detected during 2016 breeding bird surveys.**
Canada Warbler (*Wilsonia canadensis*)	Threatened (federal) / Special Concern (provincial)	Suspected to Occur	Generally prefers wet coniferous, deciduous and mixed forest types, with a dense shrub layer. Nests on the ground, on logs or hummocks, and uses dense shrub layer to conceal the nest.	**No suitable habitat present on site or on adjacent lands. Not detected during 2016 breeding bird surveys.**
Chimney Swift (*Chaetura pelagica*)	Threatened	Known to Occur	Historically found in deciduous and coniferous, usually wet forest types, all with a well developed, dense shrub layer; now most are found in urban areas in large uncapped chimneys.	**Seen foraging over main ponds. Not nesting on-site or in adjacent lands as no suitable chimneys available or large (50+ cm dbh) cavity trees.**
Common Nighthawk (*Chordeiles minor*)	Threatened (federal) / Special Concern (provincial)	Known to Occur	Generally prefers open, vegetation-free habitats, including dunes, beaches, recently harvested forests, burnt-over areas, logged areas, rocky outcrops, rocky barrens, grasslands, pastures, peat bogs, marshes, lakeshores, and river banks. This species also inhabits mixed and coniferous forests. Can also be found in urban areas (nests on flat roof-tops).	**No suitable habitat present on site or on adjacent lands.**
Eastern Meadowlark (*Sturnella Magna*)	Threatened	Known to Occur	Generally prefers grassy pastures, meadows and hay fields. Nests are always on the ground and usually hidden in or under grass clumps.	**One pair present in field at east side of site; see report for details.**
Eastern Wood-Pewee (*Contopus virens*)	Special Concern (federal only)	Known to Occur	Found in deciduous, mixed woods, or pine plantations; also found in mature woodlands, urban shade trees, roadsides, and orchards; usually found in clearings and forest edges.	**Suitable habitat present on site and on adjacent lands. Not detected during 2016 breeding bird surveys.**
Golden-winged Warbler (*Vermivora chrysoptera*)	Special Concern	Known to Occur	Generally prefers areas of early successional vegetation, found primarily on field edges, hydro or utility right-of-ways, or recently logged areas.	**No suitable habitat present on site or on adjacent lands. Not detected during 2016 breeding bird surveys.**
Red-Headed Woodpecker (*Melanerpes erythrocephalus*)	Threatened (federal) / Special Concern (provincial)	Known to Occur	Generally prefers open oak and beech forests, grasslands, forest edges, orchards, pastures, riparian forests, roadsides, urban parks, golf courses, cemeteries, as well as along beaver ponds and brooks.	**No suitable habitat present on site or on adjacent lands. Not detected during 2016 breeding bird surveys.**

Wood Thrush (***Hylocichla mustelina***)	Special Concern (federal only)	Known to Occur	Breeds in mature deciduous and mixed forests, most commonly those with American beech, sweet gum, red maple, black gum, eastern hemlock, flowering dogwood, American hornbeam, oaks, or pines; nests less successfully in fragmented forests and suburban parks with enough large trees for a territory; ideal habitat includes trees over 50 feet tall, a moderate understory of saplings/shrubs, an open floor with moist soil and decaying leaf litter, and water nearby.	**No suitable habitat present on site or on adjacent lands. Not detected during 2016 breeding bird surveys.**
Yellow-breasted Chat ***(Icteria virens)***	Endangered	Historically Known to Occur	Generally prefers dense thickets around wood edges, riparian areas, and in overgrown clearings.	**No suitable habitat present on site or on adjacent lands. Not detected during 2016 breeding bird surveys.**
INSECTS				
Monarch ***(Danaus plexippus)***	Special Concern	Known to Occur	Exist primarily wherever milkweed and wildflowers exist, such as abandoned farmland, along roadsides, and other open spaces.	**May occur during migration in non-significant numbers; may breed as Common Milkweed is present in some open areas.**
Rusty-patched Bumble Bee (***Bombus affinis***)	Endangered	Known to Occur	Generally inhabits a range of diverse habitats including mixed farmlands, sand dunes, marshes, urban and wooded areas. It usually nests underground in abandoned rodent burrows.	**No suitable habitat present on site or on adjacent lands.**
West Virginia White (***Pieris virginiensis***)	Special Concern	Known to Occur	Generally prefer moist, deciduous woodlands; the larvae feed only on the leaves of the two-leaved toothwort (Cardamine diphylla), which is a small, spring-blooming plant of the forest floor.	**No suitable habitat present on site or in adjacent lands.**
MAMMALS				
Eastern Small-footed Myotis (***Myotis leibii***)	Endangered	Known to Occur	Overwintering habitat: caves and mines that remain above 0 degrees Celsuis; Maternal roosts: primarily under loose rocks on exposed rock outcrops, crevices and cliffs, and occasionally in buildings, under bridges and highway overpasses, and under tree bark.	**No overwintering habitat on site; no suitable buildings available for roosting are on site although some are present in adjacent areas. Some potential cavity trees available on site although none of these will be negatively impacted by the proposed works.**
Little Brown Myotis (***Myotis lucifugus***)	Endangered	Known to Occur	Overwintering habitat: caves and mines that remain above 0 C; Maternal roosts: Often associated with buildings (attics, barns, etc.). Occasionally found in trees (25-44 cm dbh).	**No overwintering habitat on site; no suitable buildings available for roosting are on site although some are present in adjacent areas. Some potential cavity trees available on site although none of these will be negatively impacted by the proposed works.**
Northern Myotis ***(Myotis septentrionalis)***	Endangered	Known to Occur	Overwintering habitat: caves and mines that remain above 0 C; Maternal roosts: often asssociated with cavities of large diameter trees (25-44 cm dbh). Occasionally found in structures (attics, barns, etc.)	**No overwintering habitat on site; no suitable buildings available for roosting are on site although some are present in adjacent areas. Some potential cavity trees available on site although none of these will be negatively impacted by the proposed works.**
REPTILES				
Blanding's Turtle ***(Emydonidea blandingii)***	Threatened	Known to Occur	Generally occurs in freshwater lakes, permanent or temporary pools, slow-flowing streams, marshes and swamps. Prefers shallow water that is rich in nutrients, organic soil and dense vegetation. Adults are generally found in open or partially vegetated sites, and juveniles prefer areas that contain thick aquatic vegetation including sphagnum, water lilies and algae. They dig their nest in a variety of loose substrates, including sand, organic soil, gravel and cobblestone. Overwintering occurs in permanent pools that average about one metre in depth, or in slow-flowing streams.	**No records from area in NHIC and MNRF databases. None were observed during extensive basking turtle surveys undertaken in 2016. Character of main ponds and adjacent Eramosa River generally unsuitable for species.**
Eastern Ribbonsnake ***(Thamnophis sauritus)***	Special Concern	Known to Occur	Generally occurs along the edges of shallow ponds, streams, marshes, swamps, or bogs bordered by dense vegetation that provides cover. Abundant exposure to sunlight is also required, and adjacent upland areas may be used for nesting.	**Potential habitat occurs on site and in adjacent areas, although upland areas not present. None found during extensive snake surveys undertaken in 2016. Record from April 25, 1990 in NHIC database.**
Milksnake ***(Lampropeltis triangulum)***	Special Concern (pre 2016)	Known to Occur	Generally occurs in rural areas, where it is most frequently reported in and around buildings, especially old structures. It is also found in a wide variety of habitats, from prairies, pastures, and hayfields, to rocky hillsides and a wide variety of forest types. They must also be in proximity to water, and suitable locations for basking and egg-laying.	**Marginal habitat available on site, although it lacks old buildings for foraging as well as rocky hillsides and extensive uplands. None were detected during extensive snake surveys undertaken in 2016. Record from vicinity in the MNRF database; record from September 28, 1978 in NHIC database. No longer considered a SAR (as of June 15, 2016).**

Northern Map Turtle (Graptemys geographica)	Special Concern	Historically Known to Occur	Found in large rivers and lakes with slow-moving currents and soft bottoms	**Record from July 1924 in NHIC database is considered historic in nature. MNRF does not list this species in their current database for the City of Guelph (the species is considered locally extirpated).**
Snapping Turtle ***(Chelydra serpentina)***	Special Concern	Known to Occur	Generally inhabit shallow waters where they can hide under the soft mud and leaf litter. Nesting sites usually occur on gravely or sandy areas along streams. Snapping Turtles often take advantage of man-made structures for nest sites, including roads (especially gravel shoulders), dams and aggregate pits.	**Observed in main pond in 2016, and undoubtedly occurs elsewhere. No suitable nesting sites (i.e., areas of sand and gravel with a southerly aspect in proximity to water). Overwintering habitat occurs in main ponds and potentially along adjacent Eramosa River. Record from vicinity in MNRF database.**
Vascular Plants				
Butternut (*Juglans cinerea*)	Endangered	Known to Occur	Generally grows in rich, moist, and well-drained soils often found along streams. It may also be found on well-drained gravel sites, especially those made up of limestone. It is also found, though seldomly, on dry, rocky and sterile soils. In Ontario, the Butternut generally grows alone or in small groups in deciduous forests as well as in hedgerows.	**Potential habitat occurs on site and in adjacent lands; none detected during 2016 field investigations.**

Scientific Name (NHIC 2016)	Common Name (NHIC 2016)	GRANK	SRANK	City of Guelph (2012)	Wellington Status (2004)	Native Status	Polygon ID																		Stantec (2006)	NRSI (2012)
							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Acer negundo	Manitoba Maple	G5	S5			N				X	X		X	X		X	X			X					X	X
Acer platanoides	Norway Maple	GNR	SNA			I	X	X	X	X	X	X	X			X	X		X	X				X		X
Acer saccharinum	Silver Maple	G5	S5			N						X	X			X	X			X	X				X	X
Acer saccharum	Sugar Maple	G5	S5			N	X	X	X	X							X								X	
Acer x freemanii	(Acer rubrum X Acer saccharinum)	GNA	SNA			I			X								X						X			
Achillea millefolium	Common Yarrow	G5	SNA			N			X			X	X				X		X	X	X		X	X	X	X
Agrostis gigantea	Redtop	G4G5	SNA			I						X								X						
Agrostis stolonifera	Creeping Bentgrass	G5	SNA			N			X						X			X	X		X	X	X	X		
Alisma triviale	Northern Water-plantain	G5	S5			N			X																	
Alliaria petiolata	Garlic Mustard	GNR	SNA			I		X	X				X			X	X			X		X				X
Alnus glutinosa	European Alder	GNR	SNA			I			X													X				
Amaranthus powellii ssp. powellii	Powell's Amaranth	G5T5	SNA			I																			X	
Ambrosia artemisiifolia	Annual Ragweed	G5	S5		X	N								X			X		X							
Amelanchier arborea	Downy Serviceberry	G5	S5		X	N					X															
Amelanchier sp	Serviceberry Species									X																X
Anemone canadensis	Canada Anemone	G5	S5		X	N						X		X			X	X	X		X					
Angelica atropurpurea	Great Angelica	G5	S5		X	N							X				X			X	X					X
Apocynum androsaemifolium	Spreading Dogbane	G5	S5		X	N																			X	
Apocynum sp	Dogbane Species																							X		
Arctium lappa	Greater Burdock	GNR	SNA			I			X																	
Arctium minus	Common Burdock	GNR	SNA			I		X				X													X	X
Asclepias incarnata	Swamp Milkweed	G5	S5		X	N								X					X				X		X	
Asclepias syriaca	Common Milkweed	G5	S5		X	N						X		X			X						X		X	X
Aster sp	Aster Species								X													X				
Betula papyrifera	Paper Birch	G5	S5		X	N																			X	
Bidens connata	Purple-stemmed Beggarticks	G5	S4?											X												X
Bidens sp	Beggar's Ticks Species								X															X		
Bromus inermis	Awnless Brome	G5TNR	SNA			I			X	X		X	X				X			X	X		X		X	X
Calla palustris	Wild Calla	G5	S5		X	N			X													X				
Capsella bursa-pastoris	Common Shepherd's Purse	GNR	SNA			I																			X	
Carex bebbii	Bebb's Sedge	G5	S5		X	N			X			X					X	X	X		X					
Carex blanda	Woodland Sedge	G5?	S5		X	N											X									
Carex comosa	Bristly Sedge	G5	S5		X	N																	X			
Carex crawei	Crawe's Sedge	G5	S4			N															X					

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							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Carex eburnea	Ebony Sedge	G5	S5		X	N																			X	
Carex flava	Yellow Sedge	G5	S5		X	N			X	X		X					X									
Carex hystericina	Porcupine Sedge	G5	S5		X	N			X	X																
Carex lacustris	Lake-bank Sedge	G5	S5		X	N							X	X									X		X	
Carex retrorsa	Retrorse Sedge	G5	S5		X	N												X								
Carex sp	Sedge Species											X		X							X					X
Carex spicata	Spiked Sedge	GNR	SNA			I											X									
Carex stipata	Awl-fruited Sedge	G5	S5		X	N			X								X									
Carex stricta	Tussock Sedge	G5	S5		X	N			X					X								X				
Carex sychnocephala	Many-headed Sedge	G4	S4	LS		N												X								
Carex utriculata	Bladder Sedge	G5	S5		X	N												X								
Carex vulpinoidea	Fox Sedge	G5	S5		X	N			X	X							X	X	X				X			
Cerastium sp	Chickweed Species									X							X									
Chelidonium majus	Greater Celadine	GNR	SNA			I						X														
Chelone glabra	White Turtlehead	G5	S5		X	N			X				X				X			X					X	X
Chenopodium album	White Goosefoot	G5	SNA			I													X						X	
Cichorium intybus	Chicory	GNR	SNA			I			X														X		X	
Cicuta bulbifera	Bulb-bearing Water-hemlock	G5	S5		X	N			X					X								X				
Cicuta maculata var. maculata	Spotted Water-hemlock	G5T5	S5		X	N			X													X				
Circaea canadensis	Broad-leaved Enchanter's Nightshade	G5T5	S5		X	N					X		X													
Cirsium arvense	Canada Thistle	GNR	SNA			I			X	X		X					X				X	X	X		X	X
Cirsium vulgare	Bull Thistle	GNR	SNA			I						X											X		X	X
Clematis virginiana	Virginia Virgin's-bower	G5	S5		X	N						X		X							X				X	
Convolvulus arvensis	Field Bindweed	GNR	SNA			I				X																
Cornus alternifolia	Alternate-leaved Dogwood	G5	S5		X	N																		X		
Cornus amomum	Silky Dogwood	G5	S5		X	N																		X		
Cornus stolonifera	Red-osier Dogwood	G5	S5			N			X	X		X	X	X	X	X	X		X	X		X	X	X	X	X
Crataegus punctata	Dotted Hawthorn	G5	S5		X	N					X															
Cynanchum sp	Swallow-wort Species																X									
Cyperus sp	Umbrella Sedge Species											X														
Dactylis glomerata	Orchard Grass	GNR	SNA			I	X	X	X	X		X	X									X			X	X
Daucus carota	Wild Carrot	GNR	SNA			I		X	X			X					X					X	X	X	X	X
Dipsacus fullonum	Fuller's Teasel	GNR	SNA			I																			X	
Dryopteris marginalis	Marginal Wood Fern	G5	S5		X	N																			X	
Echinochloa crus-galli	Large Barnyard Grass	GNR	SNA			I																			X	
Echinocystis lobata	Wild Mock-cucumber	G5	S5		X	N						X	X	X		X	X			X	X				X	X

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							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Echium plantagineum	Viperine	GNR	SNA			I						X														X
Echium vulgare	Common Viper's-bugloss	GNR	SNA			I						X													X	
Eleocharis sp	Spikerush Species								X	X							X	X								
Elymus virginicus var. virginicus	Virginia Wildrye	G5T5	S5		X	N								X											X	
Epilobium hirsutum	Hairy Willowherb	GNR	SNA			I			X																	
Epilobium parviflorum	Small-flowered Willowherb	GNR	SNA			I												X	X				X	X		
Epilobium sp	Willow-herb Species								X													X				
Equisetum arvense	Field Horsetail	G5	S5		X	N			X			X					X					X		X		
Equisetum variegatum	Variegated Horsetail	G5	S5	LS		N													X							
Erigeron annuus	Annual Fleabane	G5	S5		X	N			X			X														
Erigeron canadensis	Canada Horseweed	G5	S5		X	N																			X	
Erigeron philadelphicus	Philadelphia Fleabane	G5	S5		X	N			X								X									
Erucastrum gallicum	Common Dogmustard	G5	SNA			I																			X	
Erysimum cheiranthoides	Wormseed Wallflower	G5	SNA			I															X				X	
Euonymus europaeus	European Euonymus	GNR	SNA			I																			X	
Eupatorium perfoliatum	Common Boneset	G5	S5		X	N			X										X	X			X			
Euphorbia sp	Spurge Species																				X					
Euthamia graminifolia	Grass-leaved Goldenrod	G5	S5		X	N													X					X		
Eutrochium maculatum var. maculatum	Spotted Joe Pye Weed	G5T5	S5		X	I			X				X	X			X		X	X	X				X	X
Fallopia convolvulus	Black Bindweed	GNR	SNA			I								X												
Fallopia japonica	Japanese Knotweed	GNR	SNA			I								X												
Festuca rubra ssp. rubra	Red Fescue	G5T5	SNA			I													X							
Fragaria sp	Strawberry Species								X													X				
Fragaria vesca	Woodland Strawberry	G5	S5		X	N															X					X
Fragaria virginiana	Wild Strawberry	G5	S5		X	N	X		X	X		X					X						X		X	
Frangula alnus	Glossy Buckthorn	GNR	SNA			I			X	X		X	X	X		X	X		X	X			X		X	X
Fraxinus americana	White Ash	G5	S4		X	N						X													X	
Fraxinus pennsylvanica	Green Ash	G5	S4		X	N																	X	X	X	
Galium asprellum	Rough Bedstraw	G5	S5		X	N								X												
Galium mollugo	Smooth Bedstraw	GNR	SNA			I			X													X				
Galium palustre	Marsh Bedstraw	G5	S5		X	N			X	X							X		X		X					X
Galium sp	Bedstraw Species								X												X					
Geum aleppicum	Yellow Avens	G5	S5		X	N			X				X				X			X	X	X				X
Geum canadense	White Avens	G5	S5		X	N											X									
Geum laciniatum	Rough Avens	G5	S4	LS	SR	N			X								X									
Geum sp	Avens Species										X	X	X	X			X			X					X	X

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Glechoma hederacea	Ground Ivy	GNR	SNA			I			X													X	X			
Glyceria grandis	Tall Mannagrass	G5	S4S5		X	N			X																	
Glyceria striata	Fowl Mannagrass	G5	S5		X	N			X										X							
Hemerocallis fulva	Orange Daylily	GNA	SNA			I						X														
Heracleum maximum	Cow-parsnip	G5	S5		X	N						X														
Hesperis matronalis	Dame's Rocket	G4G5	SNA			I							X													
Hypericum perforatum	Common St. John's-wort	GNR	SNA			I	X					X											X			
Impatiens capensis	Spotted Jewelweed	G5	S5		X	N			X	X							X				X		X	X		
Impatiens sp	Jewel-weed Species															X										X
Inula helenium	Elecampane	GNR	SNA			I											X									
Iris versicolor	Harlequin Blue Flag	G5	S5		X	N			X														X			
Jacobaea vulgaris	Tansy Ragwort	GNR	SNA			I																	X			
Juglans nigra	Black Walnut	G5	S4		X	N			X																	
Juncus articulatus	Jointed Rush	G5	S5		X	N													X							
Juncus dudleyi	Dudley's Rush	G5	S5		X	N			X								X						X			
Juncus effusus	Soft Rush	G5	S5			N			X														X			
Juncus tenuis	Path Rush	G5	S5		X	N																	X		X	
Juniperus communis	Ground Juniper	G5	S5			N				X																
Juniperus virginiana	Eastern Red Cedar	G5	S5		X	N		X																	X	
Larix laricina	American Larch	G5	S5		X	N																			X	
Leonurus cardiaca	Common Motherwort	GNR	SNA			I		X				X		X											X	X
Lepidium densiflorum	Dense-flowered Peppergrass	G5	SNA			I																			X	
Leucanthemum vulgare	Oxeye Daisy	GNR	SNA			I			X														X			
Ligustrum vulgare	European Privet	GNR	SNA			I							X				X			X						X
Linaria vulgaris	Butter-and-eggs	GNR	SNA			I													X		X				X	
Liriodendron tulipifera	Tulip Tree	G5	S4			N				X																
Lonicera tatarica	Tartarian Honeysuckle	GNR	SNA			I		X	X		X		X	X			X			X		X		X	X	X
Lotus corniculatus	Garden Bird's-foot Trefoil	GNR	SNA			I			X								X								X	
Lycopodium sp	Clubmoss Species																X			X	X					X
Lycopus americanus	American Water-horehound	G5	S5		X	N																			X	
Lycopus uniflorus	Northern Water-horehound	G5	S5		X	N			X					X												
Lysimachia thyrsiflora	Water Loosestrife	G5	S5		X	N							X													
Lythrum salicaria	Purple Loosestrife	G5	SNA			I			X					X			X		X				X			
Malus sp	Apple Species								X													X				
Matteuccia struthiopteris	Ostrich Fern	G5	S5		X	N							X			X	X			X					X	X

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Medicago lupulina	Black Medic	GNR	SNA			I	X		X			X					X									
Medicago sativa	Alfalfa	GNR	SNA			I			X																	
Melilotus albus	White Sweet-clover	G5	SNA			I						X														
Melilotus sp	Sweet Clover Species																								X	
Mentha arvensis	Field Mint	G5	S5			N			X								X	X	X				X	X		
Mentha spicata	Spearmint	GNR	SNA			I												X								
Mentha x piperita	(Mentha aquatica X Mentha spicata)	GNA	SNA			I			X	X								X					X	X		
Muhlenbergia frondosa	Wirestem Muhly	G5	S4		X	N								X							X					
Myosotis scorpioides	True Forget-me-not	G5	SNA			I			X									X								
Myosotis sp	Forget-me-not Species									X													X	X		
Myriophyllum spicatum	Eurasian Water-milfoil	GNR	SNA			I																	X	X		
Nasturtium microphyllum	Small-leaved Watercress	GNR	SNA			I																			X	
Nasturtium officinale	Watercress	GNR	SNA			I			X			X										X				X
Nepeta cataria	Catnip	GNR	SNA			I																			X	
Nuphar sp	Pond-lily Species																						X			
Nymphaea odorata ssp. odorata	Fragrant Water-lily	G5T5	S5?		X	N											X									
Oenothera biennis	Common Evening Primrose	G5	S5		X	N		X	X	X		X	X	X			X			X	X	X	X	X	X	X
Onoclea sensibilis	Sensitive Fern	G5	S5		X	N			X																	
Origanum vulgare	Wild Marjoram	GNR	SNA			I																	X			
Ostrya virginiana	Eastern Hop-hornbeam	G5	S5		X	N																			X	
Oxalis sp	Wood Sorrel Species																							X		
Panicum capillare	Common Panicgrass	G5	S5		X	N																			X	
Parthenocissus inserta	Thicket Creeper	G5	S5		X	N			X																	
Persicaria lapathifolia	Pale Smartweed	G5	S5		X	N								X				X								
Persicaria maculosa	Spotted Lady's-thumb	G3G 5	SNA			I												X								
Phalaris arundinacea	Reed Canary Grass	G5	S5		X	N			X			X		X			X		X	X	X	X		X	X	X
Phleum pratense	Common Timothy	GNR	SNA			I						X														
Phragmites australis ssp. australis	European Reed	G5T5	SNA			I													X		X					X
Picea abies	Norway Spruce	G5	SNA			I			X	X		X	X				X			X			X		X	X
Picea glauca	White Spruce	G5	S5		X	N			X	X	X	X	X				X			X					X	X
Picea pungens	Blue Spruce	G5	SNA			I			X			X	X				X			X			X	X		X
Pinus banksiana	Jack Pine	G5	S5			N																			X	
Pinus nigra	Black Pine	GNR	SNA			I			X		X		X				X			X						X
Pinus resinosa	Red Pine	G5	S5		X	N				X			X			X	X			X					X	X
Pinus strobus	Eastern White Pine	G5	S5		X	N			X	X															X	X

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							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Pinus sylvestris	Scotch Pine	GNR	SNA			I			X	X	X														X	X
Plantago lanceolata	English Plantain	G5	SNA			I	X	X		X							X						X	X	X	
Plantago major	Common Plantain	G5	S5			N				X		X							X						X	X
Poa pratensis ssp. pratensis	Kentucky Bluegrass	G5T5	S5			N			X	X							X		X			X				
Poa sp	Bluegrass Species													X							X					X
Polygonatum pubescens	Hairy Solomon's Seal	G5	S5		R	N								X					X							
Polygonatum sp	Solomon's Seal Species											X														
Polygonum sp	Smartweed Species																X									
Populus balsamifera	Balsam Poplar	G5	S5		X	N													X							
Populus grandidentata	Large-tooth Aspen	G5	S5		X	N																			X	
Populus tremuloides	Trembling Aspen	G5	S5		X	N																			X	
Potamogeton crispus	Curly-leaved Pondweed	G5	SNA			I																		X		
Potentilla anserina ssp. anserina	Common Silverweed	GNR	S5			N				X													X			
Potentilla norvegica	Norwegian Cinquefoil	G5	S5			N													X							
Potentilla recta	Sulphur Cinquefoil	GNR	SNA			I																			X	
Prunus serotina	Wild Black Cherry	G5	S5		X	N				X	X															X
Prunus virginiana	Choke Cherry	G5	S5		X	N			X		X	X	X				X			X	X	X	X	X		X
Quercus macrocarpa	Bur Oak	G5	S5		X	N																			X	
Ranunculus acris	Tall Buttercup	G5	SNA			I				X																
Ranunculus recurvatus	Hooked Buttercup	G5	S5			N															X					X
Ranunculus repens	Creeping Buttercup	GNR	SNA			I							X				X			X						X
Ranunculus sp	Buttercup Species													X												
Rhamnus cathartica	Common Buckthorn	GNR	SNA			I		X	X	X	X	X	X	X		X	X		X	X		X	X	X	X	X
Rhus typhina	Staghorn Sumac	G5	S5			N						X													X	
Ribes americanum	Wild Black Currant	G5	S5		X	N							X													
Ribes sp	Currant Species													X												
Robinia pseudoacacia	Black Locust	G5	SNA			I							X				X			X					X	X
Rosa rugosa	Rugosa Rose	GNR	SNA			I				X																
Rubus idaeus ssp. idaeus	Common Red Raspberry	G5T5	SNA			I					X	X	X	X			X			X	X					X
Rubus occidentalis	Black Raspberry	G5	S5		X	N			X					X								X				
Rudbeckia hirta var. hirta	Black-eyed Susan	G5T4 T5	SU					X																		
Rumex crispus	Curly Dock	GNR	SNA			I		X	X														X			
Sagittaria latifolia	Broad-leaved Arrowhead	G5	S5		X	N			X								X						X			
Salix alba	White Willow	G5	SNA			I														X				X		
Salix amygdaloides	Peach-leaved Willow	G5	S5		X	N													X							

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Salix discolor	Pussy Willow	G5	S5		X	N								X												
Salix eriocephala	Heart-leaved Willow	G5	S5		X	N			X					X								X				
Salix humilis	Prairie Willow	G5	S5		X	N								X												
Salix interior	Sandbar Willow	GNR	S5		X	N			X																	
Salix petiolaris	Meadow Willow	G5	S5		X	N								X												
Salix purpurea	Basket Willow	G5	SNA			I																			X	
Salix sp	Willow Species															X										
Salix x fragilis	(Salix alba X Salix euxina)	GNR	SNA			I			X			X	X	X		X	X		X	X					X	X
Sambucus canadensis	Common Elderberry	G5T5	S5		X	N								X												X
Schedonorus arundinaceus	Tall Fescue	GNR	SNA			I			X																	
Schoenoplectus tabernaemontani	Soft-stemmed Bulrush	G5	S5		X	N																	X			
Scirpus atrovirens	Dark-green Bulrush	G5?	S5		X	N			X			X		X			X		X	X			X			
Scirpus sp	Bulrush Species																X									
Scutellaria galericulata	Hooded Skullcap	G5	S5		X	N													X							
Senecio vulgaris	Common Ragwort	GNR	SNA			I																			X	
Setaria pumila	Yellow Foxtail	GNR	SNA			I																			X	
Silene latifolia	White Campion	GNR	SNA			I				X														X		
Silene vulgaris	Maiden's Tears	GNR	SNA			I																			X	
Solanum dulcamara	Climbing Nightshade	GNR	SNA			I			X																	
Solidago altissima ssp. altissima	Eastern Late Goldenrod	GNR	S5			N		X	X			X	X	X	X		X			X	X	X		X	X	X
Solidago canadensis var. canadensis	Canada Goldenrod	G5T5	S5		X	N						X	X							X	X		X	X		X
Solidago flexicaulis	Zigzag Goldenrod	G5	S5		X	N																			X	
Solidago gigantea	Smooth Goldenrod	G5	S5		X	N													X							
Solidago nemoralis ssp. nemoralis	Gray-stemmed Goldenrod	G5T5	S5		X	N																			X	
Solidago rugosa var. rugosa	Northern Rough-leaved Goldenrod	G5T5	S5		X	N													X							
Solidago sp	Goldenrod Species								X	X	X		X			X	X			X				X		X
Sonchus arvensis ssp. arvensis	Field Sow-thistle	GNR TNR	SNA			I						X					X						X	X		
Sorbus aucuparia	European Mountain-ash	G5	SNA			I					X															
Sorbus decora	Northern Mountain-ash	G4G 5	S5		X	N				X																
Sorbus sp	Mountain-ash Species																							X		
Stellaria graminea	Grass-leaved Starwort	GNR	SNA			I											X									
Stellaria media	Common Chickweed	GNR	SNA			I																			X	
Symphoricarpos albus var. albus	Common Snowberry	G5T5	S5		X	N				X																
Symphyotrichum ericoides var. ericoides	White Heath Aster	G5T5	S5			N															X					X

Scientific Name (NHIC 2016)	Common Name (NHIC 2016)	GRANK	SRANK	City of Guelph (2012)	Wellington Status (2004)	Native Status	Polygon ID																		Stantec (2006)	NRSI (2012)
							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Symphyotrichum lanceolatum ssp. lanceolatum	Panicled Aster	G5T5	S5			N			X						X	X		X	X	X	X		X	X		X
Symphyotrichum lateriflorum	Starved Aster	G5	S5			N														X	X					X
Symphyotrichum novae-angliae	New England Aster	G5	S5		X	N				X		X	X				X			X	X					X
Symphyotrichum puniceum	Swamp Aster	G5	S5		X	N			X					X				X	X							
Symphytum officinale	Common Comfrey	GNR	SNA			I			X													X				
Syringa vulgaris	Common Lilac	GNR	SNA			I				X	X													X	X	X
Tanacetum vulgare	Common Tansy	GNR	SNA			I																			X	
Taraxacum ceratophorum	Horned Dandelion	G5T5	S5			N			X																	
Taraxacum officinale	Common Dandelion	G5	SNA			I	X	X	X		X	X										X			X	
Thalictrum dioicum	Early Meadow-rue	G5	S5		X	N			X													X				
Thalictrum pubescens	Tall Meadow-rue	G5	S5		X	N			X											X	X					
Thalictrum sp	Meadowrue Species											X	X													
Thlaspi arvense	Field Penny-cress	GNR	SNA			I																			X	
Thuja occidentalis	Eastern White Cedar	G5	S5		X	N		X	X	X	X	X	X	X		X	X			X			X	X	X	X
Tilia americana	American Basswood	G5	S5		X	N																			X	
Toxicodendron radicans	Climbing Poison Ivy	G5	S5			N											X									
Tragopogon pratensis	Meadow Goat's-beard	GNR	SNA			I			X																X	
Trifolium pratense	Red Clover	GNR	SNA			I																			X	
Tussilago farfara	Colt's-foot	GNR	SNA			I			X													X		X		
Typha angustifolia	Narrow-leaved Cattail	G5	SNA		X	I						X		X								X		X	X	X
Typha latifolia	Broad-leaved Cattail	G5	S5		X	N			X					X			X		X	X						X
Typha x glauca	(Typha angustifolia X Typha latifolia)	GNA	SNA		X	I			X																	
Ulmus americana	American Elm	G5?	S5		X	N			X		X	X					X								X	
Ulmus pumila	Siberian Elm	GNR	SNA			I																		X		
Ulmus thomasii	Rock Elm	G5	S4?		X	N																			X	
Urtica dioica ssp. dioica	European Stinging Nettle	G5T5 ?	SNA			I				X		X	X	X		X	X		X	X	X					X
Urtica dioica ssp. gracilis	Slender Stinging Nettle	G5T5	S5		X	N				X											X					X
Verbascum thapsus	Common Mullein	GNR	SNA			I			X			X	X				X			X		X			X	X
Verbena hastata	Blue Vervain	G5	S5		X	N						X	X	X			X			X	X		X		X	X
Verbena urticifolia	White Vervain	G5	S5		X	N							X					X							X	
Veronica officinalis	Common Speedwell	G5	SNA			I																			X	
Viburnum lantana	Wayfaring-tree	GNR	SNA			I					X	X												X		
Viburnum lentago	Nannyberry	G5	S5		X	N					X			X											X	
Viburnum opulus ssp. opulus	Cranberry Viburnum	GNR	SNA			I											X									
Viburnum opulus ssp. trilobum	Highbush Cranberry	GNR	S5		X	N																			X	

Scientific Name (NHIC 2016)	Common Name (NHIC 2016)	GRANK	SRANK	City of Guelph (2012)	Wellington Status (2004)	Native Status	Polygon ID																		Stantec (2006)	NRSI (2012)
							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Vicia cracca	Tufted Vetch	GNR	SNA			I						X							X	X	X		X		X	
Viola cucullata	Marsh Blue Violet	G4G5	S5		X	N						X														
Viola sp	Violet Species													X					X							
Vitis riparia	Riverbank Grape	G5	S5		X	N			X							X					X		X		X	X
Zanthoxylum americanum	Northern Prickley Ash	G5	S5		X	N																			X	

Global Conservation Status *(GRank)*

Global Conservation Status: *NatureServe Explorer* provides conservation status, taxonomy, distribution, and life history information for more than 70,000 plants, animals, and ecological communities and systems in the United States and Canada Natureserve (2014).

Global conservation status assessments (G-Ranks) generally are carried out by NatureServe scientists (including biologists in state and provincial member programs), with input from other experts. These assessments are widely used throughout the conservation community and are regarded as highly credible by scientists, government agencies and private-sector organizations. Status assessments are based on the best available information and consider a variety of factors such as species abundance, distribution, population trends and threats. (Documentation of the methods for developing these assessments is available at www.natureserve.org/explorer/ranking.htm).

- **G1** **Critically Imperiled**—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
- **G2** **Imperiled**—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
- **G3** **Vulnerable**—At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
- **G4** **Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
- **G5** **Secure**—Common; widespread and abundant.
- **G#G#** **Range Rank**—A numeric range rank (e.g., G2G3) is used to indicate the range of uncertainty in the status of a species or community. Ranges cannot skip more than one rank (e.g., GU should be used rather than G1G4).
- **GU** **Unrankable**—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Whenever possible, the most likely rank is assigned and the question mark qualifier is added (e.g., G2?) to express uncertainty, or a range rank (e.g., G2G3) is used to delineate the limits (range) of uncertainty.
- **GNR** **Unranked**—Global rank not yet assessed.
- **GNA** **Not Applicable**—A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
- **?** **Inexact Numeric Rank**—Denotes inexact numeric rank (e.g., G2?)
- **Q** **Questionable taxonomy**—Taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority.
- **C** **Captive or Cultivated Only**—At present extant only in captivity or cultivation, or as a reintroduced population not yet established.
- **T#** **Infraspecific Taxon** (trinomial)—The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above for global conservation status ranks. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T-rank cannot imply the subspecies or variety is more abundant than the species as a whole-for example, a G1T2 cannot occur. A vertebrate animal population, such as those listed as distinct population segments under under the U.S. Endangered Species Act, may be considered an infraspecific taxon and assigned a T-rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status.
- **HYB** **Hybrid** – Applied by Dougan & Associates to individuals of hybrid origin.

Provincial rarity ranks (i.e. Subnational or "SRanks") are evaluated & assigned by the (Ontario) Natural Heritage Information Centre (NHIC, 2014)

Provincial (or Subnational) ranks are used by the Natural Heritage Information Centre to set protection priorities for rare species and natural communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of Ontario. By comparing the global and provincial ranks, the status, rarity, and the urgency of conservation needs can be ascertained. The NHIC evaluates provincial ranks on a continual basis and produces updated lists at least annually

- **SX** **Presumed Extirpated**—Species or community is believed to be extirpated from the nation or state/province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
- **SH** **Possibly Extirpated (Histor.ical)**—Species or community occurred historically in the nation or state/province, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become NH or SH without such a 20-40 year delay if the only known occurrences in a nation or state/province were destroyed or if it had been extensively and unsuccessfully looked for. The NH or SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.
- **S1** **Critically Imperiled**—Critically imperiled in the nation or state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.
- **S2** **Imperiled**—Imperiled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.
- **S3** **Vulnerable**—Vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
- **S4** **Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
- **S5** **Secure**—Common, widespread, and abundant in the nation or state/province.
- **SNR** **Unranked**—Nation or state/province conservation status not yet assessed.
- **SU** **Unrankable**—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
- **SNA** **Not Applicable** —A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
- **S#S#** **Range Rank** —A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).

Regional Conservation Status

Native Status (Newmaster et al. 1998; Oldham et al. 1995)

"N" = Plant is considered native to this region.

"I" = Plant has been introduced from another region.

Local Conservation Status

City of Guelph (2012)

R-A Included based on "rare" status (i.e., occurrence at between 1 and 10 natural sites in the County) in the Flora of Wellington County;

R-B Added as a plant record from post-1990 environmental studies within Guelph with global and/or provincial significance. (Anderson and Frank 2004, unpublished) and subsequent revisions by A. Anderson over 2005-2008;

R-C Added based on records provided by Mike Oldham (NHIC) for Wellington County in 2005, verification of records in OAC herbarium (Jan. - Feb. 2008) and supplementary review by Mike Oldham Dec. 2007 - Feb. 2008. R-D New record for Wellington County, assumed significant (observed during field work conducted by Dougan & Associates 2005-2006).

Wellington County 2009

Defined by the number of survey sites where the species was found.

R1 1-3 sites; **R2** 4-6 sites; **R3** 6-10 sites.

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Appendix H-4 - Tree Inventory Data Table

Tree Tag #	Scientific Name	Common Name	DBH1 [1] (cm)	DBH2	DBH3	DBH4	DBH5	DBH6	Crown Reserve [2] (m)	Height [3] (m)	Structural Condition [4]	Biological Health [5]	Preservation Priority [6]	Native Status [7]	Tree Action [8]	Compensation Required [9]	NAD83 UTM Zone 17N X Coordinate	Y Coordinate	Comments
1687	Acer negundo	Manitoba Maple	15	12	10				03-05	03-05	Low	High	Low	Introduced	Preserve	N/A	562973.9623	4822662.4481	overgrew dead cedar
1688	Thuja occidentalis	White Cedar	19	19	10				03-05	05-10	Medium	High	Medium	Native	Injure	Yes	562969.3361	4822659.4857	overgrew and replaced dead cedar
1689	Thuja occidentalis	White Cedar	15	15	12	10			03-05	05-10	Medium	High	Medium	Native	Preserve	N/A	562972.8552	4822657.2643	multi-stemmed clump
1690	Thuja occidentalis	Eastern White Cedar	20	20	20	15	12		03-05	05-10	Medium	Medium	Medium	Native	Preserve	N/A	562982.0564	4822653.5729	supressed and leaning
1691	Acer platanoides	Norway Maple	30						05-10	10-15	Medium	Medium	Low	Introduced	Preserve	N/A	562978.4742	4822653.0938	supressed
1692	Acer platanoides	Norway Maple	33						10-15	10-15	High	High	Medium	Introduced	Preserve	N/A	562976.6431	4822658.2247	
1693	Acer platanoides	Norway Maple	35						05-10	10-15	Medium	High	Medium	Introduced	Preserve	N/A	562982.1672	4822659.4770	
1694	Acer platanoides	Norway Maple	42						10-15	10-15	Medium	High	Medium	Introduced	Injure	Yes	562979.3442	4822665.1020	
1695	Thuja occidentalis	White Cedar	35	30					05-10	05-10	Medium	High	Medium	Native	Preserve	N/A	562985.9943	4822665.7171	leaning, forked low
1696	Thuja occidentalis	White Cedar	30	25	20	10			03-05	05-10	Medium	Medium	Medium	Native	Preserve	N/A	562984.8243	4822664.6210	multi-stemmed clump
1697	Thuja occidentalis	White Cedar	35	20	10	15			05-10	05-10	Low	High	Low	Native	Injure	Yes	562993.9825	4822684.3643	leaning over creek
1698	Thuja occidentalis	White Cedar	35	20					03-05	05-10	Low	Low	Low	Native	Preserve	N/A	562996.0715	4822687.7805	leaning over creek
1699	Rhamnus cathartica	European Buckthorn	15	20	12	10			03-05	03-05	Low	Low	Low	Introduced	Preserve	N/A	563013.7724	4822705.7081	dead limbs
1700	Acer negundo	Manitoba Maple	10						03-05	03-05	Low	Medium	Low	Introduced	Remove	Yes	563012.6490	4822711.4505	leaning over
1701	Acer saccharinum	Silver Maple	59						10-15	05-10	Medium	High	Medium	Native	Remove	Yes	563822.9950	4823534.3615	limb removed
1702	Acer saccharinum	Silver Maple	72						05-10	05-10	Medium	High	High	Native	Remove	Yes	563812.6110	4823523.7275	cavities
1703	Acer saccharinum	Silver Maple	73						05-10	10-15	Low	Medium	Low	Native	Remove	Yes	563801.9880	4823512.8015	crown dieback, rotting crotch, cut limbs
1704	Acer saccharinum	Silver Maple	73						05-10	10-15	Medium	High	High	Native	Remove	Yes	563791.8820	4823502.5955	broken branch , poor form
1705	Acer saccharinum	Silver Maple	67						05-10	10-15	Low	High	Medium	Native	Remove	Yes	563781.6080	4823491.4835	broken branch , potential rot in bole, uneven crown
1706	Acer platanoides	Norway Maple	65						05-10	10-15	Low	Medium	Low	Introduced	Remove	Yes	563770.9520	4823480.4735	cracked healing, large cavity, leaning
1707	Acer platanoides	Norway Maple	48						10-15	10-15	Low	Medium	Low	Introduced	Preserve	N/A	563745.3567	4823433.0478	crack, cavity, crown dieback
1708	Picea glauca	White Spruce	50						05-10	10-15	High	Medium	High	Native	Preserve	N/A	563736.3161	4823423.7938	dead tip
1709	Acer platanoides	Norway Maple	14						03-05	05-10	Medium	High	Medium	Introduced	Preserve	N/A	563717.6047	4823419.3962	rooted in rocks - unstable
1710	Acer platanoides	Norway Maple	17	18					05-10	05-10	Medium	High	Medium	Introduced	Injure	Yes	563721.9186	4823417.1266	2 stems
1711	Thuja occidentalis	White Cedar	25	11	13	7			03-05	05-10	Medium	High	High	Native	Preserve	N/A	563720.8214	4823413.0427	multistem - 4
1712	Acer saccharinum	Silver Maple	20	7	6				03-05	05-10	Medium	High	Medium	Native	Injure	Yes	563707.4977	4823404.9686	callused crack
1713	Acer saccharinum	Silver Maple	40						05-10	10-15	Medium	High	High	Native	Injure	Yes	563694.9574	4823380.3635	leaning slightly
1714	Acer saccharinum	Silver Maple	40						05-10	10-15	Medium	High	High	Native	Preserve	N/A	563687.9430	4823374.7441	wound healed over
1715	Picea pungens	Blue Spruce	45						05-10	10-15	Medium	High	High		Preserve	N/A	563670.0810	4823355.8406	leaning
1716	Acer saccharinum	Silver Maple	82						10-15	15-20	Medium	High	High	Native	Preserve	N/A	563643.4693	4823322.0997	minor dieback , poor form
1717	Ulmus americana	White Elm	17						05-10	10-15	Medium	High	High	Native	Preserve	N/A	563636.3160	4823327.9566	rooted into rocks, old shoots from base
1718	Picea pungens	Blue Spruce	45						05-10	10-15	High	High	High		Injure	Yes	563630.3375	4823328.5877	
1719	Acer saccharinum	Silver Maple	70						05-10	10-15	Low	Low	Low	Native	Preserve	N/A	563627.9392	4823321.1057	extensive dieback and decay
1720	Salix fragilis	Crack Willow	146						10-15	15-20	Low	Low	Low	Introduced	Preserve	N/A	563625.7434	4823315.5968	crown dieback, broken branchs, measured below split so smaller
1721	Thuja occidentalis	Eastern White Cedar	17						03-05	05-10	Medium	High	Medium	Native	Remove	Yes	563619.4221	4823323.3086	rooted into boulder
1722	Thuja occidentalis	White Cedar	49	28	25				05-10	10-15	Medium	High	Medium	Native	Injure	Yes	563616.9922	4823313.9633	multi-stemmed clump
1723	Ulmus americana	White Elm	14						03-05	05-10	Medium	Low	Low	Native	Preserve	N/A	563615.7751	4823307.6840	supressed, insect damage, dieback
1724	Thuja occidentalis	White Cedar	32						03-05	05-10	Low	Medium	Low	Native	Remove	Yes	563602.1838	4823308.6674	rotting cavity at base
1725	Ulmus americana	American Elm	10						01-03	05-10	Medium	High	Medium	Native	Remove	Yes	563591.3475	4823297.0080	growing from rocks
1726	Picea glauca	White Spruce	38						05-10	10-15	Medium	High	Medium	Native	Injure	Yes	563575.9532	4823277.3626	leaning slightly , no dieback
1726	Ulmus americana	American Elm	15	12					03-05	05-10	Medium	High	Medium	Native	Injure	Yes	563578.7045	4823285.3109	growing from rocks
1728	Pinus resinosa	Red Pine	67						05-10	10-15	Low	Medium	Low	Native	Injure	Yes	563559.3723	4823256.1359	pinunig? ticket creeper choking out
1729	Thuja occidentalis	White Cedar	17	16	14	12			03-05	05-10	Medium	High	Medium	Native	Preserve	N/A	563551.0467	4823248.8616	multi-stemmed clump,
1730	Pinus resinosa	Red Pine	62						05-10	05-10	Low	Low	Low	Native	Remove	Yes	563528.4002	4823234.0141	likely pinunig, dieback and dead limbs
1731	Acer saccharinum	Silver Maple	34						05-10	05-10	Low	Medium	Low	Native	Remove	Yes	563510.7350	4823211.2858	likely acer x freemanii, epicormic shoots , leaning
1732	Acer x freemanii	Hybrid Maple	26	10	7				03-05	05-10	High	High	High	Introduced	Preserve	N/A	563475.3098	4823171.7049	poor form but healthy
1733	Juniperus virginiana	Eastern Red Cedar	21						03-05	05-10	High	High	High	Native	Preserve	N/A	563459.2635	4823127.4567	
1734	Juniperus virginiana	Eastern Red Cedar	22						03-05	05-10	Medium	Medium	Medium	Native	Preserve	N/A	563464.2437	4823134.6385	minor dieback
1735	Picea pungens	Blue Spruce	32						03-05	15-20	High	Medium	Medium	Introduced	Remove	Yes	563473.0378	4823142.9099	dieback
1736	Picea abies	Norway Spruce	45						05-10	10-15	High	High	High	Introduced	Remove	Yes	563462.6929	4823148.7254	
1737	Picea abies	Norway Spruce	65						05-10	15-20	Medium	High	Medium	Introduced	Remove	Yes	563474.9610	4823152.1181	cavity at base
1738	Picea pungens	Blue Spruce	43						03-05	15-20	High	High	High	Introduced	Remove	Yes	563480.0159	4823158.9932	
1739	Thuja occidentalis	Eastern White Cedar	37	32	30	30	25		05-10	10-15	Medium	High	Medium	Native	Remove	Yes	563481.2015	4823155.4574	
1740	Pinus sylvestris	Scotch Pine	25						03-05	05-10	Medium	Medium	Low	Introduced	Remove	Yes	563496.2109	4823168.3592	
1741	Pinus sylvestris	Scotch Pine	25						03-05	05-10	Medium	Medium	Low	Introduced	Preserve	N/A	563499.1949	4823169.1282	
1742	Pinus sylvestris	Scotch Pine	34						05-10	05-10	Low	Low	Low	Introduced	Remove	Yes	563497.1945	4823169.9655	dieback
1743	Thuja occidentalis	Eastern White Cedar	15	13	7	7	7	7	05-10	05-10	Low	Medium	Low	Native	Preserve	N/A	563486.8368	4823181.0005	broken multistem
1744	Salix fragilis	Crack Willow	200						15-20	15-20	Low	Medium	Low	Introduced	Injure	Yes	563506.9012	4823190.9290	poor form, broken branches, crotch decay
1745	Pinus sylvestris	Scotch Pine	34						03-05	05-10	Medium	Medium	Medium	Introduced	Remove	Yes	563522.1996	4823190.4445	
1746	Acer saccharinum	Silver Maple	33						03-05	05-10	High	High	High	Native	Preserve	N/A	563520.2420	4823203.1380	
1747	Acer saccharinum	Silver Maple	19						03-05	05-10	Medium	High	High	Native	Preserve	N/A	563525.5181	4823207.1674	leaning
1748	Acer saccharinum	Silver Maple							15-20	15-20	Medium	High	High	Native	Preserve	N/A	563534.2358	4823215.1342	poor form but no decay
1749	Acer saccharinum	Silver Maple							10-15	15-20	Medium	Medium	Medium	Native	Preserve	N/A	563541.5353	4823214.2557	dieback , cut limb but no decay
1750	Acer saccharinum	Silver Maple	13						03-05	05-10	Medium	High	High	Native	Preserve	N/A	563537.5579	4823226.8732	wound on lower bole callusing
1751	Acer saccharinum	Silver Maple	88						15-20	15-20	Low	Medium	Low	Native	Preserve	N/A	563552.3770	4823230.9536	crown dieback , poor form
1752	Picea abies	Norway Spruce	48						05-10	15-20	High	High	High	Introduced	Preserve	N/A	563562.2303	4823239.0951	
1753	Picea glauca	White Spruce	30						03-05	05-10	High	High	High	Native	Remove	Yes	563560.5142	4823212.6556	
1754	Acer platanoides	Norway Maple	13	11	6				03-05	05-10	Low	High	Low	Introduced	Remove	Yes	563567.5243	4823218.7064	

Appendix H-4 - Tree Inventory Data Table

Tree Tag #	Scientific Name	Common Name	DBH1[1] (cm)	DBH2	DBH3	DBH4	DBH5	DBH6	Crown Reserve[2] (m)	Height[3] (m)	Structural Condition[4]	Biological Health[5]	Preservation Priority[6]	Native Status[7]	Tree Action[8]	Compensation Required[9]	NAD83 UTM Zone 17N X Coordinate	Y Coordinate	Comments
1755	Acer platanoides	Norway Maple	12	10	9				03-05	05-10	Low	Medium	Low	Introduced	Remove	Yes	563566.6241	4823218.2915	
1756	Acer platanoides	Norway Maple	17	16					03-05	05-10	Low	Medium	Low	Introduced	Remove	Yes	563566.3163	4823218.4981	
1757	Acer platanoides	Norway Maple	11						01-03	05-10	Medium	Medium	Low	Introduced	Remove	Yes	563565.9015	4823219.0274	suppressed
1758	Acer platanoides	Norway Maple	11						03-05	05-10	Low	Low	Low	Introduced	Remove	Yes	563565.1889	4823217.5867	
1759	Acer platanoides	Norway Maple	10						01-03	05-10	Medium	Medium	Low	Introduced	Remove	Yes	563566.7251	4823219.1628	suppressed
1760	Acer platanoides	Norway Maple	13	10	6				03-05	05-10	Low	Low	Low	Introduced	Remove	Yes	563569.6538	4823221.0447	
1761	Acer platanoides	Norway Maple	16	13	11	10			03-05	05-10	Low	Medium	Low	Introduced	Remove	Yes	563571.6062	4823222.7444	
1762	Acer negundo	Manitoba Maple	22	25					03-05	05-10	Low	High	Low	Introduced	Remove	Yes	563583.4214	4823234.6835	
1763	Picea abies	Norway Spruce	24						03-05	10-15	High	High	High	Introduced	Remove	Yes	563591.5741	4823239.9815	
1764	Picea abies	Norway Spruce	30						03-05	10-15	High	High	High	Introduced	Remove	Yes	563592.6899	4823240.7427	
1765	Picea abies	Norway Spruce	20						03-05	10-15	High	High	High	Introduced	Remove	Yes	563593.6079	4823241.2978	
1766	Picea abies	Norway Spruce	33						03-05	10-15	High	High	High	Introduced	Preserve	N/A	563596.1458	4823240.5294	
1767	Picea abies	Norway Spruce	30						03-05	05-10	High	High	High	Introduced	Preserve	N/A	563597.5470	4823241.0895	
1768	Acer saccharinum	Silver Maple	121						15-20	15-20	Medium	Medium	Medium	Native	Preserve	N/A	563567.0234	4823245.5253	dieback , poor form
1769	Salix fragilis	Crack Willow	39	120					10-15	15-20	Low	Low	Low	Introduced	Preserve	N/A	563582.4800	4823259.7036	falling apart, dead limbs
1770	Acer saccharinum	Silver Maple	47						05-10	10-15	Medium	High	Medium	Native	Remove	Yes	563603.0563	4823258.5818	poor form, some wounds healng
1771	Pinus strobus	Eastern White Pine	34						03-05	10-15	Low	Low	Low	Native	Preserve	N/A	563591.2484	4823267.8957	almost dead
1772	Thuja occidentalis	Eastern White Cedar	25						03-05	05-10	High	High	High	Native	Preserve	N/A	563580.6962	4823271.6301	
1773	Thuja occidentalis	Eastern White Cedar	17	11	9	8			03-05	05-10	Medium	High	High	Native	Preserve	N/A	563584.7281	4823267.2157	
1774	Thuja occidentalis	Eastern White Cedar	34						03-05	10-15	Medium	High	High	Native	Preserve	N/A	563585.8337	4823278.3555	
1775	Thuja occidentalis	Eastern White Cedar	32	31					05-10	10-15	Medium	High	High	Native	Preserve	N/A	563591.6857	4823275.7822	
1776	Thuja occidentalis	Eastern White Cedar	27	24	20				05-10	10-15	Medium	High	High	Native	Preserve	N/A	563588.0669	4823280.6722	
1777	Acer saccharinum	Silver Maple	94						10-15	15-20	Low	Low	Low	Native	Preserve	N/A	563589.4733	4823284.7608	large cavity. good wildlife tree, extensive dieback
1778	Thuja occidentalis	Eastern White Cedar	32	35	22	19			05-10	10-15	Medium	High	High	Native	Preserve	N/A	563591.7809	4823285.3763	
1779	Thuja occidentalis	Eastern White Cedar	34	38	32	30	28	17	05-10	10-15	Low	High	Medium	Native	Preserve	N/A	563597.3516	4823282.2977	large burl, cracked but healing
1780	Thuja occidentalis	Eastern White Cedar	34	25					05-10	10-15	Medium	High	High	Native	Preserve	N/A	563597.6361	4823293.4038	
1781	Thuja occidentalis	Eastern White Cedar	34	40					05-10	05-10	Medium	High	Medium	Native	Preserve	N/A	563605.8300	4823297.4940	leaning over creek
1782	Thuja occidentalis	Eastern White Cedar	34	29					05-10	10-15	Medium	High	Medium	Native	Preserve	N/A	563604.7720	4823294.9408	cracked but healing
1783	Thuja occidentalis	Eastern White Cedar	68						05-10	10-15	Medium	High	High	Native	Preserve	N/A	563614.5197	4823282.9233	geocache
1784	Thuja occidentalis	Eastern White Cedar	43						03-05	10-15	Medium	High	High	Native	Preserve	N/A	563632.1060	4823302.2487	leaning
1785	Salix fragilis	Crack Willow	11						03-05	05-10	Medium	High	Low	Introduced	Preserve	N/A	563640.9832	4823313.0896	over creek
1786	Acer platanoides	Norway Maple	39						05-10	05-10	Medium	High	Medium	Introduced	Preserve	N/A	563651.2130	4823318.2456	crimson, crooked trunk
1787	Thuja occidentalis	Eastern White Cedar	20	20	18	18	17	17	05-10	10-15	Medium	High	High	Native	Preserve	N/A	563655.4666	4823326.1820	over creek
1788	Acer platanoides	Norway Maple	40						05-10	10-15	Medium	High	Medium	Introduced	Preserve	N/A	563662.4587	4823331.2762	crimson, crackedhealing
1789	Salix fragilis	Crack Willow	200						10-15	15-20	Low	Medium	Low	Introduced	Preserve	N/A	563683.6789	4823352.2176	minor dieback , broken limbs
1790	Acer saccharinum	Silver Maple	36						05-10	10-15	Medium	High	High	Native	Remove	Yes	563693.8720	4823352.1065	
1791	Acer platanoides	Norway Maple	43						05-10	05-10	Medium	High	Medium	Introduced	Remove	Yes	563695.8812	4823364.2742	crimson
1792	Thuja occidentalis	Eastern White Cedar	60						03-05	10-15	Low	High	Medium	Native	Remove	Yes	563703.1745	4823372.3902	big crack
1793	Acer saccharinum	Silver Maple	38						05-10	10-15	Medium	High	High	Native	Preserve	N/A	563709.3974	4823367.3970	
1794	Thuja occidentalis	Eastern White Cedar	40						03-05	10-15	Medium	High	Medium	Native	Preserve	N/A	563708.9263	4823377.0113	cracked
1795	Picea pungens	Blue Spruce	60						05-10	10-15	High	High	High	Introduced	Preserve	N/A	563716.6701	4823377.2835	
1796	Malus sp	Apple Species	24						03-05	05-10	Low	Medium	Low	Genus	Preserve	N/A	563717.5278	4823387.4371	dead limb, rotting
1797	Acer platanoides	Norway Maple	51	15	12				10-15	10-15	Medium	High	Medium	Introduced	Remove	Yes	563716.5813	4823390.1456	leaning , cracked
1798	Acer platanoides	Norway Maple	57						10-15	10-15	Medium	High	Medium	Introduced	Preserve	N/A	563750.4191	4823401.1209	girdling roots, old crack
1799	Acer platanoides	Norway Maple	47						10-15	10-15	Low	Medium	Low	Introduced	Preserve	N/A	563747.0611	4823408.8004	crown dieback
1800	Acer platanoides	Norway Maple	62						05-10	10-15	Low	Medium	Low	Introduced	Preserve	N/A	563746.7801	4823416.8876	large crack, dieback
1801	Acer platanoides	Norway Maple	62						05-10	10-15	Low	Medium	Low	Introduced	Preserve	N/A	563745.8113	4823425.3641	dieback, decay, cracked
1802	Acer saccharinum	Silver Maple	66						10-15	10-15	Medium	High	High	Native	Preserve	N/A	563468.4653	4823122.4220	
1803	Liriodendron tulipifera	Tulip Tree	38						05-10	05-10	Medium	High	High	Native	Remove	Yes	563445.0795	4823110.1395	
1804	Ulmus americana	American Elm	16						03-05	05-10	Medium	Low	Low	Native	Preserve	N/A	563430.0634	4823117.1238	
1805	Acer platanoides	Norway Maple	59						05-10	03-05	Low	Medium	Low	Introduced	Remove	Yes	563402.5307	4823097.0672	topped
1806	Thuja occidentalis	Eastern White Cedar	32	28					03-05	05-10	Medium	High	Medium	Native	Remove	Yes	563389.8391	4823081.7717	probably tree 346 from the previous NRSI survey
1807	Acer saccharinum	Silver Maple	109						10-15	15-20	Low	Medium	Low	Native	Remove	Yes	563381.1365	4823078.9259	broken leader , rotting , poor form, dieback ; probably tree 345 from previous NRSI study
1808	Acer platanoides	Norway Maple	41						05-10	05-10	High	Medium	Medium	Introduced	Injure	Yes	563361.5565	4823068.3440	probably tree 342 from the previous NRSI survey
1809	Acer platanoides	Norway Maple	40						05-10	05-10	Medium	Medium	Medium	Introduced	Injure	Yes	563356.6094	4823064.0186	minor dieback ; probably tree 341 from the previous NRSI survey
1810	Acer saccharinum	Silver Maple	28						05-10	10-15	Medium	Medium	Medium	Native	Injure	Yes	563351.9701	4823058.0064	minor dieback , crack; potentially tree 340 from NRSI survey but NRSI had species list as Silver Maple
1811	Acer platanoides	Norway Maple	46						05-10	10-15	High	High	High	Introduced	Injure	Yes	563347.1917	4823054.6370	probably tree 339 from previous NRSI survey
1812	Acer platanoides	Norway Maple	29						05-10	05-10	Low	Medium	Low	Introduced	Injure	Yes	563331.9291	4823037.5192	dieback , healed crack; probably Tree 388 from previous NRSI survey
1813	Acer platanoides	Norway Maple	22						03-05	05-10	Medium	Medium	Medium	Introduced	Injure	Yes	563325.6744	4823032.1802	minor dieback ; probably tree 337 from previous NRSI survey
1814	Acer saccharinum	Silver Maple	49						05-10	10-15	High	High	High	Native	Remove	Yes	563333.7216	4823022.7946	Identifed as tree 336 in previous NRSI survey.
1815	Acer saccharinum	Silver Maple	38	32					05-10	10-15	Medium	Medium	Medium	Native	Remove	Yes	563329.7618	4823021.2363	moderate dieback in crown ; Identifed as tree 335 in previous NRSI survey.
1816	Acer saccharinum	Silver Maple	34	26					05-10	10-15	Medium	Medium	Medium	Native	Remove	Yes	563324.8277	4823011.9753	crown dieback
1817	Acer platanoides	Norway Maple	35						03-05	05-10	High	Medium	Medium	Introduced	Injure	Yes	563310.7349	4823015.9774	minor dieback
1818	Acer platanoides	Norway Maple	26						03-05	05-10	Medium	Medium	Low	Introduced	Remove	Yes	563236.2122	4822940.3561	dieback

Appendix H-4 - Tree Inventory Data Table

Tree Tag #	Scientific Name	Common Name	DBH1 [1] (cm)	DBH2	DBH3	DBH4	DBH5	DBH6	Crown Reserve [2] (m)	Height [3] (m)	Structural Condition [4]	Biological Health [5]	Preservation Priority [6]	Native Status [7]	Tree Action [8]	Compensation Required [9]	NAD83 UTM Zone 17N X Coordinate	Y Coordinate	Comments
1819	Acer saccharinum	Silver Maple	47						05-10	05-10	Medium	Medium	Medium	Native	Remove	Yes	563209.7541	4822905.8035	dieback
1820	Acer saccharinum	Silver Maple	45						05-10	05-10	Medium	Medium	Medium	Native	Remove	Yes	563197.3529	4822890.0943	epicormic shoots
1821	Acer saccharinum	Silver Maple	67						10-15	10-15	Low	Medium	Low	Native	Remove	Yes	563192.2734	4822878.1606	broken limbs , cracked , large cavity
1822	Picea pungens	Blue Spruce	32						03-05	10-15	High	High	High		Remove	Yes	563183.7015	4822875.9544	
1823	Picea pungens	Blue Spruce	40						03-05	10-15	Medium	High	Medium		Remove	Yes	563181.8616	4822862.6471	lean over creek
1824	Acer platanoides	Norway Maple	23						03-05	05-10	Low	Low	Low	Introduced	Remove	Yes	563176.1946	4822858.8306	cavity, leaning, epicormic shoots
1825	Acer platanoides	Norway Maple	38						05-10	05-10	High	Medium	Medium	Introduced	Remove	Yes	563172.1456	4822860.3478	minor dieback
1826	Acer platanoides	Norway Maple	29						03-05	05-10	Low	Low	Low	Introduced	Remove	Yes	563172.4982	4822855.7159	cracked, extensive dieback
1827	Acer platanoides	Norway Maple	40						05-10	05-10	Medium	Medium	Low	Introduced	Remove	Yes	563166.7072	4822855.6318	open wound, dieback
1828	Acer saccharinum	Silver Maple	31						05-10	05-10	Low	Low	Low	Native	Remove	Yes	563124.3733	4822820.3635	beaver damage and dieback
1829	Acer saccharinum	Silver Maple	36						05-10	05-10	Medium	Low	Low	Native	Remove	Yes	563113.0478	4822806.2261	dieback and wounds
1830	Acer platanoides	Norway Maple	35						05-10	05-10	Medium	High	Medium	Introduced	Remove	Yes	563058.9030	4822761.0525	cracked
1831	Acer saccharinum	Silver Maple	125						10-15	15-20	Medium	High	High	Native	Preserve	N/A	563097.1606	4822758.8756	
1832	Acer saccharinum	Silver Maple	123						10-15	15-20	Low	Medium	Low	Native	Remove	Yes	563078.7661	4822740.9106	half of tree broken off
1833	Acer saccharinum	Silver Maple	50						05-10	10-15	Low	Medium	Low	Native	Preserve	N/A	563078.8025	4822720.1933	broken, split bole
1834	Acer saccharinum	Silver Maple	50						05-10	10-15	Medium	High	High	Native	Preserve	N/A	563093.3624	4822734.7288	leaning
1835	Acer saccharinum	Silver Maple	51						05-10	10-15	Medium	High	High	Native	Preserve	N/A	563100.4628	4822745.1241	leaning slightly
1836	Acer platanoides	Norway Maple	25						03-05	05-10	Low	Low	Low	Introduced	Remove	Yes	563132.4442	4822789.3962	
1837	Acer platanoides	Norway Maple	24						03-05	05-10	Medium	Low	Low	Introduced	Remove	Yes	563133.0866	4822795.3445	
1838	Acer platanoides	Norway Maple	26						03-05	05-10	Low	Medium	Low	Introduced	Remove	Yes	563139.5212	4822801.0078	dieback , cracked healing
1839	Picea abies	Norway Spruce	20						03-05	05-10	High	High	High	Introduced	Remove	Yes	563140.8414	4822817.6488	
1840	Picea abies	Norway Spruce	25						03-05	05-10	High	High	High	Introduced	Remove	Yes	563143.4145	4822817.9019	
1841	Picea abies	Norway Spruce	18						03-05	05-10	High	High	High	Introduced	Remove	Yes	563141.2621	4822819.5942	
1842	Picea pungens	Blue Spruce	10	13	20				03-05	05-10	Medium	High	High	Introduced	Remove	Yes	563154.4716	4822810.4363	fallen tree that resprouted
1843	Picea pungens	Blue Spruce	18						01-03	05-10	Medium	High	Medium	Introduced	Remove	Yes	563173.3080	4822835.4385	leaning
1844	Picea abies	Norway Spruce	20						01-03	05-10	Medium	High	Medium	Introduced	Remove	Yes	563172.2537	4822832.0166	leaning
1845	Acer negundo	Manitoba Maple	14						03-05	05-10	Medium	High	Medium	Introduced	Remove	Yes	563182.8064	4822838.1419	
1846	Picea abies	Norway Spruce	17						03-05	05-10	Medium	High	Medium	Introduced	Remove	Yes	563184.8657	4822837.2592	
1847	Picea pungens	Blue Spruce	45						03-05	05-10	High	High	High	Introduced	Remove	Yes	563190.9958	4822855.1377	
1848	Acer saccharinum	Silver Maple	36						05-10	05-10	Low	Low	Low	Native	Remove	Yes	563204.8715	4822858.3019	
1849	Thuja occidentalis	Eastern White Cedar	26	30	23	18			03-05	05-10	Low	Medium	Low	Native	Remove	Yes	563224.4243	4822884.9911	fallen over
1850	Acer saccharinum	Silver Maple	73						10-15	15-20	High	High	High	Native	Remove	Yes	563237.8559	4822897.5194	
1851	Acer saccharinum	Silver Maple	110						15-20	15-20	Low	Medium	Medium	Native	Remove	Yes	563266.2309	4822928.2342	
1852	Picea glauca	White Spruce	35						03-05	10-15	High	Medium	Medium	Native	Remove	Yes	563273.4678	4822926.7560	some dieback on lower crown
1853	Thuja occidentalis	Eastern White Cedar	18						01-03	05-10	Low	Low	Low	Native	Remove	Yes	563283.0081	4822943.9484	dieback
1854	Thuja occidentalis	Eastern White Cedar	23	18					03-05	05-10	Medium	High	Medium	Native	Remove	Yes	563286.0349	4822933.7810	
1855	Thuja occidentalis	Eastern White Cedar	30	20	22	15			03-05	05-10	Medium	High	High	Native	Preserve	N/A	563288.1816	4822929.8029	
1856	Picea pungens	Blue Spruce	50						03-05	10-15	High	High	High	Introduced	Remove	Yes	563289.9840	4822938.6377	
1857	Picea pungens	Blue Spruce	40	30					03-05	10-15	High	Medium	Medium	Introduced	Preserve	N/A	563306.2175	4822942.3261	
1858	Picea abies	Norway Spruce	35						03-05	05-10	Medium	Low	Low	Introduced	Remove	Yes	563301.9722	4822954.7117	
1859	Picea abies	Norway Spruce	35						03-05	05-10	Medium	Low	Low	Introduced	Injure	Yes	563323.4734	4822965.0625	dieback
1860	Picea pungens	Blue Spruce	45						03-05	10-15	Medium	Low	Low	Introduced	Remove	Yes	563317.6314	4822983.7788	
1861	Acer saccharinum	Silver Maple							05-10	10-15	Low	Low	Low	Native	Remove	Yes	563329.4340	4822994.7347	decayed, broken
1862	Picea pungens	Blue Spruce	35						03-05	05-10	Medium	Medium	Medium	Introduced	Remove	Yes	563337.0250	4823002.8805	overgrown, dieback
1863	Acer saccharinum	Silver Maple	67						05-10	10-15	Medium	Medium	Medium	Native	Injure	Yes	563359.3656	4822999.3240	dieback
1864	Pinus sylvestris	Scotch Pine	30						03-05	15-20	Medium	Medium	Low	Introduced	Remove	Yes	563354.1335	4823015.7424	small cracks, broken limbs
1865	Pinus sylvestris	Scotch Pine	30						03-05	15-20	Medium	Medium	Low	Introduced	Remove	Yes	563356.0543	4823017.8038	small cracks, broken limbs
1866	Acer saccharinum	Silver Maple	115						10-15	15-20	Medium	High	High	Native	Remove	Yes	563358.3492	4823020.1020	minor dieback , poor form
1867	Acer saccharinum	Silver Maple	81						10-15	10-15	Medium	High	Medium	Native	Remove	Yes	563352.4424	4823033.5735	cavity and decay
1868	Acer saccharinum	Silver Maple	110						10-15	15-20	Medium	High	Medium	Native	Remove	Yes	563372.8473	4823033.7790	included bark split
1869	Acer saccharinum	Silver Maple	95						10-15	15-20	High	High	High	Native	Remove	Yes	563380.2072	4823035.2334	
1870	Thuja occidentalis	Eastern White Cedar	20	18					03-05	05-10	Medium	High	Medium	Native	Remove	Yes	563378.5853	4823040.1736	supressed
1871	Acer saccharinum	Silver Maple	135						10-15	15-20	Low	Medium	Medium	Native	Remove	Yes	563383.2764	4823049.0024	poor form, split
1872	Thuja occidentalis	Eastern White Cedar	32						03-05	05-10	High	Medium	Medium	Native	Remove	Yes	563383.0721	4823051.4031	cracked healing
1873	Thuja occidentalis	Eastern White Cedar	23	14					03-05	03-05	Medium	Medium	Low	Native	Remove	Yes	563381.0194	4823051.5526	suppressed, rotting base
1874	Acer saccharinum	Silver Maple	25						05-10	05-10	Medium	Medium	Medium	Native	Remove	Yes	563389.8163	4823058.7342	epicormic shoots
1875	Acer saccharinum	Silver Maple	105						10-15	15-20	Low	Medium	Medium	Native	Remove	Yes	563402.1819	4823065.8105	decay, poor form
1876	Thuja occidentalis	Eastern White Cedar	33	35	16				03-05	05-10	Medium	High	Medium	Native	Remove	Yes	563404.8502	4823069.5949	
1877	Thuja occidentalis	Eastern White Cedar	23	28					03-05	10-15	Medium	Medium	Medium	Native	Remove	Yes	563401.8799	4823071.3898	
1878	Thuja occidentalis	Eastern White Cedar	17	13					03-05	05-10	Medium	Medium	Medium	Native	Remove	Yes	563417.7185	4823087.9712	callused wounds , leaning over , supressed
1879	Thuja occidentalis	Eastern White Cedar	14						01-03	03-05	Low	Medium	Low	Native	Remove	Yes	563417.3696	4823088.6119	callused wounds , leaning over , supressed
1880	Thuja occidentalis	Eastern White Cedar	13						01-03	03-05	High	High	High	Native	Remove	Yes	563420.4848	4823088.4496	suppressed , leaning over slightly
1881	Thuja occidentalis	Eastern White Cedar	11						01-03	03-05	Medium	High	Medium	Native	Remove	Yes	563420.7191	4823088.7175	suppressed , leaning
1882	Thuja occidentalis	Eastern White Cedar	16						01-03	03-05	Low	Low	Low	Native	Remove	Yes	563420.3984	4823086.3639	suppressed , leaning
1883	Thuja occidentalis	Eastern White Cedar	16	14					03-05	05-10	Medium	High	Medium	Native	Remove	Yes	563421.0928	4823085.6256	suppressed , leaning
1884	Thuja occidentalis	Eastern White Cedar	16						01-03	05-10	Low	Low	Low	Native	Remove	Yes	563427.4147	4823083.0728	bark mostly gone, but callused
1885	Thuja occidentalis	Eastern White Cedar	14						01-03	05-10	Low	Medium	Low	Native	Remove	Yes	563429.4010	4823083.1829	
1886	Thuja occidentalis	Eastern White Cedar	11						01-03	03-05	Medium	Medium	Medium	Native	Remove	Yes	563425.5007	4823085.1538	suppressed , leaning
1887	Thuja occidentalis	Eastern White Cedar	11						01-03	03-05	Medium	Low	Low	Native	Remove	Yes	563426.1388	4823085.5649	suppressed , leaning
1888	Thuja occidentalis	Eastern White Cedar	13						01-03	05-10	Low	Medium	Low	Native	Remove	Yes	563422.9414	4823085.7484	suppressed , leaning

Appendix H-4 - Tree Inventory Data Table

Tree Tag #	Scientific Name	Common Name	DBH1 [1] (cm)	DBH2	DBH3	DBH4	DBH5	DBH6	Crown Reserve [2] (m)	Height [3] (m)	Structural Condition [4]	Biological Health [5]	Preservation Priority [6]	Native Status [7]	Tree Action [8]	Compensation Required [9]	NAD83 UTM Zone 17N X Coordinate	Y Coordinate	Comments
1889	Thuja occidentalis	Eastern White Cedar	19						01-03	05-10	Low	Medium	Low	Native	Remove	Yes	563429.4847	4823081.4314	minor dieback , leaning over
1890	Thuja occidentalis	Eastern White Cedar	26						01-03	03-05	Low	Medium	Low	Native	Remove	Yes	563430.1324	4823080.0301	1 broken limbs
1891	Acer platanoides	Norway Maple	132						10-15	15-20	Medium	High	Medium	Introduced	Remove	Yes	563435.7548	4823087.6466	overall healthy tree but spreading form and cracked codomjnant stems may fail
1892	Acer saccharinum	Silver Maple	100	100					10-15	15-20	Low	Medium	Low	Native	Remove	Yes	563429.6037	4823087.5224	2nd stem broken and recently fallen, decay and included bark in fork, other limb may fail
1893	Prunus virginiana	Choke Cherry	12	10					01-03	03-05	Low	Low	Low	Native	Remove	Yes	563428.2216	4823091.3996	Decay and large wound
1894	Acer saccharinum	Silver Maple	140						10-15	15-20	Low	Medium	Low	Native	Remove	Yes	563419.7388	4823089.5750	forked above 2m, broken limbs , 2 lateral limbs are main concern, minor dieback in crown
1895	Picea abies	Norway Spruce	55		22				05-10	15-20	High	High	High	Introduced	Preserve	N/A	563444.3072	4823097.7137	
1896	Sorbus decora	Northern Mountain-ash	27	23	22				05-10	10-15	Medium	Medium	Low	Native	Preserve	N/A	563445.0023	4823102.9035	spreading , suppressed , epicormic shoots - see photos to confrim species
1897	Juniperus communis	Ground Juniper	13						03-05	01-03	Low	0	Low	Native	Preserve	N/A	563447.4755	4823105.8497	spreading
1898	Thuja occidentalis	Eastern White Cedar	26	19					03-05	05-10	Medium	High	Medium	Native	Preserve	N/A	563437.7992	4823115.5716	
1899	Juniperus communis	Ground Juniper	12						03-05	01-03	Medium	High	Medium	Native	Preserve	N/A	563449.7349	4823106.5089	spreading , pruned
1900	Thuja occidentalis	Eastern White Cedar	27						03-05	05-10	Low	Medium	Low	Native	Preserve	N/A	563032.5983	4822728.6638	Tree number 318 in previous NRSI survey.
332	Ulmus americana	White Elm	81						26					Native	N/A		563272.9117	4822970.9858	Tree not present. Removed since previous NRSI survey.
343	Thuja occidentalis	White Cedar	24						3					Native	N/A		563375.3264	4823076.3021	Tree not present. Removed since previous NRSI survey.
344	Thuja occidentalis	White Cedar	32						5					Native	N/A		563376.6087	4823077.1895	Tree not present. Removed since previous NRSI survey.
348	Thuja occidentalis	White Cedar	28											Native	N/A		563517.5017	4823214.3147	dead
349	Thuja occidentalis	White Cedar	32						6					Native	N/A		563530.0140	4823225.4592	dead
355	Thuja occidentalis	White Cedar	48											Native	N/A		563609.6207	4823311.2965	Tree not present. Removed since previous NRSI survey.
357	Ulmus americana	White Elm	13						6					Native	N/A		563625.4857	4823312.4179	dead
358	Ulmus americana	White Elm	12						3					Native	N/A		563621.9067	4823311.6855	dead
360	Ulmus americana	White Elm	12						8					Native	N/A		563628.2240	4823309.7201	dead
366	Ulmus americana	White Elm	145						10					Native	N/A		563632.3933	4823310.9801	dead

Tree Assessment Criteria

1 DBH (cm): Diameter at breast height, 1.4 m above ground, measured in centimetres.

2 Crown Reserve (m): Crown diameter (tree's canopy) measured at intervals of 1, 3, 5, 7.5, 10, 15 metres

3 Height (m): Height of tree from ground to top of crown.

4 Structural Condition: Related to defects in a tree's structure, (i.e., lean, codominant trunks).
High - No structural defects, well-developed crown.
Medium - Presence of minor structural defects.
Low - Presence of major structural defects including drastic leans and imminent branch and/or trunk failure.

5 Biological Health: Related to presence and extent of disease/disease symptoms and the vigour of the tree.
High - No diseases/disease symptoms present, and moderate to high vigour.
Medium - Presence of minor diseases/disease symptoms, and/or moderate vigour.
Low - Presence of major diseases/disease symptoms, (i.e., extensive crown dieback), and/or severely poor vigour.

6. Preservation Priority: A rating of each tree's projected survival related to existing conditions.
High - High to moderate biological health, and well developed crown. Well suited as a shade tree or screen planting. Will survive existing conditions indefinitely.
Medium - One or more moderate to severe defects in biological health and/or structural condition. Marginally suited as a shade tree or screen planting. Can survive at least 3 - 5 years under existing conditions.
This category also includes stock planted within past 2 years that is not yet established.
Low - Low biological health and/or severely damaged/defective structural condition, and/or unsuitable for urban uses. If biologically defective, survival for more than 1-3 years under existing conditions is unlikely.

7 Native Status:
Native – Native to Ontario
Introduced – Not native to Ontario
Genus - Unable to identify species level due to lack of key characteristics at the time of survey.
Source: NHIC (Natural Heritage Information Centre). 2009. Ontario Vascular Plant Species List. Biodiversity Explorer Online Database. Ontario Ministry of Natural Resources.

8. Tree Action:
Preserve - Trees that have a dripline that is substantially outside the limits of disturbance (less than 30% of the crown reserve will be impacted) and having moderate to high Preservation Priority. Protection of the entire root zone of the tree is desirable.
Injure - Impacts due to grading and/or construction may encroach into more than 30% of crown reserve and cause significant damage within the root zone; preserve and protect with fencing as far as possible from the tree trunk; monitor during and following construction.
Remove - Any tree for which at least 30% of the dripline is within the limits of disturbance, has low biological health, and/or severe structural defects, and is not likely to survive more than 1-3 years, and/or will not survive proposed development.
N/A - Not applicable. During the 2016 D&A arborist assessment the tree was either dead or not present, removed since NRSI survey.

9. Compensation Required:
Yes; 1:1 ratio or $500 per tree removed - Yes, compensation is required for this tree removal. A 1:1 ratio is required as per City of Guelph Tree By-Law (2010) 19058.
No - Species is exempted from compensation due to being an invasive exotic as per City of Guelph Tree By-Law (2010) 19058.

Appendix I

Terrestrial Ecology – Wildlife

Appendix I-1: Wildlife Species List from Available Background Resources.

Natural Resources Solutions Inc. (2013)	Stantec (2006)	NHIC (2015)	OMNRF (Guelph District) SAR Records (2015)	OBBA 2001-2005 (Cadman et al. 2007)	Atlas of the Mammals of Ontario (Dobbyn 1994)	Ontario Reptile and Amphibian Atlas (Ontario Nature 2015)	Ontario Butterfly Atlas Online (Toronto Entomologists' Association 2015)	City of Guelph Municipal List – Wildlife SAR (2015)	Clythe Creek Subwatershed Overview (Ecologistics Ltd. and Blackport and Associates,1998)	Common Name	Scientific Name	COSEWIC (2013)	OMNRF (2014)	GRANK (Nature Serve, 2014)	Srank (OMNRF, 2013 Update)	BCR 13 Priority Landbird Sp. (OPIF, 2008)	Wellington County (D&A 2009) (*i.e.* local rarity only)	Area Sensitivity (OMNR, 2000)
Insects:																		
		1								Painted Skimmer	*Libellula semifasciata*	---	---	G5	S2	n/a	X	n/a
							1			Common Sootywing	*Pholisora catullus*	---	---	G5	S3	n/a	X	n/a
							1			Little Glassywing	*Pompeius verna*	---	---	G5	S4	n/a	X	n/a
							1			Delaware Skipper	*Anatrytone logan*	---	---	G5	S4	n/a	X	n/a
							1			Dion Skipper	*Euphyes dion*	---	---	G4	S3	n/a	X	n/a
							1			Black Dash	*Euphyes conspicua*	---	---	G4	S3	n/a	X	n/a
							1			Giant Swallowtail	*Papilio cresphontes*	---	---	G5	S3	n/a	X	n/a
							1	1		West Virginia White	*Pieris virginiensis*	---	SC	G3G4	S3	n/a	X	n/a
1										Cabbage White	*Pieris rapae*	---	---	G5	SNA	n/a		n/a
							1			Hickory Hairstreak	*Satyrium caryaevorum*	---	---	G4	S3	n/a	X	n/a
1										Mourning Cloak	*Nymphalis antiopa*	---	---	G5	S5	n/a		n/a
1										Red Admiral	*Vanessa atalanta*	---	---	G5	S5	n/a		n/a
1							1	1		Monarch	*Danaus plexippus*	SC	SC	G5	S2N,S4B	n/a	X	n/a
Amphibians:																		
						1				Mudpuppy	*Necturus maculosus*	NAR	NAR	G5	S4	n/a	X	---
						1				Red-spotted Newt	*Notophthalmus viridescens viridescens*	---	---	G5T5	S5	n/a	X	---
						1		1	1	Jefferson Salamander	*Ambystoma jeffersonianum*	END	END	G4	S2	n/a	X	---
						1				Blue-spotted Salamander	*Ambystoma laterale*	---	---	G5	S4	n/a	X	---
						1				Four-toed Salamander	*Hemidactylium scutatum*	NAR	NAR	G5	S4	n/a	X	---
						1				Western Chorus Frog (Great Lakes/St. Lawrence - Canadian Shield Pop.)	*Pseudacris triseriata*	THR	NAR	G5	S3	n/a	X	---
						1				American Bullfrog	*Lithobates catesbeianus*	---	---	G5	S4	n/a	X	AS
						1				Pickerel Frog	*Lithobates palustris*	NAR	NAR	G5	S4	n/a	X	---
Reptiles:																		
			1			1		1		Snapping Turtle	*Chelydra serpentina*	SC	SC	G5	S3	n/a		---
						1		1		Blanding's Turtle	*Emydoidea blandingii*	THR	THR	G4	S3	n/a	X	---
		1				1				Northern Map Turtle	*Graptemys geographica*	SC	SC	G5	S3	n/a	X	AS
		1	1			1		1		Eastern Milksnake	*Lampropeltis t. triangulum*	SC	SC	G5	S3	n/a	X	---
						1				Smooth Greensnake	*Opheodrys vernalis*	---	---	G5	S4	n/a	X	---
						1				Northern Watersnake	*Nerodia sipedon sipedon*	NAR	NAR	G5T5	S5	n/a	X	---
						1				DeKay's Brownsnake	*Storeria dekayi*	NAR	NAR	G5	S5	n/a	X	---
						1				Northern Red-bellied Snake	*Storeria o. occipitomaculata*	---	---	G5	S5	n/a	X	---
		1				1		1		Northern Ribbonsnake	*Thamnophis sauritus septentrionalis*	SC	SC	G5	S3	n/a	X	---
Birds:																		
									1	Northern Bobwhite	*Colinus virginianus*	END	END	G5	S1	PLS	X	---
				1					1	Least Bittern	*Ixobrychus exilis*	THR	THR	G5	S4B	---	X	AS
				1				1		Bald Eagle	*Haliaeetus leucocephalus*	NAR	SC	G4	S2N,S4B	PLS	X	AS
									1	Red-shouldered Hawk	*Buteo lineatus*	NAR	NAR	G5	S4B	PLS	X	AS
				1				1		Common Nighthawk	*Chordeiles minor*	THR	SC	G5	S4B	---	X	---
				1				1		Chimney Swift	*Chaetura pelagica*	THR	THR	G5	S4B,S4N	PLS		---

Appendix I-1: Wildlife Species List from Available Background Resources.

Natural Resources Solutions Inc. (2013)	Stantec (2006)	NHIC (2015)	OMNRF (Guelph District) SAR Records (2015)	OBBA 2001-2005 (Cadman et al. 2007)	Atlas of the Mammals of Ontario (Dobbyn 1994)	Ontario Reptile and Amphibian Atlas (Ontario Nature 2015)	Ontario Butterfly Atlas Online (Toronto Entomologists' Association 2015)	City of Guelph Municipal List – Wildlife SAR (2015)	Clythe Creek Subwatershed Overview (Ecologistics Ltd. and Blackport and Associates,1998)	Common Name	Scientific Name	COSEWIC (2013)	OMNR F (2014)	GRANK (Nature Serve, 2014)	Srank (OMNRF , 2013 Update)	BCR 13 Priority Landbir d Sp. (OPIF, 2008)	Wellingto n County (D&A 2009) (*i.e.* local rarity only)	Area Sensitivity (OMNR, 2000)
1										Belted Kingfisher	*Megaceryle alcyon*	---	---	G5	S4B	PLS		---
				1				1		Red-headed Woodpecker	*Melanerpes erythrocephalus*	THR	SC	G5	S4B	PLS	X	---
				1				1		Eastern Wood-Pewee	*Contopus virens*	SC	SC	G5	S4B	PLS		---
1										Eastern Kingbird	*Tyrannus tyrannus*	---	---	G5	S4B	PLS		---
				1				1		Bank Swallow	*Riparia riparia*	THR	THR	G5	S4B	PLS		---
				1				1		Barn Swallow	*Hirundo rustica*	THR	THR	G5	S4B	---		---
				1				1		Wood Thrush	*Hylocichla mustelina*	THR	SC	G5	S4B	PLS		---
								1		Golden-winged Warbler	*Vermivora chrysoptera*	THR	SC	G4	S4B	PLS	X	---
1										American Redstart	*Setophaga ruticilla*	---	---	G5	S5B	---		AS
								1		Canada Warbler	*Cardellina canadensis*	THR	SC	G5	S4B	PLS	X	AS
				1				1		Yellow-breasted Chat	*Icteria virens*	END	END	G5	S2B	PLS	X	---
				1						Grasshopper Sparrow	*Ammodramus savannarum*	SC	---	G5	S4B	PLS	X	AS
									1	Henslow's Sparrow	*Ammodramus henslowii*	END	END	G4	SHB	PLS	X	AS
1	1									Dark-eyed Junco	*Junco hyemalis*	---	---	G5	S5B	---	X	---
	1									Northern Cardinal	*Cardinalis cardinalis*	---	---	G5	S5	---		---
				1				1		Bobolink	*Dolichonyx oryzivorus*	THR	THR	G5	S4B	PLS		AS
				1				1		Eastern Meadowlark	*Sturnella magna*	THR	THR	G5	S4B	PLS		AS
Mammals:																		
					1				1	Smoky Shrew	*Sorex fumeus*	---	---	G5	S5	n/a		---
					1					Water Shrew	*Sorex palustris*	---	---	G5	S5	n/a	X	---
					1					Hairy-tailed Mole	*Parascalops breweri*	---	---	G5	S4	n/a	X	---
					1					Star-nosed Mole	*Condylura cristata*	---	---	G5	S5	n/a		---
					1			1		Small-footed Bat	*Myotis leibii*	---	END	G3	S2S3	n/a	X	---
					1			1		Little Brown Myotis	*Myotis lucifugus*	END	END	G5	S4	n/a		---
					1			1		Northern Myotis	*Myotis septentrionalis*	END	END	G4	S3	n/a	X	---
					1					Silver-haired Bat	*Lasionycteris noctivagans*	---	---	G5	S4	n/a		---
					1					Red Bat	*Lasiurus borealis*	---	---	G5	S4	n/a		---
					1					Hoary Bat	*Lasiurus cinereus*	---	---	G5	S4	n/a		---
					1					Snowshoe Hare	*Lepus americanus*	---	---	G5	S5	n/a	X	---
					1					Northern Flying Squirrel	*Glaucomys sabrinus*	---	---	G5	S5	n/a	X	AS
					1					Southern Flying Squirrel	*Glaucomys volans*	SC	NAR	G5	S4	n/a	X	AS
					1					Deer Mouse	*Peromyscus maniculatus*	---	---	G5	S5	n/a		---
					1					Woodland Vole	*Microtus pinetorum*	SC	SC	G5	S3?	n/a	X	---
					1					Woodland Jumping Mouse	*Napaeozapus insignis*	---	---	G5	S5	n/a	X	---
					1					Long-tailed Weasel	*Mustela frenata*	---	---	G5	S4	n/a	X	---

LEGEND:
COSEWIC: THR - Threatened; SC - Special Concern; NAR - assessed and deemed to be not at risk; --- = not assessed as population secure
OMNRF: THR - Threatened; SC - Special Concern; NAR - assessed and deemed to be not at risk; --- = not assessed as population secure
Global Granks: G3 - vulnerable; G4 - apparently secure; G5 - secure;
Provincial Sranks: S3 - vulnerable; S4 - apparently secure; S5 - secure; SNA - non-native exotic; B –breeding; N -; SH - Possibly Extirpated (Historical)

OPIF: PLS - Priority Landbird Species
Wellington County: X - rare
Area Sensitivity: AS = Area Sensitive species

Appendix I-1: Wildlife Species List from Available Background Resources.

Appendix I-2: Screening for Known/Candidate SWH at York Road Environmental Design site – using Ecoregion 6E Criteria Schedule (Final version: OMNRF, January 2015)

Significant Wildlife Habitat (SWH) Type	ELC Categories indicated for SWH Type	SWH present on site or within 120 m?	Rationale (Habitat Presence or Absence)	Additional field studies required?
Seasonal Concentration Areas of Animals				
Waterfowl Stopover and Staging Areas (Terrestrial)	CUM1; CUT1; plus evidence of spring (Mar – May) flooding; does not include AGR	No	No suitable habitats were detected on site or in adjacent lands during field visits.	No
Waterfowl Stopover and Staging Areas (Aquatic)	MAS1; MAS2; MAS3; SAS1; SAM1; SAF1; SWD1; SWD2; SWD3; SWD4; SWD5; SWD6; SWD7	No	Habitat available in two main ponds and adjacent Eramosa River; however, indicator species diversity and numbers unlikely to exceed significance thresholds.	No
Shorebird Migratory Stopover Area	BB01; BB02; BBS1; BBS3; BBT1; BBT2; SDO1; SDS2; SDT1; MAM1; MAM2; MAM3; MAM4; MAM5	No	No suitable habitats were detected on site or in adjacent lands during field visits.	No
Raptor Wintering Area	One of FOD, FOM, FOC and one of CUM, CUT, CUS, CUW (20+ ha); least disturbed sites 15+ ha with adjacent woodlands; BAEA: FOD, FOM, FOC, SWD or SWC on shoreline areas adjacent to large rivers or adjacent to lakes with open water	No	Open areas have suitable wintering habitats for raptors; however, they do not meet size thresholds for both open areas and adjacent woodlands. Bald Eagle may winter along adjacent Eramosa River but would not be present at the site as the main ponds would freeze in winter.	No
Bat Hibernacula	BBBA/TRBA only; CCR1; CCR2; CCA1; CCA2; does not include buildings	No	No suitable habitats were found on site or in adjacent lands.	No
Bat Maternity Colonies	BBBA/SHBA only; all FOD, FOM, SWD, SWM; 10+ ha AND 25+ cm dbh	No	No FOD or FOM habitats of greater than 10 hectares are present on site or in adjacent lands.	No
Bat Migratory Stopover Area	No specific ELC types	No	No landforms present to concentrate migrant bats although they may move along the Eramosa River; note that MNRF has not yet determined thresholds/criteria for this category.	No
Turtle Wintering Areas	SNTU/PATU: SW, MA, OA, SA; FEO and BOO; NMTU: open water areas (e.g. deeper rivers, streams) and lakes with current can also be used as over-wintering habitat.	Candidate	Open waters of the two main ponds and the adjacent Eramosa River could serve as over-wintering habitat for Painted Turtle and Snapping Turtle (both confirmed from the site).	No

Appendix I-2: Screening for Known/Candidate SWH at York Road Environmental Design site – using Ecoregion 6E Criteria Schedule (Final version: OMNRF, January 2015)

Significant Wildlife Habitat (SWH) Type	**ELC Categories indicated for SWH Type**	**SWH present on site or within 120 m?**	**Rationale (Habitat Presence or Absence)**	**Additional field studies required?**
Reptile Hibernaculum	Snakes: any ecosite except very wet ones; talus, rock barren, crevice, cave, and alvar site may be directly related; FLSK: FOD, FOM and FOC1/FOC3	No	No suitable habitats were detected on site or in adjacent lands during field visits.	No
Colonially - Nesting Bird Breeding Habitat (Bank and Cliff)	CUM1, CUS1, BLS1, CLO1, CLT1; CUT1; BLO1; BLT1; CLS1	No	No suitable habitats were detected on site or in adjacent lands during field visits.	No
Colonially - Nesting Bird Breeding Habitat (Tree/Shrubs)	SWM2; SWM3; SWM5; SWM6; SWD1; SWD2; SWD3; SWD4; SWD5; SWD6; SWD7; FET1	No	No suitable habitats were detected on site or in adjacent lands during field visits.	No
Colonially - Nesting Bird Breeding Habitat (Ground)	MAM1 – 6; MAS1 – 3; CUM; CUS; CUT	No	No suitable habitats were detected on site or in adjacent lands during field visits.	No
Migratory Butterfly Stopover Areas	Field: CUM, CUS, CUT; Forest: FOC, FOD, FOM, CUT; 10+ ha, within 5 km of Lake Ontario	No	No combination of field and forest of sufficient size found within site and adjacent lands; site not within 5 km of Lake Ontario.	No
Landbird Migratory Stopover Areas	FOC, FOM, FOD, SWC, SWM, SWD; 10+ ha, within 5 km of Lake Ontario	No	No woodlands greater than 10 ha within site or adjacent lands; site not within 5 km of Lake Ontario.	No
Deer Yarding Areas	FOM, FOC, SWM, SWC; CUP2, CUP3, FOD3, CUT; identified by MNRF	No	No suitable habitats were detected on site or in adjacent lands during field visits. None have been identified in area by MNRF.	No
Deer Winter Congregation Areas	FOC; FOM; FOD; SWC; SWM; SWD; typically 100+ ha; identified by MNRF	No	No suitable habitats were detected on site or in adjacent lands during field visits. None have been identified in area by MNRF.	No
	Rare Vegetation Communities			
Cliffs and Talus Slopes	TAO; TAS; TAT; CLO; CLS; CLT	No	None identified on site or in adjacent lands.	No
Sand Barren	SBO1; SBS1; SBT1	No	None identified on site or in adjacent lands.	No
Alvar	ALO1; ALS1; ALT1; FOC1; FOC2; CUM2; CUS2; CUT2-1; CUW2; 0.5+ ha	No	None identified on site or in adjacent lands.	No
Old Growth Forest	FOD; FOC; FOM; SWC; SWD; SWM; 30+ ha with 10+ ha IF (100m buffer)	No	None identified on site or in adjacent lands.	No
Savannah	TPS1; TPS2; TPW1; TPW2; CUS2	No	None identified on site or in adjacent lands.	No
Tallgrass Prairie	TPO1; TPO2	No	None identified on site or in adjacent lands.	No

Appendix I-2: Screening for Known/Candidate SWH at York Road Environmental Design site – using Ecoregion 6E Criteria Schedule (Final version: OMNRF, January 2015)

Significant Wildlife Habitat (SWH) Type	ELC Categories indicated for SWH Type	SWH present on site or within 120 m?	Rationale (Habitat Presence or Absence)	Additional field studies required?
Other Rare Vegetation Communities	S1, S2, or S3 vegetation communities	No	None identified on site or in adjacent lands.	No
Specialized Habitat for Wildlife				
Waterfowl Nesting Area	MAS1; MAS2; MAS3; SAS1; SAM1; SAF1; MAM1; MAM2; MAM3; MAM4; MAM5; MAM6; SWT1; SWT2; SWD1; SWD2; SWD3; SWD4	No	Potential habitat found within site; no nesting waterfowl were detected during 2016 breeding bird surveys. If present, the number and diversity of indicator species not likely to exceed significance thresholds.	No
Bald Eagle and Osprey Nesting, Foraging, and Perching Habitat	FOD; FOM; FOC; SWD; SWM; SWC; adjacent to riparian areas (rivers, lakes, ponds and wetlands)	No	No suitable habitats were detected on site or in adjacent lands during field visits; likely habitat along Eramosa River. No Bald Eagles or Ospreys or their nests were detected during the breeding bird surveys in 2016.	No
Woodland Raptor Nesting Habitat	All forested ELC ecosites; also SWC, SWM, SWD, CUP3; 30+ ha with 10+ ha IF (200m buffer)	No	No forest sites of adequate size for breeding woodland raptors are located within the sites or their adjacent lands.	No
Turtle Nesting Areas	MAM1; MAM2; MAM3; MAM4; MAM5; MAM6; SAS1; SAM1; SAF1; BOO1; FEO1	Candidate	Potential nesting areas occur along the Eramosa River and in open areas with sand and gravel. No suitable habitat was observed along Clythe Creek.	No
Seeps and Springs	Any forested ecosite within headwater area of stream	No	None identified on sites or in adjacent lands during field investigations.	No
Amphibian Breeding Habitat (Woodland)	FOC; FOM; FOD; SWC; SWM; SWD	No	No suitable habitats were detected on sites or in adjacent lands during field visits.	No
Amphibian Breeding Habitat (Wetlands)	SW, MA, FE, BO, OA, SA; typically 120+ from woodlands (except AMBU)	No	The two main ponds serve as breeding habitat for several common and widespread amphibian species; however, the number and diversity detected during the 2016 nocturnal amphibian surveys did not meet significance thresholds.	No
Woodland Area-Sensitive Bird Breeding Habitat	FOC, FOM, FOD, SWC, SWM, SWD; mature (60+ years), 30+ ha; IF 200+ m from edge	No	No large enough woodlands (30+ ha) with interior forest (greater than 200 m from edge) and 60+ years old are present on sites or in adjacent lands.	No
Habitats for Species of Conservation Concern (not including END or THR species)				

Appendix I-2: Screening for Known/Candidate SWH at York Road Environmental Design site – using Ecoregion 6E Criteria Schedule (Final version: OMNRF, January 2015)

Significant Wildlife Habitat (SWH) Type	ELC Categories indicated for SWH Type	SWH present on site or within 120 m?	Rationale (Habitat Presence or Absence)	Additional field studies required?
Marsh Breeding Bird Habitat	MAM1; MAM2; MAM3; MAM4; MAM5; MAM6; SAS1; SAM1; SAF1; FEO1; BOO1; GRHE – all SW, MA, CUM1 sites	No	No suitable habitats were detected on site or in adjacent lands during field visits. No indicator species were detected during 2016 breeding bird surveys.	No
Open Country Bird Breeding Habitat	CUM1; CUM2; 30+ ha; not Class 1 or 2 AGR or actively used for farming in last 5 years	No	No CUM1 or CUM2 habitat of greater than 30 hectares in size found in study area or adjacent lands. No indicator species were found during BBS in 2016.	No
Shrub/Early Successional Bird Breeding Habitat	CUT1; CUT2; CUS1; CUS2; CUW1; CUW2; 10+ ha; not Class 1 or 2 AGR or actively used for farming in last 5 years	No	No suitable ELC categories of sufficient size exist within the study area and adjacent lands; only one indicator species (Willow Flycatcher) found during BBS in 2016.	No
Terrestrial Crayfish	MAM1; MAM2; MAM3; MAM4; MAM5; MAM6; MAS1; MAS2; MAS3; SWT; SWD; SWM; CUM1 with inclusions of above MAM or swamp ecosites can be used by crayfish	No	No suitable habitats were detected on site or in adjacent lands during field visits	No
Special Concern and Rare Wildlife Species	SC and S1, S2, S3, and SH species	Candidate	Only one Special Concern species was found during the 2016 field investigations: Snapping Turtle. No S1 to S3 species of fauna were observed in 2016. Monarch (SC) may occur in non-significant numbers during migration and may also breed as Common Milkweed is present. No suitable habitat exists for other SC species known from the City of Hamilton (e.g., Common Nighthawk, Eastern Wood-Pewee, Canada Warbler).	No
Animal Movement Corridors				
Amphibian Movement Corridors	All ecosites associated with water	Candidate	Small numbers of amphibians were detected in the two main ponds in 2016; amphibian movement would not be to the north as no habitat exists in that direction. Eramosa River, immediately to the south, likely serves as an amphibian movement corridor.	No
Deer Movement Corridors	All forested ecosites; Stratum II Deer Wintering Areas have potential to contain corridors.	No	Such corridors are within Stratum II yarding areas, typically following riparian zones, woodlots, and ravines/ridges, and are unbroken by roads and	No

Appendix I-2: Screening for Known/Candidate SWH at York Road Environmental Design site – using Ecoregion 6E Criteria Schedule (Final version: OMNRF, January 2015)

Significant Wildlife Habitat (SWH) Type	ELC Categories indicated for SWH Type	SWH present on site or within 120 m?	Rationale (Habitat Presence or Absence)	Additional field studies required?
			residential areas. Therefore, no deer movement corridors occur on the sites or in adjacent lands.	

Common Name	Scientific Name	Conservation Status: National: COSEWIC Designation (COSEWIC 2015)	Provincial: OMNRF Designation (OMNRF 2016)	Provincial: Srank (NHIC 2016)	Provincial: Checklist of Ontario Butterflies (Jones 2012)	Local: Regional Municipality of Waterloo Herpetofauna, Mammals & Birds - (RMW 1985a,b; 1996	Local: Wellington County (local rarity only) (D&A 2009)	Covered by MBCA (1994) (Government of Canada 1994)	Area Sensitivity (OMNR, 2000)	Breeding Evidence (OBBA 2001)	Notes
Butterflies:											
Least Skipper	*Ancyloxypha numitor*	---	---	S5	C, L, Re			n/a	n/a	n/a	
European Skipper	*Thymelicus lineola*	---	---	SNA	C, Re			n/a	n/a	n/a	
Tawny-edged Skipper	*Polites themistocles*	---	---	S5	C, Re			n/a	n/a	n/a	
Eastern Tiger Swallowtail	*Papilio glaucus*	---	---	S5	C, Re			n/a	n/a	n/a	
Black Swallowtail	*Papilio polyxenes*	---	---	S5	C, Re			n/a	n/a	n/a	
Cabbage White	*Pieris rapae*	---	---	SNA	C, E, Re			n/a	n/a	n/a	
Spring Azure	*Celastrina lucia*	---	---	S5	C, Re			n/a	n/a	n/a	
Pearl Crescent	*Phyciodes tharos*	---	---	S4	C, Re			n/a	n/a	n/a	
Mourning Cloak	*Nymphalis antiopa*	---	---	S5	C, Re			n/a	n/a	n/a	
Painted Lady	*Vanessa cardui*	---	---	S5	R-C, BI			n/a	n/a	n/a	
Red Admiral	*Vanessa atalanta*	---	---	S5	U-C, BI			n/a	n/a	n/a	
Common Ringlet	*Coenonympha tullia*	---	---	S5	C, Re			n/a	n/a	n/a	
Monarch	*Danaus plexippus*	SC	SC	S2	C, BI		X	n/a	n/a	n/a	Two seen in northeast field on June 17 only; Common Milkweed is present in this area so potentially breeding.
Amphibians:											
American Toad	*Anaxyrus americanus*	---	---	S5	n/a			n/a	n/a	n/a	Recorded in small numbers (1 to 3) from survey station 2 on April 21 and May 9
Spring Peeper	*Pseudacris crucifer*	---	---	S5	n/a			n/a	n/a	n/a	Recorded in small numbers (two or less) from survey station 2 on April 21 and May 9 and survey station 3 on May 9
Northern Leopard Frog	*Lithobates pipiens*	---	---	S5	n/a			n/a	n/a	n/a	Observed in small numbers during diurnal surveys
Green Frog	*Lithobates clamitans*	---	---	S5	n/a			n/a	n/a	n/a	Recorded in small numbers in four areas outside of the three survey stations on June 21 only
Reptiles:											
Midland Painted Turtle	*Chrysemys picta marginata*	---	---	S4	n/a			n/a	n/a	n/a	
Snapping Turtle	*Chelydra serpentina*	SC	SC	S3	n/a			n/a	n/a	n/a	One seen on June 17 in small easternmost pond; carapace approximately 15 cm.
Pond Slider	*Trachemys scripta*	---	---	SNA	n/a			n/a	n/a	n/a	
Eastern Gartersnake	*Thamnophis sirtalis sirtalis*	---	---	S5	n/a			n/a	n/a	n/a	
Birds:											
Canada Goose	*Branta canadensis*	---	---		n/a			Y	---	PROBABLE	
Mute Swan	*Cygnus olor*	---	---	SNA	n/a			Y	---	POSSIBLE	
Mallard	*Anas platyrhynchos*	---	---	S5	n/a			Y	---	PROBABLE	
Ring-necked Duck	*Aythya collaris*	---	---	S5	n/a	p	X	Y	---	M	One female seen on May 20 only.
Great Blue Heron	*Ardea herodias*	---	---	S4	n/a	U	X	Y	---	X	Seen flying over site only; no colonies detected.
Green Heron	*Butorides virescens*	---	---	S4	n/a	U		Y	---	X	Seen flying ove site only.
Turkey Vulture	*Cathartes aura*	---	---	S5	n/a	U	X	N	---	X	Seen flying over site only.
Osprey	*Pandion haliaetus*	---	---	S5	n/a	p	X	N	---	X	Seen foraging over both main ponds; no evidence of nest on-site but is likely nesting locally.
Sharp-shinned Hawk	*Accipiter striatus*	NAR	NAR	S5	n/a	R		N	AS	M	One bird seen on May 3 was migrating over site.
Red-tailed Hawk	*Buteo jamaicensis*	NAR	NAR	S5	n/a			N	---	PROBABLE	One pair present.
Killdeer	*Charadrius vociferus*	---	---	S5	n/a			Y	---	PROBABLE	

Common Name	Scientific Name	Conservation Status						Covered by MBCA (1994) (Government of Canada 1994)	Area Sensitivity (OMNR, 2000)	Breeding Evidence (OBBA 2001)	Notes
		National	Provincial			Local					
		COSEWIC Designation (COSEWIC 2015)	OMNRF Designation (OMNRF 2016)	Srank (NHIC 2016)	Checklist of Ontario Butterflies (Jones 2012)	Regional Municipality of Waterloo Herpetofauna, Mammals & Birds - (RMW 1985a,b; 1996	Wellington County (local rarity only) (D&A 2009)				
Spotted Sandpiper	*Actitis macularius*	---	---	S5	n/a			Y	---	PROBABLE	
American Woodcock	*Scolopax minor*	---	---	S5	n/a			Y	---	POSSIBLE	Detected during nocturnal amphibian survey.
Herring Gull	*Larus argentatus*	---	---	S5	n/a		X	Y	---	X	Seen flying over site only; no colonies detected.
Rock Pigeon	*Patagioena livia*	---	---	SNA	n/a			N	---	X	
Mourning Dove	*Zenaida macroura*	---	---	S5	n/a			Y	---	PROBABLE	
Chimney Swift	*Chaetura pelagica*	THR	THR	S4	n/a			Y	---	POSSIBLE	Up to three birds seen foraging over the main ponds on May 20, June 3, and June 17; no suitable nesting sites (e.g. chimneys) detected but are present locally.
Belted Kingfisher	*Megaceryle alcyon*	---	---	S4	n/a	U		Y	---	PROBABLE	One pair present along Eramosa River and creek.
Downy Woodpecker	*Picoides pubescens*	---	---	S5	n/a			Y	---	POSSIBLE	
Northern Flicker	*Colaptes auratus*	---	---	S4	n/a			Y	---	PROBABLE	
Willow Flycatcher	*Empidonax traillii*	---	---	S5	n/a	U		Y	---	PROBABLE	
Great Crested Flycatcher	*Myiarchus crinitus*	---	---	S4	n/a			Y	---	POSSIBLE	
Eastern Kingbird	*Tyrannus tyrannus*	---	---	S4	n/a			Y	---	PROBABLE	Three pairs present.
Warbling Vireo	*Vireo gilvus*	---	---	S5	n/a	U		Y	---	PROBABLE	
Blue Jay	*Cyanocitta cristata*	---	---	S5	n/a			N	---	PROBABLE	
American Crow	*Corvus brachyrhynchos*	---	---	S5	n/a			N	---	PROBABLE	
Tree Swallow	*Tachycineta bicolor*	---	---	S4	n/a			Y	---	PROBABLE	
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	---	---	S4	n/a			Y	---	PROBABLE	
Barn Swallow	*Hirundo rustica*	THR	THR	S4	n/a			Y	---	PROBABLE	Up to eight birds seen foraging over baseball fields and northeast fields; no suitable structures for nesting are present on site but they are available locally.
Black-capped Chickadee	*Poecile atricapillus*	---	---	S5	n/a			Y	---	PROBABLE	
House Wren	*Troglodytes aedon*	---	---	S5	n/a			Y	---	PROBABLE	
American Robin	*Turdus migratorius*	---	---	S5	n/a			Y	---	CONFIRMED	Fledged young observed.
Gray Catbird	*Dumetella carolinensis*	---	---	S4	n/a			Y	---	PROBABLE	
European Starling	*Sturnus vulgaris*	---	---	SNA	n/a			N	---	CONFIRMED	Fledged young observed.
Cedar Waxwing	*Bombycilla cedrorum*	---	---	S5	n/a			Y	---	PROBABLE	
Common Yellowthroat	*Geothlypis trichas*	---	---	S5	n/a			Y	---	PROBABLE	
Yellow Warbler	*Setophaga petechia*	---	---	S5	n/a			Y	---	PROBABLE	
Chipping Sparrow	*Spizella passerina*	---	---	S5	n/a			Y	---	PROBABLE	
Savannah Sparrow	*Passerculus sandwichensis*	---	---	S4	n/a			Y	AS	PROBABLE	Two pairs present along south end of baseball fields.
Song Sparrow	*Melospiza melodia*	---	---	S5	n/a			Y	---	CONFIRMED	Fledged young observed.
Swamp Sparrow	*Melospiza georgiana*	---	---	S5	n/a	U		Y	---	PROBABLE	
Northern Cardinal	*Cardinalis cardinalis*	---	---	S5	n/a			Y	---	CONFIRMED	Fledged young observed.
Indigo Bunting	*Passerina cyanea*	---	---	S4	n/a			Y	---	PROBABLE	
Red-winged Blackbird	*Agelaius phoeniceus*	---	---	S4	n/a			N	---	PROBABLE	
Eastern Meadowlark	*Sturnella magna*	THR	THR	S4	n/a			Y	AS	PROBABLE	One pair present on both breeding bird surveys in northeast field.
Common Grackle	*Quiscalus quiscula*	---	---	S5	n/a			N	---	CONFIRMED	Fledged young observed.
Brown-headed Cowbird	*Molothrus ater*	---	---	S4	n/a			N	---	CONFIRMED	Fledged young observed.
Baltimore Oriole	*Icterus galbula*	---	---	S4	n/a			Y	---	PROBABLE	
American Goldfinch	*Spinus tristis*	---	---	S5	n/a			Y	---	PROBABLE	

Common Name	Scientific Name	Conservation Status						Covered by MBCA (1994) (Government of Canada 1994)	Area Sensitivity (OMNR, 2000)	Breeding Evidence (OBBA 2001)	Notes
		National	Provincial			Local					
		COSEWIC Designation (COSEWIC 2015)	OMNRF Designation (OMNRF 2016)	Srank (NHIC 2016)	Checklist of Ontario Butterflies (Jones 2012)	Regional Municipality of Waterloo Herpetofauna, Mammals & Birds - (RMW 1985a,b; 1996	Wellington County (local rarity only) (D&A 2009)				
House Sparrow	*Passer domesticus*	---	---	SNA	n/a			N	---	PROBABLE	
Mammals:											
Gray Squirrel	*Sciurus carolinensis*	---	---	S5	n/a			n/a	n/a	n/a	
Beaver	*Castor canadensis*	---	---	S5	n/a			n/a	n/a	n/a	
Raccoon	*Procyon lotor*	---	---	S5	n/a			n/a	n/a	n/a	

WEATHER AND SURVEY TIMES:

Nocturnal amphibian survey 1 - April 21, 2016; 20:44 – 21:18; Cloudy, calm, 11 – 14 °C
Snake & turtle survey 1 - May 3, 2016; 10:00 - 15:00; clear to partly cloudy, calm, 9 - 14 °C
Nocturnal amphibian survey 2 - May 9, 2016; 21:13 – 21:45; Partly cloudy, calm, 9 – 11 °C
Snake & turtle survey 2 - May 20, 2016; 10:30 - 15:30; partly cloudy, light north winds, 17 - 20 °C
Breeding bird survey (BBS) 1 - June 3, 2016; 06:15 - 09:45; clear, calm, 16 - 19 °C
Breeding bird survey (BBS) 2 - June 17, 2016; 06:30 - 10:00; clear, calm, 17 - 20 °C
Nocturnal amphibian survey 3 - June 21, 2016; 21:47 – 22:16; Partly cloudy, calm, 21 °C

LEGEND:

COSEWIC: THR - Threatened; SC - Special Concern; NAR - assessed and deemed to be not at risk; --- = not assessed as population secure
OMNRF: THR - Threatened; SC - Special Concern; NAR - assessed and deemed to be not at risk; --- = not assessed as population secure
Provincial Sranks: S2 - imperiled; S3 - vulnerable; S4 - apparently secure; S5 - secure; SNA - non-native exotic
Area Sensitivity: AS = Area Sensitive species
OBBA 2001: X - species observed flying over site only and not considered a potential breeder; M - migrant only (not breeding)
Jones 20102 - C - common; L - local; R - rare; Re - resident; E - exotic (non-native, introduced); BI - migrant (does not winter)
RMW 1985/1996 - U - uncommon; R - rare; p - probable
D&A 2009: X - rare

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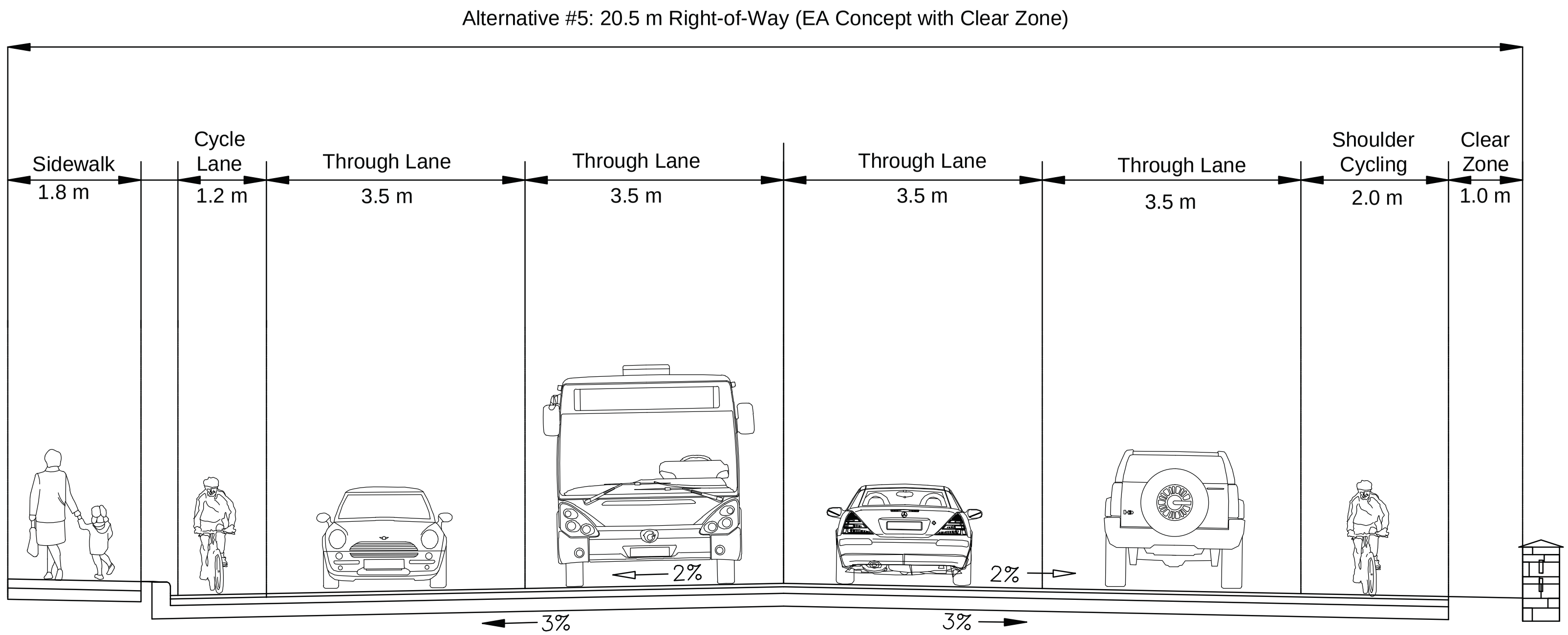
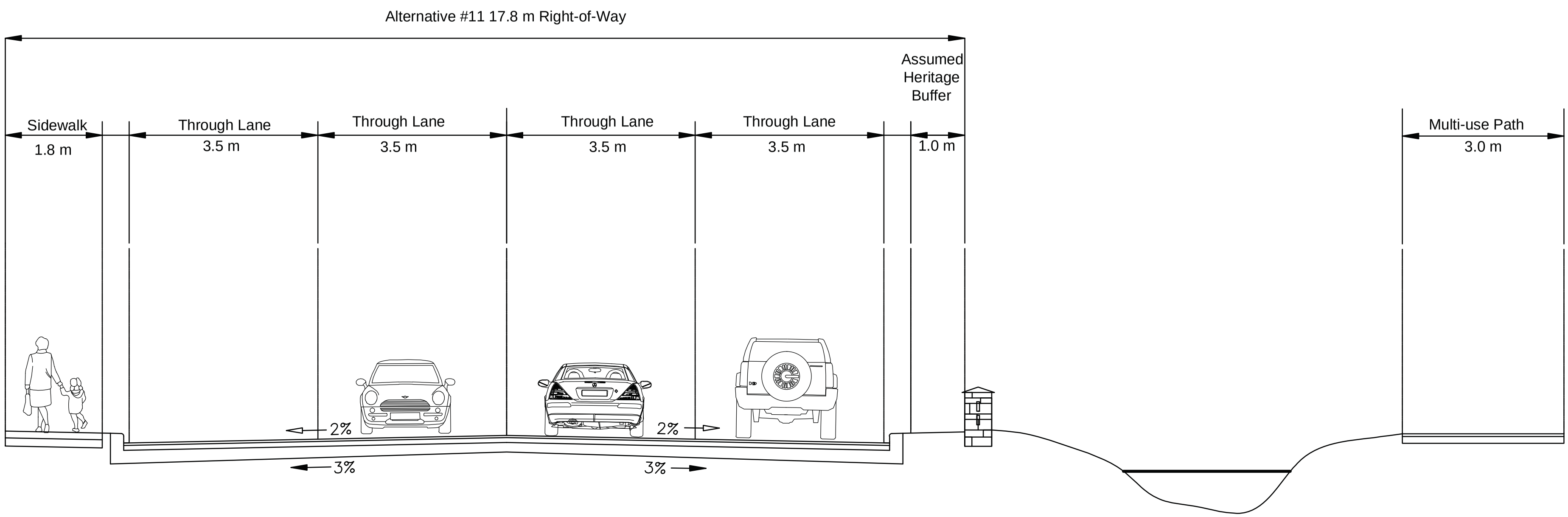
Appendix J

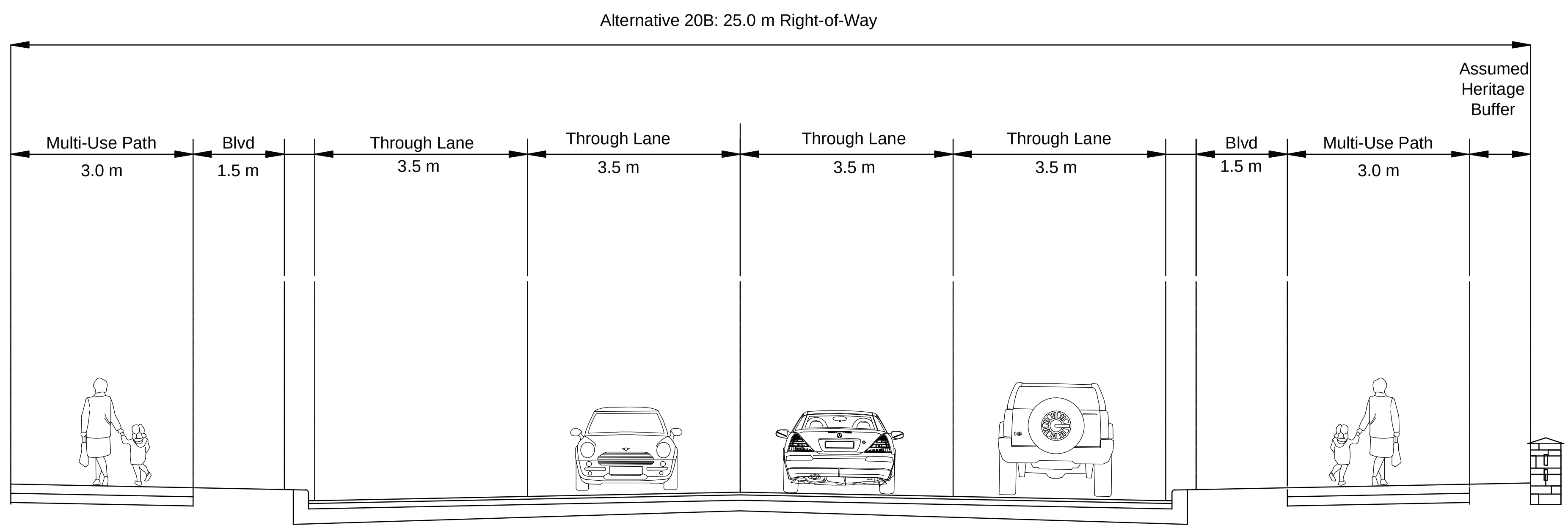
Road Assessment



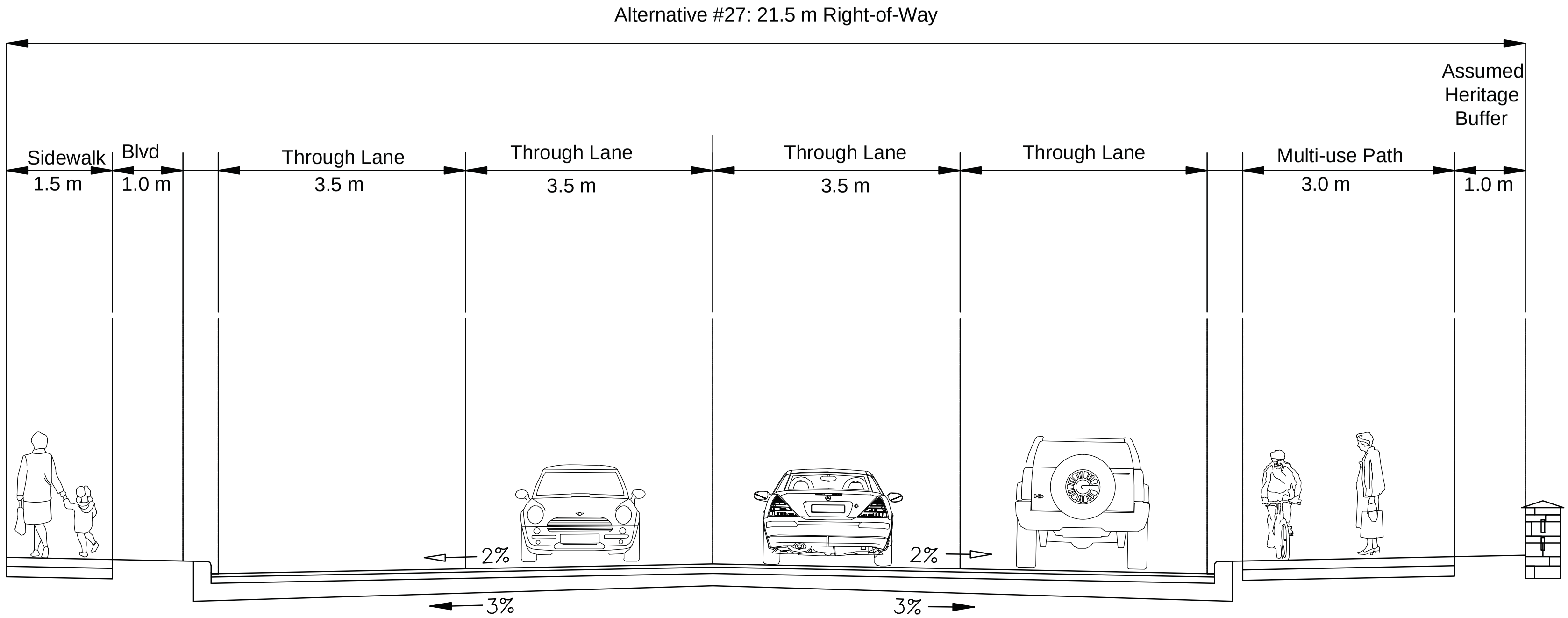
CITY OF Guelph ENGINEERING SERVICES	YORK ROAD TYPICAL SECTION - ALTERNATIVE #5 20.5m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
		SCALE : N.T.S.	DRAWING No. : -



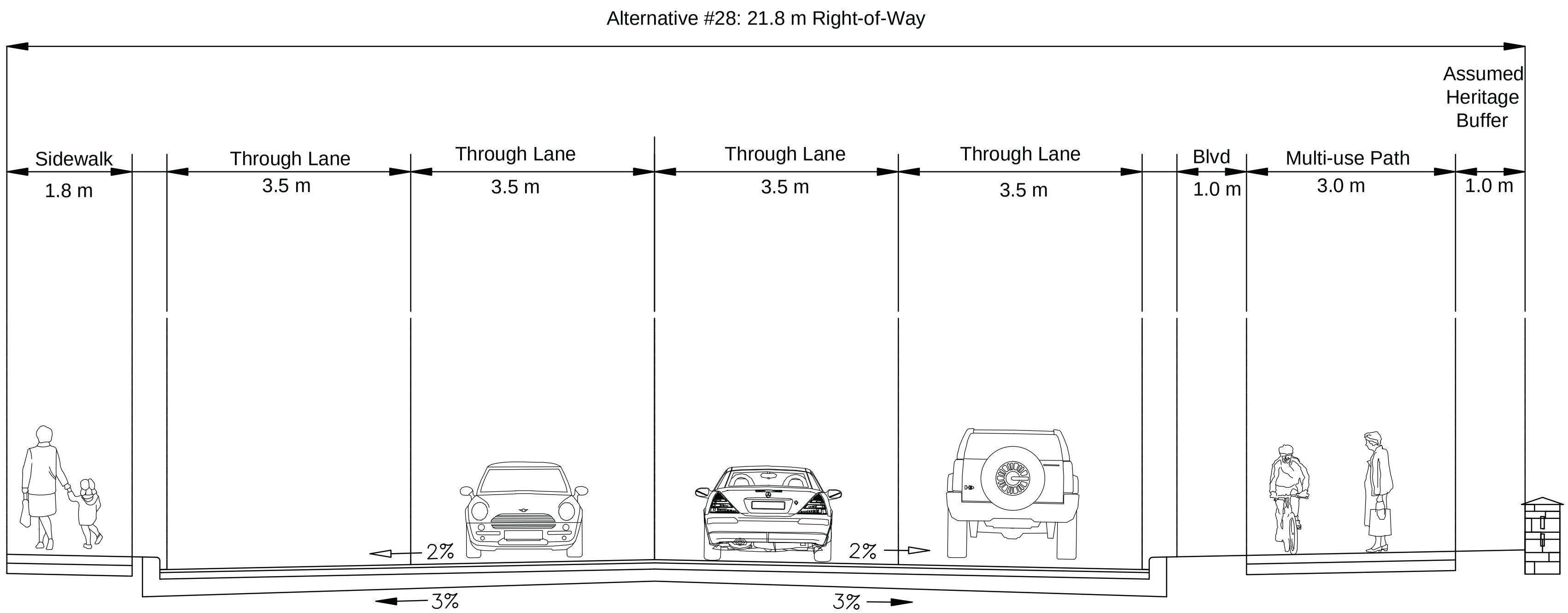
CITY OF Guelph ENGINEERING SERVICES	YORK ROAD TYPICAL SECTION - ALTERNATIVE #11 17.8m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
		SCALE : N.T.S.	DRAWING No. : -



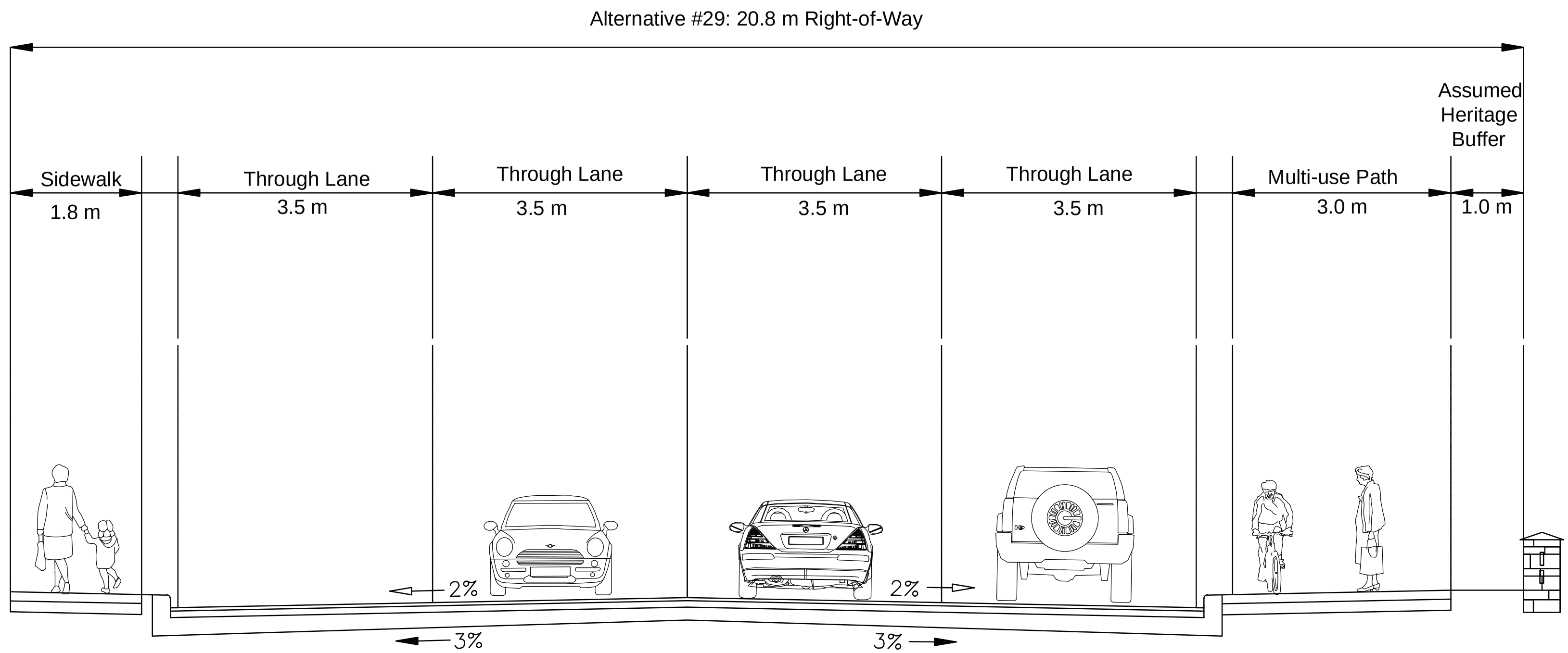
CITY OF Guelph ENGINEERING SERVICES	YORK ROAD TYPICAL SECTION - ALTERNATIVE #20B 25.0m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
		SCALE : N.T.S.	DRAWING No. : -



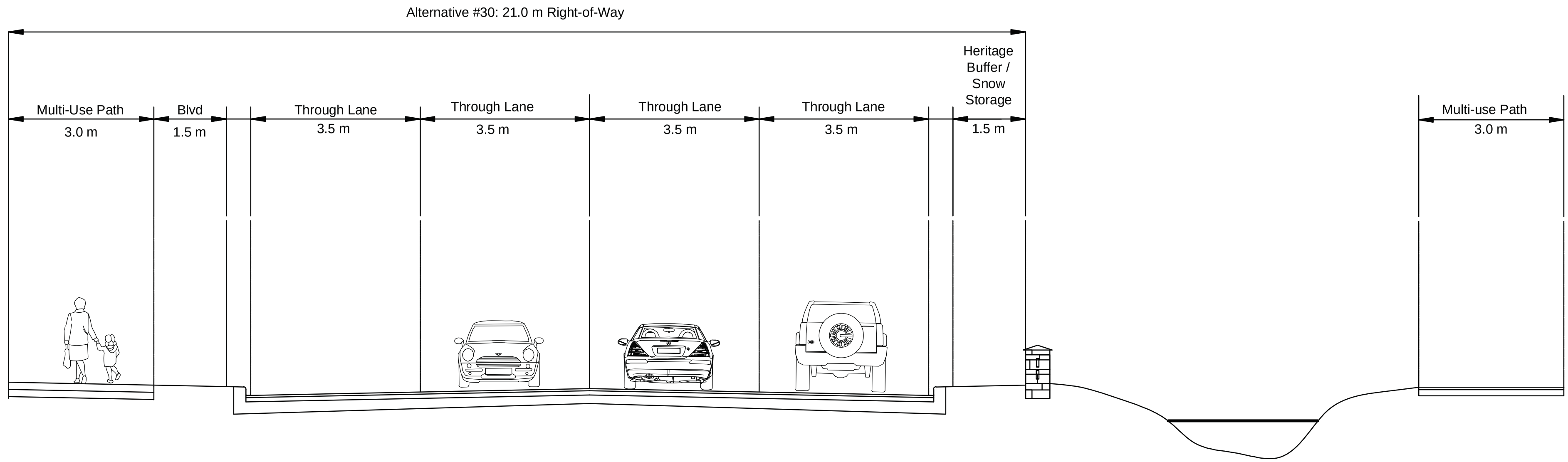
CITY OF Guelph ENGINEERING SERVICES	YORK ROAD TYPICAL SECTION - ALTERNATIVE #27 21.5m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
		SCALE : N.T.S.	DRAWING No. : -



ENGINEERING SERVICES	YORK ROAD TYPICAL SECTION - ALTERNATIVE #28 21.8m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
		SCALE : N.T.S.	DRAWING No. : -



CITY OF Guelph ENGINEERING SERVICES	YORK ROAD TYPICAL SECTION - ALTERNATIVE #29 20.8m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
		SCALE : N.T.S.	DRAWING No. : -



ENGINEERING SERVICES

YORK ROAD

TYPICAL SECTION - ALTERNATIVE #30

21.0m RIGHT OF WAY

DATE DRAWN : 2016/08/25	DRAWN BY : BS
SCALE : N.T.S.	DRAWING No. : -

York Road Cross-Section Alternatives

25-Aug-16

Alt #	General Description	Inside Lane Width (m)	Outside Lane Width (m)	Cycle Lane Width (m)		Sidewalk Width (m)		Multi-Use Pathway (m)		Curb Width (m)		Boulevard Width (m)		Shoulder Width, Incl. Clear Zone (m)		Heritage Buffer (m)	Total Width
				North Side	South Side	North Side	South Side	North Side	South Side	North Side	South Side	North Side	South Side	North Side	South Side		
1	Sidewalks and Cycle Lanes on Both Sides	3.5	4.0	1.5	1.5	1.5	1.5			0.5	0.5	1.0	1.0				24.00
2		3.5	3.5	1.5	1.5	1.5	1.5			0.5	0.5	1.0	1.0				23.00
3		3.5	4.0	1.5	1.5	1.8	1.8			0.5	0.5						22.60
4		3.5	3.5	1.5	1.5	1.8	1.8			0.5	0.5						21.60
5		3.5	3.5	1.2		1.8				0.5					3.0		20.50
6	Sidewalks Only, with and without Shared Use Lanes	3.5	4.3			1.5	1.5			0.5	0.5	1.0	1.0				21.60
7		3.5	4.3			1.8	1.8			0.5	0.5						20.20
8		3.5	3.5			1.5	1.5			0.5	0.5	1.0	1.0				20.00
9		3.5	3.5			1.8	1.8			0.5	0.5						18.60
10		3.5	3.5			1.5				0.5	0.5	1.0			0.5		18.00
11		3.5	3.5			1.8				0.5	0.5				0.5	0.5	17.80
12		3.5	3.5			1.5				0.5		1.0			3.0		20.00
13		3.5	3.5			1.8				0.5					3.0		19.30
14	Sidewalk on North Side, Cycle Lanes on Both Sides	3.5	3.5	1.5	1.5	1.5				0.5		1.0			1.5	1.0	22.50
15		3.5	3.5	1.5	1.5	1.8				0.5					1.5	1.0	21.80
16		3.5	3.5	1.5	1.5	1.5				0.5	0.5	1.0			0.5	0.5	21.50
17		3.5	3.5	1.5	1.5	1.8				0.5	0.5				0.5	0.5	20.80
18	Multi-Use on Both Sides, With Boulevards	3.5	4.3					3.0	3.0	0.5	0.5	1.0	1.0			1.0	25.60
19		3.5	4.0					3.0	3.0	0.5	0.5	1.0	1.0			1.0	25.00
20		3.5	3.5					3.0	3.0	0.5	0.5	1.0	1.0			1.0	24.00
21	Multi-Use on Both Sides, Without Boulevards	3.5	4.3					3.0	3.0	0.5	0.5					1.0	23.60
22		3.5	4.0					3.0	3.0	0.5	0.5					1.0	23.00
23		3.5	3.5					3.0	3.0	0.5	0.5					1.0	22.00
24	Sidewalk and Shared-Use Lane on North Side, Multi-Use on South Side	3.5	4.3/3.5			1.5			3.0	0.5	0.5	1.0	1.0			1.0	23.20
25		3.5	4.3/3.5			1.5			3.0	0.5	0.5	1.0				1.0	22.20
26		3.5	4.3/3.5			1.8			3.0	0.5	0.5					1.0	21.50
27	Sidewalk on North Side, Multi-Use on South Side	3.5	3.5			1.5			3.0	0.5	0.5	1.0				1.0	21.50
28		3.5	3.5			1.8			3.0	0.5	0.5		1.0			1.0	21.80
29		3.5	3.5			1.8			3.0	0.5	0.5					1.0	20.80

Notes:

- Profile will need to be reviewed in all instances to ensure roadway surface can be properly drained
- Storm sewer system will be required

Appendix K

Road Alternatives 1-4 Assessment

Memo

To: Arun Hindupur, City of Guelph

From: Steve Chipps, Linda Axford and Maria King, Amec Foster Wheeler

Date: December 19, 2017

File: TP115100-26

cc: Todd Fell, Dougan & Associates and Mark Wojda, Matrix Solutions

Re: **York Road Environmental Design Study, Road Alternatives Assessment, City of Guelph**

1. INTRODUCTION

In March 2017, the Amec Foster Wheeler Team (Team) submitted the draft Environmental Impact Study (EIS) and the Heritage Impact Assessment (HIA) to the City of Guelph for consideration. Subsequent to that submission, the Team presented the findings to the River Systems Advisory Committee (RSAC) on April 19, 2017 and the Heritage Committee (HC), May 8, 2017. The City provided verbal comments on the EIS and HIA at the associated committee meetings and formal written comments on May 11, 2017 (ref. A.Hindupur, City of Guelph – S.Chipp, Amec Foster Wheeler). The Team prepared a comments response matrix and provided this to the City on June 30, 2017. Subsequently, the City provided additional clarification comments and input on the road design alternatives on August 16 and August 22, 2017 respectively (ref. S.Chipps, Amec Foster Wheeler – A.Hindupur, City of Guelph).

In discussion with City staff regarding the comments of August 16th, 2017 the main point of concern regarding the EIS, is the recommendation for the multi-use pathway (MUP) on the south side of Clythe Creek, where, due to space restrictions related to the required road lanes, boulevards, MUPs and setback widths, the MUP could not be within the road right-of-way (ROW) on the south side. City staff has concerns with the usability, property requirements and capital and operation costs of a MUP located south of the creek, and as of August 22nd, 2017, determined potential reduced MUP and boulevard widths that could be used within the road ROW design in conjunction with preferred road section alternatives 20A/ 20B (20) and 23. Previously, reduced MUP and/or boulevard widths, were not considered acceptable for a preferred road ROW configuration, and as such, City staff agreed on the MUP being located south of Clythe Creek, as has been assessed within the draft EIS.

In discussion with City staff on August 16th, 2017, it was recognized that additional assessment would be required by the Team to assess road section alternatives with reduced MUP and boulevard widths. It was understood by City staff that based on these updated parametrics, there could be impacts to both the EIS recommended creek alignment and configuration, existing cultural heritage features and vegetation. The revisions could also impact the preferred drainage system and stormwater management strategy currently outlined within the draft EIS.

2. PREVIOUSLY-ADVANCED ROADWAY CROSS-SECTIONS

2.1. 2007 York Road Environmental Assessment

The 2007 York Road Improvements Class EA completed by TSH recommended a partially-rural typical section adjacent to the York District Lands that included four lanes of vehicular traffic, on-street cycle lanes, and a sidewalk on the north side only. This typical section, which is illustrated in Figure 2.1, provided a combined total width of active transportation infrastructure of 4.5 m. At the time of development of this section, there was little concern for preservation of the heritage features along the south side of York Road.

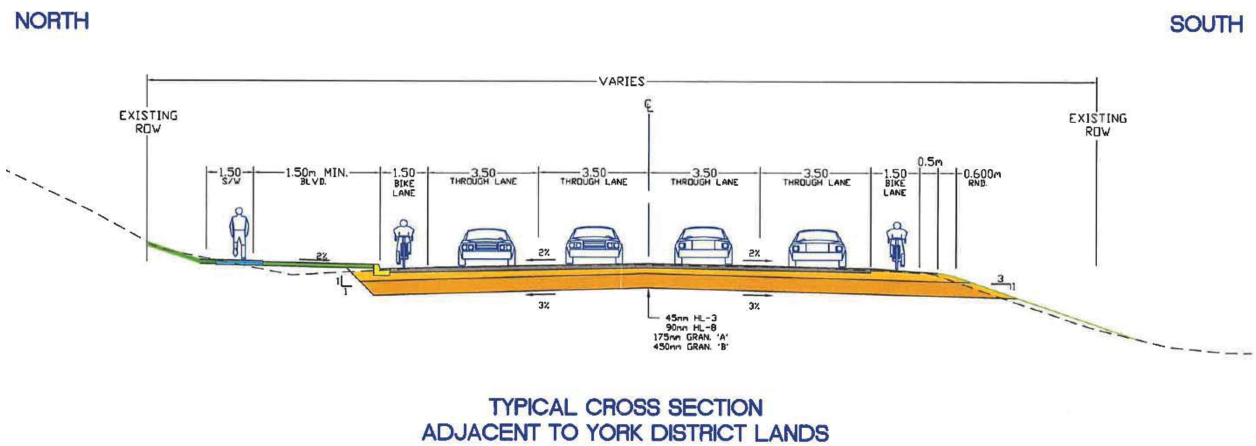


Figure 2.1: Typical Section from 2007 York Road Environmental Assessment

2.2. 2017 York Road Environmental Impact Study

When Amec Foster Wheeler completed the Environmental Impact Study (EIS) for the portion of York Road between Victoria Street and the East City Limits in 2017, direction was provided by the City to ensure pedestrian and cycling facilities were provided on both sides of the roadway. Based on results of the detailed cycling infrastructure alternative evaluation process laid out in OTM Book 18, recommendations were made to either provide buffered on-street cycling lanes (acceptable) or off-road cycle track or multi-use pathway (preferred) to accommodate cyclists in the corridor. In order to limit the cross-sectional width required to accommodate active transportation infrastructure, multi-use pathways on both the north and south sides of York Road, were recommended. Along the majority of the corridor, it was recommended that the multi-use pathways be located adjacent to the roadway, set back by a 1.5 m boulevard to facilitate snow storage. At the former Reformatory entrance, however, it was determined that a roadway cross-section that included the requested multi-use pathways, boulevards and heritage setbacks could not be provided without impacts to the north property limit. As such, it was determined that the multi-use pathway should be relocated away from the roadway from the most feasible western location (across from the future Elizabeth Street intersection), to a point beyond the Reformatory entrance gates. The typical section for this alternative is provided as Figure 2.2, below.

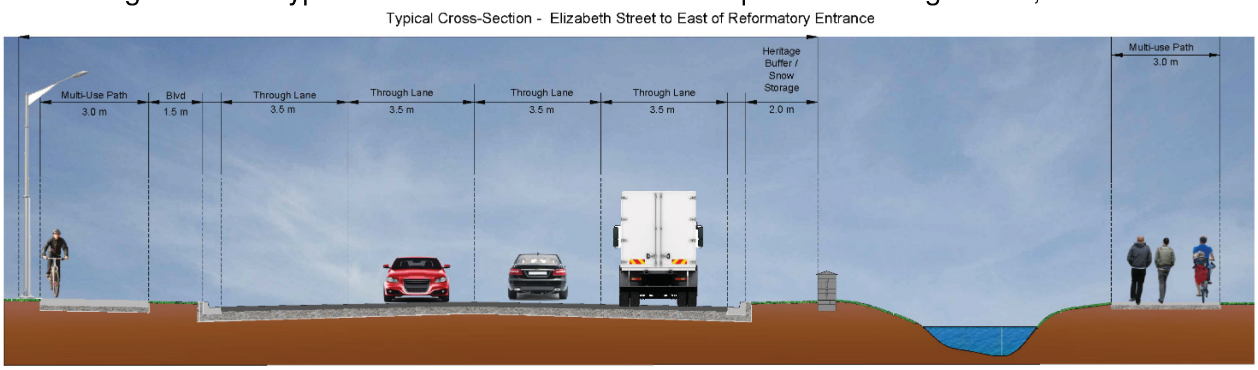


Figure 2.2: 2017 EIS-Recommended Typical Section Adjacent to York District Lands

3. ALTERNATIVE 1: (ROAD ALTERNATIVE 20: 3 M MUP ON BOTH SIDES WITH 1.0 M BOULEVARDS)

3.1. Road Design

Roadway Alternative 1 considers the provision of both north and south multi-use pathways within the York Road right-of-way, along with 1.0 m wide boulevards, a 1.0 m platform and 0.5 m rounding on the south side (per City direction), and 3:1 embankment slopes. Although the boulevards used in Alternative 1 are 0.5 m narrower than what was recommended in the 2007 York Road Improvements Environmental Study Report, and 3.5 m narrower than the City standard, they do provide some snow storage adjacent to the roadway. In order to optimize available space within the ROW, the roadway alignment has been shifted 0.5 m to the north relative to the design presented in the EIS. The profile has also been adjusted to minimize grading impacts on adjacent properties. Similar to the design presented in the EIS, extension of the Hadati Creek culvert would be required, and opportunities to reduce impacts to the creek and heritage features through implementation of various segments of retaining walls/soil systems could be investigated, although not completed at this time. Roadway cross-section Alternative 1 is illustrated in Figure 3.1, Appendix A, with the associated plan and profile drawings provided in Appendix A.

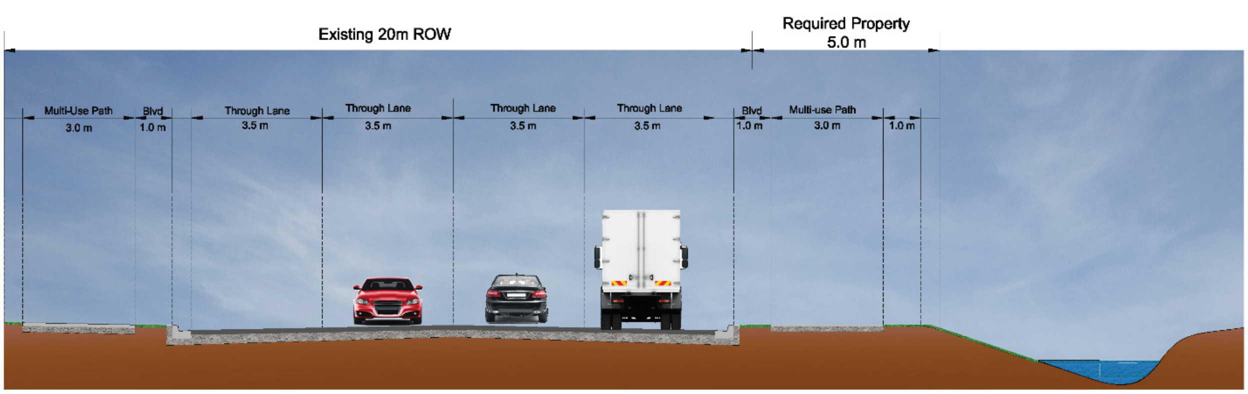


Figure 3.1 Typical Roadway Cross-Section for York Road Alternative 1.

3.2. Creek Design

The grading slopes (i.e. either 2:1 or 3:1 H:V) that are required to accommodate the proposed 3 m wide MUP alongside York Road and adjacent to Clythe Creek extends further south into the floodplain area than the previously-established preferred alternative (ref. Appendices A and B). Matrix Solutions (Stream Morphologists) selected the 3:1 H:V roadway grading slope in order to establish the constraining limits when considering changes to the channel planform. An evaluation of the new grading limit for Alternative 1 reveals that it overlaps with the preferred channel alignment at two separate locations.

The first location where the revised grading slope intersects with the preferred channel alignment is within Reach C-9A, upstream of the Reformatory driveway (approximate chainage 0+425 m, Sheet 01). Within this reach, the existing planform of Clythe Creek flows over a stone weir (Cultural Feature ‘14’). The preferred channel alignment option realigns the primary flow pathway further south around the stone weir, reconnecting to the existing channel at a pool immediately downstream of the weir. From this location, the creek then flows under the Reformatory Bridge. At the stone weir, the preferred alignment has incorporated a ‘high-flow’ channel that directs flows exceeding bankfull (i.e., close to overtopping the channel banks) towards and through the existing channel at the weir. This approach supports fish passage through the primary channel but also allows for the weir to be activated at higher flows, partially mitigating its disconnection from the main channel. However, to accommodate the 3:1 H:V road grading associated with Alternative 1, an adjustment to the currently preferred channel alignment is necessary. Based on the new grading, it is not possible to re-connect the channel at the pool immediately downstream of the weir, as the pool must be infilled to achieve the desired grading. As this pool becomes unusable, the proposed channel alignment must tie-in to the existing channel further downstream. In addition, this new configuration would eliminate the ‘high-flow’ channel and any continued flow through the weir as the grading and fill would cut off the connection location. The adjustments required at this location do not otherwise impact the form and function of Clythe Creek from the previously-identified preferred channel alignment.

The second location requiring adjustment is in the vicinity of the Hadati Creek confluence (approximate chainage 0+850 to 1+050 m, Sheet 03). The grading to accommodate the alternative roadway/MUP cross section would necessitate shifting the design planform slightly south. The shifted planform aligns with the concrete box culvert that is proposed to replace the existing corrugated steel pipes at this location. Downstream of the crossing, Hadati Creek flows south through a box culvert under York Road where it enters Clythe Creek at the outlet. The box culvert is to be extended on the south side, facilitated by the shift south of the Clythe Creek planform. Whereas the preferred channel alignment utilized the existing creek planform for approximately 40 m west of the culvert, the revised planform requires additional cut, as the creek bend begins further upstream. The existing length of creek that was previously intended as part of the design channel will need to be filled. The design change at the second location does not have significant implications on channel function when compared to the original preferred channel alignment.

3.3. Cultural Heritage Assessment

Alternative 1 would require changes to, and removals of, cultural heritage resources which would dramatically change the cultural heritage landscape along York Road.

In Alternative 1, the proposed roadway improvements include the potential widening of York Road, a 3 m multi-use path on each side of the roadway, a 1 m additional area for snow storage south of the multi-use path on the south side of York Road and a re-alignment of major portions of Clythe Creek. These improvements are expected to impact the cultural heritage resources leaving some heritage features in situ but without water flow and the complete removal of other heritage features.

The changes in Alternative 1 would include the removal of the stone culvert (#1) which travels under York Road; the remnant bridge railing on the north side of York Road (#2); the intermittent stream which feeds into Clythe Creek (#13); the fieldstone entrance wing walls on both side of the entrance way (#15 and 16); fieldstone weirs #22, 24, 25, and 26; and the limestone pillars and wood board fencing alongside York Road (#28, 29 and 30). Some fieldstone weirs and steps would remain in situ but without water flow (these include weirs #3, 5, 8, 23 and 35).

Fieldstone weirs # 9, 10, 11, and 14 may be removed or could possibly be maintained in situ with retaining walls or grading. However, if they remain they would all be impacted by loss of flow as a result of channel realignment. In Alternative 1 the new creek bed is moved south of the existing creek bed just west of weir #14 with the existing bed filled in and re-graded.

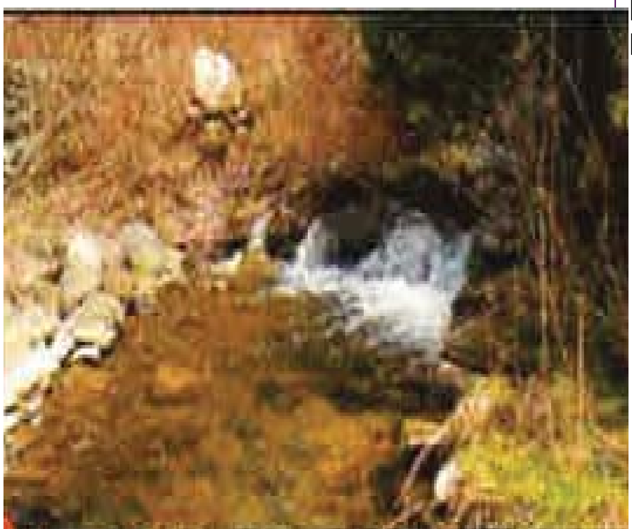
In Alternative 1, roadway and pathway grading may impact the fieldstone steps (#6), and a large bedrock outcrop (#7). There is a potential modification of the limestone terrace wall (#12), the arched pedestrian bridge (#27), the metal and wood bridges (# 31, 32 and 33) and the box culvert (#34) due to the channel work or pedestrian traffic needs.

Below are photos and descriptions of each of the recognized 36 “listed” or “potential” heritage resources with possible impacts. Where there are variances between Alternative 1 and Alternative 2, explanations are included:

No	Photo of CH Resource	Description	Impacts
1		Ashlar stone culvert, of unknown age, on the north side of York Road Clythe Creek passes under this	**<u>Removal: Alternative 1&2</u>** Culvert will be removed and replaced with a wider arched culvert for the road widening.

No	Photo of CH Resource	Description	Impacts
2		Reinforced concrete road bridge railing (remnant) circa 1920	**<u>Removal: Alternative 1&2</u>** This feature will be removed due to road widening and multi-use path.
3		Fieldstone weir with steps and sentinel stones This is a barrier to fish passage	**<u>Maintained in situ: Alternative 1&2</u>** This feature will be maintained in landscape but will be impacted by loss of flow as a result of channel realignment.
4		Fieldstone garden wall with sentinel stones	**<u>No Impact: Alternative 1&2</u>** Wall to remain in existing condition.
5		**Fieldstone weir with clay pipes** This is a barrier to fish passage	**<u>Maintained in situ: Alternative 1&2</u>** This feature will be maintained in landscape but will be impacted by loss of flow as a result of channel realignment.

No	Photo of CH Resource	Description	Impacts
6		**Fieldstone steps**	**<u>Potentially impacted: Alternative 1&2</u>** The steps may be covered by grading for road and pathway.
7		**Large Boulder or bedrock outcrop**	**<u>Potentially impacted: Alternative 1&2</u>** This feature may be covered by grading for road and pathway.
8		**Fieldstone weir** This is a barrier to fish passage	**<u>Maintained in situ: Alternative 1&2</u>** The weir will be maintained in landscape but will be impacted by loss of flow as a result of channel realignment.

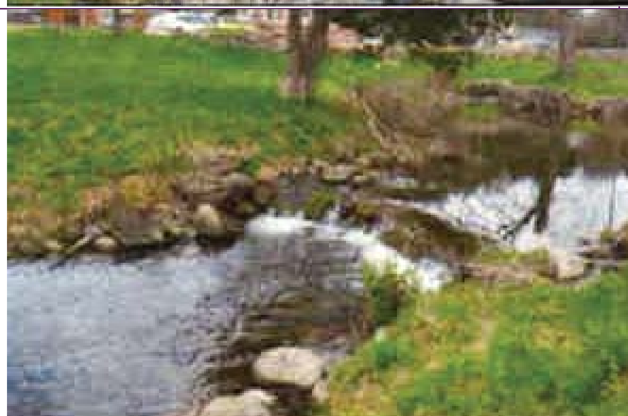
No	Photo of CH Resource	Description	Impacts
9		**Fieldstone weir beside gabion baskets**	**<u>Removal or possibly maintained in situ: Alternative 1&2</u>** This feature will be removed due to grading for road widening and multi-use path. If a proposed retaining wall is built it could be maintained in the landscape but will be impacted by loss of flow.
10		**Fieldstone weir**	**<u>Removal or possibly maintained in situ: Alternative 1&2</u>** This feature will be removed due to grading needed for road widening and multi-use path. If a proposed retaining wall is built it could be maintained in the landscape but will be impacted by loss of flow.

No	Photo of CH Resource	Description	Impacts
11		**Fieldstone weir, steps and ashlar stone terrace wall**	**Removal or possibly maintained in situ: Alternative 1&2** This feature will be removed due to grading needed for road widening and multi-use path. If a proposed retaining wall is built it could be maintained in the landscape but will be impacted by loss of flow.
12		**Ashlar cut limestone terrace wall**	**Partial removal: Alternative 1&2** Feature will be partially impacted by proposed creek realignment and grading requirements.
13		**Confluence of creek and intermittent stream**	**Removal: Alternative 1&2** The existing intermittent stream will be filled and re-graded.

No	Photo of CH Resource	Description	Impacts
14		**Fieldstone weir with cut stone terrace wall** **<u>Alternative 1</u>:** New channel would be created south of existing creek which would be filled from #14 westward. **<u>Alternative 2</u>**: New channel would tie into existing creek just west of #14.	**<u>Removal or possibly maintained in situ: Alternative 1&2</u>** This feature might be removed due to grading needed for road widening and multi-use path. Or, if left in situ it will be impacted by loss of flow.
15		**Fieldstone entrance wall**	**<u>Removal: Alternative 1&2</u>** This feature will be removed due to grading needed for road widening and multi-use path
16		**Fieldstone west entrance wall, curved with sentinel stones**	**<u>Removal: Alternative 1&2</u>** This feature will be removed due to grading needed for road widening and multi-use path

No	Photo of CH Resource	Description	Impacts
17		**Stone and concrete road bridge**	**No Impact: Alternative 1&2** Feature to remain in existing condition
18		**Fieldstone steps to the south of road bridge**	**No Impact: Alternative 1&2** Feature to remain in existing condition .
19		**Entrance sign, ashlar, rock-faced limestones with jack arch**	**No Impact: Alternative 1&2** Feature to remain in existing condition

No	Photo of CH Resource	Description	Impacts
20		**Ashlar dry stone wall**	**No Impact: Alternative 1&2** Feature to remain in existing condition
21		• **Willowbank Hall**	**No Impact: Alternative 1&2** Feature to remain in existing condition
22		**Fieldstone weir**	**Removal: Alternative 1&2** This feature will be removed as a result of channel work
23		**Fieldstone weir and culvert**	**Maintained in situ: Alternative 1&2** Feature will be maintained in landscape but will be impacted by loss of flow as a result of channel realignment

No	Photo of CH Resource	Description	Impacts
24		**Fieldstone weir and culvert**	**<u>Removal: Alternative 1&2</u>** This feature will be removed as a result of channel work and grading for roadway and pathway
25		**Fieldstone weir**	**<u>Removal: Alternative 1&2</u>** This feature will be removed as a result of channel work and grading for roadway and pathway
26		**Fieldstone weir**	**<u>Removal: Alternative 1&2</u>** This feature will be removed as a result of channel work

No	Photo of CH Resource	Description	Impacts
27		**Arched concrete and metal pedestrian bridge with stone abutments**	**<u>Potential Modification: Alternative 1&2</u>** This feature may need to be modified to accommodate pedestrian traffic and channel work
28		**Limestone pillars with wood board fencing leading to main entrance**	**<u>Removal: Alternative 1&2</u>** This feature will be removed due to grading needed for road widening and multi-use path
29		**Limestone pillars with wood board fencing leading to main entrance** (same as above).	**<u>Removal: Alternative 1&2</u>** This feature will be removed due to grading needed for road widening and multi-use path

No	Photo of CH Resource	Description	Impacts
30		**Limestone pillars with wood board fencing leading to main entrance**	**<u>Removal: Alternative 1&2</u>** This feature will be removed due to grading needed for road widening and multi-use path
31		**Metal and wood pedestrian bridge**	**<u>Potential Modification or Removal: Alternative 1&2</u>** Potential for feature to be modified to accommodate pedestrian traffic or removed due to channel works
32		**Metal and wood pedestrian bridge**	**<u>Potential Modification or Removal: Alternative 1&2</u>** Potential for feature to be modified to accommodate pedestrian traffic or removed due to channel works

No	Photo of CH Resource	Description	Impacts
33		**Metal and wood pedestrian bridge**	**<u>Potential Modification or Removal: Alternative 1&2</u>** Potential for feature to be modified to accommodate pedestrian traffic or removed due to channel works
34		**Box culvert at confluence of Clythe Creek and Hadati Creek**	**<u>Potential Modification: Alternative 1&2</u>** Culvert may be extended to accommodate roadway grading requirement and CSP replacement
35		**Concrete and stone weir**	**<u>Maintained in situ: Alternative 1&2</u>** Feature will be maintained in landscape but will be impacted by loss of flow as a result of channel realignment
36		**GJR railroad bridge**	**<u>No Impact: Alternative 1&2</u>** Feature to remain in existing condition

3.4. Terrestrial Habitat Assessment

A comprehensive background review supported by multiple field investigations was completed as a part of the draft York Road Environmental Design Environmental Impact Study (March 2017) which yielded a long list of key terrestrial ecological sensitivities present, or potentially present, within the York Road Environmental Design (YRED) Study Area. The key sensitivities potentially present within the Study Area include:

- Sensitive ELC communities;
- Species at Risk (SAR);
- Regionally Important Vegetation - City of Guelph (City of Guelph, 2012) & Wellington County (Frank and Anderson 2009);
- Other significant vegetation;
- Area Sensitive Birds;
- Potentially Breeding Locally Sensitive Birds; and
- Candidate Significant Wildlife Habitat (SWH).

Appendix C-1 includes a summary of these sensitivities and where they are located within the Study Area.

The potential terrestrial habitat impacts associated with the Alternative 1 road widening can be described as direct, indirect, and induced and can vary in magnitude and permanence. Magnitude refers to the size or severity of the impacts and permanence refers both the duration and the reversibility of an impact. The potential impacts to terrestrial habitat reviewed in the draft York Road Environmental Design Environmental Impact Study (March 2017) include:

- Changes to soil permeability, water balance, drainage patterns, run off, and soil stability;
- Modification to vegetation communities;
- Modification to arboricultural resources;
- Construction disturbance of wildlife;
- Import/export of fill;
- Removal of Open Country Bird Habitat;
- Encroachment of natural areas;
- Indirect pollution; and
- Removal of significant species and their habitat.

For a description of each impact, its potential magnitude, and the duration; review Section 4.2 of draft York Road Environmental Design Environmental Impact Study (March 2017) which has been provided in Appendix C-2.

For Alternative 1, road and creek design are expected to impact a sensitive ELC community (Fresh-Moist Lowland Deciduous Forest Type (FOD7-4)) and a regionally important plant (Rough Aven's (*Geum laciniatum*)). There is a potential to also directly impact Polygon 12 and 13 (ref. Appendix C, Figure 1), Mineral Meadow Marsh (MAM2) and Forb Mineral Meadow Marsh

(MAM2-10) respectively, as it is directly adjacent to the creek alignment. There is a potential for indirect impacts to the following sensitivities:

- Sensitive ELC communities;
- Regionally Important Vegetation;
- Other significant vegetation;
- Species at Risk (SAR);
- Area Sensitive Birds;
- Potentially Breeding Locally Sensitive Birds; and
- Candidate Significant Wildlife Habitat (SWH).

Appendix C-1 provides a description of expected and potential impacts to each sensitivity. Many potential indirect impacts can be avoided through mitigation measures and recommendations, discussed further in Section 4.1 and 4.2.

3.5. Stormwater Management Strategy

The assessment of drainage impacts associated with the proposed road condition as documented in the March 2017 Environmental Impact Statement (EIS), indicates that quantity controls are either not required or will be limited, based on the minimal difference between future and existing road right-of-way conditions (i.e. net imperviousness). Notwithstanding the lack or need for stormwater quantity controls to mitigate the estimated differences in peak flows for the 2 year to 100 year storm events, quality and erosion controls are still considered necessary and important. In general, there are numerous stormwater management practices, which can be used to provide either erosion control and/ or treatment of contaminated stormwater runoff from roadway surfaces, these include the following:

i. Wet ponds/wetlands/hybrids (generally linear facilities)
ii. Enhanced grass swales
iii. Filter Strips
iv. Bioretention Systems
v. Infiltration Systems
vi. Oil and grit separators
vii. Off-site stormwater management facilities
viii. Cash-in-lieu of on-site treatment

The respective characteristics, advantages and disadvantages of the foregoing have been well documented in previous municipal and provincial literature and hence this information has not been repeated within this document. The advantages and disadvantages of the various Best Management Practices associated with both quantity (erosion) and quality control measures are as follows:

Erosion Control

For erosion control, on-site measures to temporarily detain runoff volume and reduce peak flow impacts can be highly constraining due to the general lack of properly configured land. Roadway corridors, due to their inherent linear nature, can only effectively manage relatively small volumes of increased runoff (peak flows), in the absence of stand-alone land acquisition and / or costly subsurface storage system. Combinations of measures to mitigate impacts through some on-site underground storage, along with off-site upgrades as necessary, can be required to offset impacts.

Quality Control

i. Wet ponds, Wetlands, Hybrids

For York Road, this particular opportunity (new stormwater management facilities) is not considered practical and has not been considered further for Road Alternative 1 or Road Alternative 2.

ii. Enhanced Grassed Swales

Grassed swales designed with a trapezoidal geometry and flat longitudinal profiles with largely un-maintained turf can provide excellent filtration and treatment for storm runoff from roadways. Gutter outlets along outside lanes function to convey flow from the road to enhanced grass swales next to sidewalks or multi-use trails. That said, there is little to no space on either side of the proposed multi-use paths for Alternative 1 and 2, as such this alternative has not been short-listed.

iii. Filter Strips

Filter strips require flat areas with slopes ranging from 1 to 5% and are usually in the range of 10 to 20 m in length in the direction of flow. Based on the space requirement, this water quality measure has not been short-listed for either Alternative 1 or Alternative 2.

iv. Oil and Grit Separators

These systems tend to serve limited drainage areas of 2 ha +/- and provide levels of treatment often (less than Enhanced, formerly Level 1 unless combined with other measures as part of a treatment train). Disadvantages include the need for frequent maintenance, as well as relatively high capital costs and the ability to only serve small drainage areas. Given these systems consume comparatively less space, this water quality measure has been short-listed for further consideration.

v. Off-Site Stormwater Management Facilities

There are no practical opportunities for roadway runoff conveyance to off-site facilities for the York Road improvements, under either Alternative 1 or Alternative 2.

vi. Cash-in-Lieu of On-Site Treatment

Often, due to the sensitivity of downstream systems (i.e. low habitat potential) and the difficulty of providing affordable and effective stormwater management on-site, roadway authorities have proposed the contribution of cash-in-lieu of on-site stormwater management, to be directed towards other environmental enhancement projects. Given the cold water (upstream of Haditi Creek) designation of the local receivers of roadway runoff, this approach would not be supported for Alternative 1 and Alternative 2, as it does not address the road runoff being directed to Clythe Creek.

vii. Low Impact Development Best Management Practices (LID BMPs)

Low Impact Development represents the application of a suite of BMPs normally related to source and conveyance storm water management controls to promote infiltration and pollutant removal on a local site by site basis. These measures rely on eliminating the direct connection between impervious surfaces such as roofs, roads, parking areas, and the storm drainage system, as well as the promotion of infiltration on each development or redevelopment site, including related infrastructure improvements, such as roadway upgrades. The benefits from LID BMPs are generally focused on the more frequent storm events (e.g. 2 year storm) with lower volumes, as opposed to the less frequent storm events (e.g. 100 year storm) with higher volumes. It is also recognized that the forms of LID BMPs which promote infiltration or filtration through a granular medium, can provide thermal mitigation for storm runoff.

Various LID BMPs, as well as their function and applicability to York Road Alternative 1 and Alternative 2, are summarized in Table 3.5.1.

Table 3.5.1 LID Source And Conveyance Controls

Technique	Function
Bio-retention Cells	► Vegetated technique for filtration of storm runoff ► Storm water quality control provided through filtration of runoff through soil medium and vegetation ► Infiltration/ evapotranspiration/ water balance maintenance and additional erosion control may be achieved if no subdrain provided ► *Due to the lack of space with the ROW, this technique could not be practically used for Alternatives 1 and 2.*
Grassed Swales	► Vegetated technique to provide storm water quality control ► Storm water quality control provided by filtration through vegetated system ► Runoff volume reduction may be achieved by supplementing with soil amendments ► *Due to the lack of space with the ROW, this technique could not be practically used for Alternatives 1 and 2.*
Infiltration/ Filtration Trenches	► Infiltration technique to provide storm water quality control and maintain water balance ► Erosion controls may be achieved depending upon soil conditions ► If infiltration is not possible due to localized high groundwater levels, the trench system could be designed to provide filtration of runoff ► This alternative could be practically used within the ROW for Alternatives 1 and 2.
Permeable Pavers/Pavement	► Infiltration technique to reduce surface runoff volume ► Benefits to storm water quality and erosion control are informal ► Multi-use path could be permeable to reduce runoff
Pervious Pipes	► Technique to reduce storm runoff through the implementation of perforated pipes within storm sewers

Table 3.5.1 LID Source And Conveyance Controls	
Technique	**Function**
	► Promotion of infiltration can potentially maintain water balance and provides storm water quality and erosion control benefits ► This alternative would not provide the volume required for water quality or erosion control, as such it has not been short-listed.

Short-listed Stormwater Management Alternatives

The assessment of stormwater management alternatives for both quantity (erosion) and quality control has focused on alternatives that could be implemented within the road with-of-way. Erosion control storage would have to use underground storage, based on the lack of available space in the right-of-way. The assessment has been conducted as per the following:

i. Underground Storage

Underground storage within infiltration filtration systems for erosion control for the proposed York Road improvements could use cellular tank systems, stone trench systems or combinations thereof. Based upon the anticipated limited storage volumes (ref. Appendix C) required to provide 24 hours of detention of the 25 mm storm event, underground storage could be considered feasible. The proposed storm sewer depths, bedrock and water table elevations (based on available information) will have to be considered prior to the preliminary design. Further consideration of this alternative will be provided within the future stormwater management reporting.

ii. Infiltration/ Filtration Systems

Underground storage for water quality control for the proposed York Road improvements could be used and would have the added benefit of providing thermal mitigation of road runoff. Based upon the anticipated limited storage volumes required to provide storage of a 13 mm stormwater quality event, infiltration trenches could be considered feasible. Proposed storm sewer depths, bedrock and water table elevations (ref. Appendix D) will have to be considered prior to the preliminary design. Further consideration of this alternative will be provided within the future stormwater management reporting.

iii. Oil/ Grit Separators

To provide a *Normal* Level of water quality treatment, oil/grit separators could be used as part of a treatment train approach. Each drainage system outlet could use an appropriately sized oil/grit separator in combination with vegetative filtering (where space is available) and other associated infiltration systems.

iv. Permeable Pavers/Pavement

The City of Guelph has stated that permeable or porous pavements are not recommended within a 2 year time of travel zone within well head protection areas. Based on the November 2015 Grand River Source Water Protection Plan, York Road is located adjacent to a well head protection zone (ref. Appendix D). This perspective is understood to be based on guidance from CVC and TRCA's 2011 Low Impact Development Stormwater Management Planning and Design

Guide, which refers to road or parking surfaces where salt would be applied, rather than multi-use-paths (MUP) where the City could use alternative snow and ice management techniques. In addition the City has indicated that a permeable pavement should be at least 1 m above ground water level, as such ground water elevations need to be determined along the York Road corridor. For winter operations, sand or other granular materials could not be applied as anti-skid agents, as the open spaces within the permeable pavement could clog, hence would snow need to be cleared using plowing and ice melted with de-icing liquids, applied sparingly. Based on the foregoing, the MUPs could be implemented using permeable pavements, as long as the City adhered to appropriate winter maintenance practices.

Preferred Stormwater Management Alternatives

The preferred roadway stormwater management approach based on the foregoing assessment would include oil/grit separators and combinations of infiltration/ filtration cooling trenches to provide an *Enhanced* Level of stormwater quality treatment and erosion control (25 mm). The multi-use pathway could be constructed from pervious pavement, where it does not cross vehicle travelled areas.

Using available groundwater information from the York Road Reconstruction and Trunk Watermain Drawings, constructed in 1988 (ref. Appendix D), the groundwater profile has been estimated along York Road. The groundwater depth matches close to Clythe Creek elevation west of the York Road and Elizabeth Street intersection. East of Elizabeth Street, the estimated groundwater profile is above Clythe Creek and is within 1.2 m to 1.5 m of the proposed road profile. At road station 11+100 m, 60 m east of the former Reformatory driveway, the estimated groundwater profile and the proposed road profile begin to diverge with the estimated groundwater depths being greater than 1.5 m. Groundwater depths east of the Clythe Creek crossing are not known, due to a lack of available information, however are estimated to be deeper than 1.5 m from the proposed road profile.

Based on the shallow groundwater depth, infiltration trenches using a designated 1 m minimum height) are not considered practical until at least road station 11+230 m, 190 m east of the former Reformatory driveway. As such, west of road station 11+230 m, it is proposed to use filtration trenches, while east of road station 11+230 m, it may be possible to use infiltration trenches. Both the filtration trenches and infiltration trenches would have pre-treatment systems such as catchbasins with goss traps and/or oil/grit chambers depending on locations. Oil/grit chambers would receive drainage from the trenches, prior to each drainage system outlet to Clythe Creek.

Both the infiltration trenches and filtration trenches could be designed to allow drainage to overflow through the top of the trenches to a Cultec™ Contractor™ 0.32 m height and 0.92 m wide underground storage chamber system (or equivalent). The underground chamber system (ref. Appendix D) would be 3 units wide and would fit under the multi-use trail. Each filtration trench would have a controlled outlet. Infiltration trenches would rely on infiltration with an overflow to the Cultec™ chamber system. Using the combined method of trench and chamber system, would provide both water quality and erosion control and would reduce the overall storm sewer length and sizing required. The combined trench and chamber system could replace portions of the typical storm sewer system, for west of the Clythe Creek crossing, while east of the crossing, due to large contributing area, sewers would be required.

Table 3.5.2 provides preliminary sizing for the infiltration/ filtration systems required to store the runoff from both the 13 mm and 25 mm storm events for the increase in road pavement area for road sections selected, based on proposed drainage outlet locations. Runoff volumes for each storm event have been conservatively estimated using 100 % runoff from the increase in paved areas. The effective storage within the infiltration/ filtration trenches has been estimated using a 40% void ratio based on the likely stone media within the trenches. The infiltration/filtration trenches would be located under the proposed 3 m wide MUP on the south side of road. The trenches have been sized using a 3 m width and 1 m depth.

Table 3.5.2 Infiltration/ Filtration Trench Sizing

Road Section	Increase in Pavement Area (m^2)	13 mm Storm Event		25 mm Storm Event	
		Volume (m^3)	Length (m)	Volume (m^3)	Length (m)
East of Clythe Creek Crossing	4975	161.7	54	310.9	104
Clythe Creek to Former Reformatory Driveway	2025	65.8	22	126.65	43
Former Reformatory Driveway to Hadati Creek	2710	88.1	30	169.4	57
Hadati Creek to Victoria	3104	100.9	34	194.0	65

In addition to the oil/grit chambers and infiltration/filtration trench systems, the City could consider permeable pavement for the MUPs, as groundwater is greater than 1 m in depth from the proposed road profile for the study area.

3.6. Property Requirements

As the cross-sectional width of Alternative 1 is 25.0 m, and the roadway follows (to the extent possible) the north side of the existing 20 m ROW through this section (west of the Clythe Creek crossing), it is anticipated that approximately 5.0 m of additional property on the south side of the right-of-way will be required along the entire length of this section of York Road. Grading easements will also be required during construction.

In addition to property required for the road, property would be required for the proposed creek realignment. To determine the required property, the meander belt for the proposed creek would have to be determined, along with the minimum setbacks required by GRCA.

3.7. Preliminary Capital Costs

Preliminary capital costs for Road Alternative 1 have been determined for the proposed road, creek and stormwater management/ drainage components of the York Road improvements (ref. Appendix E. The following assumptions and considerations have been used to develop the preliminary capital works costing:

- Stormwater management and drainage system costs have not included culvert upgrades for this current assessment, but could be included for the preferred road alternative.

- Oil/grit chamber costing has been estimated using one (1) oil/grit system for each drainage outlet. Should the stormwater management strategy be revised, costing would have to be adjusted accordingly. Oil/grit chamber sizes have not been determined for this current assessment but could be determined for the preferred road alternative.
- Storm sewer system costing has been estimated using approximate storm sewer sizing and would require validation using modelling as part of the detailed design process.
- Costing does not include construction, staging, sediment and erosion controls, all utility locates and relocation, but does include hydro.
- Costing does not include cultural heritage feature protection/ repairs/ reconstruction
- Costing does not include tree protection, planting and seeding
- Costing does not include property purchase or facilitation of easements

The following preliminary capital costing has been determined for Road Alternative 1.

► Drainage system and stormwater management:	$2,420,000
► Road system and MUP (to Clythe Creek crossing)[1]	$4,260,000
► Creek works	$ 859,230
	$7,539,230

[1] Road works from Victoria Road to Skyway Drive costed at $ 13,695, 000, as such, total project costs would be approximately $ 16,974,230.

4. ALTERNATIVE 2: (ROAD ALTERNATIVE 23: - 3 M MUP ON BOTH SIDES WITH 1.0 M BOULEVARDS)

4.1. Road Design

Roadway Alternative 2 considers the provision of both north and south multi-use pathways within the York Road right-of-way, a 1.0 m green space and 0.5 m rounding on the south side (per City direction), and 3:1 embankment slopes. The boulevard has been completely eliminated from this alternative, in order to determine the minimal potential impacts associated with relocating the south MUP into the ROW. To maximize available space within the ROW, the roadway alignment has been shifted 1.5 m to the north relative to the design presented in the EIS. The profile has been also adjusted to minimize grading impacts on adjacent properties. Similar to the design presented in the EIS, extension of the Hadati Creek culvert would be required, and opportunities to reduce impacts to the creek and heritage features through implementation of segments of retaining walls/soil systems could be investigated, although not completed at this time. Roadway cross-section Alternative 2 is illustrated in Figure 4.1, with the associated plan and profile drawings provided in Appendix A. Alternative 2 represents the least impactful alternative possible with the north property limit held and the south MUP located within the York Road ROW. Note that this alternative limits opportunities to locate overhead utilities on the north side without additional property acquisition and/or protection (clear zone for AADT of 18,320 and a design speed of 80 km/h is 5.0 m). Overhead utilities could be relocated underground or to the south side with protection and/or localized extension of the 1.5 m wide green space on the south side.

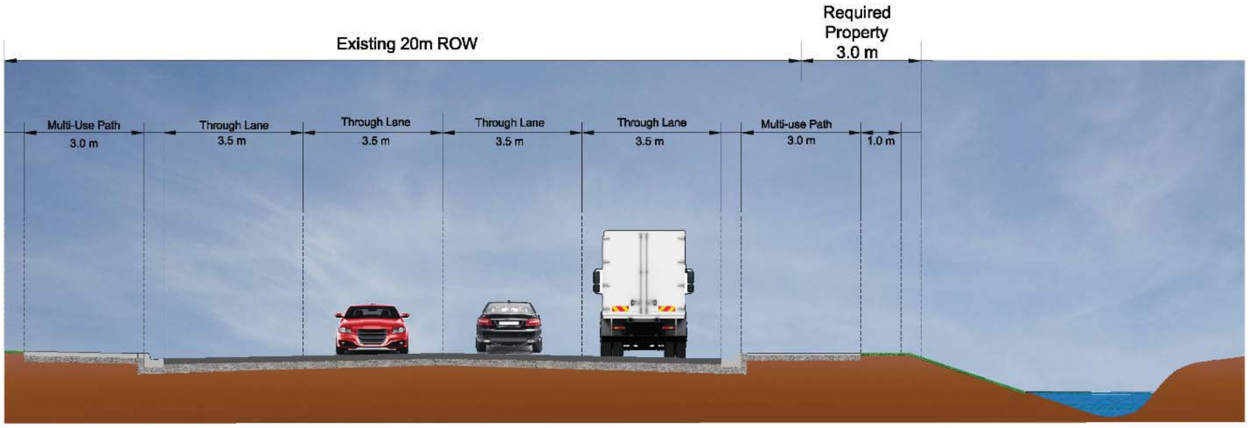


Figure 4.1 Typical Cross-Section for York Road Alternative 2.

4.2. Creek Design

A second channel design (for Alternative 2) has been prepared for consideration based on the grading required to accommodate Road Alternative 23 (ref. Appendix B). The Alternative 2 creek design is similar to Alternative 1 aside from the weir location (approximate chainage 0+375 to 0+425 m, Sheet 04). The grading associated with Alternative 2 does not encroach on the channel to the extent of Alternative 1 and, as a result, it is possible to incorporate the 'high-flow' channel that conveys higher flows over the weir structure. This design would involve the establishment of an island-type feature downstream of the weir that separates the newly constructed primary channel and the existing length of channel that will be maintained to convey flows passing over the weir. The two channels connect further downstream, towards the Reformatory driveway at approximate chainage 0+430 m, same as the previously-identified preferred alignment in the EIS. The design at this location is differentiated from the preferred channel alignment based on the absence of a crossing for the MUP, which is considered a benefit from a corridor connectivity standpoint. The adjustments required at this location do not otherwise impact the form and function of Clythe Creek, from the previously-identified preferred channel alignment in the EIS.

The second location requiring adjustment for Alternative 2 (approximate chainage 0+850 to 1+050m, Sheet 06) is the same as Alternative 1. The associated implications to the planform and proposed design refinements discussed for Alternative 1, are consistent between the two Alternatives.

4.3. Cultural Heritage Assessment

Alternative 2 would require changes to, and removals of, cultural heritage resources which would dramatically change the cultural heritage landscape along York Road.

In Alternative 2, the proposed roadway improvements include the potential widening of York Road, a 3 m multi-use path on each side of the roadway, and a re-alignment of major portions of Clythe Creek. These improvements are expected to impact the cultural heritage resources, leaving some heritage features in situ but without water flow and the complete removal of other heritage features.

In Alternative 2, the changes would include the removal of the stone culvert (#1) which travels under York Road; the remnant bridge railing on the north side of York Road (#2); the intermittent stream which feeds into Clythe Creek (#13); the fieldstone entrance wing walls on both side of the entrance way (#15 and 16); fieldstone weirs #22, 24, 25, and 26; and the limestone pillars and wood board fencing alongside York Road (#28, 29 and 30). Some fieldstone weirs and steps would remain in situ but without water flow. These include weirs #3, 5, 8, 23 and 35.

Fieldstone weirs # 9, 10, 11, and 14 may be removed or could possibly be maintained in situ with retaining walls or grading. However, if they remained they would all be impacted by loss of flow as a result of channel realignment. The only difference between Alternative 1 and Alternative 2 occurs west of weir #14. In Alternative 2, the new creek bed ties into the existing creek bed just west of weir #14. Both Alternatives would impact weir #14.

In Alternative 2, roadway and pathway grading may impact the fieldstone steps (#6), and a large bedrock outcrop (#7). There is a potential modification of the limestone terrace wall (#12), the arched pedestrian bridge (#27), the metal and wood bridges (# 31, 32 and 33) and the box culvert (#34) due to the channel work or pedestrian traffic needs.

4.4. Terrestrial Habitat Assessment

The key sensitivities potentially present within the Study Area include sensitive ELC communities, Species at Risk (SAR), regionally important vegetation - City of Guelph (City of Guelph, 2012) & Wellington County (Frank and Anderson 2009) and other significant vegetation, area sensitive birds, potentially breeding locally sensitive birds; and candidate Significant Wildlife Habitat (SWH) (Appendix C-1).

The potential impacts to terrestrial habitat include changes to soil permeability, water balance, drainage patterns, runoff, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance to wildlife; import/export of fill; removal of Open Country Bird Habitat encroachment of natural areas indirect pollution; and removal of significant species and their habitat. For a description of each impact, its potential magnitude, and the duration; review Section 4.2 of draft York Road Environmental Design Environmental Impact Study (March 2017) which has been provided in Appendix C-2.

The proposed area of impact, determined using the limit of grading activities, is very similar between Alternative 1 and Alternative 2. There is only one difference in the creek alignment options which is between creek interval 0+450 and 0+350, upstream from the Reformatory bridge. The road alignment Alternatives are also quite similar in area of impact, as they only vary slightly due to the addition/removal of a 1 m boulevard. Since the area of impacts and the overall construction activities are so similar, Alternative 2 also has the following potential to impact in the same way as Alternative 1:

- Sensitive ELC communities (both direct and indirect);
- Regionally Important Vegetation (both direct and indirect);
- Other significant vegetation;
- Species at Risk (SAR);
- Area Sensitive Birds;
- Potentially Breeding Locally Sensitive Birds; and
- Candidate Significant Wildlife Habitat (SWH).

For a description of each impact, its potential magnitude, and the duration, review Section 4.2 of draft York Road Environmental Design Environmental Impact Study (March 2017) which has been provided in Appendix C-2. Many potential indirect impacts can be avoided through mitigation measures and recommendations, discussed further in Section 4.1 and 4.2.

4.5. Stormwater Management Strategy

The preferred stormwater management strategy for Alternative 2 would be the same as that determined for Road Alternative 1, as per the following:

- Infiltration trenches with overflow chamber system and controlled outlet (where groundwater elevations permit)
- Lined filtration trenches with overflow chamber system and controlled outlets (where groundwater elevations are high)
- Catchbasins to have goss traps and to be connected to infiltration/filtration trenches, west of Watson Road, with standard storm sewer system for east of Watson Road.
- Oil/grit chambers upstream of outlets
- Permeable MUPS where groundwater is 1 m or more below proposed grades
- Appropriate winter operation and maintenance procedures to be implemented for MUPs

4.6. Property Requirements

As the right-of-way cross-section width of Road Alternative 2 is 23.0 m, and the north MUP follows (to the extent possible) the north side of the existing 20 m ROW through this section, it is anticipated that approximately 3.0 m of additional property on the south side of the right-of-way will be required along the entire length of this section of York Road. Grading easements will also be required during construction.

In addition to property required for the road, property would be required for the proposed creek alignment. To determine property, the meander belt for the proposed creek would have to be determined, along with the minimum setbacks required by GRCA.

4.7. Preliminary Capital Costs

Preliminary capital costs for Road Alternative 2 have been determined for the proposed road, creek and stormwater management/ drainage components of the York Road improvements (ref. Appendix E). The assumptions and considerations indicated for Road Alternative 1 apply to Alternative 2 and therefore have not been reiterated.

The following preliminary capital costing has been determined for Road Alternative 2.

► Drainage system and stormwater management:	$2,420,000
► Road system and MUP (to Clythe Creek crossing) [1]	$3,990,000
► Creek works	$ 859,230
	$7,269,230

[1] Road works from Victoria Road to Skyway Drive costed at $ 13,695,000, as such, the total projects costs would be approximately $ 16,974,230.

As Road Alternative 1 and 2 are basically the same from a drainage and stormwater management perceptive, there would be little to no cost difference between Alternative 1 and Alternative 2. Creek work costing would be approximately the same cost for both road alternatives.

5. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations have been determined by discipline based on the assessment of Road Alternatives 1 and 2.

5.1. Conclusions

Road Design

Both cross-section Alternatives 1 and 2 are acceptable from a transportation design perspective. Alternative 2 minimizes impacts to existing heritage features within the road ROW, although elimination of the boulevard (Alternative 2) reduces opportunities to provide street lighting on both sides of York Road and will require additional winter maintenance considerations. Use of steep embankment slopes and/or retained soil systems should be investigated where they have the potential to mitigate risks to heritage features.

Creek Design

The creek designs for Alternatives 1 and 2 do not represent a substantial change to the channel form and function of the previously-identified preferred channel alignment within the EIS. For Alternative 1, it will not be possible to maintain any connection with the weir feature (Cultural Feature '14') located upstream of the former Reformatory driveway. From a channel design perspective, this is not considered detrimental. Alternative 2 would allow for the development of a high flow channel that could convey higher flows, typical of 1.5 to 2 year storm event, over the weir structure. In either scenario, the existing barriers to fish passage would be mitigated.

With both Alternatives, the planform must be shifted south near the confluence with Hadati Creek. Under both Alternative 1 and 2, less existing channel length would be utilized than was possible with the previously-identified preferred alignment in the EIS, as the planforms for both Alternative 1 and 2 begin to bend at a point further upstream, directing the planform south towards the Eramosa River. This is equally advantageous for both Alternatives, as there would be an increased buffer between the roadway/culvert and the channel at this location, however additional cut and fill would subsequently be required during construction.

Beyond the minor changes noted above, the advantages associated with the previously-identified preferred channel alignment in the EIS are provided by both alternatives. The creek channel would be removed further from the York Road right-of-way and floodplain connectivity is improved. The outlet of the northern Reformatory Pond will be closed to limit interactions between the pond and the creek channel. The existing groundwater-fed tributary planform is utilized as part of the design channel and narrowing of the channel in sections will support natural channel processes. Overall, both alternatives are realignments that would provide improvements to natural channel function and habitat when compared to existing conditions.

Cultural Heritage

Both Alternative 1 and Alternative 2 would require changes to, and removals of, cultural heritage resources which would dramatically change the cultural heritage landscape along York Road. There is little difference in the potential impacts to cultural heritage features, resulting from both Alternatives 1 and 2. Both Alternatives 1 and 2 would require removal of the entrance walls at the former Reformatory driveway. Impacts to the features with the creek could be partially mitigated using retaining walls along the south right-of-way limits.

Terrestrial Habitat

The study area and the adjacent lands present several ecological sensitivities including but not limited to natural vegetation communities, open country bird habitat, turtle habitat, three Species at Risk birds, and existing trees. In terms of terrestrial ecology, there is not a significant difference between Alternative 1 and Alternative 2. The road and creek alterations proposed in both Alternatives will cause some direct negative impacts, specifically to trees and natural vegetation. The negative impacts though can be compensated for as a part of the new creek realignment design. The proposed roadway development may indirectly impact wildlife including turtles, open country birds, and Species a Risk birds. No habitat for any of the species is proposed to be removed but avoidance during construction is possible. There are no expected induced impacts. York Road is already a heavily used road, therefore widening, is not likely to cause a noticeable change in human use. The park land is remaining parkland with no additional programming. In conclusion, the widening of York Road and the realignment of the creek will cause some negative impacts, but can be mitigated and compensated completely, resulting a net neutral or positive impact.

Stormwater Management Strategy

Based on the need for erosion and water quality controls, with no or limited quantity controls, the stormwater management strategy is proposed as a combination of oil/grit chambers and infiltration/filtration systems. Stormwater quality control / treatment would be provided for the proposed additional paved area. Storm sewer length and sizing would be practically limited by the use of the combined infiltration/filtration trench and underground chamber systems. A storm sewer system east of the Clythe Creek crossing would be required, but would be configured to convey the 25 mm storm event to an infiltration/filtration trench system. A permeable MUP system could be used where groundwater is 1 m below the proposed grades.

Property Requirements

As the cross-sectional widths of Alternatives 1 and 2 are 24.5 m and 22.5 m respectively, approximately 4.5 m and 2.5 m of additional property would be required along the entire length of this section of York Road. Grading easements will also be required during construction. Additional property would be required for the proposed creek alignment based on the proposed meander belt width along with the minimum setbacks required by GRCA.

5.2. Recommendations

Road Design

Moving forward to future stages of the study, it is recommended that alternatives that consider either reduced multi-use pathways widths and/or elimination of portions of the north side multi-use pathway be considered to further mitigate impacts to the former Reformatory entrance cultural heritage features. A mid-block pedestrian signal could be provided at the easterly terminus of the multi-use pathway to facilitate safe pedestrian and cyclist movements between either side of York Road. The estimated cost for provision of a mid-block pedestrian signal is $100,000.

Creek Design

The creek designs for road Alternatives 1 and 2 do not differ significantly from the creek alignment and profile developed for the EIS. That said, for Alternative 1, it would not be possible to maintain a connection with the weir feature (Cultural Heritage Feature '14') located upstream of the former Reformatory driveway, which from a cultural heritage perspective would represent an impact. Road Alternative 2 would facilitate the connection to the cultural heritage feature, as such it would be preferred.

Cultural Heritage Assessment:

Neither Alternative 1 nor Alternative 2 preserve the cultural heritage landscape along the south side of York Road. It is suggested that either the roadway is shifted further north or the multi-use pathway is only on one side of York Road.

Terrestrial Habitat

Both road alternatives have the potential for both direct and indirect negative impacts to terrestrial habitat. There would be minimally expected or potential induced negative impacts to terrestrial habitat, as the general use of the road corridor is not changing, nor is the way that people would interact with it. Mitigation and compensation efforts should be reviewed and finalized as a part of Detailed Design. That being said, the draft March 2017 EIS provided mitigation measures to reduce or eliminate the magnitude and duration of the potential negative impacts (ref. Appendix C-3). Aadditional recommendations to verify that there are no negative impacts include:

- Development of a monitoring plan with quantitative thresholds to ensure that the proposed mitigation and compensation measures perform as intended. The monitoring plan will need to consist of baseline, during construction, and post-construction stages. It should include monitoring stations, design and reporting guidelines and deadlines. Deficiencies identified through monitoring activities will need to be addressed to the satisfaction of the City of Guelph. The post-development monitoring program will need to include potential management responses to rectify potential negative impacts, verify performance targets (e.g. habitat for target species), and unforeseen negative ecological impacts.
- Bald Eagle winter surveys as part of the environmental studies required through the future block plan process for the GID area.
- Further assessment of the area towards the western edge of the study area to identify its potential to support wetland communities; identification of biosalvage opportunities; and development of a protocol to check for nesting

Stormwater Management Strategy

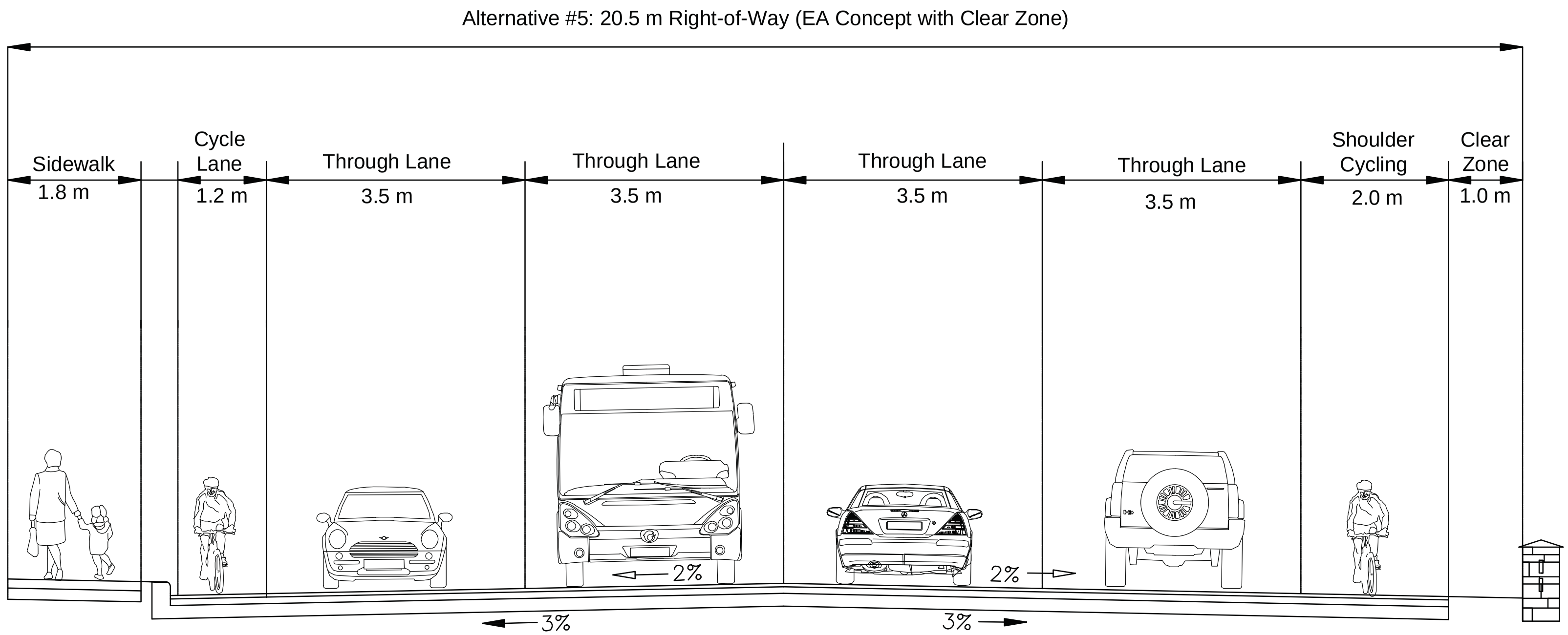
As noted, the preferred stormwater management strategy, would use a treatment train approach of oil/grit chambers and infiltration/filtration trenches. As both Road Alternatives 1 and 2 have limited boulevard widths, implementation of either bioretention or biofiltration of road runoff within roadside LID BMPs would be considered largely impractical. Adjustments to the road section to allow for bioretention and/or biofiltration LID BMPs would improve the preliminary preferred treatment train approach.

Property Requirements

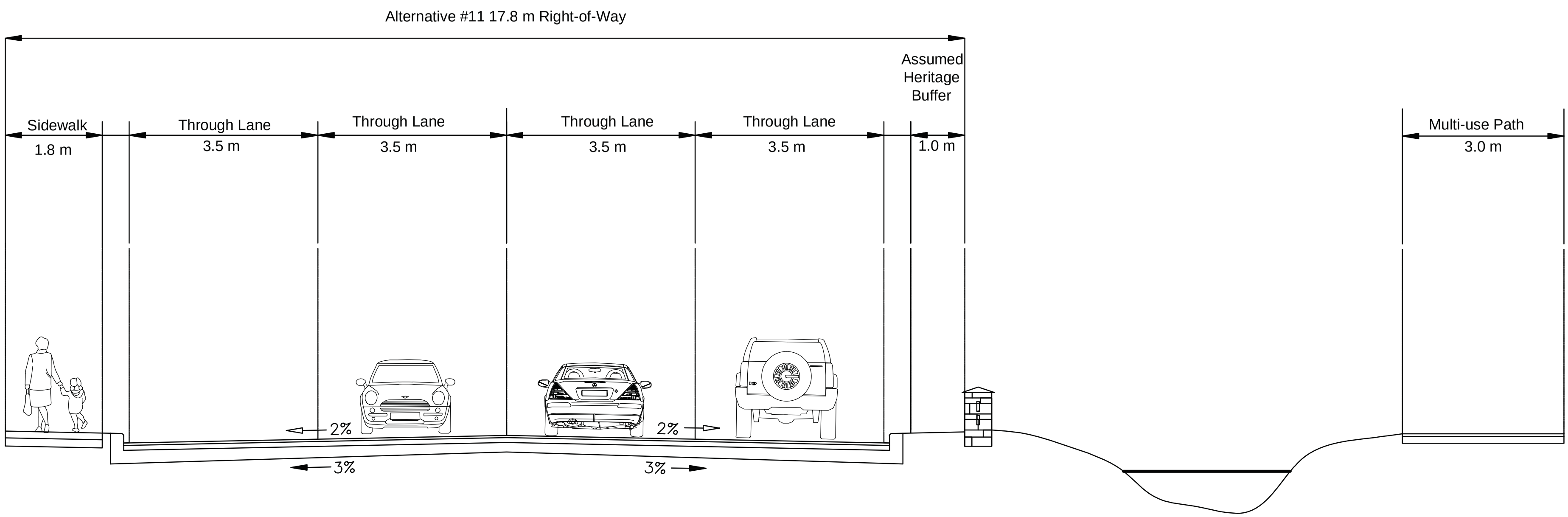
Property requirements for the road would be more than that determined within the original Class EA due to the two (2) alternative road sections. Property would have to be taken along the south side of the right-of-way, along with the required property for the creek corridor.

Appendix A

Road Alternatives



ENGINEERING SERVICES	YORK ROAD TYPICAL SECTION - ALTERNATIVE #5 20.5m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
		SCALE : N.T.S.	DRAWING No. : -

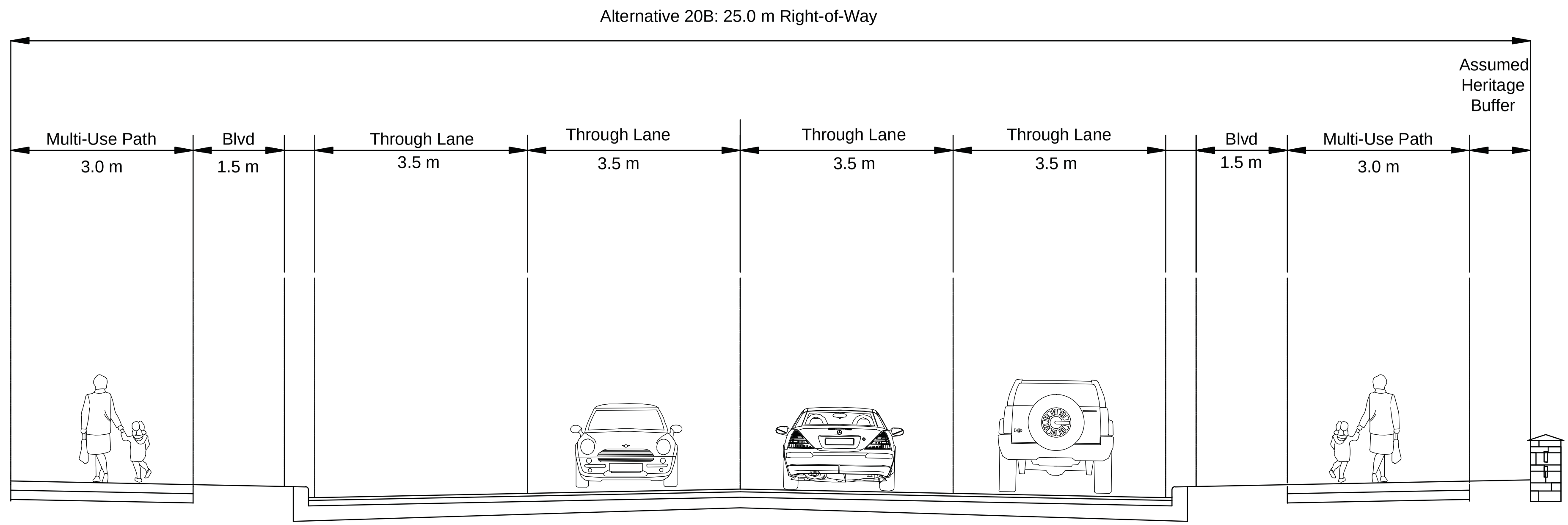


ENGINEERING SERVICES

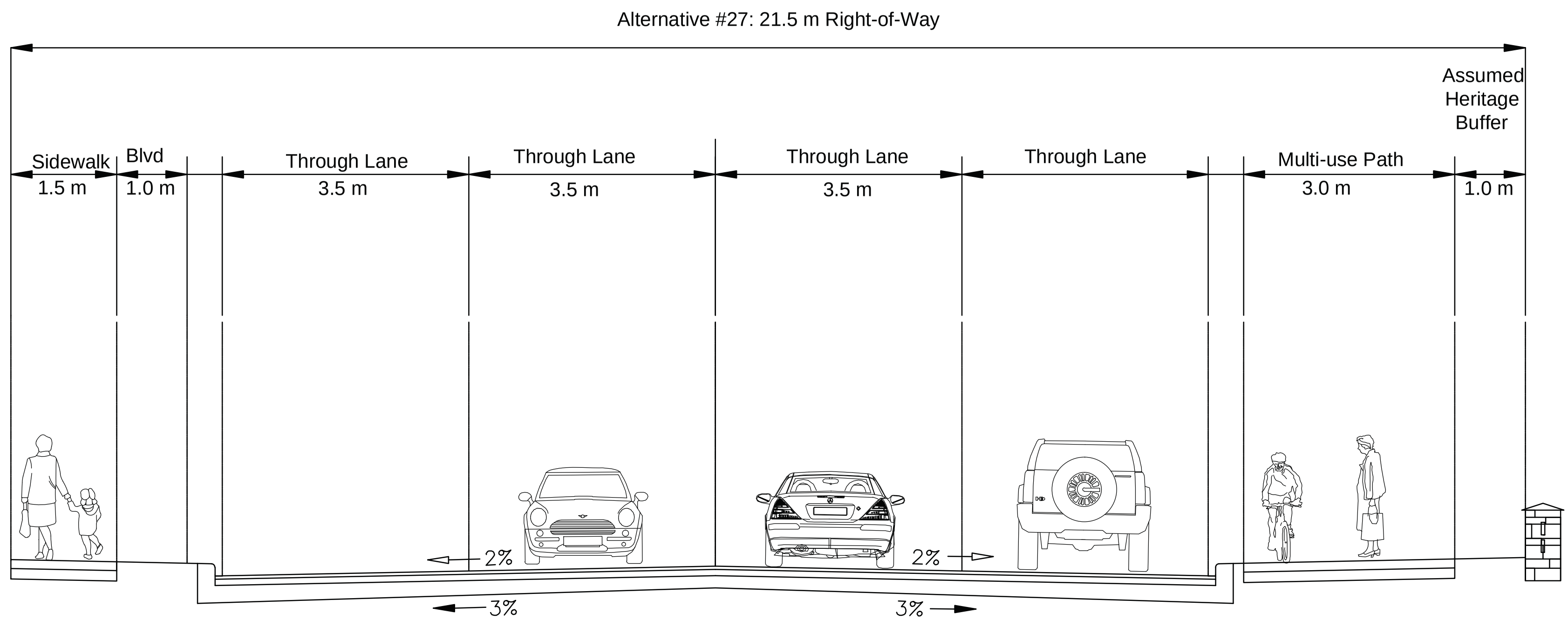
YORK ROAD

TYPICAL SECTION - ALTERNATIVE #11
17.8m RIGHT OF WAY

DATE DRAWN :	DRAWN BY :
2016/08/25	BS
SCALE :	DRAWING No. :
N.T.S.	-

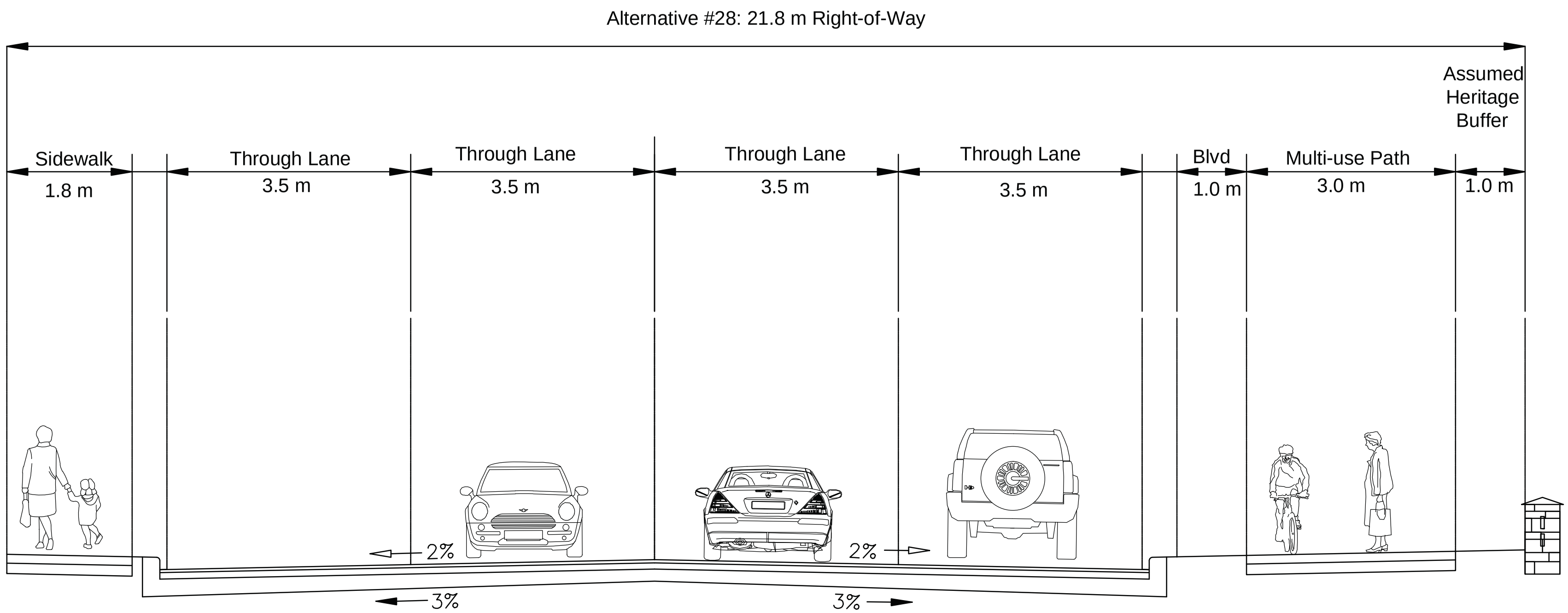


CITY OF Guelph ENGINEERING SERVICES	YORK ROAD TYPICAL SECTION - ALTERNATIVE #20B 25.0m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
		SCALE : N.T.S.	DRAWING No. : -

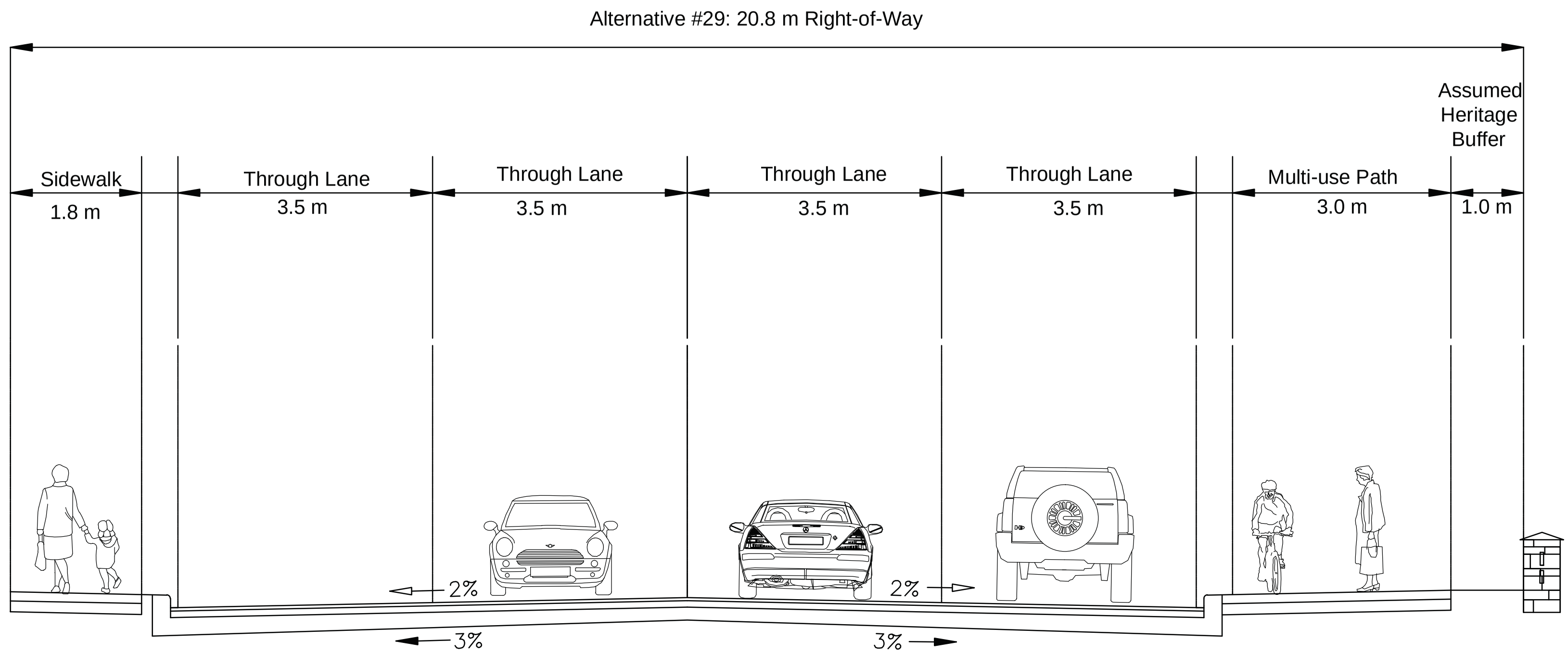


ENGINEERING SERVICES

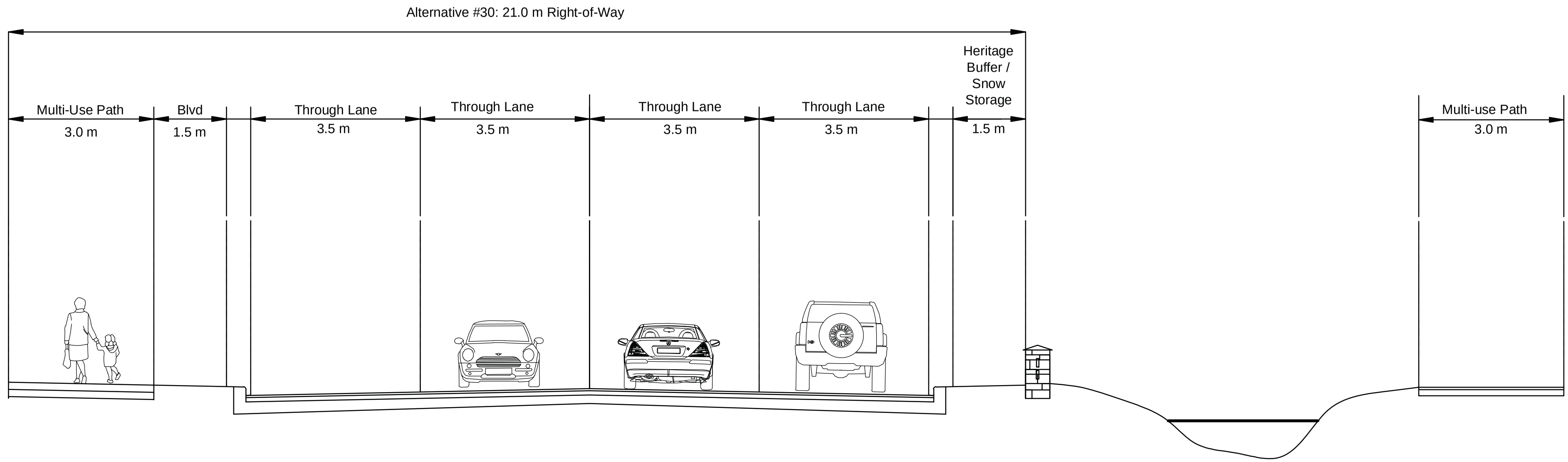
YORK ROAD TYPICAL SECTION - ALTERNATIVE #27 21.5m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
	SCALE : N.T.S.	DRAWING No. : -



CITY OF Guelph ENGINEERING SERVICES	YORK ROAD TYPICAL SECTION - ALTERNATIVE #28 21.8m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
		SCALE : N.T.S.	DRAWING No. : -



CITY OF Guelph ENGINEERING SERVICES	YORK ROAD TYPICAL SECTION - ALTERNATIVE #29 20.8m RIGHT OF WAY	DATE DRAWN : 2016/08/25	DRAWN BY : BS
		SCALE : N.T.S.	DRAWING No. : -



CITY OF Guelph
ENGINEERING SERVICES

YORK ROAD
TYPICAL SECTION - ALTERNATIVE #30
21.0m RIGHT OF WAY

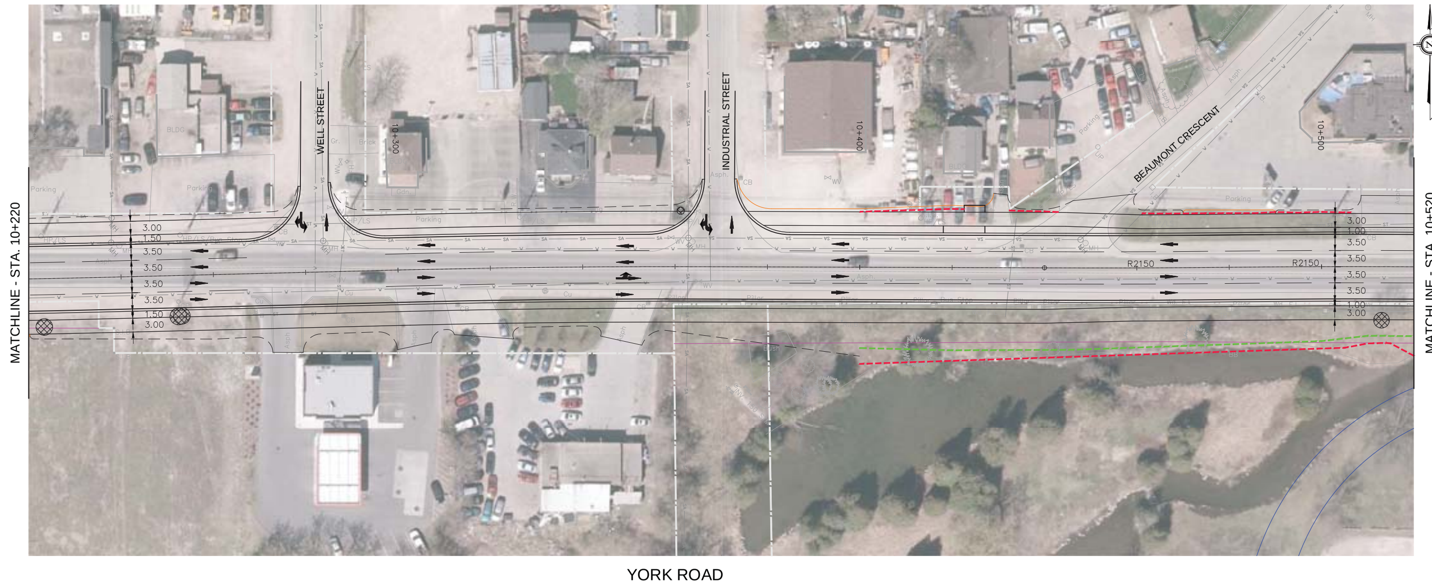
DATE DRAWN :	DRAWN BY :
2016/08/25	BS
SCALE :	DRAWING No. :
N.T.S.	-

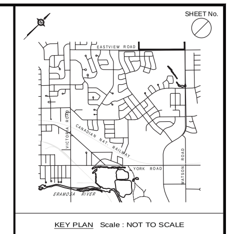
York Road Cross-Section Alternatives

25-Aug-16

Alt #	General Description	Inside Lane Width (m)	Outside Lane Width (m)	Cycle Lane Width (m)		Sidewalk Width (m)		Multi-Use Pathway (m)		Curb Width (m)		Boulevard Width (m)		Shoulder Width, Incl. Clear Zone (m)		Heritage Buffer (m)	Total Width
				North Side	South Side	North Side	South Side	North Side	South Side	North Side	South Side	North Side	South Side	North Side	South Side		
1	Sidewalks and Cycle Lanes on Both Sides	3.5	4.0	1.5	1.5	1.5	1.5			0.5	0.5	1.0	1.0				24.00
2		3.5	3.5	1.5	1.5	1.5	1.5			0.5	0.5	1.0	1.0				23.00
3		3.5	4.0	1.5	1.5	1.8	1.8			0.5	0.5						22.60
4		3.5	3.5	1.5	1.5	1.8	1.8			0.5	0.5						21.60
5		3.5	3.5	1.2		1.8				0.5					3.0		20.50
6	Sidewalks Only, with and without Shared Use Lanes	3.5	4.3			1.5	1.5			0.5	0.5	1.0	1.0				21.60
7		3.5	4.3			1.8	1.8			0.5	0.5						20.20
8		3.5	3.5			1.5	1.5			0.5	0.5	1.0	1.0				20.00
9		3.5	3.5			1.8	1.8			0.5	0.5						18.60
10		3.5	3.5			1.5				0.5	0.5	1.0			0.5		18.00
11		3.5	3.5			1.8				0.5	0.5				0.5	0.5	17.80
12		3.5	3.5			1.5				0.5		1.0			3.0		20.00
13		3.5	3.5			1.8				0.5					3.0		19.30
14	Sidewalk on North Side, Cycle Lanes on Both Sides	3.5	3.5	1.5	1.5	1.5				0.5		1.0			1.5	1.0	22.50
15		3.5	3.5	1.5	1.5	1.8				0.5					1.5	1.0	21.80
16		3.5	3.5	1.5	1.5	1.5				0.5	0.5	1.0			0.5	0.5	21.50
17		3.5	3.5	1.5	1.5	1.8				0.5	0.5				0.5	0.5	20.80
18	Multi-Use on Both Sides, With Boulevards	3.5	4.3					3.0	3.0	0.5	0.5	1.0	1.0			1.0	25.60
19		3.5	4.0					3.0	3.0	0.5	0.5	1.0	1.0			1.0	25.00
20		3.5	3.5					3.0	3.0	0.5	0.5	1.0	1.0			1.0	24.00
21	Multi-Use on Both Sides, Without Boulevards	3.5	4.3					3.0	3.0	0.5	0.5					1.0	23.60
22		3.5	4.0					3.0	3.0	0.5	0.5					1.0	23.00
23		3.5	3.5					3.0	3.0	0.5	0.5					1.0	22.00
24	Sidewalk and Shared-Use Lane on North Side, Multi-Use on South Side	3.5	4.3/3.5			1.5			3.0	0.5	0.5	1.0	1.0			1.0	23.20
25		3.5	4.3/3.5			1.5			3.0	0.5	0.5	1.0				1.0	22.20
26		3.5	4.3/3.5			1.8			3.0	0.5	0.5					1.0	21.50
27	Sidewalk on North Side, Multi-Use on South Side	3.5	3.5			1.5			3.0	0.5	0.5	1.0				1.0	21.50
28		3.5	3.5			1.8			3.0	0.5	0.5		1.0			1.0	21.80
29		3.5	3.5			1.8			3.0	0.5	0.5					1.0	20.80

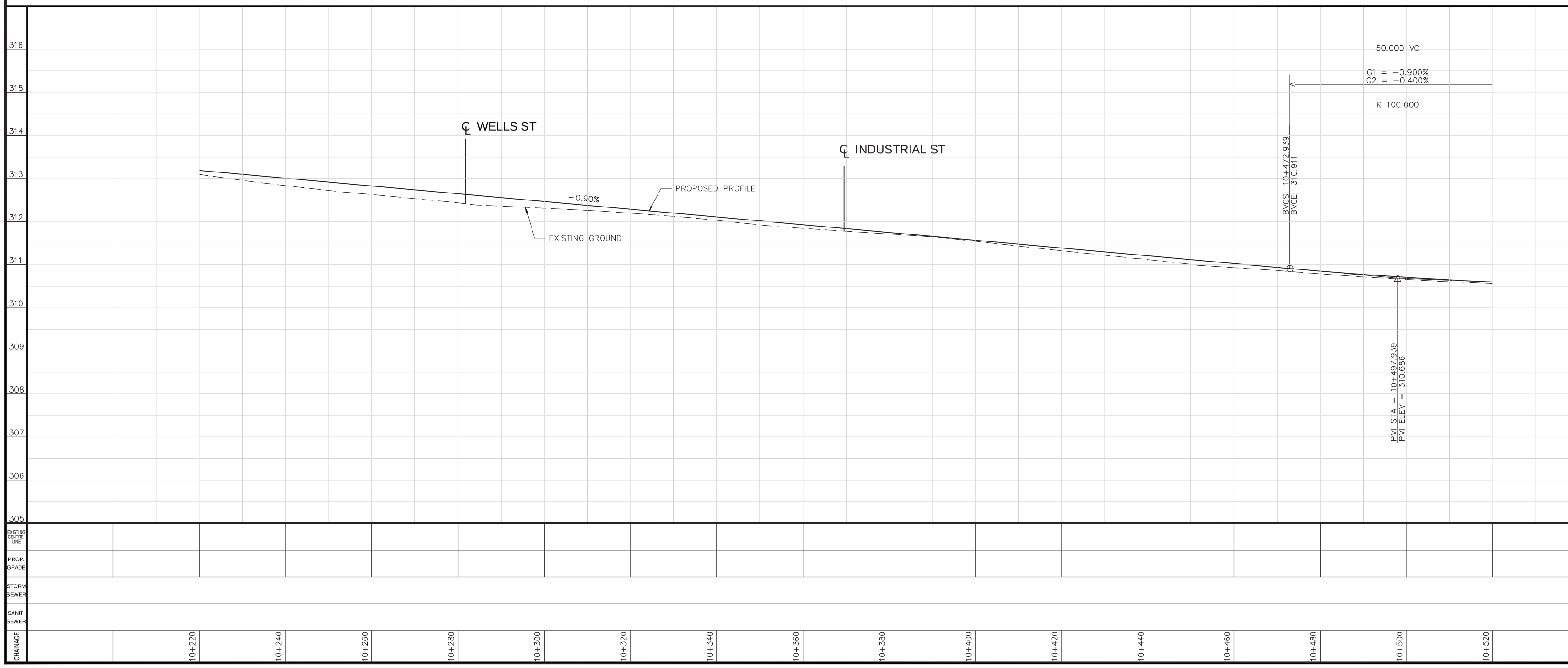
Notes:
- Profile will need to be reviewed in all instances to ensure roadway surface can be properly drained
- Storm sewer system will be required





LEGEND

- EXISTING RIGHT OF WAY
- PROPOSED RIGHT OF WAY WIDENING
- GRADING LINE 3:1 SLOPE
- GRADING LINE 2:1 SLOPE



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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

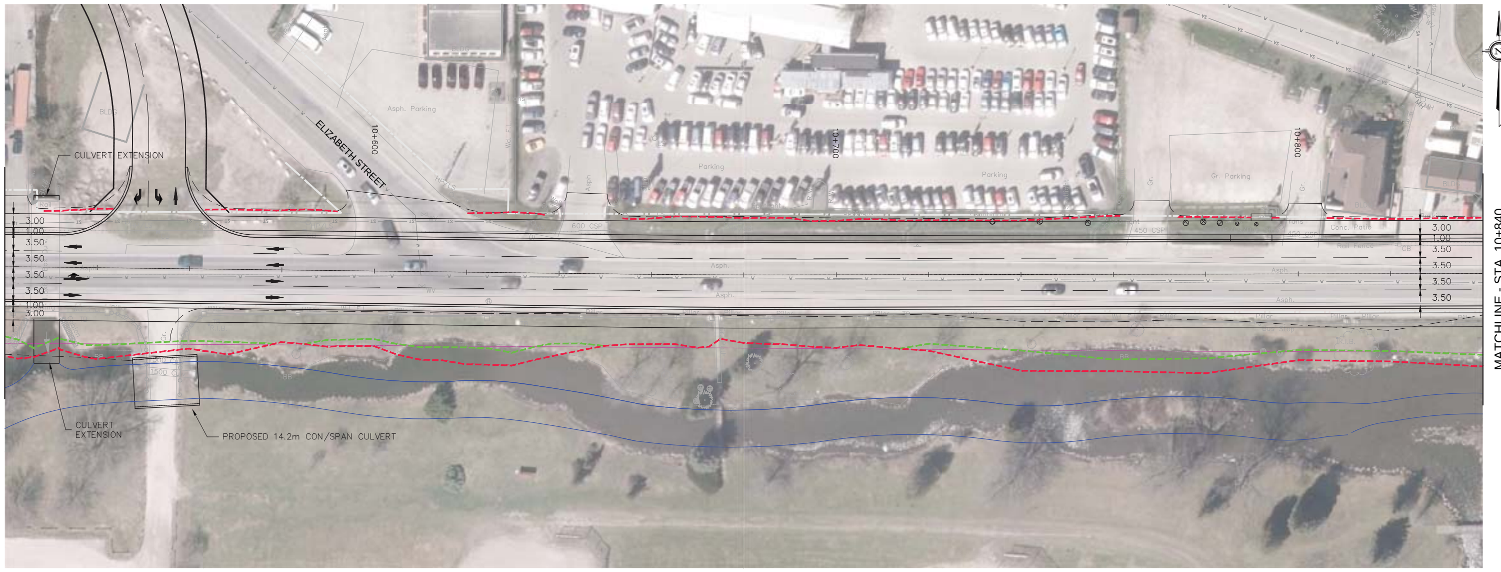
CITY OF Guelph

ENGINEERING SERVICES

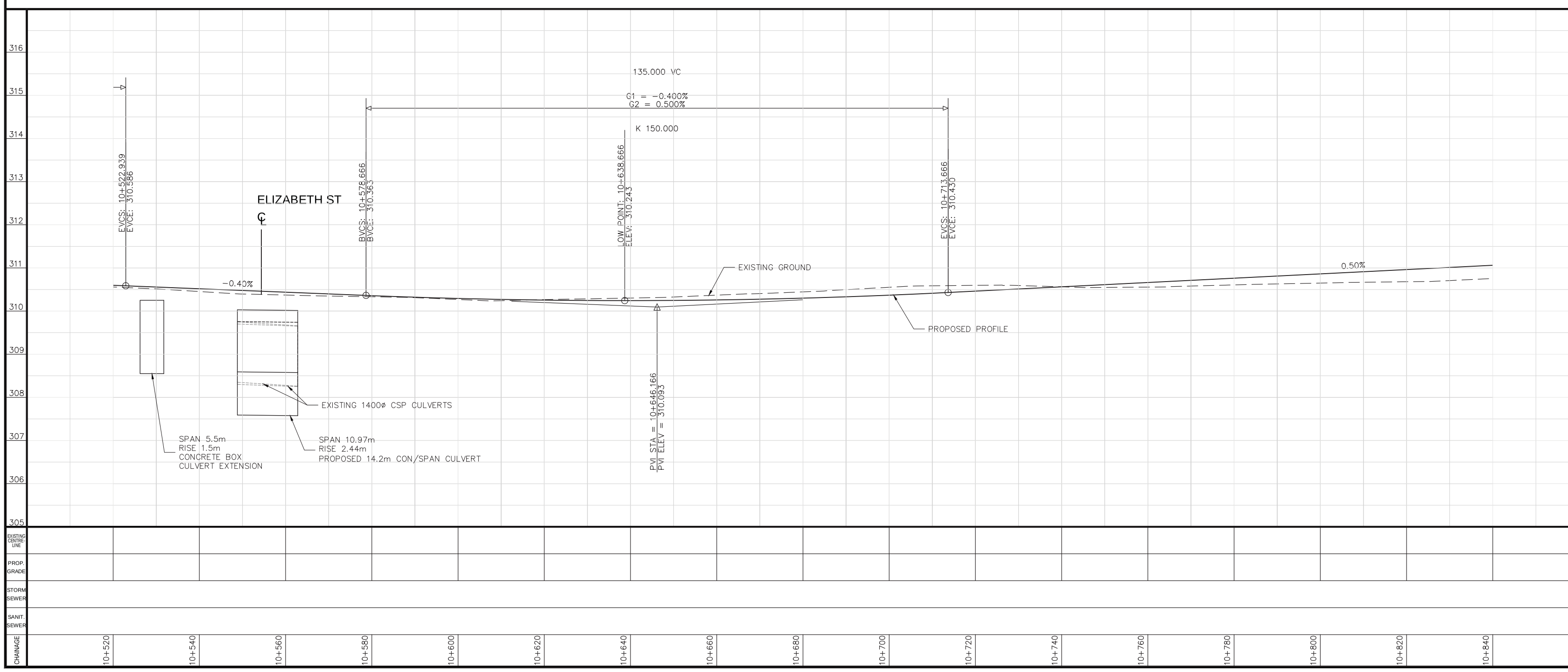
amec foster wheeler

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2017-12-13
	DRAWN BY: D.K. / CHECKED BY: M.E.K.
STORM SEWER	CONSULTANT DRAWING No. OPTION 1
SANITARY SEWER	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 1 OF 4 / REV.



YORK ROAD



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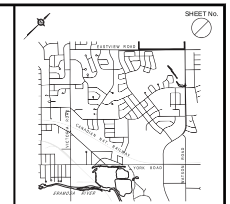

KEY PLAN Scale : NOT TO SCALE

LEGEND

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ENGINEERING SERVICES

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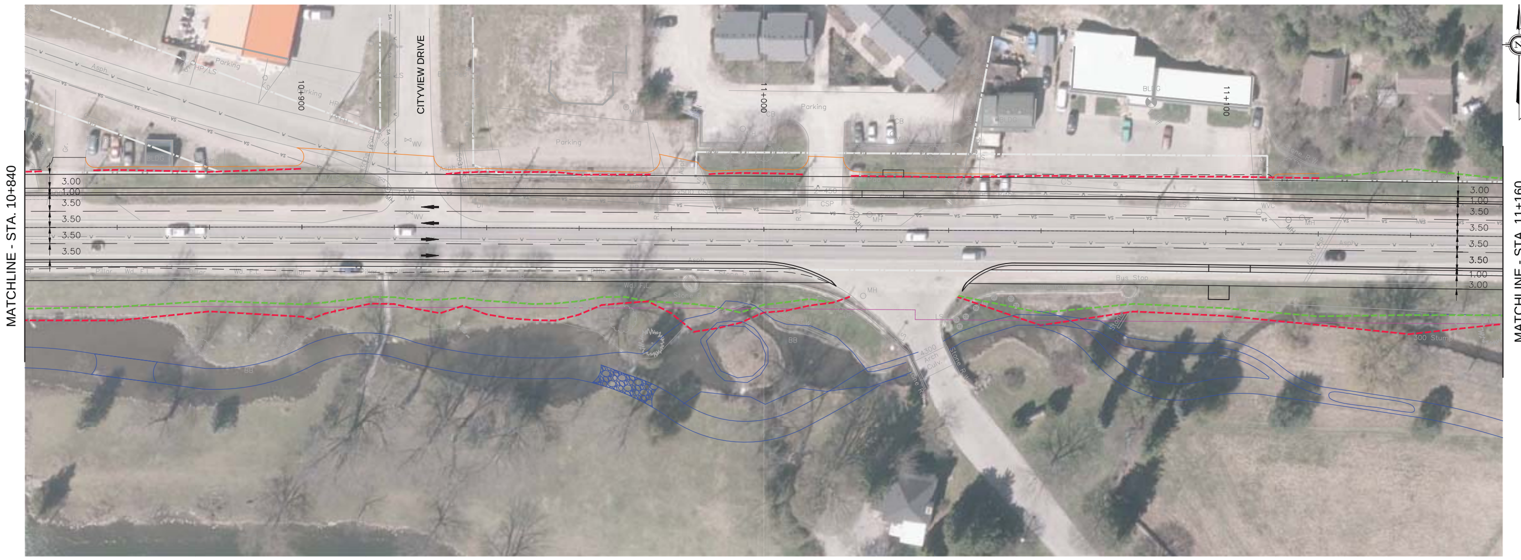
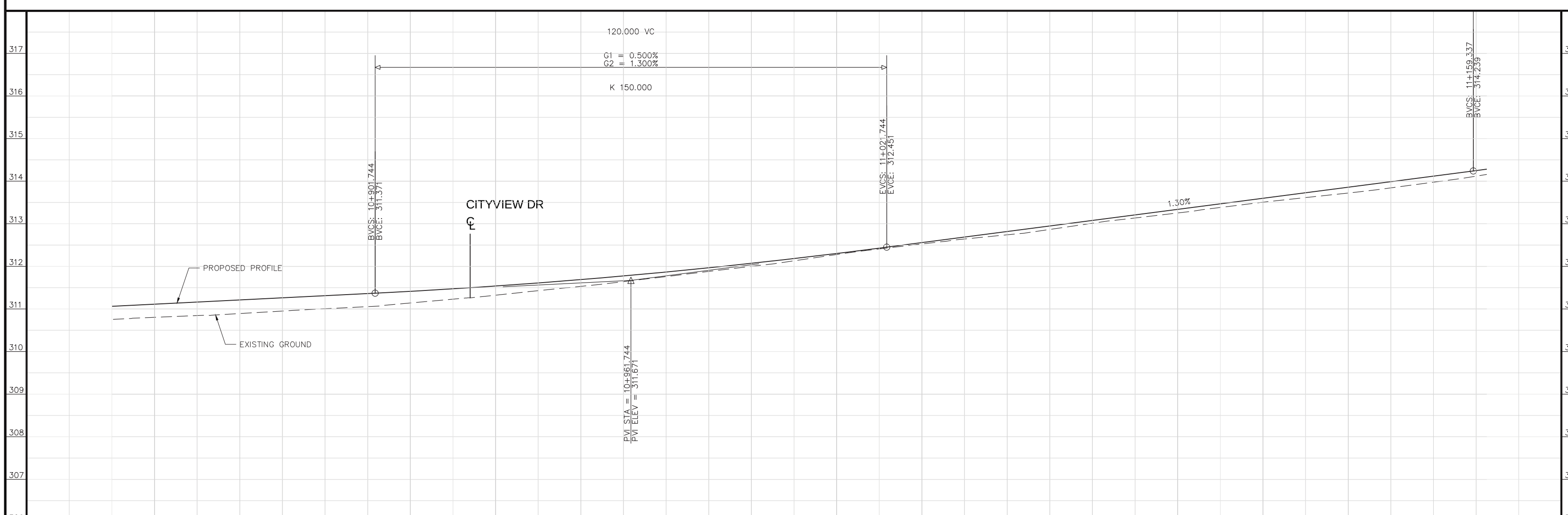
SANITARY SEWER	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 2 OF 4 / REV.

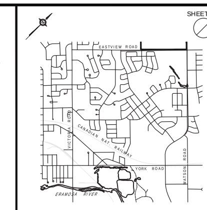


YORK ROAD



EXISTING CENTRE LINE																	EXISTING CENTRELINE
PROP. GRADE																	PROPOSED GRADE
STORM SEWER																	STORM SEWER
SANIT. SEWER																	SANITARY SEWER
CHAINAGE	10+840	10+860	10+880	10+900	10+920	10+940	10+960	10+980	11+000	11+020	11+040	11+060	11+080	11+100	11+120	11+140	11+160	CHAINAGE

SHEET No.



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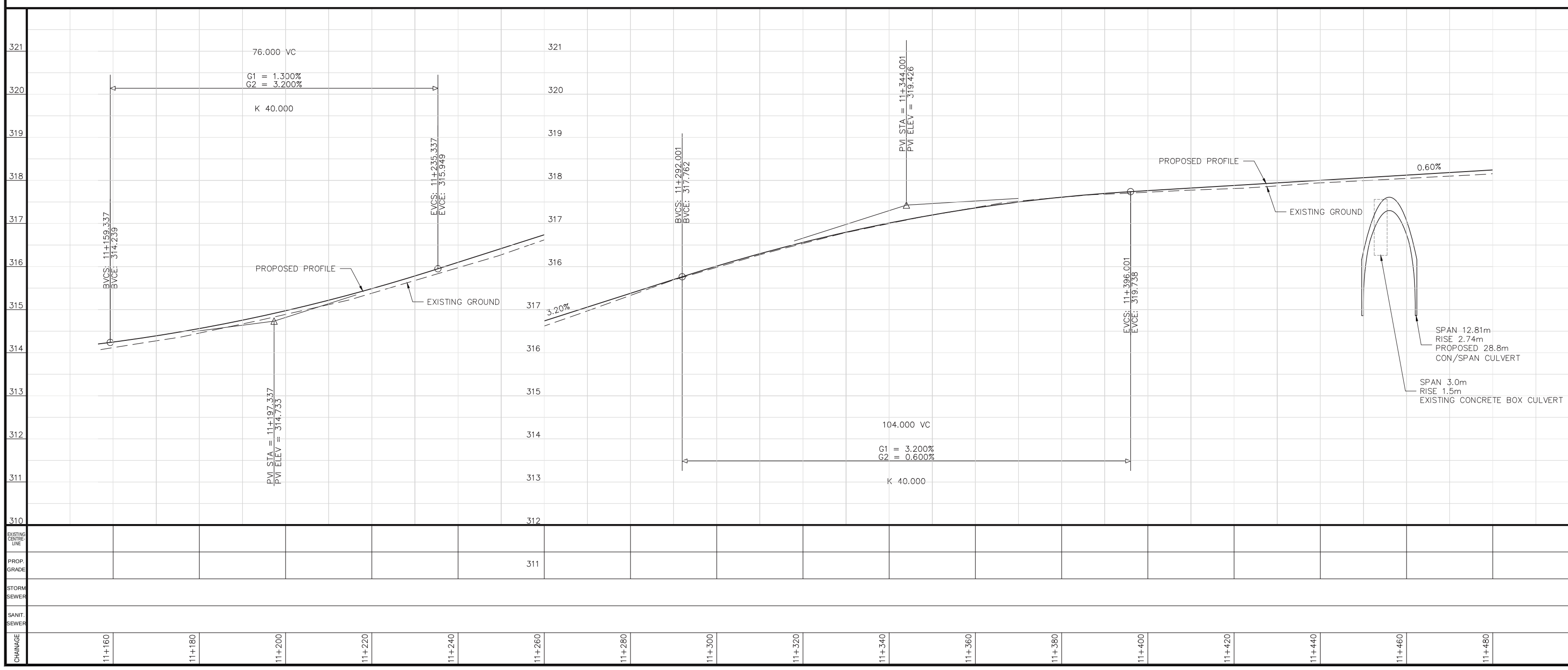

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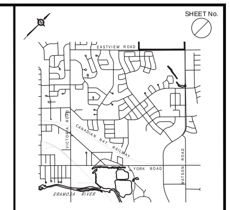

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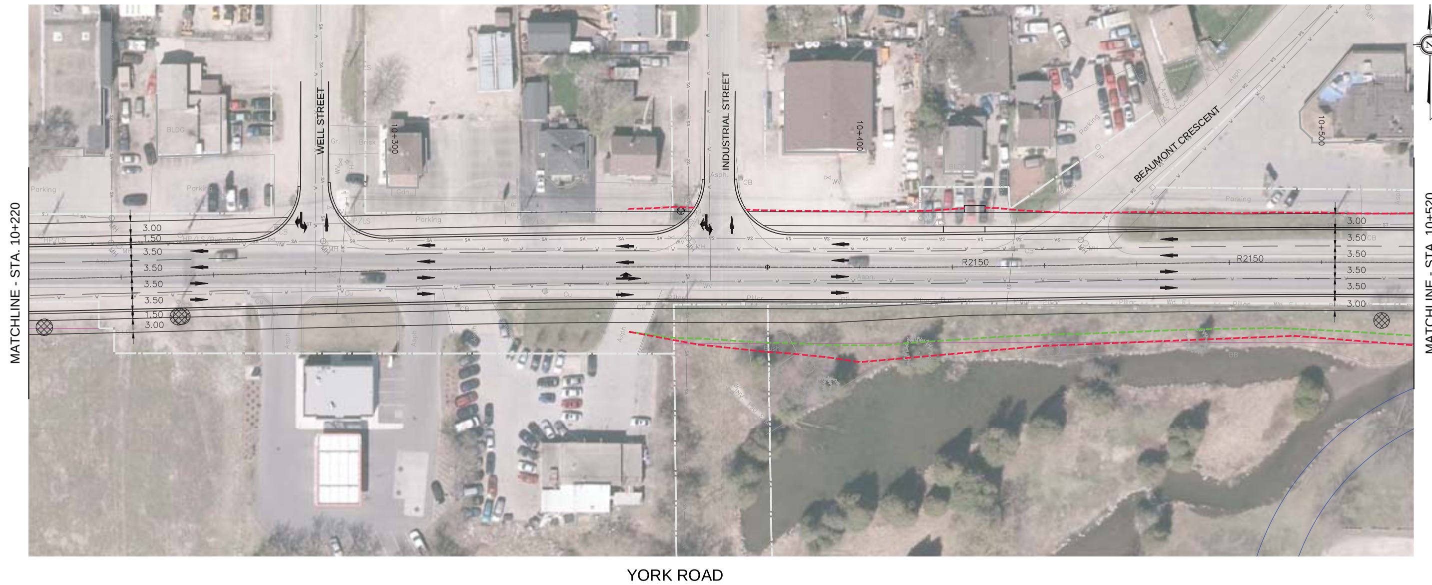
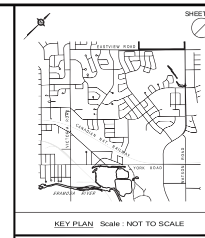
CONSULTANT DRAWING No. OPTION 1
CITY CONTRACT No.
CITY REFERENCE No. REV.
SHEET 4 OF 4





LEGEND

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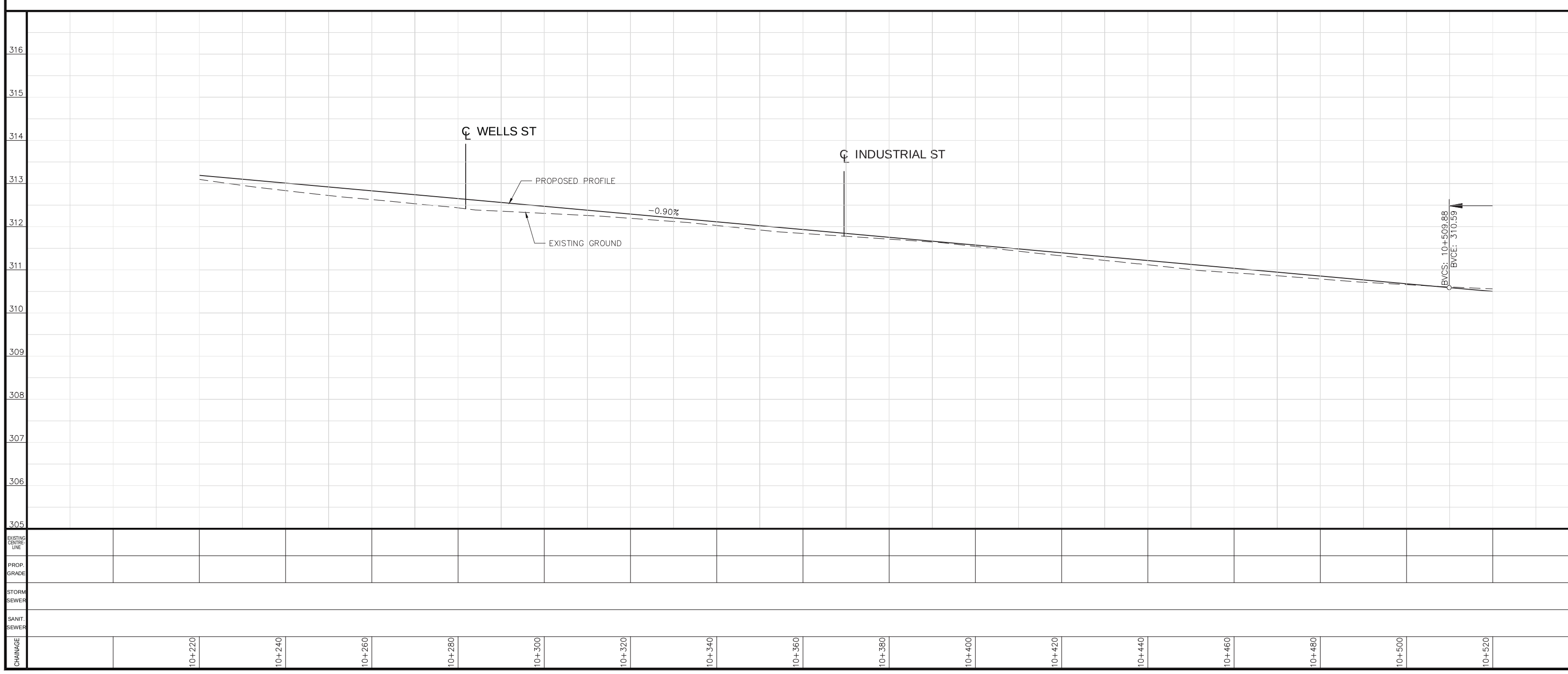
- GRADING LINE 3:1 SLOPE
- GRADING LINE 2:1 SLOPE



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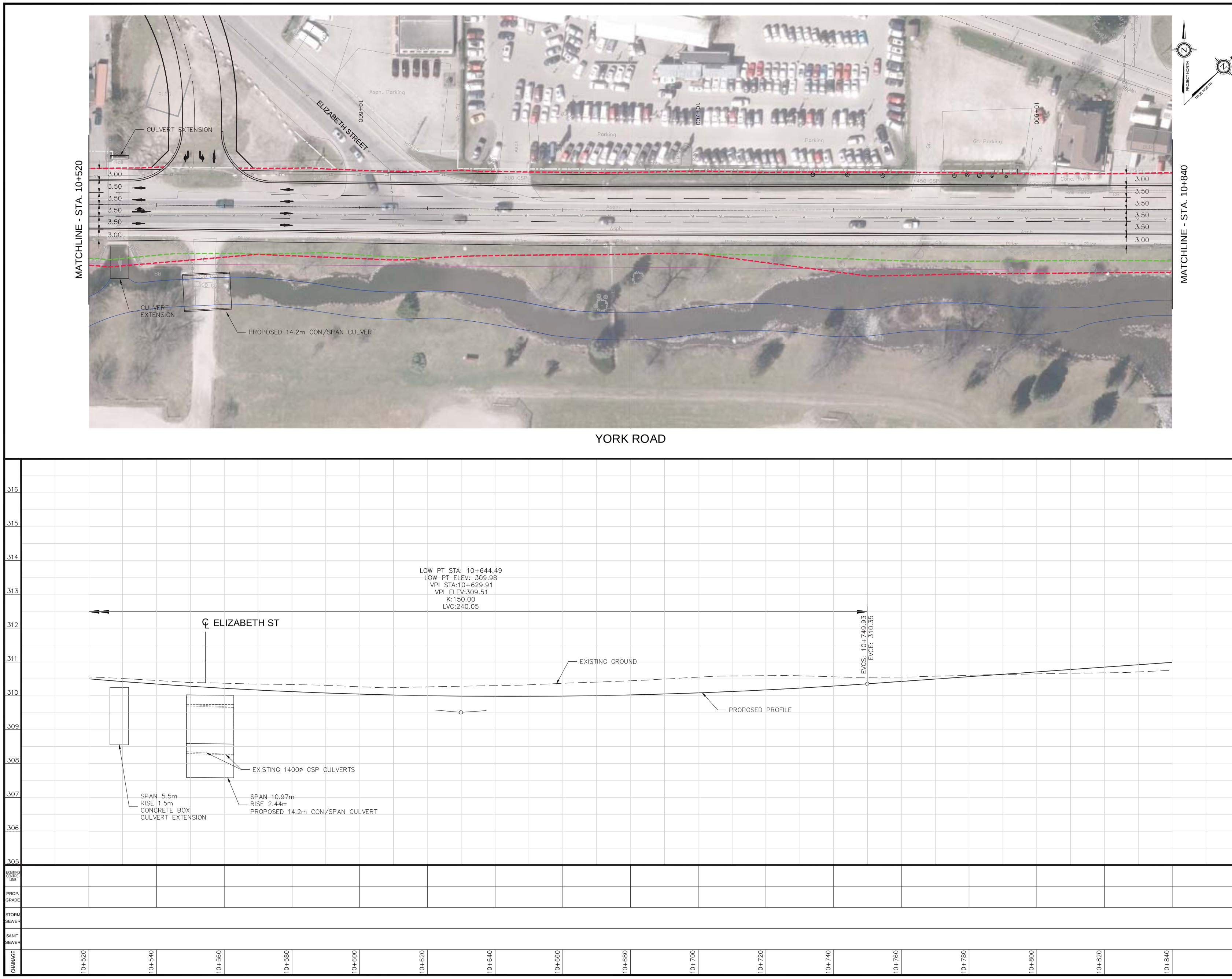
PROPOSED GRADE	DATE DRAWN: 2017-12-13
STORM SEWER	DRAWN BY: D.K. CHECKED BY: M.E.K.
	CONSULTANT DRAWING No. OPTION 2
SANITARY SEWER	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 1 OF 4 REV.



SHEET No.

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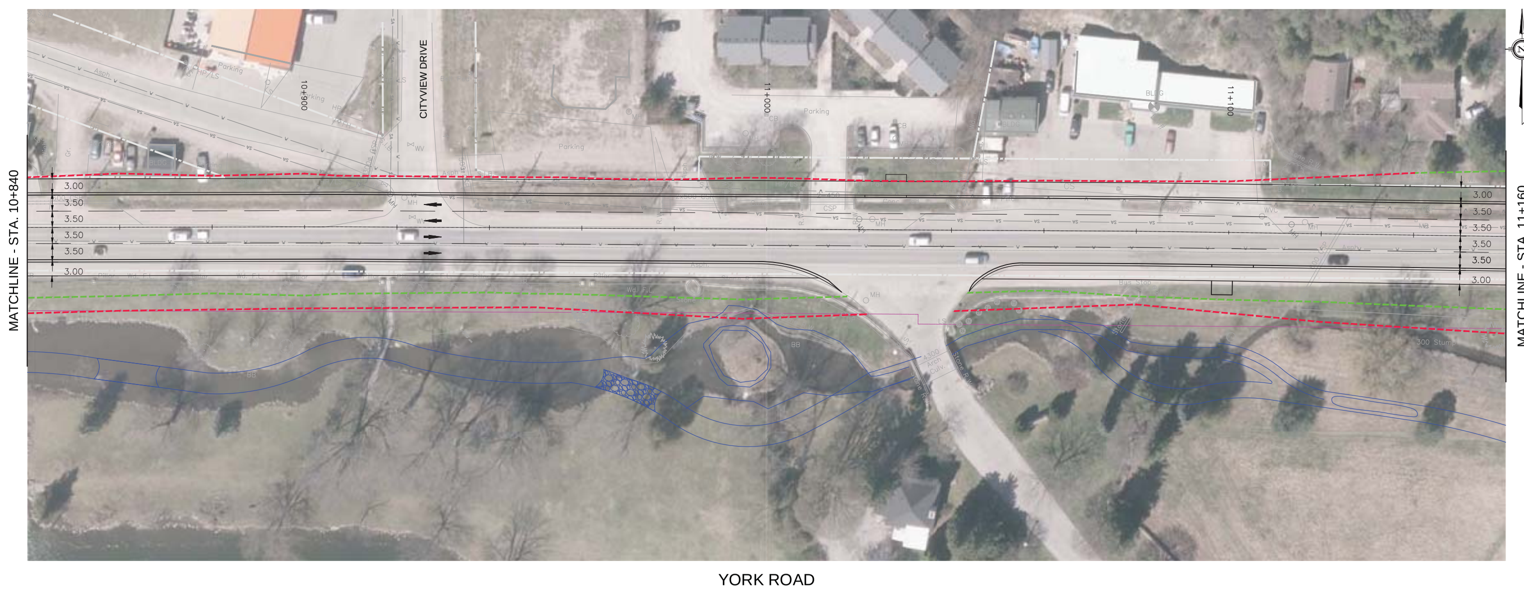

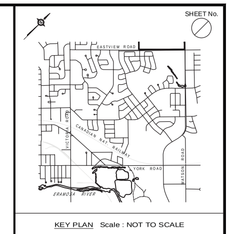

LEGEND

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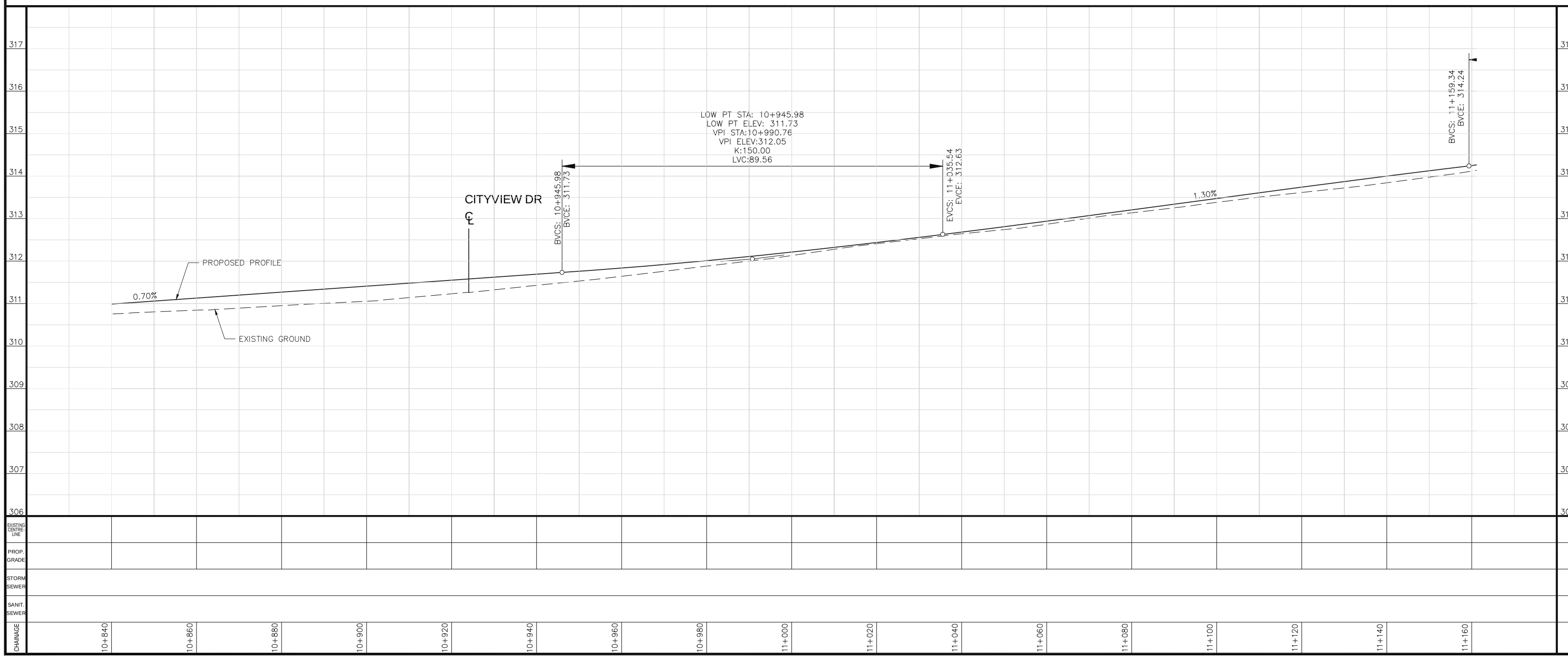
- PROPOSED RIGHT OF WAY WIDENING
- GRADING LINE 3:1 SLOPE
- GRADING LINE 2:1 SLOPE



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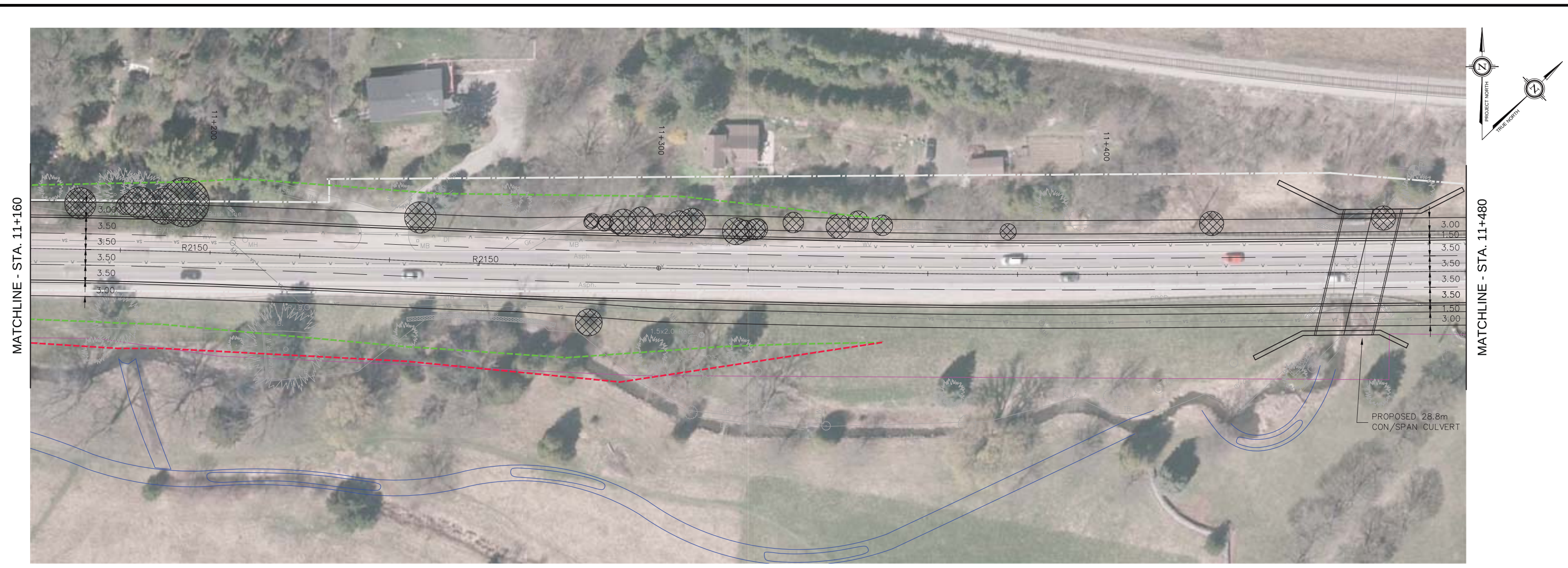
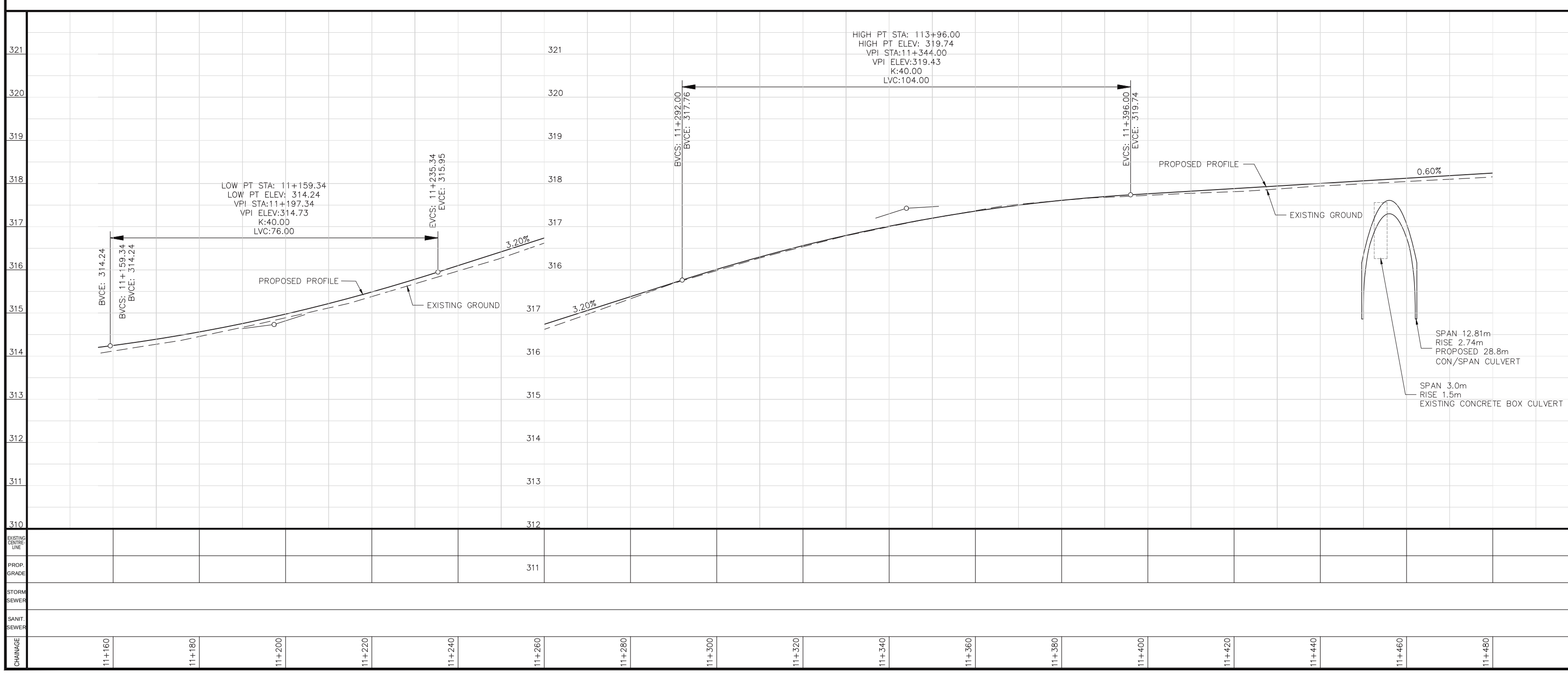
CITY CONTRACT No.
CITY REFERENCE No. SHEET 3 OF 4 REV.



YORK ROAD



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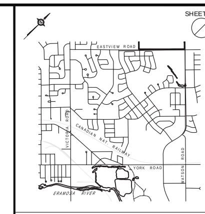

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CITY OF Guelph

ENGINEERING SERVICES

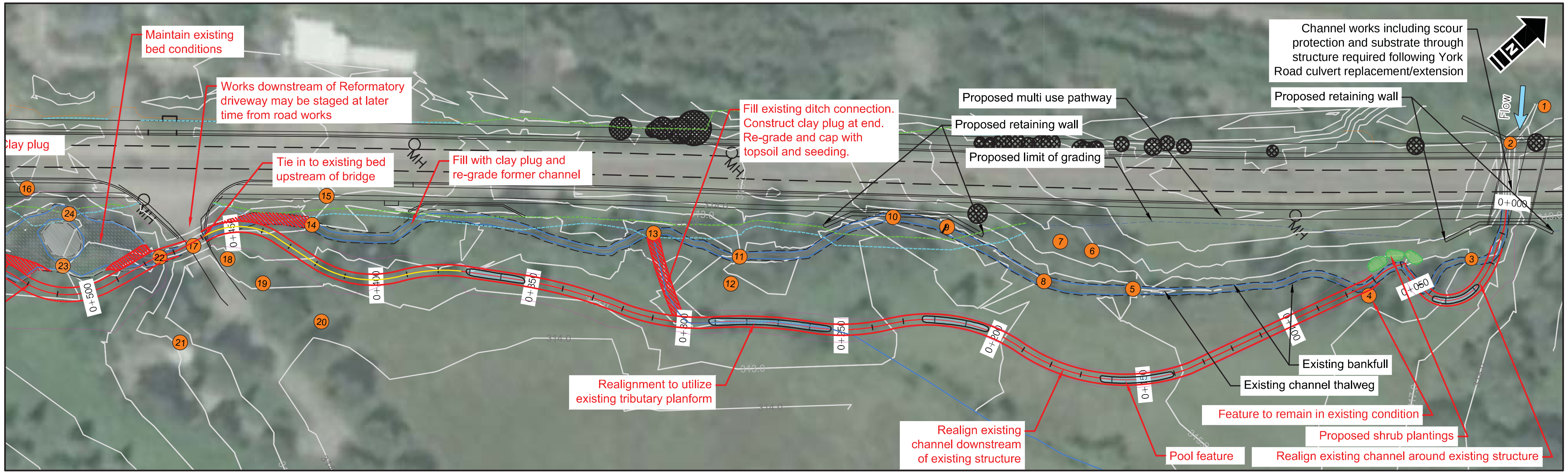
amec foster wheeler

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2017-12-13
	DRAWN BY: D.K. CHECKED BY: M.E.K.
STORM SEWER	CONSULTANT DRAWING No. OPTION 2
SANITARY SEWER	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 4 OF 4 REV.

Appendix B

Stream Morphology

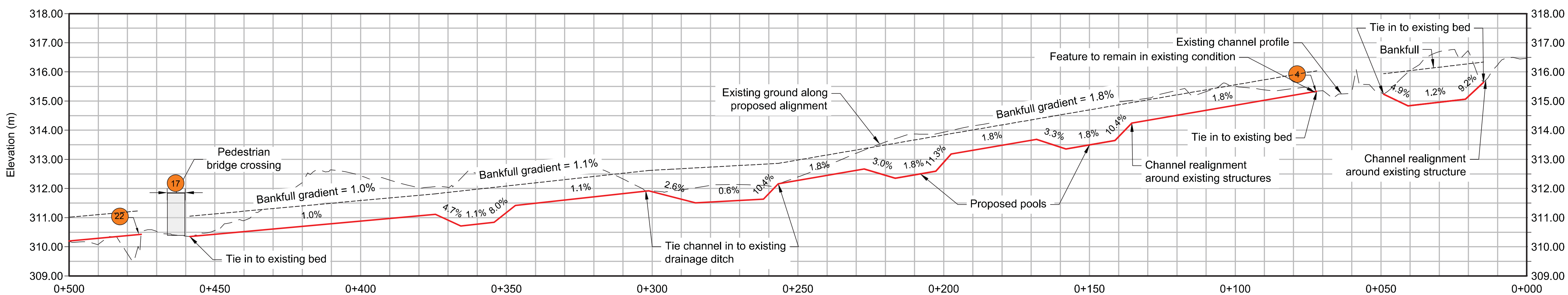


1:1500 Meters
15 0 15 30
Datum

Legend

Surveyed edge of water	
Surveyed bankfull	
Toe of 2:1 road grading	
Toe of 3:1 road grading	
Proposed realignment	
Proposed fill/bank treatment	
Proposed shrubs and plantings	
Cultural heritage feature/structure	
Maintain existing bed	
Proposed pool	
Approximate grading limit	

Notes:
1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
03	03 08 2017	Revised based on client comments	JH	JP	ED
02	01 17 2017	Revised based on client comments	JH	JP	ED
01	12 09 2016	Revised based on client comments	JH	JP	ED
00	09 15 2016	Draft for client review	JH	JP	ED

REVISION

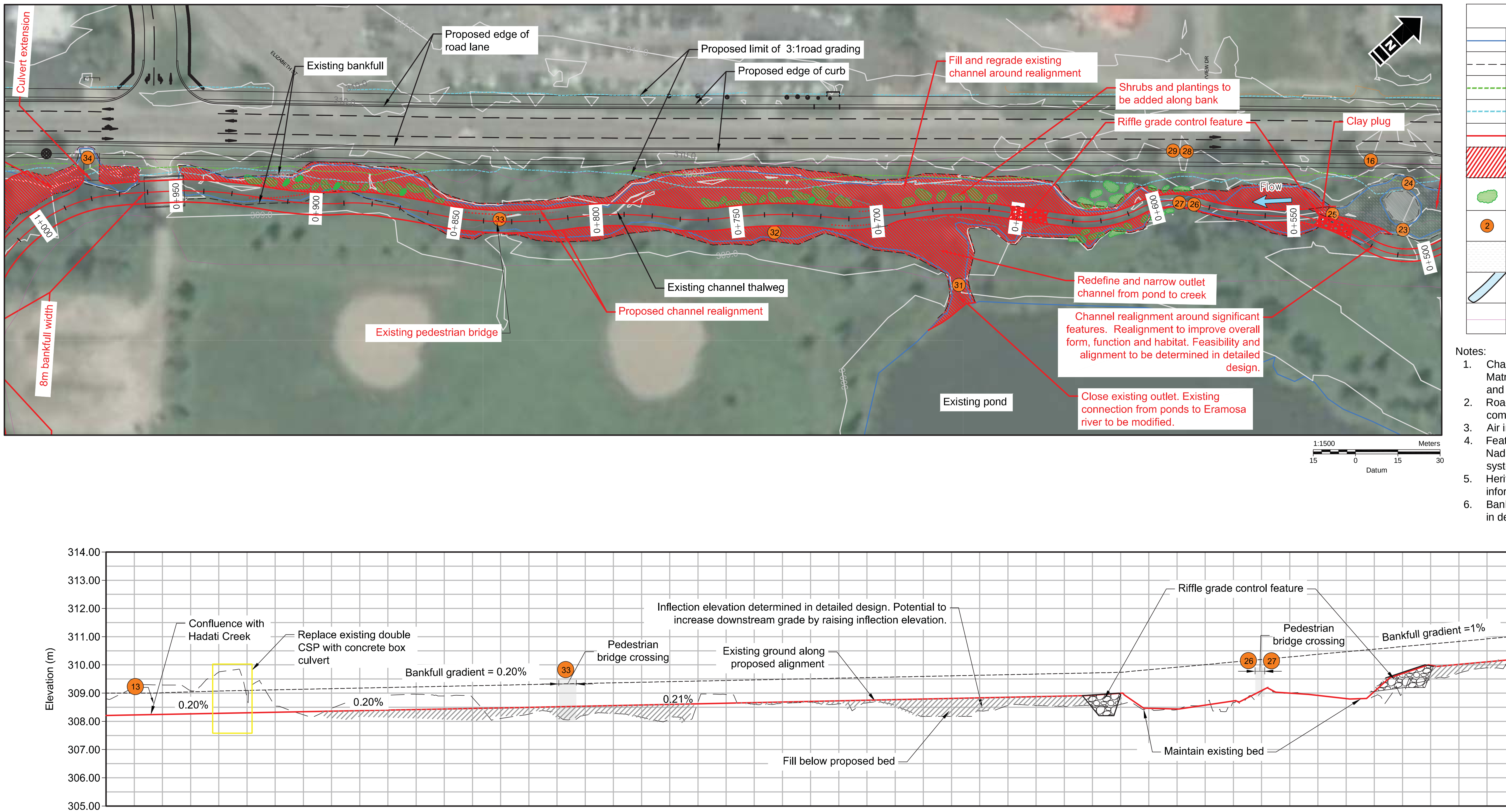
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 1
Preliminary Plan and Profile 0+000-0+500m

Date: 11 22 2017 | Project: 22257 York Road | Technical: J. Henshaw | Reviewer: J. Parish | Drawn: E. Drost

Figure 01



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

Legend	
	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
	Proposed shrubs and plantings
	Cultural heritage feature/structure
	Maintain existing bed
	Proposed pool
	Approximate grading limit

Notes:
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2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.

REVISION

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
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03	03 08 2017	Revised based on client comments	JH	JP	ED
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Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 1
Preliminary Plan and Profile 0+500-1+000m

Date: 11 22 2017 | Project: 22257 York Road | Technical: J. Henshaw | Reviewer: J. Parish | Drawn: E. Drost | Figure 02

Legend

	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
2	Cultural heritage feature/structure
	Approximate grading limit

Notes:

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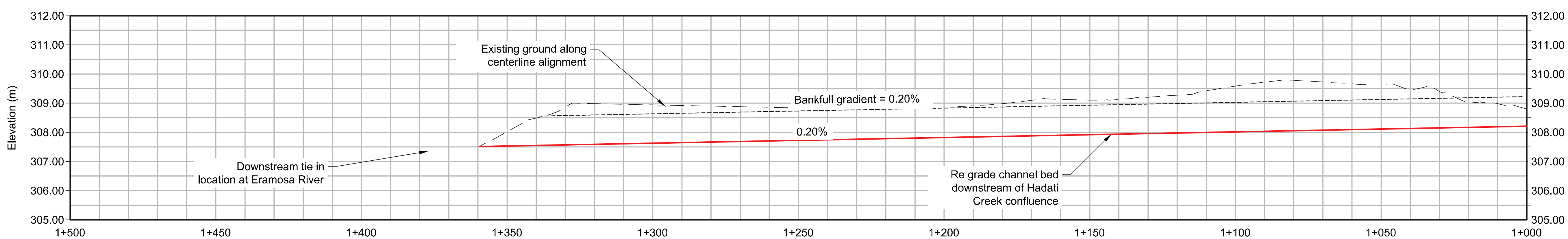
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
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Vertical Scale 1:150

REVISION

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
03	03 08 2017	Revised based on client comments	JH	JP	ED
02	01 17 2017	Revised based on client comments	JH	JP	ED
01	12 09 2016	Revised based on client comments	JH	JP	ED
00	09 15 2016	Draft for client review	JH	JP	ED

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

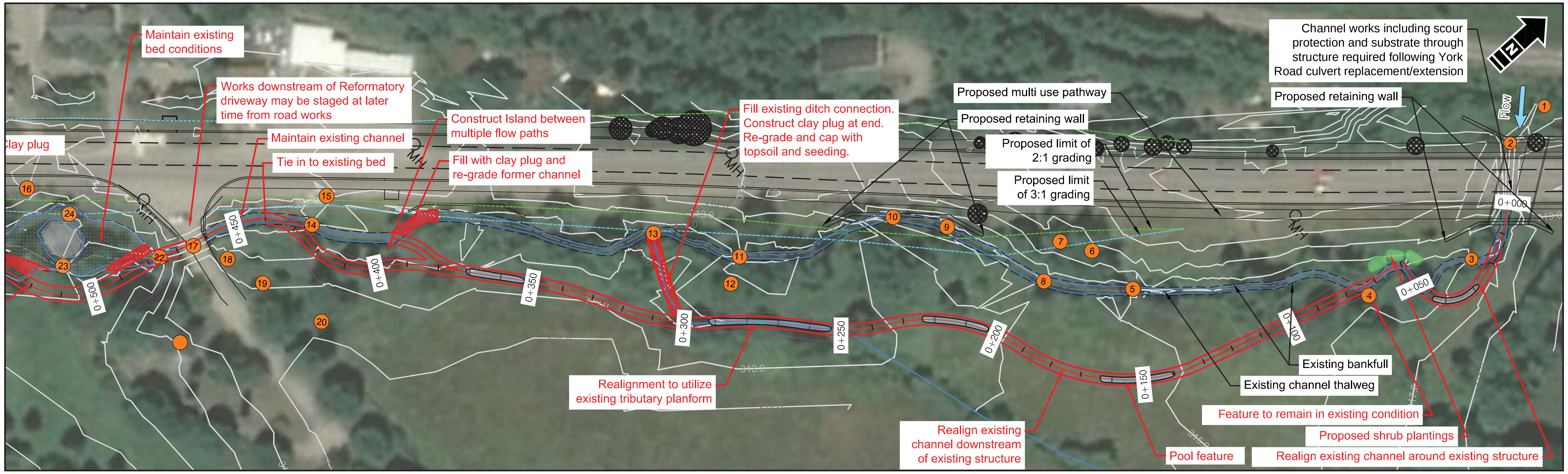
AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 1
Preliminary Plan and Profile 1+000-1+500m

Date: 11 22 2017 | Project: 22257 York Road | Technical: J. Henshaw | Reviewer: J. Parish | Drawn: E. Drost

Figure 03

N:\PROJECTS\22257 - York Road Guelph\145912 - AMEC - York Road Environmental Design Study\03 Data\CAD\Matrix CAD\22257 York Road - Concept Option 1_11-21-2017.dwg - Option 1 (03) - Thursday, November 23, 2017 2:43:43 PM - Eric Drost
Plot 1:1 = Tabloid (L)

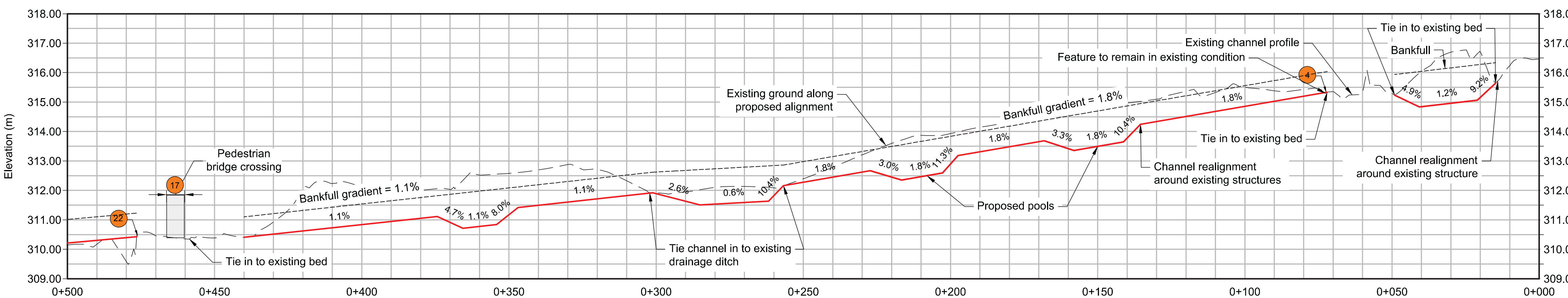


Legend

	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
	Proposed shrubs and plantings
2	Cultural heritage feature/structure
	Maintain existing bed
	Proposed pool
	Approximate grading limit

Notes:

1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
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REVISION					
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03	03 08 2017	Revised based on client comments	JH	JP	ED
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01	12 09 2016	Revised based on client comments	JH	JP	ED
00	09 15 2016	Draft for client review	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

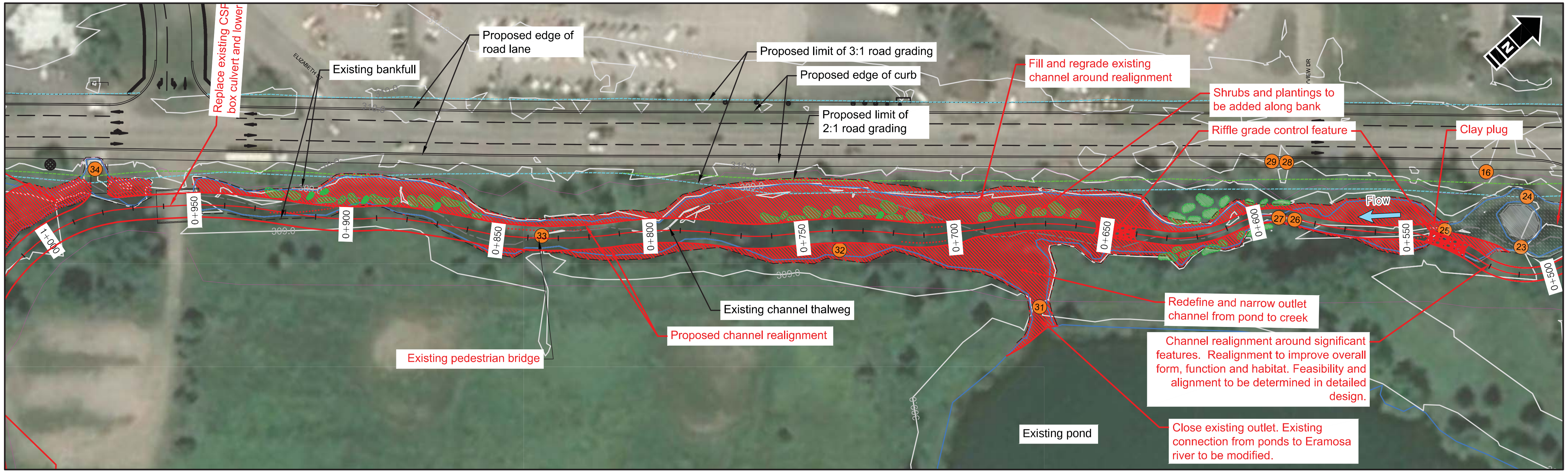
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 0+000-0+500m

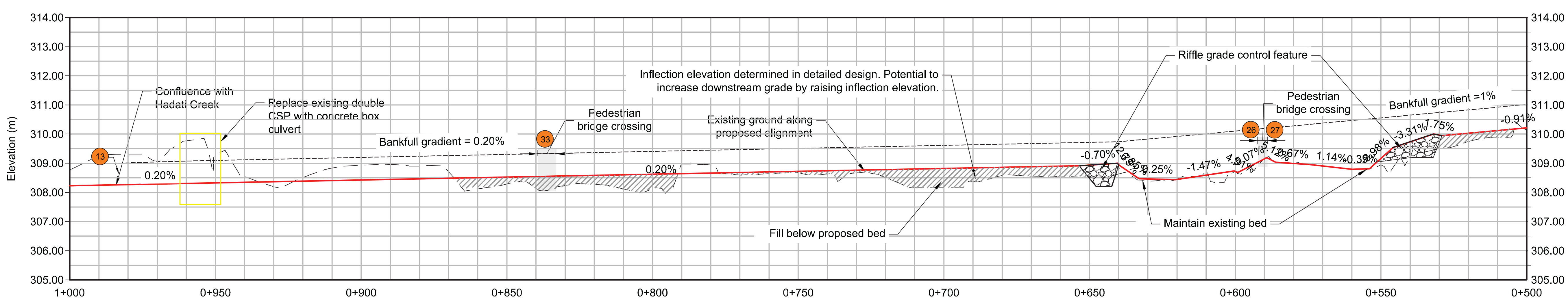
Date:	Project:	Technical:	Reviewer:	Drawn:
11 22 2017	22257 York Road	J. Henshaw	J. Parish	E. Drost

Figure 04



Legend	
	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
	Proposed shrubs and plantings
2	Cultural heritage feature/structure
	Maintain existing bed
	Proposed pool
	Approximate grading limit

Notes:
1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
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01	12 09 2016	Revised based on client comments	JH	JP	ED
00	09 15 2016	Draft for client review	JH	JP	ED

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 0+500-1+000m

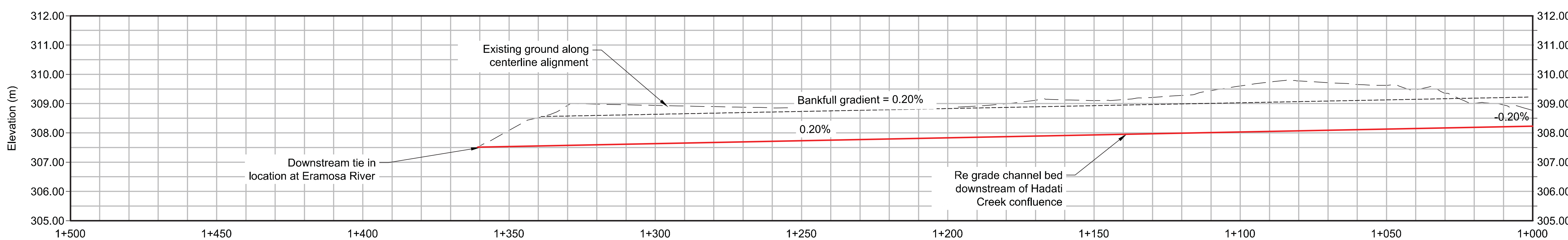
Date: 11 22 2017 | Project: 22257 York Road | Technical: J. Henshaw | Reviewer: J. Parish | Drawn: E. Drost | Figure 05

Legend

- Surveyed edge of water
- Surveyed bankfull
- Toe of 2:1 road grading
- Toe of 3:1 road grading
- Proposed realignment
- Proposed fill/bank treatment
- Cultural heritage feature/structure
- Approximate grading limit

Notes:

1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
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Vertical Scale 1:150

REVISION

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
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Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 1+000-1+500m

Date: 11 22 2017 | Project: 22257 York Road | Technical: J. Henshaw | Reviewer: J. Parish | Drawn: E. Drost

Figure 06

Appendix C

Terrestrial

Appendix C-1: Potential Key Sensitivities and their Location

Key Sensitivity	Description	Location *(ELC polygons found on Figure 1and 2)*	Option 1 Potential Impacts			Option 2 Potential Impacts		
			Direct	Indirect	Induced	Direct	Indirect	Induced
Sensitive ELC communities	Cattail Mineral Shallow Marsh (MAS2-1) with MAM2-2 incl.	Found in ELC Polygon 8	-	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-	-	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-
	Fresh-Moist Lowland Deciduous Forest Type (FOD7-4)	Found in ELC Polygon 10	Expected; proposed creek alignment transects polygon	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-	Expected; proposed creek alignment transects polygon	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-
	Forb Mineral Meadow Marsh (MAM2-10)	Found in ELC Polygon 13	Potential; proposed creek alignment directly adjacent to polygon	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-	Potential; proposed creek alignment directly adjacent to polygon	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-
	Mineral Meadow Marsh (MAM2)	Found in ELC Polygon 12	-	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-	-	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-
Regionally Important Vegetation *City of Guelph (City of Guelph, 2012) & Wellington County (Frank and Anderson 2009)*	Downy Serviceberry (*Amelanchier arborea*) – rare	Found in ELC Polygon 5	-	-	-	-	-	-
	Red Fescue (*Festuca rubra ssp. rubra*) – rare	Found in ELC Polygon 13	Potential; proposed creek alignment directly adjacent to polygon species was observed in	Potential; Removal of significant species and their habitat.	-	Potential; proposed creek alignment directly adjacent to polygon species was observed in	Potential; Removal of significant species and their habitat.	-
	Rough Aven's (*Geum laciniatum*) – rare and significant	Found in ELC Polygon 3 and 11	Expected (both polygons); proposed creek alignment transects polygon where species was observed	Potential; Removal of significant species and their habitat.	-	Expected (both polygons); proposed creek alignment transects polygon where species was observed	Potential; Removal of significant species and their habitat.	-
	Hairy Solomon's Seal (*Polygonatum pubescens*) – rare	Found in ELC Polygon 8 and 13	Potential (polygon 13); proposed creek alignment directly adjacent to polygon species was observed in	Potential; Removal of significant species and their habitat.	-	Potential (polygon 13); proposed creek alignment directly adjacent to polygon species was observed in	Potential; Removal of significant species and their habitat.	-
	Variegated Horsetail (*Equisetum variegatum*) – significant	Found in ELC Polygon 13	Potential; creek alignment directly adjacent to	Potential; Removal of significant species and their habitat.	-	Potential; creek alignment directly adjacent to	Potential; Removal of significant species and their habitat.	-

Appendix C-1: Potential Key Sensitivities and their Location

Key Sensitivity	Description	Location *(ELC polygons found on Figure 1and 2)*	Option 1 Potential Impacts			Option 2 Potential Impacts		
			Direct	Indirect	Induced	Direct	Indirect	Induced
			polygon species was observed in			polygon species was observed in		
	Many-headed Sedge (*Carex synchnocephala*) - significant	Found in ELC Polygon 12	-	Potential; Removal of significant species and their habitat.	-	-	Potential; Removal of significant species and their habitat.	-
Other significant vegetation	Prairie Willow (*Salix humilis*) (Frank and Anderson 2009)	Found in ELC Polygon 8	-	-	-	-	-	-
Species at Risk (SAR)	Chimney Swift (*Chaetura pelagica*) – Threatened (federal and provincial)	Observed foraging over ELC polygons 17 and 18. No breeding habitat present within the Study Area.	-	Potential; construction disturbance of wildlife	-	-	Potential; construction disturbance of wildlife	-
	Barn Swallow (*Hirundo rustica)* – Threatened (federal and provincial)	Observed foraging over ELC polygons 12, 13, and 16. No breeding habitat present within the Study Area.	-	Potential; construction disturbance of wildlife	-	-	Potential; construction disturbance of wildlife	-
	Eastern Meadowlark (*Sturnella magna*) – Threatened (federal and provincial)	Observed foraging south of polygon 16 but could be found foraging in any grass, agricultural, or open community including ELC polygons 3 and 16. No breeding habitat present within the Study Area.	-	Potential; construction disturbance of wildlife	-	-	Potential; construction disturbance of wildlife	-
	Monarch (*Danaus plexippus*)– Special Concern (federal and provincial)	Observed in ELC Polygon 6; could potentially be found breeding wherever host plant, Common Milkweed (*Asclepias syriaca*), is located (ELC polygons 6, 8, 11, and 17)	-	Potential; construction disturbance of wildlife	-	-	Potential; construction disturbance of wildlife	-
	Snapping Turtle (*Chelydra serpentina*)	Observed in the small pond located northeast of the Study Area, on the other side of the correctional facility's driveway. Could potentially overwinter in large ponds (ELC polygons 17 and 18) and in the Eramosa River (ELC polygons 21 and 22). No nesting habitat found in the Study Area.	-	Potential; construction disturbance of wildlife	-	-	Potential; construction disturbance of wildlife	-
Area Sensitive Birds	Savannah Sparrow (*Passerculus sandwichensis*)	It was observed in ELC polygon 7 and is probably breeding within the Study Area. They inhabit meadows, pastures, grassy roadsides, sedge wetlands, and agricultural fields including ELC polygons 3, 5, 6, 11, 14, and 16.	Potential; species may breed in polygon 3, 11, and 16 which contain the proposed creek alignment	Potential; construction disturbance of wildlife	-	Potential; species may breed in polygon 3 and 16 which contain the proposed creek alignment	Potential; construction disturbance of wildlife	-
	Eastern Meadowlark (*Sturnella magna*)	Observed foraging south of polygon 16 but could be found foraging in any grass, agricultural, or open community including ELC polygons 3, and 16. No breeding habitat present within the Study Area.	-	Potential; construction disturbance of wildlife	-	-	Potential; construction disturbance of wildlife	-
	Belted Kingfisher (*Megaceryle alcyon)*	A pair was observed along the Eramosa River and are probably breeding within	-	Potential; construction disturbance of wildlife	-	-	Potential; construction disturbance of wildlife	-

Key Sensitivity	Description	Location (*ELC polygons found on Figure 1and 2*)	Option 1 Potential Impacts			Option 2 Potential Impacts		
			Direct	Indirect	Induced	Direct	Indirect	Induced
Potentially Breeding Locally Sensitive Birds		the Study Area. They prefer wetlands and open water (ELC polygons 17, 18, 19, 20, 21, and 22)						
	Northern Flicker (*Colaptes auratus*)	Probably breeding within the Study Area in open woods (ELC polygons 6, 7, 10, 11, 14)	Potential; species may breed in polygon 10 and 11 which contain the proposed creek alignment	Potential; construction disturbance of wildlife	-	Potential; species may breed in polygon 10 and 11 which contain the proposed creek alignment	Potential; construction disturbance of wildlife	-
	Eastern Kingbird (*Tyrannus tyrannus*)	Three pairs were probably breeding within the Study Area. They inhabit meadows, pastures, grassy roadsides, sedge wetlands, and agricultural fields including ELC polygons 3, 12, 13, and 16.	Potential; species may breed in polygon 3 and 16 which are transected by the proposed creek alignment as well as polygon 13 which is directly adjacent to the proposed creek alignment.	Potential; construction disturbance of wildlife	-	Potential; species may breed in polygon 3 and 16 which are transected by the proposed creek alignment as well as polygon 13 which is directly adjacent to the proposed creek alignment.	Potential; construction disturbance of wildlife	-
	Savannah Sparrow (*Passerculus sandwichensis*)	Two pairs were observed in ELC polygon 7 and is probably breeding within the Study Area. They inhabit meadows, pastures, grassy roadsides, sedge wetlands, and agricultural fields including ELC polygons 3, 5, 6, 11, 14, and 16.	Potential; species may breed in polygon 3, 10, 11, and 16 which are transected by the proposed creek alignment	Potential; construction disturbance of wildlife	-	Potential; species may breed in polygon 3, 10, 11, and 16 which are transected by the proposed creek alignment	Potential; construction disturbance of wildlife	-
	Baltimore Oriole (*Icterus galbula*)	Probably breeding within the Study Area in open woods (ELC polygons 6, 7, 10, 11, 14).	Potential; may breed in polygon 10 and 11 which are transected by the proposed creek alignment	Potential; construction disturbance of wildlife	-	Potential; may breed in polygon 10 and 11 which are transected by the proposed creek alignment	Potential; construction disturbance of wildlife	-
	Willow Flycatcher (*Empidonax traillii*)	Probably breeding within the Study Area in Shrubs/early successional communities (ELC polygon 6, 7, 11, and 14).	Potential; may breed in polygon 11 which are transected by the proposed creek alignment	Potential; construction disturbance of wildlife	-	Potential; may breed in polygon 11 which are transected by the proposed creek alignment	Potential; construction disturbance of wildlife	-
Candidate Significant Wildlife Habitat (SWH)	Seasonal concentration of Animals: Turtles Wintering Area	The two large ponds in the Study Area (ELC polygons 17 and 18) and the Eramosa River (ELC polygon 21 and 22) may contain Turtle over-wintering habitat for Painted Turtle and Snapping turtles.	-	Potential; construction disturbance of wildlife and indirect pollution	-	-	Potential; construction disturbance of wildlife and indirect pollution	-
	Specialized Habitat for Wildlife: Turtle Nesting Area	Potential nesting areas occur along the Eramosa River (ELC polygon 21 and 22) and in open areas with sand and gravel. No suitable habitat was observed along Clythe Creek.	-	-	-	-	-	-
	Habitats for Species of Conservation Concern (not including Endangered and Threatened Species): Special Concern and Rare Wildlife Species	Both Snapping turtle and Monarch were found within the Study Area. Snapping turtles may use ELC polygons 17, 18, 21, and 22 but are not likely to be nesting within the Study Area. Monarch could	-	Potential; construction disturbance of wildlife and indirect pollution	-	-	Potential; construction disturbance of wildlife and indirect pollution	-

Appendix C-1: Potential Key Sensitivities and their Location

Key Sensitivity	Description	Location *(ELC polygons found on Figure 1and 2)*	Option 1 Potential Impacts			Option 2 Potential Impacts		
			Direct	Indirect	Induced	Direct	Indirect	Induced
		potentially breed in ELC polygons 6, 8, 11, and 17.						
	Animal Movement Corridors: Amphibian Movement Corridor	Small numbers of amphibians were detected in the two main ponds in 2016 (ELC polygon 17 and 18); amphibian movement would not be to the north as no habitat exists in that direction. Eramosa River, immediately to the south, likely serves as an amphibian movement corridor (ELC polygon 21 and 22).	-	Potential; construction disturbance of wildlife and indirect pollution	-	-	Potential; construction disturbance of wildlife and indirect pollution	-

Appendix C-2: Excerpt of Section 4.2 Potential Impacts

Draft Environmental Impact Study (EIS) York Road Environmental Design (March 2017)

4.2 Potential Impacts

The preferred alternative has considered and taken into account the environmental sensitivities of the study area. Notwithstanding, there are environmental impacts could result from the implementation of the preferred alternative. As such, all disciplines have assessed the potential for environmental impacts, and have generated mitigation measures to reduce or eliminate these potential impacts.

Impacts can be defined as the consequences that result from an activity or site alteration and can be either positive, neutral, or negative. Impacts can be divided into three categories as defined by the City of Guelph's Guidelines for the Preparation of Environmental Impact Studies (2014).

> **Direct Impact:** Impacts that specifically result from the proposed development layout and/or construction activities. These impacts can be mitigated through modification of site plans and managing construction practices.
> **Indirect Impact:** Impacts that may be caused by altered uses and activities after construction is completed.
> **Induced Impact:** These impacts are a subset of indirect impacts and are the consequences of the changes in human behaviours resulting from the new development.

Direct, indirect, and induced impacts have been considered along with potential avoidance measures. The time period of any identified impacts (i.e. short-term vs. long-term) has also been taken into consideration.

4.2.1 Changes to Permeability

Soil permeability is the measure of how well a fluid passes through it. A soil with high permeability such as sand, allows for faster and greater infiltration than a soil with low permeability such as clay. Changes in the soil permeability will be a one-time occurrence (i.e., during construction). All effort to use in situ soils for creek and road works should be made. It is understood that compaction of the soils within the proposed road widening would occur, that said beyond the road area the area for machinery access should be minimized to reduce soil compaction.

4.2.2 Changes to Water Balance

Water balance analysis allows the quantification of different components of a hydrologic cycle. Water balance analysis is an integral part of the decision support or policy evaluation process at the strategic or functional planning stages of the project. Water balance models are decision support and scenario management tools for promoting rainwater management and stream health protection. Changes in the water balance will be a one-time occurrence (i.e., during construction). Wetland communities have the greatest sensitivity to changes in water balance. The communities along the existing watercourse are likely to be impacted directly but can be compensated for along the relocated watercourse. Wetland vegetation can be salvaged during the construction process to help expedite the naturalization process of the new creek alignment. Wildlife that relies on the impacted wetland communities will be temporarily indirectly negatively impacted during the construction and planting phases. There are no expected induced impacts.

As previously discussed the potential for groundwater discharge exists along the Clythe Creek reaches within the study area. The potential exists due to the permeable nature and thickness of the overburden and the existence of a bedrock channel within the larger scale hydrogeologic setting. This setting is prevalent within the study area including the proposed realigned reach. As such it is expected there would be no significant change to the groundwater discharge potential.

4.2.3 Potential Alteration of Drainage Patterns

Grading activities are often required to accommodate the relocation of the creek and may also alter the way water flows on the study area. Proposed site development will result in an alteration of drainage pattern of the existing study area. Changes in the grading will be a one-time occurrence (i.e., during construction) and will result in a permanent alteration of drainage patterns. The proposed changes are not likely to change the drainage pattern to the catchment but local changes to permeability could directly negatively impact wetlands by modifying the amount of water they retain as well as the duration of the hydroperiod. Wetland communities along the existing watercourse are going to be impacted but can be mitigated though compensating wetland area along the proposed watercourse. Wildlife that relies on the impacted wetland communities will be temporarily indirectly negatively impacted during the construction and planting phases. There are no expected induced impacts.

It is understood that sections of Clythe Creek upstream of the former Reformatory will not be receiving external contributing flow due to the proposed partial creek realignment. Under less frequent storm events, commencing at the 5 year storm, flow would overtop the proposed low flow channel and enter the existing low flow channel. In addition local drainage from York Road will drain to the existing low flow channel via proposed storm sewer outlets. Additional detail on the storm sewer outlets will be provided in the detailed stormwater management reporting.

Drainage patterns would also change from removing the connection from the Royal Jaycees Park north pond to Clythe Creek. The south pond is currently connected to the north pond and the Eramosa River, as such there would be additional flow contribution directly to the Eramosa River from both ponds. Assessment of the thermal benefits to Clythe Creek and potential impacts to the Eramosa River are beyond the scope of this EIS.

4.2.4 Potential Increases in Runoff

The addition of two (2) road lanes each 3.5 m in width will increase the runoff from York Road to Clythe Creek. The proposed two (2) multi-use paths each 3 m wide will not have a considerable impact to runoff as it proposed to use permeable pavement (apart from driveway areas). To offset the increase in runoff from York Road, it is proposed to use infiltration cells along the corridor, capable of storing approximately the 25 mm storm event, sized for the additional road paved area. The infiltration of 25 mm would mean no increase in runoff volume from the additional paved road areas for up to 90% of local storm events. Additional detail will be provided in the stormwater management reporting.

4.2.5 Potential Changes in Water Quality and Temperature

Stormwater water quality will be provided in a treatment train approach, using bio-filtering (when space allows), oil/grit separators and infiltration trenches. The recommended infiltration stormwater trenches would also act as cooling trenches for any flow that is not infiltrated from the paved area of York Road. The water temperature of Clythe Creek should also benefit from the removal of the north pond connection to the creek.

4.2.6 Potential Changes in Channel Erosion and Stability

The preferred alternative channel alignment eliminates contact with the majority of instream cultural heritage features. As a result, backwatering and local increases in channel velocity and scour associated with the features will not be a controlling aspect of channel morphology. The preferred alternative channel alignment will improve the functionality of Clythe Creek in terms of downstream sediment transport and flow connection. In addition proposed channel geometries have been developed to remain stable up to the anticipated 2-year return period flow with the overall goal of improving channel stability.

4.2.7 Potential Changes in Fish Passage

Clythe Creek has been extensively altered through the study area and contains several barriers to upstream fish migration. The existing barriers only allow downstream fish movement, thus creating a series of semi-isolated reaches. Barriers such as these are considered detrimental, as they prevent fish from undertaking movements such as spawning migrations or seasonal movements to locations with more favourable temperatures. Such movements allow fish to make optimal use of the available habitats. Removing such barriers, as recommended in the Grand River Fisheries Management Plan (Ontario Ministry of Natural Resources and Grand River Conservation Authority, 1998), is therefore considered to be positive.

4.2.8 Potential Changes in Fish Habitat

There do not appear to be any critical habitats present within the study area, such as spawning areas for fish from the Eramosa River, where modification would have a negative impact that would extend beyond the modification footprint. The elimination of several barriers to upstream migration, can be expected to provide benefits that extend throughout and beyond the study area by allowing fish to move freely between habitats, thus making use of seasonally optimal conditions and avoiding seasonally incompatible conditions, such as high summer water temperatures.

The series of small ponds that has been created along Clythe Creek downstream from the entrance to the York District lands differs from the stream habitat that would originally have been present. The decreased water velocity and large surface area probably results in increased summer water temperatures and the submergent aquatic vegetation may cause low night-time dissolved oxygen concentrations during the summer. These ponds provide habitat for tolerant fish species and restoring Clythe Creek to a more natural channel configuration would reduce the amount of that habitat present. The proposed channel realignment is a return to conditions that would naturally occur in a stream of this nature, as recommended in the Grand River Fisheries Management Plan (Ontario Ministry of Natural Resources and Grand River Conservation Authority, 1998).

The proposed plan does result in a reduction in the length of the small tributary that enters Clythe Creek upstream from the York District Lands entrance (Feature #13). Currently, however, this watercourse is only contiguous, in a fish utilization sense, with the short reach of Clythe Creek that is between the barriers to fish movement identified as Features #11 and #14. Elimination of the migration barriers would make this watercourse contiguous with a much longer reach of Hadati

Creek. It should be noted that no fish were captured when 117 m of this tributary were electrofished in 2009 (Table 2.6.1).

4.2.9 Modification of Vegetation Communities

The modification of existing vegetation communities to accommodate the relocation of the creek and widening of York Road. Vegetation Removal will be a one-time occurrence (i.e. during construction) and will result in permanent shift in vegetation community composition (ref. Figure 3.6.1). The proposed development will directly impact vegetation communities by removing a total of 3.41 ha of vegetation communities from the study area (Table 4.2.1). The majority of the removed vegetation occurs in cultural communities. There will be removals of some Forest communities and some marsh communities. Planting along the proposed creeks of equal or greater area will replace natural cover removed.

Table 4.2.1 Vegetation Removal Areas

ELC Code	Vegetation Community Name	Total Area (ha)	Area to be Impacted (ha)	Area to be Impacted (%)
Cultural Communities				
CUM1-1	Dry-Moist Old Field Meadow	2.39	0.13	5.4
CUT2-6	Buckthorn Cultural Thicket Type	3.69	0.33	8.9
CUM1-1/MAM2-10	Dry-Moist Old Field Meadow Type/Forb Mineral Meadow Marsh Type Complex	4.94	2.86	57.9
ANTH	Anthropogenic	2.05	0.19	9.3
Natural Communities				
FOD7-4	Fresh-Moist Lowland Willow Deciduous Forest Type	0.71	0.07	9.9
MAM2-10	Forb Mineral Meadow Marsh Type	4.35	0.06	1.4
OAO	Open Aquatic	12.10	0	0

Wildlife that relies on the impacted vegetation communities will be temporarily indirectly negatively impacted during the construction and planting phases. There are no expected induced impacts. Restoration along the proposed creek alignment, implementing vegetation salvages can compensate for the removed communities. Salvaging vegetation can advance the rehabilitation of vegetation communities, making them accessible to wildlife sooner.

4.2.10 Modification of Arboricultural Resources

Modification of arboricultural resources includes the proposed removal and/or potential injury of trees to accommodate the creek realignment. The location and extent of arboricultural resources were considered during site plan development with the intent to avoid impacts wherever feasible. The arborist study completed in 2016 did not survey the extent of the proposed creek realignment and a supplemental survey is proposed for the remaining portion of the modification footprint and will be included in the Vegetation Compensation Plan (Figure 3.6.2). Tree removal is to be a one-time event during construction. The loss will be temporary as new plantings are proposed to replace trees being removed.

The proposed actions summarized in Section 4.1 will apply to accommodate the site alterations. The realignment along York Road will require 115 trees removed and may injure an additional 79 trees (ref. Table 4.2.2); refer to Section 3.6.3 for details. Additional trees may be injured or removed pending the results of the remaining arborist assessment.

Table 4.2.2 Tree Impact Summary

Proposed Action	Total (No. of Trees)
Preserve	20
Injure	79
Remove	115
Replacement Requirement (1:1)	**194**

The permanent removal of trees will result in a loss of canopy habitat. The removed trees will be compensated at a ratio of 1:1 or greater depending on size to comply with City of Guelph polices. Within the surveyed section of the modification footprint, 194 trees are required to replace the trees proposed for removal or injury. An additional arborist assessment will determine the remaining replacement requirements. If replacement planting is not achievable on the subject land, a cash in lieu amount of $500.00 per tree destroyed or injured is to be paid as a substitute. Given time to grow, the canopy will increase in size and will consist of more native species. No induced impacts are expected. A Vegetation Compensation Plan and Tree Protection Plan are required as a part of Guelph Tree By-law (2010).

4.2.11 Construction Disturbance of Wildlife

Construction activities often result in a number of direct impacts to wildlife inhabiting the study area, including but not limited to: increased noise, light pollution, and vibrations which may result in avoidance behaviors of local wildlife. Clearing and grading operations may disturb wildlife and interfere with nesting birds if conducted during breeding season. Impacts are possible from the commencement of construction activities, and could range between 6 months to a year. Construction activities are a single occurrence activity. Clearing and grading activities could directly negatively impact birds by interfering with nesting. There is specific concern for Eastern Meadowlark which was recorded on the adjacent property. Avoidance behaviour of wildlife may occur for a short period after construction activities have ceased. Minor increases in noise and light pollution may also deter area sensitive species, (ref. Section 4.2.16 for more details). No induced impacts are expected. Impacts prior to mitigation measures are negative and of moderate significance. Construction activities including, but not limited to, clearing and grading activities should occur outside of the breeding season (April 15th and July 31st) to avoid impacts to nesting of significant species. Impacts after mitigation measures are neutral, and of moderate significance as impacts are temporary and can be avoided by timing activities outside of breeding season. It is possible to avoid or reduce the magnitude of the disturbance if clearing, grading, and/or general construction works take place outside the breeding bird season. In Guelph the breeding bird season corresponds roughly to the period of April 15th and July 31st.

4.2.12 Decreased Soil Stability

Decreased soil stability is caused by clearing of vegetation and grading activities as it breaks up soil layers, reduces compaction, and increases bare soil which is more susceptible to erosion and/or sedimentation leading to loss of soil. Impacts are possible from the commencement of construction activities and could range between 6 months to a year. Construction activities are a single occurrence activity and soil stability will be restored upon revegetation of the site. Construction activities are a single occurrence short term activity. Soil stability will be restored upon revegetation of the site, therefore impacts are temporary. Decreased soil stability can cause more erosion and sedimentation resulting in reduced vegetation vigor and decreased water quality and fish habitat. By adhering to Greater Golden Horseshoe Area Conservation Authorities (GGHACA) 2006 Erosion and Sedimentation Control Guidelines for Urban Construction, little soil erosion and sedimentation should occur, minimizing the indirect impacts. If guidelines are not adhered to, prolonged reduction in plant vigor and fish habitat quality may occur. There are no expected induced impacts.

Impacts prior to mitigation and compensation measures are negative and of moderate significance due to:

- Minimal magnitude relative to area disturbed;
- Duration is temporary; and
- The frequency is a single occurrence event.

Soil destabilization is reversible through revegetation following construction using temporary seed mix/annual nurse crop grass species within limits of disturbance. Adjacent natural feature should be protected from sedimentation through the use of siltation fencing outlined in GGHACA's Erosion and Sedimentation Control Guidelines for Urban Construction (2006).

The proposed site alterations were developed to require minimal grading, but some grading is still required to accommodate site activities. It is not possible to avoid soil disturbance in order to grub out the root systems of trees and other vegetation to accommodate construction. Sedimentation in the adjacent natural areas can be avoided through use of siltation fencing erected around disturbance zone in conformance with GGHACA 2006 Erosion and Sedimentation Control Guidelines for Urban Construction. Soil destabilization is reversible through revegetation following construction.
Impacts after mitigation and compensation measures are neutral, as negative impacts can be avoided through the use of GGHACA 2006 Erosion and Sedimentation Control Guidelines for Urban Construction, and soil destabilization can be reversed through revegetation.

4.2.13 Import/Export of Fill

Imported fill will be of divergent origin and character to that of existing soils and may affect stability and/or permeability functions. However, as the imported material will be used primarily as a base for the road widening and the overall magnitude will be commensurate to that caused by the construction of new roads, and proposed creek. Importation of topsoil may bring in weed seed from non-native invasive species. Once imported, the duration of the fill placement is considered permanent. This is a single occurrence event. Some top soil may be imported to amend landscaping areas. It is not likely that this presents a significant source of non-native invasive seeds. Introduction of non-native invasive seeds may lower the quality of vegetation communities by out competing native species for resources, reducing the biodiversity of the study area, and the resiliency of the plant communities. The plant communities are all cultural in nature and many non-native invasive species are already present, therefore the impacts are likely insignificant. No induced impacts are expected.

Impacts prior to mitigation measures are negative and of low significance due to sensitivity of target is low and the extent is limited and the effect of the impact is permanent. Careful stockpiling and amendment of existing topsoil may allow avoidance of importing additional topsoil. If importing soil is unavoidable, top soil should be sourced in a manner that has the least potential for containing invasive exotic seeds. Granular fill is required to construct stable foundation for proposed roads and is therefore unavoidable. Once imported and placed it is not possible to reverse this impact while maintaining the proposed roads. Impacts after mitigation measures are neutral.

4.2.14 Removal of Open Country Bird Habitat

A pair of Eastern Meadowlark was recorded during the 2016 breeding bird survey on the property adjacent to the east of the study area (south of polygon 16 on Figure 3.6.1), south of Clythe Creek and east of the driveway to the correctional institute. The proposed work will be confined to the creek corridor and, as such, will not negatively impact these fields, therefore, there are no direct impacts expected. The pair may be indirectly impacted by the noise and other indirect pollution created during the construction period. No induced impacts are expected. Indirect impacts can be avoided by limiting construction activities to outside of the breeding season (April 15th to July 31st).

4.2.15 Encroachment of Natural Areas

Encroachment is the induced impact caused by human occupation or use of land adjacent to natural areas and the associated buffers. Encroachment activities following establishment of buffers could affect the long term success of NHS features and functions if encroachment is severe or excessive. Construction activities will result in avoidance behaviour of many wildlife species, see Section 4.2.11 for details. Noise and light pollution is likely limited to the lands immediately adjacent to York Road, see Section 4.2.16 for further details. Impacts would likely occur post construction and are potentially long term and iterative. Increased encroachment to the natural areas is not expected to increase significantly and would only incurred by the increased traffic on York Rd. Very little to no induced impacts are expected as the land use is not changing from parkland.

4.2.16 Indirect Pollution

Pollution from the creek realignment and road widening include noise, light, and chemicals. Wildlife tend to respond through behavior modifications such as avoidance. Introduction of chemicals into the environment leads to reduced fecundity of aquatic and terrestrial wildlife and flora. Dust can cause avoidance behavior from wildlife and reduce the success of flora along roadsides. Potential effects of indirect pollution on wildlife include:

- Reduced habitat quality;
- Potential loss of habitat due to quality reduction;
- Reduced population densities (particularly breeding birds);
- Reduced species diversity;

- Increased susceptibility to predation;
- Negative physiological effect; and
- Alteration of reproductive behavior (particularly herpetofauna).

Impacts would likely occur post-construction and are potentially long-term and iterative. Construction activities will likely result in noise, light, and chemical pollution which may cause avoidance behaviours in many wildlife species, see Section 4.2.11 for details.

Based on available information and the existing park lands surrounding the natural features, lighting is not expected to change and, therefore, is expected to have a negligible effect on wildlife habitat use or bird migration. Wildlife species that are crepuscular (active during dawn and dusk) or nocturnal may avoid suitable habitat located near roadways due to light pollution. The study area is likely to be occupied mostly during daylight hours, reducing the amount of noise and light pollution during key times for crepuscular species.

Contaminants from York Rd are not likely to change dramatically but may increase slightly due to increased road use. Contaminants can directly impact vegetation community, resulting in increased abundance of salt tolerant weedy species. It can indirectly impact wildlife by modifying the habitat adjacent to the road. The impacts are not expected to be significant as the communities adjacent to the roadways are cultural. No induced impacts are expected.

4.2.17 Removal of Species at Risk

The Endangered Species Act (2007) (O. Reg. 242/08) protects flora and fauna that is Threatened, Endangered or Special Concern at the provincial level. Significant habitats of provincially Endangered and Threatened species are specifically protected from development in the PPS, and habitats of provincial Special Concern species are recognized under the Province's Significant Wildlife Habitat categories.

Three Species at Risk birds were recorded including Chimney Swift – Threatened (federal and provincial); Barn Swallow – Threatened (federal and provincial); and Eastern Meadowlark – Threatened (federal and provincial). Chimney Swift and Barn Swallow are not suspected to be nesting in the study area as there is no suitable habitat present. Barn Swallows are known to be nesting in the vicinity and four birds were seen foraging over the baseball fields on the west side of the study area and in the open field on the east side of the study area. Eastern Meadowlark was recorded in the field east of the study area (south of polygon 16 on Figure 3.6.1), south of Clythe Creek and east of the driveway to the correctional institute. The proposed work will be confined to the creek corridor and, as such, will not negatively impact these fields.

A Snapping Turtle – Special Concern (federal and provincial) – was observed in the pond. Although turtles are likely nesting in the general vicinity, such as along the Eramosa River to the south, there were no significant areas of potential nesting habitat along Clythe Creek and York Road. The two main ponds likely represent overwintering habitat for all three turtle species.

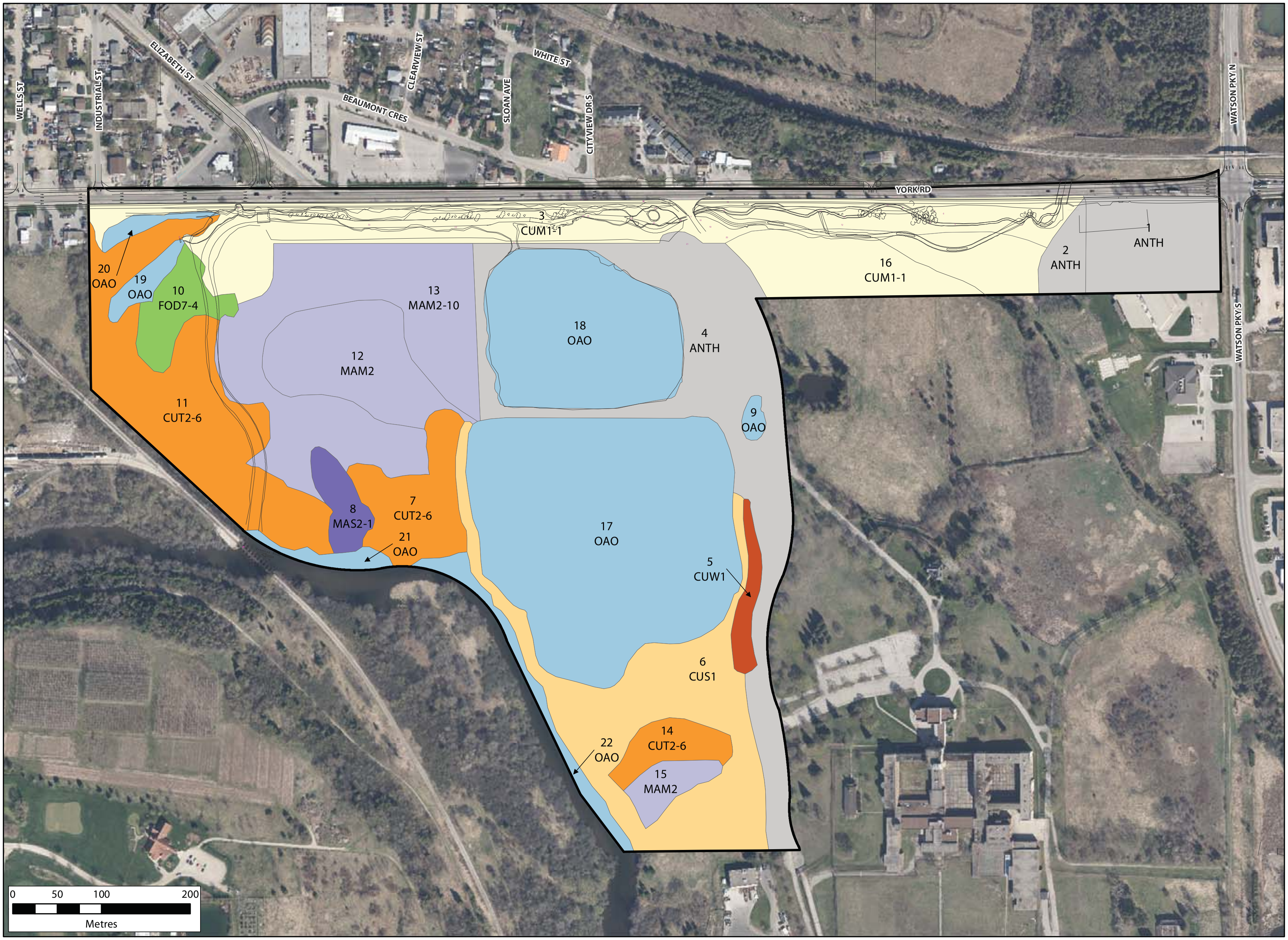
Downy Serviceberry, Red Fescue, Rough Aven's, and Hairy Solomon's Seal were found in the study area and are considered rare in Wellington County (Appendix H-3). Rough Aven's were recorded near the watercourse in polygon 3 as well as in polygon 11 and will likely be removed when the creek is relocated. Red Fescue and Hairy Solomn's Seal were recorded in the Meadow Marsh (polygon 13) and may be impacted by the footprint of the proposed watercourse.

Construction activities could result in avoidance behaviours of Eastern Meadowlark in the field adjacent to the study area and Snapping Turtles in the pond. During the 2016 wildlife surveys, there was no evidence of snapping turtles nesting along the existing watercourse, or anywhere else within the study area. It is likely that they are nesting offsite. As stated in section 4.2.11, construction should occur outside of the breeding window to mitigate any impacts to breeding birds. No induced impacts are expected.

Although there is open country bird habitat, no habitat is to be removed as a part of the road widening and creek relocation. Three locally rare species may be impacted. Locally rare plants found within the creek modification footprint could be salvaged and relocated on site outside of the footprint prior to construction.

Appendix C-3: EIS Terrestrial Habitat Mitigative and Protective Measures

- Sediment and Erosion Control measures including silt fencing;
- Works should be confined to creek and associated riparian habitat and specifically outside of the open fields which is Eastern Meadowlark habitat and foraging habitat for and Chipping Sparrow;
- Vegetation removal to occur outside of breeding bird window: of April 15th and July 31st; if vegetation removal is to occur in this window, a qualified avian ecologist needs to sweep for nests;
- Replace trees at a 3:1 or greater ratio or cash in lieu amount of $500.00 per tree destroyed or injured;
-
- Development and implementation of a Vegetation Compensation Plan and a Tree Protection Plan;
- No removal of Common Milkweed; if it must be removed, replace it elsewhere on site;
- Construction of areas of sand and gravel for turtles to nest away from roadway;
- Construction of turtle basking sites in/near ponds;
- Installation of permanent wildlife exclusionary fence between road and ponds;
- Construction of nesting boxes and platforms for species such as Wood Duck and Osprey;
- Construction of snake hibernacula;
- Bio-salvage of wetland plants along Clythe Creek;
- Transplanting regionally rare and significant plants;
- Planting native flower patches with Common Milkweed; and
- Invasive species control.



Legend

Creek & Road Alignment Option 1 (Matrix & AMECFW, received Nov. 23, 2017)

D&A Study Area

Vegetation Communities

- Anthropogenic
- Cultural Meadow
- Cultural Savannah
- Cultural Thicket
- Cultural Woodland
- Deciduous Forest
- Meadow Marsh
- Shallow Marsh
- Open Aquatic

2016 Orthoimagery provided by City of Guelph

York Rd Environmental Design Study, Road Alternatives Assessment Memo

Road / Creek Alignment Option 1 & Vegetation Communities

DOUGAN & ASSOCIATES
ECOLOGICAL CONSULTING & DESIGN

PROJECT: DA15-061-01

CLIENT: City of Guelph

DATE: DECEMBER 4, 2017

SCALE: 1:4,000

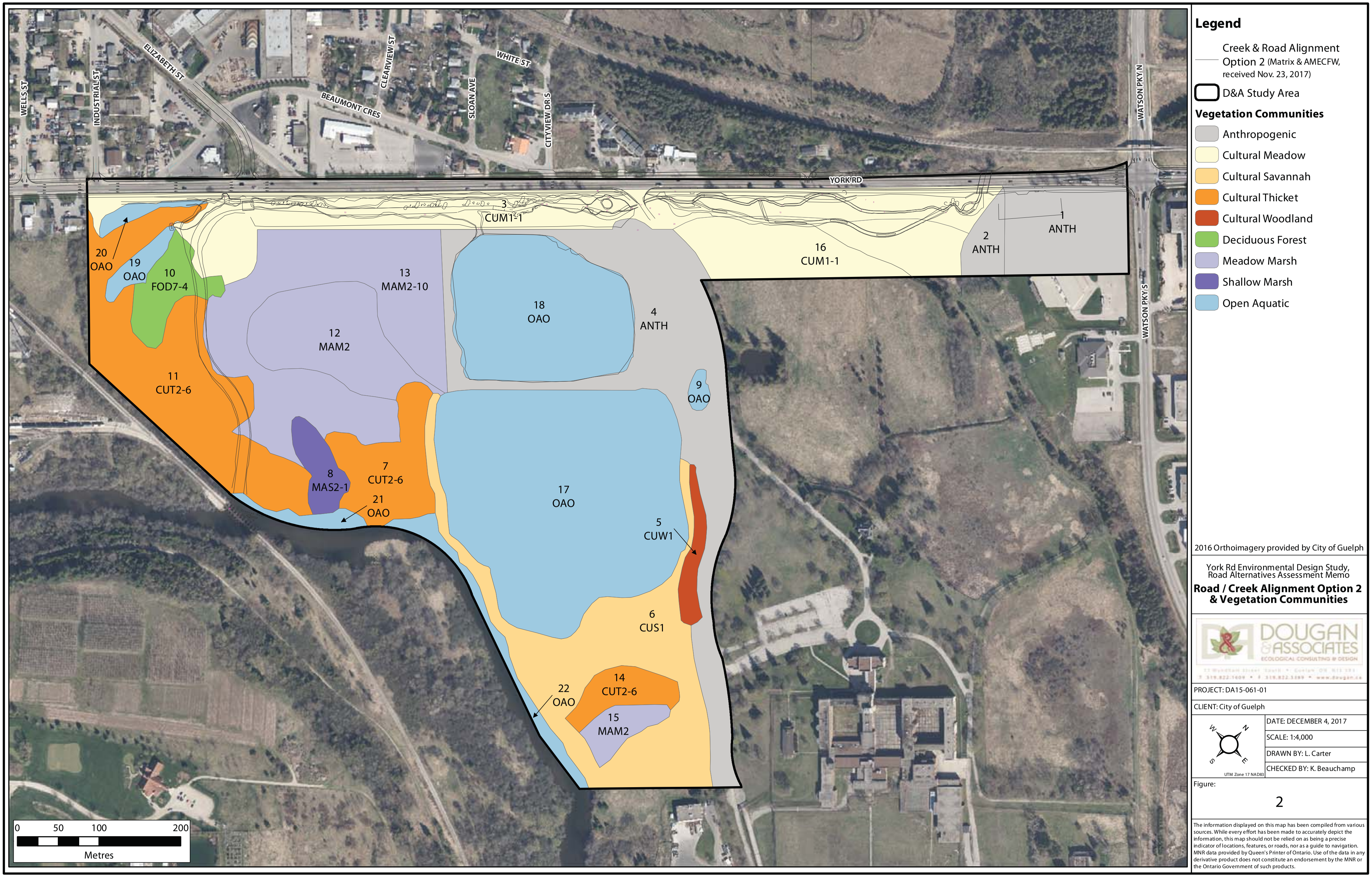
DRAWN BY: L. Carter

CHECKED BY: K. Beauchamp

UTM Zone 17 NAD83

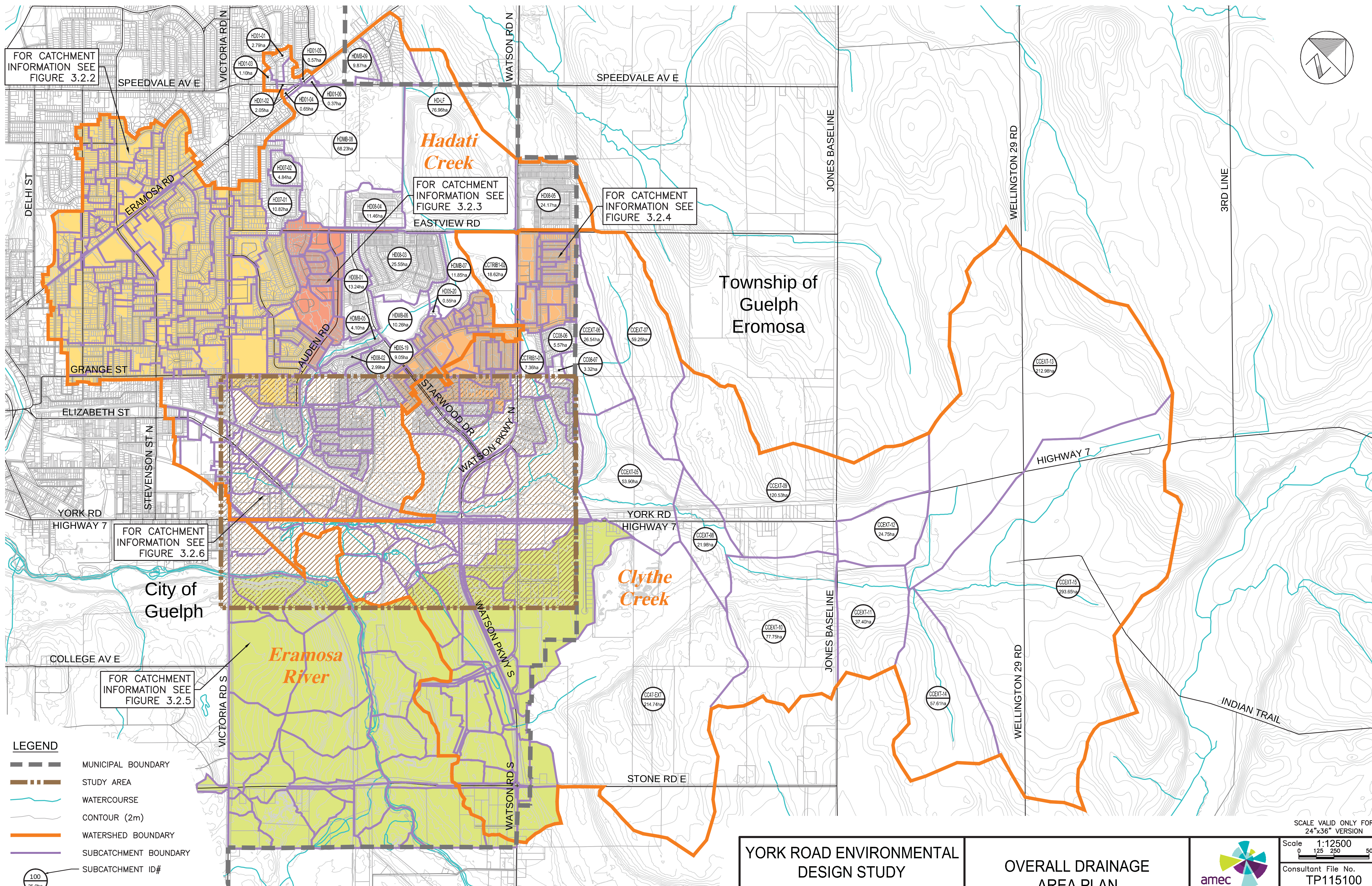
Figure:

1


WELLS ST
INDUSTRIAL ST
ELIZABETH ST
BEAUMONT CRES
CLEARVIEW ST
SLOAN AVE
WHITE ST
CITYVIEW DR S
YORK RD
WATSON PKY N
WATSON PKY S
1 ANTH
2 ANTH
3 CUM1-1
4 ANTH
5 CUW1
6 CUS1
7 CUT2-6
8 MAS2-1
9 OAO
10 FOD7-4
11 CUT2-6
12 MAM2
13 MAM2-10
14 CUT2-6
15 MAM2
16 CUM1-1
17 OAO
18 OAO
19 OAO
20 OAO
21 OAO
22 OAO
0 50 100 200
Metres
Legend
Creek & Road Alignment Option 2 (Matrix & AMECFW, received Nov. 23, 2017)
D&A Study Area
Vegetation Communities
Anthropogenic
Cultural Meadow
Cultural Savannah
Cultural Thicket
Cultural Woodland
Deciduous Forest
Meadow Marsh
Shallow Marsh
Open Aquatic
2016 Orthoimagery provided by City of Guelph
York Rd Environmental Design Study, Road Alternatives Assessment Memo
Road / Creek Alignment Option 2 & Vegetation Communities
DOUGAN & ASSOCIATES
ECOLOGICAL CONSULTING & DESIGN
PROJECT: DA15-061-01
CLIENT: City of Guelph
DATE: DECEMBER 4, 2017
SCALE: 1:4,000
DRAWN BY: L. Carter
CHECKED BY: K. Beauchamp
N
E
S
W
UTM Zone 17 NAD83
Figure:
2
The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.

Appendix D

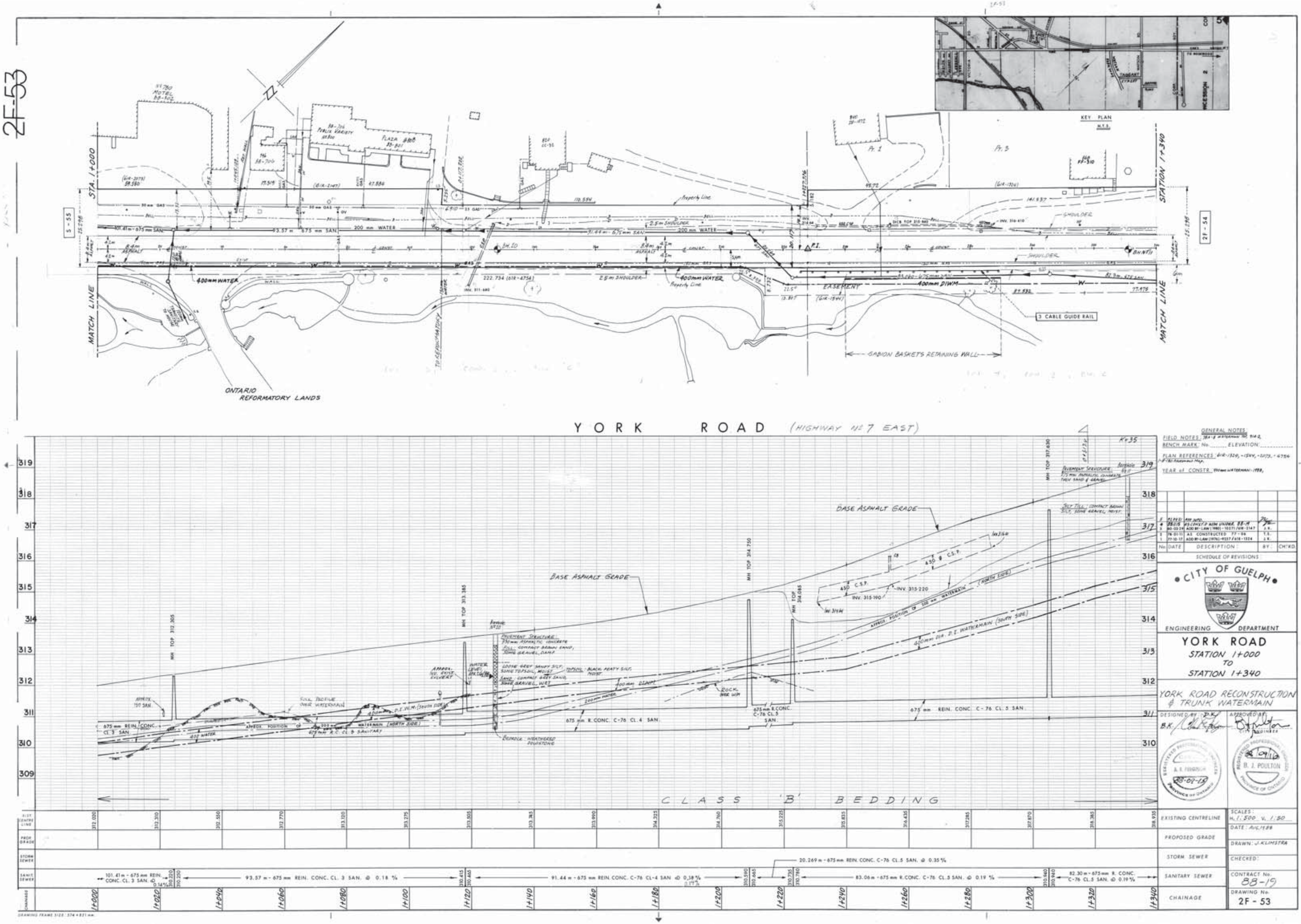
Drainage and Stormwater Management



YORK ROAD ENVIRONMENTAL DESIGN STUDY CITY OF GUELPH	OVERALL DRAINAGE AREA PLAN	amec foster wheeler	Scale 1:12500 0 125 250 500 Consultant File No. TP115100 Figure No. 3.2.1

SCALE VALID ONLY FOR 24"x36" VERSION

Plotted: 2017-03-09 Plotted By: richard.bartolo
Last Saved: 2017-03-08 Last Saved By: richard.bartolo
Path: P:\Work\TP115100\water\dwg\2016-11\Fig1 OverallDrainage(Ex).dwg


2F-53
KEY PLAN
STA. 1+000
STATION 1+340
MATCH LINE
ONTARIO REFORMATORY LANDS
3 CABLE GUIDE RAIL
GABION BASKETS RETAINING WALL
400mm WATER
200 mm WATER
400mm DIWM
EASEMENT
YORK ROAD (HIGHWAY No 7 EAST)
BASE ASPHALT GRADE
CLASS 'B' BEDDING
GENERAL NOTES
FIELD NOTES
BENCH MARK
ELEVATION
PLAN REFERENCES
YEAR of CONSTR.
SCHEDULE OF REVISIONS
No. DATE DESCRIPTION BY CH'KD
CITY OF GUELPH
ENGINEERING DEPARTMENT
YORK ROAD
STATION 1+000
TO
STATION 1+340
YORK ROAD RECONSTRUCTION & TRUNK WATERMAIN
DESIGNED BY
APPROVED BY
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
SCALES: H. 1:500 V. 1:50
DATE: AUG.1988
DRAWN: J.KLIMSTRA
CHECKED:
CONTRACT No. 88-19
DRAWING No. 2F - 53
101.41 m - 675 mm REIN. CONC. CL. 3 SAN. @ 0.14%
93.57 m - 675 mm REIN. CONC. CL. 3 SAN. @ 0.18 %
91.44 m - 675 mm REIN. CONC. C-76 CL-4 SAN @ 0.38 %
20.269 m - 675 mm REIN. CONC. C-76 CL.5 SAN. @ 0.35 %
83.06 m - 675 mm R.CONC. C-76 CL.5 SAN. @ 0.19 %
82.30 m - 675 mm R. CONC. C-76 CL.5 SAN. @ 0.19 %
1+000
1+020
1+040
1+060
1+080
1+100
1+120
1+140
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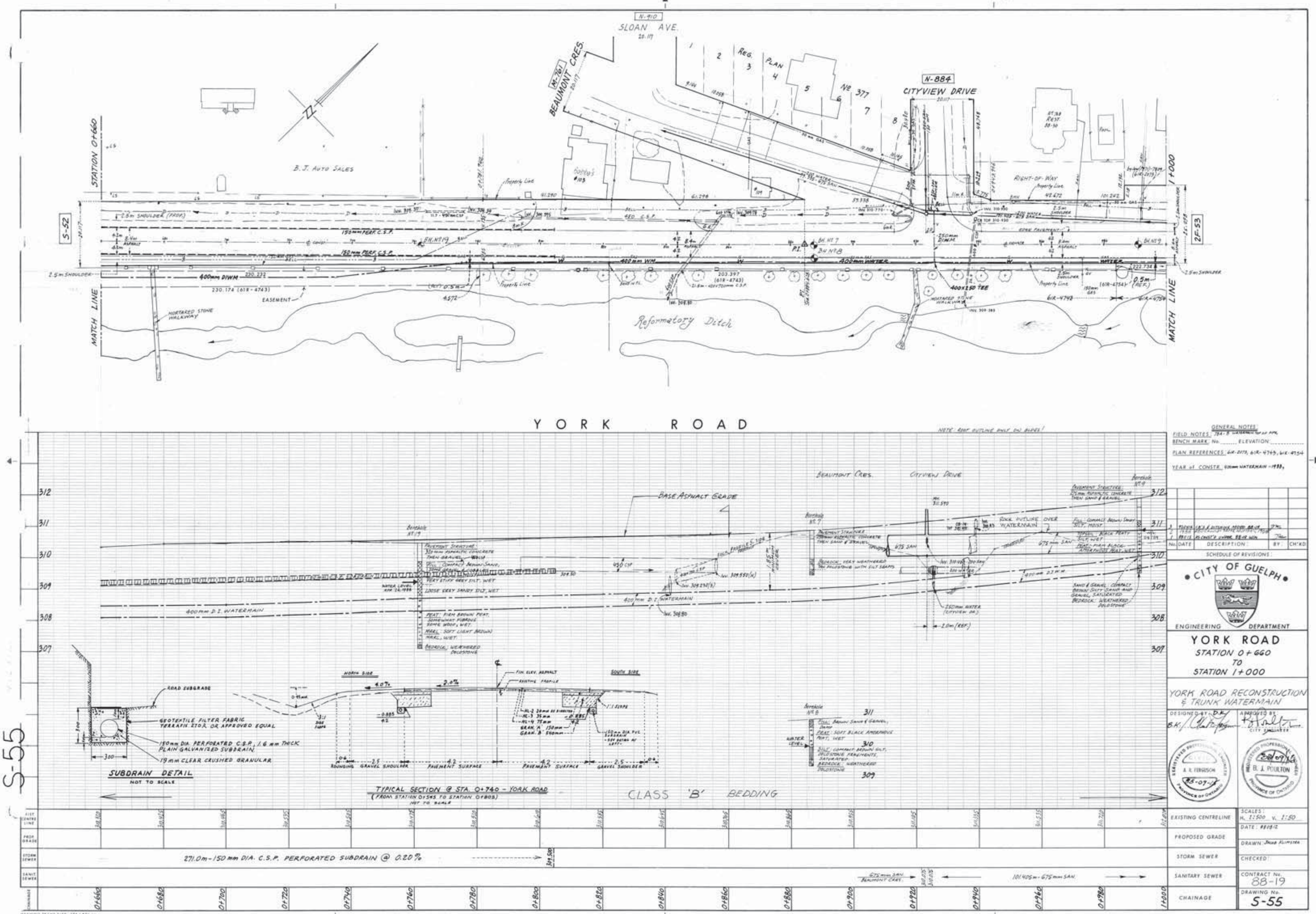
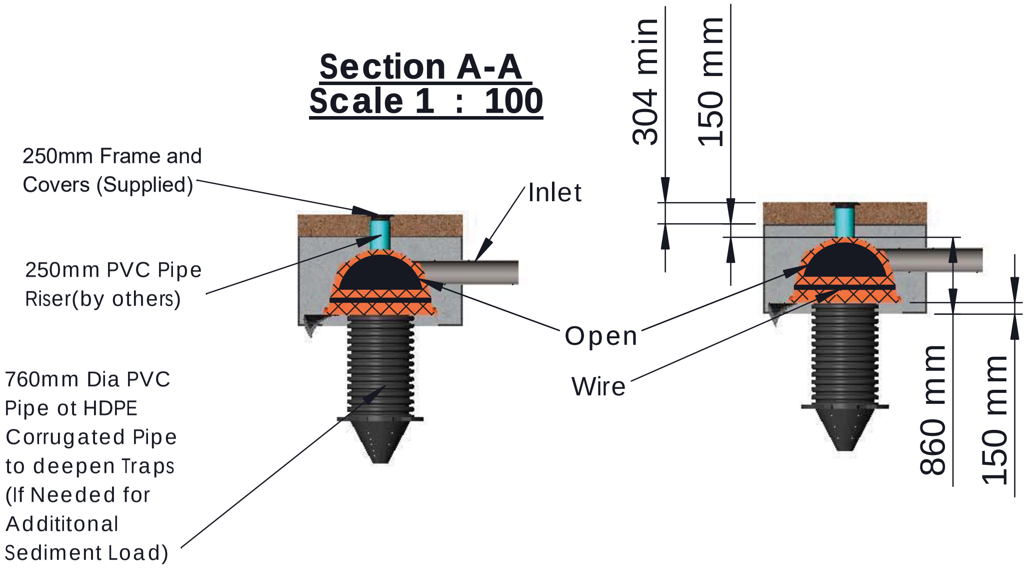
1+300
1+320
1+340



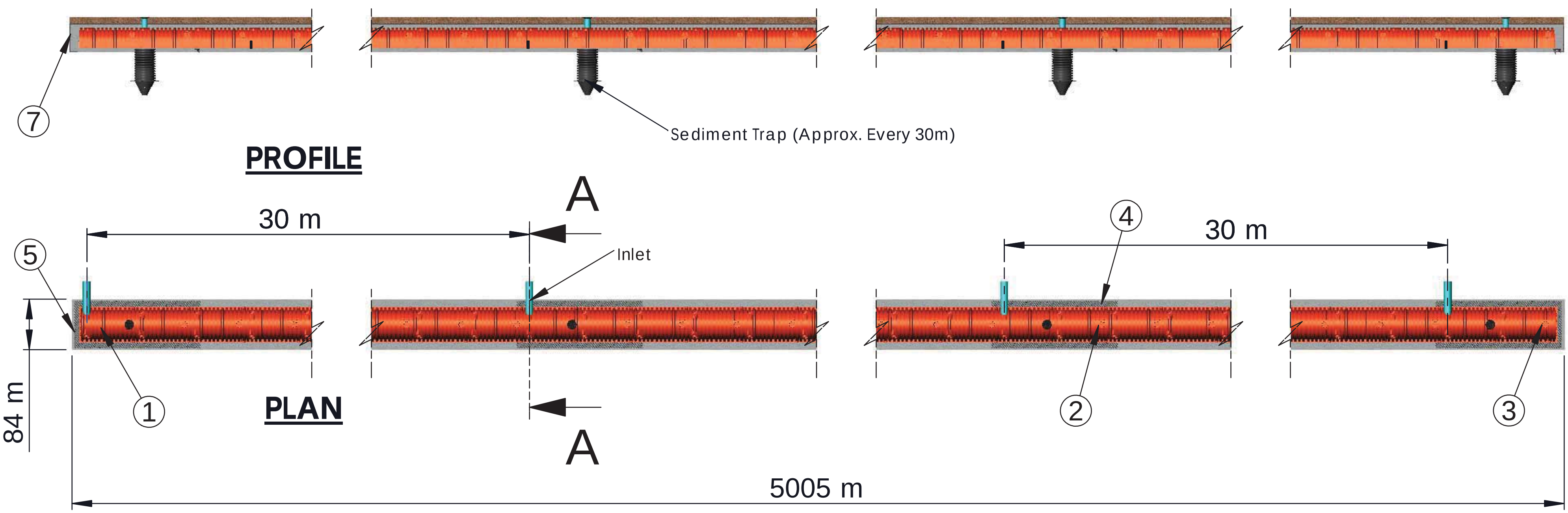
N-910
SLOAN AVE.
BEAUMONT CRES.
M-761
REG. PLAN
N-884
CITYVIEW DRIVE
B. J. AUTO SALES
STATION 0+660
RIGHT-OF-WAY
1+000
MATCH LINE
S-52
2F-53
400mm DIWM
400mm WM
400mm WATER
150mm PERF. C.S.P.
Reformatory Ditch
MORTARED STONE WALKWAY
EASEMENT
400x250 TEE
YORK ROAD
BEAUMONT CRES.
CITYVIEW DRIVE
BASE ASPHALT GRADE
400mm D.I. WATERMAIN
ROCK OUTLINE OVER WATERMAIN
250mm WATER (CITYVIEW DR.)
Borehole No. 7
Borehole No. 8
Borehole No. 9
Borehole No. 19
SUBDRAIN DETAIL
NOT TO SCALE
ROAD SUBGRADE
GEOTEXTILE FILTER FABRIC TERRAFIX 270R OR APPROVED EQUAL
150mm DIA. PERFORATED C.S.P., 1.6 mm THICK PLAIN GALVANIZED SUBDRAIN
19mm CLEAR CRUSHED GRANULAR
TYPICAL SECTION @ STA. 0+740 - YORK ROAD
(FROM STATION 0+545 TO STATION 0+805)
NOT TO SCALE
NORTH SIDE
SOUTH SIDE
ROUNDING
GRAVEL SHOULDER
PAVEMENT SURFACE
CLASS 'B' BEDDING
271.0m - 150 mm DIA. C.S.P. PERFORATED SUBDRAIN @ 0.20%
101.405m - 675mm SAN.
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
0+660
0+680
0+700
0+720
0+740
0+760
0+780
0+800
0+820
0+840
0+860
0+880
0+900
0+920
0+940
0+960
0+980
1+000
GENERAL NOTES:
FIELD NOTES:
BENCH MARK No.
ELEVATION:
PLAN REFERENCES:
YEAR of CONSTR.
No. DATE DESCRIPTION: BY: CH'KD
SCHEDULE OF REVISIONS:
CITY OF GUELPH
ENGINEERING DEPARTMENT
YORK ROAD
STATION 0+660
TO
STATION 1+000
YORK ROAD RECONSTRUCTION & TRUNK WATERMAIN
DESIGNED BY:
APPROVED BY:
CITY ENGINEER
A. R. FERGUSON
B. J. POULTON
SCALES: H. 1:500 V. 1:50
DATE:
DRAWN:
CHECKED:
CONTRACT No. 88-19
DRAWING No. S-55
S-55

Section A-A
Scale 1 : 100



ITEM NO.	STORMCHAMBER PROPOSED LAYOUT DESCRIBTION	QTY
1	START UNITS	1
2	MIDDLE UNITS	2301
3	END UNITS	1
4	7'X10' HEAVY DUTY NETTING (SUPPLIED)	664
5	LIGHTWEIGHT STABILIZATION NETTING (INFLOW AND ADJACENT ROWS) (SUPPLIED)	10
6	10" PVC INSPECTION / CLEAN OUT RISER - (SUPPLIED BYOTHERS) W/ FRAME AND LID AND SEDIMENTRAP(SUPPLIED)	167
7	4oz NON WOVEN STORMCHAMBER GEOTEXTILE FILTER FABRIC (SUPPLIED)	105
8	ROW CONNECTING 10" PVC (SUPPLIED BY OTHERS)	N/A
9	MODIFIED STARTS	162

INSTALLED WITH 150 mm COVER STONE, 150 mm BASE STONE, 40% STONE VOID. INSTALLED SYSTEM VOLUME (PERIMETER STONE INCLUDED) = 7,167 m³



THIS DRAWING WAS PREPARED TO SUPPORT THE DESIGN ENGINEER FOR THE PROPOSED PROJECT. IT IS THE ULTIMATE RESPONSIBILITY OF THE DESIGN ENGINEER TO ENSURE THAT THE STORM WATER DESIGN IS IN FULL COMPLIANCE WITH ALL APPLICABLE LAWS AND REGULATIONS. STORMCHAMBER DOES NOT APPROVE PLANS , SIZING, OR SYSTEM DESIGNS. THE DESIGN ENGINEER IS RESPONSIBLE FOR ALL DESIGN DECISIONS.

U.S. GREEN BUILDING COUNCIL MEMBER

STORMCHAMBER® BY HydroLogic SOLUTIONS

TOLL FREE: 1-877-426-9128
EMAIL: INFO@STORMCHAMBERS.COM
WWW.STORMCHAMBERS.COM

ADDRESS: **Concept Drawing Only**

STORMCHAMBER®	
PROJECT NAME: Bramble Trail	
DATE: March 26, 2016	
DESIGNED BY: ARH	DRAWN BY: SAL
SCALE: N.T.S.	SHEET NO: 1 OF 4

StormChamber 34 - Design Calculator

Select a System of Measurement:	Metric

Cubic Meters of Storage Required:	7,167	<Start Here	% Stone Void In Decimals:	0.40

Bramble Trail

	m^3 per Chamber	Number of Chambers	Number Wide**	Number Long**	Min.*** Trench Depth (m)	Min. Trench Width (m)	Avg. Trench Length (m)	Total m^2	m^3 Excavation*	m^3 Stone	m^2 Filter Fabric
StormChamber Without Stone	2.1	3375			1.5						
150 mm Stone Above, 150 mm Below	**3.3**	**2165**	**1**	**2165**	**1.5**	**2**	**5005**	**10686**	**12377**	**7779**	**43803**
150 mm Stone Above, 300 mm Below	3.5	2004			1.6						
150 mm Stone Above, 450 mm Below	3.8	1865			1.8						
150 mm Stone Above, 600 mm Below	4.0	1745			1.9						
150 mm Stone Above, 750 mm Below	4.3	1639			2.1						
150 mm Stone Above, 900 mm Below	4.6	1545			2.2						
150 mm Stone Above, 1050 mm Below	4.8	1461			2.4						
Custom Above (mm): 6 / Below (mm): 9	2.8	2554	10	255	1.2	18	590	10593	9307	3883	15784

Notes:

* The displayed m^3 of Excavation accounts for the chamber system only. It does not include the additional cover above the top stone layer as this may vary.

** If the number long multiplied by the number wide does not equal the total number of chambers, the total number is the correct number.

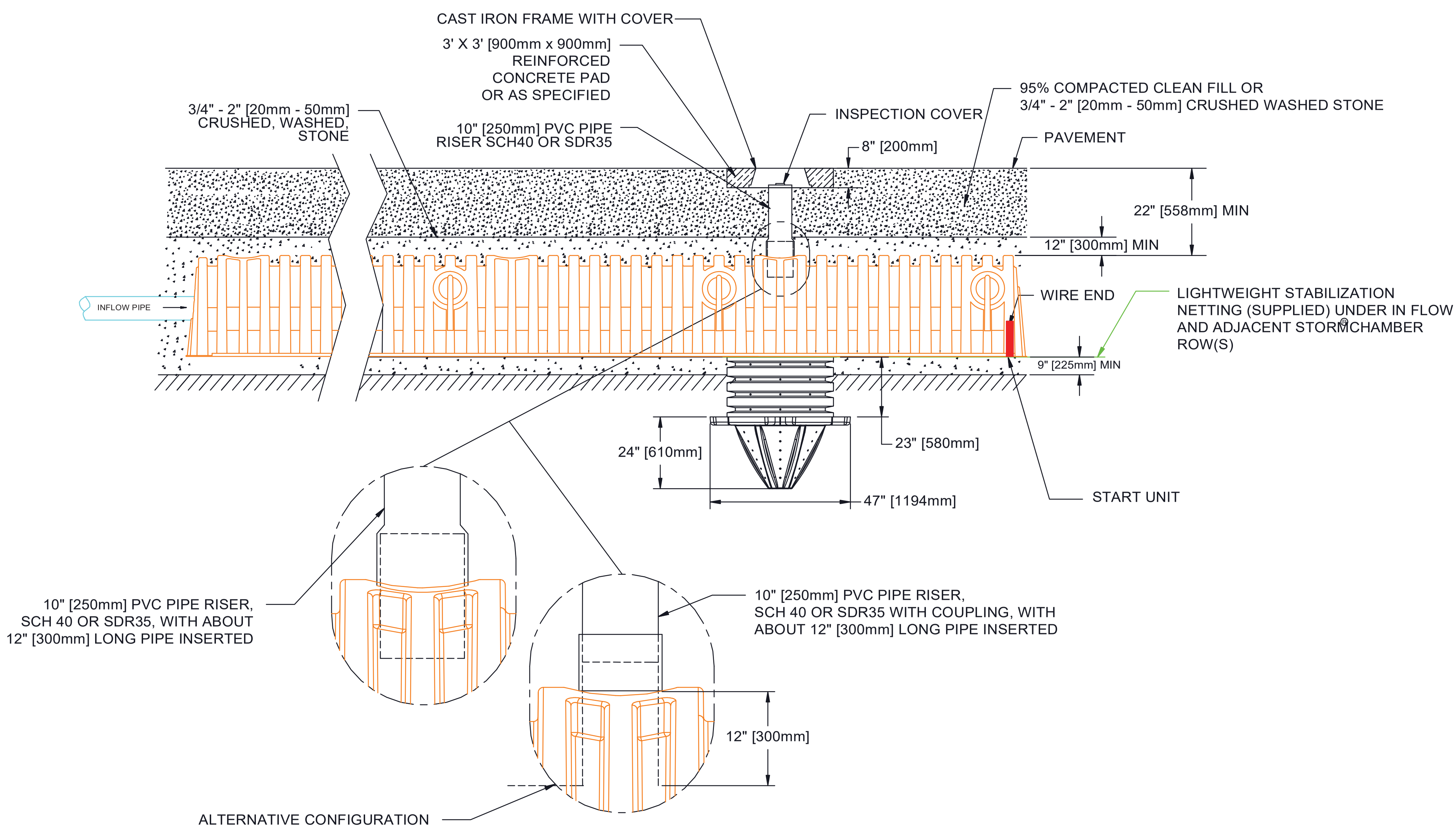
*** Trench Depth includes the minimum 0.3048 meters above stone cover. This may be increased if needed or desired.

How To Use The StormChamber Design Calculator:

1. Select a system of measurement.
2. Input the cubic meters of storage required.
3. Enter the stone void allowed, in decimals. This will normally be 0.40.
4. Determine the stone configuration desired in the left hand column. Standard configuration is 150 mm above & below.
5. Enter an approximate number of chambers wide. The number of chambers long for each of the rows will automatically be displayed. Adjust the number of chambers wide to obtain the desired trench dimensions.
6. The minimum trench depth is shown for each of the stone configuration. Alternate configurations can be inputed in the "custom" category in the bottom of the first column.

For Availibility and Pricing Please Call:
StormChamber®
TOLL FREE: 1-877-426-9128
E-mail: Info@StormChambers.com

STORMCHAMBER® WITH SEDIMENTRAP™



INSTALLATION OF STORMCHAMBER SYSTEMS (can be downloaded and printed from www.stormchambers.com)

TRENCH PREPARATION

1. Do not excavate trench until dry weather is forecast long enough to allow at least coverage of the StormChamber system with filter fabric prior to raining.
2. Excavate to a width and length sufficient to accommodate the number of StormChambers plus a minimum one foot border around the entire bed. The bottom of the bed must be level, unless otherwise specified.
3. Do not use heavy equipment on the excavated trench bed in order to avoid soil compaction.
4. If use of heavy equipment on the excavated trench bed can not be avoided, scarify the trench bottom and break up soil clumps and till smooth before adding the stone base.
5. Line trench walls with a 4-ounce [113g] non-woven filter fabric such as Mirafi 140N or 140NC, Synthetic Industries 401, or AMOCCO 4545 or 4535. Overlap adjacent filter fabric by at least 2' [600mm]. Do not place filter fabric under the StormChambers.
6. Unless otherwise specified, place 9" [230mm] of crushed, washed, 3/4" - 2" [20mm - 50mm] hard, non-calcarious stone on the bottom of the trench. The base must be level and at a zero grade.
7. If it becomes impractical to level the stone base by hand, use a low pressure, tracked dozer, not exceeding 1,100 lbs/sf [500kg/sf], maintaining at least 9" [230mm] of stone under the tracks at all times.

STORMCHAMBER INSTALLATION

1. Verify quantities of StormChamber units and other materials that have arrived. If anything is damaged or missing please contact StormChamber immediately.
2. Start building the StormChamber system with the Start Unit StormChambers at the inflow end of the StormChamber system. The Start Units are completely closed at the end with the two side portals.
3. Roll out rows of StormChamber light weight stabilization netting (provided with the StormChambers) parallel with the inflow and adjacent(s). Overlap the rows by approximately 1' [300mm]. Keep the netting flat; if moved, straighten and flatten out.
4. Place one piece of the StormChamber heavy weight stabilization netting (provided with the StormChambers) under each StormChamber that will be receiving inlet storm drain pipes. Cut a hole in the netting to fit snuggly around the exposed top of the SedimenTrap. Place on top of the light weight netting and extend beyond all edges of the StormChamber. The purpose of heavy weight stabilization netting is to function as a "splash pan", preventing excavation of the underlying stone and soil, while allowing infiltration to occur.
5. Place the Start Unit StormChambers (completely closed at the end with the two side portals), spaced a minimum of 7' 3" [2057mm] apart at the center line of the chamber crown. Position the closed ends at least 1' [300mm] from the trench wall.
6. Cut open the side portals for the inflow storm drain pipes (size and location specified on the plans) and lateral connecting pipes between StormChamber Start Units (8" [200mm] or 10" [250mm] Schedule 40 or SDR 35 PVC; 8" [200mm] or 10" [250mm] HDPE will not fit) with a reciprocating saw, router bit on a drill, or keyhole saw along the defines indented circle. 10" [250mm] PVC pipe is the largest diameter pipe that can fit into the side portals. If the inflow storm drain pipe is specified to enter the closed end wall, place a piece of the pipe against the end wall. Trace the diameter of the pipe on the end wall and cut out the circle. The maximum pipe size that can be inserted into the end wall is 30" [750mm] O.D.
7. If a cut extends more than 0.5" [13mm] beyond the intended diameter, place a piece of the StormChamber non-woven filter fabric over the hole, cut an "X" just short of the width of the opening, and insert the pipe.
8. Mark the midpoints of 8" [200mm] or 10" [250mm] PVC pipe and insert into the adjacent StormChamber Start Units where specified so that the marked midpoint is centered between the two adjacent StormChambers. Pipe length should be sufficient to extend 6" [150mm] - 12" [300mm] into both adjacent StormChambers (about 4' [1200mm]). In order to facilitate placement, install the lateral connecting pipes in the specified StormChambers before attaching the next StormChambers in the row.
9. If the locations of row - connecting PVC pipes are not specified, add 8" [200mm] or 10" [250mm] PVC pipes to connect the inflow chamber and adjacent chamber(s) of the inflow row.
10. Place the first rib of a Middle Unit (completely open at side portal end partially open at top portal end) over the last rib of each of the Start Unit StormChambers.
11. Screw the StormChambers together at their base on both sides with regular 3" [75mm] dry wall screws. One screw on each side is sufficient to temporarily hold the StormChambers together until the stone is place. The gap between the two StormChambers near their base must be closed enough to prevent stone from migrating into them to prevent potential surface subsidence.
12. Continue placing and screwing the rest of the StormChambers, one at a time, leaving at least 1' [300mm] between the end of the End Unit (completely open at the side portal end, completely closed at the top portal end) and the trench wall.
13. For large StormChamber systems it is advisable to install and backfill a few StormChambers of all rows at a time as you continue to install the rest of the chambers.
14. Deposit 3/4" - 2" [20mm - 50mm] crushed, washed, hard stone directly along the centerline of the StormChambers to evenly flow down each side to keep the StormChambers in proper alignment. Avoid the use of limestone, if possible. Limestone gets pasty when wet and will tend to reduce the void spaces in the stone. Do not place the stone directly against the closed end walls at the start and end of the rows. Add stone to 6" [150mm] above the StormChambers, unless otherwise specified.
15. Level the stone cover with a vibratory compactor, not to exceed a dynamic force of 10,000 pounds [4536kg], or with a low pressure, tracked vehicle not exceeding 1, 100 lbs/sf [500kg/sf].

<u>IMPORTANT:</u> If a low pressure, tracked dozer is used, do not run the dozer on anything less than 6" [150mm] of stone above the StormChambers. Spread stone is small piles to prevent movement of the StormChambers. Caution must be exercised when placing stone on top of the StormChambers so that excessive pressure is not applied directly on the StormChambers by equipment "buckets".

16 Cover the stone with StormChamber non-woven filter fabric. Overlap adjacent sheets by at least 2' [600mm].

<u>BACKFILLING</u>

1. Backfill soil must be free from large stones and large organic material (e.g. tree limbs and root stumps), and is capable of being compacted to at least 90% of the Standard Proctor Test (AASHTO Method T-99). If not, crusher run or other suitable backfill material must be used. The stone surrounding the StormChambers can also be extended up to the pavement subgrade, if desired.
2. Compaction of the soil backfill must be achieved in 6" [150mm] - 8" [200mm] lifts. Grading of lifts should start in one corner of the system with a low pressure, tracked dozer, with a pressure not exceeding 1,100 lbs/sf [500kg/sf], keeping at least 1' [300mm] of fill in front of the blade at all times. Compact lifts to 90% Standard Proctor with tracked vehicles not exceeding 1,100 lbs/sf [500kg/sf], or with a hand operated compactor or vibratory roller not exceeding a dynamic force of 20,000 lbs [9071kg].
3. Keep the StormChamber system closed or protected from receiving sediment until the site is completely stabilized (grass growing and all pavement placed).

IMPORTANT: After compaction of backfill and setting of final grade, avoid parking on or traversing over the StormChamber installation with heavily loaded trucks and heavy equipment until paved.

MPORTANT: These instructions assume accepted construction procedures and trucks that do not exceed specified DOT load limits. Uncustomary loads or improper load distributions in vehicles may require additional cover. Contact StormChamber for installation under abnormal conditions. Installations not in compliance with these instructions will void warranty.

<u>PRODUCT ENGINEERING SPECIFICATIONS FOR STORMCHAMBER</u>

Each chamber will be formed from high molecular weight/high density polyethylene.

Each chamber will be composed of at least 40% recycled material.

The stone base that the chambers are placed on will not be compacted in order to avoid compaction of the stone-soil interface, which restricts soil infiltration.

The chamber system will be designed without filter fabric under the chambers in order to avoid restriction of soil infiltration, which occurs from the normal clogging of the filter fabric from sediment and debris deposition.

Use of filter fabric between the soil and stone backfill layer and lining the side walls of the excavated area will be required to prevent intrusion of soil or silt into the chambers and surrounding stone.

Each chamber will be capable of supporting a minimum of 24,000 pounds [10,886kg] per square foot (i.e., three times the AASHTO H-20 Wheel Load Rating).

Each chamber will be capable of being installed with a minimum of 25 feet [7620mm] of cover above the crown of the chamber.

Each chamber system will be capable of being installed in at least two layers, providing a minimum of 0.8 cubic feet of storage per square foot of surface area.

Each chamber system will be capable of being installed with a minimum of six inches [150mm] of stone base.

Each chamber will be 34.04" [864mm] high, 60" [1524mm] wide and 102.5" [2591mm] long.

Lay-up length will be 8.1' [2464mm] (start and end unit) and 7.6' [2311mm] (middle unit).

Each chamber will have 14 ribs of approximately 3.6" [91.4mm] in height, 3.8" [96.5mm] wide at the top and tapering to 4.4" [112mm] at the bottom.

Spacing of the ribs at the bottom of the chamber will be approximately 4.9" [124mm] and approximately 3.2" [81.3mm] at the top. One smaller rib sized dimensionally to effectively nest under and interlock to connect units will be 2.9" [73.7mm] high, 3.3" [83.8] wide at the top of the rib, and 4.1" [104mm] wide at the base.

Overall height to the inside rib will be 30.44" [864.62mm]. Overall height to the outside rib will be 34.04" [773.18mm].

Each chamber will have a defined top portal which is structurally enhanced to compensate for loss of structural integrity when apertures are cut open to receive pipe. Each such portal will be capable to receive up to a 12" [300mm] PVC pipe.

Each chamber will have defined side portals on opposing sides which are structurally enhanced to compensate for loss of structural integrity when apertures are cut open to receive pipe.

Invert height for a 10" [250mm] PVC pipe through a defined side portal will be 17.49" [444.25mm]. Invert height for an 8" [200mm] PVC pipe through a defined side portal will be 18.49" [469.65mm].

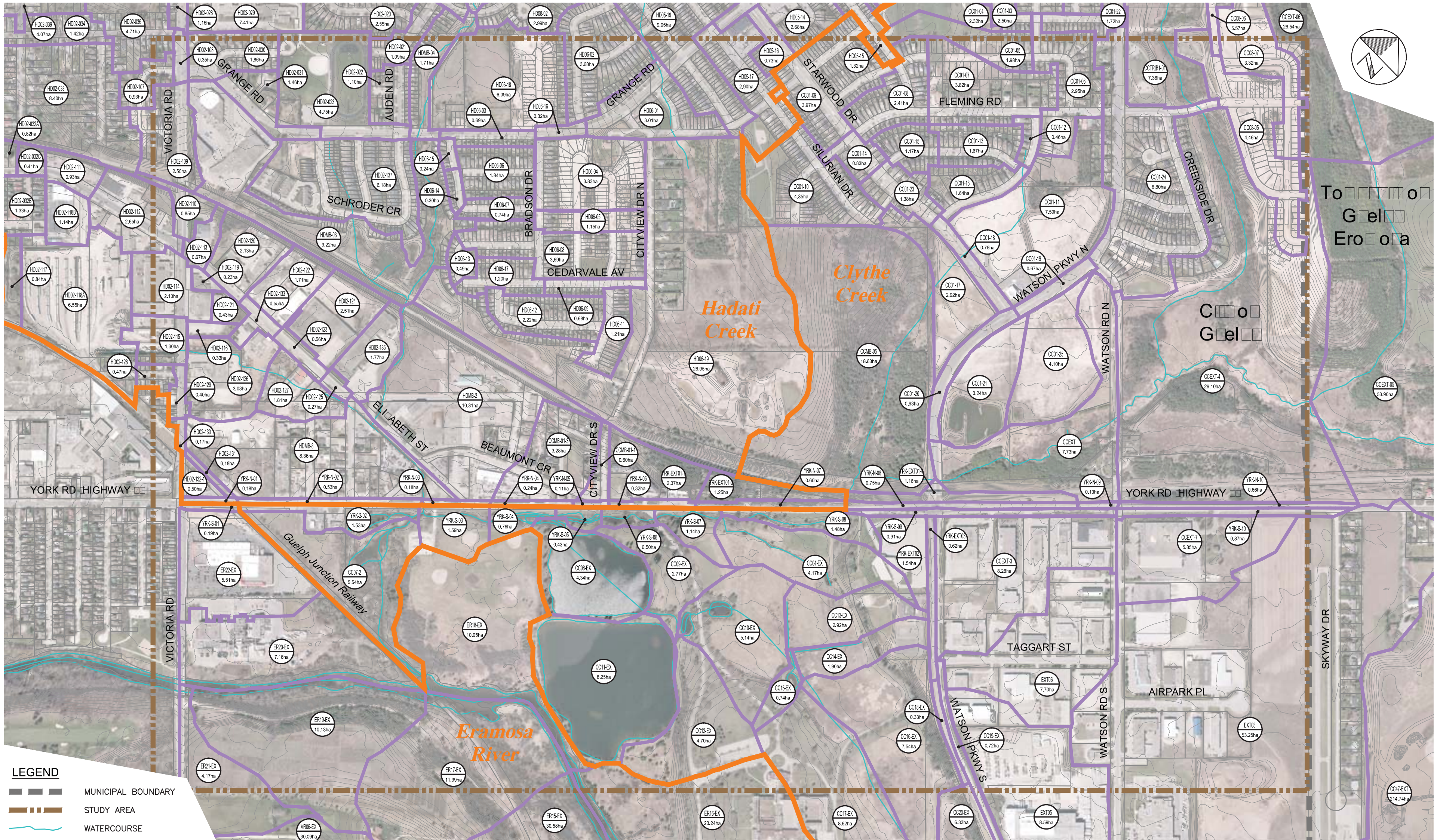
Each chamber will be capable to accept an 8" [200mm] or 10" [250mm] PVC feed pipe through a defined side portal.

Each chamber will be capable to accept up to a 30" [750mm] OD pipe through its end wall.

Each chamber will be capable of storing at least 15 cubic feet per lineal foot with 6" [150mm] or stone above and below the chamber.

Each chamber system will be designed without utilizing a header pipe manifold system.

Stone diameter will be 3/4" - 2" [20mm - 50mm].



SCALE VALID ONLY FOR 24"x36" VERSION

YORK ROAD ENVIRONMENTAL DESIGN STUDY CITY OF GUELPH	STUDY AREA DRAINAGE PLAN (EXISTING CONDITIONS)	amec foster wheeler	Scale 1:4000 Consultant File No. TP115100 Figure No. 3.2.6

Path: P:\Work\TP115100\water\dwg\2016-11\Fig2 StudyAreaDrainage(Ex).dwg
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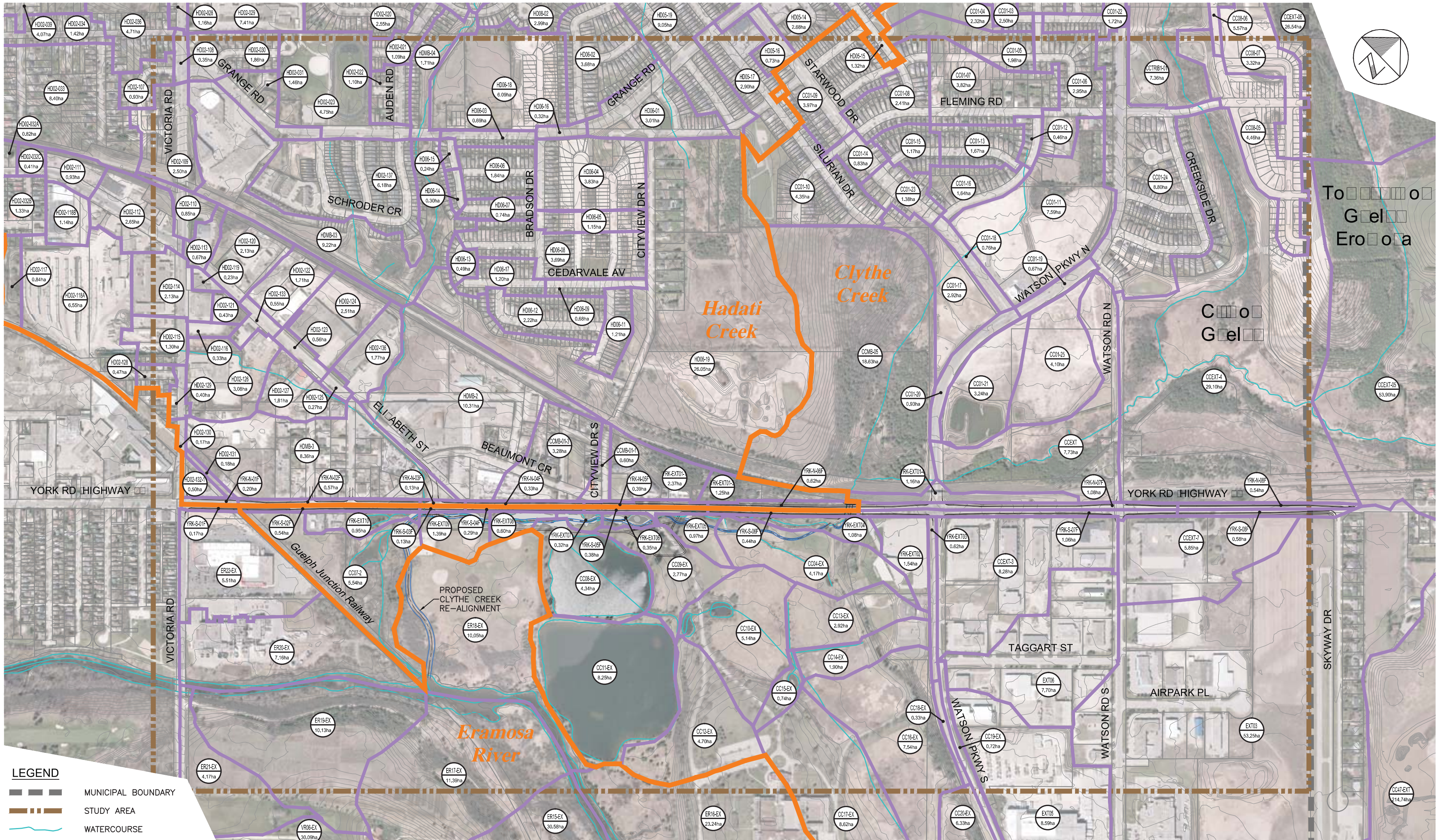
Plotted: 2017-03-09 Last Saved: 2017-03-09



YORK ROAD ENVIRONMENTAL DESIGN STUDY CITY OF GUELPH	STUDY AREA DRAINAGE PLAN (FUTURE CONDITIONS)	amec foster wheeler	Scale 1:4000 Consultant File No. TP115100 Figure No. 4.1.11

Plotted: 2017-03-10 Plotted By: richard.bortolo
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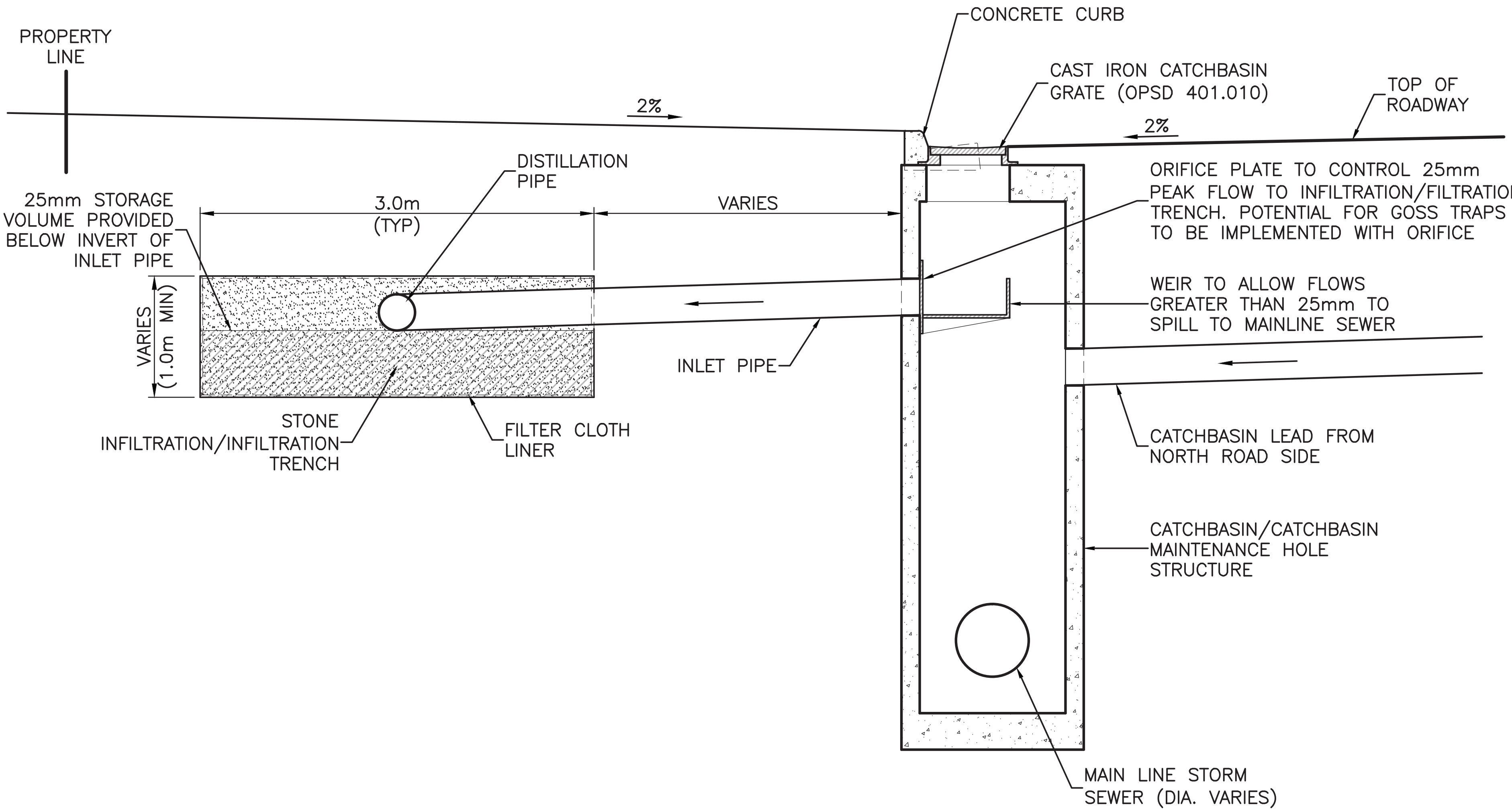
Plotted: 2017-12-18 Plotted By: richard.bartolo
Last Saved: 2017-12-18 Last Saved By: richard.bartolo Path: P:\Work\TP115100\water\dwg\2017 12 Infiltration System\Fig Tanks.dwg



NOTE:
1. IMPERMEABLE LINER MAY BE REQUIRED DUE TO GROUND WATER LEVELS. LINER IS NOT REQUIRED WHERE GROUNDWATER >=1.0m BELOW UNDERSIDE OF TANK.

YORK ROAD EIS ADDENDUM

CITY OF GUELPH

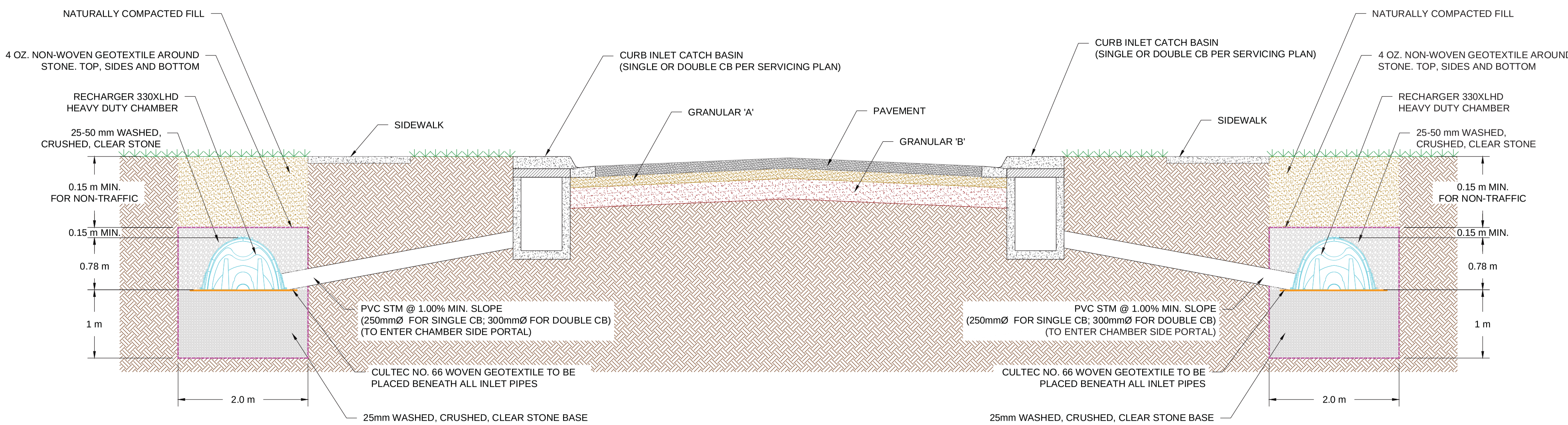
INFILTRATION/FILTRATION TRENCH CONFIGURATION

amec foster wheeler

Scale 1:50

Consultant File No. TP115100

Figure No.



CULTEC™

CULTEC, Inc.

Subsurface Stormwater Management Systems

P.O. Box 280
878 Federal Road
Brookfield, CT 06804
www.cultec.com

PH: (203) 775-4416
PH: (800) 4-CULTEC
FX: (203) 775-1462
tech@cultec.com

GEOSTORM

GeoStorm Inc.
122 Creditstone Road
Vaughan, Ontario
L4K 1P2

CULTEC RECHARGER 330XLHD
TRAFFIC APPLICATION
CROSS SECTION DETAIL

CULTEC RECHARGER® 330XLHD	
PROJECT NO: -	DATE: 12/4/15
DESIGNED BY: DPG	DRAWN BY: JC
SCALE: N.T.S.	SHEET NO: 1 OF 1

CULTEC Contactor® 100HD Stormwater Chamber

The Contactor® 100HD is a 12.5" (318 mm) tall, low profile chamber and is typically used for installations with depth restrictions or when a larger infiltrative area is required. The Contactor 100HD has the side portal internal manifold feature. The HVLV® SFCx2 Feed Connector is inserted into the side portal of the Contactor 100HD to create the internal manifold.

Size (L x W x H)	8' x 36" x 12.5" 2.44 m x 914 mm x 318 mm
Installed Length	7.5' 2.29 m
Length Adjustment per Run	0.5' 0.15 m
Chamber Storage	1.87 ft³/ft 0.17 m³/m 14.00 ft³/unit 0.40 m³/unit
Min. Installed Storage	3.84 ft³/ft 0.36 m³/m 28.81 ft³/unit 0.82 m³/unit
Min. Area Required	25 ft² 2.32 m²
Min. Center to Center Spacing	3.33' 1.02 m
Max. Allowable Cover	12' 3.66 m
Max. Inlet Opening in End Wall	10" 250 mm
Max. Allowable O.D. in Side Portal	6.9" 175 mm
Compatible Feed Connector	HVLV SFCx2 Feed Connector

Contactor® 100HD Bare Chamber Storage Volumes

Elevation		Incremental Storage Volume				Cumulative Storage	
in.	mm	ft³/ft	m³/m	ft³	m³	ft³	m³
12	305	0.009	0.001	0.068	0.002	13.995	0.396
11	279	0.067	0.006	0.503	0.014	13.928	0.394
10	254	0.110	0.010	0.825	0.023	13.425	0.380
9	229	0.139	0.013	1.043	0.030	12.600	0.357
8	203	0.159	0.015	1.193	0.034	11.558	0.327
7	178	0.174	0.016	1.305	0.037	10.365	0.294
6	152	0.184	0.017	1.380	0.039	9.060	0.257
5	127	0.192	0.018	1.440	0.041	7.680	0.217
4	102	0.203	0.019	1.523	0.043	6.240	0.177
3	76	0.203	0.019	1.523	0.043	4.718	0.134
2	51	0.203	0.019	1.523	0.043	3.195	0.090
1	25	0.223	0.021	1.673	0.047	1.673	0.047
Total		**1.866**	**0.173**	**13.995**	**0.396**	**13.995**	**0.396**

Calculations are based on installed chamber length.

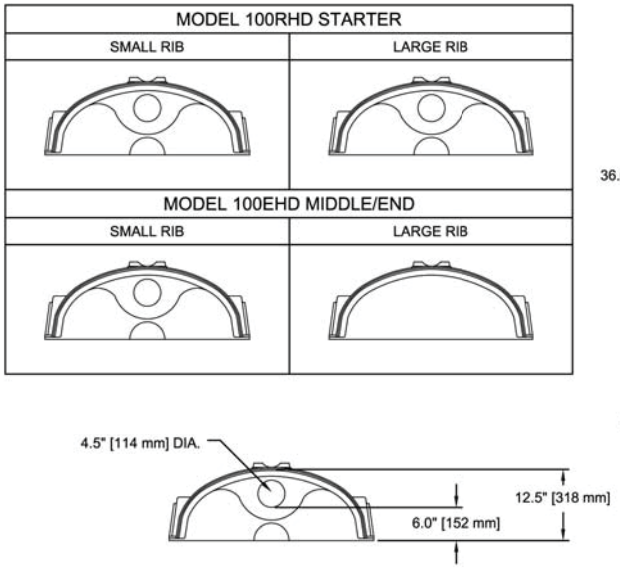
Visit www.cultec.com/downloads.html for Product Downloads and CAD details.

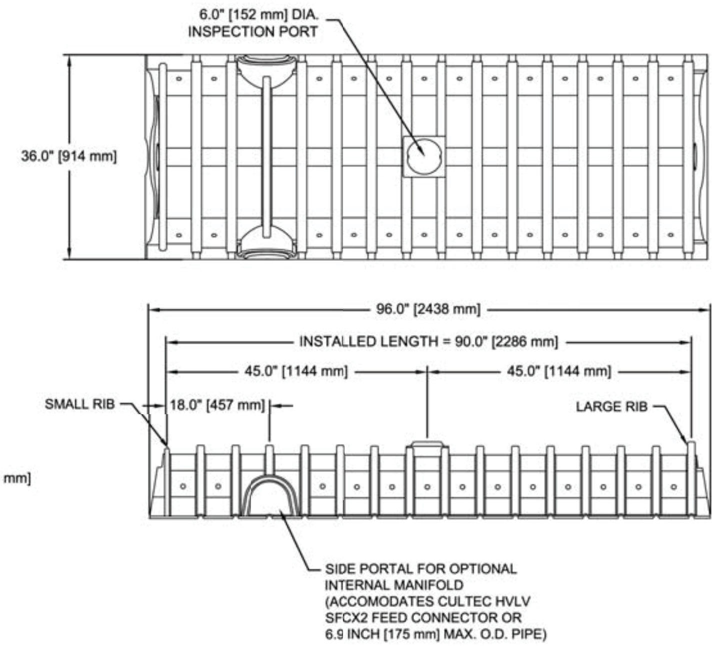
	Stone Foundation Depth		
	6" 152 mm	12" 305 mm	18" 457 mm
Chamber and Stone Storage Per Chamber	28.81 ft³ 0.82 m³	33.81 ft³ 0.96 m³	38.81 ft³ 1.10 m³
Min. Effective Depth	2.04' 0.62 m	2.54' 0.77 m	3.04' 0.93 m
Stone Required Per Chamber	1.37 yd³ 1.05 m³	1.84 yd³ 1.40 m³	2.30 yd³ 1.76 m³

Calculations are based on installed chamber length.
Includes 6" (152 mm) stone above crown of chamber and typical stone surround.
Stone void calculated at 40%.

For more information, contact CULTEC at (203) 775-4416 or visit www.cultec.com.

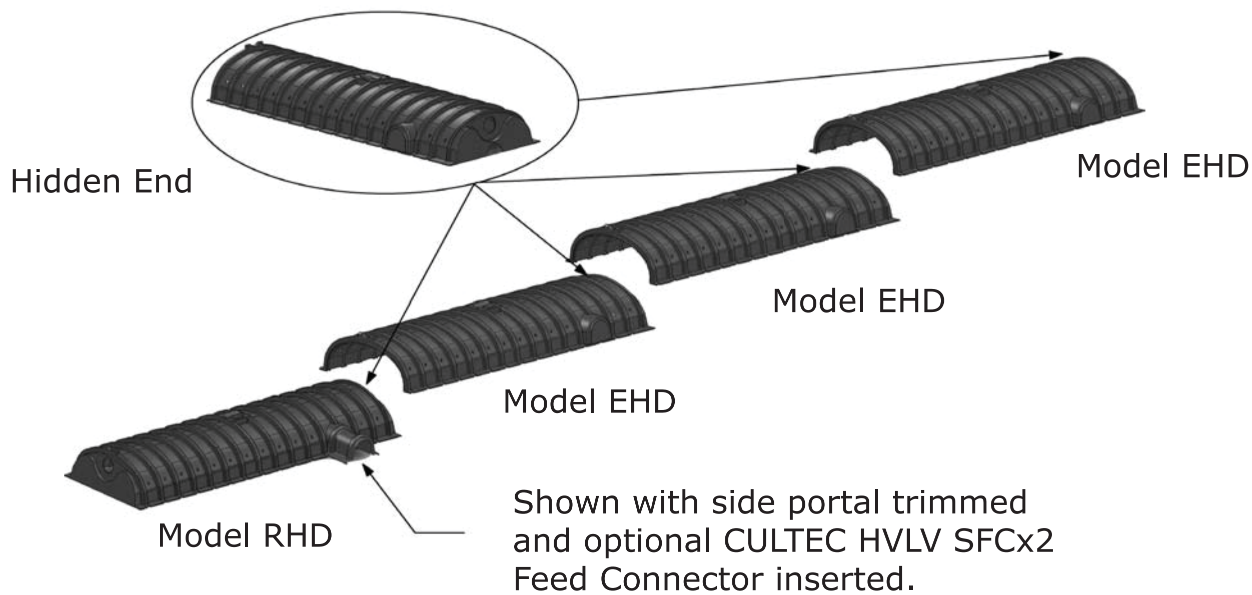
Three View Drawing



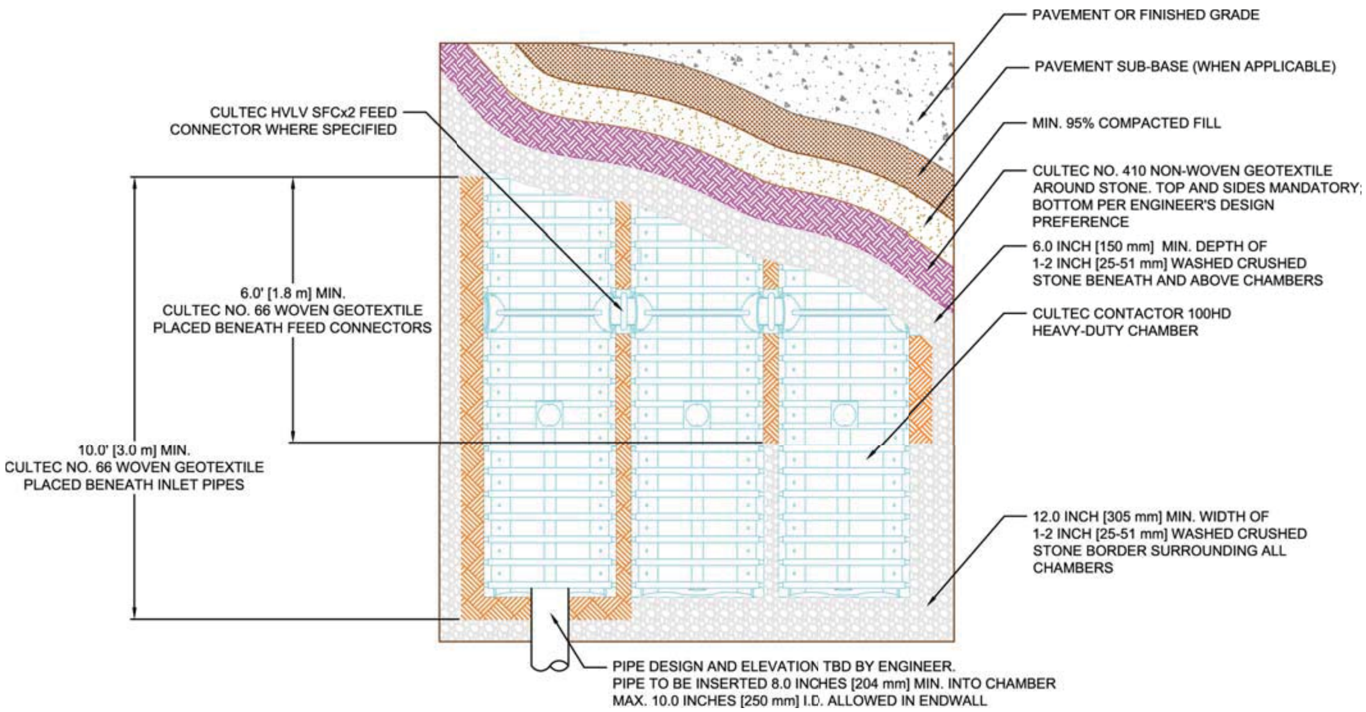


CULTEC CONTACTOR 100HD CHAMBER STORAGE = 1.866 CF/FT [0.173 m³/m]
INSTALLED LENGTH ADJUSTMENT = 0.5' [0.15 m]
ALL CONTACTOR 100HD HEAVY DUTY UNITS ARE MARKED WITH A COLORED STRIPE FORMED INTO THE PART ALONG THE LENGTH OF THE CHAMBER.

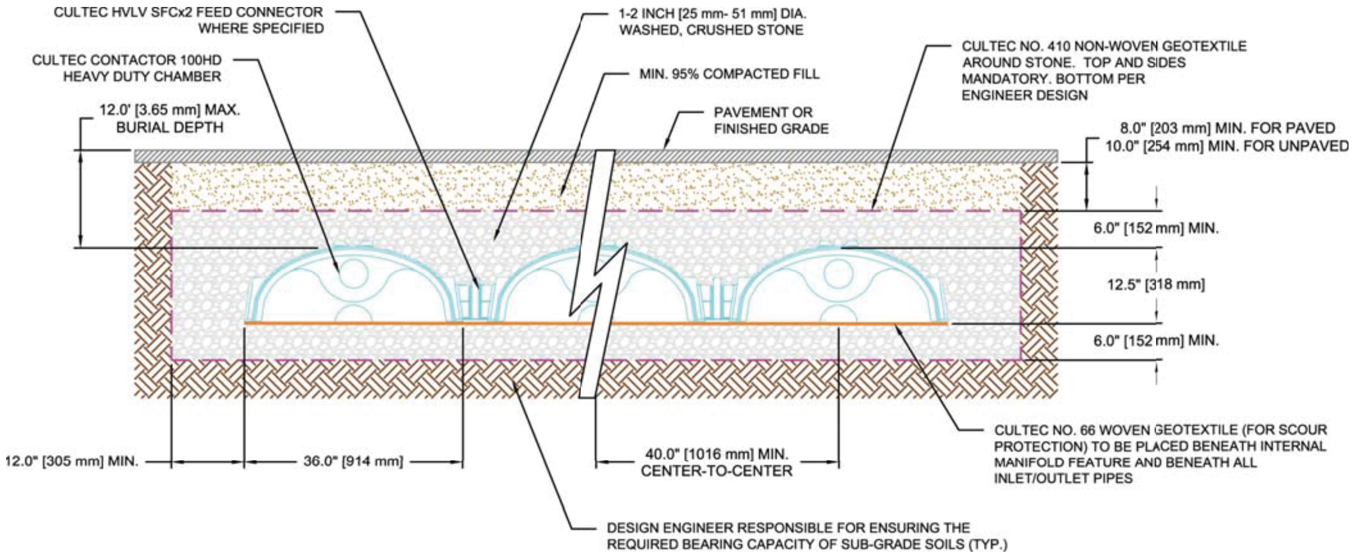
Typical Interlock Installation



Plan View Drawing



Typical Cross Section for Traffic Application



For more information, contact CULTEC at (203) 775-4416 or visit www.cultec.com.

CULTEC Contactor® 100HD Specifications

GENERAL

CULTEC Contactor® 100HD chambers are designed for underground stormwater management. The chambers may be used for retention, recharging, detention or controlling the flow of on-site stormwater runoff.

CHAMBER PARAMETERS

1. The chambers shall be manufactured in the U.S.A. by CULTEC, Inc. of Brookfield, CT (cultec.com, 203-775-4416).
2. The chamber shall be vacuum thermoformed of black polyethylene.
3. The chamber shall be arched in shape.
4. The chamber shall be open-bottomed.
5. The chamber shall be joined using an interlocking overlapping rib method. Connections must be fully shouldered overlapping ribs, having no separate couplings or separate end walls.
6. The nominal chamber dimensions of the CULTEC Contactor® 100HD shall be 12.5 inches (318 mm) tall, 36 inches (914 mm) wide and 8 feet (2.44 m) long. The installed length of a joined Contactor® 100HD shall be 7.5 feet (2.29 m).
7. Maximum inlet opening on the chamber end wall is 10 inches (250 mm).
8. The chamber shall have two side portals to accept CULTEC HVLV® SFCx2 Feed Connectors to create an internal manifold. The nominal I.D. dimensions of each side portal shall be 5.75 inches (146 mm) high by 7.5 inches (191 mm) wide. Maximum allowable O.D. in the side portal is 6.9 inches (175 mm).
9. The nominal chamber dimensions of the CULTEC HVLV® SFCx2 Feed Connector shall be 7.6 inches (194 mm) tall, 12 inches (305 mm) wide and 19.7 inches (500 mm) long.
10. The nominal storage volume of the Contactor® 100HD chamber shall be 1.866 ft^3 / ft (0.173 m^3 / m) - without stone. The nominal storage volume of a single Contactor® 100RHD Stand Alone unit shall be 14.93 ft^3 (0.42 m^3) - without stone. The nominal storage volume of a joined Contactor® 100EHD as an Intermediate unit shall be 13.995 ft^3 (0.396 m^3) - without stone. The nominal storage volume of the length adjustment amount per run shall be 0.93 ft^3 (0.09 m^3) - without stone.
11. The nominal storage volume of the HVLV® SFCx2 Feed Connector shall be 0.294 ft^3 / ft (0.027 m^3 / m) - without stone.
12. The Contactor® 100HD chamber shall have fifty-six discharge holes bored into the sidewalls of the unit's core to promote lateral conveyance of water.
13. The Contactor® 100HD chamber shall have 16 corrugations.
14. The end wall of the chamber, when present, shall be an integral part of the continuously formed unit. Separate end plates cannot be used with this unit.
15. The Contactor® 100RHD Starter/Stand Alone unit must be formed as a whole chamber having two fully formed integral end walls and having no separate end plates or separate end walls.
16. The Contactor® 100EHD Middle/End unit must be formed as a whole chamber having one fully formed integral end wall and one fully open end wall and having no separate end plates or end walls.
17. The HVLV® SFCx2 Feed Connector must be formed as a whole chamber having two open end walls and having no separate end plates or separate end walls. The unit shall fit into the side portals of the Contactor® 100HD and act as cross feed connections.
18. Chambers must have horizontal stiffening flex reduction steps between the ribs.
19. Heavy duty units are designated by a colored stripe formed into the part along the length of the chamber.
20. The chamber shall have a raised integral cap at the top of the arch in the center of each unit to be used as an optional inspection port or clean-out.
21. The units may be trimmed to custom lengths by cutting back to any corrugation on the large rib end.
22. The chamber shall be manufactured in an ISO 9001:2008 certified facility.
23. Maximum allowable cover over the top of the chamber shall be 12' (3.66 m) for the Heavy Duty version.
24. The chamber shall be designed to withstand traffic loads when installed according to CULTEC's recommended installation instructions.

Appendix E

Preliminary Capital Cost Estimates

Project Description York Road Environmental Impact Study, Victoria Roa to East City Limit
Option EIS Recommended Design
Limits of Quantities STA 10+400 to STA 11+280 (880 m)

Item	Description	Unit	Quantity	Unit Price	Amount
Section A - General					
	Labour and Materials Bond	LS	1	$ 50,000.00	$ 50,000.00
	Pre-Construction Survey	LS	1	$ 10,000.00	$ 10,000.00
	Site Office	LS	1	$ 10,000.00	$ 10,000.00
	Construction Layout	LS	1	$ 15,000.00	$ 15,000.00
	Clearing and Grubbing	LS	1	$ 5,000.00	$ 5,000.00
	Tree Removal, Small (<100 mm d)	ea	24	$ 5,000.00	$ 120,000.00
	Tree Removal, Large (>100 mm d)	ea	1	$ 580.00	$ 580.00
	Construction Signs, Traffic Control and TMP	LS	1	$ 5,000.00	$ 5,000.00
	Contingency (30%)	LS	1	$ 920,000.00	$ 920,000.00
Section B - Roadwork, Pavement Markings and Signage					
	Removal of stone wall (south side)	m2	880	$ 100.00	$ 88,000.00
	Removal of any buried pipes, conduit, etc.	m	880	$ 40.00	$ 35,200.00
	Earth Excavation (Grading), Including Full Depth Asphalt Removal	m2	10535	$ 15.00	$ 158,025.00
	Clean Fill	m2	3908	$ 20.00	$ 78,160.00
	Hot Mix HL-3 HS (45 mm lift)	t	1426	$ 120.00	$ 171,072.00
	Hot Mix HL-8 HS (90 mm in 2 x 45 mm lifts)	t	2851	$ 100.00	$ 285,120.00
	Granular 'A' Crushed Limestone	t	5285	$ 18.00	$ 95,135.00
	Granular 'B' Crushed Limestone	t	14270	$ 16.00	$ 228,324.00
	Multi-Use Pathway Including Granular	m2	6220	$ 85.00	$ 528,700.00
	Concrete Curb and Gutter	m	1778	$ 60.00	$ 106,677.00
	100 mm Diameter Pipe Subdrains	m	1800	$ 18.00	$ 32,400.00
	Pavement Marking and Signs (Estimated)	LS	1	$ 20,000.00	$ 20,000.00
	50mm Imported Topsoil and Sod	m^2	710	$ 12.00	$ 8,520.00
	50 mm Imported Topsoil, Seed and Mulch	m^2	1648	$ 5.00	$ 8,240.00
	Supply and Install Trees, 60 mm Caliber, Species	each	25	$ 350.00	$ 8,750.00
	Removal and Relocate Bus Stop	LS	1	$ 30,000.00	$ 30,000.00
Section C - Storm Sewers and Manholes					
	Catch Basins and Manholes (Estimated)	LS	1	$ 240,000.00	$ 240,000.00
Section D - Traffic Signals					
	Traffic Signals	LS	1	$ 500,000.00	$ 500,000.00
Section E - Utility Relocations					
	Remove and Relocate HP/LS	ea	20	$ 7,100.00	$ 142,000.00
	Utility Relocation - Other	LS	1	$ 100,000.00	$ 100,000.00
Conceptual Level Total Estimate					
					$ 4,000,000.00

Project Description York Road Environmental Impact Study, Victoria Roa to East City Limit
Option Addendum Alternative 1
Limits of Quantities STA 10+400 to STA 11+280 (880 m)

Item	Description	Unit	Quantity	Unit Price	Amount
Section A - General					
	Labour and Materials Bond	LS	1	$ 50,000.00	$ 50,000.00
	Pre-Construction Survey	LS	1	$ 10,000.00	$ 10,000.00
	Site Office	LS	1	$ 10,000.00	$ 10,000.00
	Construction Layout	LS	1	$ 15,000.00	$ 15,000.00
	Clearing and Grubbing	LS	1	$ 5,000.00	$ 5,000.00
	Tree Removal, Small (<100 mm d)	ea	45	$ 5,000.00	$ 225,000.00
	Tree Removal, Large (>100 mm d)	ea	5	$ 580.00	$ 2,900.00
	Construction Signs, Traffic Control and TMP	LS	1	$ 5,000.00	$ 5,000.00
	Contingency (30%)	LS	1	$ 980,000.00	$ 980,000.00
Section B - Roadwork, Pavement Markings and Signage					
	Removal of stone wall (south side)	m2	880	$ 100.00	$ 88,000.00
	Removal of any buried pipes, conduit, etc.	m	880	$ 40.00	$ 35,200.00
	Earth Excavation (Grading), Including Full Depth Asphalt Removal	m2	12056	$ 15.00	$ 180,840.00
	Clean Fill	m2	6491	$ 20.00	$ 129,820.00
	Hot Mix HL-3 HS (45 mm lift)	t	1408	$ 120.00	$ 168,985.00
	Hot Mix HL-8 HS (90 mm in 2 x 45 mm lifts)	t	2816	$ 100.00	$ 281,642.00
	Granular 'A' Crushed Limestone	t	5285	$ 18.00	$ 95,135.00
	Granular 'B' Crushed Limestone	t	14270	$ 16.00	$ 228,324.00
	Multi-Use Pathway Including Granular	m2	6220	$ 85.00	$ 528,700.00
	Concrete Curb and Gutter	m	1762	$ 60.00	$ 105,741.00
	100 mm Diameter Pipe Subdrains	m	1800	$ 18.00	$ 32,400.00
	Pavement Marking and Signs (Estimated)	LS	1	$ 20,000.00	$ 20,000.00
	50mm Imported Topsoil and Sod	m^2	302	$ 12.00	$ 3,625.99
	50 mm Imported Topsoil, Seed and Mulch	m^2	6348	$ 5.00	$ 31,738.70
	Supply and Install Trees, 60 mm Caliber, Species	each	50	$ 350.00	$ 17,500.00
	Removal and Relocate Bus Stop	LS	1	$ 30,000.00	$ 30,000.00
Section C - Storm Sewers and Manholes					
	Catch Basins and Manholes (Estimated)	LS	1	$ 240,000.00	$ 240,000.00
Section D - Traffic Signals					
	Traffic Signals	LS	1	$ 500,000.00	$ 500,000.00
Section E - Utility Relocations					
	Remove and Relocate HP/LS	ea	20	$ 7,100.00	$ 142,000.00
	Utility Relocation - Other	LS	1	$ 100,000.00	$ 100,000.00
Conceptual Level Total Estimate					
					$ 4,260,000.00

Project Description York Road Environmental Impact Study, Victoria Roa to East City Limit
Option Addendum Alternative 2
Limits of Quantities STA 10+400 to STA 11+280 (880 m)

Item	Description	Unit	Quantity	Unit Price	Amount
Section A - General					
	Labour and Materials Bond	LS	1	$ 50,000.00	$ 50,000.00
	Pre-Construction Survey	LS	1	$ 10,000.00	$ 10,000.00
	Site Office	LS	1	$ 10,000.00	$ 10,000.00
	Construction Layout	LS	1	$ 15,000.00	$ 15,000.00
	Clearing and Grubbing	LS	1	$ 5,000.00	$ 5,000.00
	Tree Removal, Small (<100 mm d)	ea	40	$ 5,000.00	$ 200,000.00
	Tree Removal, Large (>100 mm d)	ea	4	$ 580.00	$ 2,320.00
	Construction Signs, Traffic Control and TMP	LS	1	$ 5,000.00	$ 5,000.00
	Contingency (30%)	LS	1	$ 920,000.00	$ 920,000.00
Section B - Roadwork, Pavement Markings and Signage					
	Removal of stone wall (south side)	m2	100	$ 100.00	$ 10,000.00
	Removal of any buried pipes, conduit, etc.	m	880	$ 40.00	$ 35,200.00
	Earth Excavation (Grading), Including Full Depth Asphalt Removal	m2	11144	$ 15.00	$ 167,160.00
	Clean Fill	m2	3151	$ 20.00	$ 63,020.00
	Hot Mix HL-3 HS (45 mm lift)	t	1410	$ 120.00	$ 169,239.00
	Hot Mix HL-8 HS (90 mm in 2 x 45 mm lifts)	t	2821	$ 100.00	$ 282,064.00
	Granular 'A' Crushed Limestone	t	5285	$ 18.00	$ 95,135.00
	Granular 'B' Crushed Limestone	t	14270	$ 16.00	$ 228,324.00
	Multi-Use Pathway Including Granular	m2	5888	$ 85.00	$ 500,476.00
	Concrete Curb and Gutter	m	1781	$ 60.00	$ 106,849.00
	100 mm Diameter Pipe Subdrains	m	1800	$ 18.00	$ 32,400.00
	Pavement Marking and Signs (Estimated)	LS	1	$ 20,000.00	$ 20,000.00
	50mm Imported Topsoil and Sod	m²	391	$ 12.00	$ 4,687.43
	50 mm Imported Topsoil, Seed and Mulch	m²	6261	$ 5.00	$ 31,307.00
	Supply and Install Trees, 60 mm Caliber, Species	each	44	$ 350.00	$ 15,400.00
	Removal and Relocate Bus Stop	LS	1	$ 30,000.00	$ 30,000.00
Section C - Storm Sewers and Manholes					
	Catch Basins and Manholes (Estimated)	LS	1	$ 240,000.00	$ 240,000.00
Section D - Traffic Signals					
	Traffic Signals	LS	1	$ 500,000.00	$ 500,000.00
Section E - Utility Relocations					
	Remove and Relocate HP/LS	ea	20	$ 7,100.00	$ 142,000.00
	Utility Relocation - Other	LS	1	$ 100,000.00	$ 100,000.00
Conceptual Level Total Estimate					
					$ 3,990,000.00

Project Description York Road Environmental Impact Study, Victoria Road to East City Limit
Option EIS Recommended Design
Limits of Quantities Victoria Street to Skyway Drive

Item	Description	Unit	Quantity	Unit Price	Amount
Section A - General					
	Labour and Materials Bond	LS	1	$ 50,000.00	$ 50,000.00
	Pre-Construction Survey	LS	1	$ 20,000.00	$ 20,000.00
	Site Office	LS	1	$ 20,000.00	$ 20,000.00
	Construction Layout	LS	1	$ 25,000.00	$ 25,000.00
	Clearing and Grubbing	LS	1	$ 15,000.00	$ 15,000.00
	Tree Removal, Small (<100 mm d)	ea	140	$ 5,000.00	$ 700,000.00
	Tree Removal, Large (>100 mm d)	ea	5	$ 580.00	$ 2,900.00
	Construction Signs, Traffic Control and TMP	LS	1	$ 15,000.00	$ 15,000.00
	Contingency (30%)	LS	1	$ 3,160,000.00	$ 3,160,000.00
Section B - Roadwork, Pavement Markings and Signage					
	Removal of stone wall (south side)	m2	1600	$ 100.00	$ 160,000.00
	Removal of any buried pipes, conduit, etc.	m	2500	$ 40.00	$ 100,000.00
	Removal of Concrete Curb and Gutter	m	325	$ 20.00	$ 6,500.00
	Removal of Concrete Sidewalk	m²	173	$ 20.00	$ 3,460.00
	Removal of Culverts, Diameter Less Than 500 mn	m	106	$ 35.00	$ 3,710.00
	Removal of Culverts, Diameter Equal to, or Greate	m	117	$ 60.00	$ 7,020.00
	Earth Excavation (Grading), Including Full Depth Asphalt Removal	m3	119970	$ 15.00	$ 1,799,551.00
	Clean Fill	m3	9000	$ 20.00	$ 180,000.00
	Hot Mix HL-3 HS (45 mm lift)	t	4264	$ 120.00	$ 511,680.00
	Hot Mix HL-8 HS (90 mm in 2 x 45 mm lifts)	t	8527	$ 100.00	$ 852,700.00
	Granular 'A' Crushed Limestone	t	15400	$ 18.00	$ 277,200.00
	Granular 'B' Crushed Limestone	t	37800	$ 16.00	$ 604,800.00
	Multi-Use Pathway Including Granular	m2	15224	$ 85.00	$ 1,294,040.00
	Concrete Curb and Gutter	m	5889	$ 60.00	$ 353,340.00
	100 mm Diameter Pipe Subdrains	m	5073	$ 18.00	$ 91,314.00
	Pavement Marking and Signs (Estimated)	LS	1	$ 50,000.00	$ 50,000.00
	50mm Imported Topsoil and Sod	m²	5315	$ 12.00	$ 63,780.00
	50 mm Imported Topsoil, Seed and Mulch	m²	9909	$ 5.00	$ 49,542.53
	Supply and Install Trees, 60 mm Caliber, Species	each	145	$ 350.00	$ 50,750.00
	Removal and Relocate Bus Stop	LS	7	$ 30,000.00	$ 210,000.00
Section C - Storm Sewers and Manholes					
	Catch Basins and Manholes (Estimated)	LS	1	$ 1,200,000.00	$ 1,200,000.00
Section D - Traffic Signals					
	Traffic Signals (1 intersection)	LS	3	$ 500,000.00	$ 1,500,000.00
Section E - Utility Relocations					
	Remove and Relocate HP/LS	ea	20	$ 7,100.00	$ 142,000.00
	Utility Relocation - Other	LS	1	$ 100,000.00	$ 100,000.00
Section F - Structural					
	TerraSteep® Retaining Walls, Installed	m2	376	$ 200.00	$ 75,200.00
Conceptual Level Total Estimate					
					$ 13,694,487.53

YORK ROAD DRAINAGE

ITEM	DESCRIPTION	EST. QTY.	UNIT	UNIT PRICE	TOTAL
1	600 x 600mm Catchbasins	23	ea	$2,500.00	$57,500.00
2	DICB	3	ea	$3,500.00	$10,500.00
3	1200mm CB Manholes OPSD 701.010	17	ea	$5,000.00	$85,000.00
4	1500mm CB Manholes OPSD 701.010	2	ea	$7,500.00	$15,000.00
5	1800mm CB Manholes OPSD 701.010	1	ea	$8,500.00	$8,500.00
6	2400mm CB Manholes OPSD 701.010	3	ea	$10,000.00	$30,000.00
7	3000mm CB Manholes OPSD 701.010	1	ea	$12,500.00	$12,500.00
8	250mm CB Leads PVC SDR 35 Granular Bedding and Backfill	356	m	$150.00	$53,400.00
9	300mm Storm Sewer PVC SDR 35 Granular Bedding and Native Backfill	0	m	$200.00	$0.00
10	375mm Storm Sewer PVC SDR 35 Granular Bedding and Backfill	97	m	$225.00	$21,825.00
11	450mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$250.00	$25,000.00
12	525mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$300.00	$30,000.00
13	750 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$780.00	$78,000.00
14	825mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$900.00	$90,000.00
15	1050 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	33	m	$1,430.00	$47,190.00
16	1350 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	200	m	$2,250.00	$450,000.00
17	1500 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$2,800.00	$280,000.00
18	Chamber System with excavation and bedding	1040	m	$60.00	$62,400.00
19	Inspection Ports (1/30m)	35	ea	$250.00	$8,750.00
20	Orifice Plates	5	ea	$250.00	$1,250.00
21	Weir Plates	3	ea	$500.00	$1,500.00
22	Stone Trench and Lining	1040	m	$175.00	$182,000.00
23	Oil/grit Chambers	5	ea	$100,000.00	$500,000.00
24	Drainage Outlets	6	ea	$25,000.00	$150,000.00
25	Contingency of 10%	0.1	LS	$2,200,315.00	$220,031.50
				TOTAL PRICE	**$2,420,346.50**

Channel Works		Cost Estimate
Mobilization/Demobilization/Admin	$	7,500
Site Prep/ Clearing and Grubbing	$	9,000
Staging/Stockpile Area(s)	$	5,000
Excavation and Offsite Disposal of Excavated Materials	$	65,000
Fill (from Stockpiled Excavated Materials)	$	340,000
Coarse Channel Bed Stone	$	140,000
Gravel Bed Treatments and Void Mix	$	65,000
Vegetated Block Treatment	$	80,000
Vegetated Riprap	$	40,000
Environmental Measures (ESC, Pumping/Dewatering, Fish Relocations, etc.)	$	30,000
Tree and Shrub Plantings/Site Restoration costs by others		
Total	**$**	**781,500.00**
Total with Contingency (10%)	**$**	**859,650.00**

Memo

To: Arun Hindupur, City of Guelph

From: Steve Chipps, Linda Axford and Maria King, Wood

Date: April 5, 2018 (Revised October 5, 2018)

File: TP115100-26

cc: Todd Fell, Dougan & Associates and Mark Wojda, Matrix Solutions

Re: York Road Environmental Design Study, Road Alternatives Assessment, City of Guelph

1. Introduction

Following the Project Team meeting held at the City of Guelph on December 20, 2017 (where Wood presented Road Alternatives 1 and 2 as discussed in a December 19, 2017 memorandum), Wood was requested by the City of Guelph to further investigate the opportunities, constraints and costs associated with two (2) additional roadway design alternatives. The objective of investigating these two (2) new alternatives was to determine if the multi-use pathways could be maintained adjacent to York Road through either compromise of the multi-use pathway width, or acceptance of the cost of relocating the built heritage features at the Reformatory Entrance.

The two (2) new alternatives are as follows:

Alternative 3: Eliminate the boulevards and narrow the multi-use pathways on both the north and south sides of York Road to 2.5 m adjacent to the Reformatory Property entrances, maintaining heritage walls in place;

Alternative 4: Eliminate the boulevards, maintain 3.0 m multi-use pathways on both the north and south sides of York Road, and relocate the heritage wall outside of the clear zone.

At the December 20, 2017 meeting and in an email dated April 23, 2018, the City of Guelph Heritage Planner, Steven Robinson, indicated that he was not opposed to the curved, stone ring walls on both sides of the main entrance to the Correctional Centre being carefully dismantled and relocated and reconstructed southward. He further stated in the April 23rd email that before he could give a full recommendation this option would need to include the creation and approval of a Conservation Plan.

Accordingly, only Alternative 4 will be discussed, in the revised HIA, as the proposed site alteration at this time. The Alternative 4 road design would eliminate the boulevards and provide full 3.0 m wide multi-use paths on both the north and south sides of York Road from Beaumont Avenue to east of the Reformatory property. Unlike earlier alternatives, Alternative 4 includes relocation of the former Reformatory entrance gateway features/walls to beyond the limits of the 6.5 m roadway clear zone. Relocation of the cultural heritage walls would provide additional space for snow storage and utilities, while eliminating the need to provide a guiderail along the road side of the heritage features. Relocation of the wall will need to be undertaken by skilled heritage masons and will require additional embankment grading and use of retained soil systems (or retaining walls) between the heritage wall and the creek.

In order to optimize the available space within the right-of-way, the roadway alignment would be shifted 1.5 m to the north relative to the design presented in the March 2017 version of the EIS. The road profile has also been adjusted to minimize grading impacts on adjacent properties. Similar to the design presented in the March 2017 EIS, extension of the Hadati Creek culvert would be required, and opportunities to reduce impacts to the creek and heritage features through implementation of various segments of retaining walls/soil systems could be investigated as part of detailed design.

The application of these two (2) new alternatives was to be limited to the section of York Road between the western entrance to Royal City Jaycees Park (west of the existing Elizabeth Street intersection), and east of the Reformatory Property entrance, where the south multi-use path had been located south of the Clythe Creek in the original Environmental Design Study (March 2017 submission). At the December 20, 2017 meeting, the City of Guelph indicated that the recently-approved Active Transportation Network Study Update (June 2017) requires that active transportation facilities must (where feasible) provide the same level-of-service as vehicular modes of transportation. Locating the multi-use path to the south of Clythe Creek would place it within the floodplain and make it unusable during moderate to significant storm events (> 2 year frequency), therefore significantly compromising its level of service relative to the roadway. Therefore, as indicated by the City at the December meeting, the multi-use path is preferred to be located adjacent to the road.

The following memorandum provides details of the development and assessment of the two (2) new roadway design alternatives (Alternatives 3 and 4).

2. Alternative 3: Remove Boulevards and Reduce Multi-Use Pathways to 2.5 m Adjacent to the Reformatory Entrance

2.1. Road Design

Adjacent to the Reformatory Property, Road Alternative 3 considers the elimination of boulevards and provision of narrowed 2.5 m multi-use paths within the York Road right-of-way. Per City direction provided at the December 20, 2017 meeting, a 1.0 m platform, 0.5 m rounding, and minimum 3:1 embankment slopes are provided on the south side.

The justification for the change in cross-section is to maximize separation between the driving lanes and heritage features at the former Reformatory property. The reduced infrastructure widths permit the roadway alignment to be shifted 2.0 m to the north relative to the design presented in the Environmental Impact Study (EIS). With the road alignment shift to the north by 2.0 m and reduction in the multi-use path width from 3.0 m to 2.5 m, the south multi-use path would be located a minimum of 1.5 m from the eastern heritage wall, with an average separation distance of approximately 2.5 m. While the driving lanes would be moved further away from the heritage wall as compared to Road Alternatives 1 and 2 (discussed in the December 2017 memorandum), the distance would not be sufficient to ensure the wall would be located beyond the recommended 6.5 m clear zone of the roadway. As a result, a guiderail would need to be provided within the 1.5 m-2.5 m space between the multi-use path and heritage wall, significantly limiting both snow storage and visibility of the heritage features along this segment of York Road. Additionally, with the north side multi-use path located immediately adjacent to the property line with no boulevard, all overhead lighting and utilities would need to be located south of the roadway.

While Road Alternative 3 would have impacts on snow storage, utilities and visibility of the heritage wall, the northerly realignment and reduced cross-sectional width would minimize the impacts to the creek and would not directly impact the heritage walls. Where grading limits would impact the creek and heritage features, as per Road Alternatives 1 and 2, implementation of various segments of retaining walls/soil systems should be considered.

West of Beaumont Crescent, and east of the entrance to 840 York Road, Alternative 3 would include provision of 1.5 m wide boulevards and 3.0 m wide multi-use pathways indicated in the original EIS submission.

Roadway cross-section Alternative 3 is illustrated in

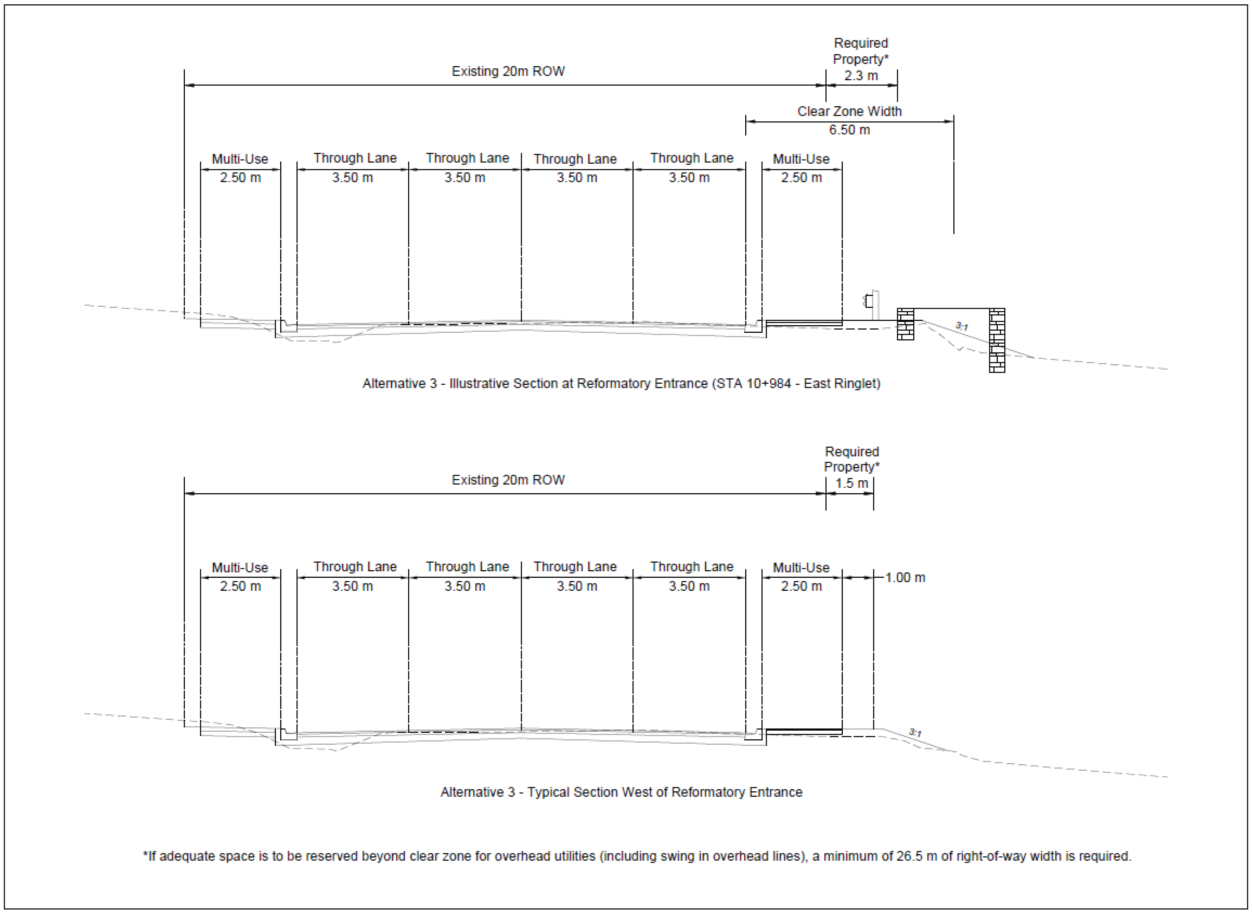


Figure 2.1, with the associated plan and profile drawings provided in Appendix A. The guiderail layout is illustrated in Figure 2.2.

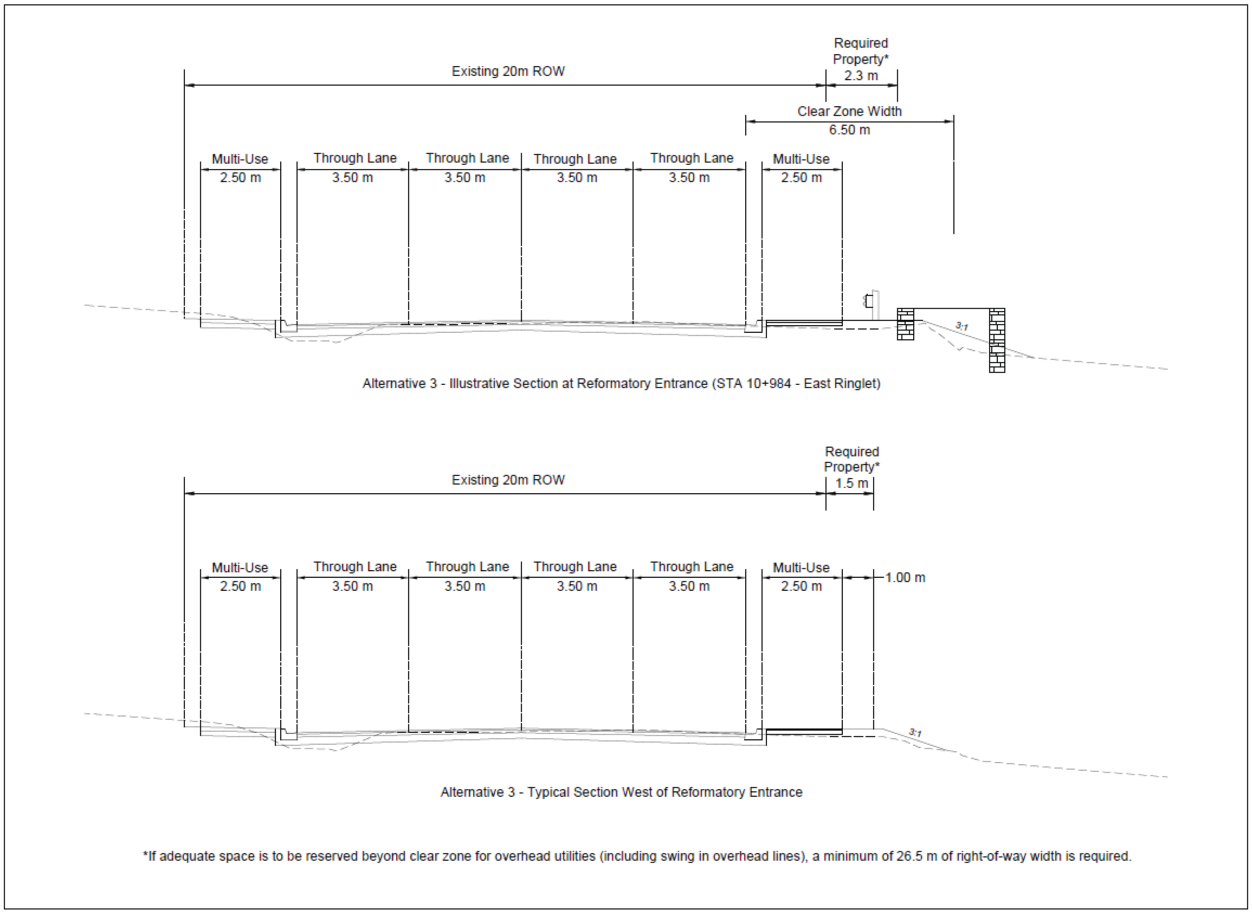
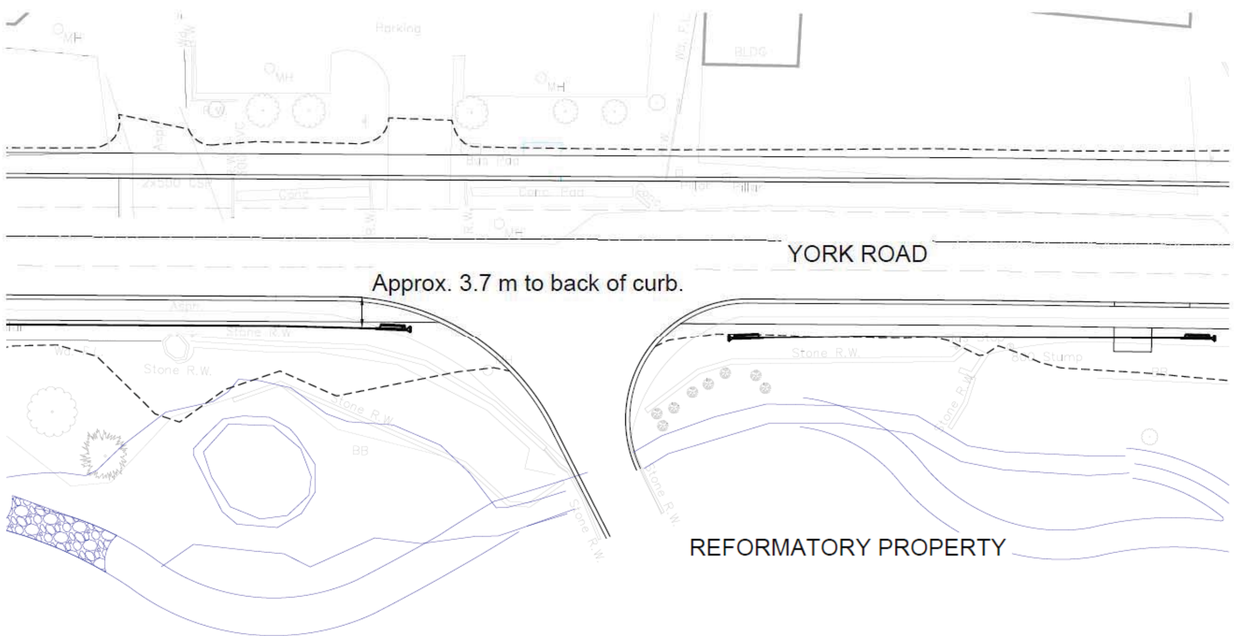


Figure 2.1: Typical Roadway Cross-Section for York Road Alternative 3.



Proposed guiderail layout for Alternative 3. Property to be obained to back of guiderail.

Figure 2.2: Roadway Plan View for York Road Alternative 3.

2.2. Creek Design

Creek Alternative 2 from the December 2017 memorandum has been carried forward for Road Alternative 3. Matrix selected a 3:1 H:V roadway grading slope to establish the constraining limits when considering changes to the channel planform. An evaluation of the new grading limit for Road Alternative 3 reveals that it overlaps with the preferred channel alignment at two separate locations.

The first location where the revised grading slope intersects with the preferred channel alignment is within Reach C-9A, upstream of the Reformatory driveway (approximate chainage 0+425m, Sheet 4, Appendix B). Within this reach, the existing planform of Clythe Creek flows over a stone weir (Cultural Feature '14'). The preferred channel alignment option realigns the primary flow south around the stone weir, reconnecting to the existing channel downstream of the weir. It is possible to incorporate the 'high-flow' channel that conveys higher flows over the weir structure. This design involves the establishment of an island-type feature downstream of the weir that separates the newly constructed primary channel and the existing length of channel that will be maintained to convey flows passing over the weir. The two channels connect further downstream towards the Reformatory driveway at approximate chainage 0+430m (ref. Sheet 4, Appendix B).

From this location, the creek then flows under the Reformatory Bridge. At the stone weir, the draft EIS preferred alignment incorporated a 'high-flow' channel that directs flows exceeding bankfull (i.e., close to overtopping the channel banks) towards and through the existing channel at the weir. This approach supports fish passage through the primary channel but also allows for the weir to be activated at higher flows, partially mitigating its disconnection from the main channel. However, to accommodate the 3:1 H:V road grading an adjustment to the preferred channel alignment is necessary. Based on the required grading, it is not possible to re-connect the channel at the pool immediately downstream of the weir as the pool must be infilled to achieve the desired grading. As this pool becomes unusable, the proposed channel alignment must tie-in to the existing channel further downstream. As such the Alternative 2 creek configuration eliminates the 'high-flow' channel and any continued flow through the weir as the grading and fill would cut off the connection location. The adjustments required at this location do not otherwise impact the form and function of Clythe Creek from the draft EIS preferred channel alignment.

The second location requiring adjustment is in the vicinity of the Hadati Creek confluence (approximate chainage 0+850 to 1+050m, Sheet 5, Appendix B). The grading to accommodate the alternative roadway/MUP cross section necessitates shifting the draft EIS design planform slightly south. The shifted planform aligns with the concrete box culvert that is proposed to replace the existing corrugated steel pipes at this location. Downstream of the crossing, Hadati Creek flows south through a box culvert under York Road where it enters Clythe Creek at the outlet. The box culvert is to be extended on the south side, facilitated by the shift south of the Clythe Creek planform. Whereas the preferred channel alignment utilized the existing creek planform for approximately 40 m west of the culvert, the revised planform requires additional cut as the creek bend begins further upstream. The existing length of creek that was previously intended as part of the design channel will be filled. The design change at the second location does not have significant implications on channel function when compared to the original preferred channel alignment.

2.3. Cultural Heritage Assessment

Former Reformatory Entranceway

Under Alternative 3 the proposed roadway improvements include the widening of York Road, a 2.5 m multi-use path on each side of the roadway in vicinity of the former Reformatory driveway, a 1.5 m to 2.5 m space between the multi-use pathway and cultural heritage walls for snow storage and a guiderail on the south side of York Road. Based on the guiderail being placed approximately 0.5 m to 1.5 m in front of the cultural heritage walls, and with the walls remaining partially buried, the view of the walls would be greatly diminished. There is a possibility of damage to the cultural heritage walls during the road construction due to the guiderail being placed as close as 0.5 m away from the walls in some locations. In addition, snow will be piled up next to the cultural heritage walls due to the lack of space from the road and multi-use pathway, potentially resulting in structural damage to the walls.

Remainder of Cultural Heritage Resources

Road Alternative 3 (ref. Appendix E) will result in re-alignment of major portions of Clythe Creek, which is expected to impact the cultural heritage resources as per Road Alternative 2, leaving some heritage features in situ but without water flow and the complete removal of other heritage features.

The changes in Alternative 3 would include the removal of the culvert (#2) which travels under York Road; the remnant culvert railing on the north side of York Road (#2); the intermittent stream which feeds into Clythe Creek (#13) and the fieldstone weirs #22, 24, 25, and 26; and the limestone pillars and wood board fencing alongside York Road (#28, 29 and 30). Some fieldstone weirs and steps would remain in situ but without water flow (these include weirs #3, 5, 8, 23 and 35).

Fieldstone weirs # 9, 10, 11, and 14 may be removed or could possibly be maintained in situ with retaining walls or grading. However, if they remain they would all be impacted by loss of flow as a result of channel realignment. Under Alternative 3 the new creek bed would be relocated south of the existing creek bed just west of weir #14 with the existing bed filled in and re-graded.

Under Alternative 3, road and multi-use path grading would impact the fieldstone steps (#6), and a large bedrock outcrop (#7). There is a potential modification of the limestone terrace wall (#12), the arched pedestrian bridge (#27), the metal and wood bridges (# 31, 32 and 33) and the box culvert (#34) due to the channel work or pedestrian traffic needs.

Below are photos and descriptions of each of the recognized 36 "listed" or "potential" heritage resources with possible impacts:

The Table below has been revised to answer Steven Robinson's concerns to the previous table. The revised Table shows Impacts and Mitigation and is discussed in more detail in Section *4.0 Analysis* in the revised HIA.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation

No.	Photo	Impacts	Mitigation
1	 Rock faced ashlar culvert, of unknown age, on the north side of York Road. Clythe Creek passes under this.	**Removal:** Culvert under tracks would be remain in place.	Protect culvert while replacing York Road culvert downstream.

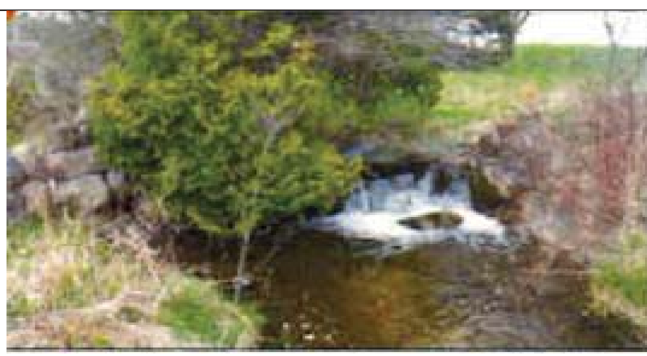
Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
2	 Reinforced concrete road bridge railing (remnant) circa 1920 on the north side of York Road.	**Removal:** This feature would be removed due to road widening and multi-use path.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.
3	 Fieldstone weir with steps and sentinel stones. This is a barrier to fish passage.	**Maintained in situ:** This feature would be maintained in landscape but will be impacted by loss of flow as a result of channel realignment.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. Where possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structure.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
4	 Fieldstone garden wall with sentinel stones.	**No Impact:** Wall to remain in existing condition	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.
5	 Fieldstone weir with clay pipes. This is a barrier to fish passage.	**Maintained in situ:** This feature would be maintained in landscape but would be impacted by loss of flow as a result of channel realignment	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. Where possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structure.
6	 Fieldstone steps.	**Potentially impacted:** The steps may be covered by grading for road and pathway.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The

Table 2:1 Heritage Resource Photos with Impacts and Mitigation

No.	Photo	Impacts	Mitigation
			appropriate context of the resource must be considered in relocation.
7	 Large Boulder or bedrock outcrop.	**Potentially impacted:** This feature may be covered by grading for road and pathway	. Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.
8	 Fieldstone weir. This is a barrier to fish passage	**Maintained in situ:** The weir would be maintained in landscape but would be impacted by loss of flow as a result of channel realignment.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. Where possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structure.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
9	 Fieldstone weir beside gabion baskets. (Gabion baskets are not part of listed heritage resource).	**Removal or possibly maintained in situ:** This feature would be removed due to grading for road widening and multi-use path. If a proposed retaining wall is built it could be maintained in the landscape but will be impacted by loss of flow.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.
10	 Fieldstone weir.	**Removal or possibly maintained in situ:** This feature would be removed due to grading needed for road widening and multi-use path. If a proposed retaining wall is built it could be maintained in the landscape but will be impacted by loss of flow.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
11	 Fieldstone weir, steps and ashlar stone terrace wall.	**Removal or possibly maintained in situ:** This feature would be removed due to grading needed for road widening and multi-use path. If a proposed retaining wall is built it could be maintained in the landscape but would be impacted by loss of flow.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.
12	 Ashlar cut limestone terrace wall.	**Removal or possibly maintained in situ:** Feature would be partially impacted by proposed creek realignment and grading requirements.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation

No.	Photo	Impacts	Mitigation
13	 Confluence of creek and intermittent stream.	**Removal:** The existing intermittent stream would be filled and re-graded.	The confluence will be relocated.
14	 Fieldstone weir with cut stone terrace wall. New channel would tie into existing creek just west of #14.	**Removal or possibly maintained in situ:** This feature might be removed due to grading needed for road widening and multi-use path. The feature is a substantial barrier to fish passage and limiting factor in overall channel function and health. Feature to be taken off-line and disconnected during low-flow stages. An overflow channel would be incorporated so that the feature will be reconnected during high-flow stages (i.e., flows greater than the 2-year discharge).	If removal is required, partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
15	 Fieldstone east entrance wall, curved with sentinel stones.	**Removal:** This feature would be removed due to grading needed for road widening and multi-use path. Road widening without moving this feature would result in less visibility of feature, potential damage due to grading requirements, snow and salt issues.	This structure would be removed and rebuilt back further from the road by skilled heritage masons. The details of the reconstruction would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.
16	 Fieldstone west entrance wall, curved with sentinel stones.	**Removal:** This feature would be removed due to grading needed for road widening and multi-use path.	This structure would be removed and rebuilt back further from the road by skilled heritage masons. The details of the reconstruction would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.
17	 Stone and concrete road bridge.	**No Impact:** Feature to remain in existing location.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
18	 Fieldstone steps to the south of road bridge.	**No Impact:** Feature to remain in existing location.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.
19	 Entrance sign, ashlar, rock-faced limestones with jack arch.	**No Impact:** Feature to remain in existing location.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.
20	 Ashlar dry stone wall.	**No Impact:** Feature is located within the floodplain and will not be impacted by proposed channel works. Feature is to remain in existing location.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
21	 Willowbank Hall.	**No Impact:** Feature to remain in existing location.	If it is to be part of the Conservation Plan, it may be rehabilitated. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.
22	 Fieldstone weir.	**Removal:** This feature would be removed as a result of channel work.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.
23	 Fieldstone weir and culvert.	**Maintained in situ:** Feature would be maintained in landscape but would be impacted by loss of flow as a result of channel realignment.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. Where possible, creek realignment design should incorporate

Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
			the 'high-flow' channel to convey higher flows over the weir structure.
24	 Fieldstone weir and culvert.	**Removal:** This feature would be removed as a result of channel work and grading for roadway and pathway.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.
25	 Fieldstone weir.	**Removal:** This feature would be removed as a result of channel work and grading for roadway and pathway.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must

Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
			be considered in relocation.
26	 Fieldstone weir.	**Removal:** This feature would be removed as a result of channel work.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.
27	 Arched concrete and metal pedestrian bridge with stone abutments.	**Potential Modification:** This feature may need to be modified to accommodate pedestrian traffic and channel work.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
28	 Limestone pillars with wood board fencing leading to main entrance.	**Removal:** This feature would be removed due to grading needed for road widening and multi-use path.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.
29	 Metal and wood pedestrian bridge.	**Potential Modification or Removal:** Potential for feature to be modified to accommodate pedestrian traffic or removed due to channel works.	The modifications to be developed during the preparation of a Conservation Plan by a qualified heritage consultant. If removal is required, partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The

Table 2:1 Heritage Resource Photos with Impacts and Mitigation			
No.	**Photo**	**Impacts**	**Mitigation**
			appropriate context of the resource must be considered in relocation.
30	 Metal and wood pedestrian bridge.	**Potential Modification or Removal** Potential for feature to be modified to accommodate pedestrian traffic or removed due to channel works. IO has recommended removal of this feature.	The modifications to be developed during the preparation of a Conservation Plan by a qualified heritage consultant. If removal is required, partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation

No.	Photo	Impacts	Mitigation
31	 Metal and wood pedestrian bridge.	**Potential Modification or Removal:** Potential for feature to be modified to accommodate pedestrian traffic or removed due to channel works. IO has recommended removal of this feature.	The modifications to be developed during the preparation of a Conservation Plan by a qualified heritage consultant. If removal is required, partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation.
32	 Box culvert at confluence of Clythe Creek and Hadati Creek.	**Potential Modification:** Culvert may be extended to accommodate roadway grading requirement and CSP replacement.	The modifications may be developed during the preparation of a Conservation Plan by a qualified heritage consultant.

Table 2:1 Heritage Resource Photos with Impacts and Mitigation

No.	Photo	Impacts	Mitigation
33	 Concrete and stone weir.	**Maintained in situ:** Feature would be maintained in landscape but would be impacted by loss of flow as a result of channel realignment.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. Were possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structure.
34	 GJR railroad bridge.	**No Impact:** Feature to remain in existing condition.	

2.4. Terrestrial Habitat Assessment

The Terrestrial Habitat Assessment as per the December 2017 assessment for Road Alternative 2 has been carried forward for Alternative 3.

A comprehensive background review supported by multiple field investigations was completed as a part of the draft York Road Environmental Design Environmental Impact Study (March 2017) which yielded a long list of key terrestrial ecological sensitivities present, or potentially present, within the York Road Environmental Design (YRED) Study Area. The key sensitivities potentially present within the Study Area include:

- Sensitive ELC communities;
- Species at Risk (SAR);

- Regionally Important Vegetation - City of Guelph (City of Guelph, 2012) & Wellington County (Frank and Anderson 2009);
- Other significant vegetation;
- Area Sensitive Birds;
- Potentially Breeding Locally Sensitive Birds; and
- Candidate Significant Wildlife Habitat (SWH).

Appendix C-1 includes a summary of these sensitivities and where they are located within the Study Area.

The potential terrestrial habitat impacts associated with the Alternative 3 road widening can be described as direct, indirect, and induced and can vary in magnitude and permanence. Magnitude refers to the size or severity of the impacts and permanence refers both the duration and the reversibility of an impact. The potential impacts to terrestrial habitat reviewed in the draft York Road Environmental Design Environmental Impact Study (March 2017) include:

- Changes to soil permeability, water balance, drainage patterns, run off, and soil stability;
- Modification to vegetation communities;
- Modification to arboricultural resources;
- Construction disturbance of wildlife;
- Import/export of fill;
- Removal of Open Country Bird Habitat;
- Encroachment of natural areas;
- Indirect pollution; and
- Removal of significant species and their habitat.

For a description of each impact, its potential magnitude, and the duration; review Section 4.2 of draft York Road Environmental Design Environmental Impact Study (March 2017) which has been provided in Appendix C-2.

For Alternative 2, road and creek design are expected to impact a sensitive ELC community (Fresh-Moist Lowland Deciduous Forest Type (FOD7-4)) and a regionally important plant (Rough Aven's (*Geum laciniatum*)). There is a potential to also directly impact Polygon 12 and 13 (ref. Appendix C, Figure 1), Mineral Meadow Marsh (MAM2) and Forb Mineral Meadow Marsh (MAM2-10) respectively, as it is directly adjacent to the creek alignment. There is a potential for indirect impacts to the following sensitivities:

- Sensitive ELC communities;
- Regionally Important Vegetation;
- Other significant vegetation;
- Species at Risk (SAR);

- Area Sensitive Birds;
- Potentially Breeding Locally Sensitive Birds; and
- Candidate Significant Wildlife Habitat (SWH).

Appendix C-1 provides a description of expected and potential impacts to each sensitivity. Many potential indirect impacts can be avoided through mitigation measures and recommendations, discussed further in Section 4.1 and 4.2.

2.5. Stormwater Management Strategy

The preferred stormwater management strategy for Road Alternative 3 would be the same as that determined for Road Alternative 2, as per the following:

- Infiltration trenches with overflow chamber system and controlled outlet (where groundwater elevations permit), (ref. Figure: Infiltration/Filtration Trench Configuration, Appendix B). A conceptual plan will be provided within the EIS
- Lined filtration trenches with overflow chamber system and controlled outlets (where groundwater elevations are high), (ref. Figure: Infiltration/Filtration Trench Configuration, Appendix B). A conceptual plan will be provided within the EIS
- Catchbasins to have goss traps and/or catchbasin shields to be connected to infiltration/filtration trenches, west of Watson Road, with standard storm sewer system for east of Watson Road.
- Oil/grit chambers upstream of outlets
- Permeable MUPS where groundwater is 1 m or more below proposed grades
- Appropriate winter operation and maintenance procedures to be implemented for MUPs

2.6. Property Requirements

The south limit of the existing ROW will need to be extended by 1.5 m, between Beaumont Avenue and the eastern Reformatory property limit, and by 2.3 m adjacent to the Reformatory entrance. If the City decides to relocate the overhead utilities to the south side of York Road, a total ROW width of 26.5 m (widened to the south) will be required to ensure the utilities are located beyond the clear zone limit. Temporary grading easements will also be required during construction.

In addition to property required for the road, property would be required for the proposed creek realignment. To determine the required property, the meander belt for the proposed creek would have to be determined, along with the minimum setbacks required by GRCA, within the detailed design process.

2.7. Preliminary Capital Costs

Preliminary capital costs for Road Alternative 3 have been determined for the proposed road, creek and stormwater management/ drainage components of the York Road improvements (ref. Appendix E). The following assumptions and considerations have been used to develop the preliminary capital works costing:

- Stormwater management and drainage system costs have not included culvert upgrades for this current assessment, but will be included for the preferred road alternative.
- Oil/grit chamber costing has been estimated using one (1) oil/grit system for each drainage outlet. Should the stormwater management strategy be revised, costing would have to be adjusted accordingly. Oil/grit chamber sizes have not been determined for this current assessment but will be determined for the preferred road alternative;
- Storm sewer system costing has been estimated using approximate storm sewer sizing and would require validation using modelling as part of the detailed design process;
- Costing does not include staging, sediment and erosion controls, or utility relocations (with exception of overhead hydro);
- Costing does not include cultural heritage feature protection/ repairs/ reconstruction;
- Costing does not include tree protection, planting and seeding; and
- Costing does not include property purchase or facilitation of easements.

The following preliminary capital costing has been determined for Road Alternative 1.

▶ Drainage system and stormwater management:	$2,420,000
▶ Road system and MUP (to Clythe Creek crossing) [1]	$3,960,000
▶ Creek works	$ 859,230
	$7,239,230

3. Alternative 4: Remove Boulevards, Maintain 3.0 m Multi-Use Pathways and Relocate Heritage Walls Beyond Clear Zone Limit.

3.1. Road Design

Similar to Road Alternative 2 (discussed in December 2017 memorandum) Road Alternative 4 would eliminate the boulevards and provide full 3.0 m wide multi-use paths on both the north and south sides of York Road from Beaumont Avenue to east of the Reformatory property. The removal of the boulevard is necessary to prevent fill limits of a widened corridor from significantly impacting the creek. Unlike earlier alternatives, Alternative 4 includes relocation of the former

[a] Road works from Victoria Road to Skyway Drive costed at $ 13,650,000, as such, the total projects costs would be approximately $ 16,929,230

Reformatory entrance gateway features/walls to beyond the limits of the 6.5 m roadway clear zone.
The ring walls at the entrance off York Road to the GCC would need to be removed and rebuilt further south, away from the roadway (ref. Section 5. Mitigation, Revised Heritage Impact Assessment). If the walls were to be left in the current locations, a guiderail would need to be placed approximately 0.5 m to 1.5 m in front of the walls, and with the walls remaining partially buried, the view of the walls would be greatly diminished. There would also be a possibility of damage to the walls during the road construction and snow would be piled up next to the walls due to the lack of space from the road and multi-use pathway. This could potentially also result in structural damage to the walls.

Alternative 4 would require the dismantling and relocation of the entrance walls to facilitate a 6.5 m separation from the edge of pavement, thereby providing an opportunity to raise the walls for improved viewing by the public. As such, a minimum distance of 3.5 m from the south edge of the multi-use path to the walls would result. A qualified heritage stone mason would be required to remove the existing walls, clean the stones, add additional stones as required and rebuild the walls and the circular end treatments. Interpretive signage would add to the understanding of the significance of the walls.

Although the walls would be further south, the relocation would bring them back to their original 1920 appearance. This, along with interpretive signage, would improve the public's view and understanding of the history of the entranceway.

Since preservation in situ is not feasible for all of the heritage resources, rehabilitation, adaptive reuse and restoration must be done in a sensitive manner in order to protect the site's heritage value.

It is recommended that a Conservation Plan (ref. Section 6: Recommendations of the Revised Heritage Impact Assessment) be prepared during the detailed design plan phase for improvements to York Road. Formulation of the detailed design plan phase will clearly show in-depth elements of how and where the protection of the heritage resources will be. A Conservation Plan would be prepared by a qualified heritage consultant and would guide the work of relocating the built heritage resources within this locally and provincially significant cultural heritage landscape.

The scope of the Conservation Plan should include the following:

- Preliminary recommendations for restoration, rehabilitation and/or adaptive reuse;
- Critical short-term maintenance required to stabilize the heritage resources and prevent deterioration;
- Measures to ensure interim protection of heritage resources during phases of construction or related development;

- Security requirements;
- Restoration and replication measures required to return the property to a higher level of cultural heritage value or interest integrity, as required;
- Appropriate conservation principles and practices, and qualifications of contractors and trades people that should be applied, especially in the dismantling and reassembling of the wing walls;
- Longer term maintenance and conservation work intended to preserve existing heritage fabric and attributes;
- Drawings, plans, specifications sufficient to describe all works outlined in the Conservation Plan;
- An implementation strategy outlining consecutive phases or milestones;
- Cost estimates for the various components of the plan; and
- Compliance with recognized *Standards and Guidelines for the Conservation of Historic Places in Canada*, the *Guelph Innovation District* (York District Lands) *Official Plan Amendment 54,* City of Guelph Official Plan (2014) and other recognized heritage protocols and standards.

Relocation of the cultural heritage walls, per a City-approved Conservation Plan, would provide additional space for snow storage and utilities, while eliminating the need to provide a guiderail along the road side of the heritage features. Relocation of the wall will need to be undertaken by skilled heritage masons, and will require additional embankment grading and use of retained soil systems (or retaining walls) between the heritage wall and the creek.

In order to optimize the available space within the right-of-way, the roadway alignment would be shifted 1.5 m to the north relative to the design presented in the EIS. The road profile has also been adjusted to minimize grading impacts on adjacent properties. Similar to the design presented in the EIS, extension of the Hadati Creek culvert would be required, and opportunities to reduce impacts to the creek and heritage features through implementation of various segments of retaining walls/soil systems could be investigated as part of detailed design. The Alternative 4 roadway cross-section adjacent to the relocated heritage walls is illustrated in

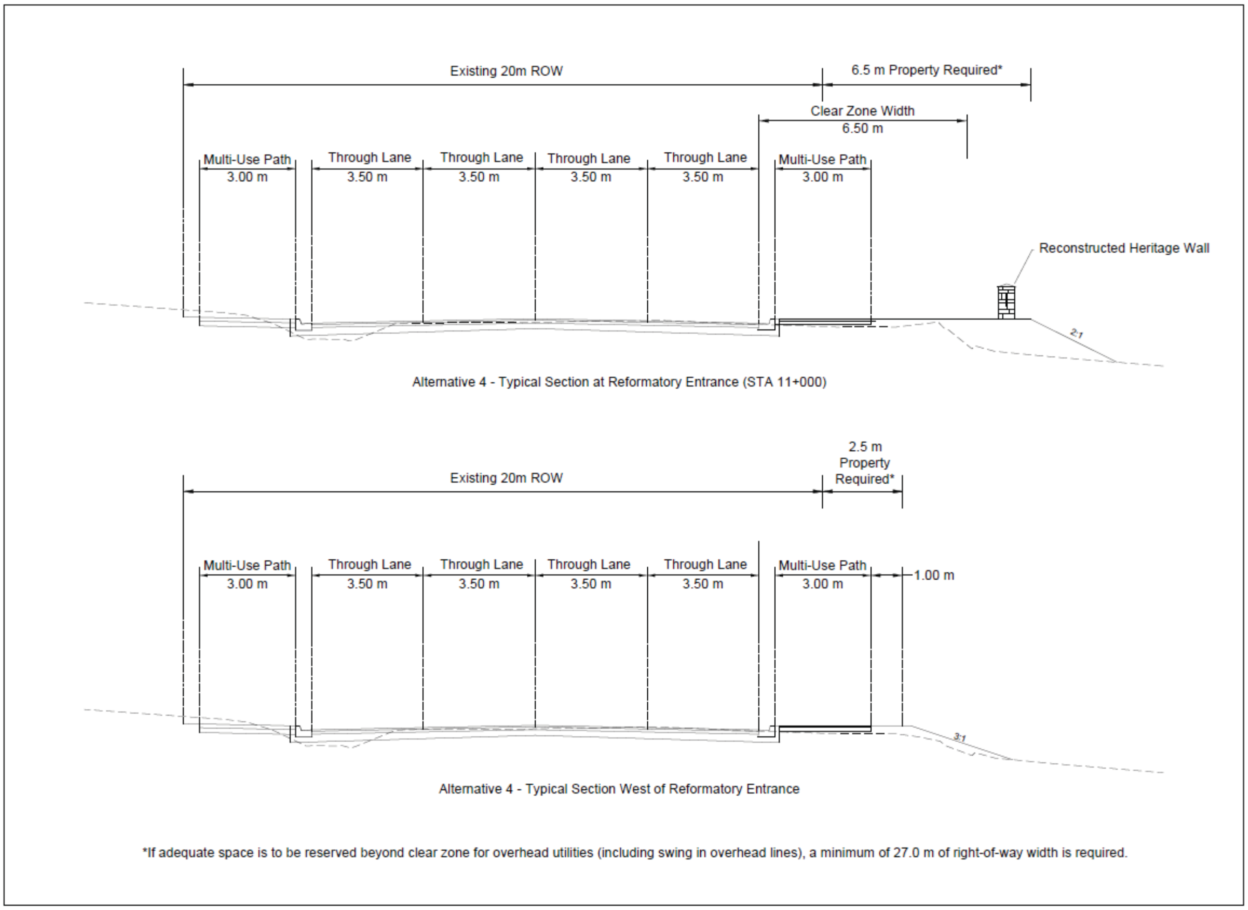


Figure 3.1 and 3.2, with the associated plan and profile drawings provided in Appendix A.

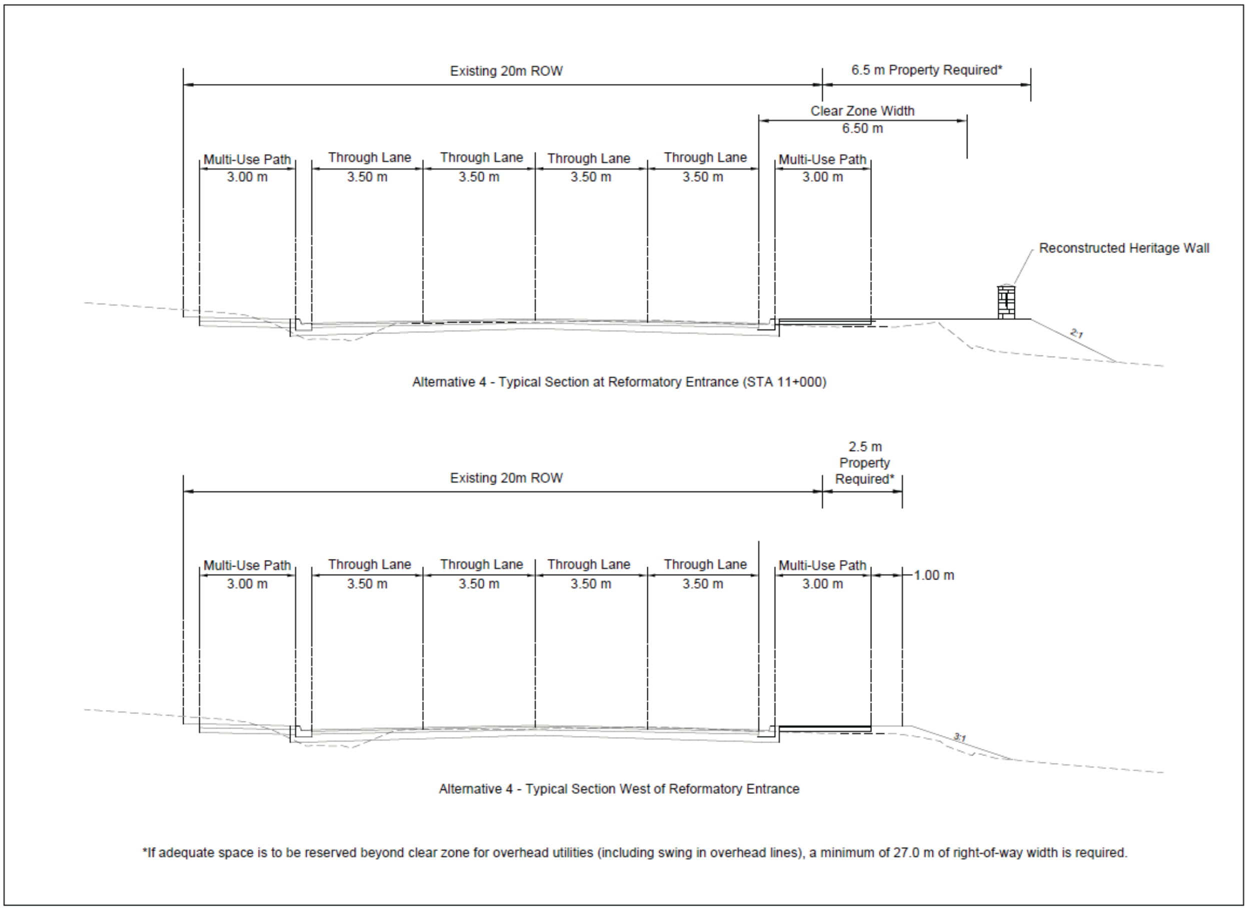


Figure 3.1: Typical Roadway Cross-Section for York Road Alternative 4.

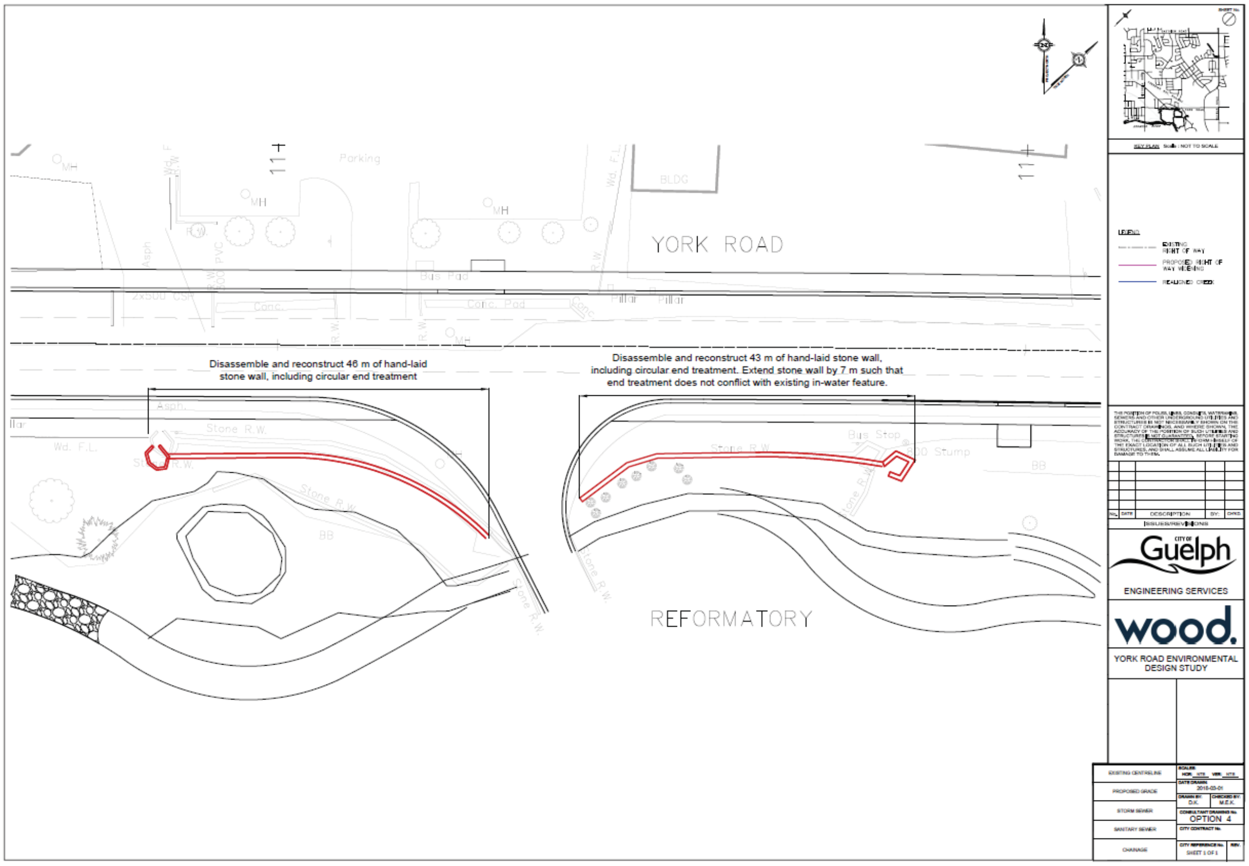


Figure 3.2: Roadway Plan View for York Road Alternative 4.

3.2. Creek Design

Please refer to Section 2.2.

3.3. Cultural Heritage Assessment

Former Reformatory Entranceway

Roadway Alternative 4 would require changes to, and removals of, cultural heritage walls adjacent to the former Reformatory driveway which would dramatically change the cultural heritage landscape along York Road. Alternative 4 would include the relocation of the fieldstone entrance wing walls on both side of the driveway (photos #15 and #16).

Under Alternative 4 the proposed roadway improvements include the widening of York Road and a 3.0 m wide multi-use path on each side of the roadway in the vicinity of the former Reformatory entranceway. Based on the required 6.5 m clear zone width from the south inside road curb, without the use of a guiderail, the cultural heritage walls would have to be relocated outside the clear zone. As such, a minimum distance of 3.5 m from the south edge of the multi-use path to the walls would result. As indicated previously, the removal of the boulevard is necessary to prevent fill limits of a widened corridor from significantly impacting the creek. A qualified heritage stone mason would be required to remove the existing walls, clean the stones, add additional stones as required and rebuild the walls and the circular end treatments. Although costly, relocating the walls would provide a resemblance of the original walls appearance from the 1920's, when the walls were viewable from the road. The current roadway elevation has been raised from the road that existed in the 1920s, as such reducing the view of the walls. Relocation of the walls would improve the public's view and understanding of the history of the entranceways' history.

Photo No	Photo	Description	Impacts
15		Fieldstone east entrance wall, curved with sentinel stones and circular end treatment	Relocation: This feature would be relocated in Option 4 due to the grading needed for road widening and multi-use path and for snow removal requirements.
16		Fieldstone west entrance wall, curved with sentinel stones and circular end treatment	Relocation: This feature would be relocated in Option 4 due to the grading needed for road widening and multi-use path and for snow removal requirements.

Three (3) heritage masons were contacted regarding the cost of the removal and replacement of the fieldstone entrance wing walls on both sides of the entrance way. They were provided an explanation of the work that was required; photos of the current walls, including a 1920's photo of how the wall looked originally; and the plan and cross-sections illustrating the extent of the wall relocations (full wall relocation, not partial relocation as per plans provided in Appendix E).

The three heritage masons chosen for preliminary quotes and subsequently contacted were all members of the Canadian Association of Heritage Professionals (CAHP), (verus local mason with no membership in the CAHP),. as per the following:

- Barkley Hunt: Owner, Hunt Heritage Masonry, 549 Runnymede Road, Toronto, ON 416-219-1616, info@huntheritage.ca
- Chris Huntley: Vice President, Heritage Restoration Inc., 14 Paisley Lane, Stouffville, ON 416-567-4522, Chris.Huntley@hrigroup.ca
- Dean McLellan: Owner, Stonework and Dry-Stone Walling, 392018 Main Street, Holstein, ON 519-321-1586, dean.mclellan@yahoo.ca

The preliminary quotes received for dismantling and rebuilding the cultural heritage walls were the following:

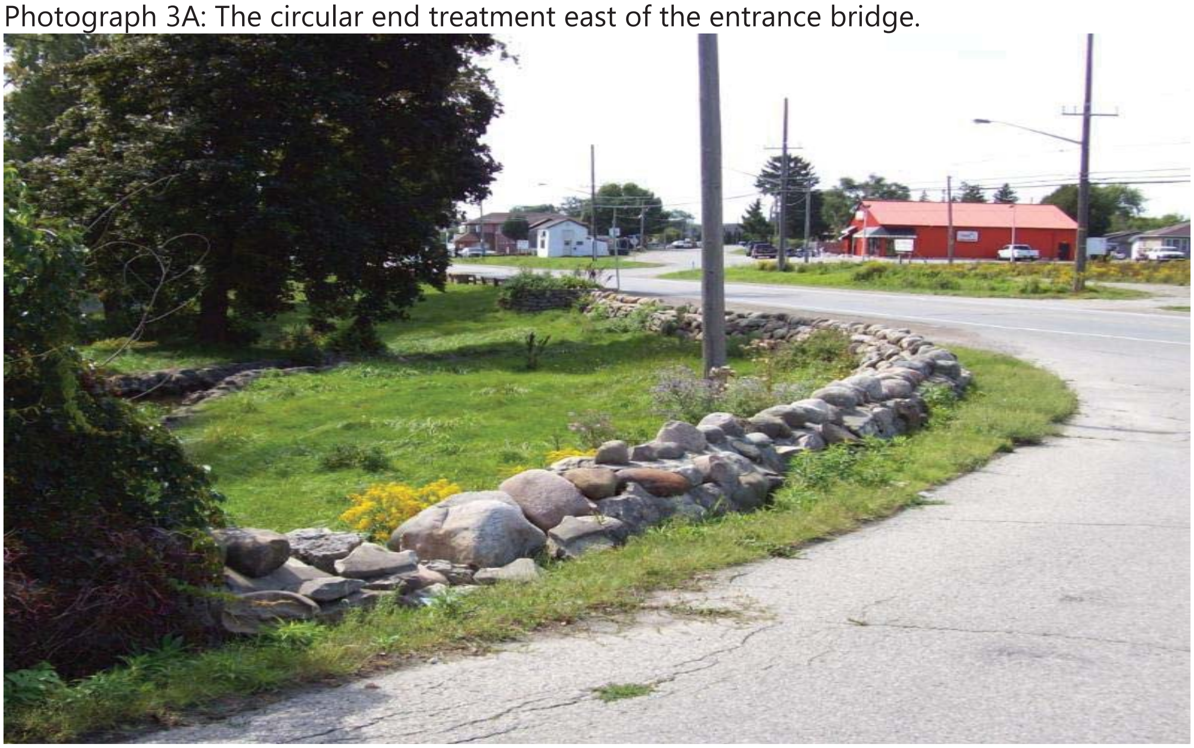
- Barkley Hunt: $150,000.00
- Chris Huntley: $300,000.00
- Dean McLellan: $150,000.00

These quotes are based on phone conversations, emails, photographs (ref. Photographs 1A-5A) and plan drawings (ref. Appendix E), and are considered to be preliminary cost estimates only. None of the stone masons visited the site for additional understanding of the wall reconstruction scope. Due to the limited nature of the information available, the preliminary cost estimates are considered to be lower than the anticipated construction costs. Detailed cost estimates from stone masons during the detailed design stage (when more information could be made available), and tender stage (requiring a mandatory site visit), would be expected to be significantly higher than the estimates received, based on the three (3) heritage masons not being able to assesses the walls in detail through a site visit, and determine more accurately the potential scope for relocation of the walls.

Photograph 1A: East side of entrance bridge. Only top of wall is visible.

Photograph 2A: Taken from inside the property with wall more visible.

Photograph 3A: The circular end treatment east of the entrance bridge.



Photograph 4A: West of the entrance. Only the top of the wall is visible.

Photograph 5A: 1920 picture of dry stone wing wall with circular end treatment. The height of the wall is noticeably taller. The existing wall has been partially buried due to road grading.

Remainder of Cultural Heritage Features

Please refer to Section 2.3.

3.4. Terrestrial Habitat Assessment

Please refer to Section 2.4.

3.5. Stormwater Management Strategy

Please refer to Section 2.5.

3.6. Property Requirements

As the cross-sectional width of Alternative 4 is 26.5 m (including width for overhead utilities), and the roadway follows (to the extent possible) the north side of the existing 20 m R.O.W through this section (west of the Clythe Creek crossing), it is anticipated that approximately 6.5 m of additional property on the south side of the right-of-way will be required along the entire length of this section of York Road. Grading easements will also be required during construction.

In addition to property required for the road, property would be required for the proposed creek realignment. To determine the required property, the meander belt for the proposed creek would have to be determined during the detailed design phase, along with the minimum setbacks required by GRCA.

3.7. Preliminary Capital Costs

Preliminary capital costs for Road Alternative 4 have been determined for the proposed road, heritage wall relocation, creek and stormwater management/ drainage components of the York Road improvements (ref. Appendix E). The following assumptions and considerations have been used to develop the preliminary capital works costing:

- Stormwater management and drainage system costs have not included culvert upgrades for this current assessment, but will be included for the preferred road alternative.
- Oil/grit chamber costing has been estimated using one (1) oil/grit system for each drainage outlet. Should the stormwater management strategy be revised, costing would have to be adjusted accordingly. Oil/grit chamber sizes have not been determined for this current assessment but will be determined for the preferred road alternative.
- Storm sewer system costing has been estimated using approximate storm sewer sizing and would require validation using modelling as part of the detailed design process.
- Costing does not include staging, sediment and erosion controls, or utility relocations (with exception of overhead hydro);
- Costing does not include tree protection, planting and seeding
- Costing does not include property purchase or facilitation of easements

The following preliminary capital costing has been determined for Road Alternative 4.

▶ Drainage system and stormwater management:	$2,420,000
▶ Road system and MUP (to Clythe Creek crossing)[2]	$3,900,000
▶ Heritage Wall Relocation (by approved Heritage Masons)	$ 300,000
▶ Creek works	$ 859,230
	$7,479,230

[b] Road works from Victoria Road to Skyway Drive costed at $ 13,680,000, as such, the total projects costs would be approximately $ 17,259,230

4. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations have been determined by discipline, based on the assessment of Road Alternatives 3 and 4.

4.1. Conclusions

Road Design

Both Road Alternatives 3 and 4 are acceptable from a strictly transportation design perspective. However, due to the lack of boulevards associated with either option (to limit creek impacts), as well as the northerly shift, there are reduced opportunities to provide street lighting on both sides of York Road, and additional winter maintenance efforts will be required. Use of steep embankment slopes and/or retained soil systems should be investigated where they have the potential to mitigate risks to heritage features.

Creek Design

The creek design for Road Alternatives 3 and 4 does not represent a substantial change to the channel form and function of the previously-identified preferred channel alignment within the EIS. Road Alternatives 3 and 4 would allow for the development of a high flow channel that could convey higher flows, typical of 1.5 to 2 year storm event, over the weir structure. In either scenario, the existing barriers to fish passage would be mitigated.

Under both alternatives, the planform must be shifted south near the confluence with Hadati Creek. Under both Road Alternatives 3 and 4, less existing channel length would be utilized than was possible with the previously-identified preferred alignment in the EIS, as the planforms for both Road Alternatives 3 and 4 begin to bend at a point further upstream, directing the planform south towards the Eramosa River. This is equally advantageous for both alternatives, as there would be an increased buffer between the roadway/culvert and the channel at this location, however additional cut and fill would subsequently be required during construction.

Beyond the minor changes noted above, the advantages associated with the previously-identified preferred channel alignment in the EIS are provided by both alternatives. The creek channel would be removed further from the York Road right-of-way and floodplain connectivity is improved. The outlet of the northern Reformatory Pond will be closed to limit interactions between the pond and the creek channel. The existing groundwater-fed tributary planform is utilized as part of the design channel and narrowing of the channel in sections will support natural channel processes. Overall, both alternatives are realignments that would provide improvements to natural channel function and habitat as compared to existing conditions.

Cultural Heritage

Both Alternative 3 and Alternative 4 would require changes to, and removals of, cultural heritage resources which would dramatically change the cultural heritage landscape along York Road. There is a significant difference in the potential impacts to cultural heritage walls at the former Reformatory entranceway resulting from both Alternatives 3 and 4. Alternative 3 would maintain the location of the existing cultural heritage walls, but would require a guiderail to be placed immediately in front of the walls, therefore blocking the view of the wall from the road and multi-use path and potentially resulting in damage to the wall during the guiderail construction. Alternative 4 would require dismantling and relocation of the entrance walls at the former Reformatory entranceway to facilitate a 6.5 m separation from the edge of pavement, therefore providing an opportunity to raise the walls for improved viewing by the public.

Along the remainder of the creek, impacts to the cultural heritage features within the creek could be partially mitigated using retaining walls along the south right-of-way limits, although flow would be dramatically reduced within sections of the original creek.

Terrestrial Habitat

The study area and the adjacent lands present several ecological sensitivities including but not limited to natural vegetation communities, open country bird habitat, turtle habitat, three Species at Risk birds, and existing trees. In terms of terrestrial ecology, there is no difference between Alternative 3 and Alternative 4. The road and creek alterations proposed in both Alternatives will cause some direct negative impacts, specifically to trees and natural vegetation. The negative impacts though can be compensated for as a part of the new creek realignment design. The proposed roadway development may indirectly impact wildlife including turtles, open country birds, and Species a Risk birds. No habitat for any of the species is proposed to be removed but avoidance during construction is possible. There are no expected induced impacts. York Road is already a heavily used road, therefore widening, is not likely to cause a noticeable change in human use. The park land is remaining parkland with no additional programming. In conclusion, the widening of York Road and the realignment of the creek will cause some negative impacts, but can be mitigated and compensated completely, resulting a net neutral or positive impact.

Stormwater Management Strategy

Based on the need for erosion and water quality controls, with no or limited quantity controls, the stormwater management strategy is proposed as a combination of oil/grit chambers and infiltration/filtration systems. Stormwater quality control / treatment would be provided for the proposed additional paved area. Storm sewer length and sizing would be practically limited by the use of the combined infiltration/filtration trench and underground chamber systems. A storm sewer system east of the Clythe Creek crossing would be required, but would be configured to convey the 25 mm storm event to an infiltration/filtration trench system. A permeable MUP system could be used where groundwater is 1 m below the proposed grades.

Property Requirements

For Alternative 3, the south limit of the existing ROW will need to be extended by 1.5 m, between Beaumont Avenue and the eastern Reformatory property limit, and by 2.3 m adjacent to the Reformatory entrance. If the City decides to relocate the overhead utilities to the south side of York Road, a total ROW width of 26.5 m (widened to the south) will be required to ensure the utilities are located beyond the clear zone limit. Temporary grading easements will also be required during construction.

For Alternative 4, as the cross-sectional width of Alternative 4 is 27.0 m (including width for overhead utilities), and the roadway follows (to the extent possible) the north side of the existing 20 m R.O.W through this section (west of the Clythe Creek crossing), it is anticipated that approximately 6.5 m of additional property on the south side of the right-of-way will be required along the entire length of this section of York Road.

Additional property would be required for the proposed creek alignment based on the proposed meander belt width to be determined in the detailed design phase along with the minimum setbacks required by GRCA.

4.2. Recommendations

Road Design

Alternative 4 would maintain multi-use pathway widths of 3.0 m on both sides of the road, however the 1.5 m wide boulevards on each side of the road would be eliminated from approximately Beaumont Crescent to road station 11+280, 260 m east of the former Reformatory driveway. Road lane widths would be maintained as 3.50 m (as such Alternative 4 would be recommended). Alternative 3 is not preferred as it would require 2.5 m wide multi-use pathways and would provide less pace for snow removal then Alternative 4.

Creek Design

The creek designs for Road Alternatives 3 and 4 do not differ from the creek alignment and profile developed Road Alternative 2. Alternatives 3 and 4 would facilitate the connection to the cultural heritage feature # 14 upstream of the former Reformatory Driveway, as such from a creek design perspective both Road Alternatives 3 and 4 would be preferred.

Cultural Heritage Assessment

Road Alternative 4 would be preferred to Alternative 3 from a cultural heritage perspective, as although it would require relocation of the walls on each side of the former Reformatory entranceway, the cultural heritage walls would be viewable to the public and the condition of the walls would be improved (ref. Figure 3.2)

Terrestrial Habitat

Both road alternatives have the potential for both direct and indirect negative impacts to terrestrial habitat. There would be minimally expected or potential induced negative impacts to terrestrial habitat, as the general use of the road corridor is not changing, nor is the way that people would interact with it. Mitigation and compensation efforts should be reviewed and finalized as a part of Detailed Design. That being said, the draft March 2017 EIS provided mitigation measures to reduce or eliminate the magnitude and duration of the potential negative impacts (ref. Appendix C-3). Additional recommendations to verify that there are no negative impacts include:

- Development of a monitoring plan with quantitative thresholds to ensure that the proposed mitigation and compensation measures perform as intended. The monitoring plan will need to consist of baseline, during construction, and post-construction stages. It should include monitoring stations, design and reporting guidelines and deadlines. Deficiencies identified through monitoring activities will need to be addressed to the satisfaction of the City of Guelph. The post-development monitoring program will need to include potential management responses to rectify potential negative impacts, verify performance targets (e.g. habitat for target species), and unforeseen negative ecological impacts.
- Bald Eagle winter surveys as part of the environmental studies required through the future block plan process for the GID area.
- Further assessment of the area towards the western edge of the study area to identify its potential to support wetland communities; identification of biosalvage opportunities; and development of a protocol to check for nesting

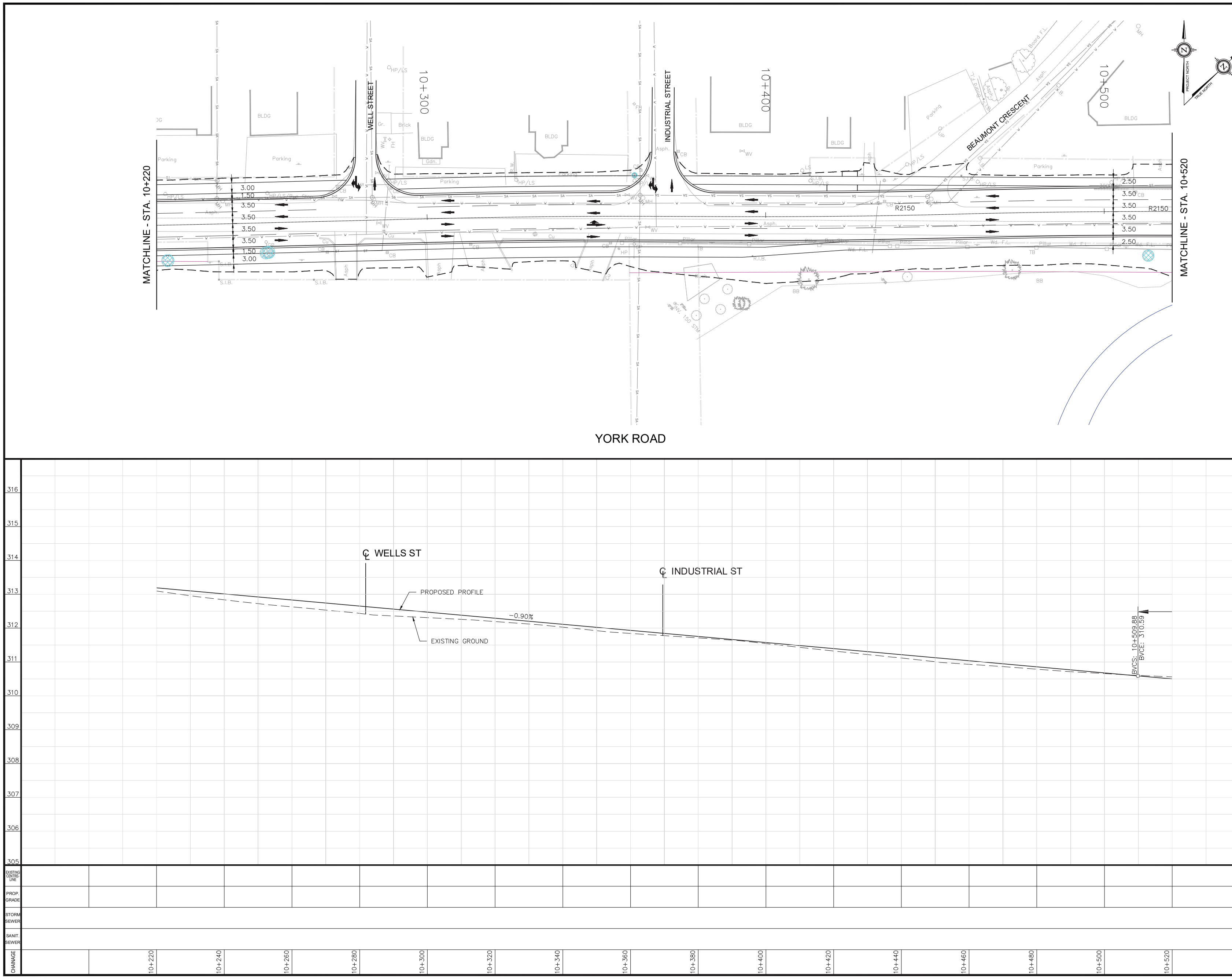
Stormwater Management Strategy

As noted, the preferred stormwater management strategy, would use a treatment train approach of oil/grit chambers and infiltration/filtration trenches. As both Road Alternatives 3 and 4 have limited boulevard widths, implementation of either bioretention or biofiltration of road runoff within roadside LID BMPs would be considered largely impractical. Adjustments to the road section to allow for bioretention and/or biofiltration LID BMPs would improve the preliminary preferred treatment train approach. Appendix D provides standard sections for infiltrative measures that could be considered further in detailed design. A conceptual layout of the stormwater management system will be provided in the updated EIS.

Property Requirements

Property requirements for the road would be more than that determined within the original Class EA due to the need to acquire additional property along the south side of the road right-of-way, along with the required property for creek realignment. The revised property limits required to facilitate construction of the roadway are illustrated in the plans provided in Appendix A, not including property related to the creek's meander belt, to be determined in detailed design and GRCA setbacks.

Appendix A:
Road Alternatives



SHEET No.

KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING RIGHT OF WAY
- PROPOSED RIGHT OF WAY WIDENING
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK

THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

No.	DATE	DESCRIPTION	BY:	CHKD.

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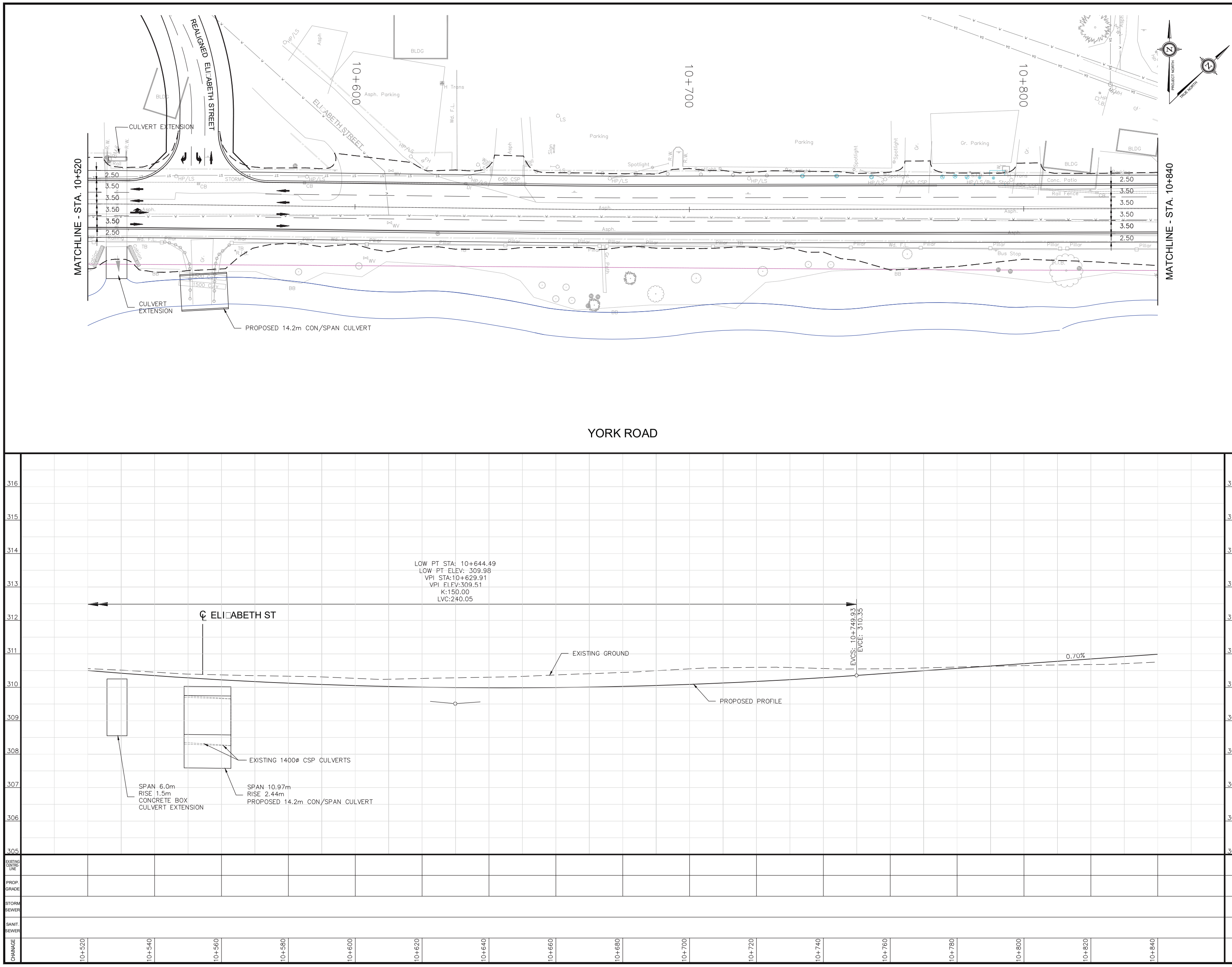
CITY OF Guelph

ENGINEERING SERVICES

amec foster wheeler

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2018-01-12
STORM SEWER	DRAWN BY: D.K. CHECKED BY: M.E.K.
SANITARY SEWER	CONSULTANT DRAWING No. OPTION ☐ / CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 1 OF 4 REV.



SHEET No.

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	DRAWN BY: D.K. / CHECKED BY: M.E.K.
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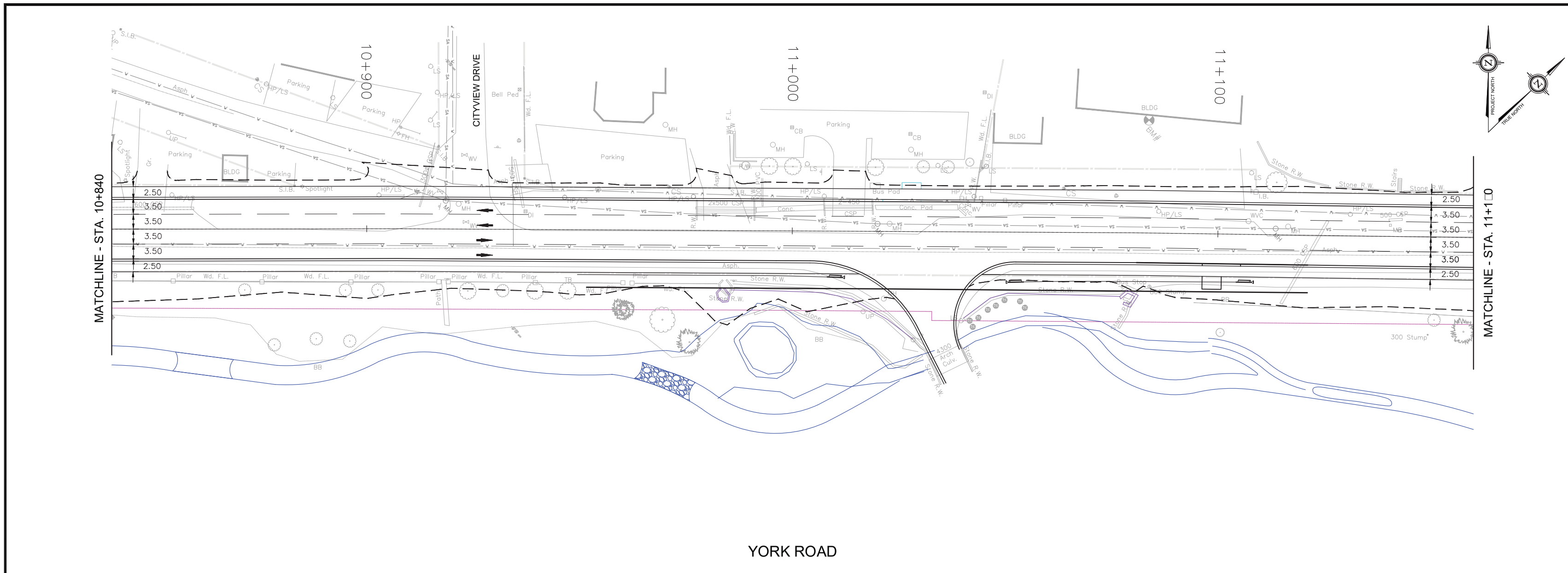

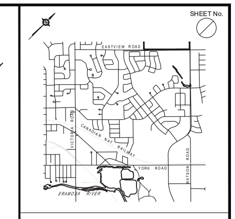

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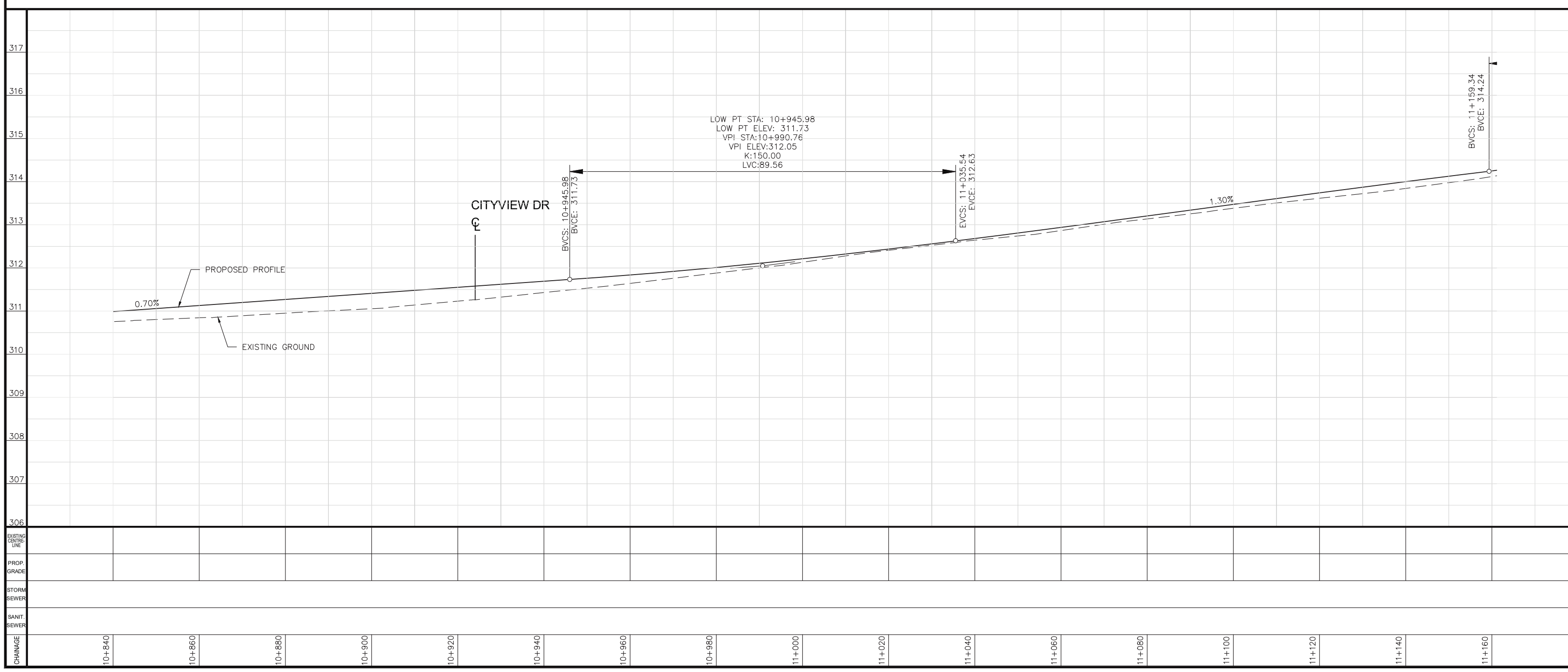

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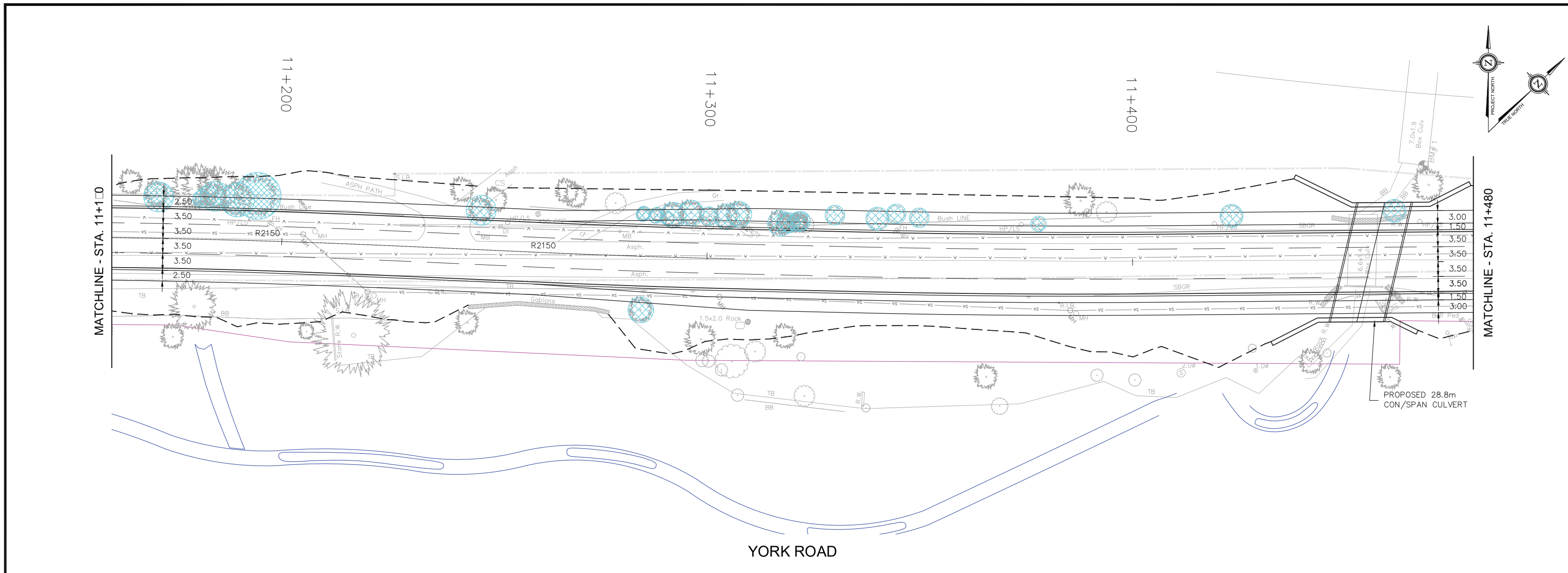

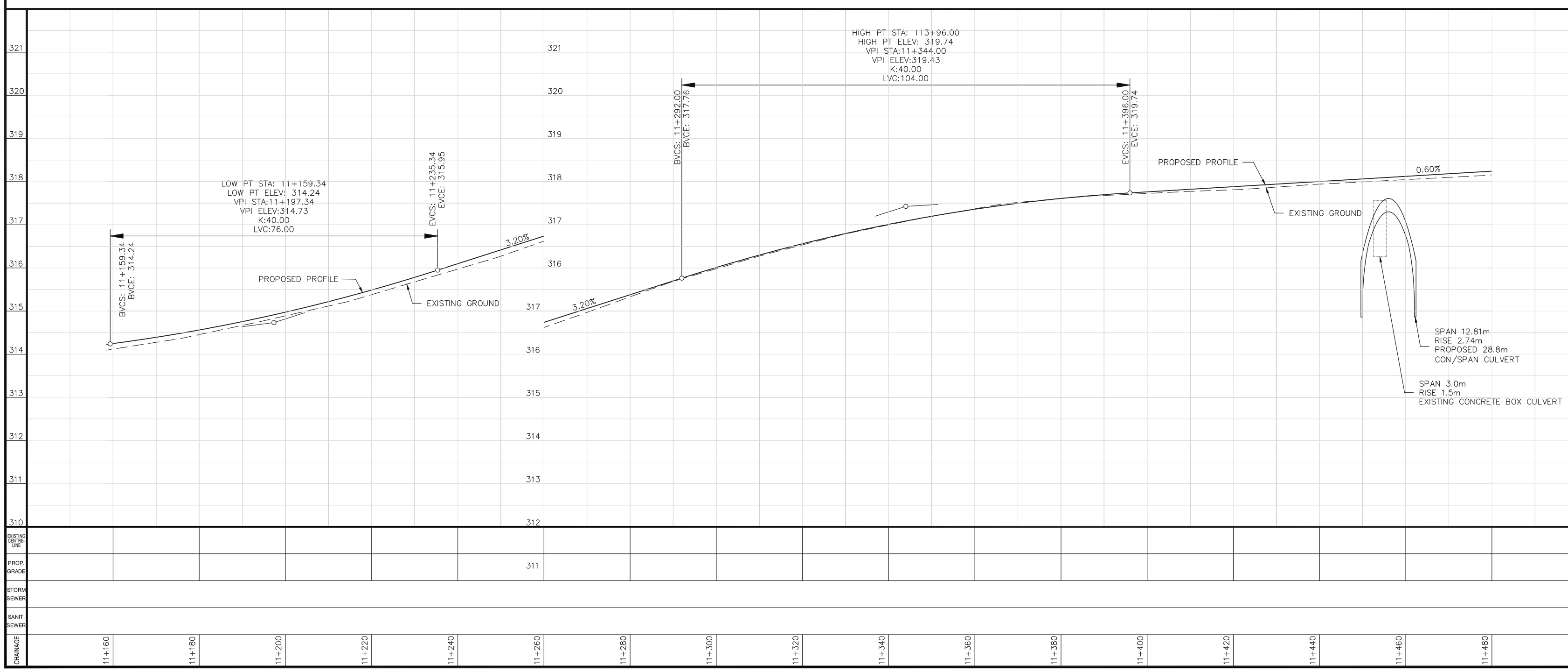

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EXISTING CENTRELINE

PROPOSED GRADE

STORM SEWER

SANITARY SEWER

CHAINAGE

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DATE DRAWN: 2018-01-12

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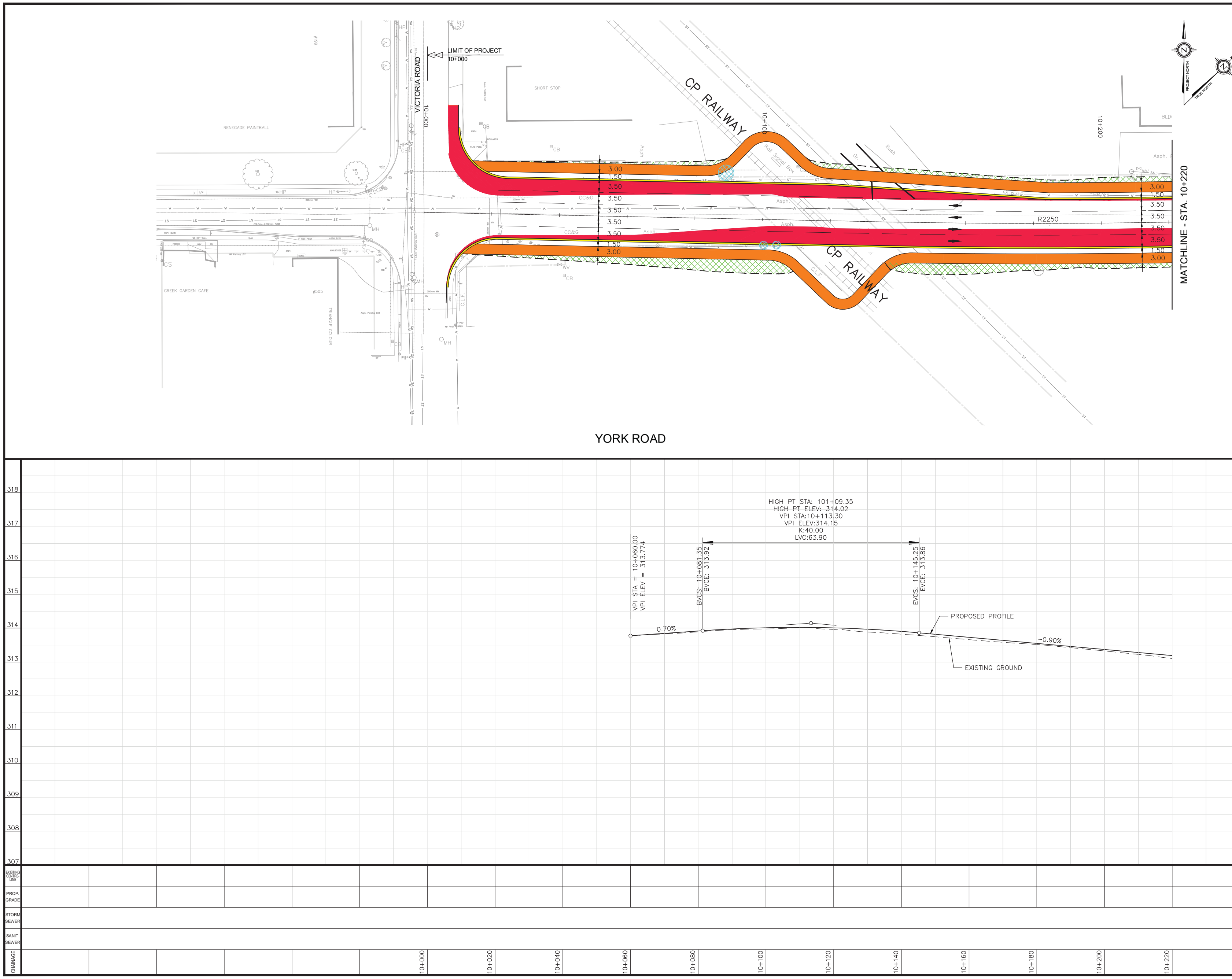

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KEY PLAN Scale : NOT TO SCALE

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- PROPOSED CURB
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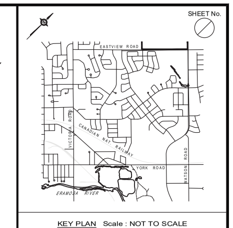

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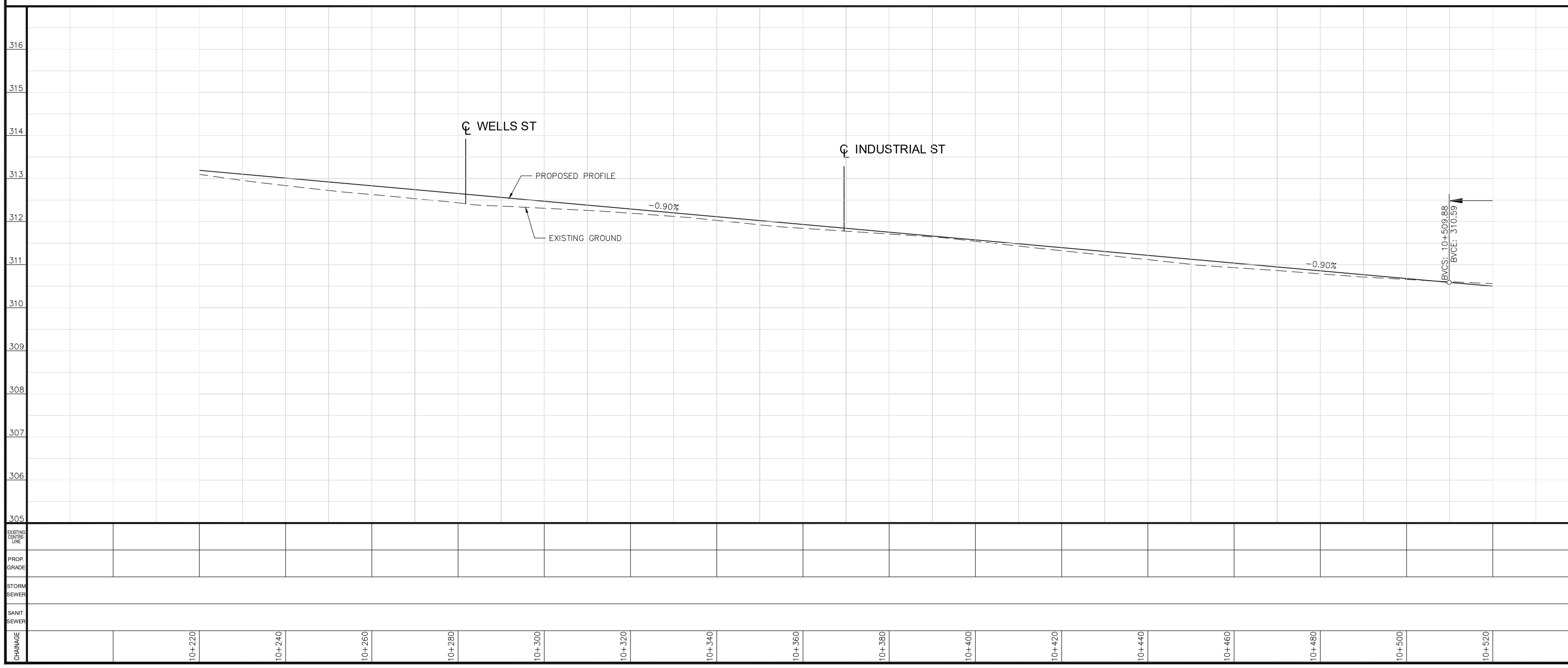

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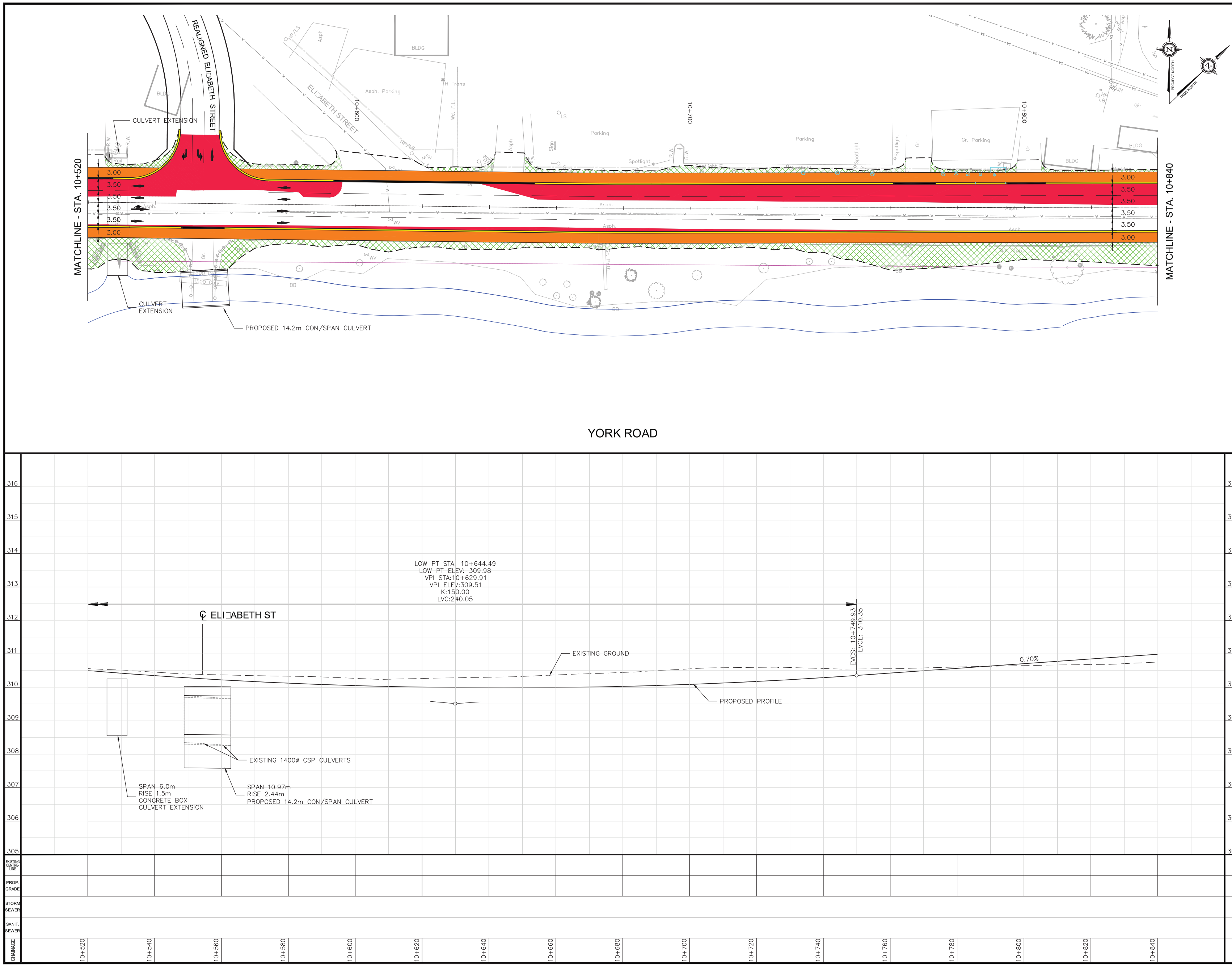

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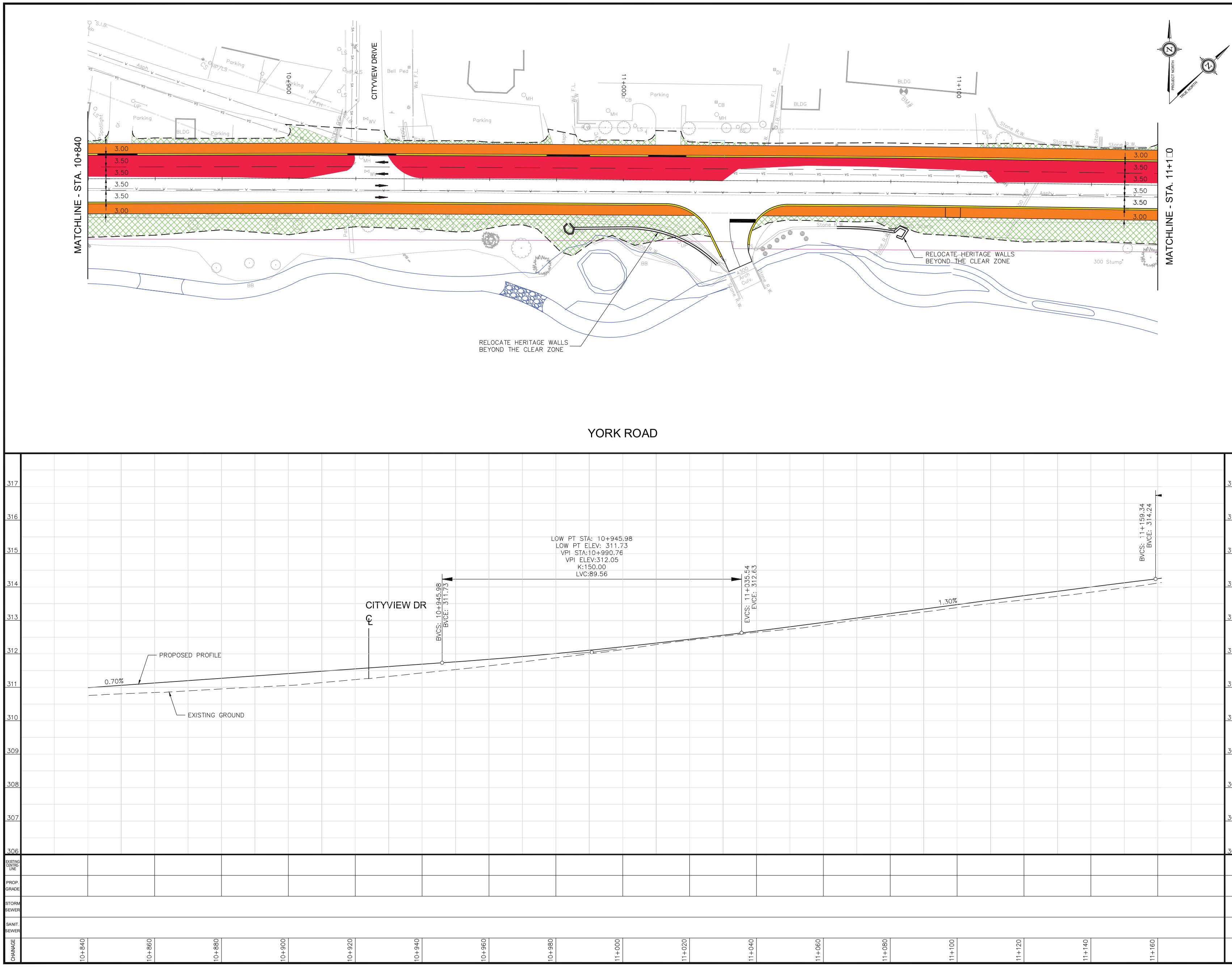

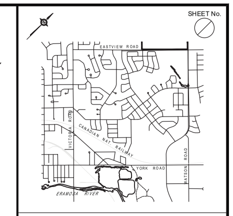

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ISSUES/REVISIONS

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ENGINEERING SERVICES

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YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE

PROPOSED GRADE

STORM SEWER

SANITARY SEWER

CHAINAGE

SCALES: HOR: 1:500 VER: 1:50

DATE DRAWN: 2018-04-02

DRAWN BY: D.K.

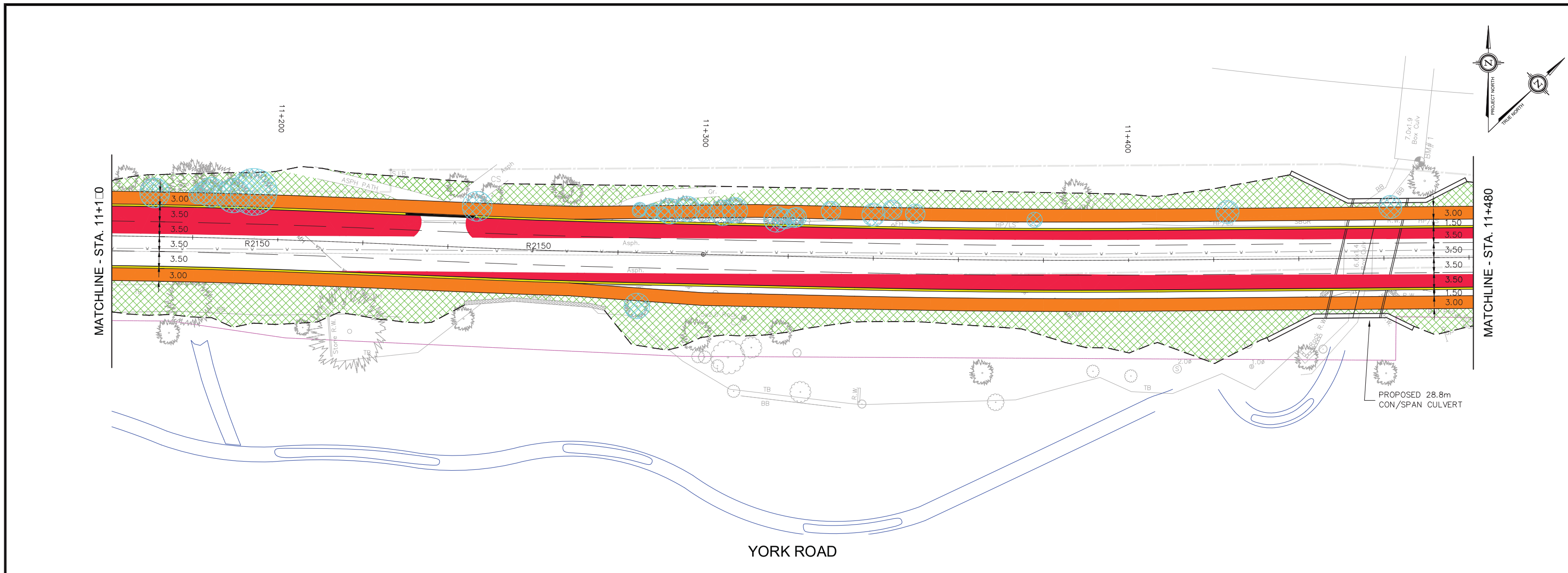
CHECKED BY: M.E.K.

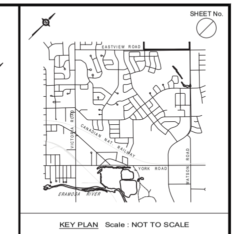
CONSULTANT DRAWING No. OPTION 4

CITY CONTRACT No.

CITY REFERENCE No. SHEET 4 OF 9

REV.





LEGEND

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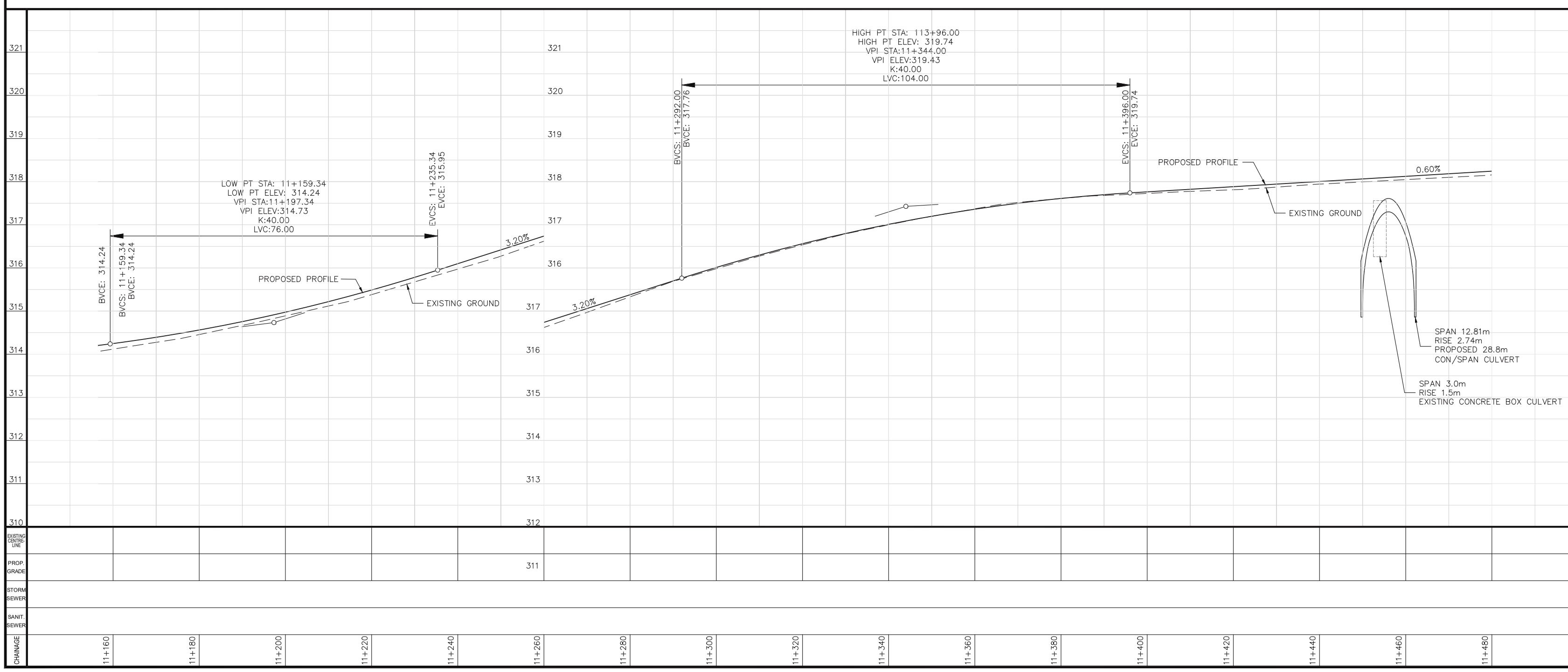

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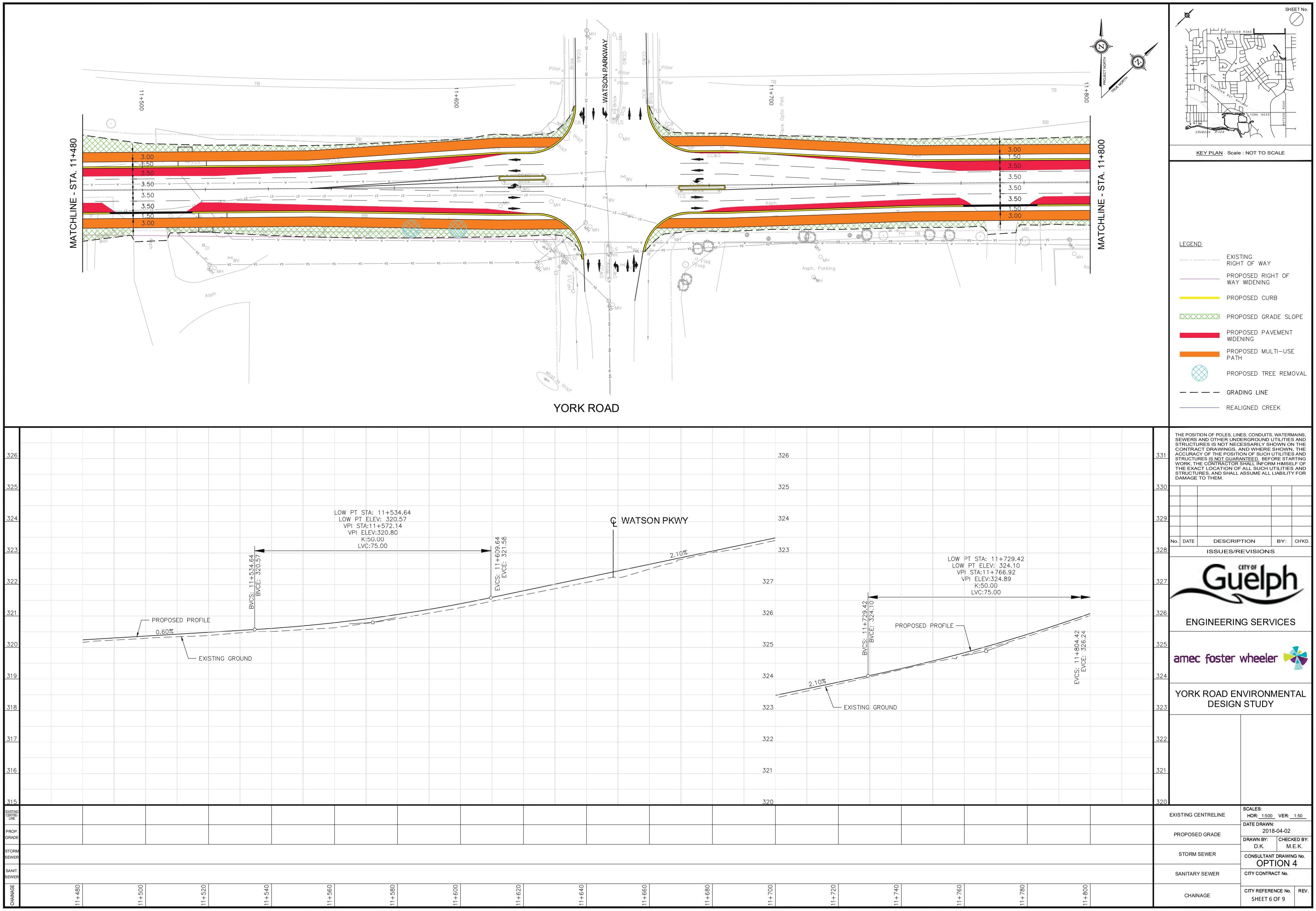

MATCHLINE - STA. 11+480
MATCHLINE - STA. 11+800
WATSON PARKWAY
YORK ROAD
11+500
11+600
11+700
11+800
3.00
1.50
3.50
3.50
3.50
3.50
1.50
3.00
PROJECT NORTH
TRUE NORTH
KEY PLAN Scale : NOT TO SCALE
SHEET No.
LEGEND
EXISTING RIGHT OF WAY
PROPOSED RIGHT OF WAY WIDENING
PROPOSED CURB
PROPOSED GRADE SLOPE
PROPOSED PAVEMENT WIDENING
PROPOSED MULTI-USE PATH
PROPOSED TREE REMOVAL
GRADING LINE
REALIGNED CREEK
LOW PT STA: 11+534.64
LOW PT ELEV: 320.57
VPI STA:11+572.14
VPI ELEV:320.80
K:50.00
LVC:75.00
BVCS: 11+534.64
BVCE: 320.57
EVCS: 11+609.64
EVCE: 321.58
℄ WATSON PKWY
2.10%
0.60%
PROPOSED PROFILE
EXISTING GROUND
LOW PT STA: 11+729.42
LOW PT ELEV: 324.10
VPI STA:11+766.92
VPI ELEV:324.89
K:50.00
LVC:75.00
BVCS: 11+729.42
BVCE: 324.10
EVCS: 11+804.42
EVCE: 326.24
THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
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YORK ROAD ENVIRONMENTAL DESIGN STUDY
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
11+480 11+500 11+520 11+540 11+560 11+580 11+600 11+620 11+640 11+660 11+680 11+700 11+720 11+740 11+760 11+780 11+800
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DATE DRAWN: 2018-04-02
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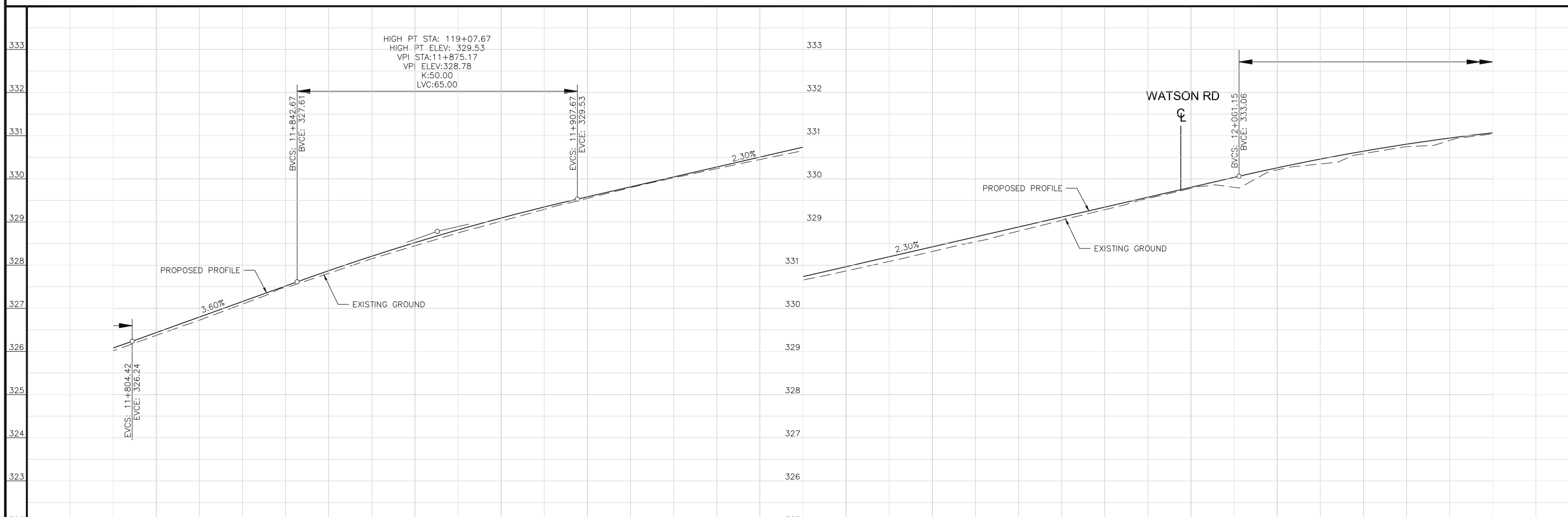
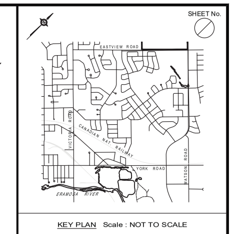


EXISTING CENTRELINE																	
PROPOSED GRADE																	
STORM SEWER																	
SANITARY SEWER																	
CHAINAGE	11+800	11+820	11+840	11+860	11+880	11+900	11+920	11+940	11+960	11+980	12+000	12+020	12+040	12+060	12+080	12+100	12+120

SHEET No.



LEGEND

- EXISTING RIGHT OF WAY
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- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI-USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK

THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

amec foster wheeler

YORK ROAD ENVIRONMENTAL DESIGN STUDY

SCALES: HOR: 1:500 VER: 1:50

DATE DRAWN: 2018-04-02

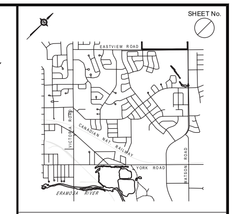
DRAWN BY: D.K. CHECKED BY: M.E.K.

CONSULTANT DRAWING No. OPTION 4

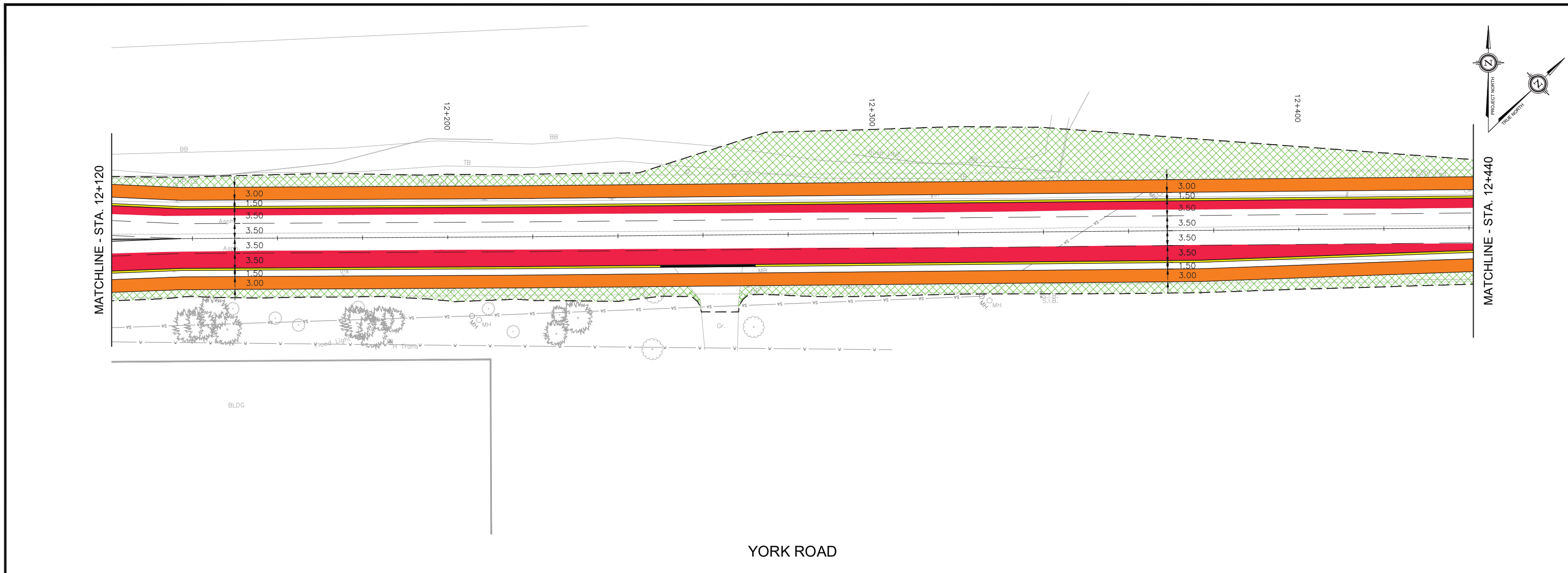
CITY CONTRACT No.

CITY REFERENCE No. SHEET 7 OF 9 REV.

SHEET No.

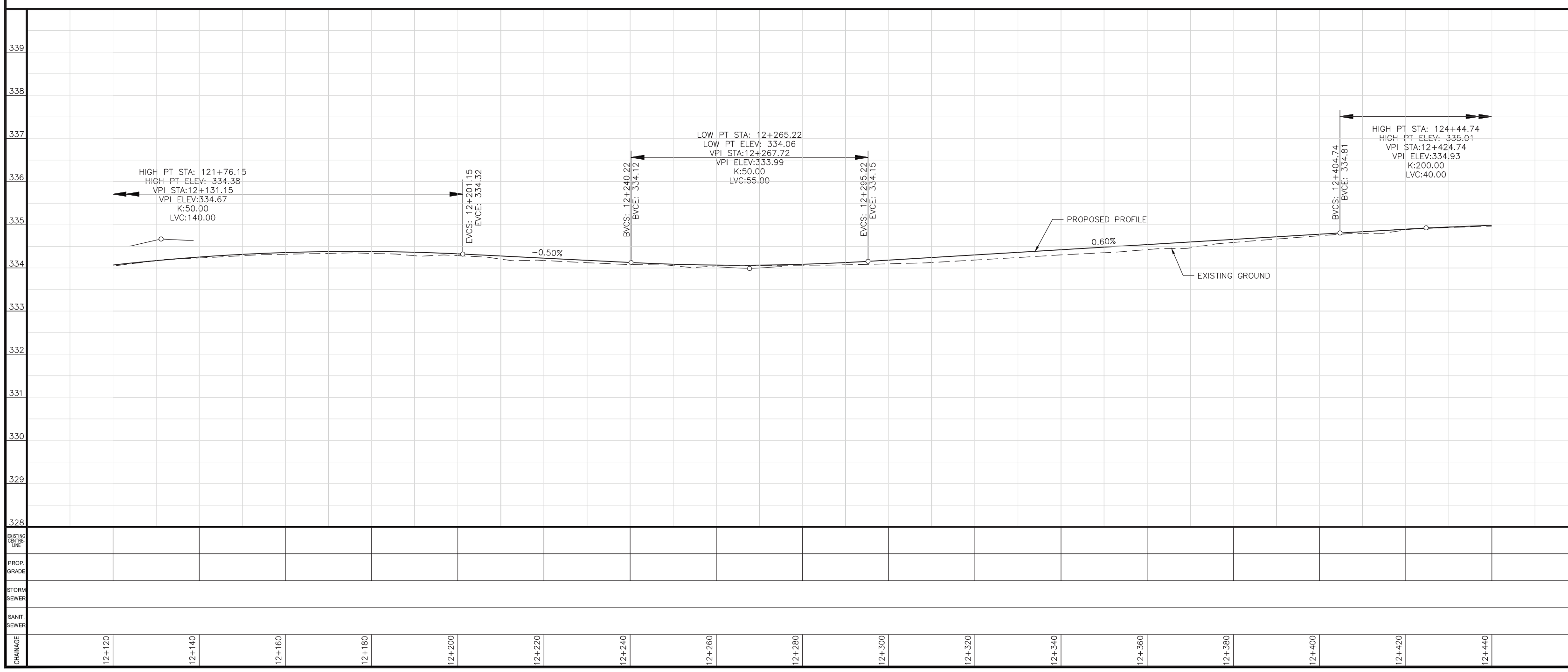


KEY PLAN Scale : NOT TO SCALE



LEGEND

- EXISTING RIGHT OF WAY
- PROPOSED RIGHT OF WAY WIDENING
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK



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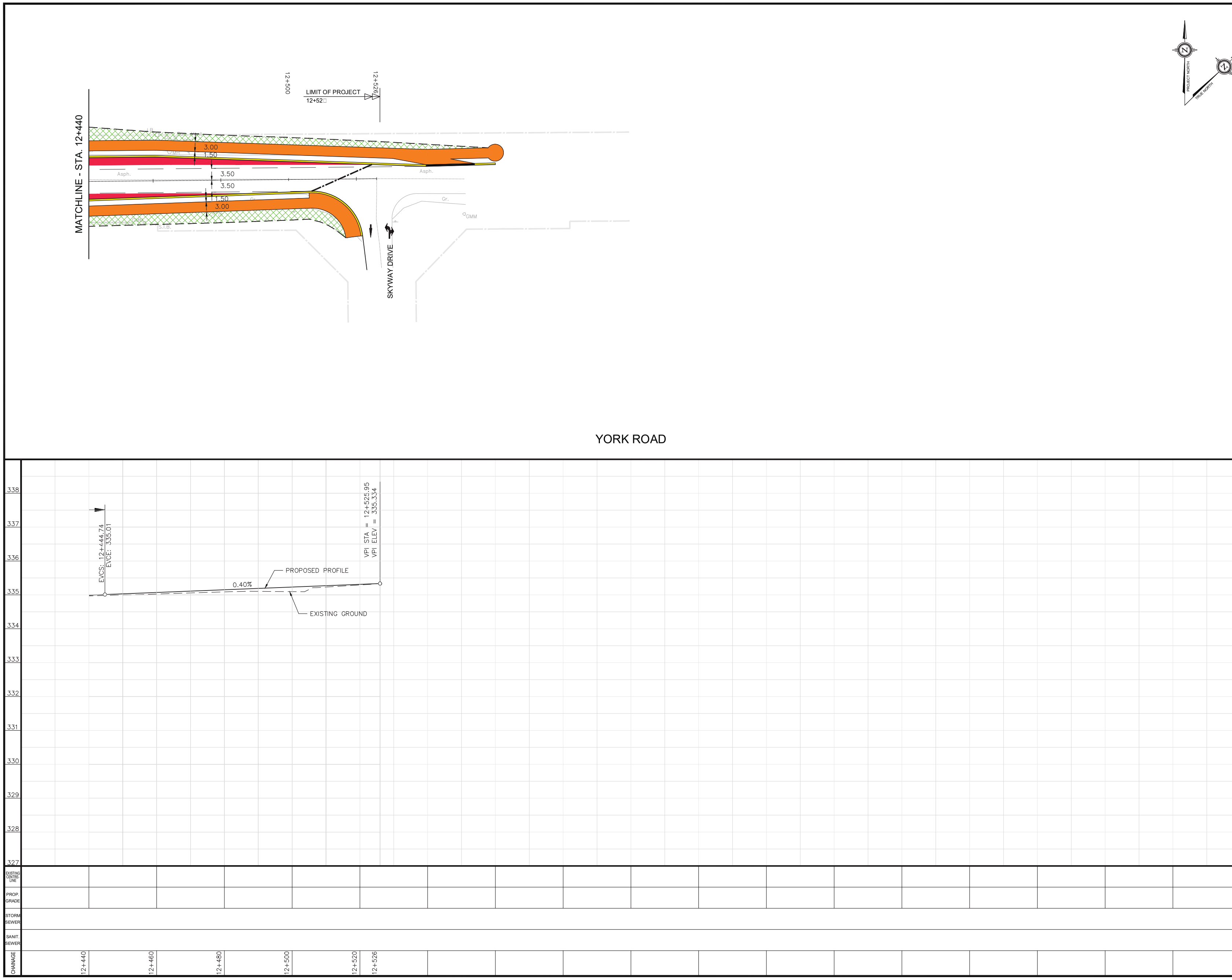
YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2018-04-02
	DRAWN BY: D.K. CHECKED BY: M.E.K.
STORM SEWER	CONSULTANT DRAWING No. OPTION 4
SANITARY SEWER	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 8 OF 9 REV.



SHEET No.

KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING RIGHT OF WAY
- PROPOSED RIGHT OF WAY WIDENING
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI-USE PATH
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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

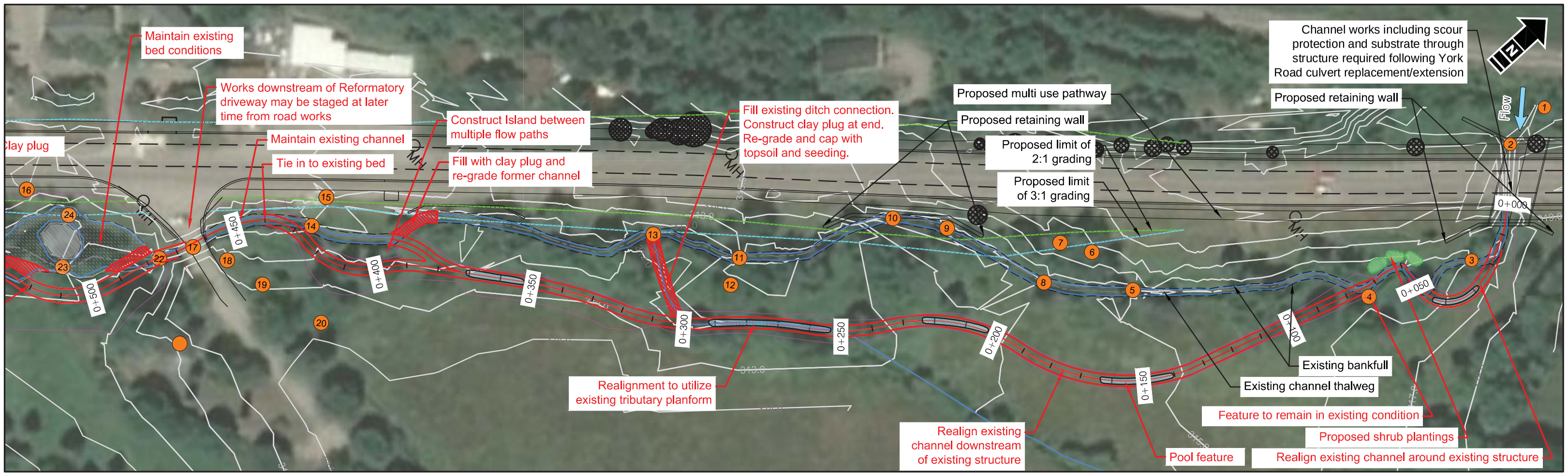
ENGINEERING SERVICES

amec foster wheeler

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2018-04-02
	DRAWN BY: D.K. CHECKED BY: M.E.K.
STORM SEWER	CONSULTANT DRAWING No. OPTION 4
SANITARY SEWER	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 9 OF 9 REV.

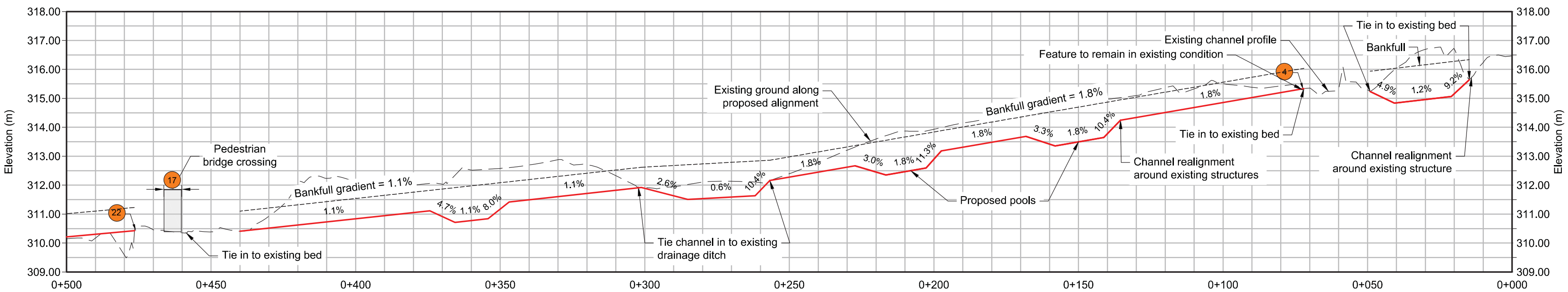
Appendix B: Stream Morphology



Legend	
	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
	Proposed shrubs and plantings
	Cultural heritage feature/structure
	Maintain existing bed
	Proposed pool
	Approximate grading limit

Notes:

1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
03	03 08 2017	Revised based on client comments	JH	JP	ED
02	01 17 2017	Revised based on client comments	JH	JP	ED
01	12 09 2016	Revised based on client comments	JH	JP	ED
00	09 15 2016	Draft for client review	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

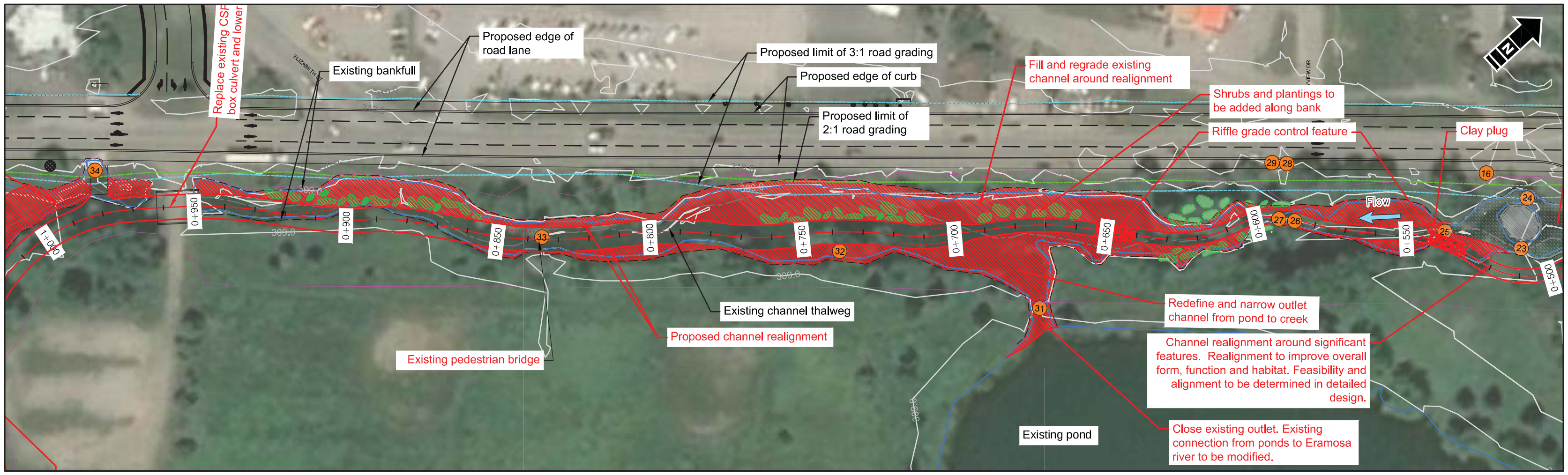
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 0+000-0+500m

Date: 11 22 2017 | Project: 22257 York Road | Technical: J. Henshaw | Reviewer: J. Parish | Drawn: E. Drost

Figure 04

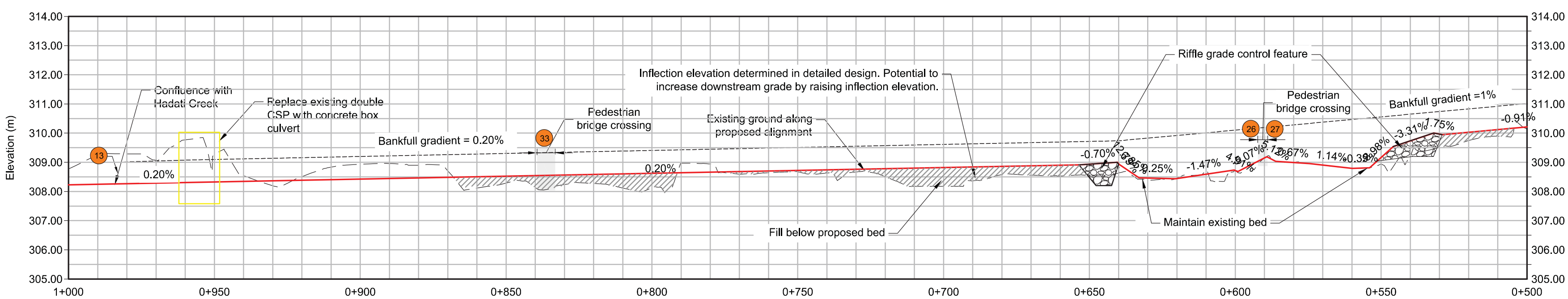


Legend

	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
	Proposed shrubs and plantings
	Cultural heritage feature/structure
	Maintain existing bed
	Proposed pool
	Approximate grading limit

Notes:

1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile

Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
03	03 08 2017	Revised based on client comments	JH	JP	ED
02	01 17 2017	Revised based on client comments	JH	JP	ED
01	12 09 2016	Revised based on client comments	JH	JP	ED
00	09 15 2016	Draft for client review	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 0+500-1+000m

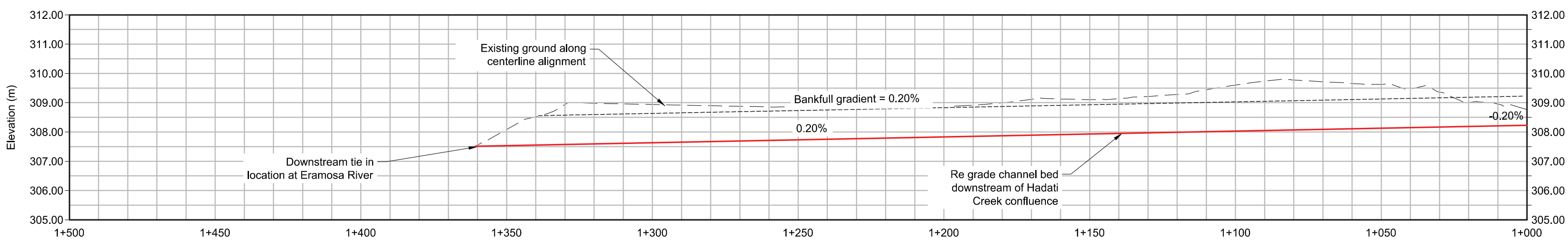
Date: 11 22 2017 | Project: 22257 York Road | Technical: J. Henshaw | Reviewer: J. Parish | Drawn: E. Drost

Figure 05

Legend	
	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
2	Cultural heritage feature/structure
	Approximate grading limit

Notes:

1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
03	03 08 2017	Revised based on client comments	JH	JP	ED
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01	12 09 2016	Revised based on client comments	JH	JP	ED
00	09 15 2016	Draft for client review	JH	JP	ED

REVISION

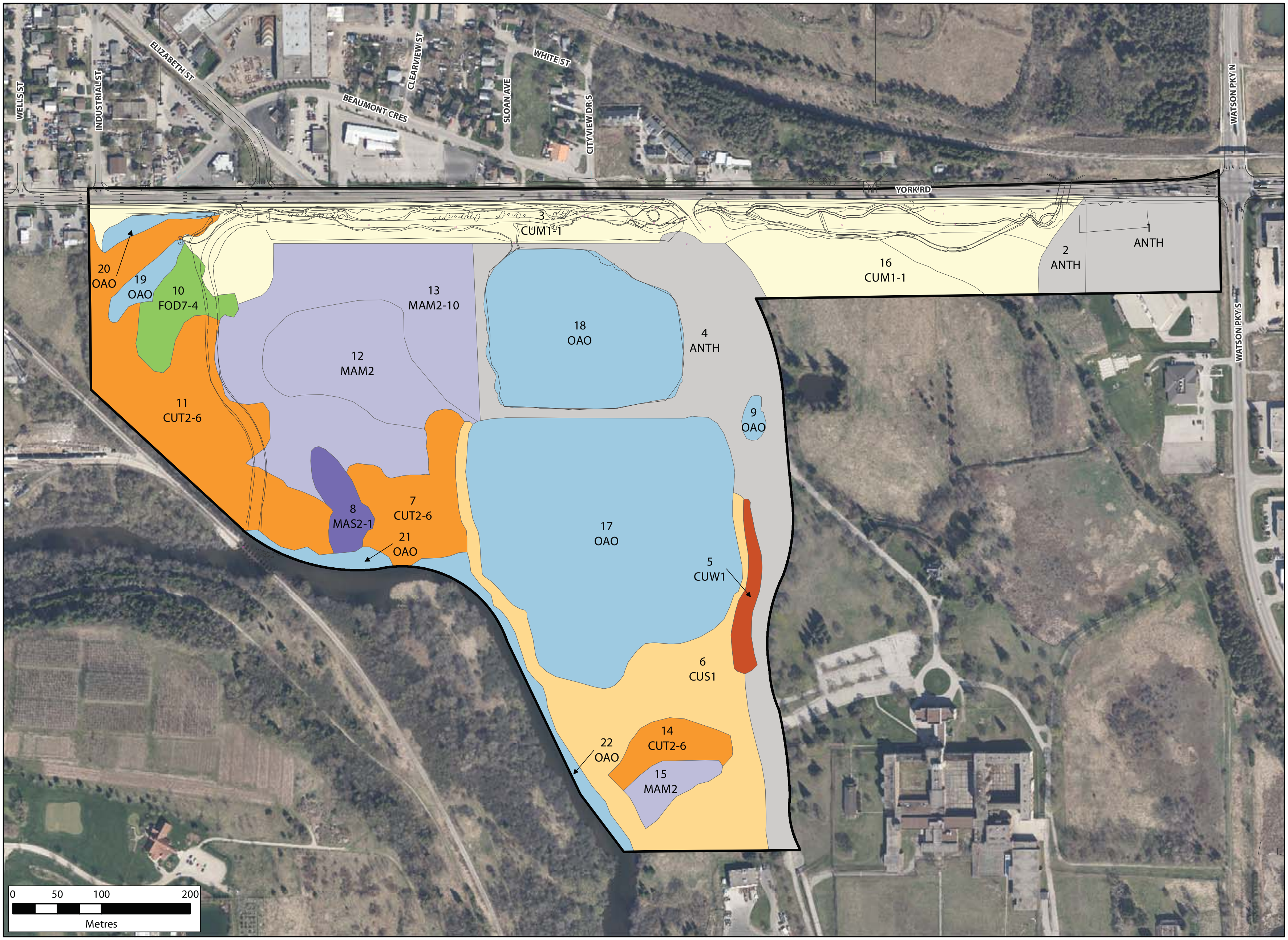
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 1+000-1+500m

Date:	Project:	Technical:	Reviewer:	Drawn:	Figure
11 22 2017	22257 York Road	J. Henshaw	J. Parish	E. Drost	06

Appendix C: Terrestrial



Legend

- Creek & Road Alignment Option 2 (Matrix & AMECFW, received Nov. 23, 2017)
- D&A Study Area

Vegetation Communities

- Anthropogenic
- Cultural Meadow
- Cultural Savannah
- Cultural Thicket
- Cultural Woodland
- Deciduous Forest
- Meadow Marsh
- Shallow Marsh
- Open Aquatic

2016 Orthoimagery provided by City of Guelph

York Rd Environmental Design Study, Road Alternatives Assessment Memo

Road / Creek Alignment Option 2 & Vegetation Communities

DOUGAN & ASSOCIATES
ECOLOGICAL CONSULTING & DESIGN

PROJECT: DA15-061-01

CLIENT: City of Guelph

UTM Zone 17 NAD83

DATE: DECEMBER 4, 2017

SCALE: 1:4,000

DRAWN BY: L. Carter

CHECKED BY: K. Beauchamp

Figure: 2

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.

Appendix C-1: Potential Key Sensitivities and their Location

Key Sensitivity	Description	Location (ELC polygons found on Figure 1and 2)	Option 2 Potential Impacts		
			Direct	Indirect	Induced
Sensitive ELC communities	Cattail Mineral Shallow Marsh (MAS2-1) with MAM2-2 incl.	Found in ELC Polygon 8	-	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-
	Fresh-Moist Lowland Deciduous Forest Type (FOD7-4)	Found in ELC Polygon 10	Expected; proposed creek alignment transects polygon	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-
	Forb Mineral Meadow Marsh (MAM2-10)	Found in ELC Polygon 13	Potential; proposed creek alignment directly adjacent to polygon	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-
	Mineral Meadow Marsh (MAM2)	Found in ELC Polygon 12	-	Potential; Changes to soil permeability, water balance, drainage patterns, run off, and soil stability; modification to vegetation communities; modification to arboricultural resources; construction disturbance of wildlife; import/export of fill; and encroachment of natural areas; indirect pollution.	-
Regionally Important Vegetation *City of Guelph (City of Guelph, 2012) & Wellington County (Frank and Anderson 2009)*	Downy Serviceberry (*Amelanchier arborea*) – rare	Found in ELC Polygon 5	-	-	-
	Red Fescue (*Festuca rubra ssp. rubra*) – rare	Found in ELC Polygon 13	Potential; proposed creek alignment directly adjacent to polygon species was observed in	Potential; Removal of significant species and their habitat.	-
	Rough Aven's (*Geum laciniatum*) – rare and significant	Found in ELC Polygon 3 and 11	Expected (both polygons); proposed creek alignment transects polygon where species was observed	Potential; Removal of significant species and their habitat.	-
	Hairy Solomon's Seal (*Polygonatum pubescens*) – rare	Found in ELC Polygon 8 and 13	Potential (polygon 13); proposed creek alignment directly adjacent to polygon species was observed in	Potential; Removal of significant species and their habitat.	-
	Variegated Horsetail (*Equisetum variegatum*) – significant	Found in ELC Polygon 13	Potential; creek alignment directly adjacent to polygon species was observed in	Potential; Removal of significant species and their habitat.	-
	Many-headed Sedge (*Carex synchnocephala*) - significant	Found in ELC Polygon 12	-	Potential; Removal of significant species and their habitat.	-
Other significant vegetation	Prairie Willow (*Salix humilis*) (Frank and Anderson 2009)	Found in ELC Polygon 8	-	-	-
Species at Risk (SAR)	Chimney Swift (*Chaetura pelagica*) – Threatened (federal and provincial)	Observed foraging over ELC polygons 17 and 18. No breeding habitat present within the Study Area.	-	Potential; construction disturbance of wildlife	-
	Barn Swallow (*Hirundo rustica)* – Threatened (federal and provincial)	Observed foraging over ELC polygons 12, 13, and 16. No breeding habitat present within the Study Area.	-	Potential; construction disturbance of wildlife	-

Appendix C-1: Potential Key Sensitivities and their Location

Key Sensitivity	Description	Location (ELC polygons found on Figure 1and 2)	Option 2 Potential Impacts		
			Direct	Indirect	Induced
	Eastern Meadowlark (*Sturnella magna*) – Threatened (federal and provincial)	Observed foraging south of polygon 16 but could be found foraging in any grass, agricultural, or open community including ELC polygons 3 and 16. No breeding habitat present within the Study Area.	-	Potential; construction disturbance of wildlife	-
	Monarch (*Danaus plexippus*)– Special Concern (federal and provincial)	Observed in ELC Polygon 6; could potentially be found breeding wherever host plant, Common Milkweed (*Asclepias syriaca*), is located (ELC polygons 6, 8, 11, and 17)	-	Potential; construction disturbance of wildlife	-
	Snapping Turtle (*Chelydra serpentina*)	Observed in the small pond located northeast of the Study Area, on the other side of the correctional facility's driveway. Could potentially overwinter in large ponds (ELC polygons 17 and 18) and in the Eramosa River (ELC polygons 21 and 22). No nesting habitat found in the Study Area.	-	Potential; construction disturbance of wildlife	-
Area Sensitive Birds	Savannah Sparrow (*Passerculus sandwichensis*)	It was observed in ELC polygon 7 and is probably breeding within the Study Area. They inhabit meadows, pastures, grassy roadsides, sedge wetlands, and agricultural fields including ELC polygons 3, 5, 6, 11, 14, and 16.	Potential; species may breed in polygon 3 and 16 which contain the proposed creek alignment	Potential; construction disturbance of wildlife	-
	Eastern Meadowlark (*Sturnella magna*)	Observed foraging south of polygon 16 but could be found foraging in any grass, agricultural, or open community including ELC polygons 3, and 16. No breeding habitat present within the Study Area.	-	Potential; construction disturbance of wildlife	-
Potentially Breeding Locally Sensitive Birds	Belted Kingfisher (*Megaceryle alcyon)*	A pair was observed along the Eramosa River and are probably breeding within the Study Area. They prefer wetlands and open water (ELC polygons 17, 18, 19, 20, 21, and 22)	-	Potential; construction disturbance of wildlife	-
	Northern Flicker (*Colaptes auratus*)	Probably breeding within the Study Area in open woods (ELC polygons 6, 7, 10, 11, 14)	Potential; species may breed in polygon 10 and 11 which contain the proposed creek alignment	Potential; construction disturbance of wildlife	-
	Eastern Kingbird (*Tyrannus tyrannus*)	Three pairs were probably breeding within the Study Area. They inhabit meadows, pastures, grassy roadsides, sedge wetlands, and agricultural fields including ELC polygons 3, 12, 13, and 16.	Potential; species may breed in polygon 3 and 16 which are transected by the proposed creek alignment as well as polygon 13 which is directly adjacent to the proposed creek alignment.	Potential; construction disturbance of wildlife	-
	Savannah Sparrow (*Passerculus sandwichensis*)	Two pairs were observed in ELC polygon 7 and is probably breeding within the Study Area. They inhabit meadows, pastures, grassy roadsides, sedge wetlands, and agricultural fields including ELC polygons 3, 5, 6, 11, 14, and 16.	Potential; species may breed in polygon 3, 10, 11, and 16 which are transected by the proposed creek alignment	Potential; construction disturbance of wildlife	-
	Baltimore Oriole (*Icterus galbula*)	Probably breeding within the Study Area in open woods (ELC polygons 6, 7, 10, 11, 14).	Potential; may breed in polygon 10 and 11 which are transected by the proposed creek alignment	Potential; construction disturbance of wildlife	-
	Willow Flycatcher (*Empidonax traillii*)	Probably breeding within the Study Area in Shrubs/early successional communities (ELC polygon 6, 7, 11, and 14).	Potential; may breed in polygon 11 which are transected by the proposed creek alignment	Potential; construction disturbance of wildlife	-

Appendix C-1: Potential Key Sensitivities and their Location

Key Sensitivity	Description	Location *(ELC polygons found on Figure 1and 2)*	Option 2 Potential Impacts		
			Direct	Indirect	Induced
Candidate Significant Wildlife Habitat (SWH)	Seasonal concentration of Animals: Turtles Wintering Area	The two large ponds in the Study Area (ELC polygons 17 and 18) and the Eramosa River (ELC polygon 21 and 22) may contain Turtle over-wintering habitat for Painted Turtle and Snapping turtles.	-	Potential; construction disturbance of wildlife and indirect pollution	-
	Specialized Habitat for Wildlife: Turtle Nesting Area	Potential nesting areas occur along the Eramosa River (ELC polygon 21 and 22) and in open areas with sand and gravel. No suitable habitat was observed along Clythe Creek.	-	-	-
	Habitats for Species of Conservation Concern (not including Endangered and Threatened Species): Special Concern and Rare Wildlife Species	Both Snapping turtle and Monarch were found within the Study Area. Snapping turtles may use ELC polygons 17, 18, 21, and 22 but are not likely to be nesting within the Study Area. Monarch could potentially breed in ELC polygons 6, 8, 11, and 17.	-	Potential; construction disturbance of wildlife and indirect pollution	-
	Animal Movement Corridors: Amphibian Movement Corridor	Small numbers of amphibians were detected in the two main ponds in 2016 (ELC polygon 17 and 18); amphibian movement would not be to the north as no habitat exists in that direction. Eramosa River, immediately to the south, likely serves as an amphibian movement corridor (ELC polygon 21 and 22).	-	Potential; construction disturbance of wildlife and indirect pollution	-

Appendix C-2: Excerpt of Section 4.2 Potential Impacts

Draft Environmental Impact Study (EIS) York Road Environmental Design (March 2017)

4.2 Potential Impacts

The preferred alternative has considered and taken into account the environmental sensitivities of the study area. Notwithstanding, there are environmental impacts could result from the implementation of the preferred alternative. As such, all disciplines have assessed the potential for environmental impacts, and have generated mitigation measures to reduce or eliminate these potential impacts.

Impacts can be defined as the consequences that result from an activity or site alteration and can be either positive, neutral, or negative. Impacts can be divided into three categories as defined by the City of Guelph's Guidelines for the Preparation of Environmental Impact Studies (2014).

> **Direct Impact:** Impacts that specifically result from the proposed development layout and/or construction activities. These impacts can be mitigated through modification of site plans and managing construction practices.
> **Indirect Impact:** Impacts that may be caused by altered uses and activities after construction is completed.
> **Induced Impact:** These impacts are a subset of indirect impacts and are the consequences of the changes in human behaviours resulting from the new development.

Direct, indirect, and induced impacts have been considered along with potential avoidance measures. The time period of any identified impacts (i.e. short-term vs. long-term) has also been taken into consideration.

4.2.1 Changes to Permeability

Soil permeability is the measure of how well a fluid passes through it. A soil with high permeability such as sand, allows for faster and greater infiltration than a soil with low permeability such as clay. Changes in the soil permeability will be a one-time occurrence (i.e., during construction). All effort to use in situ soils for creek and road works should be made. It is understood that compaction of the soils within the proposed road widening would occur, that said beyond the road area the area for machinery access should be minimized to reduce soil compaction.

4.2.2 Changes to Water Balance

Water balance analysis allows the quantification of different components of a hydrologic cycle. Water balance analysis is an integral part of the decision support or policy evaluation process at the strategic or functional planning stages of the project. Water balance models are decision support and scenario management tools for promoting rainwater management and stream health protection. Changes in the water balance will be a one-time occurrence (i.e., during construction). Wetland communities have the greatest sensitivity to changes in water balance. The communities along the existing watercourse are likely to be impacted directly but can be compensated for along the relocated watercourse. Wetland vegetation can be salvaged during the construction process to help expedite the naturalization process of the new creek alignment. Wildlife that relies on the impacted wetland communities will be temporarily indirectly negatively impacted during the construction and planting phases. There are no expected induced impacts.

As previously discussed the potential for groundwater discharge exists along the Clythe Creek reaches within the study area. The potential exists due to the permeable nature and thickness of the overburden and the existence of a bedrock channel within the larger scale hydrogeologic setting. This setting is prevalent within the study area including the proposed realigned reach. As such it is expected there would be no significant change to the groundwater discharge potential.

4.2.3 Potential Alteration of Drainage Patterns

Grading activities are often required to accommodate the relocation of the creek and may also alter the way water flows on the study area. Proposed site development will result in an alteration of drainage pattern of the existing study area. Changes in the grading will be a one-time occurrence (i.e., during construction) and will result in a permanent alteration of drainage patterns. The proposed changes are not likely to change the drainage pattern to the catchment but local changes to permeability could directly negatively impact wetlands by modifying the amount of water they retain as well as the duration of the hydroperiod. Wetland communities along the existing watercourse are going to be impacted but can be mitigated though compensating wetland area along the proposed watercourse. Wildlife that relies on the impacted wetland communities will be temporarily indirectly negatively impacted during the construction and planting phases. There are no expected induced impacts.

It is understood that sections of Clythe Creek upstream of the former Reformatory will not be receiving external contributing flow due to the proposed partial creek realignment. Under less frequent storm events, commencing at the 5 year storm, flow would overtop the proposed low flow channel and enter the existing low flow channel. In addition local drainage from York Road will drain to the existing low flow channel via proposed storm sewer outlets. Additional detail on the storm sewer outlets will be provided in the detailed stormwater management reporting.

Drainage patterns would also change from removing the connection from the Royal Jaycees Park north pond to Clythe Creek. The south pond is currently connected to the north pond and the Eramosa River, as such there would be additional flow contribution directly to the Eramosa River from both ponds. Assessment of the thermal benefits to Clythe Creek and potential impacts to the Eramosa River are beyond the scope of this EIS.

4.2.4 Potential Increases in Runoff

The addition of two (2) road lanes each 3.5 m in width will increase the runoff from York Road to Clythe Creek. The proposed two (2) multi-use paths each 3 m wide will not have a considerable impact to runoff as it proposed to use permeable pavement (apart from driveway areas). To offset the increase in runoff from York Road, it is proposed to use infiltration cells along the corridor, capable of storing approximately the 25 mm storm event, sized for the additional road paved area. The infiltration of 25 mm would mean no increase in runoff volume from the additional paved road areas for up to 90% of local storm events. Additional detail will be provided in the stormwater management reporting.

4.2.5 Potential Changes in Water Quality and Temperature

Stormwater water quality will be provided in a treatment train approach, using bio-filtering (when space allows), oil/grit separators and infiltration trenches. The recommended infiltration stormwater trenches would also act as cooling trenches for any flow that is not infiltrated from the paved area of York Road. The water temperature of Clythe Creek should also benefit from the removal of the north pond connection to the creek.

4.2.6 Potential Changes in Channel Erosion and Stability

The preferred alternative channel alignment eliminates contact with the majority of instream cultural heritage features. As a result, backwatering and local increases in channel velocity and scour associated with the features will not be a controlling aspect of channel morphology. The preferred alternative channel alignment will improve the functionality of Clythe Creek in terms of downstream sediment transport and flow connection. In addition proposed channel geometries have been developed to remain stable up to the anticipated 2-year return period flow with the overall goal of improving channel stability.

4.2.7 Potential Changes in Fish Passage

Clythe Creek has been extensively altered through the study area and contains several barriers to upstream fish migration. The existing barriers only allow downstream fish movement, thus creating a series of semi-isolated reaches. Barriers such as these are considered detrimental, as they prevent fish from undertaking movements such as spawning migrations or seasonal movements to locations with more favourable temperatures. Such movements allow fish to make optimal use of the available habitats. Removing such barriers, as recommended in the Grand River Fisheries Management Plan (Ontario Ministry of Natural Resources and Grand River Conservation Authority, 1998), is therefore considered to be positive.

4.2.8 Potential Changes in Fish Habitat

There do not appear to be any critical habitats present within the study area, such as spawning areas for fish from the Eramosa River, where modification would have a negative impact that would extend beyond the modification footprint. The elimination of several barriers to upstream migration, can be expected to provide benefits that extend throughout and beyond the study area by allowing fish to move freely between habitats, thus making use of seasonally optimal conditions and avoiding seasonally incompatible conditions, such as high summer water temperatures.

The series of small ponds that has been created along Clythe Creek downstream from the entrance to the York District lands differs from the stream habitat that would originally have been present. The decreased water velocity and large surface area probably results in increased summer water temperatures and the submergent aquatic vegetation may cause low night-time dissolved oxygen concentrations during the summer. These ponds provide habitat for tolerant fish species and restoring Clythe Creek to a more natural channel configuration would reduce the amount of that habitat present. The proposed channel realignment is a return to conditions that would naturally occur in a stream of this nature, as recommended in the Grand River Fisheries Management Plan (Ontario Ministry of Natural Resources and Grand River Conservation Authority, 1998).

The proposed plan does result in a reduction in the length of the small tributary that enters Clythe Creek upstream from the York District Lands entrance (Feature #13). Currently, however, this watercourse is only contiguous, in a fish utilization sense, with the short reach of Clythe Creek that is between the barriers to fish movement identified as Features #11 and #14. Elimination of the migration barriers would make this watercourse contiguous with a much longer reach of Hadati

Creek. It should be noted that no fish were captured when 117 m of this tributary were electrofished in 2009 (Table 2.6.1).

4.2.9 Modification of Vegetation Communities

The modification of existing vegetation communities to accommodate the relocation of the creek and widening of York Road. Vegetation Removal will be a one-time occurrence (i.e. during construction) and will result in permanent shift in vegetation community composition (ref. Figure 3.6.1). The proposed development will directly impact vegetation communities by removing a total of 3.41 ha of vegetation communities from the study area (Table 4.2.1). The majority of the removed vegetation occurs in cultural communities. There will be removals of some Forest communities and some marsh communities. Planting along the proposed creeks of equal or greater area will replace natural cover removed.

Table 4.2.1 Vegetation Removal Areas

ELC Code	Vegetation Community Name	Total Area (ha)	Area to be Impacted (ha)	Area to be Impacted (%)
Cultural Communities				
CUM1-1	Dry-Moist Old Field Meadow	2.39	0.13	5.4
CUT2-6	Buckthorn Cultural Thicket Type	3.69	0.33	8.9
CUM1-1/MAM2-10	Dry-Moist Old Field Meadow Type/Forb Mineral Meadow Marsh Type Complex	4.94	2.86	57.9
ANTH	Anthropogenic	2.05	0.19	9.3
Natural Communities				
FOD7-4	Fresh-Moist Lowland Willow Deciduous Forest Type	0.71	0.07	9.9
MAM2-10	Forb Mineral Meadow Marsh Type	4.35	0.06	1.4
OAO	Open Aquatic	12.10	0	0

Wildlife that relies on the impacted vegetation communities will be temporarily indirectly negatively impacted during the construction and planting phases. There are no expected induced impacts. Restoration along the proposed creek alignment, implementing vegetation salvages can compensate for the removed communities. Salvaging vegetation can advance the rehabilitation of vegetation communities, making them accessible to wildlife sooner.

4.2.10 Modification of Arboricultural Resources

Modification of arboricultural resources includes the proposed removal and/or potential injury of trees to accommodate the creek realignment. The location and extent of arboricultural resources were considered during site plan development with the intent to avoid impacts wherever feasible. The arborist study completed in 2016 did not survey the extent of the proposed creek realignment and a supplemental survey is proposed for the remaining portion of the modification footprint and will be included in the Vegetation Compensation Plan (Figure 3.6.2). Tree removal is to be a one-time event during construction. The loss will be temporary as new plantings are proposed to replace trees being removed.

The proposed actions summarized in Section 4.1 will apply to accommodate the site alterations. The realignment along York Road will require 115 trees removed and may injure an additional 79 trees (ref. Table 4.2.2); refer to Section 3.6.3 for details. Additional trees may be injured or removed pending the results of the remaining arborist assessment.

Table 4.2.2 Tree Impact Summary

Proposed Action	Total (No. of Trees)
Preserve	20
Injure	79
Remove	115
Replacement Requirement (1:1)	**194**

The permanent removal of trees will result in a loss of canopy habitat. The removed trees will be compensated at a ratio of 1:1 or greater depending on size to comply with City of Guelph polices. Within the surveyed section of the modification footprint, 194 trees are required to replace the trees proposed for removal or injury. An additional arborist assessment will determine the remaining replacement requirements. If replacement planting is not achievable on the subject land, a cash in lieu amount of $500.00 per tree destroyed or injured is to be paid as a substitute. Given time to grow, the canopy will increase in size and will consist of more native species. No induced impacts are expected. A Vegetation Compensation Plan and Tree Protection Plan are required as a part of Guelph Tree By-law (2010).

4.2.11 Construction Disturbance of Wildlife

Construction activities often result in a number of direct impacts to wildlife inhabiting the study area, including but not limited to: increased noise, light pollution, and vibrations which may result in avoidance behaviors of local wildlife. Clearing and grading operations may disturb wildlife and interfere with nesting birds if conducted during breeding season. Impacts are possible from the commencement of construction activities, and could range between 6 months to a year. Construction activities are a single occurrence activity. Clearing and grading activities could directly negatively impact birds by interfering with nesting. There is specific concern for Eastern Meadowlark which was recorded on the adjacent property. Avoidance behaviour of wildlife may occur for a short period after construction activities have ceased. Minor increases in noise and light pollution may also deter area sensitive species, (ref. Section 4.2.16 for more details). No induced impacts are expected. Impacts prior to mitigation measures are negative and of moderate significance. Construction activities including, but not limited to, clearing and grading activities should occur outside of the breeding season (April 15th and July 31st) to avoid impacts to nesting of significant species. Impacts after mitigation measures are neutral, and of moderate significance as impacts are temporary and can be avoided by timing activities outside of breeding season. It is possible to avoid or reduce the magnitude of the disturbance if clearing, grading, and/or general construction works take place outside the breeding bird season. In Guelph the breeding bird season corresponds roughly to the period of April 15th and July 31st.

4.2.12 Decreased Soil Stability

Decreased soil stability is caused by clearing of vegetation and grading activities as it breaks up soil layers, reduces compaction, and increases bare soil which is more susceptible to erosion and/or sedimentation leading to loss of soil. Impacts are possible from the commencement of construction activities and could range between 6 months to a year. Construction activities are a single occurrence activity and soil stability will be restored upon revegetation of the site. Construction activities are a single occurrence short term activity. Soil stability will be restored upon revegetation of the site, therefore impacts are temporary. Decreased soil stability can cause more erosion and sedimentation resulting in reduced vegetation vigor and decreased water quality and fish habitat. By adhering to Greater Golden Horseshoe Area Conservation Authorities (GGHACA) 2006 Erosion and Sedimentation Control Guidelines for Urban Construction, little soil erosion and sedimentation should occur, minimizing the indirect impacts. If guidelines are not adhered to, prolonged reduction in plant vigor and fish habitat quality may occur. There are no expected induced impacts.

Impacts prior to mitigation and compensation measures are negative and of moderate significance due to:

- Minimal magnitude relative to area disturbed;
- Duration is temporary; and
- The frequency is a single occurrence event.

Soil destabilization is reversible through revegetation following construction using temporary seed mix/annual nurse crop grass species within limits of disturbance. Adjacent natural feature should be protected from sedimentation through the use of siltation fencing outlined in GGHACA's Erosion and Sedimentation Control Guidelines for Urban Construction (2006).

The proposed site alterations were developed to require minimal grading, but some grading is still required to accommodate site activities. It is not possible to avoid soil disturbance in order to grub out the root systems of trees and other vegetation to accommodate construction. Sedimentation in the adjacent natural areas can be avoided through use of siltation fencing erected around disturbance zone in conformance with GGHACA 2006 Erosion and Sedimentation Control Guidelines for Urban Construction. Soil destabilization is reversible through revegetation following construction.

Impacts after mitigation and compensation measures are neutral, as negative impacts can be avoided through the use of GGHACA 2006 Erosion and Sedimentation Control Guidelines for Urban Construction, and soil destabilization can be reversed through revegetation.

4.2.13 Import/Export of Fill

Imported fill will be of divergent origin and character to that of existing soils and may affect stability and/or permeability functions. However, as the imported material will be used primarily as a base for the road widening and the overall magnitude will be commensurate to that caused by the construction of new roads, and proposed creek. Importation of topsoil may bring in weed seed from non-native invasive species. Once imported, the duration of the fill placement is considered permanent. This is a single occurrence event. Some top soil may be imported to amend landscaping areas. It is not likely that this presents a significant source of non-native invasive seeds. Introduction of non-native invasive seeds may lower the quality of vegetation communities by out competing native species for resources, reducing the biodiversity of the study area, and the resiliency of the plant communities. The plant communities are all cultural in nature and many non-native invasive species are already present, therefore the impacts are likely insignificant. No induced impacts are expected.

Impacts prior to mitigation measures are negative and of low significance due to sensitivity of target is low and the extent is limited and the effect of the impact is permanent. Careful stockpiling and amendment of existing topsoil may allow avoidance of importing additional topsoil. If importing soil is unavoidable, top soil should be sourced in a manner that has the least potential for containing invasive exotic seeds. Granular fill is required to construct stable foundation for proposed roads and is therefore unavoidable. Once imported and placed it is not possible to reverse this impact while maintaining the proposed roads. Impacts after mitigation measures are neutral.

4.2.14 Removal of Open Country Bird Habitat

A pair of Eastern Meadowlark was recorded during the 2016 breeding bird survey on the property adjacent to the east of the study area (south of polygon 16 on Figure 3.6.1), south of Clythe Creek and east of the driveway to the correctional institute. The proposed work will be confined to the creek corridor and, as such, will not negatively impact these fields, therefore, there are no direct impacts expected. The pair may be indirectly impacted by the noise and other indirect pollution created during the construction period. No induced impacts are expected. Indirect impacts can be avoided by limiting construction activities to outside of the breeding season (April 15th to July 31st).

4.2.15 Encroachment of Natural Areas

Encroachment is the induced impact caused by human occupation or use of land adjacent to natural areas and the associated buffers. Encroachment activities following establishment of buffers could affect the long term success of NHS features and functions if encroachment is severe or excessive. Construction activities will result in avoidance behaviour of many wildlife species, see Section 4.2.11 for details. Noise and light pollution is likely limited to the lands immediately adjacent to York Road, see Section 4.2.16 for further details. Impacts would likely occur post construction and are potentially long term and iterative. Increased encroachment to the natural areas is not expected to increase significantly and would only incurred by the increased traffic on York Rd. Very little to no induced impacts are expected as the land use is not changing from parkland.

4.2.16 Indirect Pollution

Pollution from the creek realignment and road widening include noise, light, and chemicals. Wildlife tend to respond through behavior modifications such as avoidance. Introduction of chemicals into the environment leads to reduced fecundity of aquatic and terrestrial wildlife and flora. Dust can cause avoidance behavior from wildlife and reduce the success of flora along roadsides. Potential effects of indirect pollution on wildlife include:

- Reduced habitat quality;
- Potential loss of habitat due to quality reduction;
- Reduced population densities (particularly breeding birds);
- Reduced species diversity;

- Increased susceptibility to predation;
- Negative physiological effect; and
- Alteration of reproductive behavior (particularly herpetofauna).

Impacts would likely occur post-construction and are potentially long-term and iterative. Construction activities will likely result in noise, light, and chemical pollution which may cause avoidance behaviours in many wildlife species, see Section 4.2.11 for details.

Based on available information and the existing park lands surrounding the natural features, lighting is not expected to change and, therefore, is expected to have a negligible effect on wildlife habitat use or bird migration. Wildlife species that are crepuscular (active during dawn and dusk) or nocturnal may avoid suitable habitat located near roadways due to light pollution. The study area is likely to be occupied mostly during daylight hours, reducing the amount of noise and light pollution during key times for crepuscular species.

Contaminants from York Rd are not likely to change dramatically but may increase slightly due to increased road use. Contaminants can directly impact vegetation community, resulting in increased abundance of salt tolerant weedy species. It can indirectly impact wildlife by modifying the habitat adjacent to the road. The impacts are not expected to be significant as the communities adjacent to the roadways are cultural. No induced impacts are expected.

4.2.17 Removal of Species at Risk

The Endangered Species Act (2007) (O. Reg. 242/08) protects flora and fauna that is Threatened, Endangered or Special Concern at the provincial level. Significant habitats of provincially Endangered and Threatened species are specifically protected from development in the PPS, and habitats of provincial Special Concern species are recognized under the Province's Significant Wildlife Habitat categories.

Three Species at Risk birds were recorded including Chimney Swift – Threatened (federal and provincial); Barn Swallow – Threatened (federal and provincial); and Eastern Meadowlark – Threatened (federal and provincial). Chimney Swift and Barn Swallow are not suspected to be nesting in the study area as there is no suitable habitat present. Barn Swallows are known to be nesting in the vicinity and four birds were seen foraging over the baseball fields on the west side of the study area and in the open field on the east side of the study area. Eastern Meadowlark was recorded in the field east of the study area (south of polygon 16 on Figure 3.6.1), south of Clythe Creek and east of the driveway to the correctional institute. The proposed work will be confined to the creek corridor and, as such, will not negatively impact these fields.

A Snapping Turtle – Special Concern (federal and provincial) – was observed in the pond. Although turtles are likely nesting in the general vicinity, such as along the Eramosa River to the south, there were no significant areas of potential nesting habitat along Clythe Creek and York Road. The two main ponds likely represent overwintering habitat for all three turtle species.

Downy Serviceberry, Red Fescue, Rough Aven's, and Hairy Solomon's Seal were found in the study area and are considered rare in Wellington County (Appendix H-3). Rough Aven's were recorded near the watercourse in polygon 3 as well as in polygon 11 and will likely be removed when the creek is relocated. Red Fescue and Hairy Solomn's Seal were recorded in the Meadow Marsh (polygon 13) and may be impacted by the footprint of the proposed watercourse.

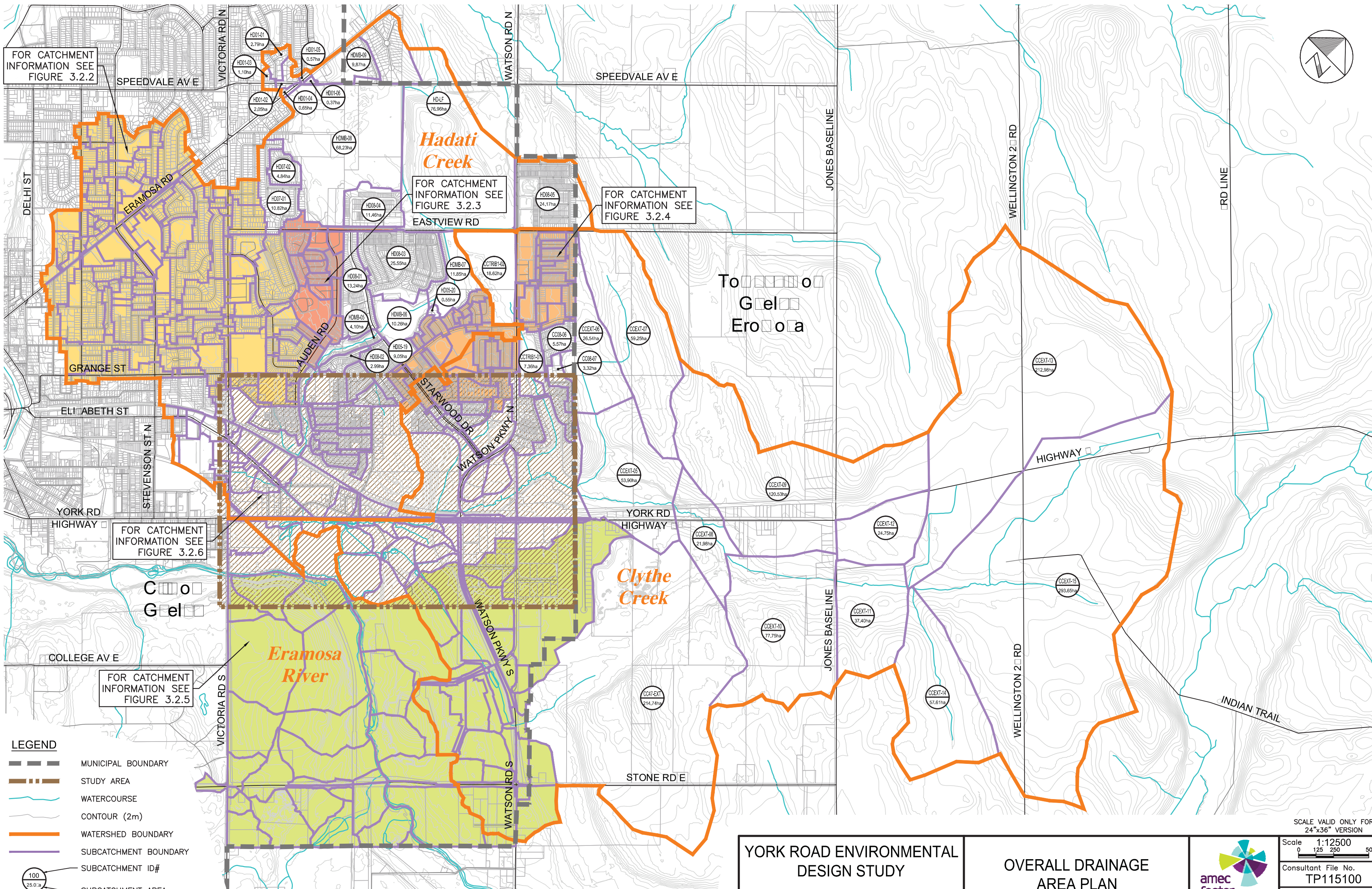
Construction activities could result in avoidance behaviours of Eastern Meadowlark in the field adjacent to the study area and Snapping Turtles in the pond. During the 2016 wildlife surveys, there was no evidence of snapping turtles nesting along the existing watercourse, or anywhere else within the study area. It is likely that they are nesting offsite. As stated in section 4.2.11, construction should occur outside of the breeding window to mitigate any impacts to breeding birds. No induced impacts are expected.

Although there is open country bird habitat, no habitat is to be removed as a part of the road widening and creek relocation. Three locally rare species may be impacted. Locally rare plants found within the creek modification footprint could be salvaged and relocated on site outside of the footprint prior to construction.

Appendix C-3: EIS Terrestrial Habitat Mitigative and Protective Measures

- Sediment and Erosion Control measures including silt fencing;
- Works should be confined to creek and associated riparian habitat and specifically outside of the open fields which is Eastern Meadowlark habitat and foraging habitat for and Chipping Sparrow;
- Vegetation removal to occur outside of breeding bird window: of April 15th and July 31st; if vegetation removal is to occur in this window, a qualified avian ecologist needs to sweep for nests;
- Replace trees at a 3:1 or greater ratio or cash in lieu amount of $500.00 per tree destroyed or injured;
-
- Development and implementation of a Vegetation Compensation Plan and a Tree Protection Plan;
- No removal of Common Milkweed; if it must be removed, replace it elsewhere on site;
- Construction of areas of sand and gravel for turtles to nest away from roadway;
- Construction of turtle basking sites in/near ponds;
- Installation of permanent wildlife exclusionary fence between road and ponds;
- Construction of nesting boxes and platforms for species such as Wood Duck and Osprey;
- Construction of snake hibernacula;
- Bio-salvage of wetland plants along Clythe Creek;
- Transplanting regionally rare and significant plants;
- Planting native flower patches with Common Milkweed; and
- Invasive species control.

Appendix D:
Drainage and Stormwater Management



YORK ROAD ENVIRONMENTAL DESIGN STUDY

CITY OF GUELPH

OVERALL DRAINAGE AREA PLAN

amec foster wheeler

Scale 1:12500

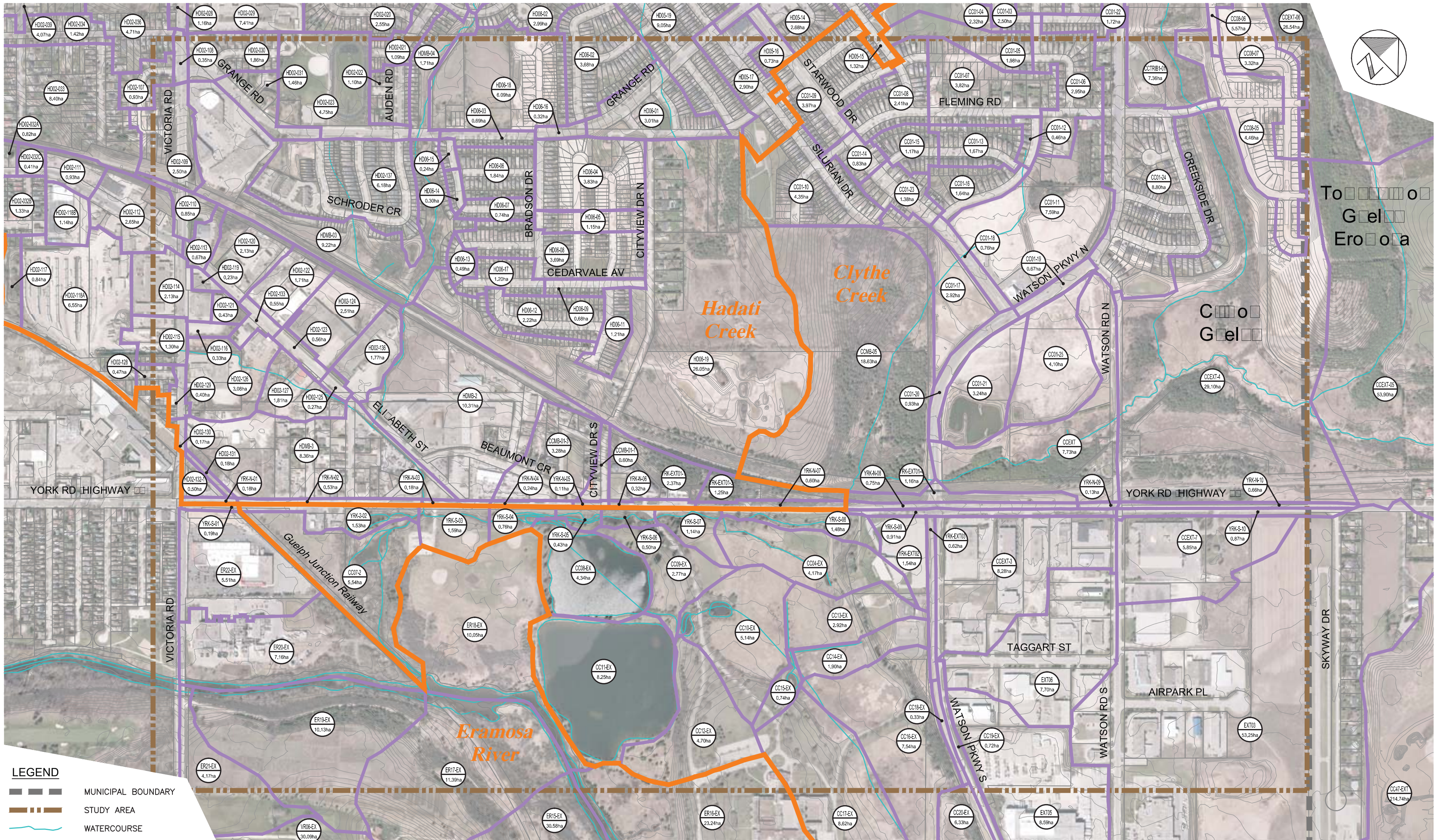
Consultant File No. TP115100

Figure No. 3.2.1

Plotted: 2017-03-09 Plotted By: richard.bortolo

Last Saved: 2017-03-08 Last Saved By: richard.bortolo

Path: P:\Work\TP115100\water\dwg\2016-11\Fig1 OverallDrainage(Ex).dwg



Path: P:\Work\TP115100\water\dwg\2016-11\Fig2 StudyAreaDrainage(Ex).dwg

Plotted By: richard.bortolo
Last Saved By: richard.bortolo
Plotted: 2017-03-09
Last Saved: 2017-03-09

YORK ROAD ENVIRONMENTAL DESIGN STUDY

CITY OF GUELPH

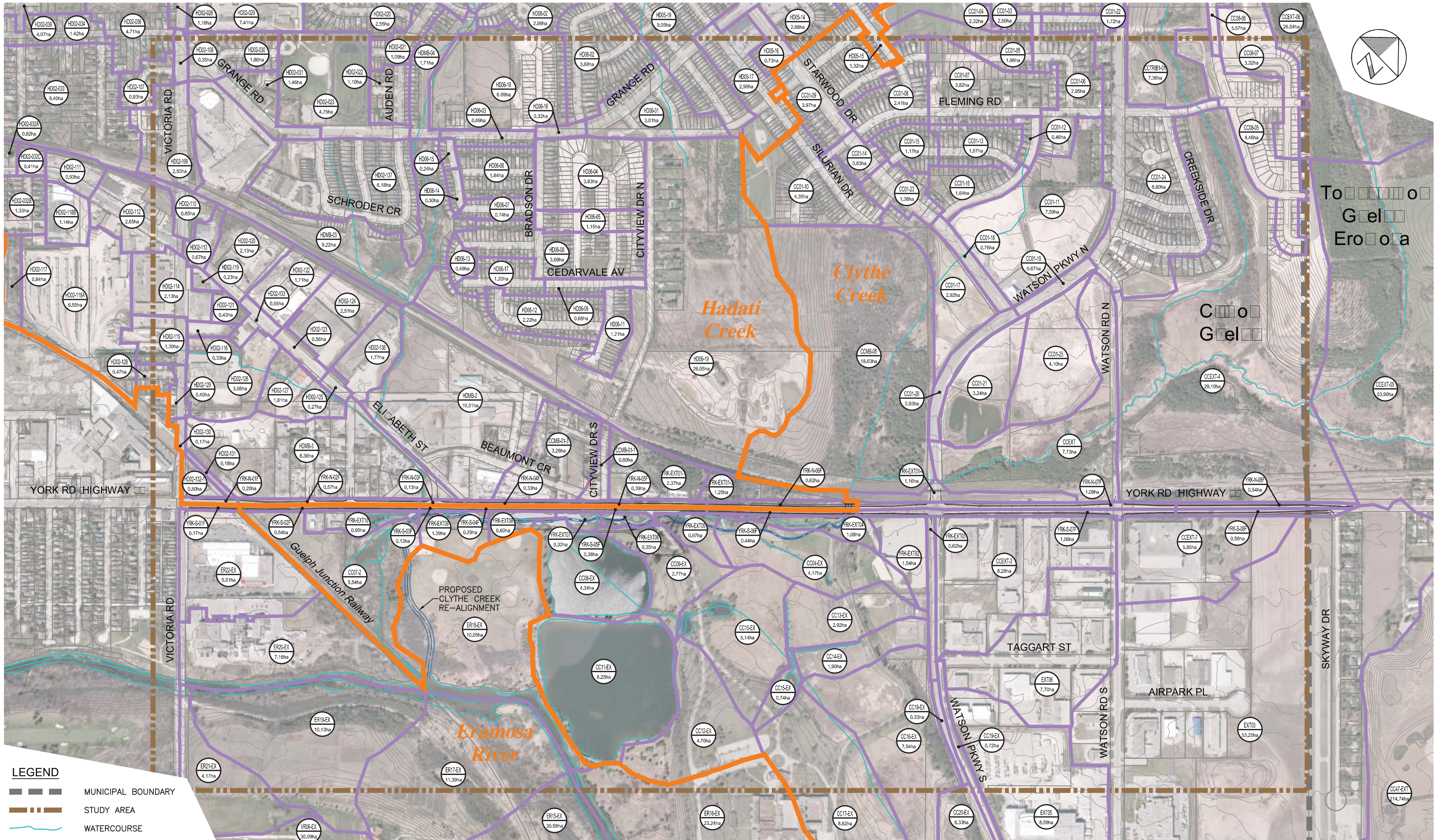
STUDY AREA DRAINAGE PLAN (EXISTING CONDITIONS)

amec foster wheeler

Scale 1:4000

Consultant File No. TP115100

Figure No. 3.2.6



LEGEND

- MUNICIPAL BOUNDARY
- STUDY AREA
- WATERCOURSE
- CONTOUR (1m)
- WATERSHED BOUNDARY
- SUBCATCHMENT BOUNDARY
- 100 — SUBCATCHMENT ID#
- 25.0 ha — SUBCATCHMENT AREA

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:4000 (0 50 100 200)

YORK ROAD ENVIRONMENTAL DESIGN STUDY

CITY OF GUELPH

STUDY AREA DRAINAGE PLAN (FUTURE CONDITIONS)

amec foster wheeler

Consultant File No. TP115100

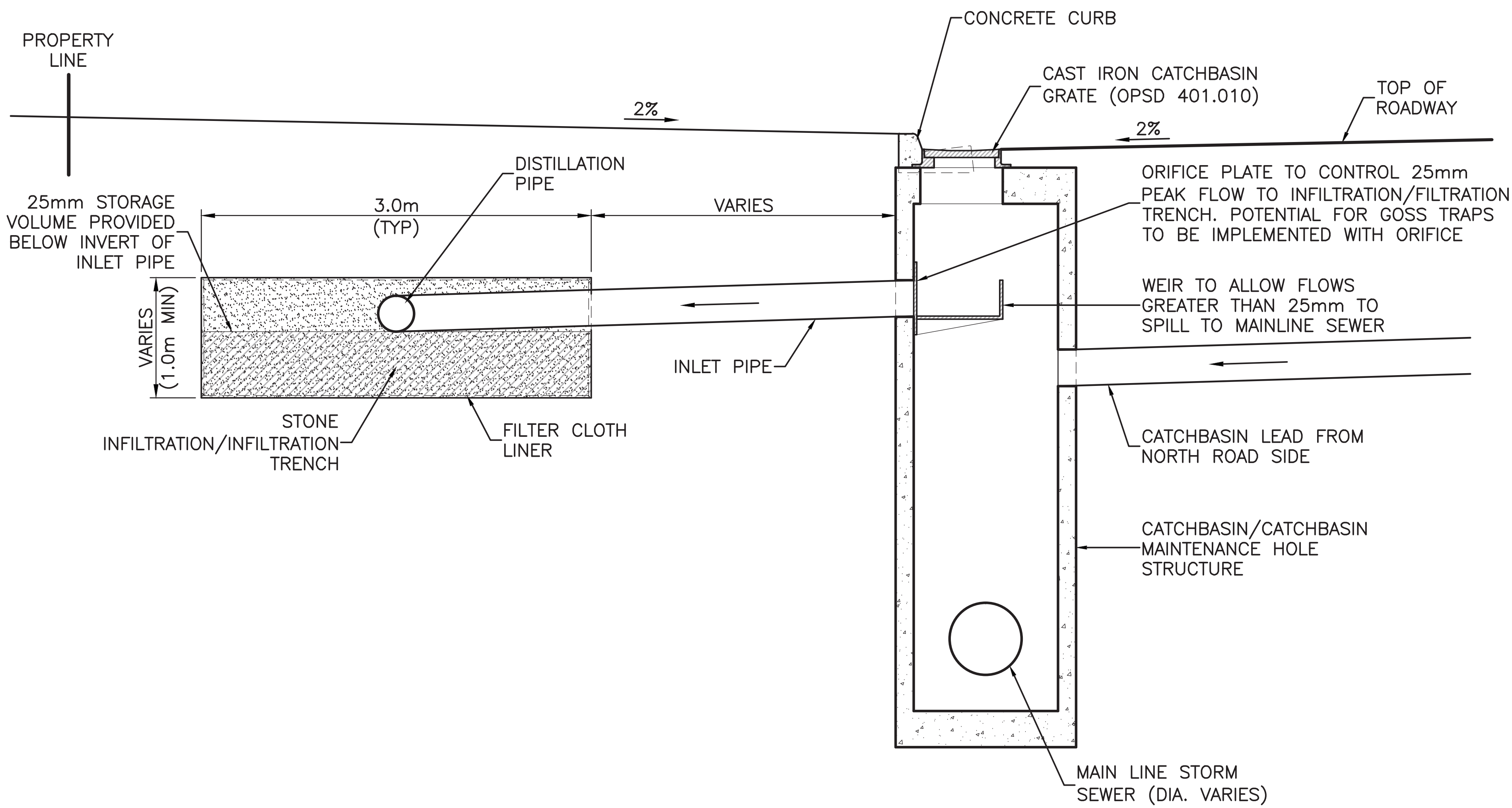
Figure No. 4.1.11

Path: P:\Work\TP115100\water\dwg\2016-11\Fig3 StudyAreaDrainage(Pro).dwg

Plotted By: richard.bortolo Last Saved By: richard.bortolo

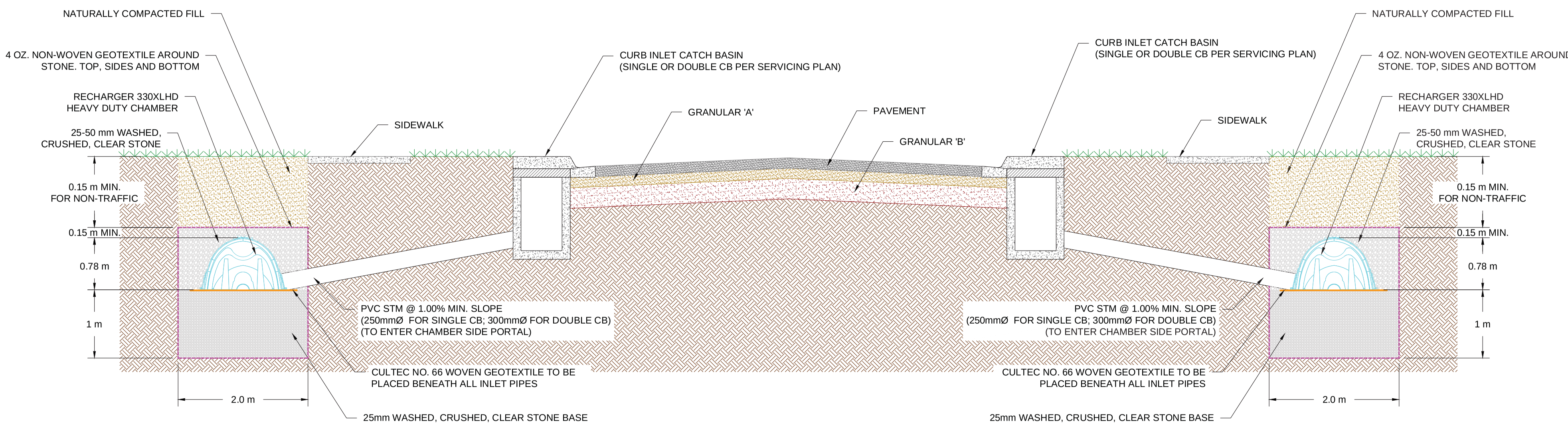
Plotted: 2017-03-10 Last Saved: 2017-03-10

Plotted: 2017-12-18 Plotted By: richard.bartolo
Last Saved: 2017-12-18 Last Saved By: richard.bartolo Path: P:\Work\TP115100\water\dwg\2017 12 Infiltration System\Fig Tanks.dwg



NOTE:
1. IMPERMEABLE LINER MAY BE REQUIRED DUE TO GROUND WATER LEVELS. LINER IS NOT REQUIRED WHERE GROUNDWATER >=1.0m BELOW UNDERSIDE OF TANK.

YORK ROAD EIS ADDENDUM CITY OF GUELPH	INFILTRATION/FILTRATION TRENCH CONFIGURATION	amec foster wheeler	Scale 1:50 Consultant File No. TP115100 Figure No.



CULTEC, Inc.
Subsurface Stormwater Management Systems
P.O. Box 280
878 Federal Road
Brookfield, CT 06804
www.cultec.com
PH: (203) 775-4416
PH: (800) 4-CULTEC
FX: (203) 775-1462
tech@cultec.com

GeoStorm Inc.
122 Creditstone Road
Vaughan, Ontario
L4K 1P2

CULTEC RECHARGER 330XLHD
TRAFFIC APPLICATION
CROSS SECTION DETAIL

CULTEC RECHARGER® 330XLHD			
PROJECT NO:	-	DATE:	12/4/15
DESIGNED BY:	DPG	DRAWN BY:	JC
SCALE:	N.T.S.	SHEET NO:	1 OF 1

CULTEC Contactor® 100HD Stormwater Chamber

The Contactor® 100HD is a 12.5" (318 mm) tall, low profile chamber and is typically used for installations with depth restrictions or when a larger infiltrative area is required. The Contactor 100HD has the side portal internal manifold feature. The HVLV® SFCx2 Feed Connector is inserted into the side portal of the Contactor 100HD to create the internal manifold.

Size (L x W x H)	8' x 36" x 12.5" 2.44 m x 914 mm x 318 mm
Installed Length	7.5' 2.29 m
Length Adjustment per Run	0.5' 0.15 m
Chamber Storage	1.87 ft^3/ft 0.17 m^3/m 14.00 ft^3/unit 0.40 m^3/unit
Min. Installed Storage	3.84 ft^3/ft 0.36 m^3/m 28.81 ft^3/unit 0.82 m^3/unit
Min. Area Required	25 ft^2 2.32 m^2
Min. Center to Center Spacing	3.33' 1.02 m
Max. Allowable Cover	12' 3.66 m
Max. Inlet Opening in End Wall	10" 250 mm
Max. Allowable O.D. in Side Portal	6.9" 175 mm
Compatible Feed Connector	HVLV SFCx2 Feed Connector

Contactor® 100HD Bare Chamber Storage Volumes

Elevation		Incremental Storage Volume				Cumulative Storage	
in.	mm	ft^3/ft	m^3/m	ft^3	m^3	ft^3	m^3
12	305	0.009	0.001	0.068	0.002	13.995	0.396
11	279	0.067	0.006	0.503	0.014	13.928	0.394
10	254	0.110	0.010	0.825	0.023	13.425	0.380
9	229	0.139	0.013	1.043	0.030	12.600	0.357
8	203	0.159	0.015	1.193	0.034	11.558	0.327
7	178	0.174	0.016	1.305	0.037	10.365	0.294
6	152	0.184	0.017	1.380	0.039	9.060	0.257
5	127	0.192	0.018	1.440	0.041	7.680	0.217
4	102	0.203	0.019	1.523	0.043	6.240	0.177
3	76	0.203	0.019	1.523	0.043	4.718	0.134
2	51	0.203	0.019	1.523	0.043	3.195	0.090
1	25	0.223	0.021	1.673	0.047	1.673	0.047
Total		**1.866**	**0.173**	**13.995**	**0.396**	**13.995**	**0.396**

Calculations are based on installed chamber length.

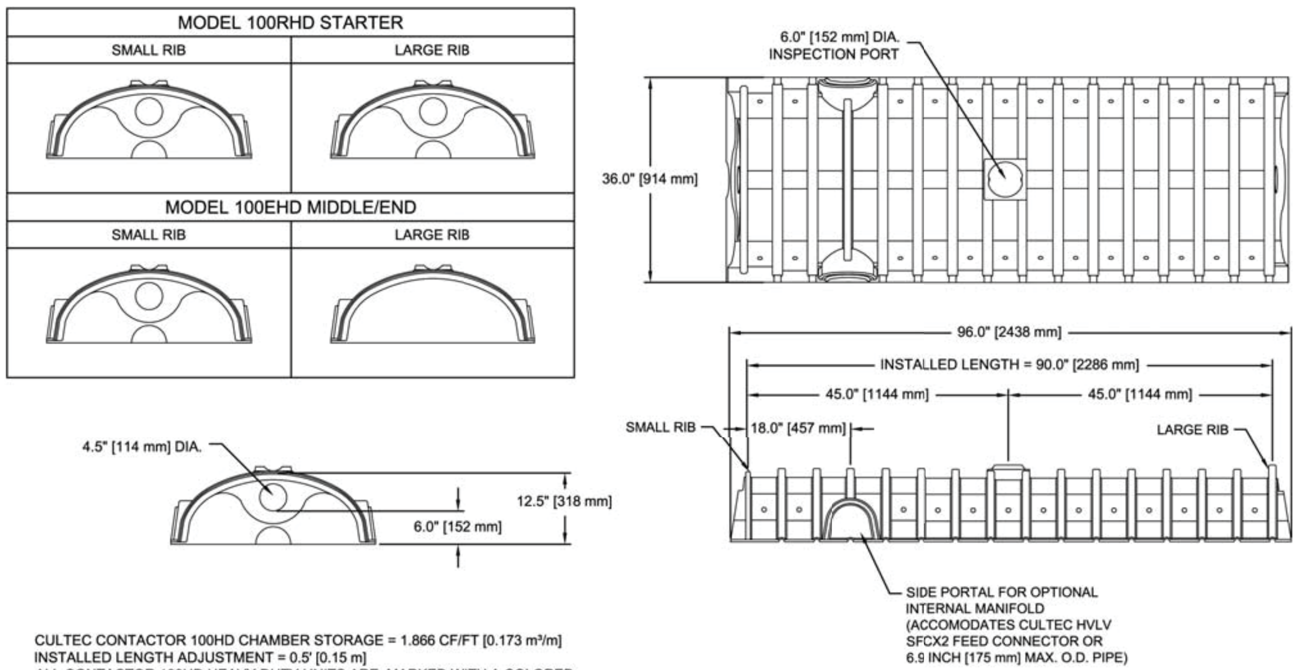
Visit www.cultec.com/downloads.html for Product Downloads and CAD details.

	Stone Foundation Depth		
	6" 152 mm	12" 305 mm	18" 457 mm
Chamber and Stone Storage Per Chamber	28.81 ft^3 0.82 m^3	33.81 ft^3 0.96 m^3	38.81 ft^3 1.10 m^3
Min. Effective Depth	2.04' 0.62 m	2.54' 0.77 m	3.04' 0.93 m
Stone Required Per Chamber	1.37 yd^3 1.05 m^3	1.84 yd^3 1.40 m^3	2.30 yd^3 1.76 m^3

Calculations are based on installed chamber length.
Includes 6" (152 mm) stone above crown of chamber and typical stone surround.
Stone void calculated at 40%.

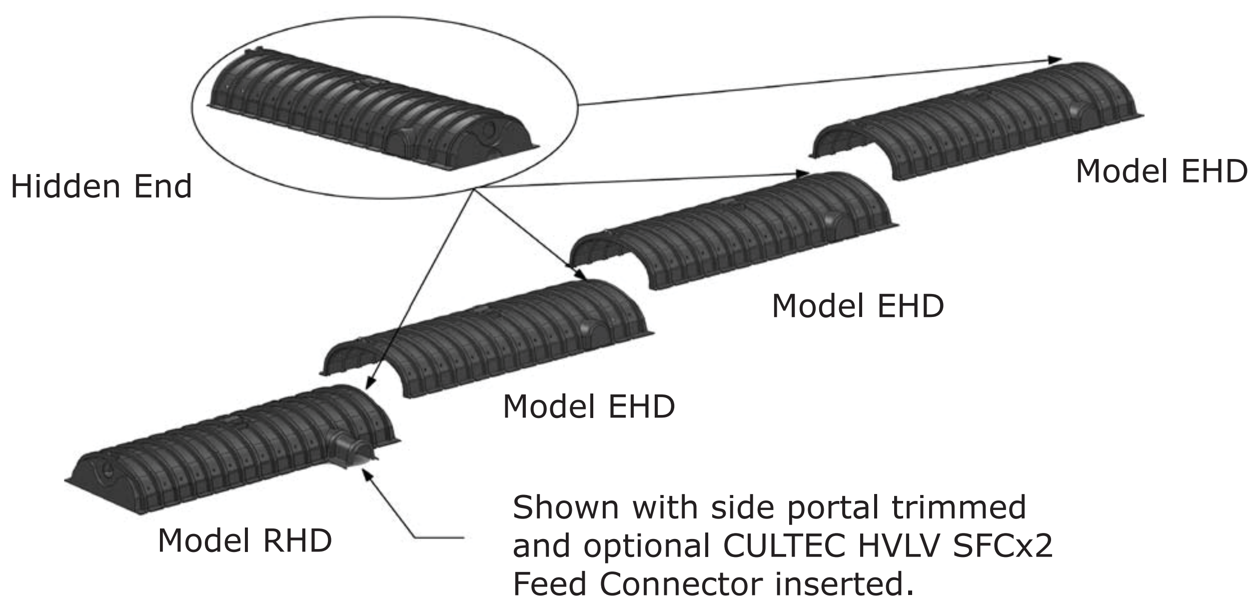
For more information, contact CULTEC at (203) 775-4416 or visit www.cultec.com.

Three View Drawing

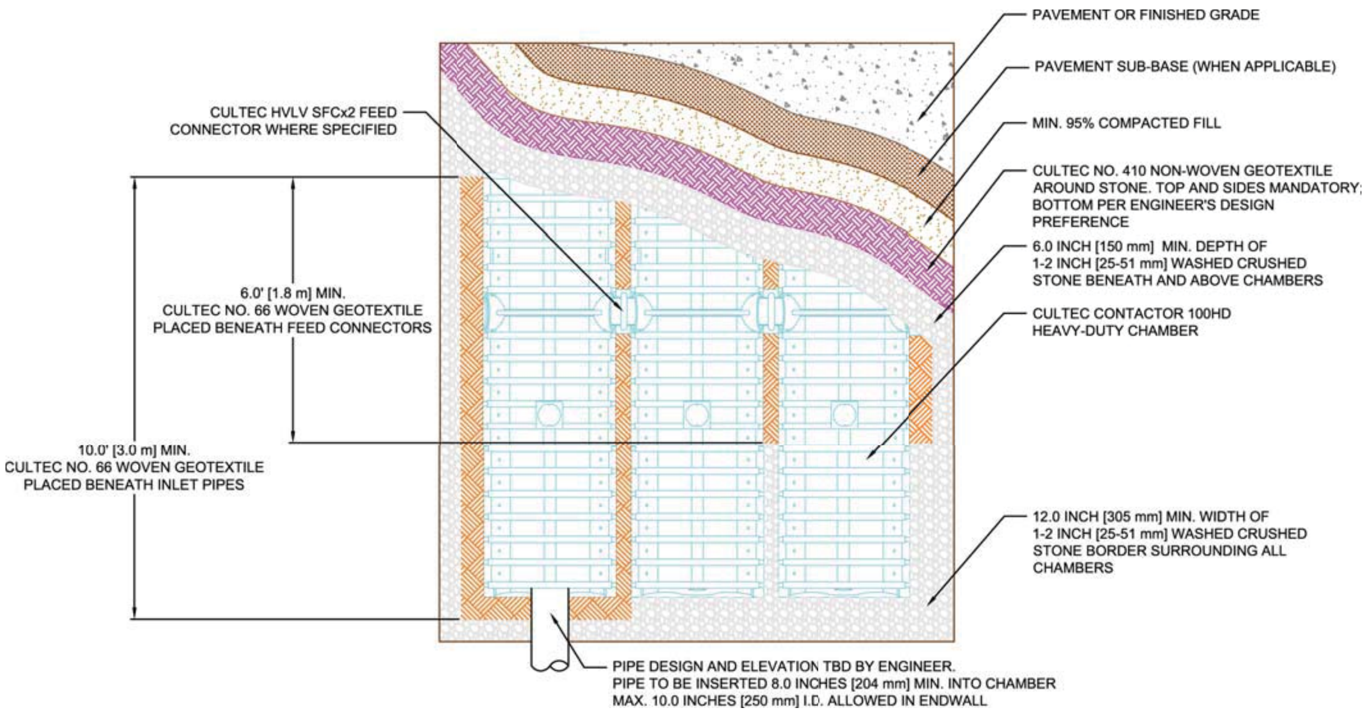


CULTEC CONTACTOR 100HD CHAMBER STORAGE = 1.866 CF/FT [0.173 m³/m]
INSTALLED LENGTH ADJUSTMENT = 0.5' [0.15 m]
ALL CONTACTOR 100HD HEAVY DUTY UNITS ARE MARKED WITH A COLORED STRIPE FORMED INTO THE PART ALONG THE LENGTH OF THE CHAMBER.

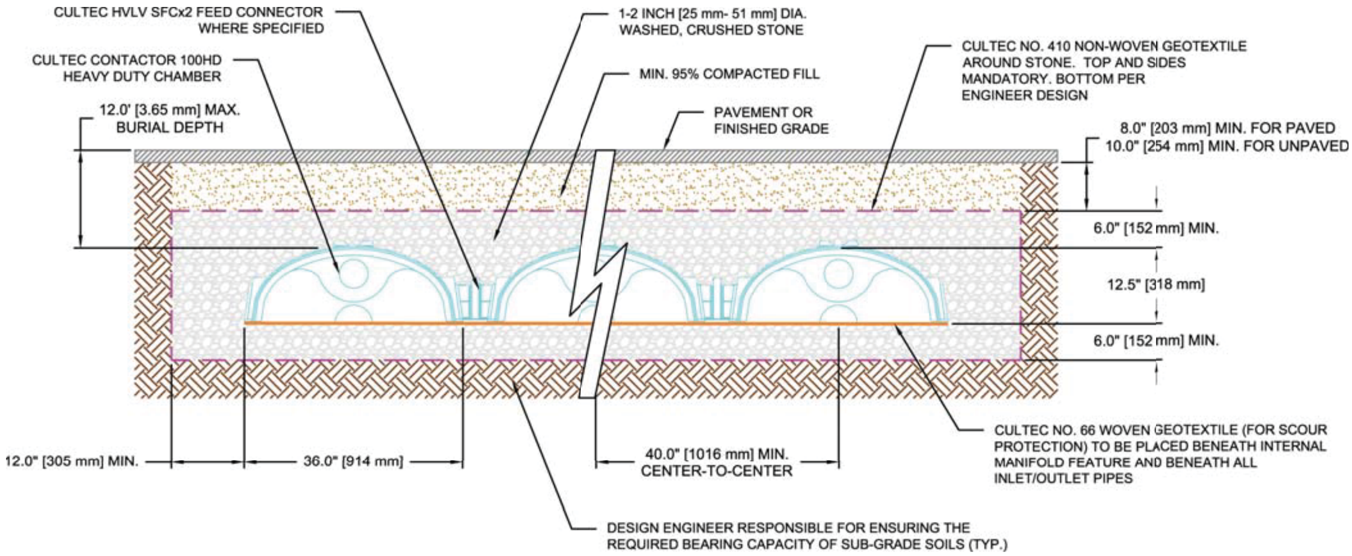
Typical Interlock Installation



Plan View Drawing



Typical Cross Section for Traffic Application



CULTEC Contactor® 100HD Specifications

GENERAL

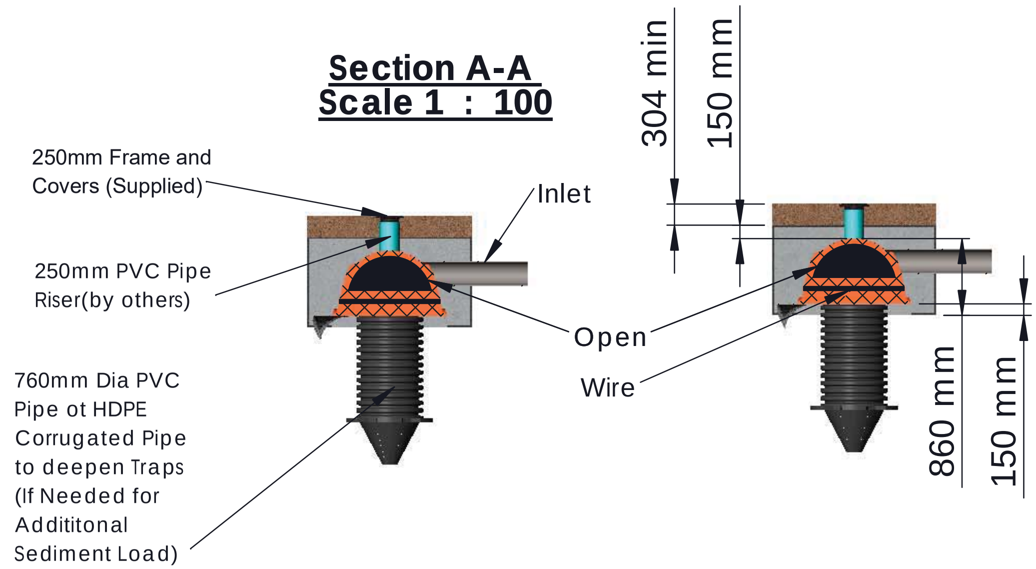
CULTEC Contactor® 100HD chambers are designed for underground stormwater management. The chambers may be used for retention, recharging, detention or controlling the flow of on-site stormwater runoff.

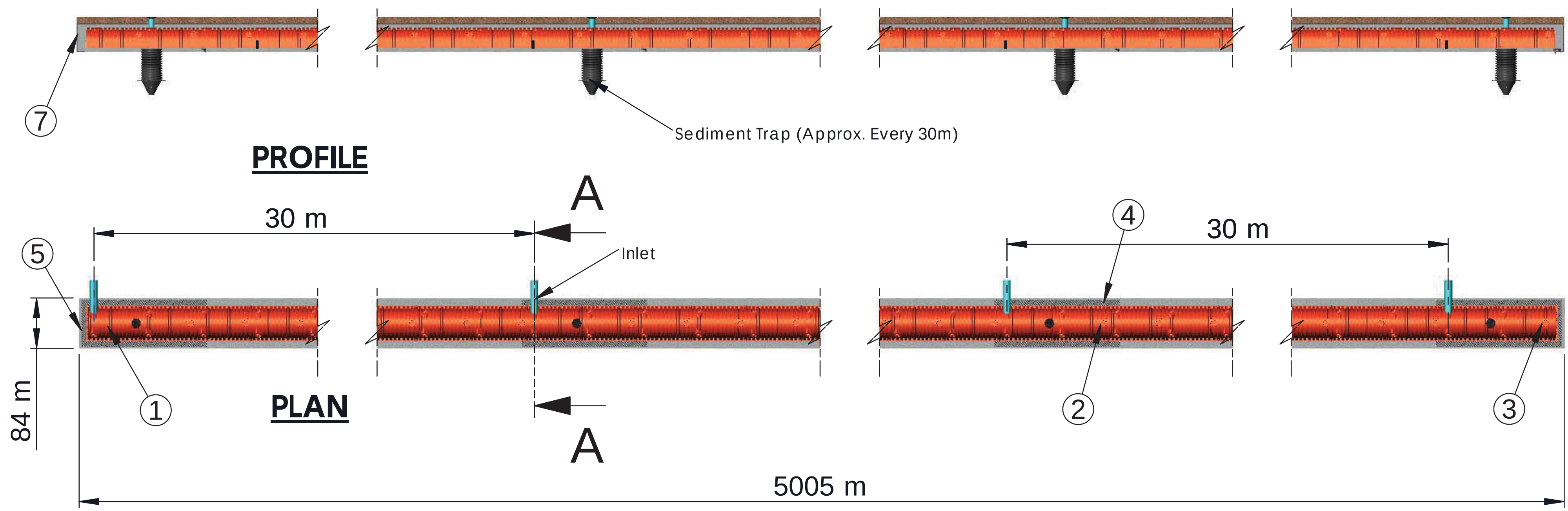
CHAMBER PARAMETERS

1. The chambers shall be manufactured in the U.S.A. by CULTEC, Inc. of Brookfield, CT (cultec.com, 203-775-4416).
2. The chamber shall be vacuum thermoformed of black polyethylene.
3. The chamber shall be arched in shape.
4. The chamber shall be open-bottomed.
5. The chamber shall be joined using an interlocking overlapping rib method. Connections must be fully shouldered overlapping ribs, having no separate couplings or separate end walls.
6. The nominal chamber dimensions of the CULTEC Contactor® 100HD shall be 12.5 inches (318 mm) tall, 36 inches (914 mm) wide and 8 feet (2.44 m) long. The installed length of a joined Contactor® 100HD shall be 7.5 feet (2.29 m).
7. Maximum inlet opening on the chamber end wall is 10 inches (250 mm).
8. The chamber shall have two side portals to accept CULTEC HVLV® SFCx2 Feed Connectors to create an internal manifold. The nominal I.D. dimensions of each side portal shall be 5.75 inches (146 mm) high by 7.5 inches (191 mm) wide. Maximum allowable O.D. in the side portal is 6.9 inches (175 mm).
9. The nominal chamber dimensions of the CULTEC HVLV® SFCx2 Feed Connector shall be 7.6 inches (194 mm) tall, 12 inches (305 mm) wide and 19.7 inches (500 mm) long.
10. The nominal storage volume of the Contactor® 100HD chamber shall be 1.866 ft^3 / ft (0.173 m^3 / m) - without stone. The nominal storage volume of a single Contactor® 100RHD Stand Alone unit shall be 14.93 ft^3 (0.42 m^3) - without stone. The nominal storage volume of a joined Contactor® 100EHD as an Intermediate unit shall be 13.995 ft^3 (0.396 m^3) - without stone. The nominal storage volume of the length adjustment amount per run shall be 0.93 ft^3 (0.09 m^3) - without stone.
11. The nominal storage volume of the HVLV® SFCx2 Feed Connector shall be 0.294 ft^3 / ft (0.027 m^3 / m) - without stone.
12. The Contactor® 100HD chamber shall have fifty-six discharge holes bored into the sidewalls of the unit's core to promote lateral conveyance of water.
13. The Contactor® 100HD chamber shall have 16 corrugations.
14. The end wall of the chamber, when present, shall be an integral part of the continuously formed unit. Separate end plates cannot be used with this unit.
15. The Contactor® 100RHD Starter/Stand Alone unit must be formed as a whole chamber having two fully formed integral end walls and having no separate end plates or separate end walls.
16. The Contactor® 100EHD Middle/End unit must be formed as a whole chamber having one fully formed integral end wall and one fully open end wall and having no separate end plates or end walls.
17. The HVLV® SFCx2 Feed Connector must be formed as a whole chamber having two open end walls and having no separate end plates or separate end walls. The unit shall fit into the side portals of the Contactor® 100HD and act as cross feed connections.
18. Chambers must have horizontal stiffening flex reduction steps between the ribs.
19. Heavy duty units are designated by a colored stripe formed into the part along the length of the chamber.
20. The chamber shall have a raised integral cap at the top of the arch in the center of each unit to be used as an optional inspection port or clean-out.
21. The units may be trimmed to custom lengths by cutting back to any corrugation on the large rib end.
22. The chamber shall be manufactured in an ISO 9001:2008 certified facility.
23. Maximum allowable cover over the top of the chamber shall be 12' (3.66 m) for the Heavy Duty version.
24. The chamber shall be designed to withstand traffic loads when installed according to CULTEC's recommended installation instructions.

ITEM NO.	STORMCHAMBER PROPOSED LAYOUT DESCRIBTION	QTY
1	START UNITS	1
2	MIDDLE UNITS	2301
3	END UNITS	1
4	7'X10' HEAVY DUTY NETTING (SUPPLIED)	664
5	LIGHTWEIGHT STABILIZATION NETTING (INFLOW AND ADJACENT ROWS) (SUPPLIED)	10
6	10" PVC INSPECTION / CLEAN OUT RISER - (SUPPLIED BYOTHERS) W/ FRAME AND LID AND SEDIMENTRAP(SUPPLIED)	167
7	4oz NON WOVEN STORMCHAMBER GEOTEXTILE FILTER FABRIC (SUPPLIED)	105
8	ROW CONNECTING 10" PVC (SUPPLIED BY OTHERS)	N/A
9	MODIFIED STARTS	162
INSTALLED WITH 150 mm COVER STONE, 150 mm BASE STONE, 40% STONE VOID. INSTALLED SYSTEM VOLUME (PERIMETER STONE INCLUDED) = 7,167 m³		

Section A-A
Scale 1 : 100





THIS DRAWING WAS PREPARED TO SUPPORT THE DESIGN ENGINEER FOR THE PROPOSED PROJECT. IT IS THE ULTIMATE RESPONSIBILITY OF THE DESIGN ENGINEER TO ENSURE THAT THE STORM WATER DESIGN IS IN FULL COMPLIANCE WITH ALL APPLICABLE LAWS AND REGULATIONS. STORMCHAMBER DOES NOT APPROVE PLANS , SIZING, OR SYSTEM DESIGNS. THE DESIGN ENGINEER IS RESPONSIBLE FOR ALL DESIGN DECISIONS.

STORMCHAMBER® BY HydroLogic SOLUTIONS
TOLL FREE: 1-877-426-9128
EMAIL: INFO@STORMCHAMBERS.COM
WWW.STORMCHAMBERS.COM

ADDRESS: **Concept Drawing Only**

STORMCHAMBER®

PROJECT NAME: Bramble Trail

DATE: March 26, 2016

DESIGNED BY: ARH | DRAWN BY: SAL

SCALE: N.T.S. | SHEET NO: 1 OF 4

StormChamber 34 - Design Calculator

Select a System of Measurement:	Metric

Cubic Meters of Storage Required:	7,167	<Start Here	% Stone Void In Decimals:	0.40

Bramble Trail

	m^3 per Chamber	Number of Chambers	Number Wide**	Number Long**	Min.*** Trench Depth (m)	Min. Trench Width (m)	Avg. Trench Length (m)	Total m^2	m^3 Excavation*	m^3 Stone	m^2 Filter Fabric
StormChamber Without Stone	2.1	3375			1.5						
150 mm Stone Above, 150 mm Below	**3.3**	**2165**	**1**	**2165**	**1.5**	**2**	**5005**	**10686**	**12377**	**7779**	**43803**
150 mm Stone Above, 300 mm Below	3.5	2004			1.6						
150 mm Stone Above, 450 mm Below	3.8	1865			1.8						
150 mm Stone Above, 600 mm Below	4.0	1745			1.9						
150 mm Stone Above, 750 mm Below	4.3	1639			2.1						
150 mm Stone Above, 900 mm Below	4.6	1545			2.2						
150 mm Stone Above, 1050 mm Below	4.8	1461			2.4						
Custom Above (mm): 6 Below (mm): 9	2.8	2554	10	255	1.2	18	590	10593	9307	3883	15784

Notes:

* The displayed m^3 of Excavation accounts for the chamber system only. It does not include the additional cover above the top stone layer as this may vary.

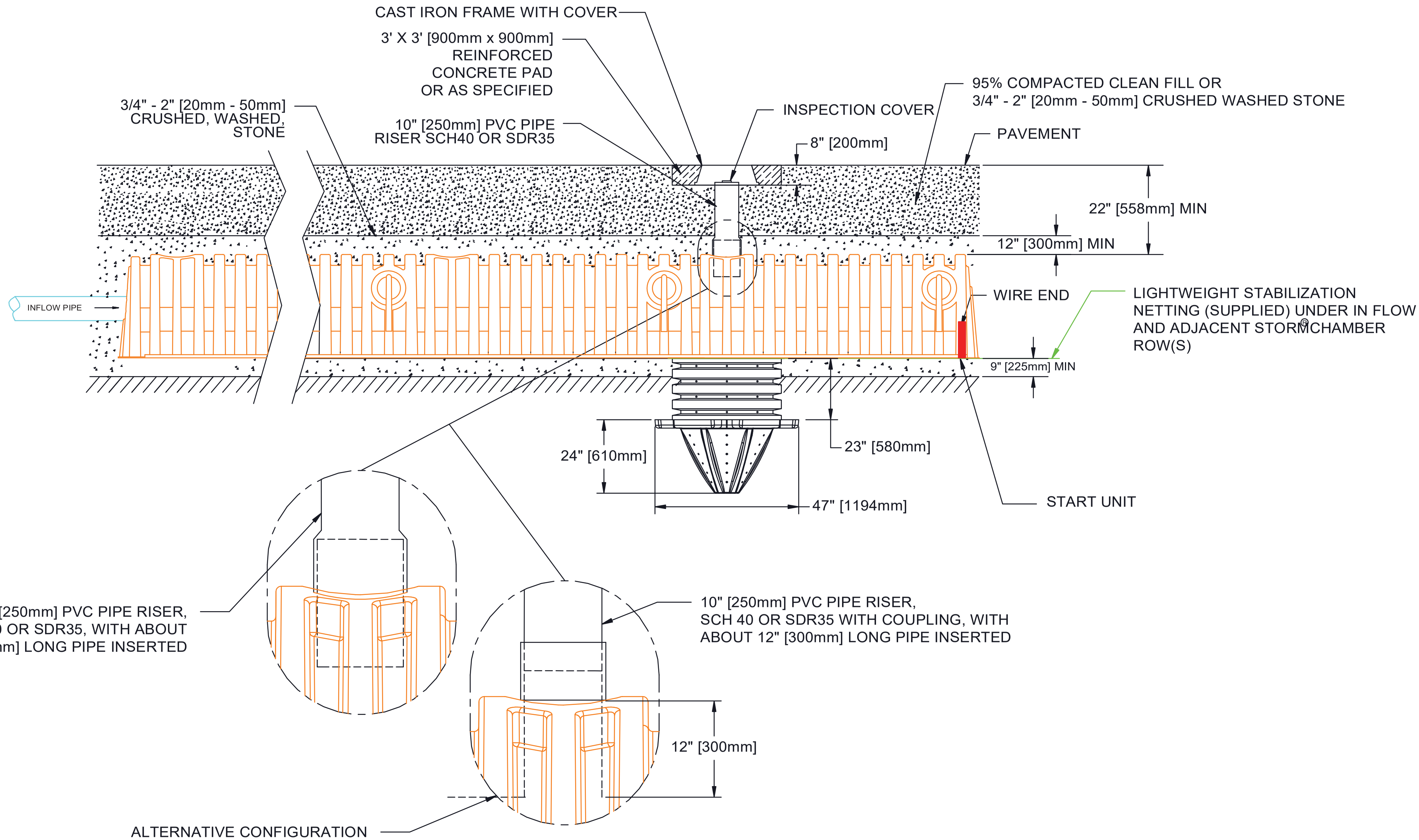
** If the number long multiplied by the number wide does not equal the total number of chambers, the total number is the correct number.

*** Trench Depth includes the minimum 0.3048 meters above stone cover. This may be increased if needed or desired.

How To Use The StormChamber Design Calculator:

1. Select a system of measurement.
2. Input the cubic meters of storage required.
3. Enter the stone void allowed, in decimals. This will normally be 0.40.
4. Determine the stone configuration desired in the left hand column. Standard configuration is 150 mm above & below.
5. Enter an approximate number of chambers wide. The number of chambers long for each of the rows will automatically be displayed. Adjust the number of chambers wide to obtain the desired trench dimensions.
6. The minimum trench depth is shown for each of the stone configuration. Alternate configurations can be inputed in the "custom" category in the bottom of the first column.

STORMCHAMBER® WITH SEDIMENTRAP™



INSTALLATION OF STORMCHAMBER SYSTEMS (can be downloaded and printed from www.stormchambers.com)

TRENCH PREPARATION

1. Do not excavate trench until dry weather is forecast long enough to allow at least coverage of the StormChamber system with filter fabric prior to raining.
2. Excavate to a width and length sufficient to accommodate the number of StormChambers plus a minimum one foot border around the entire bed. The bottom of the bed must be level, unless otherwise specified.
3. Do not use heavy equipment on the excavated trench bed in order to avoid soil compaction.
4. If use of heavy equipment on the excavated trench bed can not be avoided, scarify the trench bottom and break up soil clumps and till smooth before adding the stone base.
5. Line trench walls with a 4-ounce [113g] non-woven filter fabric such as Mirafi 140N or 140NC, Synthetic Industries 401, or AMOCCO 4545 or 4535. Overlap adjacent filter fabric by at least 2' [600mm]. Do not place filter fabric under the StormChambers.
6. Unless otherwise specified, place 9" [230mm] of crushed, washed, 3/4" - 2" [20mm - 50mm] hard, non-calcarious stone on the bottom of the trench. The base must be level and at a zero grade.
7. If it becomes impractical to level the stone base by hand, use a low pressure, tracked dozer, not exceeding 1,100 lbs/sf [500kg/sf], maintaining at least 9" [230mm] of stone under the tracks at all times.

STORMCHAMBER INSTALLATION

1. Verify quantities of StormChamber units and other materials that have arrived. If anything is damaged or missing please contact StormChamber immediately.
2. Start building the StormChamber system with the Start Unit StormChambers at the inflow end of the StormChamber system. The Start Units are completely closed at the end with the two side portals.
3. Roll out rows of StormChamber light weight stabilization netting (provided with the StormChambers) parallel with the inflow and adjacent(s). Overlap the rows by approximately 1' [300mm]. Keep the netting flat; if moved, straighten and flatten out.
4. Place one piece of the StormChamber heavy weight stabilization netting (provided with the StormChambers) under each StormChamber that will be receiving inlet storm drain pipes. Cut a hole in the netting to fit snuggly around the exposed top of the SedimenTrap. Place on top of the light weight netting and extend beyond all edges of the StormChamber. The purpose of heavy weight stabilization netting is to function as a "splash pan", preventing excavation of the underlying stone and soil, while allowing infiltration to occur.
5. Place the Start Unit StormChambers (completely closed at the end with the two side portals), spaced a minimum of 7' 3" [2057mm] apart at the center line of the chamber crown. Position the closed ends at least 1' [300mm] from the trench wall.
6. Cut open the side portals for the inflow storm drain pipes (size and location specified on the plans) and lateral connecting pipes between StormChamber Start Units (8" [200mm] or 10" [250mm] Schedule 40 or SDR 35 PVC; 8" [200mm] or 10" [250mm] HDPE will not fit) with a reciprocating saw, router bit on a drill, or keyhole saw along the defines indented circle. 10" [250mm] PVC pipe is the largest diameter pipe that can fit into the side portals. If the inflow storm drain pipe is specified to enter the closed end wall, place a piece of the pipe against the end wall. Trace the diameter of the pipe on the end wall and cut out the circle. The maximum pipe size that can be inserted into the end wall is 30" [750mm] O.D.
7. If a cut extends more than 0.5" [13mm] beyond the intended diameter, place a piece of the StormChamber non-woven filter fabric over the hole, cut an "X" just short of the width of the opening, and insert the pipe.
8. Mark the midpoints of 8" [200mm] or 10" [250mm] PVC pipe and insert into the adjacent StormChamber Start Units where specified so that the marked midpoint is centered between the two adjacent StormChambers. Pipe length should be sufficient to extend 6" [150mm] - 12" [300mm] into both adjacent StormChambers (about 4' [1200mm]). In order to facilitate placement, install the lateral connecting pipes in the specified StormChambers before attaching the next StormChambers in the row.
9. If the locations of row - connecting PVC pipes are not specified, add 8" [200mm] or 10" [250mm] PVC pipes to connect the inflow chamber and adjacent chamber(s) of the inflow row.
10. Place the first rib of a Middle Unit (completely open at side portal end partially open at top portal end) over the last rib of each of the Start Unit StormChambers.
11. Screw the StormChambers together at their base on both sides with regular 3" [75mm] dry wall screws. One screw on each side is sufficient to temporarily hold the StormChambers together until the stone is place. The gap between the two StormChambers near their base must be closed enough to prevent stone from migrating into them to prevent potential surface subsidence.
12. Continue placing and screwing the rest of the StormChambers, one at a time, leaving at least 1' [300mm] between the end of the End Unit (completely open at the side portal end, completely closed at the top portal end) and the trench wall.
13. For large StormChamber systems it is advisable to install and backfill a few StormChambers of all rows at a time as you continue to install the rest of the chambers.
14. Deposit 3/4" - 2" [20mm - 50mm] crushed, washed, hard stone directly along the centerline of the StormChambers to evenly flow down each side to keep the StormChambers in proper alignment. Avoid the use of limestone, if possible. Limestone gets pasty when wet and will tend to reduce the void spaces in the stone. Do not place the stone directly against the closed end walls at the start and end of the rows. Add stone to 6" [150mm] above the StormChambers, unless otherwise specified.
15. Level the stone cover with a vibratory compactor, not to exceed a dynamic force of 10,000 pounds [4536kg], or with a low pressure, tracked vehicle not exceeding 1, 100 lbs/sf [500kg/sf].

IMPORTANT: If a low pressure, tracked dozer is used, do not run the dozer on anything less than 6" [150mm] of stone above the StormChambers. Spread stone is small piles to prevent movement of the StormChambers. Caution must be exercised when placing stone on top of the StormChambers so that excessive pressure is not applied directly on the StormChambers by equipment "buckets".

16 Cover the stone with StormChamber non-woven filter fabric. Overlap adjacent sheets by at least 2' [600mm].

BACKFILLING

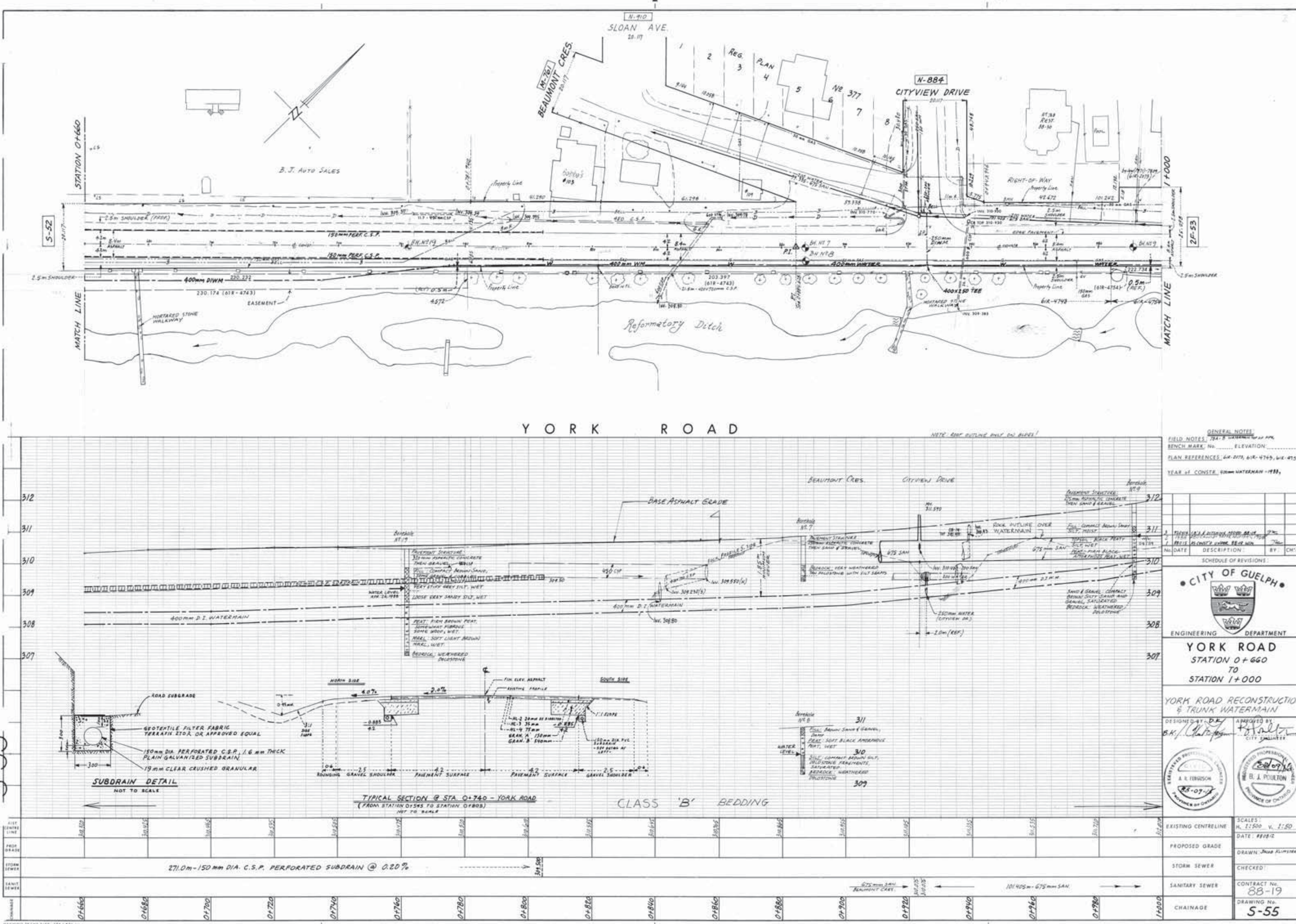
1. Backfill soil must be free from large stones and large organic material (e.g. tree limbs and root stumps), and is capable of being compacted to at least 90% of the Standard Proctor Test (AASHTO Method T-99). If not, crusher run or other suitable backfill material must be used. The stone surrounding the StormChambers can also be extended up to the pavement subgrade, if desired.
2. Compaction of the soil backfill must be achieved in 6" [150mm] - 8" [200mm] lifts. Grading of lifts should start in one corner of the system with a low pressure, tracked dozer, with a pressure not exceeding 1,100 lbs/sf [500kg/sf], keeping at least 1' [300mm] of fill in front of the blade at all times. Compact lifts to 90% Standard Proctor with tracked vehicles not exceeding 1,100 lbs/sf [500kg/sf], or with a hand operated compactor or vibratory roller not exceeding a dynamic force of 20,000 lbs [9071kg].
3. Keep the StormChamber system closed or protected from receiving sediment until the site is completely stabilized (grass growing and all pavement placed).

IMPORTANT: After compaction of backfill and setting of final grade, avoid parking on or traversing over the StormChamber installation with heavily loaded trucks and heavy equipment until paved.
MPORTANT: These instructions assume accepted construction procedures and trucks that do not exceed specified DOT load limits. Uncustomary loads or improper load distributions in vehicles may require additional cover. Contact StormChamber for installation under abnormal conditions. Installations not in compliance with these instructions will void warranty.

PRODUCT ENGINEERING SPECIFICATIONS FOR STORMCHAMBER

Each chamber will be formed from high molecular weight/high density polyethylene.
Each chamber will be composed of at least 40% recycled material.
The stone base that the chambers are placed on will not be compacted in order to avoid compaction of the stone-soil interface, which restricts soil infiltration.
The chamber system will be designed without filter fabric under the chambers in order to avoid restriction of soil infiltration, which occurs from the normal clogging of the filter fabric from sediment and debris deposition.
Use of filter fabric between the soil and stone backfill layer and lining the side walls of the excavated area will be required to prevent intrusion of soil or silt into the chambers and surrounding stone.
Each chamber will be capable of supporting a minimum of 24,000 pounds [10,886kg] per square foot (i.e., three times the AASHTO H-20 Wheel Load Rating).
Each chamber will be capable of being installed with a minimum of 25 feet [7620mm] of cover above the crown of the chamber.
Each chamber system will be capable of being installed in at least two layers, providing a minimum of 0.8 cubic feet of storage per square foot of surface area.
Each chamber system will be capable of being installed with a minimum of six inches [150mm] of stone base.
Each chamber will be 34.04" [864mm] high, 60" [1524mm] wide and 102.5" [2591mm] long.
Lay-up length will be 8.1' [2464mm] (start and end unit) and 7.6' [2311mm] (middle unit).
Each chamber will have 14 ribs of approximately 3.6" [91.4mm] in height, 3.8" [96.5mm] wide at the top and tapering to 4.4" [112mm] at the bottom.
Spacing of the ribs at the bottom of the chamber will be approximately 4.9" [124mm] and approximately 3.2" [81.3mm] at the top. One smaller rib sized dimensionally to effectively nest under and interlock to connect units will be 2.9" [73.7mm] high, 3.3" [83.8] wide at the top of the rib, and 4.1" [104mm] wide at the base.
Overall height to the inside rib will be 30.44" [864.62mm]. Overall height to the outside rib will be 34.04" [773.18mm].
Each chamber will have a defined top portal which is structurally enhanced to compensate for loss of structural integrity when apertures are cut open to receive pipe. Each such portal will be capable to receive up to a 12" [300mm] PVC pipe.
Each chamber will have defined side portals on opposing sides which are structurally enhanced to compensate for loss of structural integrity when apertures are cut open to receive pipe.
Invert height for a 10" [250mm] PVC pipe through a defined side portal will be 17.49" [444.25mm]. Invert height for an 8" [200mm] PVC pipe through a defined side portal will be 18.49" [469.65mm].
Each chamber will be capable to accept an 8" [200mm] or 10" [250mm] PVC feed pipe through a defined side portal.
Each chamber will be capable to accept up to a 30" [750mm] OD pipe through its end wall.
Each chamber will be capable of storing at least 15 cubic feet per lineal foot with 6" [150mm] or stone above and below the chamber.
Each chamber system will be designed without utilizing a header pipe manifold system.
Stone diameter will be 3/4" - 2" [20mm - 50mm].

For Availibility and Pricing Please Call:
StormChamber®
TOLL FREE: 1-877-426-9128
E-mail: Info@StormChambers.com


S-55
SLOAN AVE.
N-910
BEAUMONT CRES.
M-761
REG. PLAN
Nº 377
N-884
CITYVIEW DRIVE
B. J. AUTO SALES
STATION 0+660
MATCH LINE
S-52
2F-53
1+000
RIGHT-OF-WAY
150mm PERF. C.S.P.
400mm D.I.W.M.
400mm WM
400mm WATER
400x250 TEE
EASEMENT
MORTARED STONE WALKWAY
Reformatory Ditch
2.5m SHOULDER
YORK ROAD
GENERAL NOTES
FIELD NOTES:
BENCH MARK No. ELEVATION
PLAN REFERENCES: 61R-2173, 61R-4743, 61R-4754
YEAR of CONSTR. 400mm WATERMAIN -1988
SCHEDULE OF REVISIONS:
No. DATE DESCRIPTION: BY: CH'KD
CITY OF GUELPH
ENGINEERING DEPARTMENT
YORK ROAD
STATION 0+660
TO
STATION 1+000
YORK ROAD RECONSTRUCTION
& TRUNK WATERMAIN
DESIGNED BY:
APPROVED BY:
CITY ENGINEER
A. R. FERGUSON
B. J. POULTON
SCALES:
H. 1:500 V. 1:50
DRAWN:
CHECKED:
CONTRACT No. 88-19
DRAWING No. S-55
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
BASE ASPHALT GRADE
400mm D.I. WATERMAIN
BEAUMONT CRES.
CITYVIEW DRIVE
ROCK OUTLINE OVER WATERMAIN
SUBDRAIN DETAIL
NOT TO SCALE
ROAD SUBGRADE
GEOTEXTILE FILTER FABRIC TERRAFIX 270R OR APPROVED EQUAL
150mm DIA. PERFORATED C.S.P., 1.6 mm THICK PLAIN GALVANIZED SUBDRAIN
19mm CLEAR CRUSHED GRANULAR
TYPICAL SECTION @ STA. 0+740 - YORK ROAD
(FROM STATION 0+585 TO STATION 0+805)
NOT TO SCALE
NORTH SIDE
SOUTH SIDE
ROUNDING GRAVEL SHOULDER
PAVEMENT SURFACE
GRAVEL SHOULDER
CLASS 'B' BEDDING
271.0m-150mm DIA. C.S.P. PERFORATED SUBDRAIN @ 0.20%
101.405m-675mm SAN.
0+660
0+680
0+700
0+720
0+740
0+760
0+780
0+800
0+820
0+840
0+860
0+880
0+900
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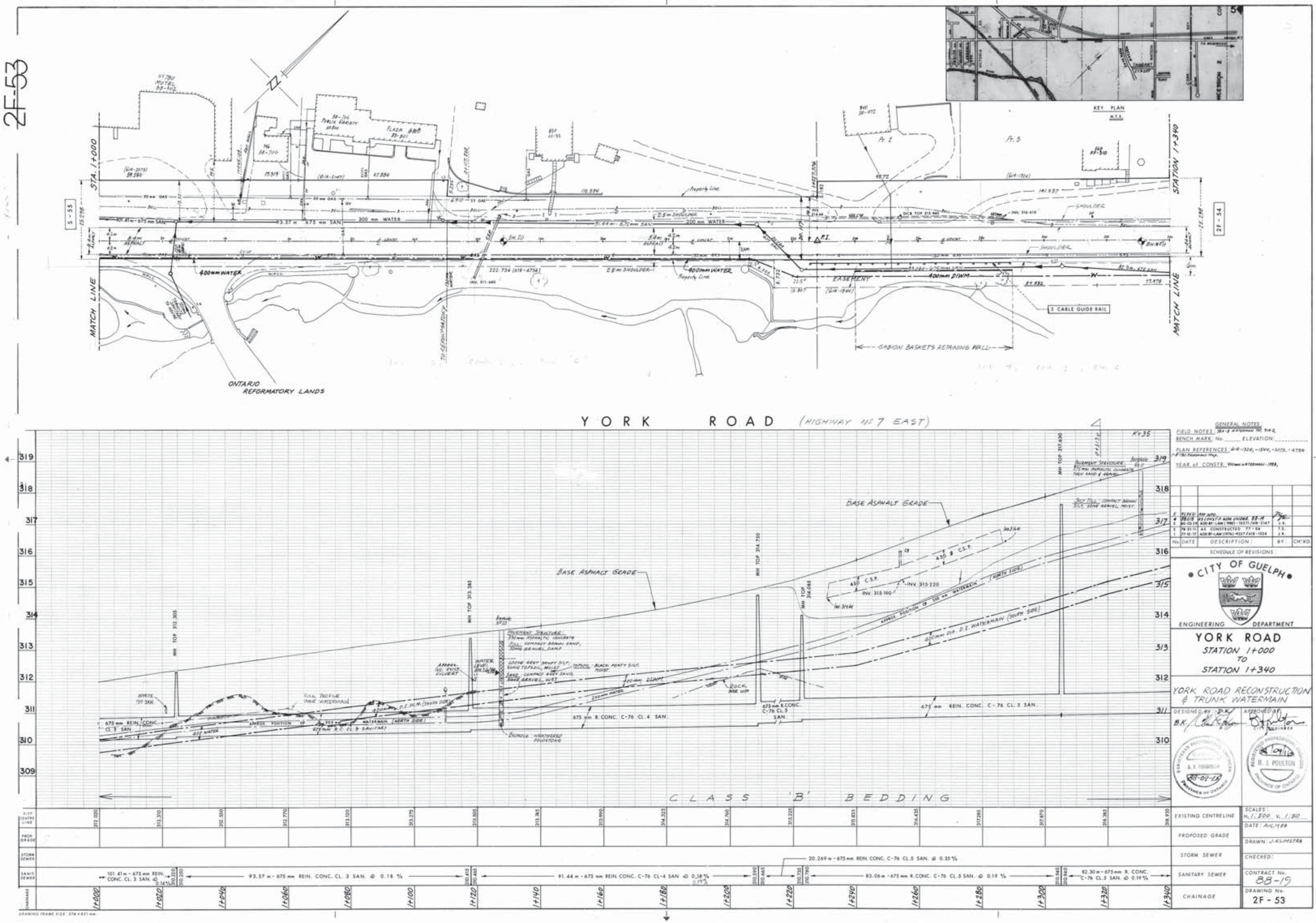
0+960
0+980
1+000


2F-53
KEY PLAN
N.T.S.
STA. 1+000
STATION 1+340
MATCH LINE
MATCH LINE
S-55
2F-54
200 mm WATER
400mm WATER
400mm DIWM
2.5m SHOULDER
EASEMENT
3 CABLE GUIDE RAIL
GABION BASKETS RETAINING WALL
ONTARIO REFORMATORY LANDS
YORK ROAD (HIGHWAY No 7 EAST)
BASE ASPHALT GRADE
BASE ASPHALT GRADE
MH TOP 312.305
MH TOP 313.385
MH TOP 314.750
MH TOP 314.085
MH TOP 317.630
675 mm R.CONC. C-76 CL.4 SAN.
675 mm REIN. CONC. C-76 CL.5 SAN.
CLASS 'B' BEDDING
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
101.41 m - 675 mm REIN. CONC. CL. 3 SAN. @ 0.14%
93.57 m - 675 mm REIN. CONC. CL. 3 SAN. @ 0.18 %
91.44 m - 675 mm REIN. CONC. C-76 CL-4 SAN @ 0.38 %
20.269 m - 675 mm REIN. CONC. C-76 CL.5 SAN. @ 0.35 %
83.06 m - 675 mm R.CONC. C-76 CL.5 SAN. @ 0.19 %
82.30 m - 675 mm R. CONC. C-76 CL.5 SAN. @ 0.19 %
1+000
1+020
1+040
1+060
1+080
1+100
1+120
1+140
1+160
1+180
1+200
1+220
1+240
1+260
1+280
1+300
1+320
1+340
GENERAL NOTES
FIELD NOTES
BENCH MARK
ELEVATION
PLAN REFERENCES
YEAR of CONSTR.
SCHEDULE OF REVISIONS
No
DATE
DESCRIPTION
BY
CH'KD
CITY OF GUELPH
ENGINEERING DEPARTMENT
YORK ROAD
STATION 1+000
TO
STATION 1+340
YORK ROAD RECONSTRUCTION & TRUNK WATERMAIN
DESIGNED BY
APPROVED BY
B. J. POULTON
SCALES: H. 1:500 V. 1:50
DATE: AUG.1988
DRAWN: J. KLIMSTRA
CHECKED:
CONTRACT No. 88-19
DRAWING No. 2F-53
DRAWING FRAME SIZE: 574 x 831 mm.

Appendix E:
Preliminary Capital Cost Estimates

Project Description York Road Environmental Impact Study, Victoria Roa to East City Limit
Option Addendum Alternative 3
Limits of Quantities STA 10+400 to STA 11+280 (880 m)

Item	Description	Unit	Quantity	Unit Price	Amount
Section A - General					
	Labour and Materials Bond	LS	1	$ 50,000.00	$ 50,000.00
	Pre-Construction Survey	LS	1	$ 10,000.00	$ 10,000.00
	Site Office	LS	1	$ 10,000.00	$ 10,000.00
	Construction Layout	LS	1	$ 15,000.00	$ 15,000.00
	Clearing and Grubbing	LS	1	$ 5,000.00	$ 5,000.00
	Tree Removal, Small (<100 mm d)	ea	40	$ 5,000.00	$ 200,000.00
	Tree Removal, Large (>100 mm d)	ea	4	$ 580.00	$ 2,320.00
	Construction Signs, Traffic Control and TMP	LS	1	$ 5,000.00	$ 5,000.00
	Contingency (30%)	LS	1	$ 910,000.00	$ 910,000.00
Section B - Roadwork, Pavement Markings and Signage					
	Removal of stone wall (south side)	m2	100	$ 100.00	$ 10,000.00
	Removal of any buried pipes, conduit, etc.	m	880	$ 40.00	$ 35,200.00
	Earth Excavation (Grading), Including Full Depth Asphalt Removal	m2	11144	$ 15.00	$ 167,160.00
	Clean Fill	m2	2966	$ 20.00	$ 59,320.00
	Hot Mix HL-3 HS (45 mm lift)	t	1410	$ 120.00	$ 169,239.00
	Hot Mix HL-8 HS (90 mm in 2 x 45 mm lifts)	t	2821	$ 100.00	$ 282,064.00
	Granular 'A' Crushed Limestone	t	5285	$ 18.00	$ 95,135.00
	Granular 'B' Crushed Limestone	t	14270	$ 16.00	$ 228,324.00
	Multi-Use Pathway Including Granular	m2	5305	$ 85.00	$ 450,925.00
	Concrete Curb and Gutter	m	1781	$ 60.00	$ 106,849.00
	100 mm Diameter Pipe Subdrains	m	1800	$ 18.00	$ 32,400.00
	Pavement Marking and Signs (Estimated)	LS	1	$ 20,000.00	$ 20,000.00
	50mm Imported Topsoil and Sod	m^2	391	$ 12.00	$ 4,687.43
	50 mm Imported Topsoil, Seed and Mulch	m^2	6261	$ 5.00	$ 31,307.00
	Supply and Install Trees, 60 mm Caliber, Species	each	44	$ 350.00	$ 15,400.00
	Removal and Relocate Bus Stop	LS	1	$ 30,000.00	$ 30,000.00
	Guide Rail	m	109	$ 150.00	$ 16,350.00
	Energy Attenuators	ea	3	4500	$ 13,500.00
Section C - Storm Sewers and Manholes					
	Catch Basins and Manholes (Estimated)	LS	1	$ 240,000.00	$ 240,000.00
Section D - Traffic Signals					
	Traffic Signals	LS	1	$ 500,000.00	$ 500,000.00
Section E - Utility Relocations					
	Remove and Relocate HP/LS	ea	20	$ 7,100.00	$ 142,000.00
	Utility Relocation - Other	LS	1	$ 100,000.00	$ 100,000.00
Conceptual Level Total Estimate					
					$ 3,960,000.00

Total Corridor Cost with This Alternative $ 13,650,000.00

Project Description York Road Environmental Impact Study, Victoria Roa to East City Limit
Option Addendum Alternative 4
Limits of Quantities STA 10+400 to STA 11+280 (880 m)

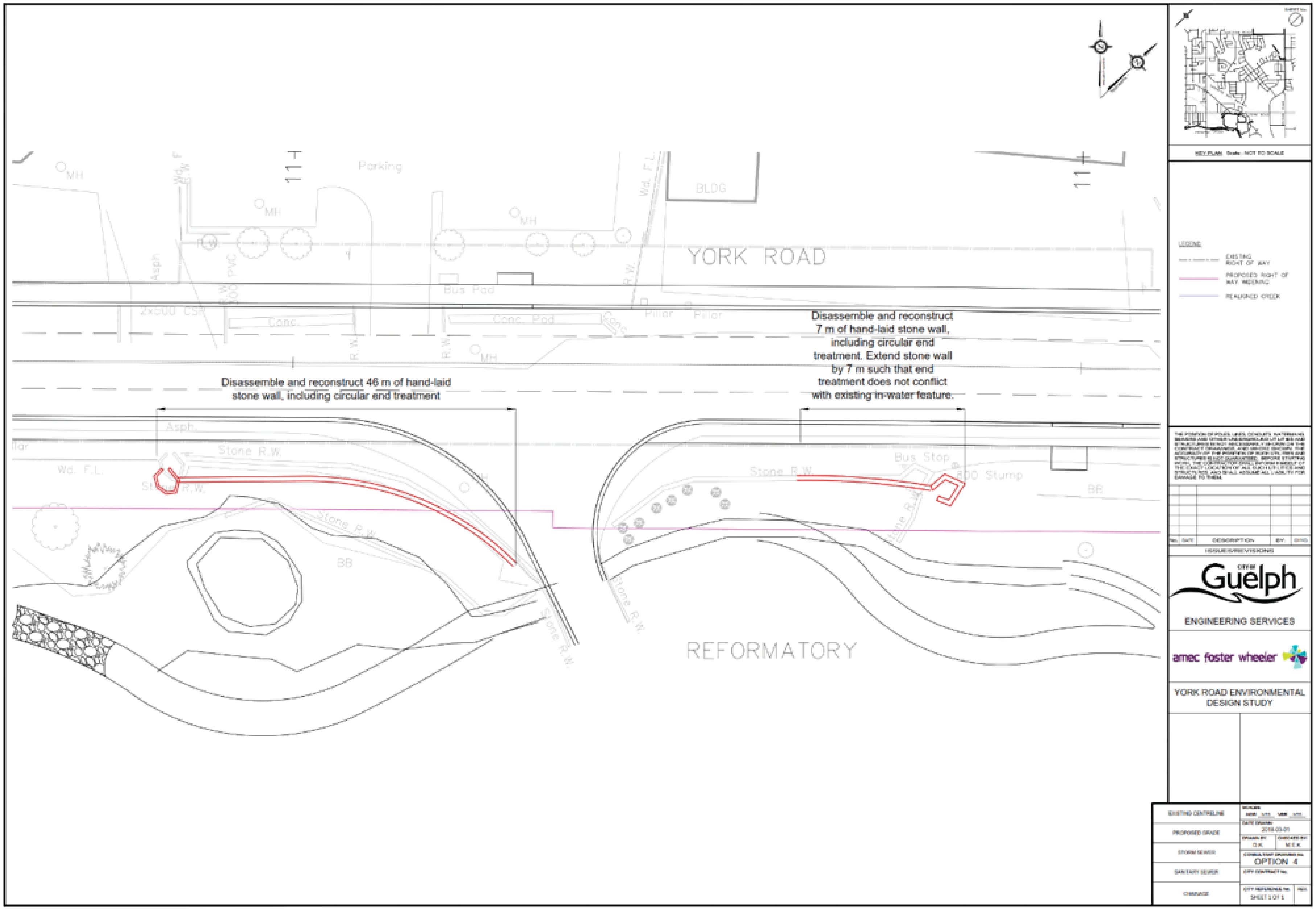
Item	Description	Unit	Quantity	Unit Price	Amount
Section A - General					
	Labour and Materials Bond	LS	1	$ 50,000.00	$ 50,000.00
	Pre-Construction Survey	LS	1	$ 10,000.00	$ 10,000.00
	Site Office	LS	1	$ 10,000.00	$ 10,000.00
	Construction Layout	LS	1	$ 15,000.00	$ 15,000.00
	Clearing and Grubbing	LS	1	$ 5,000.00	$ 5,000.00
	Tree Removal, Small (<100 mm d)	ea	40	$ 5,000.00	$ 200,000.00
	Tree Removal, Large (>100 mm d)	ea	4	$ 580.00	$ 2,320.00
	Construction Signs, Traffic Control and TMP	LS	1	$ 5,000.00	$ 5,000.00
	Contingency (30%)	LS	1	$ 920,000.00	$ 920,000.00
Section B - Roadwork, Pavement Markings and Signage					
	Removal of stone wall (south side)	m2	100	$ 100.00	$ 10,000.00
	Removal of any buried pipes, conduit, etc.	m	880	$ 40.00	$ 35,200.00
	Earth Excavation (Grading), Including Full Depth Asphalt Removal	m2	11144	$ 15.00	$ 167,160.00
	Clean Fill	m2	3225	$ 20.00	$ 64,500.00
	Hot Mix HL-3 HS (45 mm lift)	t	1410	$ 120.00	$ 169,239.00
	Hot Mix HL-8 HS (90 mm in 2 x 45 mm lifts)	t	2821	$ 100.00	$ 282,064.00
	Granular 'A' Crushed Limestone	t	5285	$ 18.00	$ 95,135.00
	Granular 'B' Crushed Limestone	t	14270	$ 16.00	$ 228,324.00
	Multi-Use Pathway Including Granular	m2	5888	$ 85.00	$ 500,476.00
	Concrete Curb and Gutter	m	1781	$ 60.00	$ 106,849.00
	100 mm Diameter Pipe Subdrains	m	1800	$ 18.00	$ 32,400.00
	Pavement Marking and Signs (Estimated)	LS	1	$ 20,000.00	$ 20,000.00
	50mm Imported Topsoil and Sod	m^2	391	$ 12.00	$ 4,687.43
	50 mm Imported Topsoil, Seed and Mulch	m^2	6261	$ 5.00	$ 31,307.00
	Supply and Install Trees, 60 mm Caliber, Species	each	44	$ 350.00	$ 15,400.00
	Removal and Relocate Bus Stop	LS	1	$ 30,000.00	$ 30,000.00
Section C - Storm Sewers and Manholes					
	Catch Basins and Manholes (Estimated)	LS	1	$ 240,000.00	$ 240,000.00
Section D - Traffic Signals					
	Traffic Signals	LS	1	$ 500,000.00	$ 500,000.00
Section E - Utility Relocations					
	Remove and Relocate HP/LS	ea	20	$ 7,100.00	$ 142,000.00
	Utility Relocation - Other	LS	1	$ 100,000.00	$ 100,000.00
Conceptual Level Total Estimate					
					$ 3,990,000.00

Total Corridor Cost with This Alternative	**$ 13,680,000.00**

Channel Works	Cost Estimate	
Mobilization/Demobilization/Admin	$	7,500
Site Prep/ Clearing and Grubbing	$	9,000
Staging/Stockpile Area(s)	$	5,000
Excavation and Offsite Disposal of Excavated Materials	$	65,000
Fill (from Stockpiled Excavated Materials)	$	340,000
Coarse Channel Bed Stone	$	140,000
Gravel Bed Treatments and Void Mix	$	65,000
Vegetated Block Treatment	$	80,000
Vegetated Riprap	$	40,000
Environmental Measures (ESC, Pumping/Dewatering, Fish Relocations, etc.)	$	30,000
Tree and Shrub Plantings/Site Restoration costs by others		
Total	**$**	**781,500.00**
Total with Contingency (10%)	**$**	**859,650.00**

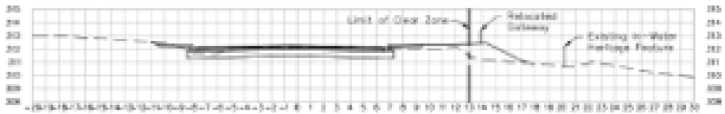
YORK ROAD DRAINAGE

ITEM	DESCRIPTION	EST. QTY.	UNIT	UNIT PRICE	TOTAL
1	600 x 600mm Catchbasins	23	ea	$2,500.00	$57,500.00
2	DICB	3	ea	$3,500.00	$10,500.00
3	1200mm CB Manholes OPSD 701.010	17	ea	$5,000.00	$85,000.00
4	1500mm CB Manholes OPSD 701.010	2	ea	$7,500.00	$15,000.00
5	1800mm CB Manholes OPSD 701.010	1	ea	$8,500.00	$8,500.00
6	2400mm CB Manholes OPSD 701.010	3	ea	$10,000.00	$30,000.00
7	3000mm CB Manholes OPSD 701.010	1	ea	$12,500.00	$12,500.00
8	250mm CB Leads PVC SDR 35 Granular Bedding and Backfill	356	m	$150.00	$53,400.00
9	300mm Storm Sewer PVC SDR 35 Granular Bedding and Native Backfill	0	m	$200.00	$0.00
10	375mm Storm Sewer PVC SDR 35 Granular Bedding and Backfill	97	m	$225.00	$21,825.00
11	450mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$250.00	$25,000.00
12	525mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$300.00	$30,000.00
13	750 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$780.00	$78,000.00
14	825mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$900.00	$90,000.00
15	1050 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	33	m	$1,430.00	$47,190.00
16	1350 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	200	m	$2,250.00	$450,000.00
17	1500 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$2,800.00	$280,000.00
18	Chamber System with excavation and bedding	1040	m	$60.00	$62,400.00
19	Inspection Ports (1/30m)	35	ea	$250.00	$8,750.00
20	Orifice Plates	5	ea	$250.00	$1,250.00
21	Weir Plates	3	ea	$500.00	$1,500.00
22	Stone Trench and Lining	1040	m	$175.00	$182,000.00
23	Oil/grit Chambers	5	ea	$100,000.00	$500,000.00
24	Drainage Outlets	6	ea	$25,000.00	$150,000.00
25	Contingency of 10%	0.1	LS	$2,200,315.00	$220,031.50
				TOTAL PRICE	**$2,420,346.50**


YORK ROAD
REFORMATORY
Disassemble and reconstruct 46 m of hand-laid stone wall, including circular end treatment
Disassemble and reconstruct 7 m of hand-laid stone wall, including circular end treatment. Extend stone wall by 7 m such that end treatment does not conflict with existing in-water feature.
Parking
BLDG
Bus Pad
Conc. Pad
Conc.
Pillar
Asph.
Stone R.W.
Bus Stop
Stump
BB
Wd. F.L.
MH
KEY PLAN Scale: NOT TO SCALE
LEGEND
EXISTING RIGHT OF WAY
PROPOSED RIGHT OF WAY WIDENING
REALIGNED CREEK
ISSUES/REVISIONS
City of Guelph
ENGINEERING SERVICES
amec foster wheeler
YORK ROAD ENVIRONMENTAL DESIGN STUDY
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
2016-03-01
OPTION 4
SHEET 1 OF 1

OPTION 4 – 2.5 m MULTI-USE PATHWAY IMMEDIATELY BEHIND BACK OF CURB

11+005.000



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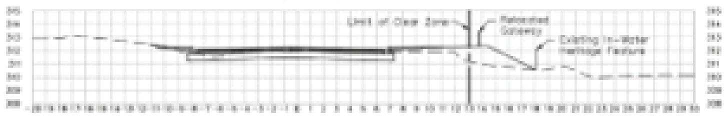

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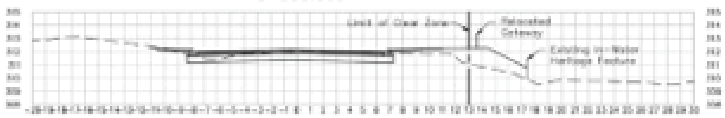

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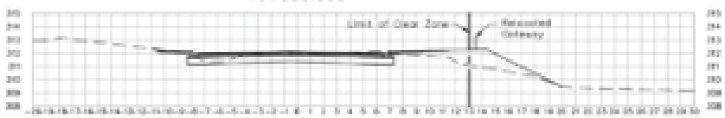

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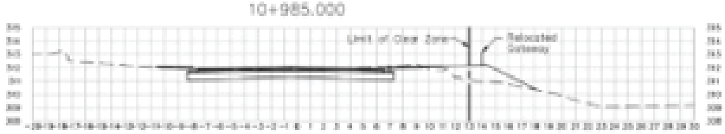

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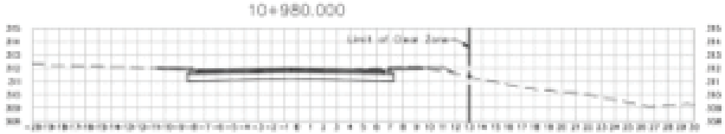

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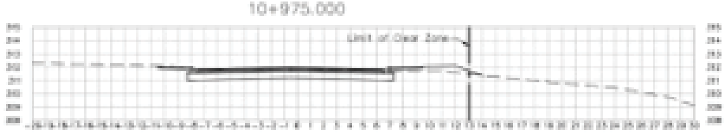

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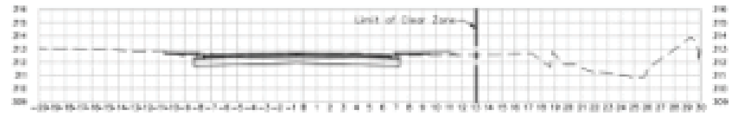
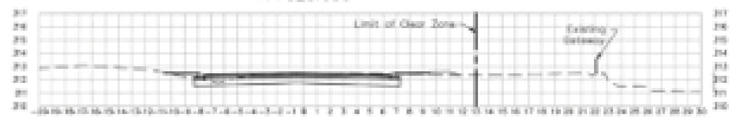


11+035.000

11+030.000

11+025.000



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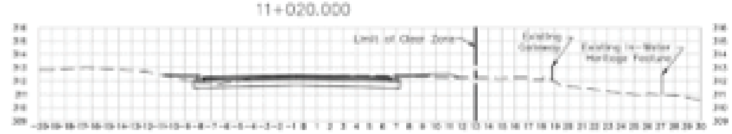

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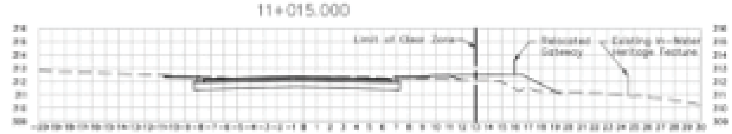

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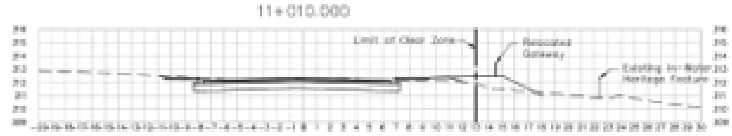

Appendix L

Heritage Impact Assessment

wood.

HERITAGE IMPACT ASSESSMENT: YORK ROAD ENVIRONMENTAL DESIGN STUDY, GUELPH, ONTARIO

PROJECT NUMBER: TP115100

Prepared for:

City of Guelph

Revised August 2019

HERITAGE IMPACT ASSESSMENT:
YORK ROAD ENVIRONMENTAL DESIGN STUDY, GUELPH, ONTARIO

Project Number: TP115100

Prepared for:

Arun Hindupur
Infrastructure Planning Engineer,
City of Guelph, Ontario
Canada
E: Arun.Hindupur@guelph.ca

Prepared by:

Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited
3450 Harvester Road, Suite 100,
Burlington, Ontario, L7N 3W5
Canada
T: 905.335.2553
F: 905.335.1414

August 2019

Executive Summary

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood), was retained by the City of Guelph ("CLIENT") to conduct a Heritage Impact Assessment (HIA) as part of the Environmental Design Study for York Road Improvements, Wyndham Street South to East City Limits. A Schedule C Class Environmental Assessment had been undertaken in accordance with the Municipal Class Environmental Assessment planning and design process approved by City council in 2007 (Appendix A: Figure 1–3).

The City of Guelph completed the 2007 York Road Improvements Class EA to identify transportation improvements to address the travel needs on York Road between Wyndham Street South and the East City Limits. The need for road improvements on York Road was identified in the Guelph Wellington Transportation Study (GWTS) that was completed in 2005. The impetus for these improvements originates from the proposed development of the Guelph Innovation District (OPA 54) Secondary Plan south of York Road, east of the CP rail line. This area was previously referred to as the Ontario Correctional Institute Lands.

While the cultural heritage of the entire study area along York Road from Victoria Road to East City Limit was reviewed in a Wood memorandum of January 2016, this Heritage Impact Assessment will focus on the area of the Guelph Correctional Centre at 785 York Road that would be impacted by the widening of York Road and the realignment of Clythe Creek. This report is to be read as an appendix to the EIS.

The memorandum of January 2016 contained:

- A summary of heritage concerns identified in previous reports: the 2005 York District Land Use & Servicing Study: Background Report; the 2007 York Road Improvements Wyndham Street South to East City Limits Class Environmental Assessment; a Preliminary Heritage Easement Assessment by the Ontario Heritage Trust Staff; a Cultural Heritage Assessment Report by the Ontario Realty Corporation; and the Official Plan Amendment 54 (Guelph Innovation District Secondary Plan [GID]) for the City of Guelph Official Plan.
- A recommendation for additional heritage research including a Heritage Impact Assessment.
- Determination of potential impacts on the identified heritage attributes with recommendations and/or mitigation.

Located within the study area is Clythe Creek, which is proposed to be relocated to permit the widening of the roadway and to create a channel that can convey higher flows, typical of 1.5 to 2-

year storm events. The creek realignment and rehabilitation would improve the natural functions of the creek and enhance floral and faunal habitats. The creek channel would be realigned south from the York Road right-of-way and the connection to the floodplain would be upgraded.

Cultural heritage resources of local and provincial significance have been identified within the study area. This report takes potential impacts to these resources into consideration within the framework of the preferred design alternative.

The background research was conducted by Ms. Linda Axford. The heritage property inspection of the entire study area between Wyndham Street south and the East City Limit was conducted on December 4, 2015. Further investigations for the Heritage Impact Assessment at 785 York Road along the Guelph Correctional Centre frontage near the roadway were undertaken on October 28, November 1, and November 22, 2016. The weather was cool and overcast during all four property reviews and did not impede the inspections in any way.

The proposed roadway widening has the potential to impact cultural heritage resources in a variety of ways. These include the loss or displacement of resources through removal or relocation and the disruption of resources by introducing physical, visual, audible or atmospheric elements that are not in keeping with the heritage resources and/or their setting.

On December 20, 2017, Wood presented the City of Guelph with Road Alternatives 1 and 2. Pursuant to a Memo sent to the City of Guelph on April 5, 2018, Wood was requested to provide two additional roadway design alternatives. The objective of investigating these two new alternatives was to determine if the multi-use pathways could be maintained adjacent to York Road through either narrowing the multi-use pathway or relocating the built heritage features at the Reformatory Entrance. The two new alternatives are as follows:

Alternative 3: Eliminate the boulevards and narrow the multi-use pathways on both the north and south sides of York Road to 2.5 m adjacent to the Reformatory Property entrances.

Alternative 4: Eliminate the boulevards, maintain 3.0 m multi-use pathways on both the north and south sides of York Road, and relocate the heritage wall outside of the clear zone.

The effects of these two new alternatives is limited to the section of York Road between the western entrance to Royal City Jaycees Park (east of the existing Elizabeth Street intersection), and east of the Reformatory Property entrance where the multi-use path had been located south of the Clythe Creek in the original Environmental Design Study (March 2017 submission). At the December 20, 2017 meeting, the City of Guelph indicated that the recently approved *Active Transportation Network Study Update* (June 2017) requires that active transportation facilities must (where feasible) provide the same level-of-service as non-active modes of transportation. Locating the multi-use path south of Clythe Creek would place it within the floodplain and make it unusable during moderate to significant storm events (>2-year frequency), therefore significantly compromising its level of service relative to the roadway. Therefore, as indicated by the City at the December 20, 2017 meeting, it is preferred that the multi-use path be located adjacent to the road.

Also, at the December 20, 2017 meeting and pursuant to an email on April 23, 2018, the City of Guelph Senior Heritage Planner, Steven Robinson indicated that he was not opposed to the curved, stone wing walls on both sides of the main entrance to the Correctional Centre being carefully dismantled and relocated and reconstructed further south. He also stated in the April 23rd email that, before he could give a full support, this option would need to include the creation and approval of a Conservation Plan.

Accordingly, only Alternative 4 will be discussed in this revised report. The Alternative 4 road design would eliminate the boulevards and provide full 3.0-m wide multi-use paths on both the north and south sides of York Road from Beaumont Avenue to east of the Reformatory property. Unlike earlier alternatives, Alternative 4 includes relocation of the former Reformatory entrance gateway features/walls to beyond the limits of the 6.5-m roadway clear zone. Relocation of the main entrance wing walls would provide additional space for snow storage and utilities, while eliminating the need to provide a guiderail along the roadway adjacent to the heritage features. A benefit of the relocation and reconstruction of both wing walls would also uncover and restore the walls' original height. The wing wall on the east side of the entranceway would be reconstructed in roughly the same location, with an extension on the east end of 7 m so that the end treatment would not conflict with the existing in-water feature. An additional advantage of rebuilding the east portion of the wing wall would be that it was more visible to the public, and it would be similar in height to the original wall. The relocation of the wing wall on the west side of the entranceway would move the wall further south so that it would be outside of the clear zone (Drawing 1). Relocation and reconstruction of both wing walls would also uncover and restore the walls' original height. Relocation of the wall would need to be undertaken by skilled heritage masons and would require additional embankment grading and the use of retained soil systems (or retaining walls) between the heritage wall and the creek.

In order to optimize the available space within the right-of-way, the roadway alignment would be shifted 1.5 m to the north relative to the design presented in the draft EIS dated March 2017. The road profile has also been adjusted to minimize grading impacts on adjacent properties. Similar to the design presented in the draft EIS, extension of the Hadati Creek culvert would be required, and opportunities to reduce impacts to the creek and heritage features through implementation of various segments of retaining walls/soil systems could be investigated as part of detailed design.

As indicated throughout this report, the Guelph Correctional Centre is a very important cultural heritage landscape. Through the convergence of two large reform movements, namely prison reform and the City Beautiful reform concept, this cultural heritage landscape is unique in its value and interest in the Province of Ontario. The heritage impacts to the listed built heritage resources are all considered important due to their proximity to the roadway or to the creek realignment.

Accordingly, it is recommended that the following mitigation measures be taken:

1) Since preservation in situ is not feasible for all of the heritage resources, rehabilitation, adaptive reuse and restoration must be done in a sensitive manner in order to protect the site's heritage value.

2) It is recommended that a Conservation Plan be prepared during the detailed design plan phase for improvements to York Road. A Conservation Plan would be prepared by a qualified heritage consultant and would guide the work of relocating the built heritage resources within this locally and provincially significant cultural heritage landscape. The scope of the Conservation Plan should include the following:

    - Interpretation plan and/or strategy
    - Preliminary recommendations for restoration, rehabilitation and/or adaptive reuse;
    - Critical short-term maintenance required to stabilize the heritage resources and prevent deterioration;
    - Measures to ensure interim protection of heritage resources during phases of construction or related development;
    - Security requirements;

- Conservation, relocation and reconstruction measures required to successfully carry out the approved interventions;

- Appropriate conservation principles and practices, and qualifications of contractors and trades people that should be applied, especially in the dismantling and reassembling of the wing walls;

- Longer term maintenance and conservation work intended to preserve existing heritage fabric and attributes;

- Drawings, plans, specifications sufficient to describe all works outlined in the Conservation Plan;

- An implementation strategy outlining consecutive phases or milestones;

- Cost estimates for the various components of the plan; and,

- Compliance with recognized *Standards and Guidelines for the Conservation of Historic Places in Canada*, the *Guelph Innovation District* (York District Lands) *Official Plan Amendment 54,* City of Guelph Official Plan (2014) and other recognized heritage protocols and standards. As stated in the *Standards and Guidelines for the Conservation of Historic Places in Canada*, it is important to begin with a thorough understanding of the heritage value of the site, along with its condition, evolution over time, and past and current importance to the community (pg.3). The author of the Conservation Plan should work closely with the City of Guelph and the Province of Ontario (Infrastructure Ontario) to compile all available information pertinent to defining the study area's cultural heritage character-defining elements.

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Appendix C: Limitations

Project Personnel

Project Director:	Linda Axford, MLA, CAHP
Field Director	Linda Axford, MLA, CAHP
Report Author	Linda Axford, MLA, CAHP
Graphics	Cara Howell, B.A.
Report Reviewer	Shaun Austin, Ph.D.

1.0 Project Context

1.1 Development Context

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood), was retained by the City of Guelph ("CLIENT") to conduct a Heritage Impact Assessment (HIA)[1] as part of the Environmental Design Study for York Road Improvements, Wyndham Street South to East City Limits. A Schedule C Class Environmental Assessment had been undertaken in accordance with the Municipal Class Environmental Assessment planning and design process approved by City council in 2007 (Appendix A: Figure 1–3).

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While the heritage of the entire study area along York Road from Victoria Road to East City Limit was reviewed in a Wood memorandum of January 2016, this Heritage Impact Assessment will focus on the area of the Guelph Correctional Centre at 785 York Road that would be impacted by road improvements. This report is to be read as an appendix to the EIS.

The memorandum of January 2016 contained:

- A summary of heritage concerns identified in previous reports: the 2005 York District Land Use & Servicing Study: Background Report; the 2007 York Road Improvements Wyndham Street South to East City Limits Class Environmental Assessment; a Preliminary Heritage Easement Assessment by the Ontario Heritage Trust Staff; a Cultural Heritage Assessment Report by the Ontario Realty Corporation; the Official Plan Amendment 54 (Guelph Innovation District Secondary Plan [GID]) for the City of Guelph Official Plan; the GCC Conservation Plan (2009) by Infrastructure Ontario.
- A recommendation for additional heritage research including a Heritage Impact Assessment.

1 The Heritage Guelph Committee refers to the type of report as a Cultural Heritage Resource Impact Assessment (CHRIA).

- Determination of potential impacts on the identified heritage attributes with recommendations and/or mitigation.

Located within the study area is Clythe Creek, which is proposed to be partially relocated to permit the widening of the roadway and to create a channel that can convey higher flows, typical of 1.5 to 2-year storm events. The creek realignment and rehabilitation would improve the natural functions of the creek and enhance floral and faunal habitats. The creek channel would be realigned south from the York Road right-of-way and the connection to the floodplain would be upgraded.

Cultural heritage resources of local and provincial significance have been identified within the study area. This report takes potential impacts to these resources into consideration within the framework of the preferred design alternative.

The background research was conducted by Ms. Linda Axford. The heritage property inspection of the entire study area between Wyndham Street south and the East City Limit was conducted on December 4, 2015. Further investigations for the Heritage Impact Assessment at 785 York Road along the Guelph Correctional Centre frontage near the roadway were undertaken on October 28, November 1, and November 22, 2016. The weather was cool and overcast during all four property reviews and did not impede the inspections in any way.

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On December 20, 2017, Wood presented the City of Guelph with Road Alternatives 1 and 2. Pursuant to a Memo sent to the City of Guelph on April 5, 2018, Wood was requested to provide two additional roadway design alternatives. The objective of investigating these two new alternatives was to determine if the multi-use pathways could be maintained adjacent to York Road through either compromise of the multi-use pathway width, or acceptance of the cost of relocating the built heritage features at the Reformatory Entrance. The two new alternatives are as follows:

Alternative 3: Eliminate the boulevards and narrow the multi-use pathways on both the north and south sides of York Road to 2.5 m adjacent to the Reformatory Property entrances.

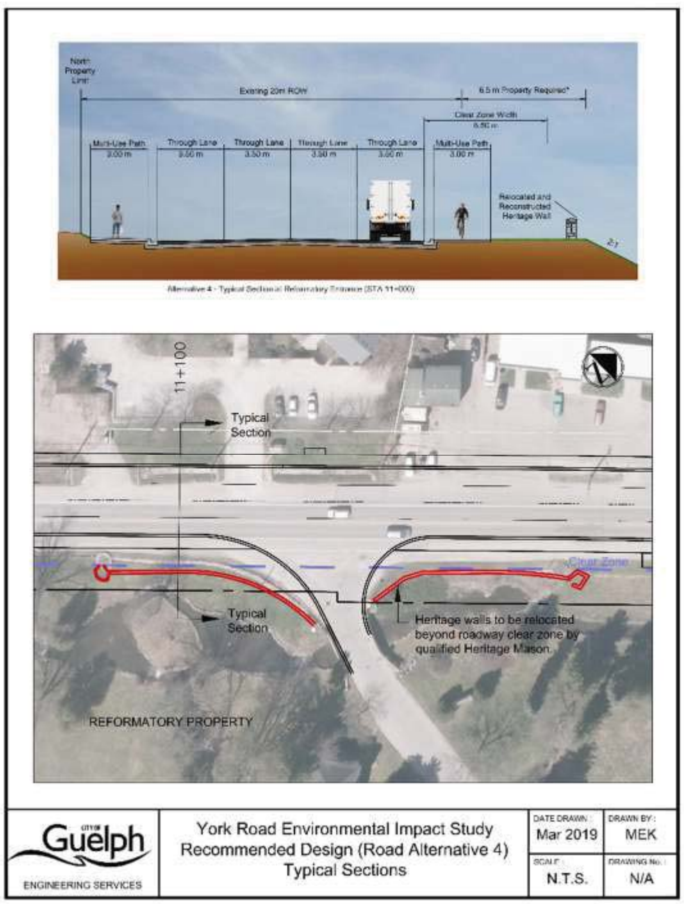
Alternative 4: Eliminate the boulevards, maintain 3.0 m multi-use pathways on both the north and south sides of York Road, and relocate the heritage wall outside of the clear zone.

The effects of these two new alternatives was to be limited to the section of York Road between the western entrance to Royal City Jaycees Park (east of the existing Elizabeth Street intersection), and east of the Reformatory Property entrance where the south multi-use path had been located south of the Clythe Creek in the original Environmental Design Study (March 2017 submission). At the December 20, 2017 meeting, the City of Guelph indicated that the recently approved *Active Transportation Network Study Update* (June 2017) requires that active transportation facilities must (where feasible) provide the same level-of-service as non-active modes of transportation. Locating the multi-use path south of Clythe Creek would place it within the floodplain and make it unusable during moderate to significant storm events (>2-year frequency), therefore significantly compromising its level of service relative to the roadway. Therefore, as indicated by the City at the December 20, 2017 meeting, it is preferred that the multi-use path be located adjacent to the road.

Also, at the December 20, 2017 meeting and pursuant to an email on April 23, 2018, the City of Guelph Senior Heritage Planner, Steven Robinson indicated that he was not opposed to the curved, stone wing walls on both sides of the main entrance to the Correctional Centre being carefully dismantled and relocated and reconstructed further south. He also stated in the April 23rd email that, before he could give a full support, this option would need to include the creation and approval of a Conservation Plan.

Accordingly, only Alternative 4 will be discussed in this report. The Alternative 4 road design would eliminate the boulevards and provide full 3.0-m wide multi-use paths on both the north and south sides of York Road from Beaumont Avenue to east of the Reformatory property. Unlike earlier alternatives, Alternative 4 includes relocation of the former Reformatory entrance gateway features/walls (Drawing 1: Walls drawn in red lines) to beyond the limits of the 6.5-m roadway clear zone. Relocation of the cultural heritage walls would provide additional space for snow storage and utilities, while eliminating the need to provide a guiderail along the roadway adjacent to the heritage features. A benefit of the relocation and reconstruction of both wing walls would also uncover and restore the walls' original height. The wing wall on the east side of the entranceway would be reconstructed in roughly the same location, with an extension on the east end of 7 m so that the end treatment would not conflict with the existing in-water feature. An additional advantage of rebuilding the east portion of the wing wall would be that it was more visible to the public, and similar in height to the original wall. The relocation of the wing wall on the west side of the entranceway would move the wall further south so that it would be outside of the clear zone (Drawing 1). Relocation and reconstruction of both wing walls would also uncover and restore the walls' original height. Relocation of the wall would need to be undertaken by skilled heritage masons and would require additional embankment grading and the use of retained soil systems (or retaining walls) between the heritage wall and the creek.

In order to optimize the available space within the right-of-way, the roadway alignment would be shifted 1.5 m to the north relative to the design presented in the draft EIS dated March 2017. The road profile has also been adjusted to minimize grading impacts on adjacent properties. Similar to the design presented in the draft EIS, extension of the Hadati Creek culvert would be required, and opportunities to reduce impacts to the creek and heritage features through implementation of various segments of retaining walls/soil systems could be investigated as part of detailed design. The Alternative 4 roadway cross-section adjacent to the relocated heritage walls is illustrated below:



Drawing 1: Typical Roadway Cross-Section for York Road Alternative 4 and Drawing Showing Relocation of Wing Walls

1.2 Methodology

Amendment No. 48 to the City of Guelph Official Plan[2], Envision Guelph – Official Plan Update Phase 3 explains in detail the requirements of a Heritage Impact Assessment:

> *i) a description of the proposed development, redevelopment or site alteration, including a location map showing proposed buildings, existing land uses, site survey, architectural drawings, detailed conceptual façade renderings, interior architectural details where the heritage attributes are identified within a building or structure and other details as specified by the City;*
>
> *ii) a detailed description of the built heritage resource(s), cultural heritage landscape features, heritage attributes, sources of research and conclusions regarding the significance of the cultural heritage resource with respect to their cultural heritage value or interest;*
>
> *iii) a description of the existing regulations if any, affecting the proposal (e.g. flood or fill regulation);*
>
> *iv) a description of cultural heritage resources and heritage attributes that may be directly or indirectly affected by the proposal;*
>
> *v) a description of the impacts that may reasonably be caused to the cultural heritage resource or heritage attributes and how the impacts may affect the value or interest of the resource or attribute;*
>
> *vi) an evaluation of alternative conservation and avoidance or mitigation measures and their effectiveness in conserving the cultural heritage resource or heritage attributes. Such evaluation shall be based on established principles, standards and guidelines for heritage conservation and include an assessment of the advantages and disadvantages of each;*
>
> *vii) an implementation and monitoring plan shall be required and include a reporting structure for the implementation of the recommended actions as development and site alteration proceeds; and*

2 The City of Guelph Official Plan, March 2018 Consolidation

viii) any other information required by the Province or the City, in consultation with Heritage Guelph that is considered necessary to evaluate the proposal.

The background research was conducted by Ms. Linda Axford. The heritage property inspection of the entire study area between Wyndham Street south and the East City Limit was conducted on December 4, 2015. Further investigations for the Heritage Impact Assessment at 785 York Road along the Guelph Correctional Centre frontage near the roadway were undertaken on October 28, November 1, and November 22, 2016. The weather was cool and overcast during all four property reviews and did not impede the inspections in any way.

This work is based on a systematic qualitative process carried out to assess the potential heritage value of a given property based on its physical and design characteristics, historical land use and associations, and context, both social and environmental.

Based on a review of all pertinent background sources and information collected during the site visit, the built heritage resources and cultural heritage landscape observed were assessed based on provincial policy guidelines. The Province states that "significant built heritage resources and significant cultural heritage landscapes shall be conserved" (PPS, 2014: Section 2.6.1). Built heritage resources are defined as "one or more significant buildings, structures, monuments, installations or remains associated with architectural, cultural, social, political, economic or military history and identified as being important to a community." Cultural heritage landscapes are defined as "a defined geographical area of heritage significance which has been modified by human activities and is valued by a community...it involves a grouping(s) of individual heritage features such as structures, spaces archaeological sites and natural elements, which together form a significant type of heritage form, distinctive from that of its constituent elements or parts". These resources may be identified through designation or heritage conservation easement under the *OHA*. In assessing a property's cultural heritage value, Wood staff refers to *Ontario Regulation 9/06 - Criteria for Determining Cultural Heritage Value or Interest* and *Ontario Regulation 10/06 – Criteria for Determining Cultural Heritage Value or Interest of Provincial Significance*.

Ontario Regulation 9/06 outlines three main criteria for determining cultural heritage value or interest, further divided into nine sub-categories. A property must meet one or more the criteria in Table 1 to be considered significant. Table 1 provides an evaluation of the given property based on each of the criteria.

Table 1: Evaluation of Cultural Heritage Value (Ontario Regulation 9/06)			
Criteria	**No.**	**Detailed Criteria**	**Evaluation**
Design or Physical Value (The property has design value or physical value because it)	1	Is a rare, unique, representative or early example of a style, type, expression, material or construction method.	It is a rare convergence of two large reform movements: prison reform and the City Beautiful movement.
	2	Displays a high degree of craftsmanship or artistic value.	The inmates were taught stone and mason work which they employed throughout the grounds of the Guelph Correction Centre. This drew on the prison reform concepts of W.J. Hanna which included moving away from imprisonment as a form of punishment, towards the use of productive work and training as a means of rehabilitating inmates and providing them with employable skills for life after prison. This coincided with the Beaux-Arts movement which emphasised civic improvements. Architect John M. Lyle incorporated the French concept of Beaux-Arts in his design of the Reformatory buildings and grounds.
	3	Displays a high degree of technical or scientific achievement.	The inmates were taught the technical skills of stone and mason work which they employed throughout the grounds of the Guelph Correction Centre.
Historical or Associative Value (The property has historical value or associative value because it)	1	Has direct associations with a theme, event, belief, person, activity, organization or institution that is significant to a community.	The cultural heritage landscape of the Reformatory (later the Guelph Correction Centre), has a direct association with W.J. Hanna, a major prison reformer, and the Beaux-Arts movement which was employed by the architect, John M. Lyle. These two themes, and the people who made use of them, were significant to the Reformatory and the community, but also had international importance.
	2	Yields or has the potential to yield information that contributes to the understanding of a community or culture.	The manner of inmate rehabilitation through the acquisition of new skills provides information as to how and why the cultural heritage landscape was created. The landscapes, including the stone walls, weirs, stairs and dams the inmates created, are still enjoyed by the Guelph public today.
	3	Demonstrates or reflects the work or ideas of an architect builder, artist	The cultural heritage landscape reflects the prison reform theories of W.J. Hanna.

Table 1: Evaluation of Cultural Heritage Value (Ontario Regulation 9/06)			
Criteria	**No.**	**Detailed Criteria**	**Evaluation**
		designer or theorist who is significant to a community.	The inmates applied their newly learned skills to stone working and landscaping.
Contextual Value (The property has contextual value because it)	1	Is important in defining, maintaining or supporting the character of an area.	The cultural heritage landscape is important in defining the character of the now closed Guelph Correction Centre, which is currently a public space for the citizens of Guelph.
	2	Is physically, functionally, visually or historically linked to its surroundings.	The cultural heritage landscape provides value as a physical, functional, visual and historical link to the City of Guelph and its inhabitants by presenting the historic stonework and landscaping done by inmates. These built features are still highly valued today.
	3	Is a landmark.	Many parts of the cultural heritage landscape can be seen from York Road and provide a landmark that links the road, the neighbourhood and the City to an important marker of past achievement.

The ORC Conservation Plan of 2006 details the design and physical value and the historical and associative value of the site due to the work of John M. Lyle, a well-known Canadian architect who used the French concept of Beaux-Arts in his designs (ORC, pg. 46). The landscape setting of the GCC also communicates the prison reform movement of W.J. Hanna through its organization of spaces and the features constructed by the inmates. These two transformative individuals contributed to the contextual value by a convergence of new thinking in both prison reform and landscape reform that created a unique site that has survived beyond the correctional facility itself. This site, while functioning visually and historically, is a landmark that is a cherished space for the inhabitants of Guelph and the surrounding area.

Ontario Regulation 10/06 outlines eight criteria for determining cultural heritage value or interest of provincial significance.

A property must meet one or more the following criteria to be considered provincially significant. In a 2013 report, by the Ontario Heritage Trust, entitled *Preliminary Heritage Easement Assessment by Ontario Heritage Trust Staff*, a preliminary evaluation based on the eight criteria of *Ontario Regulation 10/06* is made (OHT, 2013). The report concludes that the site does have provincial heritage significance based on the eight criteria which are taken from the description offered by OHT staff as per the following:

1. *The property represents or demonstrates a theme or pattern in Ontario's history*: The Guelph Correctional Centre (GCC) is associated with the provincial theme of Law and Security.
2. *The property yields, or has the potential to yield, information that contributes to an understanding of Ontario's history:* The design, architecture and landscape of the GCC property is reflective of prison reform and contributes to an understanding of the evolution and history of inmate treatment and rehabilitation in the 20th century.
3. *The property demonstrates an uncommon, rare or unique aspect of Ontario's cultural heritage:* Based on … the well preserved integrity of the heritage attributes (such as the collection of landscape features completed by inmate labour, the expanses of open space and the Beaux-arts architecture of the buildings), it is probable that the GCC demonstrates a unique aspect of Ontario's history and has the potential to possess provincial significance.
4. *The property is of aesthetic, visual or contextual importance to the province:* The City Beautiful Movement, popular in North America from the late 19th century to the start of the Great Depression was an urban planning style and strategy that promoted the creation of civic beauty through architectural harmony, unified design and visual variety.
5. *The property demonstrates a high degree of excellence or creative, technical or scientific achievement at a provincial level in a given period:* The GCC does not have the potential to possess provincial significance under Criterion 5.
6. *The property has a strong or special association with the entire province or with a community that is found in more than one part of the province. The association exists for historic, social, or cultural reasons or because of traditional use:* The GCC does not have the potential to possess provincial significance under Criterion 6.
7. *The property has a strong or special association with the life or work of a person, group or organization of importance to the province or with an event of importance to the province:* The GCC is associated with architect John M. Lyle. Lyle trained as an architect at the Yale School of the Arts and the École de Beaux-Arts in Paris …. On his return to Canada in 1906, he became a key figure in the dissemination of Beaux-Arts ideals to the architectural profession and a leader in Toronto's City Beautiful movement.
8. *The property is located in unorganized territory and the Minister determines that there is a provincial interest in the protection of the property:* The Subject Property is located in an incorporated municipality and therefore Criterion 8 does not apply (OHT, 2013).

In a 2018 report, by Infrastructure Ontario, entitled *Strategic Conservation Plan, Guelph Correctional Centre*, recommendations were made for conservation strategies for the property. This report was written to provide guidance on conserving the cultural heritage value of the property leading up to and during the proposed disposition of the property.

Resources within the Study Area have been assessed on a preliminary basis against the above criteria to determine whether they have any cultural heritage value or interest. They have also been considered in terms of potential project impacts and mitigation measures.

2.0 Historical Context

2.1 Physiography

The study area is located within the Guelph Drumlin Field physiographic region (Chapman and Putnam, 1984, pg. 137). The Guelph Drumlin Field centres on the City of Guelph and Guelph Township and occupies an area of 828 square kilometres. Topsoils are loamy and calcareous, with underlying red shale. The glacial till throughout is rather stony, with large surface boulders being more numerous in some localities than others.

The City of Guelph is the social, cultural, and commercial centre of this region. Founded in 1827 by John Galt of the Canada Company, it was located on a gravel terrace at the confluence of the Speed and Eramosa Rivers. As the city has grown it has spread over the surrounding hills. The Roman Catholic basilica surmounts a drumlin at the end of Macdonell Street in downtown Guelph, while the University of Guelph occupies another couple of drumlins in the south. In the early part of the city's development manufacturing firms were situated in the southeastern part of the city on the gravel terraces adjacent to the Eramosa River. Streams located in the Guelph Drumlin Field are in the spillway valleys, and though small, usually hold some water even in the driest summers, indicating the great reservoir capacity of the Pleistocene gravel beds. This has allowed for significant gravel excavation in the vicinity of Guelph (Chapman and Putnam, 1984, pg. 138).

2.2 Brief History of Guelph and the Guelph Correctional Centre

A review of primary and secondary source material provides a contextual overview of the study area at the front of the Guelph Correctional Centre, including a general description of Euro-Canadian settlement and land use. Historically, the study area of the front portion of the GCC next to York Road comprises Lots 1 to 5 in Concession 2 and Lots 1 to 5 in Concession 3 in the former Township of Guelph, County of Wellington. The two earliest maps used to trace property owners and historical features are the 1861 *Charles J. Wheelock Map of Wellington County*, and the 1877 map of Guelph Township from the *Illustrated Historical Atlas of the County of Wellington*. It should be noted that not all features of interest were mapped systematically in either of these maps as they were financed by subscription and subscribers were given preference with regard to the level of detail provided on the maps (Appendix A: Figures 4 and 5).

Table 2: Review of Historical Maps							
Location		1861 Illustrated Historical Atlas of Wellington County		1877 Illustrated Historical Atlas		1906 Atlas Map of Guelph Township	
Conc.	Lot	Owner(s)	Features	Owner(s)	Features	Owner(s)	Features
II	1	Thomas Coghlin	Tributary	North of the Historic Tributary D. Cameron South of the Historic Tributary H. J. Sanders	Speed River and Tributary Structure	Wm. Gibson	Canadian Pacific Railroad and Tributary
II	2	Thomas Coghlin	Tributary	D. Cameron	Structure and Tributary	Wm. Gibson	Canadian Pacific Railroad and Tributary
II	3	W. Allan	Tributary	NW corner: D.G. Farr D. Allan	Structure and Tributary	Miss. Tend(?) & Wm. Farr	Structure and Tributary
II	4	R. Mathews	Tributary	H. Matthews	Tributary	Chas. & Geo. Mathews	Tributary
II	5	R. Mathews		R. Cochrane	School and Tributary	Jas. Love	Structure and School and Tributary
III	1	R. Dunbar	Railroad	F. Lowal	Tributary and Railroad	H.O. Stutt	Railroad
III	2*	H.M. Culloch	Inn and Railroad	Triangle and West 1/2: J. Smart Eastern 1/2: W.J.P.	Railroad	West ½: Anthony Krajewski, East ½ and Triangle unreadable	Three Structures, Railroad and Tributary
III	3*	F. Kerr	Railroad	SW R.C. NW J.P. SE B.G. NE R. Cochran	Railroad	Wm. Davidson	Railroad
III	4	Traynor	Tributary and Railroad	Southern portion: P Gried Northern portion: J. Murphey	Railroad and Two Structures	Wm. Davidson	Railroad and One structure
III	5	D. Duggan	Tributary and Railroad	Mrs Duggard	Railroad	Valentine Brelski	Railroad and Tributary

Wellington County

In 1838 the District of Wellington was set apart from the previously designated Home District of 1798. Guelph became the county seat and the first meeting of the District Council was held in the Court House on February 8^{th}, 1842 (1906 Historical Atlas, pg. 2). In 1854 the Townships comprising Wellington County were organized into: Amaranth, Arthur, Eramosa, Erin, Garafraxa, Guelph, Maryborough, Nichol, Peel, Piklington and Puslinch.

Prior to the establishment of the railways, reliable roads were very important as all goods were taken by road from Guelph to Dundas to be shipped by water through the Great Lakes. Gravel, for road building, was in abundance in the area and became important in road construction.

The age of the railway followed by the mid-19th century. According to the *Illustrated Historical Atlas of Wellington County* (1906: 2): "On the 30th of January 1852, the first train over the Toronto and Guelph Railway, conveying a large deputation of visitors arrived at the York Road bridge." Thus, commenced an era of great prosperity for Guelph and Wellington County with the Toronto and Guelph Railway later becoming the Grand Trunk Railway.

City of Guelph

The City of Guelph was founded by John Galt, Superintendent of the Canada Company, and a well-known author, on April 23, 1827. Shortly thereafter a frame store was built on East Market Square, near the Grand Trunk station. A sawmill, blacksmith, gristmill and several taverns followed (1906 Historical Atlas, pg.3). By 1833, approximately 1,050 people inhabited the city. During the Rebellion of 1837-38, Guelph suffered from trade depression and it wasn't until the arrival of the railroad that the city started to prosper. Steady growth ensued, and the population rose to 5,000 by 1865 and to 10,000 by 1879.

During the first half of the 20th century, periods of war and economic downturns slowed the growth of Guelph. Factory culture dominated with more than 35% of the population employed by less than half a dozen industries. During this period, civic projects including the Carnegie Library, the Armoury, the enlargement of the Guelph Fairgrounds and the construction of the Provincial Reformatory were built (Cultural Heritage Action Plan: Background Report (July 2018), City of Guelph, pg. 52). The second half of the 20th century saw the relocation of industry outside of the downtown area which meant more automobile dependence and road construction.

Township of Guelph

In 1827 through the Canada Company, Galt bought unsold lands in Upper Canada to compensate people loyal to the British Government who had lost land during the War of 1812. Galt chose Guelph Township as it was one of the largest vacant blocks of land within reasonable distance to York for trade purposes and settlement on either side of the township was well-established (Cultural Heritage Action Plan, City of Guelph, pg. 49).

Guelph Township was patented on July 9th, 1829 and contained an area of 42,338 acres (17,134 hectares). The first settler in the township was Samuel Rife who arrived in 1825 and the first road was called the Waterloo road, and later renamed the Broad road. A ship full of Scottish settlers arrived in 1827 and left their mark in the names of various streets and buildings such as Paisley Street (1906 Historical Atlas, pg. 8).

Throughout the 19th and 20th centuries Guelph Township became a centre for agricultural excellence supported by rural and agricultural educational institutions.

Guelph Correctional Centre

In 1909, 1,000 acres (453 hectares) of farmland were purchased by the Province of Ontario along York Road in the City of Guelph for the purpose of creating a new prison. The prison was not only at a new location but was also new in concept. The driving force behind the location and the concept was William John Hanna, Secretary and Registrar General for the Province of Ontario. He was responsible for public charities, prisons, asylums, health, child welfare, statistics, corporate registration and liquor regulations.

Although eventually known as the Guelph Correctional Centre (GCC), the site was initially known as the Ontario Reformatory, and followed W.J. Hanna's reform theories of moving away from incarceration as a form of punishment toward the use of productive work and training as a means of rehabilitating inmates and giving them employable skills for life on the outside. Hanna's "reformist ideals were not restricted to corrections; Hanna was also a leading force in the building of the Whitby psychiatric hospital beginning in 1913 where he hoped that a similar program of humane treatment, useful work, extensive grounds, sympathetic architecture and attentive staff would create an environment conducive to treatment and cure" (ORC, 2006, pg.5).

Photograph 1: 1948 Aerial Photo of Guelph Correctional Centre (initially known as Ontario Reformatory) Taken from Toronto Public Library website:
https://www.torontopubliclibrary.ca/search.jsp?Erp=20&N=&No=20&Ntt=Ontario+Reformatory+Guelph+%28Ont.%29&view=grid

In 1911 Hanna hired well-known architect John M. Lyle to design the buildings at GCC. Lyle was trained in France and the United States in the Beaux-Arts style of architecture and although Hanna and Lyle could not agree on fees, the design of the early buildings have a strong Lyle design style. By 1915, Lyle had been replaced by James Govan, an architect in the Department of Provincial Secretary, who had been responsible for the designs of the Whitby hospital buildings. The grounds were planned and managed by the reformatory managers and staff of the Ontario Agricultural College at Guelph (ORC, 2006, pg.5).

While the design was done by professionals, it was the actual construction and craftsmanship that embodies the work of the prisoners. The park-like entrance way including stone gateways with wing-walls opening to the street, weirs and dams in Clythe Creek, and the gatehouse along York Road are part of the landscape's formal presentation zone. This area is unlike any previously constructed prison in the province and envisioned the prison reform theories of W.J. Hanna. The bucolic setting later became a recreational setting for the residents of Guelph who held picnics and walked the pathways.

Besides showcasing the prison reform movement, the Guelph Correctional Centre also represented the City Beautiful movement of the early twentieth century. "While the term 'City Beautiful' implied a range of civic improvement efforts, most planning historians have emphasized the so-called 'comprehensive schemes of city beautification' which focused on the treatment of streets, parks and/or civic centres. Design principles included axial arrangements, vistas and focal points, classical touches, and a tendency towards order and symmetry" (Meek 1979, pg. ii).

Similar to the prison reform movement, the City Beautiful movement espoused that beautiful cities could affect human behaviour. As a by-product of the Beaux-Arts movement, it contained the notion that urban beautification actively improved the moral and social character of the citizens. Using this model, it was assumed that citizens would value, respect and keep their surroundings beautiful and tidy and by doing so would become more genteel and respectable (http://vancouverpublicspace.ca/2016/02/04/the-city-beautiful-movement-urban-design-and-moral-well-being). As the perfect convergence of both reform movements, the Guelph Correctional Centre stood alone in its uniqueness and significance during this transformative period.

Photograph 2: 1935 Postcard Showing Water Falling over Weirs:
http://guelphpostcards.blogspot.ca/search/label/Guelph%20Correctional%20Centre

This circa 1935 postcard is entitled: "Scene by the Highway, near Guelph, Ontario, Canada. "
There is no mention of the Guelph Correctional Centre.

It was the Reformatory inmates which was integral to landscaping the site. They dug two large lakes along York Road, beautified Clythe Creek with stone retaining walls, piers and dams, and installed tile drainage systems in the now unused Royal City Jaycees Bicentennial Park and in the field opposite Willowbank Hall. They maintained the grounds, flower beds, floral displays, tree pruning and all aspects of vegetable gardening. From a visual perspective, it was their artistry and labour that created the extensive and beautiful stone walls, steps, bridge features and dams and weirs along Clythe Creek.

Photograph 3: Ontario Reformatory gardens circa 1960, taken from Guelph Museum Collections
https://guelph.pastperfectonline.com/photo/6491B56C-7EB3-41B6-AA82-162011154698

While it is the front of the property next to York Road that is the focus of this report, the entirety of the GCC contained a self-sufficient industrial complex and working farm. The whole site included an astonishing array of buildings that not only housed the inmates but added in their rehabilitation. Some of these reintegration facilities included a greenhouse, a textile shop, a woolen mill, a cannery and an abattoir.

Farm operations were discontinued in the mid-1970's when the prison reform movement changed direction yet again. The entire Centre was closed in 2001 when the Province decided that it was too expensive to maintain and chose to streamline the correctional system. It has remained vacant since then, except for occasional use by the film industry and security training groups.

3.0 Legislative Framework, Cultural Heritage Resource Evaluation Tools

3.1 Ministry of Tourism Culture and Sport

Guidelines for undertaking the assessment of cultural heritage resources are provided by various government ministries, including the Ministry of Tourism, Culture and Sport (MTCS), which acts as administrator of the *Ontario Heritage Act*, and is ultimately responsible for the conservation, protection, and preservation of cultural heritage in the province.

The MTCS has issued guidelines to assist in the identification and assessment of cultural heritage resources as part of the environmental assessment process. These guidelines include: "*Guidelines for Preparing the Cultural Heritage Resource Component of Environmental Assessments*" (1992) and *"Guidelines on the Man-Made Heritage Component of Environmental Assessments"* (1980). These guidelines distinguish between built heritage resources and cultural heritage landscapes. Built heritage resources are individual person-made or modified resources such as buildings or structures. Cultural heritage landscapes are geographical areas that have been modified by human activity over time and may include a grouping of built heritage components.

The MTCS has also issued the *Ontario Heritage Toolkit* ("Toolkit") to assist in understanding the legislation and tools available for the conservation of cultural heritage resources. The Toolkit provides a framework for heritage property evaluation and defines "cultural heritage properties" as: "built heritage resources, cultural heritage landscapes, heritage conservation districts, archaeological resources and/or areas of archaeological potential that have cultural heritage value or interest, cemeteries and burial features, landscapes, spiritual sites, ruins, archeological sites, and areas of archaeological potential (MTCS, 2006: 6).

3.2 Ontario Heritage Act

Using policy direction as outlined in the *Provincial Policy Statement* (Ministry of Municipal Affairs and Housing, 2014), the protection of cultural heritage resources is considered a matter of provincial interest under the authority of the *Planning Act* and further defines a built heritage resource as "significant" if it is "valued for the important contribution [it] make[s] to our understanding of the history of a place, an event or a people". The *Ontario Heritage Act* (OHA) charges the MTCS with the responsibility for the conservation, protection and preservation of Ontario's cultural heritage and, as such, the MTCS acts as administrator of heritage legislation.

The OHA provides tools to Ontario's municipalities to protect their heritage resources. Municipalities' conservation efforts are enabled by the OHA, which outlines the criteria to be used for the evaluation of significance. Section 29 of the OHA allows cultural heritage properties to be designated, which results in long-term protection. Further, Section 27 requires the Clerk of a municipality to keep a public register of heritage properties, which includes all those properties designated under the OHA, but also allows municipalities to list non-designated properties on the "Municipal Register," which provides short-term protection from removal. When a property is designated under the OHA, it is also placed on the Ontario Heritage Trust's provincial register of heritage properties.

The primary goals of heritage assessments are: to create a register or inventory of cultural heritage resources within a project Study Area; to evaluate potential impacts on those resources; and to propose mitigation options (MTCS, 2006). The criteria for identifying and evaluating heritage properties include both quantitative and qualitative attributes. Ontario regulation 9/06 made under the OHA, outlines three criteria for determining cultural heritage value or interest. These include: design/physical value, historical/associative value, and contextual value.

Cultural heritage landscapes can be evaluated using the same criteria. These can include remnant landscapes where only a fraction of the original heritage features is present.

Defined landscapes include gardens, parks, and cemeteries which were designed for aesthetic or economic reasons. Organically evolved landscapes result from a long-term relationship between human activity and the natural environment. They may represent a past event of process with tangible markers of that time or their use may be continuing to play a role in contemporary society but retain evidence of past use. Associative cultural landscapes include those which may have no evidence of cultural activity, but the natural features are known to have spiritual, artistic, or other cultural significance.

3.3 City of Guelph Official Plan (March 2018 Consolidation)

Within the Official Plan Consolidation (March 2018) (Section 2.2 Protecting What Is Valuable) 2c: Enhance the visual identity of the city through protecting and celebrating the City's cultural heritage resources. In section 4.8 Cultural Heritage Resources, the Official Plan states that: Cultural heritage resources are the roots of the community. They may include tangible features, structures, sites or landscapes that either individually or as a part of a whole are of historical, architectural, scenic or archaeological value. Cultural heritage resources may also represent intangible heritage such as customs, ways of life, values and activities. These resources may represent local, regional, provincial or national heritage interests and values. They include built heritage resources, cultural heritage landscapes and archaeological resources. Cultural heritage resources paint the history of the city and provide identity and character while instilling pride and contributing to economic prosperity.

Objectives:

a) To maintain and celebrate the heritage character of the city, including built heritage resources, cultural heritage landscapes and archaeological resources.

b) To identify, evaluate, list, conserve and protect cultural heritage resources through the adoption and implementation of policies and programs including partnerships amongst various public and private agencies and organizations.

c) To enhance the culture of conservation city-wide by promoting cultural heritage initiatives as part of a comprehensive environmental, economic and social strategy where cultural heritage resources contribute to achieving a sustainable, healthy and prosperous city.

d) To ensure that all new development, site alteration, building alteration and additions are contextually appropriate and maintain the integrity of all in situ cultural heritage resources or adjacent protected heritage property.

e) To promote and foster the preservation, rehabilitation and adaptive re-use or restoration of built heritage resources and cultural heritage landscapes so that they remain in active use.

f) To promote public and private awareness, appreciation and enjoyment of the City's cultural heritage resources through public programs and activities, heritage tourism and guidance on appropriate conservation practices.

g) To maintain a municipal register of properties of cultural heritage value or interest in accordance with the Ontario Heritage Act.

h) To identify, designate and conserve built heritage resources and cultural heritage landscapes in accordance with Part IV of the Ontario Heritage Act.

i) To identify, designate and conserve Heritage Conservation Districts under Part V of the Ontario Heritage Act.

j) To identify, evaluate and conserve heritage trees which satisfy the criteria for determining cultural heritage value or interest as prescribed by regulation under the Ontario Heritage Act.

k) To identify, evaluate and conserve archaeological resources and areas of archaeological potential in accordance with the Ontario Heritage Act. 2.4.15, the Culture of Conservation, the OP states the importance of cultural heritage conservation, including conservation of cultural heritage and archaeological resources, where feasible.

Section 4.8.1 Policies (that pertain to this site):

1. Cultural heritage resources shall be conserved in accordance with this Plan and all other relevant legislation.

3. A register of property situated in the city that is of cultural heritage value or interest shall be maintained and kept up to date by the City, in consultation with Heritage Guelph, according to Section 27 of the Ontario Heritage Act. The Municipal Register of Cultural Heritage Properties (or Heritage Register) will list designated cultural heritage resources and non-designated built heritage resources and cultural heritage landscape resources.

6. Built heritage resources and cultural heritage landscapes are required to be maintained with appropriate care and maintenance that conserves: i) the City's Property Standards By-law, the Tree By-law and the Site Alteration By-law; and ii) prescribed federal and provincial standards and guidelines.

7. The ongoing maintenance and care of individual built heritage resources and cultural heritage landscapes and the properties on which they are situated together with associated features and structures is required in accordance with City standards and bylaws and, where appropriate, the City will provide guidance on sound conservation practices.

10. The City will encourage property owners to seek out and apply for funding sources available for conservation and restoration work.

12. The City will ensure the conservation and protection of cultural heritage resources in all planning and development matters including site alteration, transportation, servicing and infrastructure projects.

14. It is preferred that cultural heritage resources be conserved in situ and that they not be relocated unless there is no other means to retain them. Where a cultural heritage resource cannot be conserved in situ or through relocation and approval for removal is granted, the City in consultation with Heritage Guelph will require the proponent to provide full documentation of the cultural heritage resource for archival purposes, consisting of a history, photographic record and measured drawings, in a format acceptable to the City.

15. The proponent shall provide and deliver to the City all or any part of the demolished cultural heritage resource that the City, in consultation with Heritage Guelph, considers appropriate for reuse, archival, display, or commemorative purposes, at no cost to the City. The City may use or dispose of these artifacts as it deems appropriate in accordance with the Ontario Heritage Act and any applicable regulations or guidelines.

In Section 5.8: Road Design Policies (that pertain to this site):

1. The City will ensure any impacts on the Natural Heritage System and cultural heritage resources are addressed in the design process for road capital projects in accordance with the provisions of this Plan.

2. The City shall have regard for and, when necessary, will require measures to mitigate any negative impacts on cultural heritage resources, especially the character of landscapes, streetscapes, tree lines, bridges, views and points of scenic interest and the prevailing pattern of settlement, when considering the construction of new roads and road improvements, including road re-alignment and road widening.

3.4 The Official Plan Amendment (OPA) #54 – Guelph Innovation District (York District Lands)

Principle 4: Create an Attractive and Memorable Place, specifically mentions the former Guelph Correction Centre in 'j)' by stating: "respect (and emulate where appropriate) the Beaux-Arts design of the *cultural heritage landscape* component of the historic Reformatory Complex".

In Section 11.2.2.2 Cultural Heritage the Amendment states that development within the Guelph Innovation District (Appendix A: Figure 6) that are designated as Adaptive Re-use within a *cultural heritage landscape* with *built heritage resources* should adopt an architectural vocabulary and design elements that are compatible with and respectful of the cultural heritage value and heritage attributes of the *cultural heritage resources* on site.

It further states that *cultural heritage resources* including all features identified as provincially significant shall be conserved through long term protection mechanisms (e.g. heritage conservation easements) and that a Cultural Heritage Resource Impact Assessment and/or Conservation Plan will be required as part of a complete application to ensure that the *cultural heritage resources* within the site will be conserved. Also, important in OP54 are the visual relationships between *cultural heritage landscapes* and *built heritage resources*.

Also, important to understanding the level of significance of the study area, the Amendment states that "development will respect the existing *cultural heritage resources* and important *public views* and *public vistas* in site design (OPA 54, pg. 34).

4.0 Analysis

The study area is comprised of an evolved cultural heritage landscape. While the maintenance of the GCC has been limited since the closure of the facility in 2001, the man-made landscapes in the study area are still in evidence and viable. This ornamental landscape faces York Road and consists of man-made ponds, dams and weirs in Clythe Creek, park-like grounds, lawns, mature trees, small stone wing walls at the north east corner of the CHL, stone stairs and a stone gateway with wing-walls opening to the street. Willowbank Hall, the cottage near the entrance, also adds a domestic appearance to the front of the site.

In 2006, the property was recognized as a provincially significant heritage resource by the Ontario Realty Corporation (now Infrastructure Ontario). The ensuing ORC Cultural Heritage Assessment Report gave an overview of the site, a detailed history of the facility and the individual buildings. The description of the landscape explains the reform theory of the site:

> *The evolved cultural landscape has two main parts: an ornamental landscape created by prison labour to define the hierarchy of the site and to create scenic and gardenesque elements; and the working landscape, where agricultural and industrial activities supported the correctional philosophy and everyday prison life* (ORC 2006, pg. 34).

The section of the ORC report most salient to this Heritage Impact Assessment describes the main York Road entrance which:

> *…still retains its landscape features including the mature trees and ornamental stone walls, and two decorative concrete bridges. The main driveway crosses over a manmade rustic watercourse of ponds, dams, and streams. Within the ornamental landscape with its park like arrangement of wide open lawns dotted with mature specimen trees are other stonework features which are unique and rare surviving examples of this craft. The stonework, a result of years of inmate labour, is found in the stairs, walls, gateposts, bridges and dams. There are two types of stone, native limestone and granite fieldstone used with a variety of joint patterns. The extensive stonework is generally intact and is of unrivaled heritage value* (ORC 2006, pg. 34).

The ORC report further suggested that the "two ponds are considered part of the designed landscape that forms the larger cultural heritage landscape" (ORC 2006, pg. 38).

In a 2018 report, by Infrastructure Ontario, entitled *Strategic Conservation Plan, Guelph Correctional Centre*, recommendations were made for conservation strategies for the property. This report was written to provide guidance on conserving the cultural heritage value of the property leading up to and during the proposed disposition of the property.

The primary watercourse through the study area is Clythe Creek, which crosses York Road west of Watson Parkway. Its headwaters are a coldwater stream that has historically sustained a trout population. It is feasible that at some point in time, the lower section of the creek also supported cold to cool water fish populations, however current temperature monitoring suggests this is no longer the case.

Presently, the creek is highly altered, with numerous drop structures (most of which have cultural heritage value that restrict fish passage and on-line ponds that warm the water. Clythe Creek is further constrained by the available area between York Road and two large on-line ponds.

In addition to Clythe Creek, consideration must also be given to Hadati Creek, which drains in an easterly direction along Elizabeth Street before outletting across York Road to Clythe Creek.

As noted within the original 2007 Class EA, the proposed roadway improvements were expected to impact Clythe Creek and recommendations were made with respect to an extension of the existing Clythe Creek Culvert where it crosses York Road. Also recommended was the possible relocation of approximately 135 m of the Clythe Creek Channel to accommodate the proposed road widening, which would leave the heritage features in situ but without water flow.

The potential re-alignment of Clythe Creek (Appendix A: Figure 7a, b and c), due to the potential widening of York Road and the natural heritage objective to create a cool/cold-water creek, would alter the overall look of the cultural heritage landscape in several ways. Furthermore, the widening of York Road could also potentially impact some of the heritage resources due to visibility, grading and road salt.

Appendix A: Figures 7a, b and c show the potential realignment of Clythe Creek (Option 4) and indicate numbers used in the Heritage Resources Table 3 below.

Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
1	 Bridge shown from the south side of York Road. Clythe Creek passes through the culvert under the road at this location.[3]	**Relocation or Removal:** Bridge/culvert would be removed and replaced with a wider arched culvert for the road widening.	No mitigation
2	 Reinforced concrete road bridge railing (remnant) circa 1920 on the north side of York Road.	**Relocation or Removal:** This feature would be removed due to road widening and multi-use path.	If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation. Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.

3 Source of all photos in Table 3 is the City of Guelph, Heritage Planning file photos.

Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
3	 Fieldstone weir with steps and sentinel stones. This is a barrier to fish passage.	**Maintained in situ:** This feature would be maintained in landscape but will be impacted by loss of flow as a result of channel realignment.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. Where possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structure.
4	 Fieldstone garden wall with sentinel stones.	**No Impact:** Wall to remain in existing condition	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.
5	 Fieldstone weir with clay pipes. This is a barrier to fish passage.	**Maintained in situ:** This feature would be maintained in landscape but would be impacted by loss of flow as a result of channel realignment	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. Where possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structure.

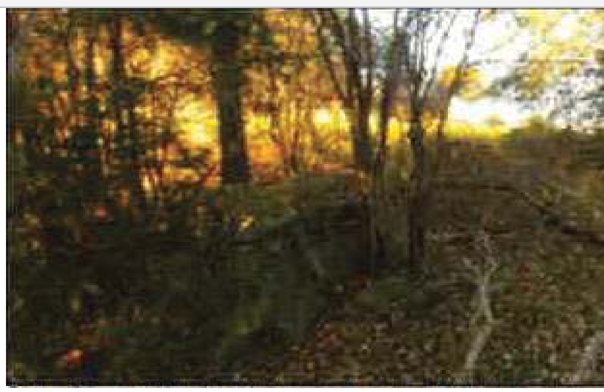
Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	Photo	Impacts	Recommended Mitigation
6	 Fieldstone steps.	**Potentially impacted:** The steps may be covered by grading for road and pathway.	If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation. Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.
7	 Large Boulder or bedrock outcrop.	**Potentially impacted:** This feature may be covered by grading for road and pathway	If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation. Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.

Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
8	 Fieldstone weir. This is a barrier to fish passage	**Maintained in situ:** The weir would be maintained in landscape but would be impacted by loss of flow as a result of channel realignment.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. Where possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structure.
9	 Fieldstone weir beside gabion baskets. (Gabion baskets are not part of listed heritage resource).	**Removal or possibly maintained in situ:** This feature would be removed due to grading for road widening and multi-use path. If a proposed retaining wall is built it could be maintained in the landscape but will be impacted by loss of flow.	If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation. Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.

Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
10	 Fieldstone weir.	**Removal or possibly maintained in situ:** This feature would be removed due to grading needed for road widening and multi-use path. If a proposed retaining wall is built it could be maintained in the landscape but will be impacted by loss of flow.	If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation. Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.
11	 Fieldstone weir, steps and ashlar stone terrace wall.	**Maintained in situ:** This feature would be not be removed. If a proposed retaining wall is built it could be maintained in the landscape but would be impacted by loss of flow.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. The installation of a closed water loop system would give periodic appearance of creek flow.
12	 Ashlar cut limestone terrace wall.	**Maintained in situ:** Feature could be maintained as the creek realignment could avoid it.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.

Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
13	 Confluence of creek and intermittent stream.	**Relocation or Removal:** The existing intermittent stream would be filled and re-graded.	The confluence will be relocated.
14	 Fieldstone weir with cut stone terrace wall. New channel would tie into existing creek just west of #14.	**Maintained in situ:** This feature does not need to be removed. An overflow channel could be incorporated so that the feature will be reconnected during high-flow stages (i.e., flows greater than the 2-year discharge).	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. The installation of a closed water loop system would give periodic appearance of creek flow.
15	 Roughly squared stones cut from the limestone quarry and fieldstone east entrance wall, curved with sentinel stones.	**Relocation:** This feature would be removed due to grading needed for road widening and multi-use path. Road widening without moving this feature would result in less visibility of feature, potential damage due to grading requirements, snow and salt issues.	This structure would be removed and reconstructed back further from the road by skilled heritage masons. The details of the reconstruction would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. See Drawing 1 on page 4.

Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
16	 Roughly squared stones cut from the limestone quarry and fieldstone west entrance wall, curved with sentinel stones.	**Relocation:** This feature would be removed due to grading needed for road widening and multi-use path.	This structure would be removed and reconstructed back further from the road by skilled heritage masons. The details of the reconstruction would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. See Drawing 1 on page 4.
17	 Stone and concrete road bridge.	**No Impact:** Feature to remain in existing location.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.
18	 Fieldstone steps to the south of road bridge.	**No Impact:** Feature to remain in existing location.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.

Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
19	 Entrance sign, ashlar, rock-faced limestones with jack arch.	**No Impact:** Feature to remain in existing location.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.
20	 Ashlar dry stone wall.	**No Impact:** Feature is located within the floodplain and will not be impacted by proposed channel works. Feature is to remain in existing location.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.
21	 Willowbank Hall.	**No Impact:** Feature to remain in existing location.	If it is to be part of the Conservation Plan, it may be rehabilitated. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant.

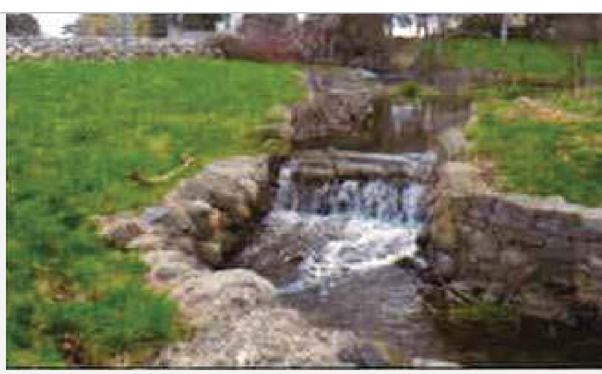
Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
22	 Fieldstone weir.	**Relocation or Removal:** This feature would be removed as a result of channel work.	If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation. Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.
23	 Fieldstone weir and culvert.	**Maintained in situ:** Feature would be maintained in landscape but would be impacted by loss of flow as a result of channel realignment.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. Where possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structure.
24	 Fieldstone weir and culvert.	**Relocation or Removal:** This feature would be removed as a result of channel work and grading for roadway and pathway.	Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.

Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
25	 Fieldstone weir.	**Relocation or Removal:** This feature would be removed as a result of channel work and grading for roadway and pathway.	If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation. Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.
26	 Fieldstone weir.	**Relocation or Removal:** This feature would be removed as a result of channel work.	If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation. Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.

Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
27	 Limestone pillars with wood board fencing leading to main entrance.	**Relocation or Removal:** This feature would be removed due to grading needed for road widening and multi-use path.	If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation. Partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.
28	 Metal and wood pedestrian bridge.	**Potential Modification or Removal:** Potential for feature to be modified to accommodate pedestrian traffic or removed due to channel works.	The modifications to be developed during the preparation of a Conservation Plan by a qualified heritage consultant. If possible, relocation within the GCC or to other parts of Guelph in order to better accommodate conservation and adaptive reuse. The appropriate context of the resource must be considered in relocation If removal is required, partial salvage, documentation through measured drawings and high-resolution digital photographs, and/or historical plaquing.

Table 3: Current Heritage Resource Photographs with Impacts and Mitigation			
No	**Photo**	**Impacts**	**Recommended Mitigation**
29	 Box culvert at confluence of Clythe Creek and Hadati Creek.	**Potential Modification:** Culvert may be extended to accommodate roadway grading requirement and CSP replacement.	No Mitigation required.
30	 Concrete and stone weir.	**Maintained in situ:** Feature would be maintained in landscape but would be impacted by loss of flow as a result of channel realignment.	May require repairs. This would be decided during the preparation of a Conservation Plan by a qualified heritage consultant. Were possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structure.
31	 GJR railroad bridge.	**No Impact:** Feature to remain in existing condition.	

5.0 Mitigation

The Ministry of Tourism, Culture and Sport in Info Sheet #2, entitled *Cultural Heritage Landscapes,* states that:

> *The conservation of a significant cultural heritage landscape considers not only the preservation of specific features which make up the landscape, but also the relationships of such features inside and outside its boundaries. Consideration should also be given to the surrounding context within which a cultural heritage landscape is located and the need for conservation strategies such as buffer zones.*

The Ontario Heritage Act enables municipalities to identify, list and protect properties with cultural heritage value or interest. It also gives municipalities and the Ontario Heritage Trust the ability to hold heritage conservation easements on real property. The Ontario Heritage Trust, an agency of the Ministry of Culture, is dedicated to identifying, preserving, protecting and promoting Ontario's rich and varied heritage resources.

Info Sheet #5, entitled *Heritage Impact Assessments and Conservation Plans,* suggests that municipalities and approval authorities can further enhance their own heritage preservation objectives by using heritage impact assessments and conservation plans.

Info Sheet #5 also lists some of the negative impacts that can affect a cultural heritage resource:

- Destruction of any, or part of any, *significant heritage attributes* or features;
- Alteration that is not sympathetic, or is incompatible, with the historic fabric and appearance;
- Shadows created that alter the appearance of a *heritage attribute* or change the viability of a natural feature or plantings, such as a garden;
- Isolation of a *heritage attribute* from its surrounding environment, context or a *significant* relationship;
- Direct or indirect obstruction of *significant* views or vistas within, from, or of built and natural features;
- A change in land use such as rezoning a battlefield form open space to residential use, allowing new *development* or *site alteration* to fill in the formerly open spaces; and,
- Land disturbances such as a change in grade that alters soils, and drainage patterns that adversely affect an archaeological resource.

Mitigation, according to the MTCS, in Info Sheet #5, allows for the avoidance or minimization of negative impacts on a cultural heritage resource and may include:

- Alternative *development* approaches;
- Isolating *developmen*t and *site alteration* from *significant* built and natural features and vistas;
- Design guidelines that harmonize mass, setback, setting, and materials;
- Limiting height and density;
- Allowing only compatible infill and additions;
- Reversible alterations; and
- Buffer zones, site plan control and other planning mechanisms.

While the development approaches that have been currently determined for the York Road improvements, leave few options for mitigation of the heritage resources, suggestions are itemized below. The heritage resources of the former GCC lands that front York Road in the City of Guelph, are unique and highly valued and, as such, would require careful planning. They include stone wing walls, a creek with multiple weirs, retaining walls and stairways, ponds and both vehicular and pedestrian bridges and form an extensive landscape enjoyed both in the past and the present by the Guelph community.

The wing walls (Table 3: #15 and #16) at the entrance off York Road to the GCC would need to be dismantled and reconstructed with the east wall in the approximate same location but extended by 7 m so that the end treatment does not conflict with the existing in-water feature. The west wall would be moved further south, away from the roadway and out of the clear zone. If the walls were left in the current locations, a guardrail would need to be placed approximately 0.5 m to 1.5 m in front of the walls, and with the walls remaining partially buried, the view of the walls would be greatly diminished. There would also be a possibility of damage to the walls during the road construction. In addition, snow could be piled up next to them due to the lack of space from the road and multi-use pathway. This could potentially also result in structural damage to the walls.

A qualified heritage stone mason would be required to document the location of key stones by a numbering system as preparation for the carefully relocation of the existing walls according to an approved Conservation Plan. Interpretive signage would add to the understanding of the significance of the walls.

Although the west wall would be further south and the east wall would be extended, the rebuilding of the two walls would bring the walls closer to the original 1920 appearance. This, along with interpretive signage, would improve the public's view and understanding of the history of the entranceway.

Photograph 4: 1920's Picture of Dry Stone Wing Wall with Circular End Treatment. The height of the wall is noticeably taller. The existing wall has been partially buried due to road grading. Photo from the Guelph Civic Museum.

The realignment of major portions of Clythe Creek also impacts the heritage features. While some of the features would need to be removed, others would stay in situ but without regular water flow; flow would occur in some locations in large storm events Mitigation may include the installation of a closed water loop system to give periodic appearance of creek flow.

Section 4.0 Analysis contains *Table 3: Heritage Resource Photos with Impacts and Mitigation* which shows each resource and the resulting road improvement impact and mitigation suggestion. The changes would include removal of the cast-in-place concrete culvert (#1) which travels under York Road; the remnant bridge railing on the north side of York Road (#2); the intermittent stream which feeds into Clythe Creek (#13) and the field stone weirs #22, 24, 25, and 26; and the limestone pillars and wood board fencing alongside York Road (#27). Some field stone weirs and steps would remain in situ but without water flow (these include stone weirs #3, 5, 8, 23 and #30 which is cast-in place concrete). Were possible, creek realignment design should incorporate the 'high-flow' channel to convey higher flows over the weir structures.

Field stone weirs #9, 10, 11, and 14 and the terrace wall #12 may be removed or could possibly be maintained in situ with retaining walls or grading. However, if they remain, the weirs would all be impacted by loss of flow as a result of channel realignment. The current design of the realignment of the creek bed would be relocated south of the existing creek bed just west of weir #14 with the existing bed filled in and re-graded.

Due to the road redesign, the grading of both the road and the multi-use path may impact the fieldstone steps (#6) and a large bedrock outcrop (#7), the metal and wood bridges (#28 and29) and the box culvert (#30) due to the channel work or pedestrian traffic needs.

Any removed heritage resources should be salvaged and reused if possible. A detailed documentation and commemoration (e.g. a heritage interpretation plaque) may also be required. A heritage consultant may need to provide a list of features of value to be salvaged. This could be accomplished in a Conservation Plan. Materials may be required to be offered to heritage-related projects, on or near the GCC, prior to exploring other salvage options.

Ruinfication would allow some of the resources to be maintained on the site. Symbolic conservation refers to the recovery of the appropriate resources and incorporating them into new development of the site, or possibly using a symbolic design method to depict a theme or remembrance of the history of the GCC.

6.0 Recommendations

In light of the preceding, it is recommended that the following mitigation measures be taken:

1) Since preservation in situ is not feasible for all of the heritage resources, rehabilitation, adaptive reuse and restoration must be done in a sensitive manner in order to protect the site's heritage value.

2) It is recommended that a Conservation Plan be prepared during the detailed design plan phase for improvements to York Road. A Conservation Plan would be prepared by a qualified heritage consultant and would guide the work of relocating the built heritage resources within this locally and provincially significant cultural heritage landscape. The scope of the Conservation Plan should include the following:

    - Interpretation plan and/or strategy
    - Preliminary recommendations for restoration, rehabilitation and/or adaptive reuse;
    - Critical short-term maintenance required to stabilize the heritage resources and prevent deterioration;
    - Measures to ensure interim protection of heritage resources during phases of construction or related development;
    - Security requirements;
    - Restoration and replication measures required to return the property to a higher level of cultural heritage value or interest integrity, as required;
    - Appropriate conservation principles and practices, and qualifications of contractors and trades people that should be applied, especially in the dismantling and reassembling of the wing walls;
    - Longer term maintenance and conservation work intended to preserve existing heritage fabric and attributes;
    - Drawings, plans, specifications sufficient to describe all works outlined in the Conservation Plan;
    - An implementation strategy outlining consecutive phases or milestones;

- Cost estimates for the various components of the plan; and,
- Compliance with recognized *Standards and Guidelines for the Conservation of Historic Places in Canada*, the *Guelph Innovation District* (York District Lands) *Official Plan Amendment 54,* City of Guelph Official Plan (2014) and other recognized heritage protocols and standards. As stated in the *Standards and Guidelines for the Conservation of Historic Places in Canada*, it is important to begin with a thorough understanding of the heritage value of the site, along with its condition, evolution over time, and past and current importance to the community (pg.3). The author of the Conservation Plan should work closely with the City of Guelph and the Province of Ontario (Infrastructure Ontario) to compile all available information pertinent to defining the study area's unique character-defining elements.

7.0 Assessor Qualifications

This report was prepared and reviewed by the undersigned, employees of Wood Environment & Infrastructure Solutions, a division of Wood Canada Limited. Wood is one of North America's leading engineering firms, with more than 50 years of experience in the earth and environmental consulting industry. The qualifications of the assessors involved in the preparation of this report are provided in Appendix B.

8.0 Closure

This report was prepared for the exclusive use of the City of Guelph and is intended to provide a Heritage Impact Assessment of the study area. The property is located on York Road, City of Guelph, Ontario.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of the third party. Should additional parties require reliance on this report, written authorization from Wood will be required. With respect to third parties, Wood has no liability or responsibility for losses of any kind whatsoever, including direct or consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

The report is based on data and information collected during the field inspections conducted by Wood. It is based solely on a review of historical information and data obtained by Wood as described in this report. Except as otherwise maybe specified, Wood disclaims any obligation to update this report for events taking place, or with respect to information that becomes available to Wood after the time during which Wood conducted the archaeological assessment.

In evaluating the property, Wood has relied in good faith on information provided by other individuals noted in this report. Wood has assumed that the information provided is factual and accurate. In addition, the findings in this report are based, to a large degree, upon information provided by the current owner/occupant. Wood accepts no responsibility for any deficiency, misstatement or inaccuracy contained in this report as a result of omissions, misinterpretations or fraudulent acts of persons interviewed or contacted.

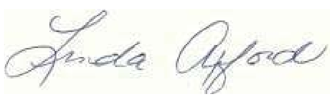
Wood makes no other representations whatsoever, including those concerning the legal significance of its findings, or as to other legal matters touched on in this report, including, but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation and change. Such interpretations and regulatory changes should be reviewed with legal counsel. This report is also subject to the further Standard Limitations contained in Appendix C.

We trust that the information presented in this report meets your current requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Respectfully Submitted,

Wood, Environment & Infrastructure,
a Division of Wood Canada Limited

Prepared by,



Linda Axford, MLA, CAHP
Senior Heritage Specialist

Reviewed by,

Shaun Austin, Ph.D.
Associate Archaeologist (P141)

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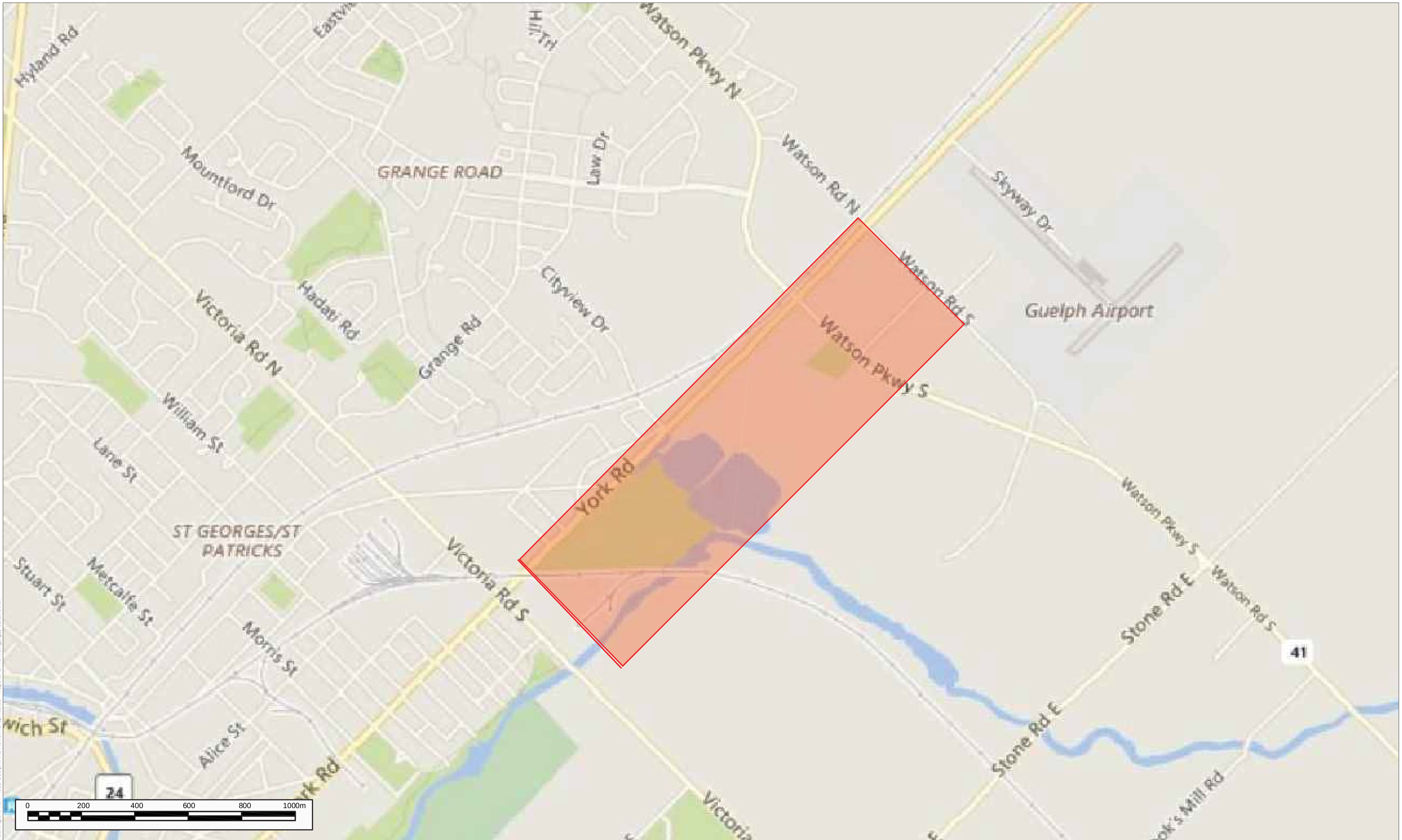
Guy Leslie and Charles J. Wheelock
1861 Wheelock's Map of the County of Wellington, Canada West, University of Toronto Map and Data Library.

Appendix A

Figures



LEGEND

Study area

NOTES:

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE REPORT No. TP115100.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Canadian Topographic maps http://www.gisapplication.lrc.gov.on.ca/matm/Index.html?site=Make_A_Topographic_Map&viewer=MATM&locale=en-US

CLIENT:
CITY OF GUELPH

Drawn By:	CH
Checked By:	SA
Revision N°:	01
Scale:	1: 20,000

N / E / S / W

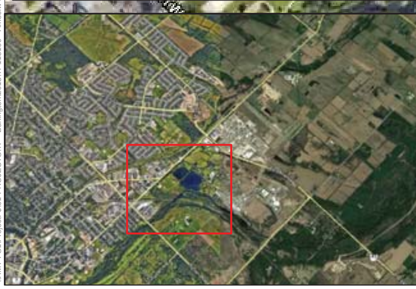
HERITAGE IMPACT ASSESSMENT
York Road Environmental Design Study

Location of the Study Area

PROJECT N°:	TP115100
DATE:	01 Mar 2019

FIGURE: 1

Wood Environment and Infrastructure Solutions
3450 Harvester Road, Suite 100, Burlington, ON L7N 3W5
tel: 905-335-2353 www.woodplc.com



LEGEND

Study area

NOTES:

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE REPORT No. TP115100.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Bing Maps

CLIENT:	CITY OF GUELPH
Drawn By:	CH
Checked By:	SA
Revision N°:	01
Scale:	1: 10,000

N W E S

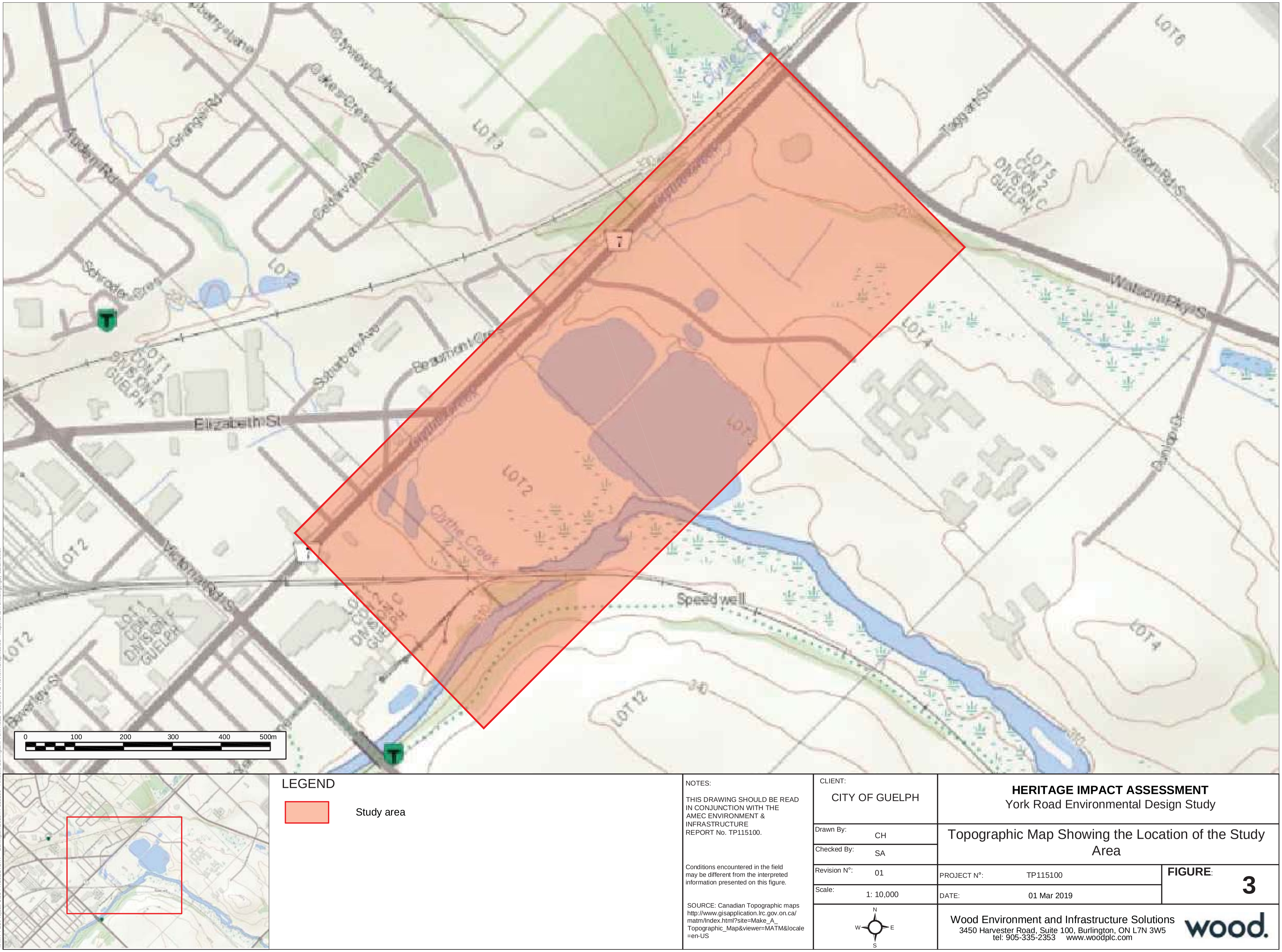
HERITAGE IMPACT ASSESSMENT
York Road Environmental Design Study

Aerial Photograph Showing the Location of the Study Area

PROJECT N°:	TP115100	**FIGURE**: 2
DATE:	01 Mar 2019	

Wood Environment and Infrastructure Solutions
3450 Harvester Road, Suite 100, Burlington, ON L7N 3W5
tel: 905-335-2353 www.woodplc.com

wood.



LEGEND

Study area

NOTES:

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE REPORT No. TP115100.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Canadian Topographic maps http://www.gisapplication.lrc.gov.on.ca/matm/Index.html?site=Make_A_Topographic_Map&viewer=MATM&locale=en-US

CLIENT:	CITY OF GUELPH
Drawn By:	CH
Checked By:	SA
Revision N°:	01
Scale:	1: 10,000

N E S W

HERITAGE IMPACT ASSESSMENT
York Road Environmental Design Study

Topographic Map Showing the Location of the Study Area

PROJECT N°:	TP115100	FIGURE: 3
DATE:	01 Mar 2019	

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LEGEND

Study area

NOTES:

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE REPORT No. TP115100.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: 1858 Tremaine Map of the County of Wellington
http://maps.library.utoronto.ca/hgis/countymaps/wellington/index.html

CLIENT:	CITY OF GUELPH
Drawn By:	CH
Checked By:	SA
Revision N°:	01
Scale:	1: 20,000

N W E S

HERITAGE IMPACT ASSESSMENT
York Road Environmental Design Study

1861 Chas. Wheelock Map of the County of Wellington Showing the Location of the Study Area

PROJECT N°:	TP115100	**FIGURE**: 4
DATE:	01 Mar 2019	

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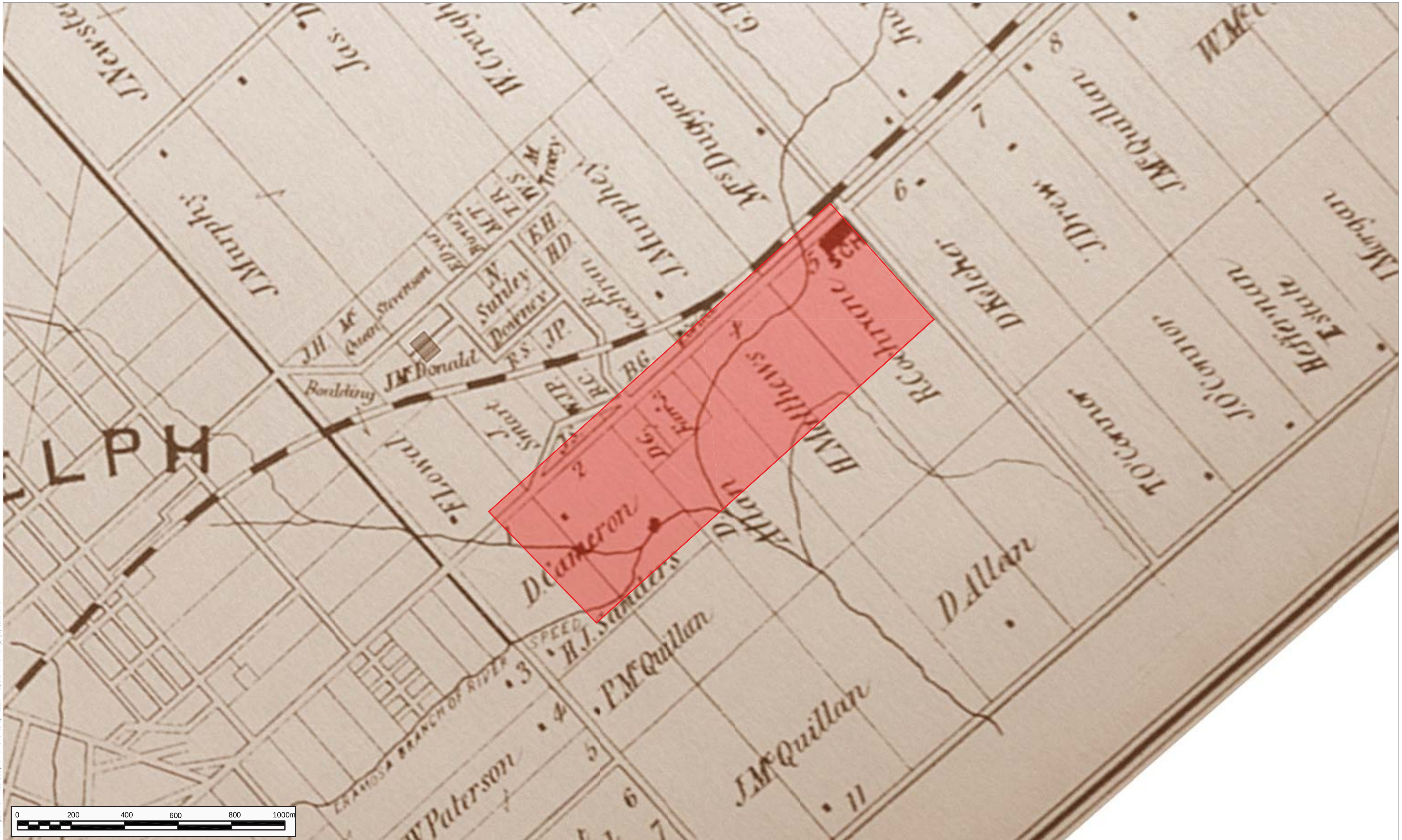
wood.



LEGEND

Study area

NOTES:

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE REPORT No. TP115100.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: 1877 Illustrated Historical Atlas of the County of Wellington

CLIENT:	CITY OF GUELPH
Drawn By:	CH
Checked By:	SA
Revision N°:	01
Scale:	1: 20,000

N / W / E / S

HERITAGE IMPACT ASSESSMENT
York Road Environmental Design Study

1877 Illustrated Historical Atlas of the County of Wellington Showing the Location of the Study Area

PROJECT N°:	TP115100	**FIGURE**: 5
DATE:	01 Mar 2019	

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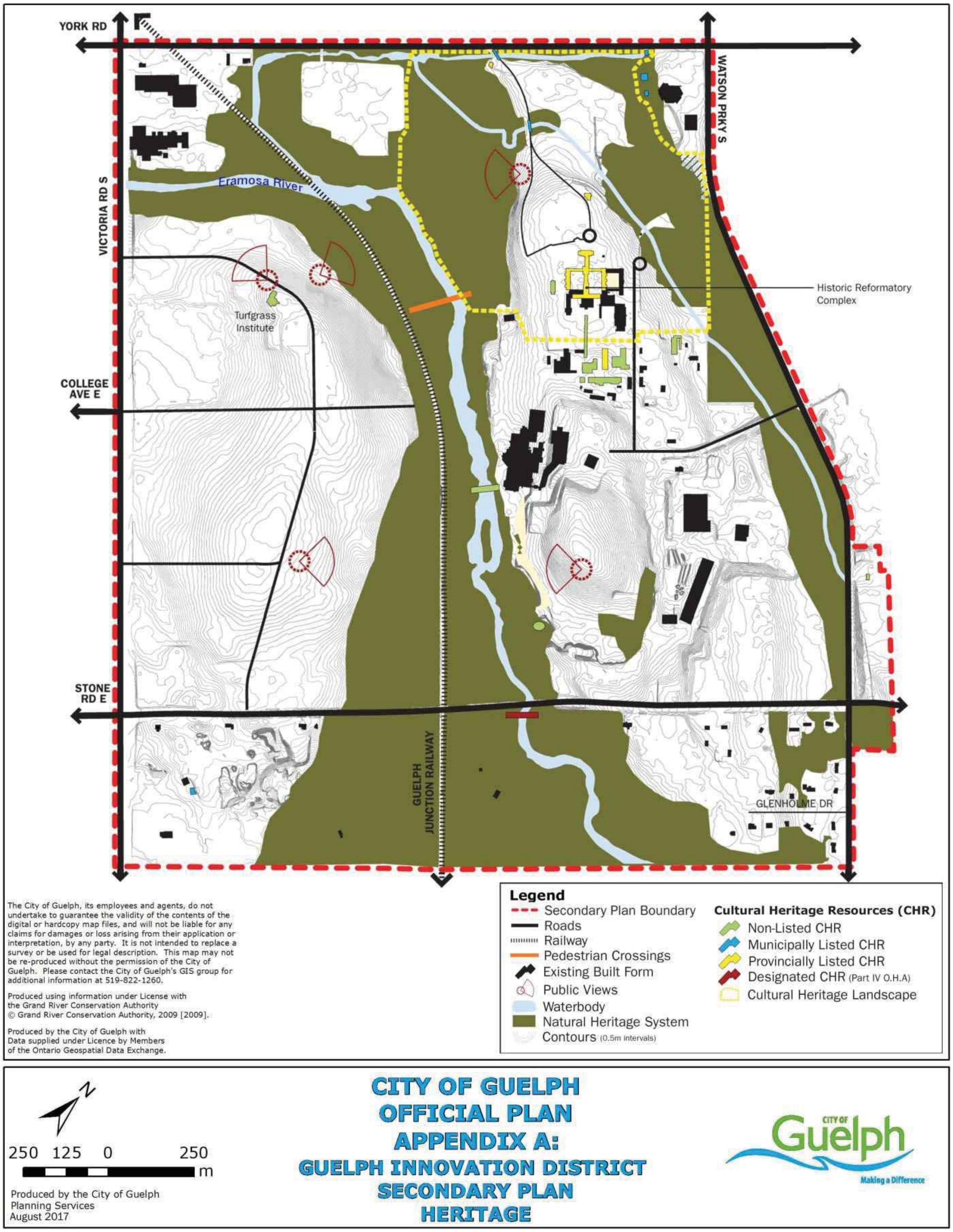
wood.



LEGEND Indicated Above	NOTES: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE REPORT No. TP115100. Conditions encountered in the field may be different from the interpreted information presented on this figure. SOURCE: City of Guelph, Official Plan, Appendix A: Guelph Innovation District Secondary Plan, heritage	CLIENT: CITY OF GUELPH Drawn By: CH Checked By: SA Revision N°: 01 Scale: 1: 25,000	**HERITAGE IMPACT ASSESSMENT** York Road Environmental Design Study Guelph Innovation District, Secondary Plan, Heritage PROJECT N°: TP115100 — **FIGURE**: **6** DATE: 01 Mar 2019 Wood Environment and Infrastructure Solutions 3450 Harvester Road, Suite 100, Burlington, ON L7N 3W5 tel: 905-335-2353 www.woodplc.com

LEGEND

- Study area
- Proposed realignment Clythe Creek
- # Cultural heritage feature/structure

NOTES:

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Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Bing Maps

CLIENT:	CITY OF GUELPH
Drawn By:	CH
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Revision N°:	01
Scale:	1: 5,000

N / E / S / W

HERITAGE IMPACT ASSESSMENT
York Road Environmental Design Study

Cultural Heritage Features/Structures within the Study Area

PROJECT N°:	TP115100	FIGURE: 7a
DATE:	01 Mar 2019	

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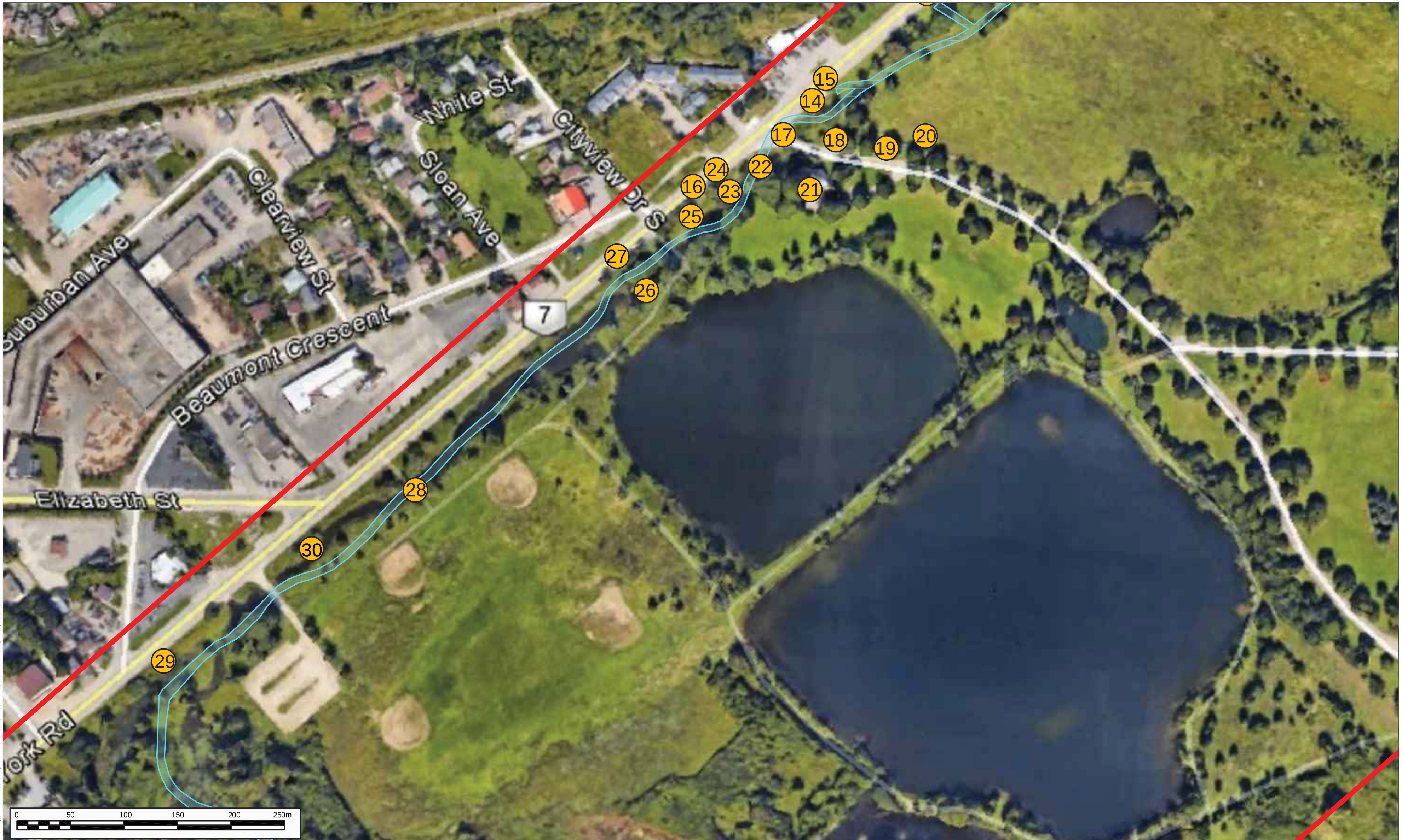
\\HMT-FS1\Project\F$01-PROJECTS\TP - Burlington\2015\TP115100 - Amec fw Burlington, York Road Guelph\AA1 Review\Graphics\02 - Maps\CAD\York.dwg[fig7a]"cara.howell"



LEGEND

Study area

Proposed realignment Clythe Creek

Cultural heritage feature/structure

NOTES:

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE REPORT No. TP115100.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Bing Maps

CLIENT: CITY OF GUELPH

Drawn By: CH

Checked By: SA

Revision N°: 01

Scale: 1: 5,000

N W E S

HERITAGE IMPACT ASSESSMENT

York Road Environmental Design Study

Cultural Heritage Features/Structures within the Study Area

PROJECT N°: TP115100

DATE: 01 Mar 2019

FIGURE: **7b**

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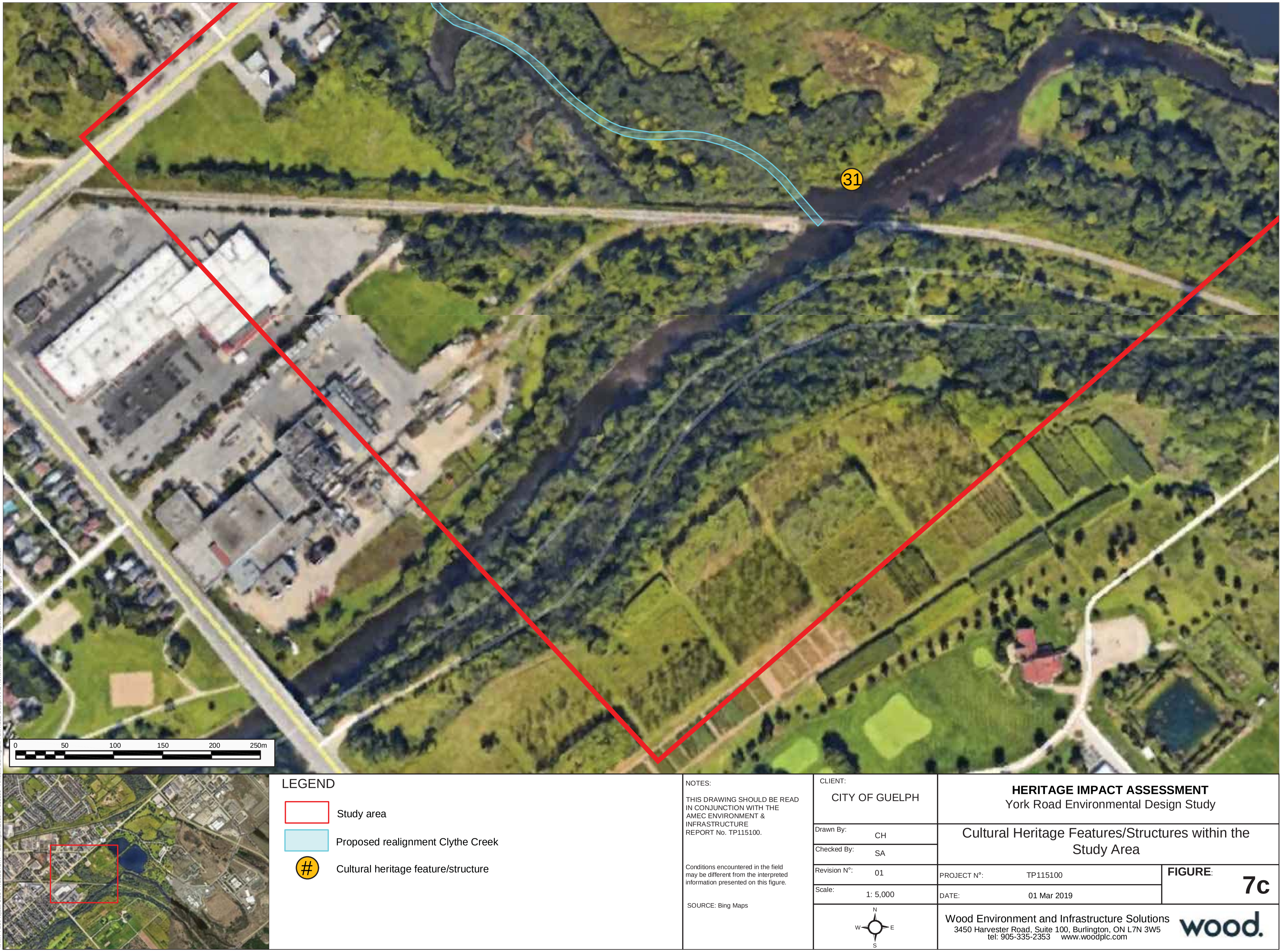

LEGEND

- Study area
- Proposed realignment Clythe Creek
- # Cultural heritage feature/structure

NOTES:

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE REPORT No. TP115100.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Bing Maps

CLIENT: CITY OF GUELPH

Drawn By:	CH
Checked By:	SA
Revision N°:	01
Scale:	1: 5,000

N S E W

HERITAGE IMPACT ASSESSMENT
York Road Environmental Design Study

Cultural Heritage Features/Structures within the Study Area

PROJECT N°: TP115100

DATE: 01 Mar 2019

FIGURE: **7c**

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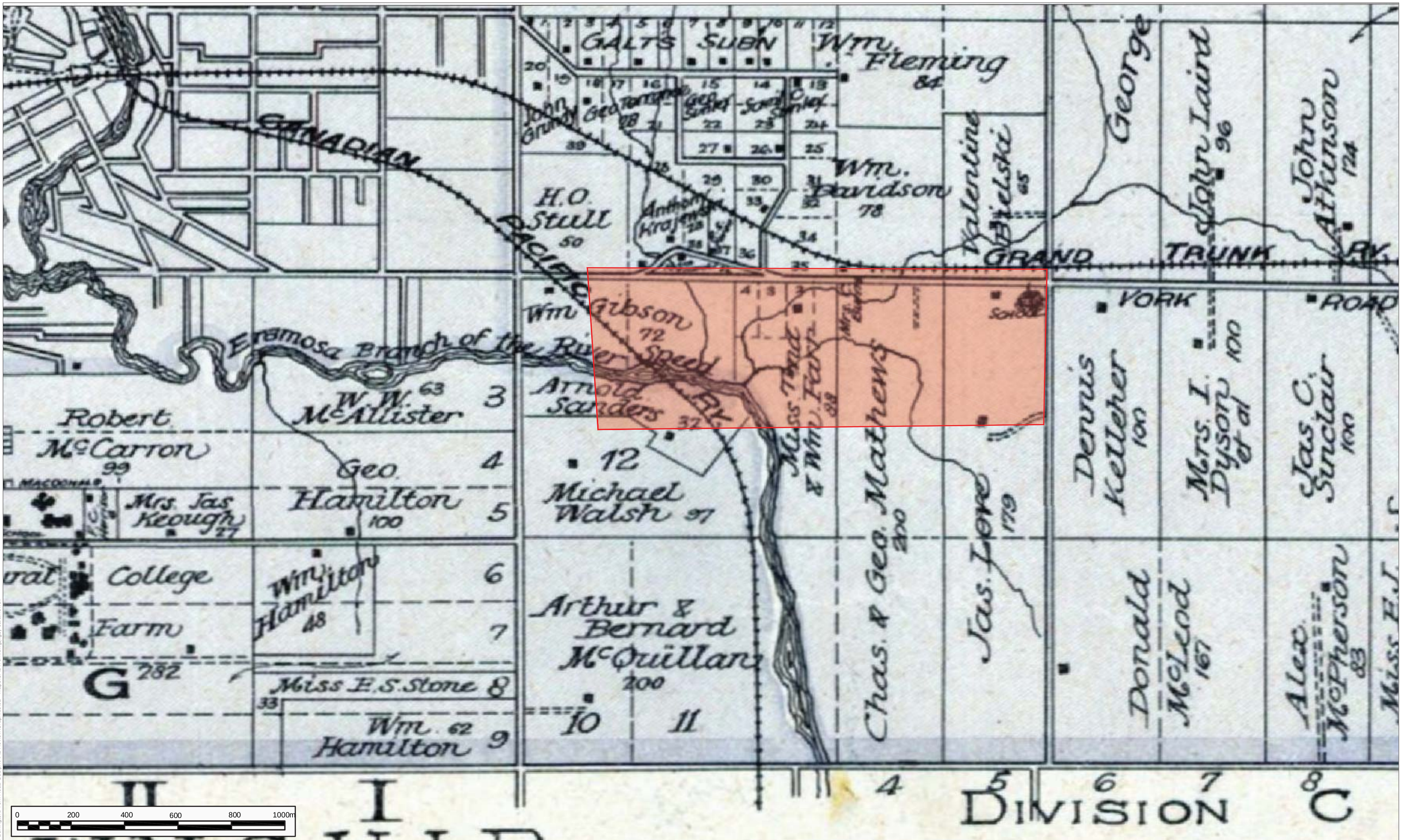

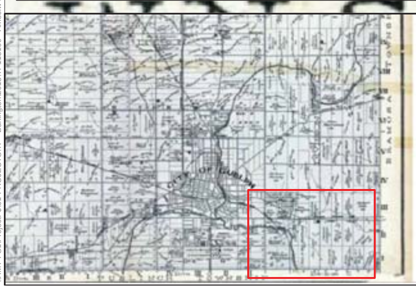

LEGEND

Study area

NOTES:

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE REPORT No. TP115100.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: 1877 Illustrated Historical Atlas of the County of Wellington

CLIENT:	CITY OF GUELPH
Drawn By:	CH
Checked By:	SA
Revision N°:	01
Scale:	1: 20,000

HERITAGE IMPACT ASSESSMENT
York Road Environmental Design Study

1906 Illustrated Historical Atlas of the County of Wellington Showing the Location of the Study Area

PROJECT N°:	TP115100	FIGURE: 8
DATE:	01 Mar 2019	

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tel: 905-335-2353 www.woodplc.com

Appendix B

Assessor Qualifications

Assessor Qualifications

Linda Axford, MLA, Senior Heritage Specialist, Role: Heritage Fieldwork and Research, Report Writer – Ms. Axford has been working in heritage planning since 2001. She has conducted historical background research, field surveys, analysis of built heritage and cultural landscapes and report writing. She has worked in municipal government and is very knowledgeable about federal and provincial planning policy as it relates to heritage. She holds a master's Degree in landscape architecture, an Honours Bachelor of Arts in History and is a **professional member of the Canadian Association of Heritage Professionals.**

Shaun Austin, Ph.D., Associate Archaeologist, Role: QA/QC Review – Dr. Austin is the Senior Advisor to Wood's Cultural Heritage Resources Group in Ontario and is based in the Burlington Office. He has been working in Canadian archaeology and heritage since 1976 and as an archaeological and heritage consultant in Ontario since 1987. He is a dedicated cultural heritage consultant with repeated success guiding projects through to completion to the satisfaction of development proponents, Indigenous nations and cultural heritage stakeholder groups. His areas of interest and expertise include pre-contact Aboriginal lithics and ceramics. Dr. Austin holds a Professional License (P141) in Archaeology, is MTO RAQs certified in Archaeology/Heritage and is a professional member of the Ontario Association of Professional Archaeologists.

Cara Howell B.A., Senior Archaeologist, Role: Graphics Support – Ms. Howell holds a B.A. in Anthropology and Classical Archaeology from McMaster University and provides CAD graphics support for Wood's Cultural Heritage Resources Group in Ontario. She holds an Applied Research Licence (R180) in Archaeology and has become an authority on early Euro-Canadian material culture and historic period background research. As the Archaeology Laboratory Director for Wood's Cultural Heritage Resources Group in Ontario, she developed and implements a computerized cataloguing system for artifacts and other resources. Ms. Howell also serves as lead liaison with Indigenous communities.

Appendix C

Limitations

Limitations

1. The work performed in the preparation of this report and the conclusions presented are subject to the following:
   - (a) The Standard Terms and Conditions which form a part of our Professional Services Contract;
   - (b) The Scope of Services;
   - (c) Time and Budgetary limitations as described in our Contract; and,
   - (d) The Limitations stated herein.
2. No other warranties or representations, either expressed or implied, are made as to the professional services provided under the terms of our Contract, or the conclusions presented.
3. The conclusions presented in this report were based, in part, on visual observations of the Study Area. Our conclusions cannot and are not extended to include those portions of the Study Area which were not reasonably available, in Wood's opinion, for direct observation.
4. The potential for heritage resources, and any actual heritage resources encountered, at the Study Area were assessed, within the limitations set out above, having due regard for applicable heritage regulations as of the date of the inspection.
5. Services including a background study and property inspection were performed. Wood's work, including archival studies and a site visit were conducted in a professional manner and in accordance with the Ministry of Tourism and Culture's guidelines. It is possible that unforeseen and undiscovered heritage resources may be present at the Study Area.
6. The utilization of Wood's services during the implementation of any further heritage work recommended will allow Wood to observe compliance with the conclusions and recommendations contained in the report. Wood's involvement will also allow for changes to be made as necessary to suit field conditions as they are encountered.
7. This report is for the sole use of the parties to whom it is addressed unless expressly stated otherwise in the report or contract. Any use which any third party makes of the report, in whole or in part, or any reliance thereon, or decisions made based on any information of conclusions in the report, is the sole responsibility of such third party. Wood accepts no responsibility whatsoever for damages or loss of any nature or kind suffered by any such third party as a result of actions taken or not taken or decisions made in reliance on the report or anything set out therein.
8. This report is not to be given over to any third-party other than a governmental entity, for any purpose whatsoever without the written permission of Wood, which shall not be unreasonably withheld.

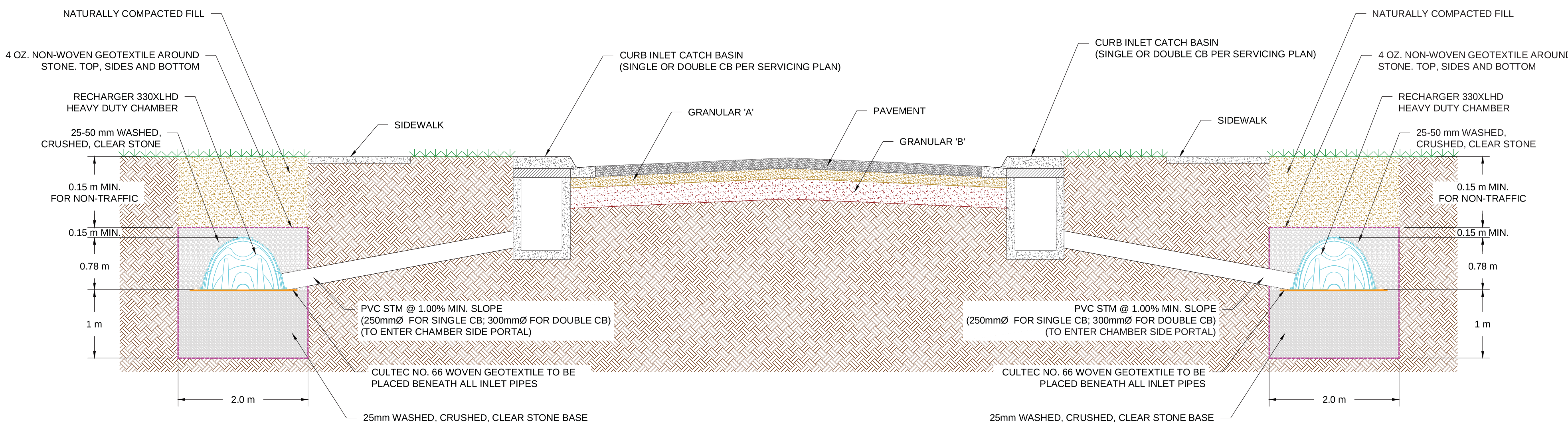
Appendix M

Stormwater Management

Average Annual Sediment Removal Rates (%) using a CB Shield (based on ETV Sediment - 1 to 1000 micron Particle Size Distribution)						
Area to CB (ha)	**Imperviousness[1] (%)**					
	20%	35%	50%	65%	80%	100%
0.02	57%	57%	57%	57%	56%	56%
0.05	56%	56%	56%	55%	55%	54%
0.10	56%	55%	54%	53%	52%	51%
0.20	54%	53%	51%	49%	48%	46%
0.30	53%	50%	48%	46%	45%	43%
0.40	51%	48%	46%	44%	42%	40%
0.50	50%	47%	44%	42%	40%	38%
0.60	49%	45%	43%	40%	39%	36%

Notes:

1. Runoff Coefficient 'C' is approximately equal to 0.05 + 0.9*Impervious Fraction.
2. Above chart is based on long term continuous hydrologic analysis of Toronto, Ontario (Bloor St) rainfall data.
3. Assumes 0.6 m sump in CB and that maintenance is performed (i.e. CB cleaning) when required by sediment/pollutant build-up or otherwise.
4. See accompanying chart for suggested maintenance scheduling - AND - get CB Shield Inc. to monitor it for you in field.
5. Sediment/Pollutant removal rates based on third party certified laboratory testing using ETV sediment (PSD analysis available on request).
6. See additional discussion regarding scour protection from CB Shield during more infrequent runoff events.



CULTEC, Inc.
Subsurface Stormwater Management Systems
P.O. Box 280
878 Federal Road
Brookfield, CT 06804
www.cultec.com
PH: (203) 775-4416
PH: (800) 4-CULTEC
FX: (203) 775-1462
tech@cultec.com

GeoStorm Inc.
122 Creditstone Road
Vaughan, Ontario
L4K 1P2

THIS DRAWING WAS PREPARED TO SUPPORT THE DESIGN ENGINEER FOR THE PROPOSED SYSTEM. IT IS THE ULTIMATE RESPONSIBILITY OF THE DESIGN ENGINEER TO ASSURE THAT THE STORMWATER SYSTEM'S DESIGN IS IN FULL COMPLIANCE WITH ALL APPLICABLE LAWS AND REGULATIONS. IT IS THE DESIGN ENGINEER'S RESPONSIBILITY TO ENSURE THAT THE CULTEC PRODUCTS ARE DESIGNED IN ACCORDANCE WITH CULTEC'S MINIMUM REQUIREMENTS. CULTEC INC. DOES NOT APPROVE PLANS, SIZING, OR SYSTEM DESIGNS. THE DESIGNING ENGINEER IS RESPONSIBLE FOR ALL DESIGN DECISIONS.

CULTEC RECHARGER 330XLHD TRAFFIC APPLICATION CROSS SECTION DETAIL

CULTEC RECHARGER® 330XLHD			
PROJECT NO:	-	DATE:	12/4/15
DESIGNED BY:	DPG	DRAWN BY:	JC
SCALE:	N.T.S.	SHEET NO:	1 OF 1

Stormceptor®

FORTERRA

Detailed Stormceptor Sizing Report – Reformatory Driveway

Project Information & Location			
Project Name	Reformatory Driveway	**Project Number**	-
City	Guelph	**State/ Province**	Ontario
Country	Canada	**Date**	11/16/2018
Designer Information		**EOR Information (optional)**	
Name	Brandon O'Leary	**Name**	Gurkanwal Arora
Company	Forterra	**Company**	John Wood Group
Phone #	905-630-0359	**Phone #**	
Email	brandon.oleary@forterrabp.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	Reformatory Driveway
Recommended Stormceptor Model	EFO8
TSS Removal (%) Provided	63
PSD	CA ETV
RainFall Station	WATERLOO WELLINGTON A

The recommended Stormceptor model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

EFO Sizing Summary

EFO Model	% TSS Removal Provided	% Runoff Volume Captured Provided	Standard EFO Hydrocarbon Storage Capacity
EFO4	51	72	265 L (70 gal)
EFO6	57	88	610 L (160 gal)
EFO8	63	94	1070 L (280 gal)
EFO10	68	97	1670 L (440 gal)
EFO12	72	98	2475 L (655 gal)
Parallel Units / MAX	Custom	Custom	Custom

OVERVIEW

Stormceptor ® EF is a continuation and evolution of the most globally recognized oil-grit separator (OGS) stormwater treatment technology - **Stormceptor ®.** Also known as a hydrodynamic separator, the enhanced flow Stormceptor EF is a high performing oil-grit separator that effectively removes a wide variety of pollutants from stormwater and snowmelt runoff at higher flow rates as compared to the original Stormceptor. Stormceptor EF captures and retains sediment (TSS), free oils, gross pollutants and other pollutants that attach to particles, such as nutrients and metals. Stormceptor EF's patent-pending treatment and scour prevention technology and internal bypass ensures sediment is retained during all rainfall events.

Sizing Methodology

Stormceptor ® EF and Stormceptor ® EFO are sized using local historical rainfall data for the site of interest, specific site parameters, and a performance curve for TSS removal derived from third-party testing conducted in accordance with the Canadian Environmental Technology Verification (ETV) Program's Procedure for Laboratory Testing of OilGrit Separators. Every Stormceptor unit is designed to achieve the specified target TSS removal, however, for sites where oil/fuel capture and retention is an additional specified water quality objective Stormceptor EFO is the proper selection. The sizing methodology includes various considerations, including:

- Site parameters
- Local historical rainfall data
- Capture of the Canadian ETV particle size distribution
- Requirements for oil/fuel capture and retention
- Performance results from third-party testing and verification

Hydrology Analysis

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of Stormceptor are based on the average annual removal of TSS for the selected site parameters. The Stormceptor is engineered to capture sediment particles by treating the required average annual runoff volume, ensuring positive removal efficiency is maintained during each rainfall event, and preventing negative removal efficiency (scour).
Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

State/Province	Ontario	**Total Number of Rainfall Events**	3521
Rainfall Station Name	WATERLOO WELLINGTON A	**Total Rainfall (mm)**	16119.1
Station ID #	9387	**Average Annual Rainfall (mm)**	474.1
Coordinates	43°27'N, 80°23'W	**Total Evaporation (mm)**	992.8
Elevation (ft)	1028	**Total Infiltration (mm)**	5072.4
Years of Rainfall Data	34	**Total Rainfall that is Runoff (mm)**	10053.9

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

ONLINE APPLICATION

Stormceptor EF's internal bypass and patent-pending scour prevention technology has demonstrated very effective retention of pollutants in third-party testing and verification following the Canadian ETV's **Procedure for Laboratory Testing of Oil-Grit Separators.** Sediment scour prevention demonstrated an effluent concentration of less than 10 mg/L for sediment particles ranging from 1 to 1,000 microns, even during peak influent flow rates associated with infrequent high intensity storm events. While Stormceptor EF will capture oil, only the Stormceptor EFO configuration has been third-party tested and verified to retain greater than 99% of captured oil. Based on these verified performance attributes, the most efficient and widely accepted application of Stormceptor EF is an online configuration, which allows all upstream conveyance flows to enter and exit the unit. The online application eliminates the need for costly additional bypass structures, piping and installation expense.

FLOW ENTRANCE OPTIONS

Single Inlet Pipe – A common design which includes one inlet pipe and one outlet pipe. A 90-degree (maximum) bend is also accepted with this configuration.

Inlet Grate – Allows surface runoff to enter the unit from grade. The inlet grate option can also be used in conjunction with one inlet pipe or multiple inlet pipes. A removable flow deflector is added in the Stormceptor EF4/EFO4.

Maximum Pipe Diameter		
Model	Inlet (In/mm)	Outlet (In/mm)
EF4 / EFO4	24 / 610	24 / 610
EF6 / EFO6	36 / 915	36 / 915
EF8/ EFO8	48 / 1220	48 / 1220
EF10/EFO10	72 / 1828	72 / 1828
EF12/EFO12	72 / 1828	72 / 1828

Multiple Inlet Pipe – Allows for multiple inlet pipes of various diameters to enter the unit.

Maximum Pipe Diameter		
Model	Inlet (In/mm)	Outlet (In/mm)
EF4 / EFO4	18 / 457	24 / 610
EF6 / EFO6	30 / 762	36 / 915
EF8/ EFO8	42 / 1067	48 / 1220
EF10/EFO10	60 / 1524	72 / 1828
EF12/EFO12	60 / 1524	72 / 1828

Drainage Area	
Total Area (ha)	1.27
Imperviousness %	68.2

Up Stream Storage	
Storage (ha-m)	Discharge (cms)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cms)	

Water Quality Objective	
TSS Removal (%)	60.0
Runoff Volume Capture (%)	90.00
Oil Spill Capture Volume (L)	
Peak Conveyed Flow Rate (L/s)	
Water Quality Flow Rate (L/s)	

Design Details	
Stormceptor Inlet Invert Elev (m)	
Stormceptor Outlet Invert Elev (m)	
Stormceptor Rim Elev (m)	
Normal Water Level Elevation (m)	
Pipe Diameter (mm)	
Pipe Material	
Multiple Inlets (Y/N)	No
Grate Inlet (Y/N)	No

Particle Size Distribution (PSD)

Removing the smallest fraction of particulates from runoff ensures the majority of pollutants, such as metals, hydrocarbons and nutrients are captured. The table below identifies the Particle Size Distribution (PSD) that was selected to define TSS removal for the Stormceptor design.

CA ETV

Particle Diameter (microns)	Distribution %	Specific Gravity
2.0	5.0	2.65
5.0	5.0	2.65
8.0	10.0	2.65
20.0	15.0	2.65
50.0	10.0	2.65
75.0	5.0	2.65
100.0	10.0	2.65
150.0	15.0	2.65
250.0	15.0	2.65
500.0	5.0	2.65
1000.0	5.0	2.65

Stormceptor® FORTERRA

Site Name	Reformatory Driveway

Site Details

Drainage Area	
Total Area (ha)	1.27
Imperviousness %	68.2
Oil Spill Capture Volume (L)	

Infiltration Parameters	
Horton's equation is used to estimate infiltration	
Max. Infiltration Rate (mm/hr)	61.98
Min. Infiltration Rate (mm/hr)	10.16
Decay Rate (1/sec)	0.00055
Regeneration Rate (1/sec)	0.01

Surface Characteristics	
Width (m)	225.00
Slope %	2
Impervious Depression Storage (mm)	0.508
Pervious Depression Storage (mm)	5.08
Impervious Manning's n	0.015
Pervious Manning's n	0.25

Evaporation	
Daily Evaporation Rate (mm/day)	2.54

Dry Weather Flow	
Dry Weather Flow (lps)	0

Maintenance Frequency	
Maintenance Frequency (months) >	12

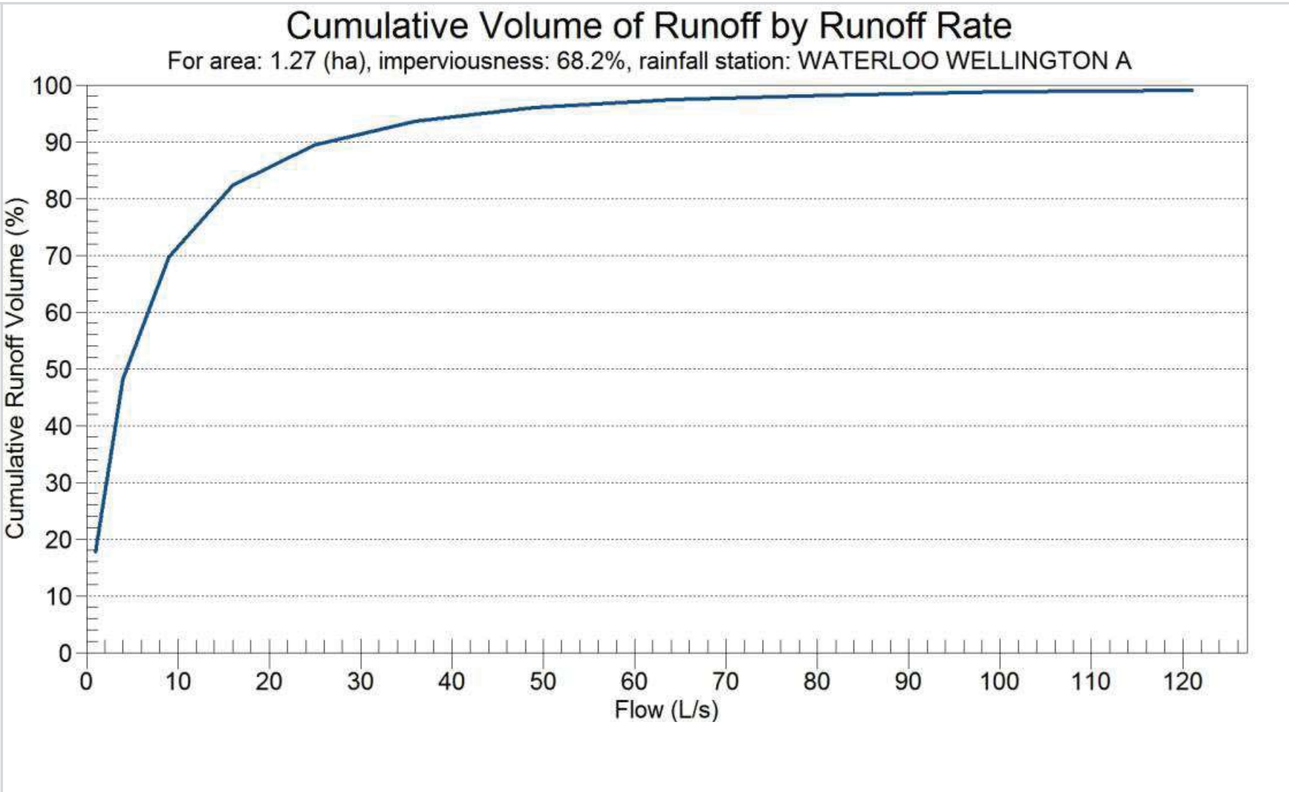
Winter Months	
Winter Infiltration	0

TSS Loading Parameters	
TSS Loading Function	Build Up/ Wash-off

Buildup/Wash-off Parameters	
Target Event Mean Conc. (EMC) mg/L	125
Exponential Buildup Power	0.40
Exponential Washoff Exponent	0.20

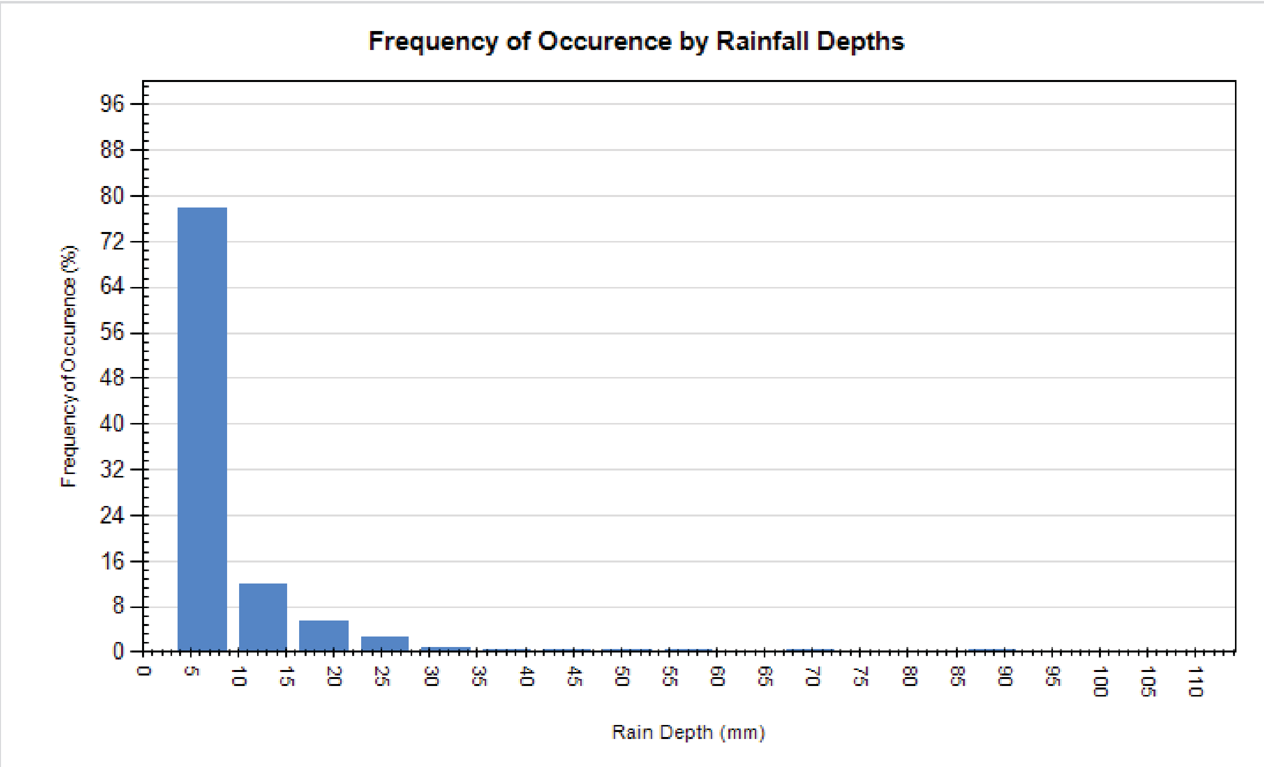
TSS Availability Parameters	
Availability Constant A	0.057
Availability Factor B	0.04
Availability Exponent C	1.10
Min. Particle Size Affected by Availability (micron)	400

Cumulative Runoff Volume by Runoff Rate			
Runoff Rate (L/s)	**Runoff Volume (m³)**	**Volume Over (m³)**	**Cumulative Runoff Volume (%)**
1	22853	105591	17.8
4	61885	66558	48.2
9	89546	38905	69.7
16	105707	22733	82.3
25	114882	13560	89.4
36	120265	8174	93.6
49	123347	5092	96.0
64	125121	3317	97.4
81	126178	2260	98.2
100	126842	1597	98.8
121	127311	1127	99.1
144	127643	795	99.4
169	127911	527	99.6
196	128099	339	99.7
225	128198	240	99.8
256	128285	153	99.9
289	128363	75	99.9
324	128391	47	100
361	128413	25	100
400	128432	6	100
441	128438	0	100
484	128438	0	100

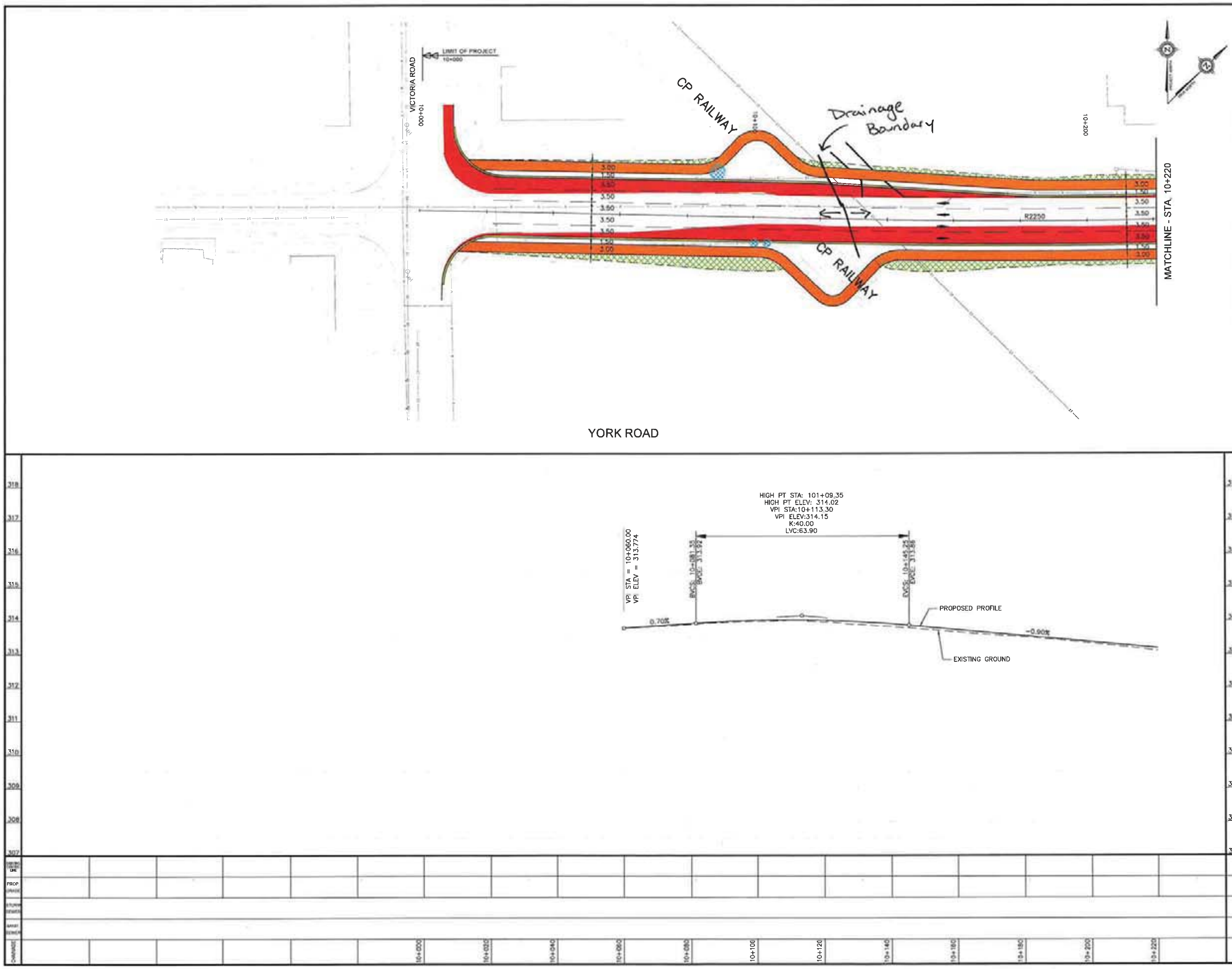

Cumulative Volume of Runoff by Runoff Rate
For area: 1.27 (ha), imperviousness: 68.2%, rainfall station: WATERLOO WELLINGTON A
Cumulative Runoff Volume (%)
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60
70
80
90
100
110
120
Flow (L/s)

Rainfall Event Analysis

Rainfall Depth (mm)	No. of Events	Percentage of Total Events (%)	Total Volume (mm)	Percentage of Annual Volume (%)
6.35	2742	77.9	4245	26.3
12.70	420	11.9	3837	23.8
19.05	193	5.5	3014	18.7
25.40	88	2.5	1904	11.8
31.75	27	0.8	769	4.8
38.10	16	0.5	563	3.5
44.45	19	0.5	774	4.8
50.80	5	0.1	241	1.5
57.15	3	0.1	156	1.0
63.50	0	0.0	0	0.0
69.85	4	0.1	267	1.7
76.20	0	0.0	0	0.0
82.55	0	0.0	0	0.0
88.90	3	0.1	255	1.6
95.25	1	0.0	93	0.6
101.60	0	0.0	0	0.0
107.95	0	0.0	0	0.0



For Stormceptor Specifications and Drawings Please Visit:
http://www.imbriumsystems.com/technical-specifications



KEY PLAN Scale : NOT TO SCALE

SHEET No.

LEGEND

- EXISTING RIGHT OF WAY
- PROPOSED RIGHT OF WAY WIDENING
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI-USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK

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No.	DATE	DESCRIPTION	BY:	CHKD

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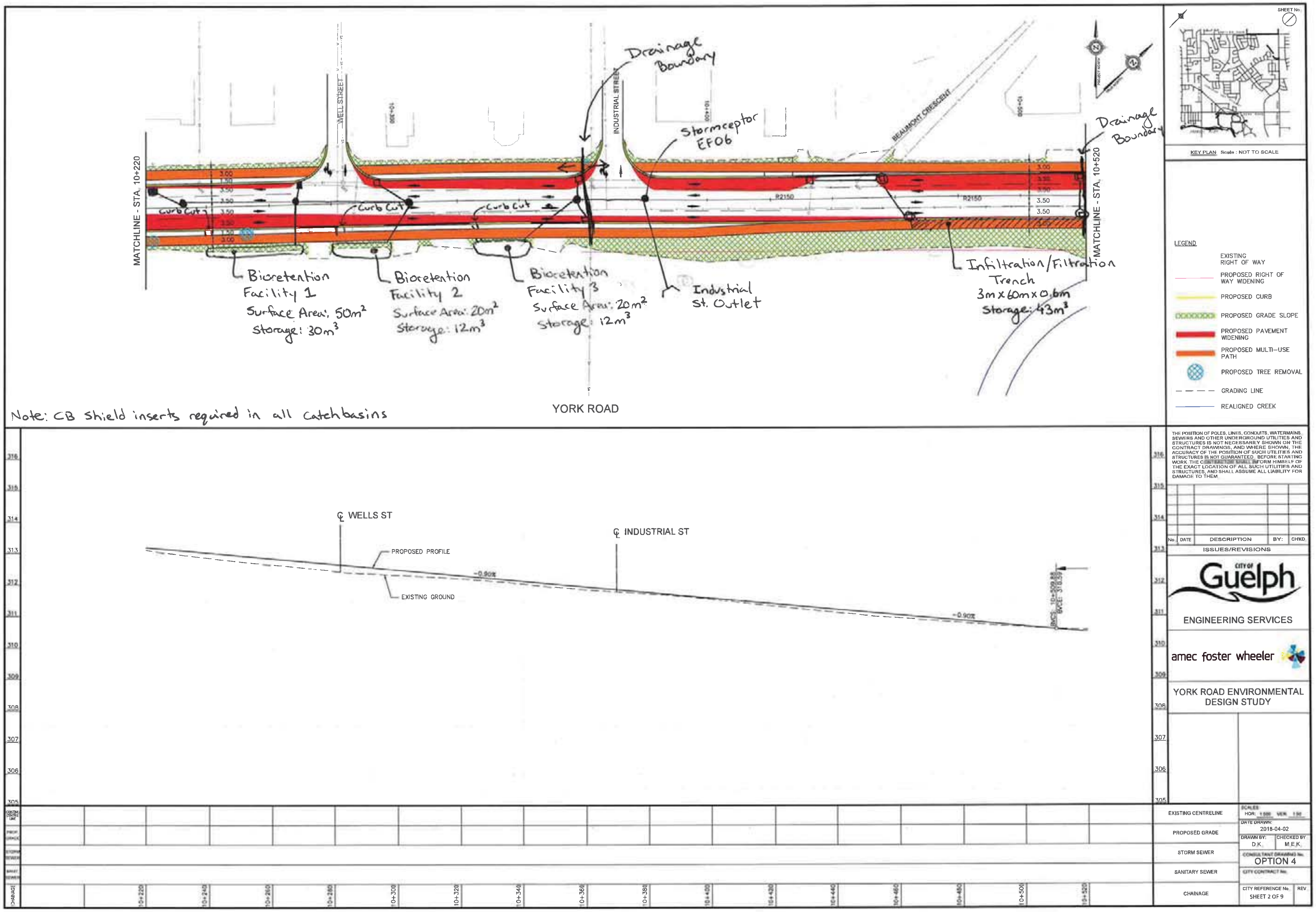
YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2018-04-02
	DRAWN BY: D.K. CHECKED BY: M.E.K.
STORM SEWER	CONSULTANT DRAWING No. OPTION 4
SANITARY SEWER	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 1 OF 9 REV.



Drainage Boundary
Stormceptor EF06
Drainage Boundary
WELL STREET
INDUSTRIAL STREET
BEAUMONT CRESCENT
MATCHLINE - STA. 10+220
MATCHLINE - STA. 10+520
Curb Cut
Curb Cut
Curb Cut
Bioretention Facility 1 Surface Area: 50m² Storage: 30m³
Bioretention Facility 2 Surface Area: 20m² Storage: 12m³
Bioretention Facility 3 Surface Area: 20m² Storage: 12m³
Industrial St. Outlet
Infiltration/Filtration Trench 3m x 60m x 0.6m Storage: 43m³
YORK ROAD
Note: CB shield inserts required in all catchbasins
KEY PLAN Scale: NOT TO SCALE
LEGEND
EXISTING RIGHT OF WAY
PROPOSED RIGHT OF WAY WIDENING
PROPOSED CURB
PROPOSED GRADE SLOPE
PROPOSED PAVEMENT WIDENING
PROPOSED MULTI-USE PATH
PROPOSED TREE REMOVAL
GRADING LINE
REALIGNED CREEK
℄ WELLS ST
℄ INDUSTRIAL ST
PROPOSED PROFILE
EXISTING GROUND
-0.90%
-0.90%
ISSUES/REVISIONS
No. DATE DESCRIPTION BY: CHKD.
City of Guelph
ENGINEERING SERVICES
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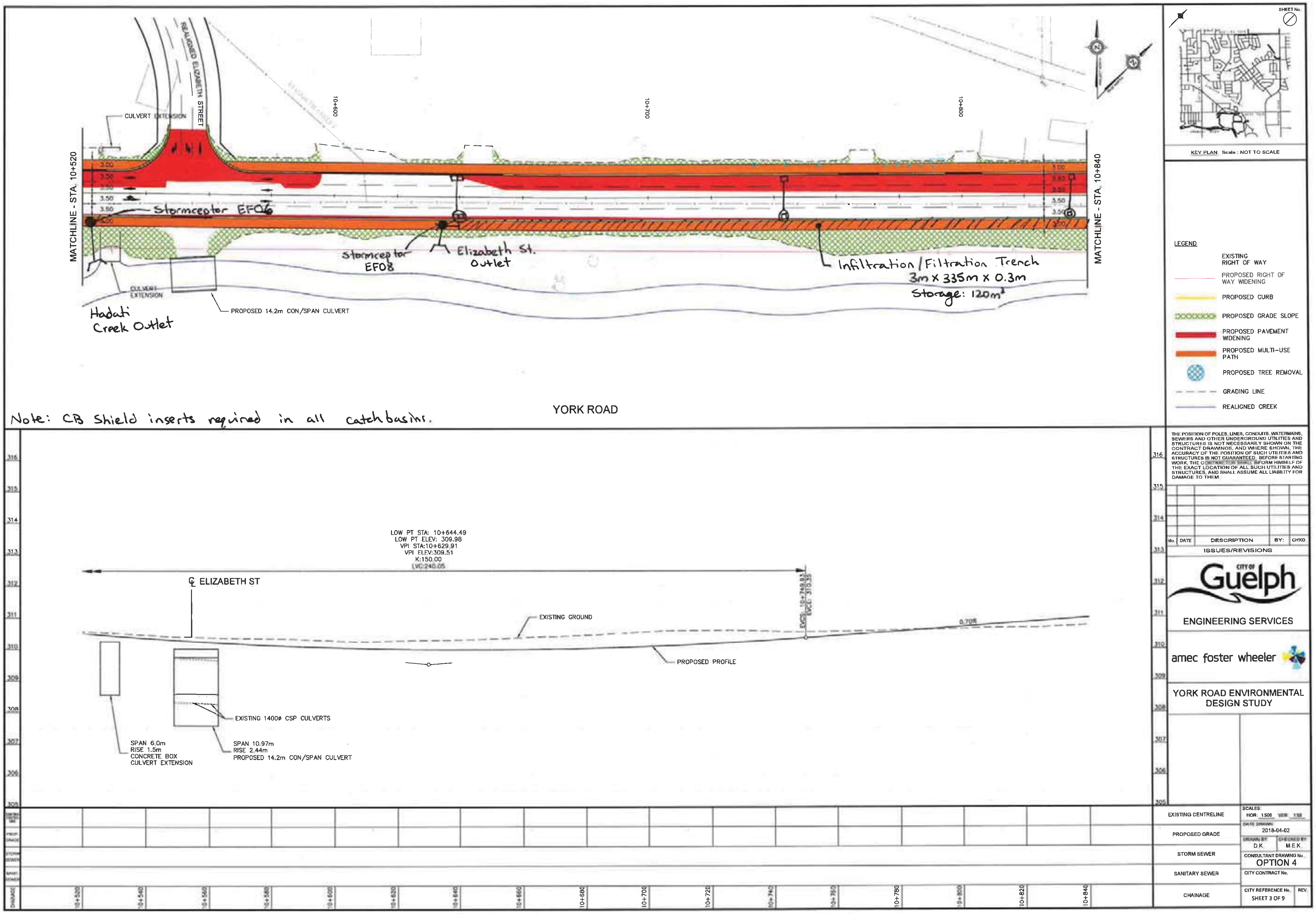
YORK ROAD ENVIRONMENTAL DESIGN STUDY
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
2018-04-02
DRAWN BY: D.K.
CHECKED BY M.E.K.
OPTION 4
SHEET 2 OF 9
10+220 10+240 10+260 10+280 10+300 10+320 10+340 10+360 10+380 10+400 10+420 10+440 10+460 10+480 10+500 10+520


MATCHLINE - STA. 10+520
MATCHLINE - STA. 10+840
CULVERT EXTENSION
REALIGNED ELIZABETH STREET
10+600
10+700
10+800
Stormceptor EF06
Stormceptor EF08
Elizabeth St. Outlet
Infiltration / Filtration Trench
3m x 335m x 0.3m
Storage: 120m³
Hadati Creek Outlet
PROPOSED 14.2m CON/SPAN CULVERT
YORK ROAD
Note: CB Shield inserts required in all catchbasins.
LEGEND
EXISTING RIGHT OF WAY
PROPOSED RIGHT OF WAY WIDENING
PROPOSED CURB
PROPOSED GRADE SLOPE
PROPOSED PAVEMENT WIDENING
PROPOSED MULTI-USE PATH
PROPOSED TREE REMOVAL
GRADING LINE
REALIGNED CREEK
KEY PLAN Scale : NOT TO SCALE
LOW PT STA: 10+644.49
LOW PT ELEV: 309.98
VPI STA:10+629.91
VPI ELEV:309.51
K:150.00
LVC:240.05
℄ ELIZABETH ST
EXISTING GROUND
PROPOSED PROFILE
0.70%
EXISTING 1400ø CSP CULVERTS
SPAN 6.0m
RISE 1.5m
CONCRETE BOX
CULVERT EXTENSION
SPAN 10.97m
RISE 2.44m
PROPOSED 14.2m CON/SPAN CULVERT
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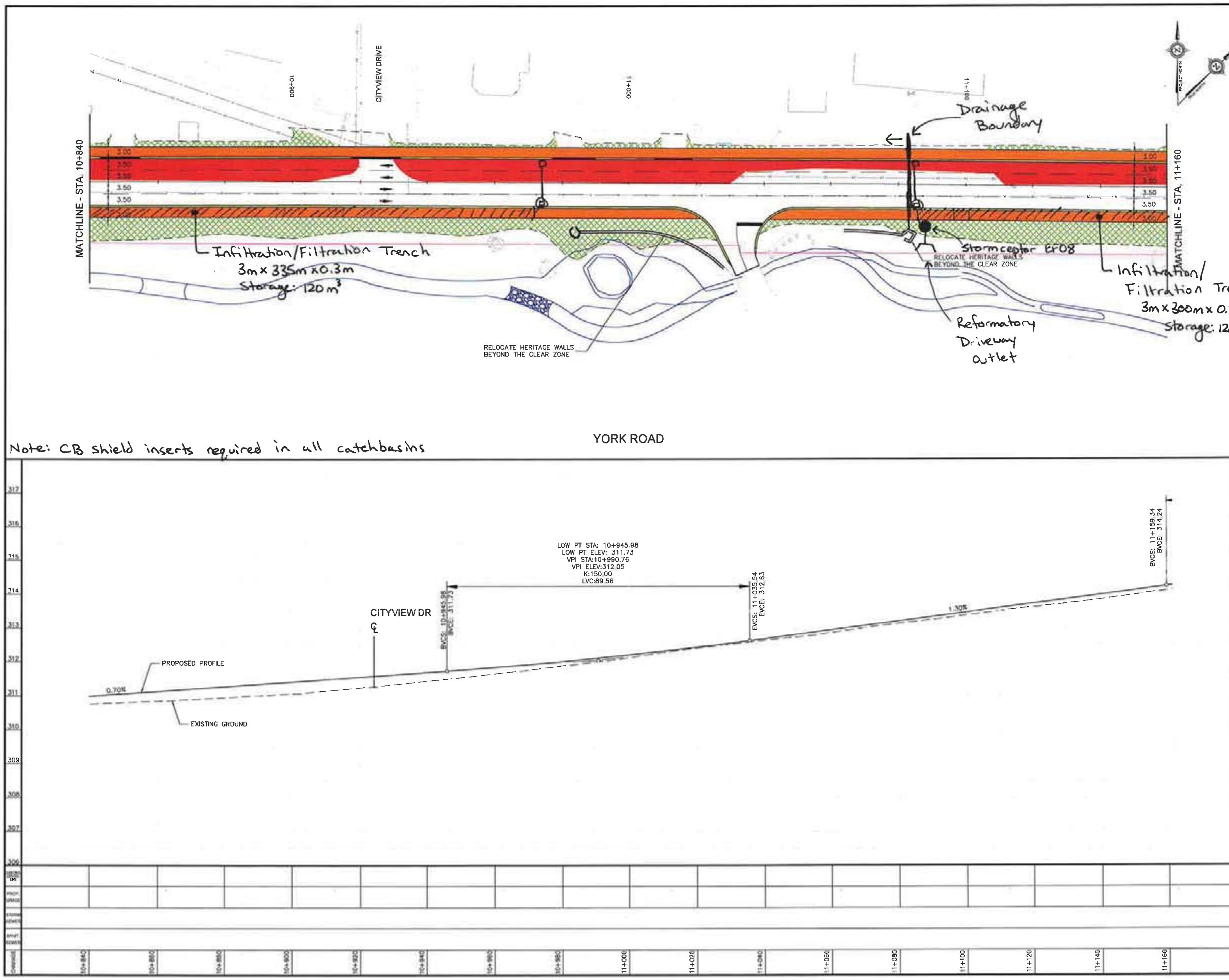
YORK ROAD ENVIRONMENTAL DESIGN STUDY
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
SCALES: HOR: 1:500 VER: 1:50
DATE DRAWN 2018-04-02
DRAWN BY D.K.
CHECKED BY M.E.K.
CONSULTANT DRAWING No. OPTION 4
CITY CONTRACT No.
CITY REFERENCE No. SHEET 3 OF 9
REV.
10+520
10+540
10+560
10+580
10+600
10+620
10+640
10+660
10+680
10+700
10+720
10+740
10+760
10+780
10+800
10+820
10+840



SHEET No.

KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING RIGHT OF WAY
- PROPOSED RIGHT OF WAY WIDENING
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI-USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK

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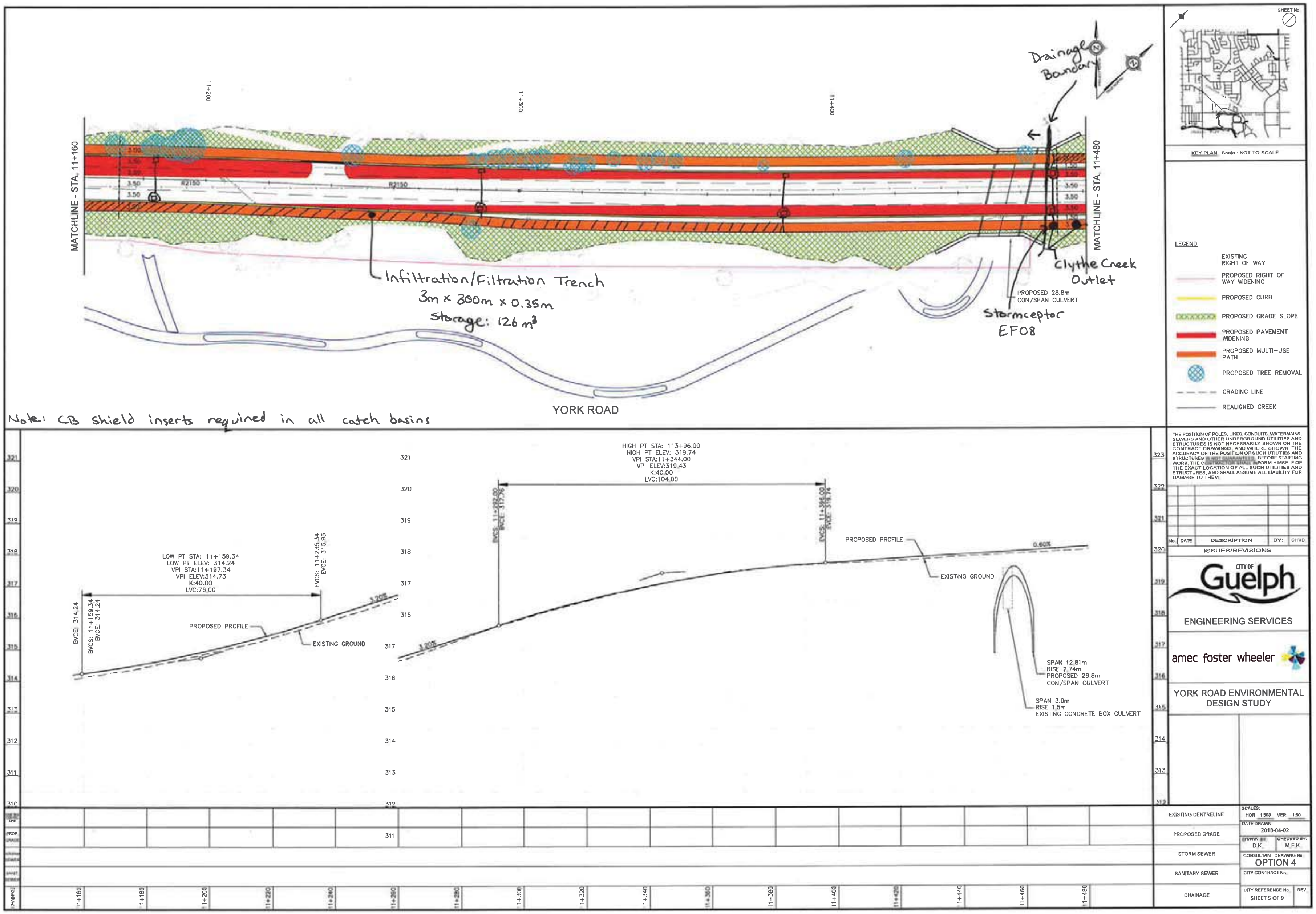
PROPOSED GRADE	DATE DRAWN: 2018-04-02
	DRAWN BY: D.K. CHECKED BY: M.E.K.
STORM SEWER	CONSULTANT DRAWING No. OPTION 4
SANITARY SEWER	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 4 OF 9 REV.



MATCHLINE - STA. 11+160
MATCHLINE - STA. 11+480
11+200
11+300
11+400
R2150
3.50
Drainage Boundary
Clythe Creek Outlet
PROPOSED 28.8m CON/SPAN CULVERT
Stormceptor EF08
Infiltration/Filtration Trench 3m x 300m x 0.35m Storage: 126 m³
YORK ROAD
Note: CB shield inserts required in all catch basins
KEY PLAN Scale : NOT TO SCALE
SHEET No.
LEGEND
EXISTING RIGHT OF WAY
PROPOSED RIGHT OF WAY WIDENING
PROPOSED CURB
PROPOSED GRADE SLOPE
PROPOSED PAVEMENT WIDENING
PROPOSED MULTI-USE PATH
PROPOSED TREE REMOVAL
GRADING LINE
REALIGNED CREEK
LOW PT STA: 11+159.34
LOW PT ELEV: 314.24
VPI STA:11+197.34
VPI ELEV:314.73
K:40.00
LVC:76.00
BVCE: 314.24
BVCS: 11+159.34
EVCS: 11+235.34
EVCE: 315.95
PROPOSED PROFILE
EXISTING GROUND
3.20%
HIGH PT STA: 113+96.00
HIGH PT ELEV: 319.74
VPI STA:11+344.00
VPI ELEV:319.43
K:40.00
LVC:104.00
BVCS: 11+292.00
BVCE: 317.76
EVCS: 11+396.00
EVCE: 319.74
0.60%
SPAN 12.81m
RISE 2.74m
PROPOSED 28.8m CON/SPAN CULVERT
SPAN 3.0m
RISE 1.5m
EXISTING CONCRETE BOX CULVERT
THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
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CITY OF Guelph
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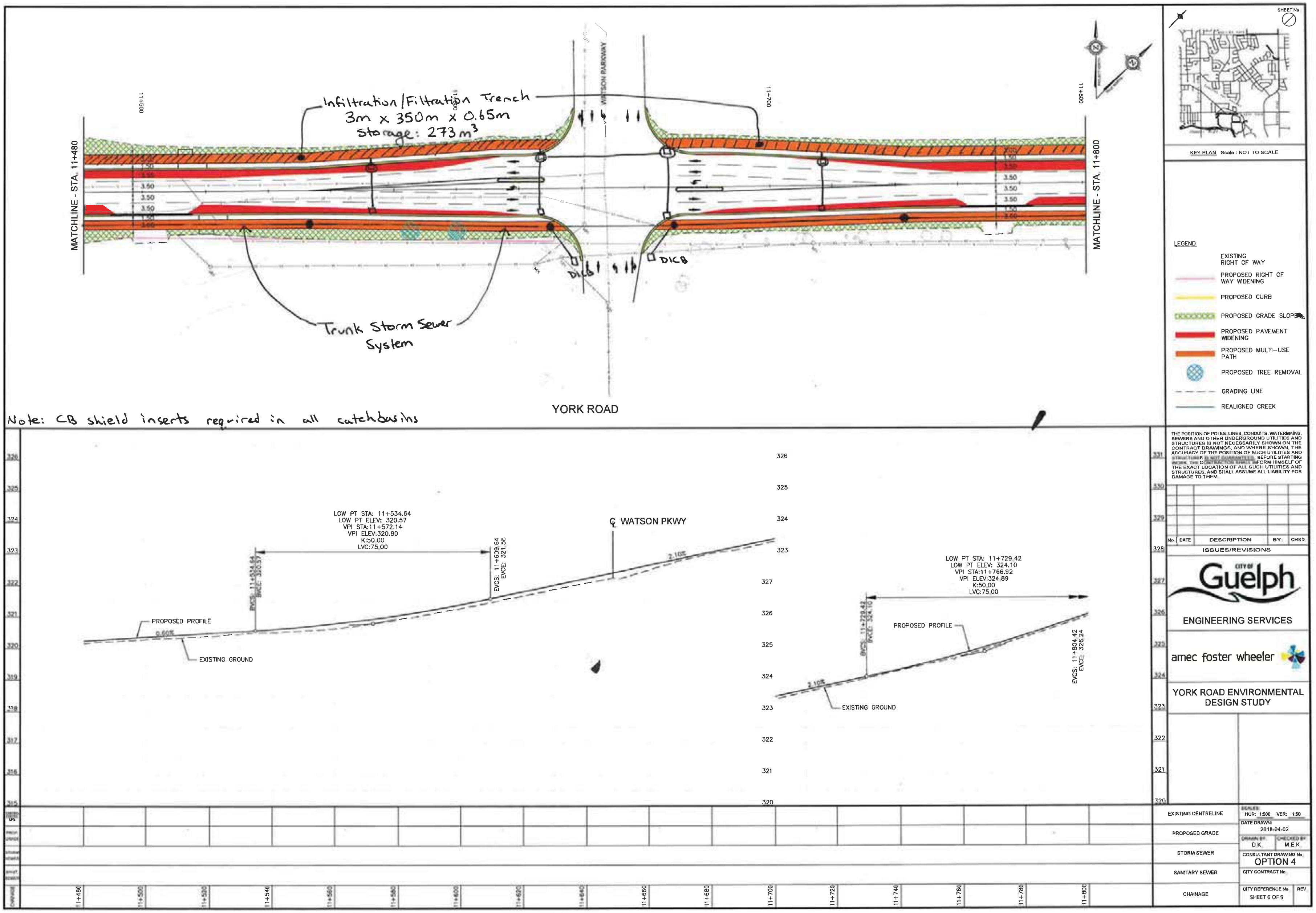
YORK ROAD ENVIRONMENTAL DESIGN STUDY
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
SCALES: HOR: 1:500 VER: 1:50
DATE DRAWN: 2018-04-02
DRAWN BY: D.K.
CHECKED BY: M.E.K.
CONSULTANT DRAWING No. OPTION 4
CITY CONTRACT No.
CITY REFERENCE No. SHEET 5 OF 9
REV
11+160
11+180
11+200
11+220
11+240
11+260
11+280
11+300
11+320
11+340
11+360
11+380
11+400
11+420
11+440
11+460
11+480


MATCHLINE - STA. 11+480
MATCHLINE - STA. 11+800
WATSON PARKWAY
YORK ROAD
Infiltration/Filtration Trench
3m x 350m x 0.65m
Storage: 273 m3
Trunk Storm Sewer
System
DICB
Note: CB shield inserts required in all catchbasins
LEGEND
EXISTING RIGHT OF WAY
PROPOSED RIGHT OF WAY WIDENING
PROPOSED CURB
PROPOSED GRADE SLOPE
PROPOSED PAVEMENT WIDENING
PROPOSED MULTI-USE PATH
PROPOSED TREE REMOVAL
GRADING LINE
REALIGNED CREEK
KEY PLAN Scale : NOT TO SCALE
LOW PT STA: 11+534.64
LOW PT ELEV: 320.57
VPI STA:11+572.14
VPI ELEV:320.80
K:50.00
LVC:75.00
EVCS: 11+609.64
EVCE: 321.56
℄ WATSON PKWY
PROPOSED PROFILE
EXISTING GROUND
LOW PT STA: 11+729.42
LOW PT ELEV: 324.10
VPI STA:11+766.92
VPI ELEV:324.89
K:50.00
LVC:75.00
EVCS: 11+804.42
EVCE: 326.24
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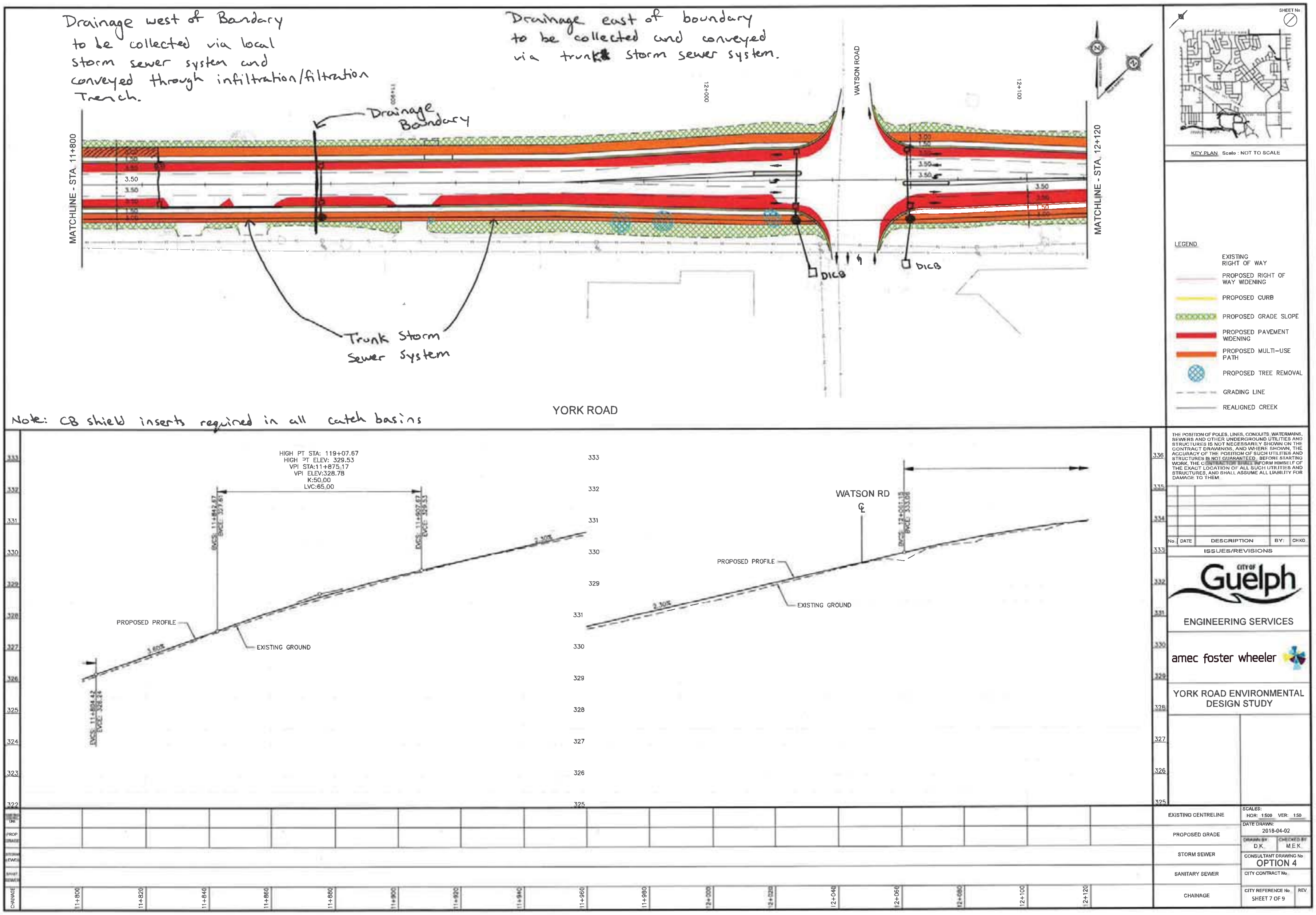
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
SCALES: HOR: 1:500 VER: 1:50
DATE DRAWN: 2018-04-02
DRAWN BY: D.K.
CHECKED BY: M.E.K.
CONSULTANT DRAWING No. OPTION 4
CITY CONTRACT No.
CITY REFERENCE No.
SHEET 6 OF 9


Drainage west of Bardary to be collected via local storm sewer system and conveyed through infiltration/filtration Trench.
Drainage east of boundary to be collected and conveyed via trunk storm sewer system.
Drainage Boundary
Trunk Storm Sewer System
DICB
DICB
WATSON ROAD
MATCHLINE - STA. 11+800
MATCHLINE - STA. 12+120
12+000
12+100
YORK ROAD
Note: CB shield inserts required in all catch basins
KEY PLAN Scale : NOT TO SCALE
LEGEND
EXISTING RIGHT OF WAY
PROPOSED RIGHT OF WAY WIDENING
PROPOSED CURB
PROPOSED GRADE SLOPE
PROPOSED PAVEMENT WIDENING
PROPOSED MULTI-USE PATH
PROPOSED TREE REMOVAL
GRADING LINE
REALIGNED CREEK
HIGH PT STA: 119+07.67
HIGH PT ELEV: 329.53
VPI STA:11+875.17
VPI ELEV:328.78
K:50.00
LVC:65.00
PROPOSED PROFILE
EXISTING GROUND
WATSON RD
3.60%
2.30%
THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
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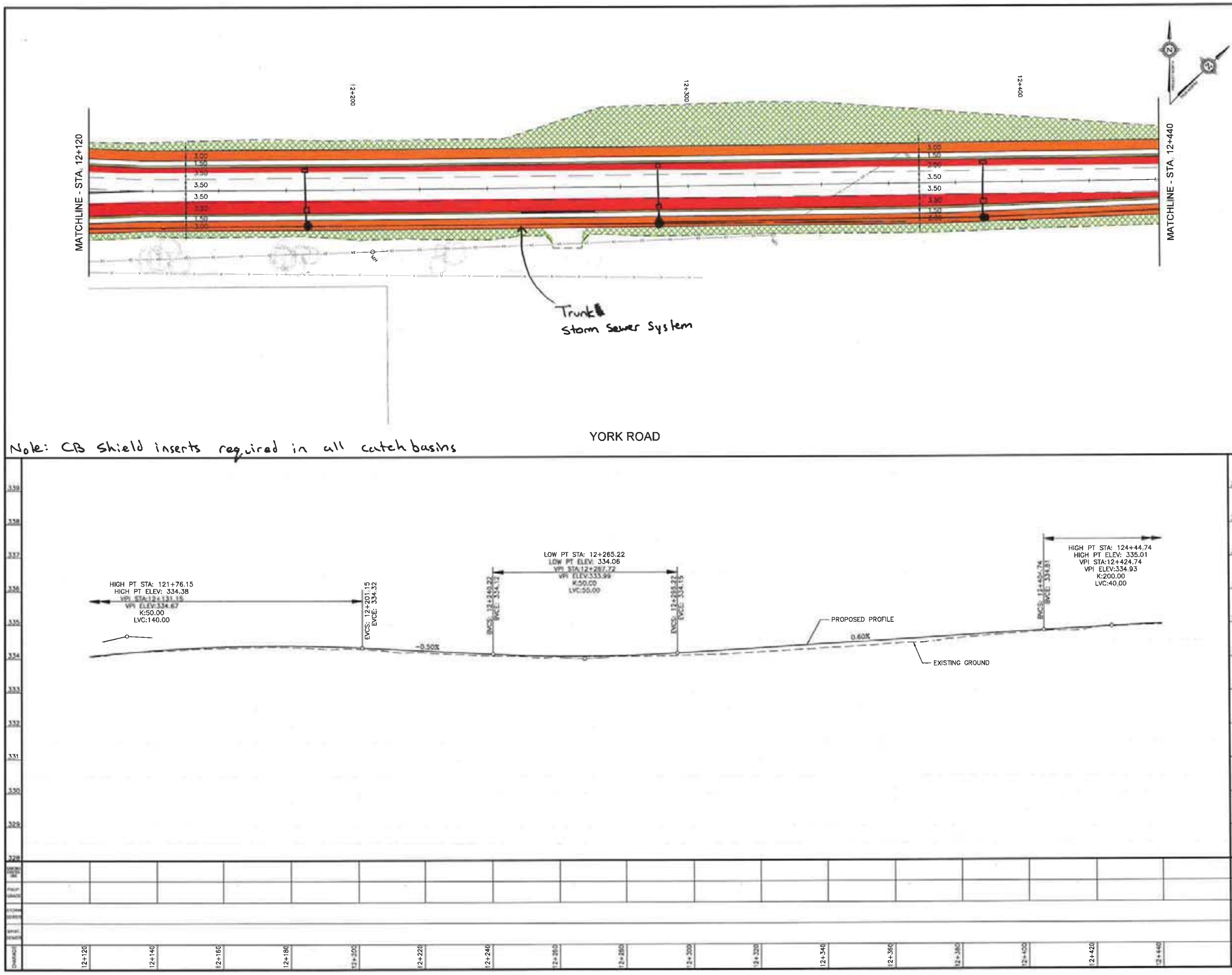
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
11+800
11+820
11+840
11+860
11+880
11+900
11+920
11+940
11+960
11+980
12+000
12+020
12+040
12+060
12+080
12+100
12+120
SCALES: HOR: 1:500 VER: 1:50
DATE DRAWN: 2018-04-02
DRAWN BY D.K.
CHECKED BY M.E.K.
CONSULTANT DRAWING No. OPTION 4
CITY CONTRACT No.
CITY REFERENCE No.
REV.
SHEET 7 OF 9



KEY PLAN Scale : NOT TO SCALE

SHEET No.

LEGEND

- EXISTING RIGHT OF WAY
- PROPOSED RIGHT OF WAY WIDENING
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI-USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK

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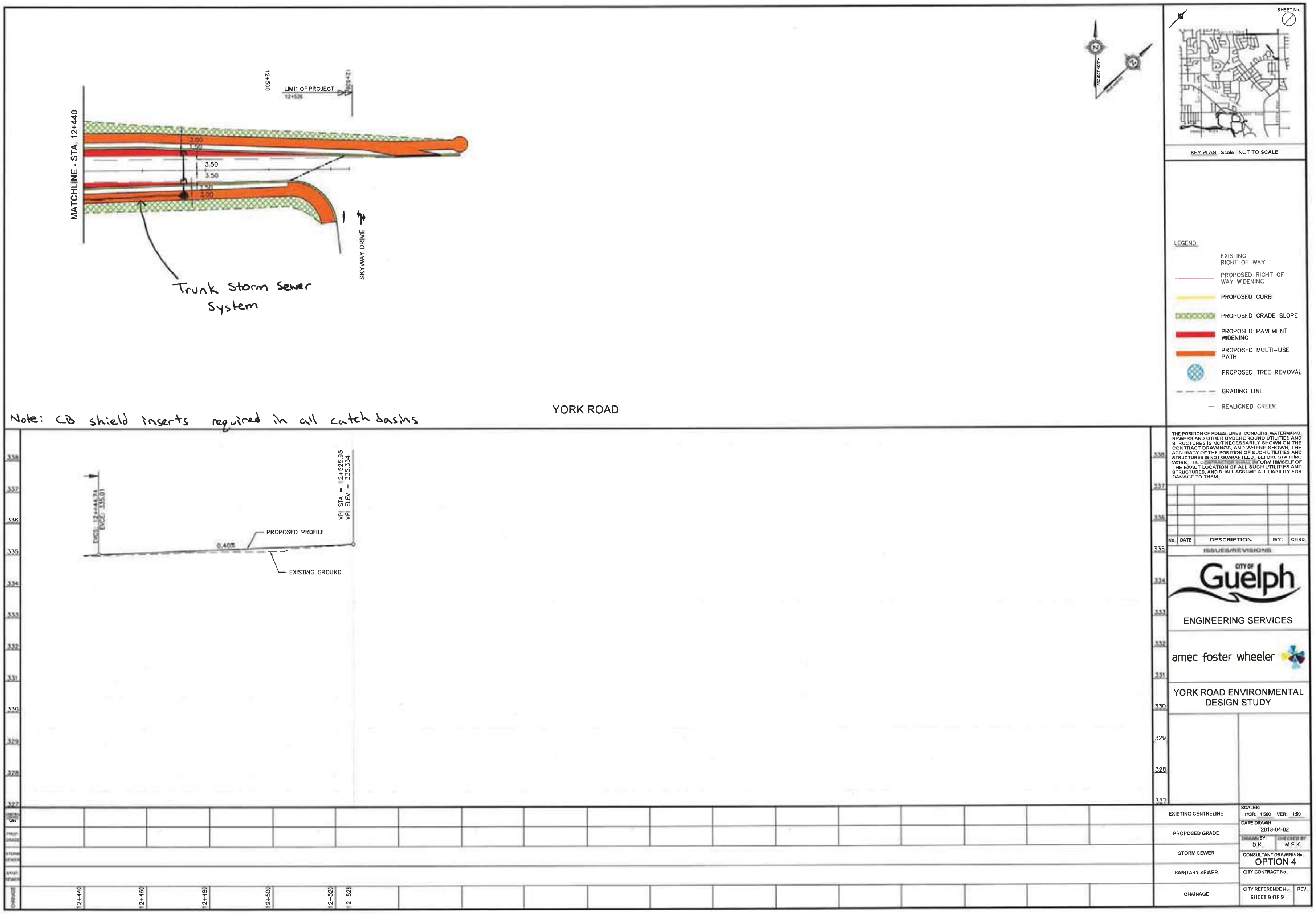
DATE DRAWN	2018-04-02
DRAWN BY	D.K
CHECKED BY	M.E.K
CONSULTANT DRAWING No.	OPTION 4
CITY CONTRACT No.	
CITY REFERENCE No.	SHEET 8 OF 9
REV.	



MATCHLINE - STA. 12+440
12+500
LIMIT OF PROJECT
12+526
3.00
1.50
3.50
3.50
1.50
3.00
SKYWAY DRIVE
Trunk Storm Sewer System
YORK ROAD
Note: CB shield inserts required in all catch basins
PROPOSED PROFILE
0.40%
EXISTING GROUND
VPI STA = 12+525.95
VPI ELEV = 335.334
KEY PLAN Scale NOT TO SCALE
SHEET No.
LEGEND
EXISTING RIGHT OF WAY
PROPOSED RIGHT OF WAY WIDENING
PROPOSED CURB
PROPOSED GRADE SLOPE
PROPOSED PAVEMENT WIDENING
PROPOSED MULTI-USE PATH
PROPOSED TREE REMOVAL
GRADING LINE
REALIGNED CREEK
No. DATE DESCRIPTION BY: CHKD.
ISSUES/REVISIONS
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EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
SCALES: HOR: 1:500 VER: 1:50
DATE DRAWN: 2018-04-02
DRAWN BY: D.K. CHECKED BY: M.E.K.
CONSULTANT DRAWING No. OPTION 4
CITY CONTRACT No.
CITY REFERENCE No. SHEET 9 OF 9
REV.
12+440
12+460
12+480
12+500
12+520
12+526

Detailed Stormceptor Sizing Report – Elizabeth St.

Project Information & Location			
Project Name	Elizabeth St.	**Project Number**	-
City	Guelph	**State/ Province**	Ontario
Country	Canada	**Date**	11/16/2018
Designer Information		**EOR Information (optional)**	
Name	Brandon O'Leary	**Name**	Gurkanwal Arora
Company	Forterra	**Company**	John Wood Group
Phone #	905-630-0359	**Phone #**	
Email	brandon.oleary@forterrabp.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	Elizabeth St.
Recommended Stormceptor Model	EFO8
TSS Removal (%) Provided	60
PSD	CA ETV
RainFall Station	WATERLOO WELLINGTON A

The recommended Stormceptor model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

EFO Sizing Summary			
EFO Model	**% TSS Removal Provided**	**% Runoff Volume Captured Provided**	**Standard EFO Hydrocarbon Storage Capacity**
EFO4	49	64	265 L (70 gal)
EFO6	56	83	610 L (160 gal)
EFO8	60	91	1070 L (280 gal)
EFO10	65	95	1670 L (440 gal)
EFO12	70	97	2475 L (655 gal)
Parallel Units / MAX	Custom	Custom	Custom

OVERVIEW

Stormceptor ® EF is a continuation and evolution of the most globally recognized oil-grit separator (OGS) stormwater treatment technology - **Stormceptor ®.** Also known as a hydrodynamic separator, the enhanced flow Stormceptor EF is a high performing oil-grit separator that effectively removes a wide variety of pollutants from stormwater and snowmelt runoff at higher flow rates as compared to the original Stormceptor. Stormceptor EF captures and retains sediment (TSS), free oils, gross pollutants and other pollutants that attach to particles, such as nutrients and metals. Stormceptor EF's patent-pending treatment and scour prevention technology and internal bypass ensures sediment is retained during all rainfall events.

Sizing Methodology

Stormceptor ® EF and Stormceptor ® EFO are sized using local historical rainfall data for the site of interest, specific site parameters, and a performance curve for TSS removal derived from third-party testing conducted in accordance with the Canadian Environmental Technology Verification (ETV) Program's Procedure for Laboratory Testing of OilGrit Separators. Every Stormceptor unit is designed to achieve the specified target TSS removal, however, for sites where oil/fuel capture and retention is an additional specified water quality objective Stormceptor EFO is the proper selection. The sizing methodology includes various considerations, including:

- Site parameters
- Local historical rainfall data
- Capture of the Canadian ETV particle size distribution
- Requirements for oil/fuel capture and retention
- Performance results from third-party testing and verification

Hydrology Analysis

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of Stormceptor are based on the average annual removal of TSS for the selected site parameters. The Stormceptor is engineered to capture sediment particles by treating the required average annual runoff volume, ensuring positive removal efficiency is maintained during each rainfall event, and preventing negative removal efficiency (scour).
Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

State/Province	Ontario	**Total Number of Rainfall Events**	3521
Rainfall Station Name	WATERLOO WELLINGTON A	**Total Rainfall (mm)**	16119.1
Station ID #	9387	**Average Annual Rainfall (mm)**	474.1
Coordinates	43°27'N, 80°23'W	**Total Evaporation (mm)**	1267.9
Elevation (ft)	1028	**Total Infiltration (mm)**	2389.9
Years of Rainfall Data	34	**Total Rainfall that is Runoff (mm)**	12461.3

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

ONLINE APPLICATION

Stormceptor EF's internal bypass and patent-pending scour prevention technology has demonstrated very effective retention of pollutants in third-party testing and verification following the Canadian ETV's **Procedure for Laboratory Testing of Oil-Grit Separators.** Sediment scour prevention demonstrated an effluent concentration of less than 10 mg/L for sediment particles ranging from 1 to 1,000 microns, even during peak influent flow rates associated with infrequent high intensity storm events. While Stormceptor EF will capture oil, only the Stormceptor EFO configuration has been third-party tested and verified to retain greater than 99% of captured oil. Based on these verified performance attributes, the most efficient and widely accepted application of Stormceptor EF is an online configuration, which allows all upstream conveyance flows to enter and exit the unit. The online application eliminates the need for costly additional bypass structures, piping and installation expense.

FLOW ENTRANCE OPTIONS

Single Inlet Pipe – A common design which includes one inlet pipe and one outlet pipe. A 90-degree (maximum) bend is also accepted with this configuration.

Inlet Grate – Allows surface runoff to enter the unit from grade. The inlet grate option can also be used in conjunction with one inlet pipe or multiple inlet pipes. A removable flow deflector is added in the Stormceptor EF4/EFO4.

Maximum Pipe Diameter		
Model	Inlet (In/mm)	Outlet (In/mm)
EF4 / EFO4	24 / 610	24 / 610
EF6 / EFO6	36 / 915	36 / 915
EF8/ EFO8	48 / 1220	48 / 1220
EF10/EFO10	72 / 1828	72 / 1828
EF12/EFO12	72 / 1828	72 / 1828

Multiple Inlet Pipe – Allows for multiple inlet pipes of various diameters to enter the unit.

Maximum Pipe Diameter		
Model	Inlet (In/mm)	Outlet (In/mm)
EF4 / EFO4	18 / 457	24 / 610
EF6 / EFO6	30 / 762	36 / 915
EF8/ EFO8	42 / 1067	48 / 1220
EF10/EFO10	60 / 1524	72 / 1828
EF12/EFO12	60 / 1524	72 / 1828

Drainage Area	
Total Area (ha)	1.44
Imperviousness %	85.0

Up Stream Storage	
Storage (ha-m)	Discharge (cms)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cms)	

Water Quality Objective	
TSS Removal (%)	60.0
Runoff Volume Capture (%)	90.00
Oil Spill Capture Volume (L)	
Peak Conveyed Flow Rate (L/s)	
Water Quality Flow Rate (L/s)	

Design Details	
Stormceptor Inlet Invert Elev (m)	
Stormceptor Outlet Invert Elev (m)	
Stormceptor Rim Elev (m)	
Normal Water Level Elevation (m)	
Pipe Diameter (mm)	
Pipe Material	
Multiple Inlets (Y/N)	No
Grate Inlet (Y/N)	No

Particle Size Distribution (PSD)

Removing the smallest fraction of particulates from runoff ensures the majority of pollutants, such as metals, hydrocarbons and nutrients are captured. The table below identifies the Particle Size Distribution (PSD) that was selected to define TSS removal for the Stormceptor design.

CA ETV		
Particle Diameter (microns)	Distribution %	Specific Gravity
2.0	5.0	2.65
5.0	5.0	2.65
8.0	10.0	2.65
20.0	15.0	2.65
50.0	10.0	2.65
75.0	5.0	2.65
100.0	10.0	2.65
150.0	15.0	2.65
250.0	15.0	2.65
500.0	5.0	2.65
1000.0	5.0	2.65

Site Name	Elizabeth St.

Site Details

Drainage Area

Total Area (ha)	1.44
Imperviousness %	85.0
Oil Spill Capture Volume (L)	

Infiltration Parameters

Horton's equation is used to estimate infiltration

Max. Infiltration Rate (mm/hr)	61.98
Min. Infiltration Rate (mm/hr)	10.16
Decay Rate (1/sec)	0.00055
Regeneration Rate (1/sec)	0.01

Surface Characteristics

Width (m)	240.00
Slope %	2
Impervious Depression Storage (mm)	0.508
Pervious Depression Storage (mm)	5.08
Impervious Manning's n	0.015
Pervious Manning's n	0.25

Evaporation

Daily Evaporation Rate (mm/day)	2.54

Dry Weather Flow

Dry Weather Flow (lps)	0

Maintenance Frequency

Maintenance Frequency (months) >	12

Winter Months

Winter Infiltration	0

TSS Loading Parameters

TSS Loading Function	Build Up/ Wash-off

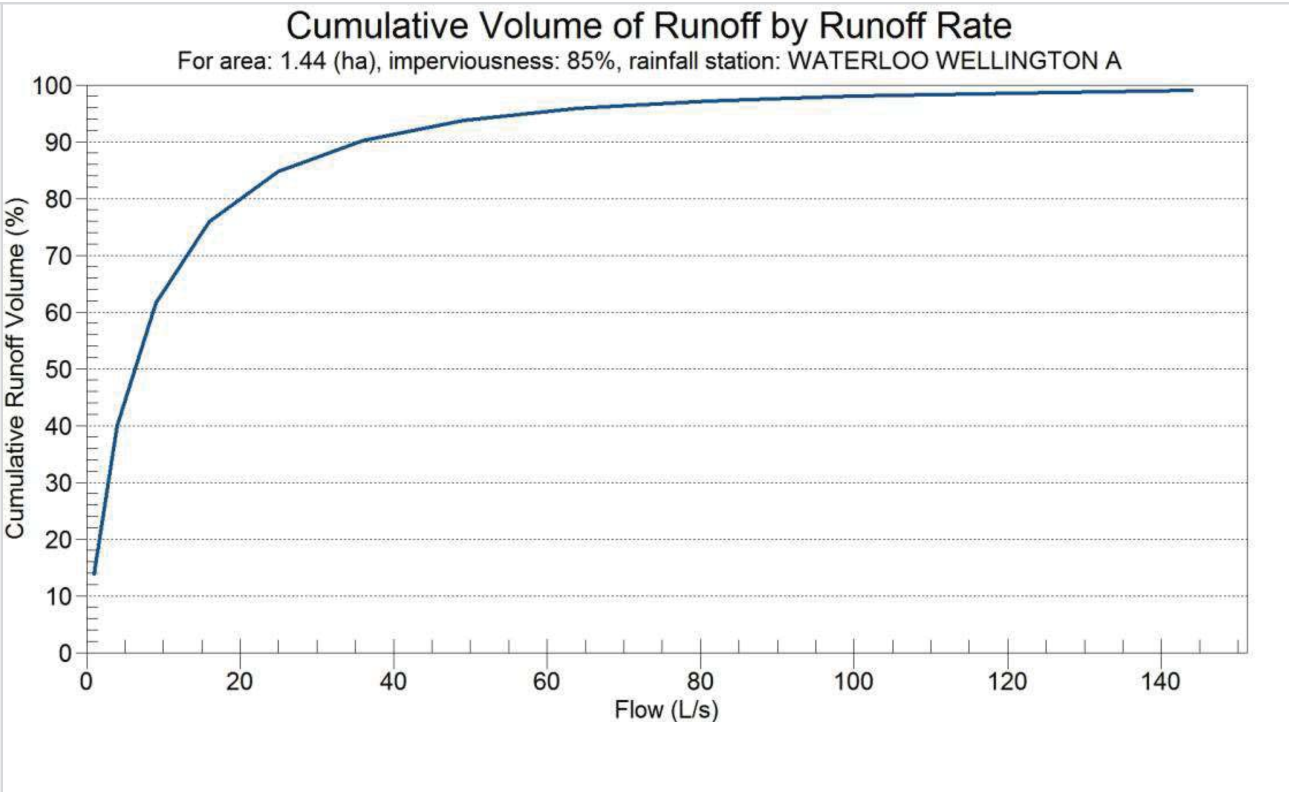
Buildup/Wash-off Parameters

Target Event Mean Conc. (EMC) mg/L	125
Exponential Buildup Power	0.40
Exponential Washoff Exponent	0.20

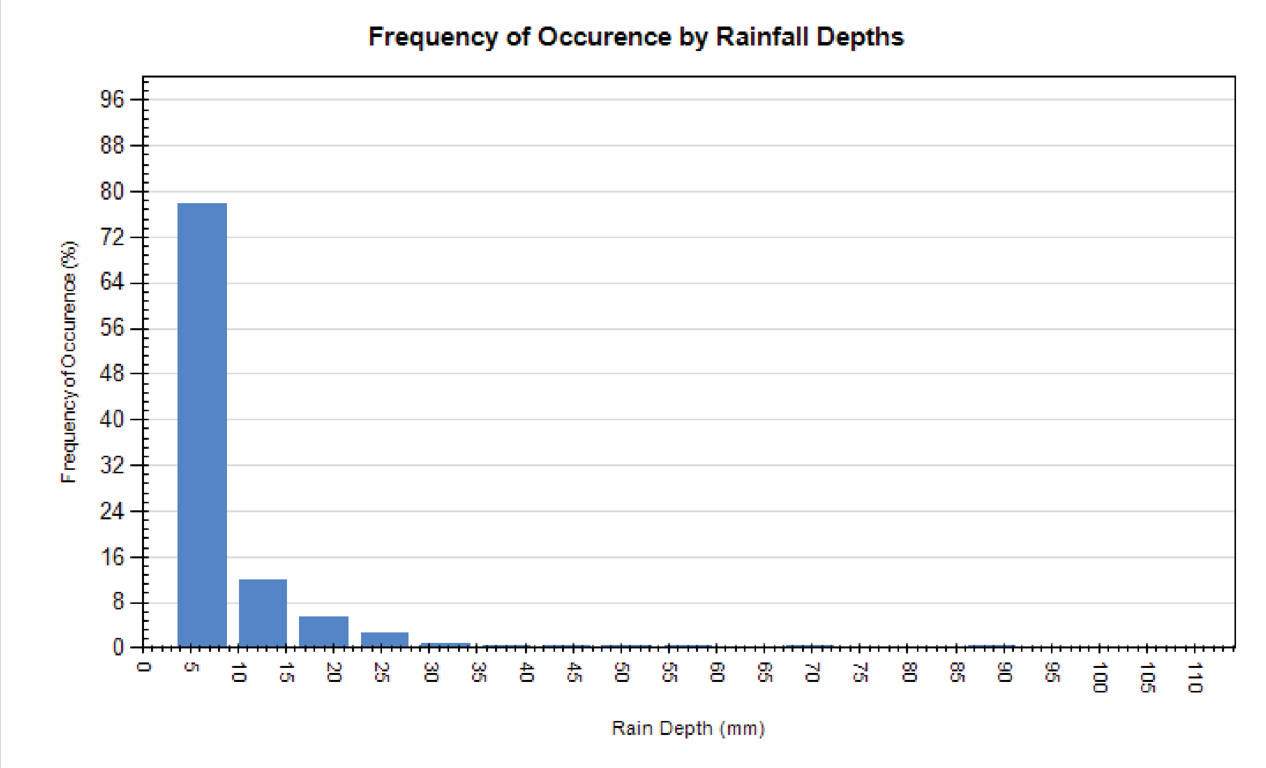
TSS Availability Parameters

Availability Constant A	0.057
Availability Factor B	0.04
Availability Exponent C	1.10
Min. Particle Size Affected by Availability (micron)	400

Cumulative Runoff Volume by Runoff Rate			
Runoff Rate (L/s)	Runoff Volume (m³)	Volume Over (m³)	Cumulative Runoff Volume (%)
1	25106	155222	13.9
4	72126	108198	40.0
9	111098	69252	61.6
16	136813	43512	75.9
25	152829	27508	84.7
36	162674	17655	90.2
49	168970	11362	93.7
64	172941	7389	95.9
81	175337	4994	97.2
100	176898	3432	98.1
121	177840	2491	98.6
144	178541	1790	99.0
169	179058	1273	99.3
196	179427	903	99.5
225	179740	591	99.7
256	179932	399	99.8
289	180064	266	99.9
324	180169	162	99.9
361	180235	96	99.9
400	180268	63	100
441	180292	38	100
484	180318	13	100
529	180331	0	100
576	180331	0	100


Cumulative Volume of Runoff by Runoff Rate
For area: 1.44 (ha), imperviousness: 85%, rainfall station: WATERLOO WELLINGTON A
Cumulative Runoff Volume (%)
0
10
20
30
40
50
60
70
80
90
100
0
20
40
60
80
100
120
140
Flow (L/s)

Rainfall Event Analysis				
Rainfall Depth (mm)	**No. of Events**	**Percentage of Total Events (%)**	**Total Volume (mm)**	**Percentage of Annual Volume (%)**
6.35	2742	77.9	4245	26.3
12.70	420	11.9	3837	23.8
19.05	193	5.5	3014	18.7
25.40	88	2.5	1904	11.8
31.75	27	0.8	769	4.8
38.10	16	0.5	563	3.5
44.45	19	0.5	774	4.8
50.80	5	0.1	241	1.5
57.15	3	0.1	156	1.0
63.50	0	0.0	0	0.0
69.85	4	0.1	267	1.7
76.20	0	0.0	0	0.0
82.55	0	0.0	0	0.0
88.90	3	0.1	255	1.6
95.25	1	0.0	93	0.6
101.60	0	0.0	0	0.0
107.95	0	0.0	0	0.0



For Stormceptor Specifications and Drawings Please Visit:
http://www.imbriumsystems.com/technical-specifications

Bioretention Facility Design

$A_f = WQV / (d_c * V_r)$

Where:

A_f = Footprint surface area (m^2)
WQV = Water quality volume (m^3)
d_c = Bioretention cell depth (m)
V_r = Void space ratio for filter bed and gravel storage layer (assume 0.4)

Source: Low Impact Development Stormwater Management Planning and Design Guide (CVC, 2010)

Required Storage Volume	51.3	m^3
Bioretention Cell Depth	1.5	m
Void Ratio	0.4	

Facility 1		
Drainage Area	1480	m^2
Storage Volume Provided	29.50	m^3
Footprint Surface Area	49.17	m^2

Facility 2		
Drainage Area	569	m^2
Storage Volume Provided	11.30	m^3
Footprint Surface Area	18.83	m^2

Facility 3		
Drainage Area	610	m^2
Storage Volume Provided	12.20	m^3
Footprint Surface Area	20.33	m^2

Stormceptor®

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Detailed Stormceptor Sizing Report – Industrial St.

Project Information & Location			
Project Name	Industrial St.	**Project Number**	-
City	Guelph	**State/ Province**	Ontario
Country	Canada	**Date**	11/16/2018
Designer Information		**EOR Information (optional)**	
Name	Brandon O'Leary	**Name**	Gurkanwal Arora
Company	Forterra	**Company**	John Wood Group
Phone #	905-630-0359	**Phone #**	
Email	brandon.oleary@forterrabp.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	Industrial St.
Recommended Stormceptor Model	EFO6
TSS Removal (%) Provided	63
PSD	CA ETV
RainFall Station	WATERLOO WELLINGTON A

The recommended Stormceptor model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

EFO Sizing Summary			
EFO Model	**% TSS Removal Provided**	**% Runoff Volume Captured Provided**	**Standard EFO Hydrocarbon Storage Capacity**
EFO4	54	82	265 L (70 gal)
EFO6	63	94	610 L (160 gal)
EFO8	69	97	1070 L (280 gal)
EFO10	72	99	1670 L (440 gal)
EFO12	74	99	2475 L (655 gal)
Parallel Units / MAX	Custom	Custom	Custom

OVERVIEW

Stormceptor ® EF is a continuation and evolution of the most globally recognized oil-grit separator (OGS) stormwater treatment technology - **Stormceptor ®.** Also known as a hydrodynamic separator, the enhanced flow Stormceptor EF is a high performing oil-grit separator that effectively removes a wide variety of pollutants from stormwater and snowmelt runoff at higher flow rates as compared to the original Stormceptor. Stormceptor EF captures and retains sediment (TSS), free oils, gross pollutants and other pollutants that attach to particles, such as nutrients and metals. Stormceptor EF's patent-pending treatment and scour prevention technology and internal bypass ensures sediment is retained during all rainfall events.

Sizing Methodology

Stormceptor ® EF and Stormceptor ® EFO are sized using local historical rainfall data for the site of interest, specific site parameters, and a performance curve for TSS removal derived from third-party testing conducted in accordance with the Canadian Environmental Technology Verification (ETV) Program's Procedure for Laboratory Testing of OilGrit Separators. Every Stormceptor unit is designed to achieve the specified target TSS removal, however, for sites where oil/fuel capture and retention is an additional specified water quality objective Stormceptor EFO is the proper selection. The sizing methodology includes various considerations, including:

- Site parameters
- Local historical rainfall data
- Capture of the Canadian ETV particle size distribution
- Requirements for oil/fuel capture and retention
- Performance results from third-party testing and verification

Hydrology Analysis

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of Stormceptor are based on the average annual removal of TSS for the selected site parameters. The Stormceptor is engineered to capture sediment particles by treating the required average annual runoff volume, ensuring positive removal efficiency is maintained during each rainfall event, and preventing negative removal efficiency (scour).
Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

State/Province	Ontario	**Total Number of Rainfall Events**	3521
Rainfall Station Name	WATERLOO WELLINGTON A	**Total Rainfall (mm)**	16119.1
Station ID #	9387	**Average Annual Rainfall (mm)**	474.1
Coordinates	43°27'N, 80°23'W	**Total Evaporation (mm)**	1142.9
Elevation (ft)	1028	**Total Infiltration (mm)**	3219.5
Years of Rainfall Data	34	**Total Rainfall that is Runoff (mm)**	11756.7

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

ONLINE APPLICATION

Stormceptor EF's internal bypass and patent-pending scour prevention technology has demonstrated very effective retention of pollutants in third-party testing and verification following the Canadian ETV's **Procedure for Laboratory Testing of Oil-Grit Separators.** Sediment scour prevention demonstrated an effluent concentration of less than 10 mg/L for sediment particles ranging from 1 to 1,000 microns, even during peak influent flow rates associated with infrequent high intensity storm events. While Stormceptor EF will capture oil, only the Stormceptor EFO configuration has been third-party tested and verified to retain greater than 99% of captured oil. Based on these verified performance attributes, the most efficient and widely accepted application of Stormceptor EF is an online configuration, which allows all upstream conveyance flows to enter and exit the unit. The online application eliminates the need for costly additional bypass structures, piping and installation expense.

FLOW ENTRANCE OPTIONS

Single Inlet Pipe – A common design which includes one inlet pipe and one outlet pipe. A 90-degree (maximum) bend is also accepted with this configuration.

Inlet Grate – Allows surface runoff to enter the unit from grade. The inlet grate option can also be used in conjunction with one inlet pipe or multiple inlet pipes. A removable flow deflector is added in the Stormceptor EF4/EFO4.

Maximum Pipe Diameter		
Model	Inlet (In/mm)	Outlet (In/mm)
EF4 / EFO4	24 / 610	24 / 610
EF6 / EFO6	36 / 915	36 / 915
EF8/ EFO8	48 / 1220	48 / 1220
EF10/EFO10	72 / 1828	72 / 1828
EF12/EFO12	72 / 1828	72 / 1828

Multiple Inlet Pipe – Allows for multiple inlet pipes of various diameters to enter the unit.

Maximum Pipe Diameter		
Model	Inlet (In/mm)	Outlet (In/mm)
EF4 / EFO4	18 / 457	24 / 610
EF6 / EFO6	30 / 762	36 / 915
EF8/ EFO8	42 / 1067	48 / 1220
EF10/EFO10	60 / 1524	72 / 1828
EF12/EFO12	60 / 1524	72 / 1828

Drainage Area	
Total Area (ha)	0.66
Imperviousness %	79.8

Up Stream Storage	
Storage (ha-m)	Discharge (cms)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cms)	

Water Quality Objective	
TSS Removal (%)	60.0
Runoff Volume Capture (%)	90.00
Oil Spill Capture Volume (L)	
Peak Conveyed Flow Rate (L/s)	
Water Quality Flow Rate (L/s)	

Design Details	
Stormceptor Inlet Invert Elev (m)	
Stormceptor Outlet Invert Elev (m)	
Stormceptor Rim Elev (m)	
Normal Water Level Elevation (m)	
Pipe Diameter (mm)	
Pipe Material	
Multiple Inlets (Y/N)	No
Grate Inlet (Y/N)	No

Particle Size Distribution (PSD)

Removing the smallest fraction of particulates from runoff ensures the majority of pollutants, such as metals, hydrocarbons and nutrients are captured. The table below identifies the Particle Size Distribution (PSD) that was selected to define TSS removal for the Stormceptor design.

CA ETV		
Particle Diameter (microns)	Distribution %	Specific Gravity
2.0	5.0	2.65
5.0	5.0	2.65
8.0	10.0	2.65
20.0	15.0	2.65
50.0	10.0	2.65
75.0	5.0	2.65
100.0	10.0	2.65
150.0	15.0	2.65
250.0	15.0	2.65
500.0	5.0	2.65
1000.0	5.0	2.65

Stormceptor®

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Site Name	Industrial St.

Site Details

Drainage Area	
Total Area (ha)	0.66
Imperviousness %	79.8
Oil Spill Capture Volume (L)	

Infiltration Parameters	
Horton's equation is used to estimate infiltration	
Max. Infiltration Rate (mm/hr)	61.98
Min. Infiltration Rate (mm/hr)	10.16
Decay Rate (1/sec)	0.00055
Regeneration Rate (1/sec)	0.01

Surface Characteristics	
Width (m)	162.00
Slope %	2
Impervious Depression Storage (mm)	0.508
Pervious Depression Storage (mm)	5.08
Impervious Manning's n	0.015
Pervious Manning's n	0.25

Evaporation	
Daily Evaporation Rate (mm/day)	2.54

Dry Weather Flow	
Dry Weather Flow (lps)	0

Maintenance Frequency	
Maintenance Frequency (months) >	12

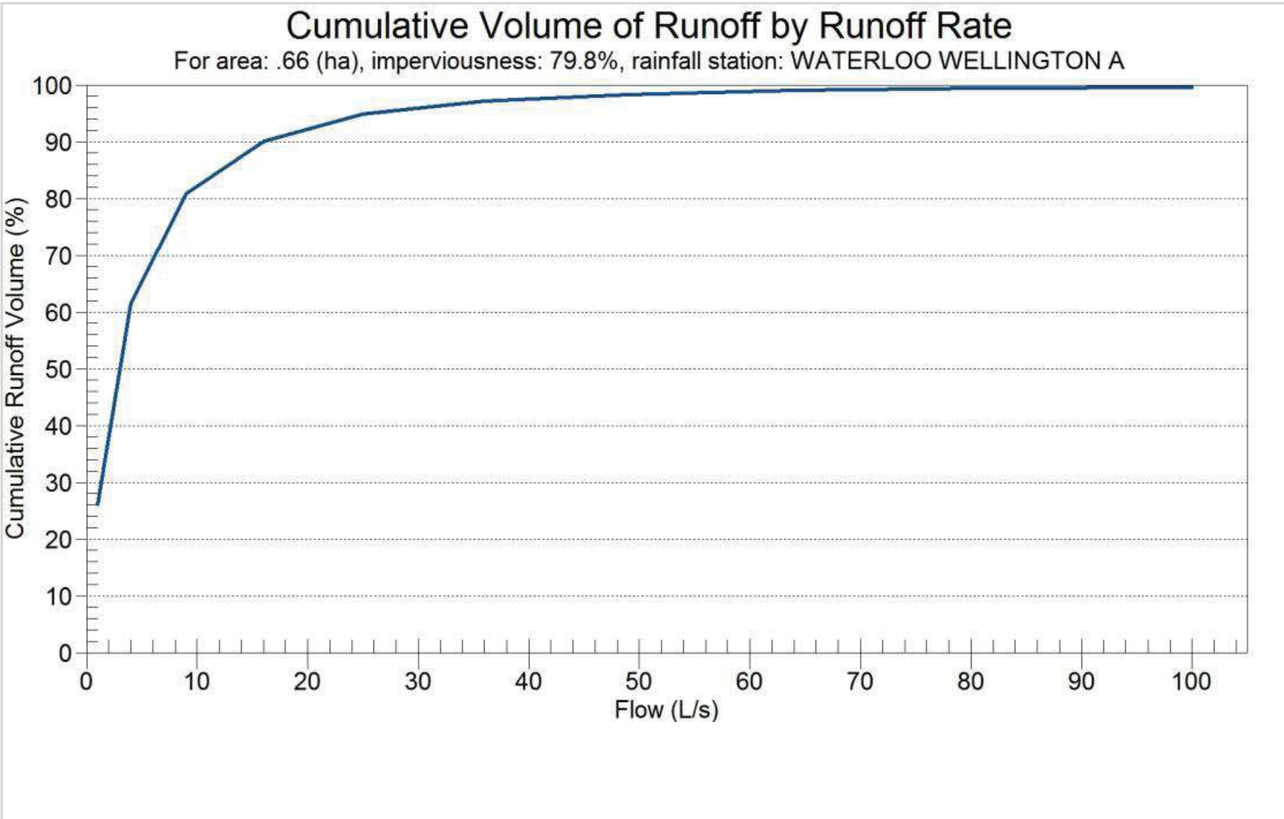
Winter Months	
Winter Infiltration	0

TSS Loading Parameters	
TSS Loading Function	Build Up/ Wash-off

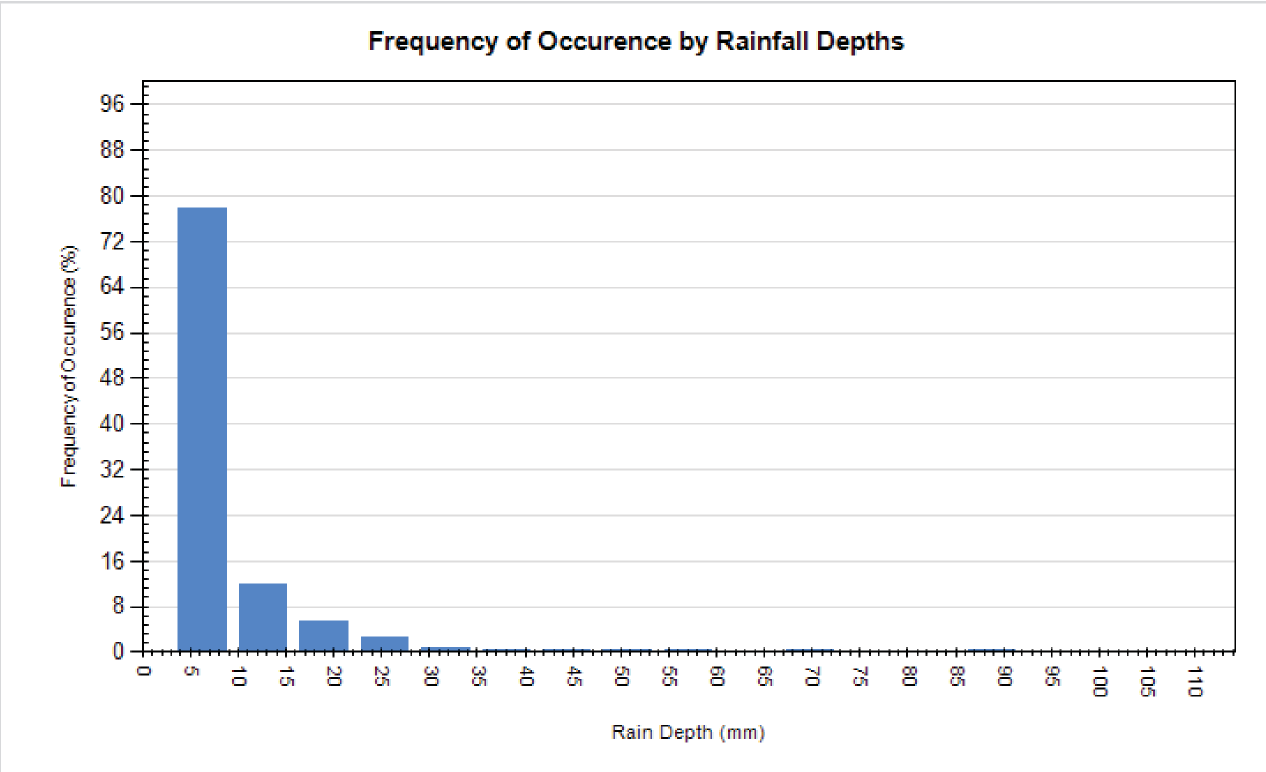
Buildup/Wash-off Parameters	
Target Event Mean Conc. (EMC) mg/L	125
Exponential Buildup Power	0.40
Exponential Washoff Exponent	0.20

TSS Availability Parameters	
Availability Constant A	0.057
Availability Factor B	0.04
Availability Exponent C	1.10
Min. Particle Size Affected by Availability (micron)	400

Cumulative Runoff Volume by Runoff Rate			
Runoff Rate (L/s)	**Runoff Volume (m³)**	**Volume Over (m³)**	**Cumulative Runoff Volume (%)**
1	20424	57655	26.2
4	47987	30093	61.5
9	63073	15006	80.8
16	70380	7699	90.1
25	74097	3980	94.9
36	75862	2215	97.2
49	76771	1306	98.3
64	77265	811	99.0
81	77576	500	99.4
100	77796	280	99.6
121	77919	157	99.8
144	77991	85	99.9
169	78035	41	99.9
196	78056	20	100
225	78073	3	100
256	78076	0	100
289	78076	0	100


Cumulative Volume of Runoff by Runoff Rate
For area: .66 (ha), imperviousness: 79.8%, rainfall station: WATERLOO WELLINGTON A
Cumulative Runoff Volume (%)
Flow (L/s)
0
10
20
30
40
50
60
70
80
90
100

Rainfall Event Analysis				
Rainfall Depth (mm)	**No. of Events**	**Percentage of Total Events (%)**	**Total Volume (mm)**	**Percentage of Annual Volume (%)**
6.35	2742	77.9	4245	26.3
12.70	420	11.9	3837	23.8
19.05	193	5.5	3014	18.7
25.40	88	2.5	1904	11.8
31.75	27	0.8	769	4.8
38.10	16	0.5	563	3.5
44.45	19	0.5	774	4.8
50.80	5	0.1	241	1.5
57.15	3	0.1	156	1.0
63.50	0	0.0	0	0.0
69.85	4	0.1	267	1.7
76.20	0	0.0	0	0.0
82.55	0	0.0	0	0.0
88.90	3	0.1	255	1.6
95.25	1	0.0	93	0.6
101.60	0	0.0	0	0.0
107.95	0	0.0	0	0.0



For Stormceptor Specifications and Drawings Please Visit:
http://www.imbriumsystems.com/technical-specifications

SPECIFICATION FOR CATCH BASIN INSERT

PART 1-PRODUCT

1.1 GENERAL:

1.1.1 The catch basin insert must be able to fit reasonably tight to the catch basin and shall be square and vertically upright within it once placed. A top sloped plate shall direct flows toward the rear of the catch basin where the majority of flow shall be directed across a grate to allow sediment to drop out, with flows exiting at the outlet pipe of the catch basin.

1.1.2 The insert shall be supported by a "leg" that in turn supports the grate and top slope. The leg will be telescopic, allowing adjustment of the grate to be equal with the invert of the outgoing pipe from the catch basin.

1.1.3 The telescopic leg shall allow for adjustments in sump depths from 150 to 900 mm.

1.1.4 The catch basin insert must be easily removed to allow maintenance of the catch basin.

1.1.5 The insert should be fabricated from either fiberglass or co-polymer polypropylene.

1.1.6 The insert shall not include a flow through membrane to trap sediment.

1.2 FIBERGLASS:

A fiberglass insert should be fabricated in accordance with the following standard: ASTM D-4097: Contact Molded Glass Fiber Reinforced Chemical Resistant Tanks

1.3 CO-POLYMER POLYPROPYLENE:

A co-polymer polypropylene insert shall conform to a tensile strength of 4000 psi (ASTM D-683), an Izod impact value of 2.5 (ASTM D-792), a flexural modulus of 195000 (ASTM D-790) , A heat distortion temperature of 190° F (ASTM 648) and a Rockwell hardness of 74 (ASTM D-785)

1.4 FASTENERS:

The insert parts shall be fastened together with stainless steel hardware Grade 304 or 316.

PART 2 – PERFORMANCE

2.1 GENERAL

The catch basin insert shall facilitate removal of sediment from stormwater by settling in the catch basin sump during frequent rain events and and snowmelt events. The insert shall prevent re-suspension of captured material during higher flow events, with sediment to remain in place until suitably removed with appropriate catch basin cleaning equipment. The insert shall not impede flows through the catch basin, and shall not be prone to blockage.

2.2 TOTAL SUSPENDED SOLIDS and PARTICLE SIZE DISTRIBUTION:

2.2.1 The catch basin insert shall enhance and not impede the catch basin's ability to capture sediment. Depending on site conditions, the system shall generally be capable of capturing and retaining a long term average of 50% to 60% of incoming total suspended solids (TSS) loading. Sediment/TSS removal calculations shall be based on the particle size distribution associated with the ETV Canada definition of test sediment as outlined in their protocol for testing of Oil Grit Separator type devices.

2.2.2 The catch basin insert performance shall be determined through independent laboratory testing with protocols based on (and in general conformance with) the Canadian ETV program's protocol for TSS removal and scour for Oil Grit Separator type devices (as authored by Toronto Region Conservation Authority, revised June 2014).

2.2.3 Alternative long term removal rates associated with assuming a different PSD for incoming TSS (such as for sediment consistent with the City of Toronto's Wet Weather Flow Management Guidelines) will be provided by CB Shield Inc. if assumed in design calculations.

2.3 SITE SPECIFIC DESIGN AND PERFORMANCE

2.3.1 The catch basin insert shall enhance a catch basin's ability to capture TSS, with actual long term sediment removal performance based on the drainage area required for treatment and the level of imperviousness. ,

2.3.2 **T**he anticipated long term TSS removal performance for site specific installations shall be determined and stamped by a licensed engineer.

2.3.3 For a **double catch basin**. There will be two standard CB Shield inserts and one center spacer installed. The first insert is installed with the high part of the slope facing the outlet hole. The center spacer complete with foot is then installed directly below the double catch basin center beam. The second insert is installed in the section that does not have an outlet pipe. This insert will have the high point of the slope face either 90 or 180 degrees away from the outlet pipe.

CB Shield Contact Info:

39 Uplands Dr

Brantford Ont

N3R5H5

Ph - 519-212-9161

msmith@c-i-p.ca

Plotted: 2017-12-18 Plotted By: richard.bartolo
Last Saved: 2017-12-18 Last Saved By: richard.bartolo
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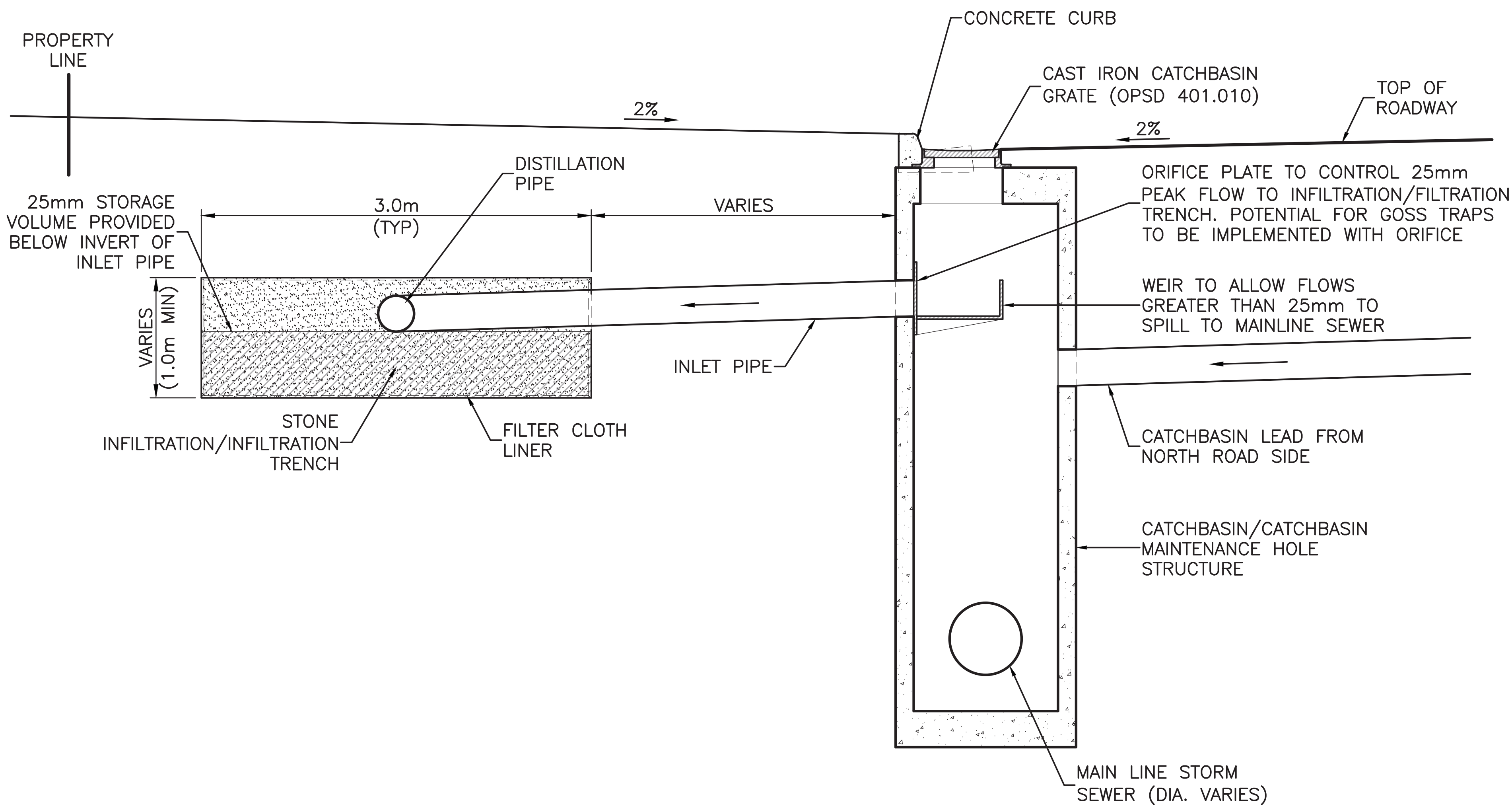

NOTE:
1. IMPERMEABLE LINER MAY BE REQUIRED DUE TO GROUND WATER LEVELS. LINER IS NOT REQUIRED WHERE GROUNDWATER >=1.0m BELOW UNDERSIDE OF TANK.

YORK ROAD EIS ADDENDUM CITY OF GUELPH	INFILTRATION/FILTRATION TRENCH CONFIGURATION	amec foster wheeler	Scale 1:50 Consultant File No. TP115100 Figure No.

Detailed Stormceptor Sizing Report – Hadati Creek

Project Information & Location			
Project Name	Hadati Creek	**Project Number**	-
City	Guelph	**State/ Province**	Ontario
Country	Canada	**Date**	11/16/2018
Designer Information		**EOR Information (optional)**	
Name	Brandon O'Leary	**Name**	Gurkanwal Arora
Company	Forterra	**Company**	John Wood Group
Phone #	905-630-0359	**Phone #**	
Email	brandon.oleary@forterrabp.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	Hadati Creek
Recommended Stormceptor Model	EFO6
TSS Removal (%) Provided	67
PSD	CA ETV
RainFall Station	WATERLOO WELLINGTON A

The recommended Stormceptor model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

EFO Sizing Summary

EFO Model	% TSS Removal Provided	% Runoff Volume Captured Provided	Standard EFO Hydrocarbon Storage Capacity
EFO4	57	89	265 L (70 gal)
EFO6	67	96	610 L (160 gal)
EFO8	72	98	1070 L (280 gal)
EFO10	74	99	1670 L (440 gal)
EFO12	75	99	2475 L (655 gal)
Parallel Units / MAX	Custom	Custom	Custom

OVERVIEW

Stormceptor ® EF is a continuation and evolution of the most globally recognized oil-grit separator (OGS) stormwater treatment technology - **Stormceptor ®.** Also known as a hydrodynamic separator, the enhanced flow Stormceptor EF is a high performing oil-grit separator that effectively removes a wide variety of pollutants from stormwater and snowmelt runoff at higher flow rates as compared to the original Stormceptor. Stormceptor EF captures and retains sediment (TSS), free oils, gross pollutants and other pollutants that attach to particles, such as nutrients and metals. Stormceptor EF's patent-pending treatment and scour prevention technology and internal bypass ensures sediment is retained during all rainfall events.

Sizing Methodology

Stormceptor ® EF and Stormceptor ® EFO are sized using local historical rainfall data for the site of interest, specific site parameters, and a performance curve for TSS removal derived from third-party testing conducted in accordance with the Canadian Environmental Technology Verification (ETV) Program's Procedure for Laboratory Testing of OilGrit Separators. Every Stormceptor unit is designed to achieve the specified target TSS removal, however, for sites where oil/fuel capture and retention is an additional specified water quality objective Stormceptor EFO is the proper selection. The sizing methodology includes various considerations, including:

- Site parameters
- Local historical rainfall data
- Capture of the Canadian ETV particle size distribution
- Requirements for oil/fuel capture and retention
- Performance results from third-party testing and verification

Hydrology Analysis

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of Stormceptor are based on the average annual removal of TSS for the selected site parameters. The Stormceptor is engineered to capture sediment particles by treating the required average annual runoff volume, ensuring positive removal efficiency is maintained during each rainfall event, and preventing negative removal efficiency (scour).
Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

State/Province	Ontario	**Total Number of Rainfall Events**	3521
Rainfall Station Name	WATERLOO WELLINGTON A	**Total Rainfall (mm)**	16119.1
Station ID #	9387	**Average Annual Rainfall (mm)**	474.1
Coordinates	43°27'N, 80°23'W	**Total Evaporation (mm)**	1057.5
Elevation (ft)	1028	**Total Infiltration (mm)**	3920.2
Years of Rainfall Data	34	**Total Rainfall that is Runoff (mm)**	11141.4

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

ONLINE APPLICATION

Stormceptor EF's internal bypass and patent-pending scour prevention technology has demonstrated very effective retention of pollutants in third-party testing and verification following the Canadian ETV's **Procedure for Laboratory Testing of Oil-Grit Separators.** Sediment scour prevention demonstrated an effluent concentration of less than 10 mg/L for sediment particles ranging from 1 to 1,000 microns, even during peak influent flow rates associated with infrequent high intensity storm events. While Stormceptor EF will capture oil, only the Stormceptor EFO configuration has been third-party tested and verified to retain greater than 99% of captured oil. Based on these verified performance attributes, the most efficient and widely accepted application of Stormceptor EF is an online configuration, which allows all upstream conveyance flows to enter and exit the unit. The online application eliminates the need for costly additional bypass structures, piping and installation expense.

FLOW ENTRANCE OPTIONS

Single Inlet Pipe – A common design which includes one inlet pipe and one outlet pipe. A 90-degree (maximum) bend is also accepted with this configuration.

Inlet Grate – Allows surface runoff to enter the unit from grade. The inlet grate option can also be used in conjunction with one inlet pipe or multiple inlet pipes. A removable flow deflector is added in the Stormceptor EF4/EFO4.

Maximum Pipe Diameter		
Model	Inlet (In/mm)	Outlet (In/mm)
EF4 / EFO4	24 / 610	24 / 610
EF6 / EFO6	36 / 915	36 / 915
EF8/ EFO8	48 / 1220	48 / 1220
EF10/EFO10	72 / 1828	72 / 1828
EF12/EFO12	72 / 1828	72 / 1828

Multiple Inlet Pipe – Allows for multiple inlet pipes of various diameters to enter the unit.

Maximum Pipe Diameter		
Model	Inlet (In/mm)	Outlet (In/mm)
EF4 / EFO4	18 / 457	24 / 610
EF6 / EFO6	30 / 762	36 / 915
EF8/ EFO8	42 / 1067	48 / 1220
EF10/EFO10	60 / 1524	72 / 1828
EF12/EFO12	60 / 1524	72 / 1828

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Drainage Area	
Total Area (ha)	0.45
Imperviousness %	75.4

Up Stream Storage	
Storage (ha-m)	Discharge (cms)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cms)	

Water Quality Objective	
TSS Removal (%)	60.0
Runoff Volume Capture (%)	90.00
Oil Spill Capture Volume (L)	
Peak Conveyed Flow Rate (L/s)	
Water Quality Flow Rate (L/s)	

Design Details	
Stormceptor Inlet Invert Elev (m)	
Stormceptor Outlet Invert Elev (m)	
Stormceptor Rim Elev (m)	
Normal Water Level Elevation (m)	
Pipe Diameter (mm)	
Pipe Material	
Multiple Inlets (Y/N)	No
Grate Inlet (Y/N)	No

Particle Size Distribution (PSD)

Removing the smallest fraction of particulates from runoff ensures the majority of pollutants, such as metals, hydrocarbons and nutrients are captured. The table below identifies the Particle Size Distribution (PSD) that was selected to define TSS removal for the Stormceptor design.

CA ETV		
Particle Diameter (microns)	Distribution %	Specific Gravity
2.0	5.0	2.65
5.0	5.0	2.65
8.0	10.0	2.65
20.0	15.0	2.65
50.0	10.0	2.65
75.0	5.0	2.65
100.0	10.0	2.65
150.0	15.0	2.65
250.0	15.0	2.65
500.0	5.0	2.65
1000.0	5.0	2.65

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Site Name	Hadati Creek

Site Details

Drainage Area	
Total Area (ha)	0.45
Imperviousness %	75.4
Oil Spill Capture Volume (L)	

Infiltration Parameters	
Horton's equation is used to estimate infiltration	
Max. Infiltration Rate (mm/hr)	61.98
Min. Infiltration Rate (mm/hr)	10.16
Decay Rate (1/sec)	0.00055
Regeneration Rate (1/sec)	0.01

Surface Characteristics	
Width (m)	134.00
Slope %	2
Impervious Depression Storage (mm)	0.508
Pervious Depression Storage (mm)	5.08
Impervious Manning's n	0.015
Pervious Manning's n	0.25

Evaporation	
Daily Evaporation Rate (mm/day)	2.54

Dry Weather Flow	
Dry Weather Flow (lps)	0

Maintenance Frequency	
Maintenance Frequency (months) >	12

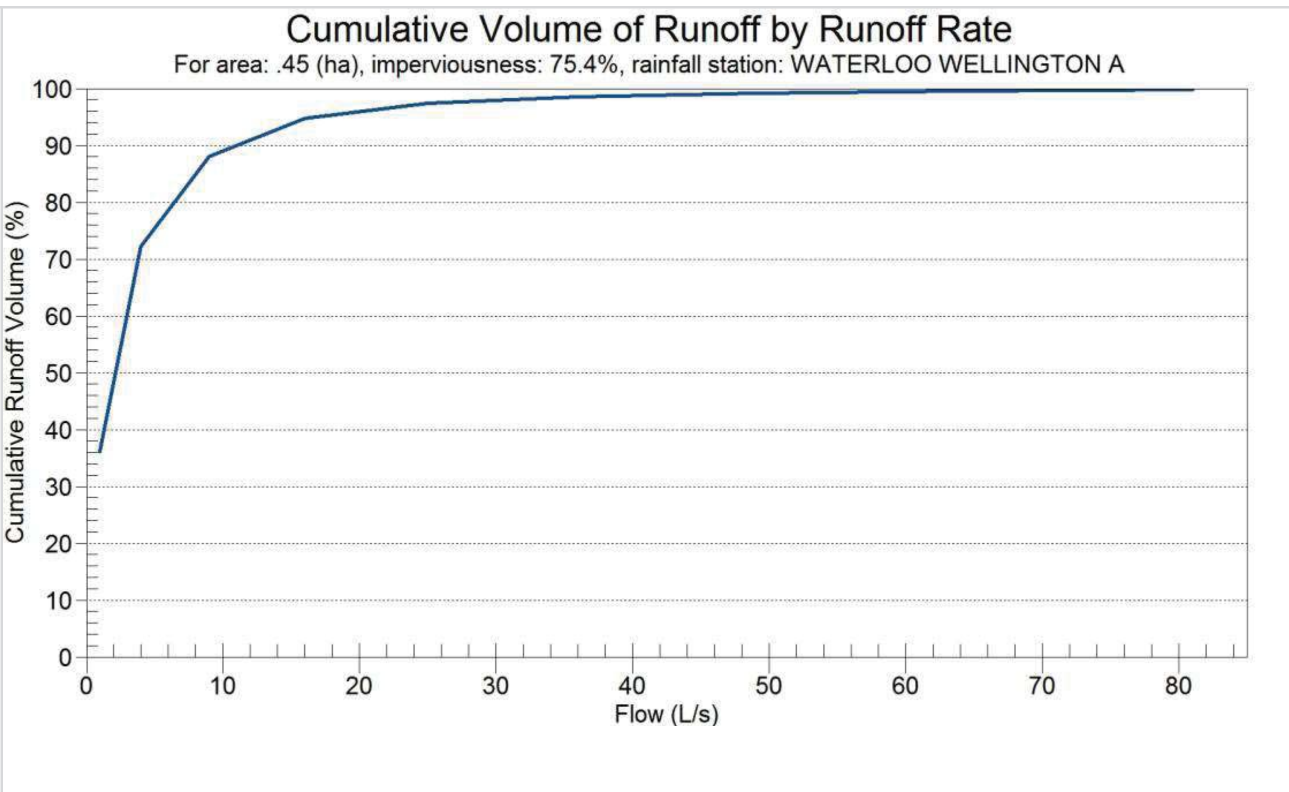
Winter Months	
Winter Infiltration	0

TSS Loading Parameters	
TSS Loading Function	Build Up/ Wash-off

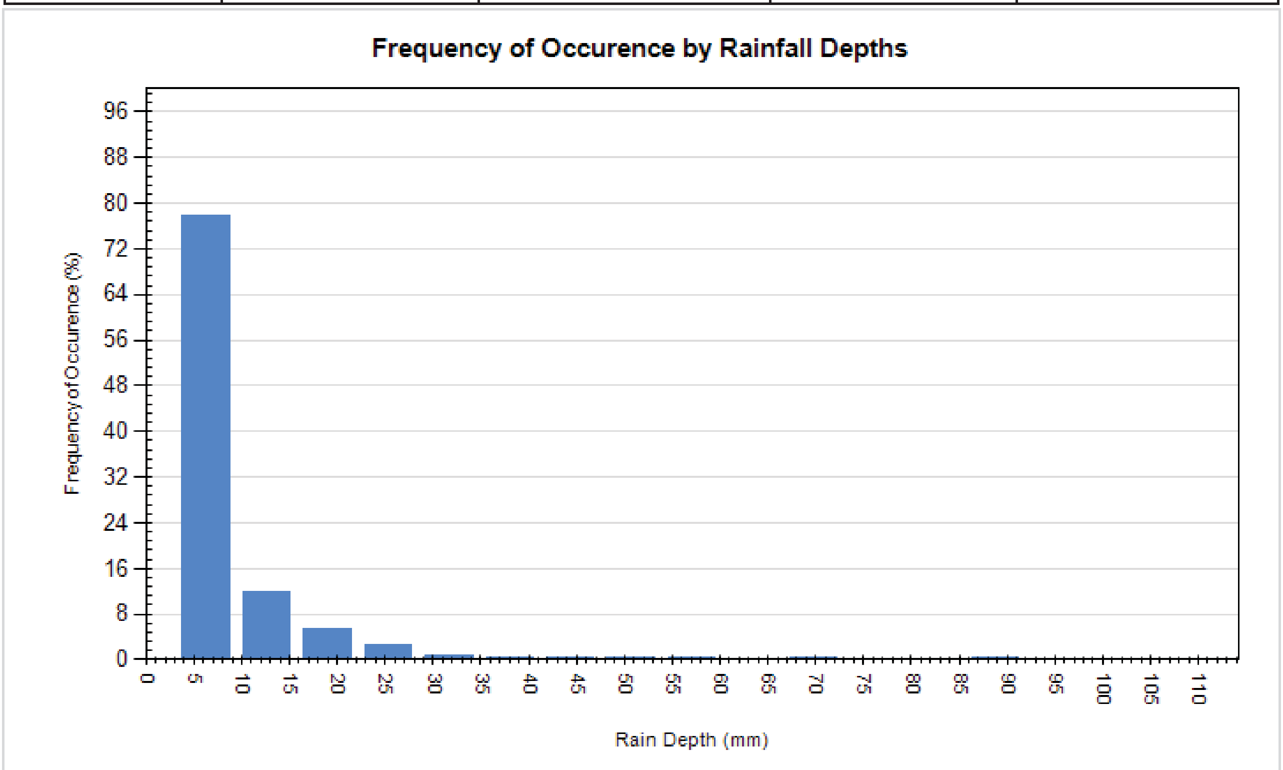
Buildup/Wash-off Parameters	
Target Event Mean Conc. (EMC) mg/L	125
Exponential Buildup Power	0.40
Exponential Washoff Exponent	0.20

TSS Availability Parameters	
Availability Constant A	0.057
Availability Factor B	0.04
Availability Exponent C	1.10
Min. Particle Size Affected by Availability (micron)	400

Cumulative Runoff Volume by Runoff Rate			
Runoff Rate (L/s)	**Runoff Volume (m³)**	**Volume Over (m³)**	**Cumulative Runoff Volume (%)**
1	18259	32217	36.2
4	36459	14017	72.2
9	44428	6046	88.0
16	47782	2691	94.7
25	49152	1321	97.4
36	49754	719	98.6
49	50069	404	99.2
64	50256	216	99.6
81	50366	106	99.8
100	50423	49	99.9
121	50451	21	100
144	50466	6	100
169	50472	0	100
196	50472	0	100



Rainfall Event Analysis				
Rainfall Depth (mm)	No. of Events	Percentage of Total Events (%)	Total Volume (mm)	Percentage of Annual Volume (%)
6.35	2742	77.9	4245	26.3
12.70	420	11.9	3837	23.8
19.05	193	5.5	3014	18.7
25.40	88	2.5	1904	11.8
31.75	27	0.8	769	4.8
38.10	16	0.5	563	3.5
44.45	19	0.5	774	4.8
50.80	5	0.1	241	1.5
57.15	3	0.1	156	1.0
63.50	0	0.0	0	0.0
69.85	4	0.1	267	1.7
76.20	0	0.0	0	0.0
82.55	0	0.0	0	0.0
88.90	3	0.1	255	1.6
95.25	1	0.0	93	0.6
101.60	0	0.0	0	0.0
107.95	0	0.0	0	0.0



For Stormceptor Specifications and Drawings Please Visit:
http://www.imbriumsystems.com/technical-specifications

Detailed Stormceptor Sizing Report – Clythe Creek Dr.

Project Information & Location			
Project Name	Clythe Creek Dr.	**Project Number**	-
City	Guelph	**State/ Province**	Ontario
Country	Canada	**Date**	11/16/2018
Designer Information		**EOR Information (optional)**	
Name	Brandon O'Leary	**Name**	Gurkanwal Arora
Company	Forterra	**Company**	John Wood Group
Phone #	905-630-0359	**Phone #**	
Email	brandon.oleary@forterrabp.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	Clythe Creek Dr.
Recommended Stormceptor Model	EFO8
TSS Removal (%) Provided	60
PSD	CA ETV
RainFall Station	WATERLOO WELLINGTON A

The recommended Stormceptor model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

EFO Sizing Summary			
EFO Model	**% TSS Removal Provided**	**% Runoff Volume Captured Provided**	**Standard EFO Hydrocarbon Storage Capacity**
EFO4	49	65	265 L (70 gal)
EFO6	56	83	610 L (160 gal)
EFO8	60	91	1070 L (280 gal)
EFO10	64	95	1670 L (440 gal)
EFO12	69	97	2475 L (655 gal)
Parallel Units / MAX	Custom	Custom	Custom

OVERVIEW

Stormceptor ® EF is a continuation and evolution of the most globally recognized oil-grit separator (OGS) stormwater treatment technology - **Stormceptor ®.** Also known as a hydrodynamic separator, the enhanced flow Stormceptor EF is a high performing oil-grit separator that effectively removes a wide variety of pollutants from stormwater and snowmelt runoff at higher flow rates as compared to the original Stormceptor. Stormceptor EF captures and retains sediment (TSS), free oils, gross pollutants and other pollutants that attach to particles, such as nutrients and metals. Stormceptor EF's patent-pending treatment and scour prevention technology and internal bypass ensures sediment is retained during all rainfall events.

Sizing Methodology

Stormceptor ® EF and Stormceptor ® EFO are sized using local historical rainfall data for the site of interest, specific site parameters, and a performance curve for TSS removal derived from third-party testing conducted in accordance with the Canadian Environmental Technology Verification (ETV) Program's Procedure for Laboratory Testing of OilGrit Separators. Every Stormceptor unit is designed to achieve the specified target TSS removal, however, for sites where oil/fuel capture and retention is an additional specified water quality objective Stormceptor EFO is the proper selection. The sizing methodology includes various considerations, including:

• Site parameters
• Local historical rainfall data
• Capture of the Canadian ETV particle size distribution
• Requirements for oil/fuel capture and retention
• Performance results from third-party testing and verification

Hydrology Analysis

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of Stormceptor are based on the average annual removal of TSS for the selected site parameters. The Stormceptor is engineered to capture sediment particles by treating the required average annual runoff volume, ensuring positive removal efficiency is maintained during each rainfall event, and preventing negative removal efficiency (scour).
Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

State/Province	Ontario	**Total Number of Rainfall Events**	3521
Rainfall Station Name	WATERLOO WELLINGTON A	**Total Rainfall (mm)**	16119.1
Station ID #	9387	**Average Annual Rainfall (mm)**	474.1
Coordinates	43°27'N, 80°23'W	**Total Evaporation (mm)**	691.9
Elevation (ft)	1028	**Total Infiltration (mm)**	8325.0
Years of Rainfall Data	34	**Total Rainfall that is Runoff (mm)**	7102.2

Notes

• Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
• Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
• For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

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Stormceptor EF's internal bypass and patent-pending scour prevention technology has demonstrated very effective retention of pollutants in third-party testing and verification following the Canadian ETV's **Procedure for Laboratory Testing of Oil-Grit Separators.** Sediment scour prevention demonstrated an effluent concentration of less than 10 mg/L for sediment particles ranging from 1 to 1,000 microns, even during peak influent flow rates associated with infrequent high intensity storm events. While Stormceptor EF will capture oil, only the Stormceptor EFO configuration has been third-party tested and verified to retain greater than 99% of captured oil. Based on these verified performance attributes, the most efficient and widely accepted application of Stormceptor EF is an online configuration, which allows all upstream conveyance flows to enter and exit the unit. The online application eliminates the need for costly additional bypass structures, piping and installation expense.

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FLOW ENTRANCE OPTIONS

Single Inlet Pipe – A common design which includes one inlet pipe and one outlet pipe. A 90-degree (maximum) bend is also accepted with this configuration.

Inlet Grate – Allows surface runoff to enter the unit from grade. The inlet grate option can also be used in conjunction with one inlet pipe or multiple inlet pipes. A removable flow deflector is added in the Stormceptor EF4/EFO4.

Maximum Pipe Diameter		
Model	Inlet (In/mm)	Outlet (In/mm)
EF4 / EFO4	24 / 610	24 / 610
EF6 / EFO6	36 / 915	36 / 915
EF8/ EFO8	48 / 1220	48 / 1220
EF10/EFO10	72 / 1828	72 / 1828
EF12/EFO12	72 / 1828	72 / 1828

Multiple Inlet Pipe – Allows for multiple inlet pipes of various diameters to enter the unit.

Maximum Pipe Diameter		
Model	Inlet (In/mm)	Outlet (In/mm)
EF4 / EFO4	18 / 457	24 / 610
EF6 / EFO6	30 / 762	36 / 915
EF8/ EFO8	42 / 1067	48 / 1220
EF10/EFO10	60 / 1524	72 / 1828
EF12/EFO12	60 / 1524	72 / 1828

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Drainage Area	
Total Area (ha)	2.36
Imperviousness %	47.9

Up Stream Storage	
Storage (ha-m)	Discharge (cms)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cms)	

Water Quality Objective	
TSS Removal (%)	60.0
Runoff Volume Capture (%)	90.00
Oil Spill Capture Volume (L)	
Peak Conveyed Flow Rate (L/s)	
Water Quality Flow Rate (L/s)	

Design Details	
Stormceptor Inlet Invert Elev (m)	
Stormceptor Outlet Invert Elev (m)	
Stormceptor Rim Elev (m)	
Normal Water Level Elevation (m)	
Pipe Diameter (mm)	
Pipe Material	
Multiple Inlets (Y/N)	No
Grate Inlet (Y/N)	No

Particle Size Distribution (PSD)

Removing the smallest fraction of particulates from runoff ensures the majority of pollutants, such as metals, hydrocarbons and nutrients are captured. The table below identifies the Particle Size Distribution (PSD) that was selected to define TSS removal for the Stormceptor design.

CA ETV		
Particle Diameter (microns)	Distribution %	Specific Gravity
2.0	5.0	2.65
5.0	5.0	2.65
8.0	10.0	2.65
20.0	15.0	2.65
50.0	10.0	2.65
75.0	5.0	2.65
100.0	10.0	2.65
150.0	15.0	2.65
250.0	15.0	2.65
500.0	5.0	2.65
1000.0	5.0	2.65

Stormceptor®   FORTERRA

Site Name	Clythe Creek Dr.

Site Details

Drainage Area	
Total Area (ha)	2.36
Imperviousness %	47.9
Oil Spill Capture Volume (L)	

Infiltration Parameters	
Horton's equation is used to estimate infiltration	
Max. Infiltration Rate (mm/hr)	61.98
Min. Infiltration Rate (mm/hr)	10.16
Decay Rate (1/sec)	0.00055
Regeneration Rate (1/sec)	0.01

Surface Characteristics	
Width (m)	307.00
Slope %	2
Impervious Depression Storage (mm)	0.508
Pervious Depression Storage (mm)	5.08
Impervious Manning's n	0.015
Pervious Manning's n	0.25

Evaporation	
Daily Evaporation Rate (mm/day)	2.54

Dry Weather Flow	
Dry Weather Flow (lps)	0

Maintenance Frequency	
Maintenance Frequency (months) >	12

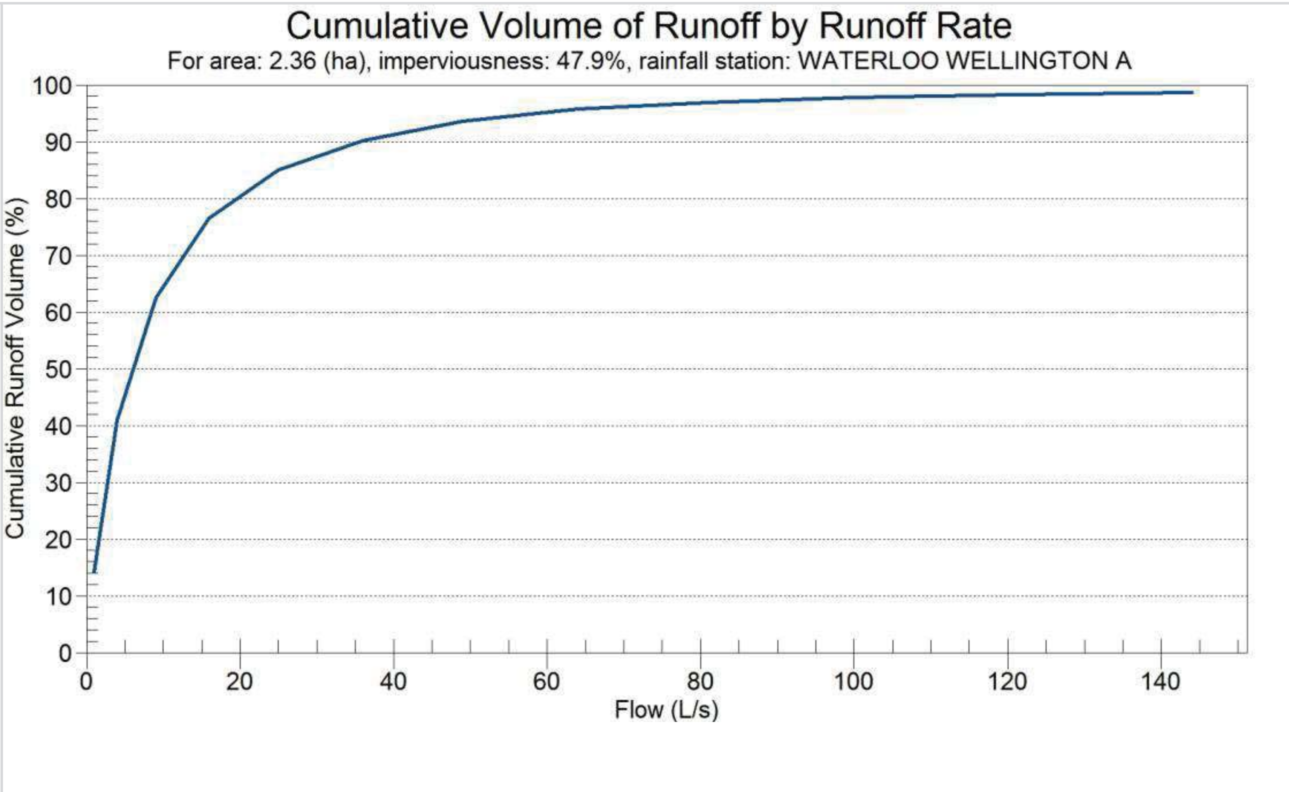
Winter Months	
Winter Infiltration	0

TSS Loading Parameters	
TSS Loading Function	Build Up/ Wash-off

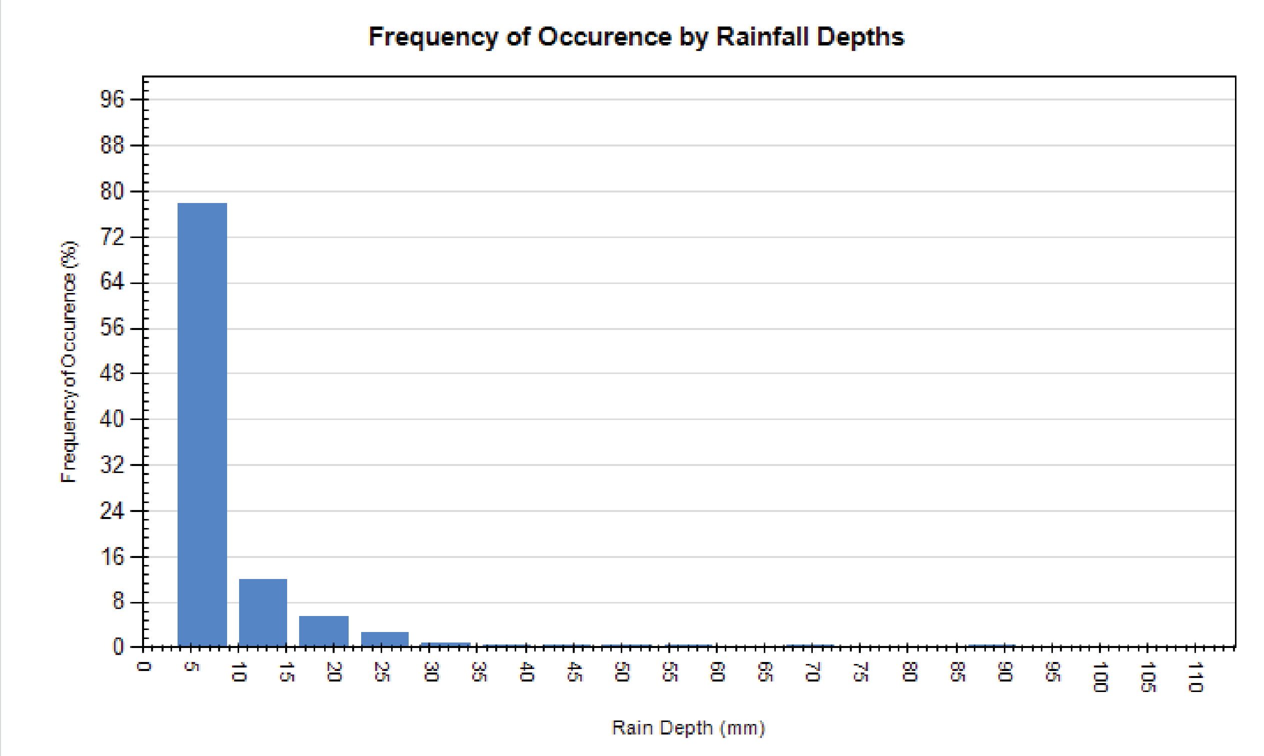
Buildup/Wash-off Parameters	
Target Event Mean Conc. (EMC) mg/L	125
Exponential Buildup Power	0.40
Exponential Washoff Exponent	0.20

TSS Availability Parameters	
Availability Constant A	0.057
Availability Factor B	0.04
Availability Exponent C	1.10
Min. Particle Size Affected by Availability (micron)	400

Cumulative Runoff Volume by Runoff Rate			
Runoff Rate (L/s)	Runoff Volume (m³)	Volume Over (m³)	Cumulative Runoff Volume (%)
1	23924	144704	14.2
4	68959	99669	40.9
9	105471	63184	62.5
16	129003	39632	76.5
25	143384	25255	85.0
36	152164	16464	90.2
49	157851	10776	93.6
64	161292	7332	95.7
81	163436	5188	96.9
100	164853	3771	97.8
121	165763	2860	98.3
144	166431	2191	98.7
169	166936	1687	99.0
196	167322	1300	99.2
225	167656	966	99.4
256	167918	704	99.6
289	168090	532	99.7
324	168201	421	99.8
361	168301	321	99.8
400	168404	218	99.9
441	168493	129	99.9
484	168560	62	100
529	168592	30	100
576	168606	16	100
625	168621	1	100
676	168622	0	100
729	168622	0	100

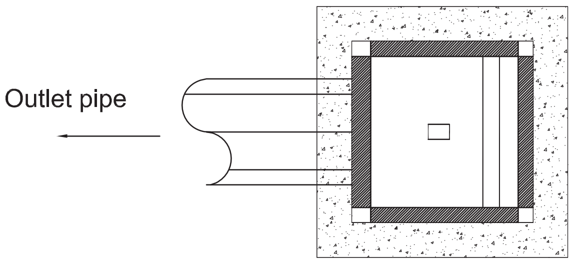

Cumulative Volume of Runoff by Runoff Rate
For area: 2.36 (ha), imperviousness: 47.9%, rainfall station: WATERLOO WELLINGTON A
Cumulative Runoff Volume (%)
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
Flow (L/s)

Rainfall Event Analysis				
Rainfall Depth (mm)	**No. of Events**	**Percentage of Total Events (%)**	**Total Volume (mm)**	**Percentage of Annual Volume (%)**
6.35	2742	77.9	4245	26.3
12.70	420	11.9	3837	23.8
19.05	193	5.5	3014	18.7
25.40	88	2.5	1904	11.8
31.75	27	0.8	769	4.8
38.10	16	0.5	563	3.5
44.45	19	0.5	774	4.8
50.80	5	0.1	241	1.5
57.15	3	0.1	156	1.0
63.50	0	0.0	0	0.0
69.85	4	0.1	267	1.7
76.20	0	0.0	0	0.0
82.55	0	0.0	0	0.0
88.90	3	0.1	255	1.6
95.25	1	0.0	93	0.6
101.60	0	0.0	0	0.0
107.95	0	0.0	0	0.0

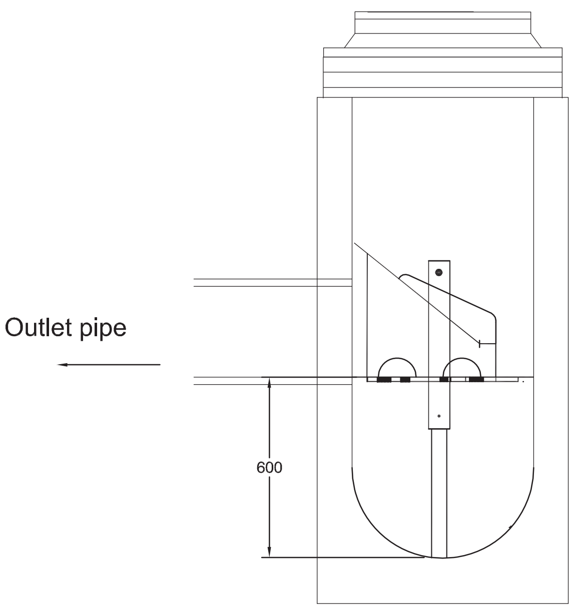


For Stormceptor Specifications and Drawings Please Visit:
http://www.imbriumsystems.com/technical-specifications

Notes
1. CB Shield can be installed at any time. In a non frozen condition.
2. The frame and cover should be well aligned with the catchbasin for proper installation
3. The catchbasin sump must be clean before installation
4. The grate should be at the same level as the standing water in the sump.



Top view



Profile view

CB Shield (600mm Sump)

CULTEC Contactor® 100HD Stormwater Chamber

The Contactor® 100HD is a 12.5" (318 mm) tall, low profile chamber and is typically used for installations with depth restrictions or when a larger infiltrative area is required. The Contactor 100HD has the side portal internal manifold feature. The HVLV® SFCx2 Feed Connector is inserted into the side portal of the Contactor 100HD to create the internal manifold.

Size (L x W x H)	8' x 36" x 12.5" 2.44 m x 914 mm x 318 mm
Installed Length	7.5' 2.29 m
Length Adjustment per Run	0.5' 0.15 m
Chamber Storage	1.87 ft^3/ft 0.17 m^3/m 14.00 ft^3/unit 0.40 m^3/unit
Min. Installed Storage	3.84 ft^3/ft 0.36 m^3/m 28.81 ft^3/unit 0.82 m^3/unit
Min. Area Required	25 ft^2 2.32 m^2
Min. Center to Center Spacing	3.33' 1.02 m
Max. Allowable Cover	12' 3.66 m
Max. Inlet Opening in End Wall	10" 250 mm
Max. Allowable O.D. in Side Portal	6.9" 175 mm
Compatible Feed Connector	HVLV SFCx2 Feed Connector

Contactor® 100HD Bare Chamber Storage Volumes

Elevation		Incremental Storage Volume				Cumulative Storage	
in.	mm	ft^3/ft	m^3/m	ft^3	m^3	ft^3	m^3
12	305	0.009	0.001	0.068	0.002	13.995	0.396
11	279	0.067	0.006	0.503	0.014	13.928	0.394
10	254	0.110	0.010	0.825	0.023	13.425	0.380
9	229	0.139	0.013	1.043	0.030	12.600	0.357
8	203	0.159	0.015	1.193	0.034	11.558	0.327
7	178	0.174	0.016	1.305	0.037	10.365	0.294
6	152	0.184	0.017	1.380	0.039	9.060	0.257
5	127	0.192	0.018	1.440	0.041	7.680	0.217
4	102	0.203	0.019	1.523	0.043	6.240	0.177
3	76	0.203	0.019	1.523	0.043	4.718	0.134
2	51	0.203	0.019	1.523	0.043	3.195	0.090
1	25	0.223	0.021	1.673	0.047	1.673	0.047
Total		**1.866**	**0.173**	**13.995**	**0.396**	**13.995**	**0.396**

Calculations are based on installed chamber length.

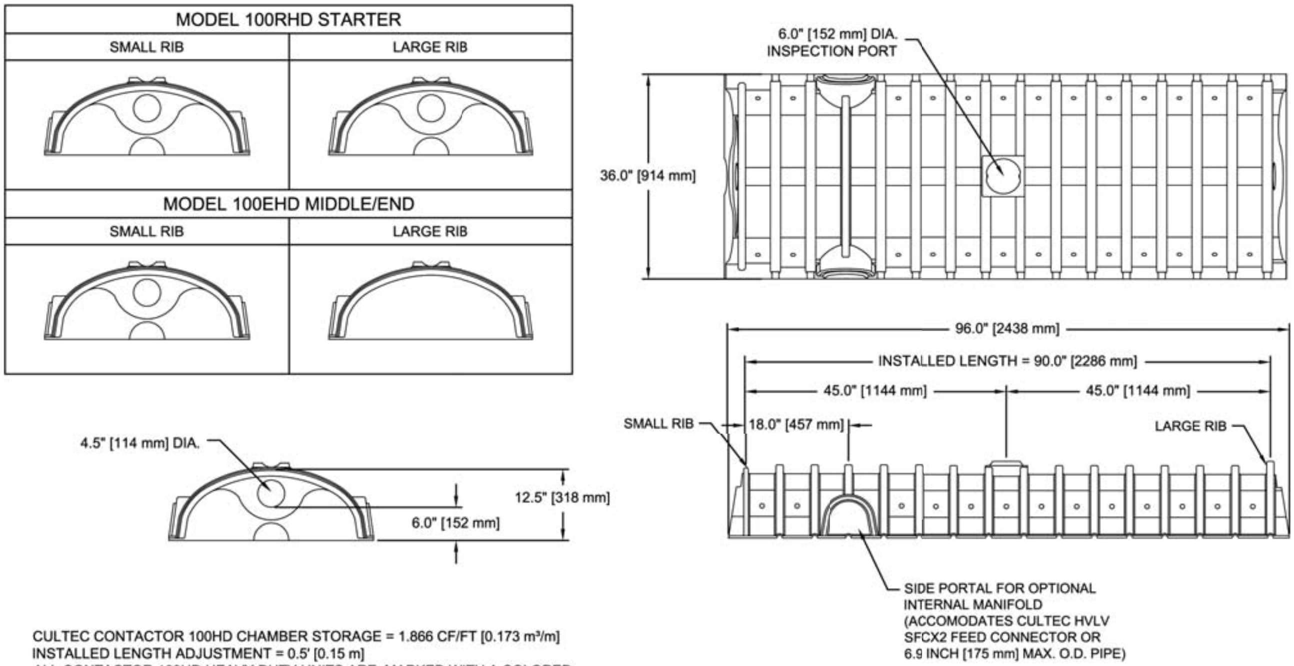
Visit www.cultec.com/downloads.html
for Product Downloads and CAD details.

	Stone Foundation Depth		
	6" 152 mm	12" 305 mm	18" 457 mm
Chamber and Stone Storage Per Chamber	28.81 ft^3 0.82 m^3	33.81 ft^3 0.96 m^3	38.81 ft^3 1.10 m^3
Min. Effective Depth	2.04' 0.62 m	2.54' 0.77 m	3.04' 0.93 m
Stone Required Per Chamber	1.37 yd^3 1.05 m^3	1.84 yd^3 1.40 m^3	2.30 yd^3 1.76 m^3

Calculations are based on installed chamber length.
Includes 6" (152 mm) stone above crown of chamber and typical stone surround.
Stone void calculated at 40%.

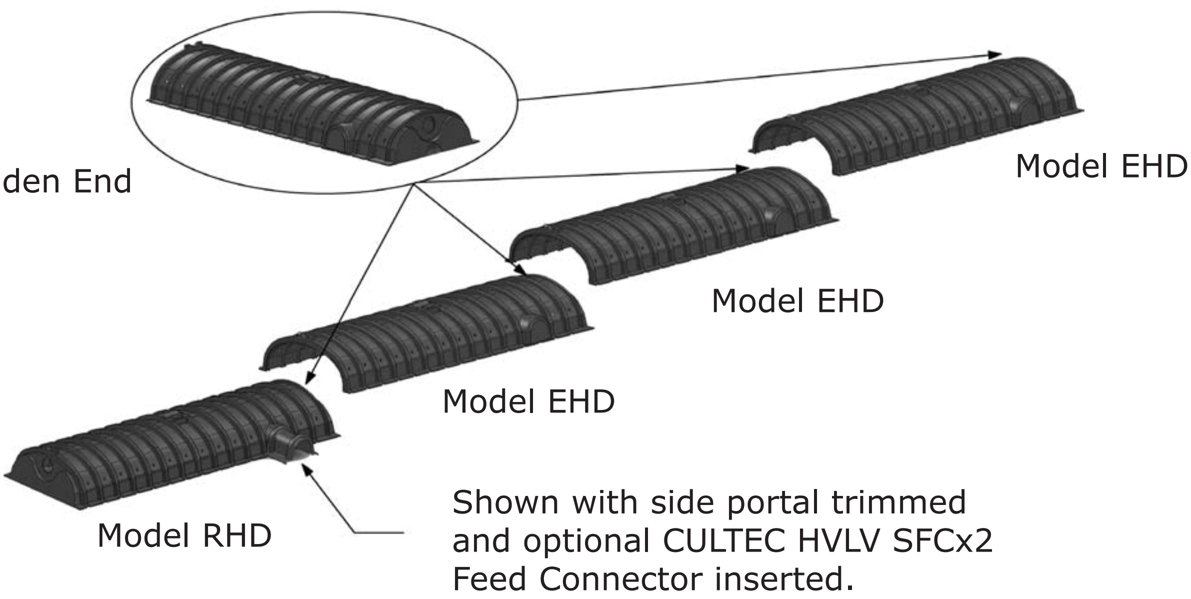
For more information, contact CULTEC at (203) 775-4416 or visit www.cultec.com.

Three View Drawing

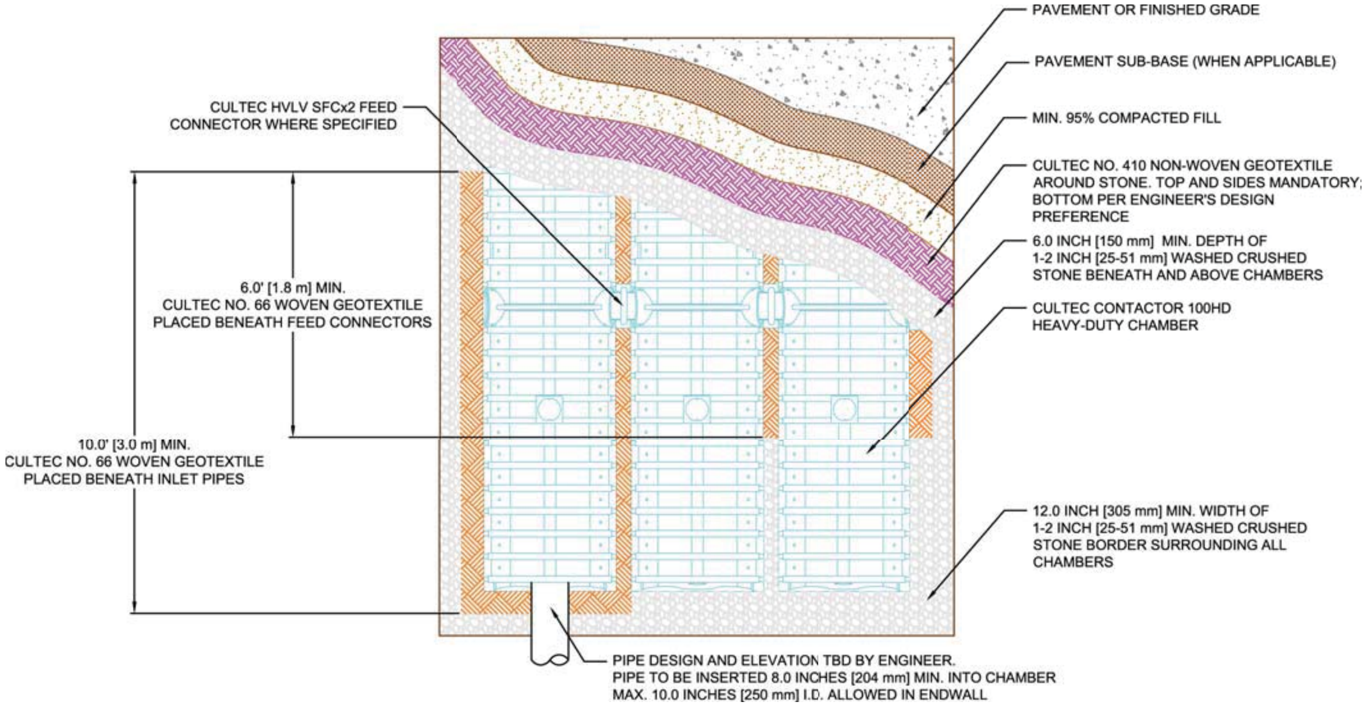


CULTEC CONTACTOR 100HD CHAMBER STORAGE = 1.866 CF/FT [0.173 m³/m]
INSTALLED LENGTH ADJUSTMENT = 0.5' [0.15 m]
ALL CONTACTOR 100HD HEAVY DUTY UNITS ARE MARKED WITH A COLORED STRIPE FORMED INTO THE PART ALONG THE LENGTH OF THE CHAMBER.

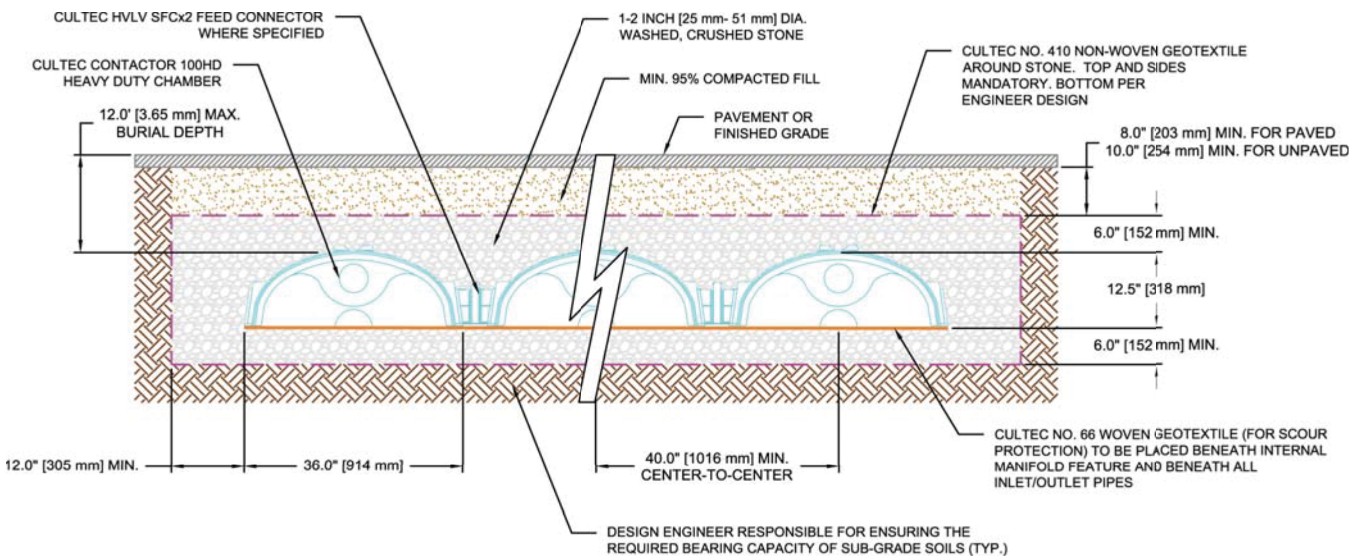
Typical Interlock Installation



Plan View Drawing



Typical Cross Section for Traffic Application



For more information, contact CULTEC at (203) 775-4416 or visit www.cultec.com.

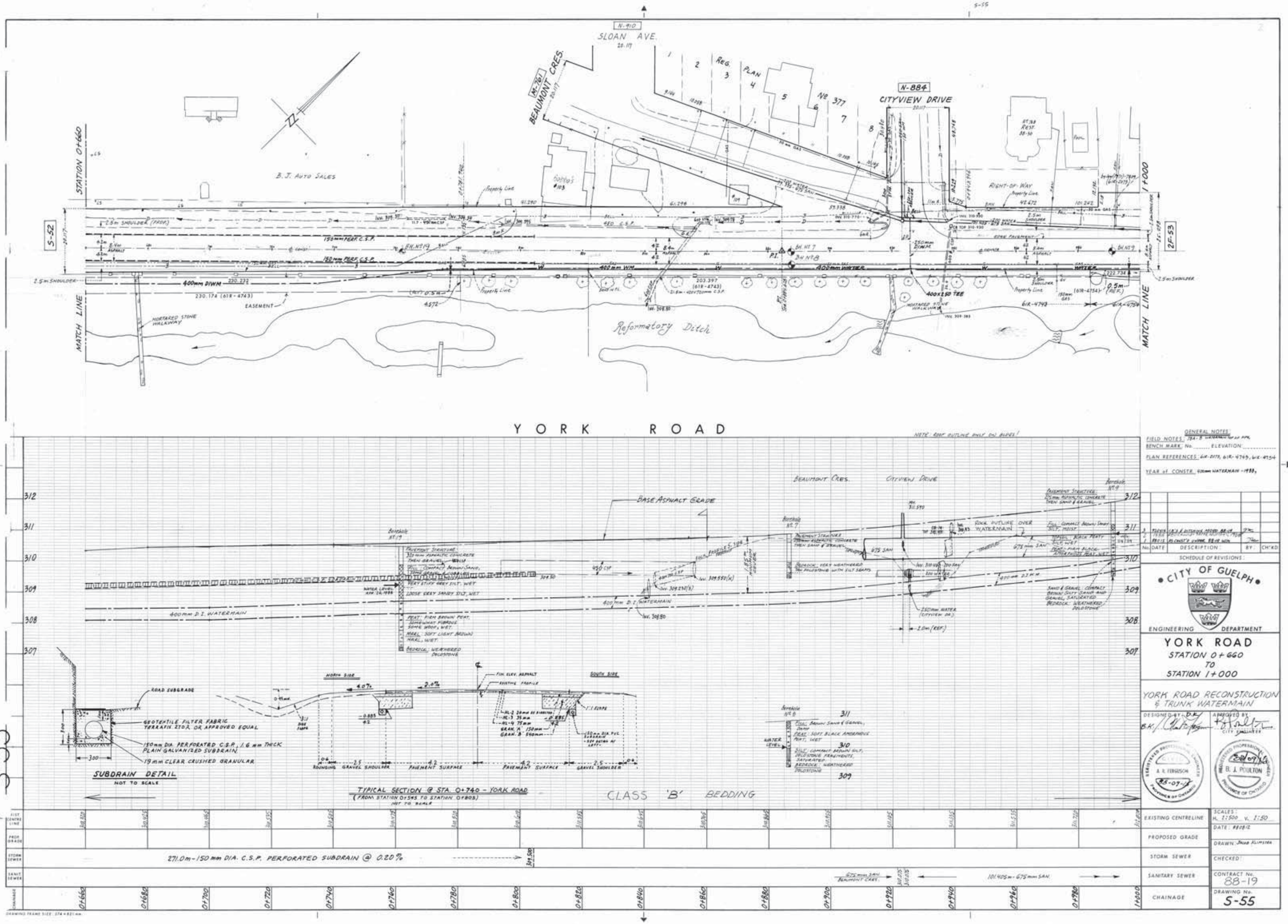
CULTEC Contactor® 100HD Specifications

GENERAL

CULTEC Contactor® 100HD chambers are designed for underground stormwater management. The chambers may be used for retention, recharging, detention or controlling the flow of on-site stormwater runoff.

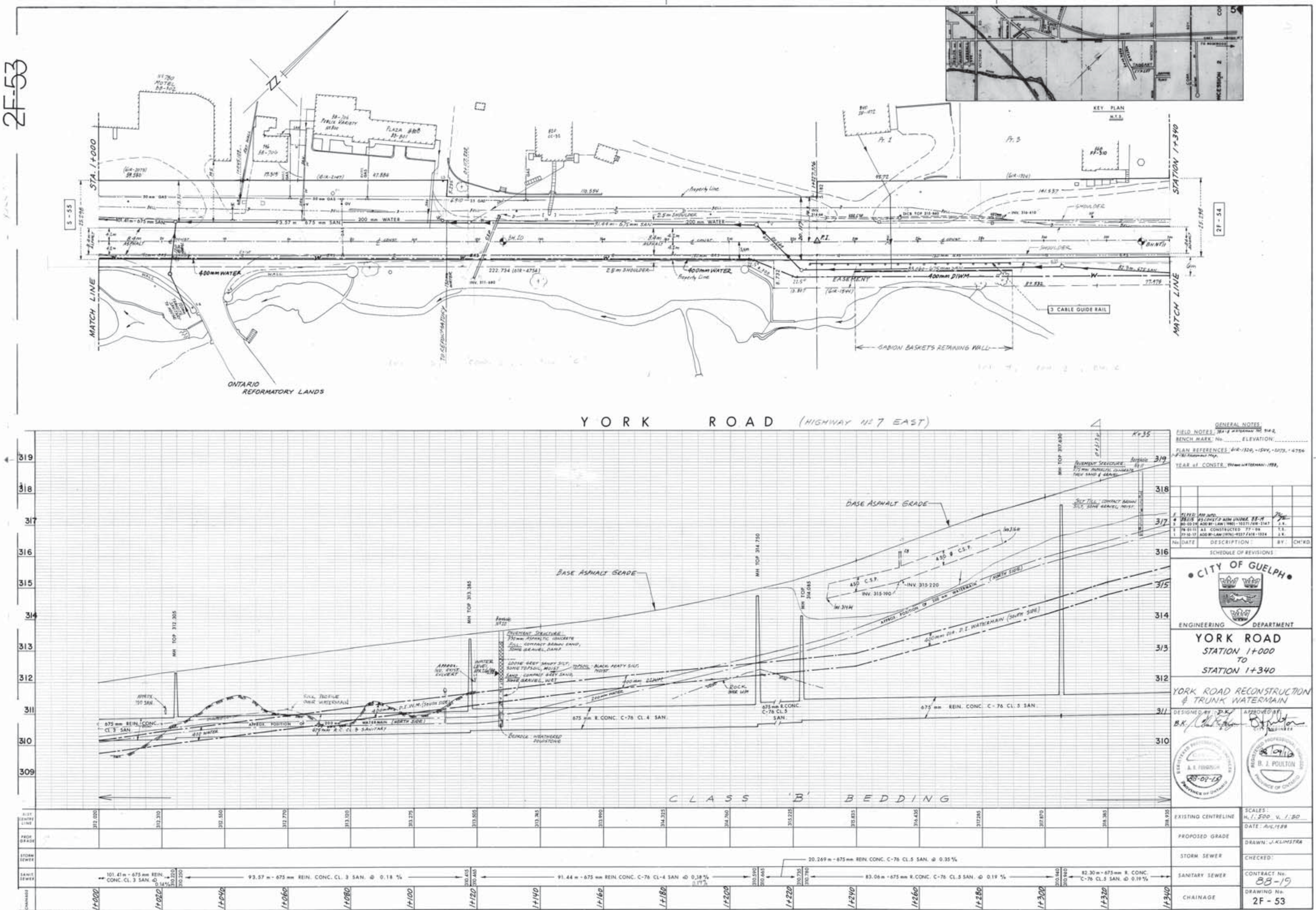
CHAMBER PARAMETERS

1. The chambers shall be manufactured in the U.S.A. by CULTEC, Inc. of Brookfield, CT (cultec.com, 203-775-4416).
2. The chamber shall be vacuum thermoformed of black polyethylene.
3. The chamber shall be arched in shape.
4. The chamber shall be open-bottomed.
5. The chamber shall be joined using an interlocking overlapping rib method. Connections must be fully shouldered overlapping ribs, having no separate couplings or separate end walls.
6. The nominal chamber dimensions of the CULTEC Contactor® 100HD shall be 12.5 inches (318 mm) tall, 36 inches (914 mm) wide and 8 feet (2.44 m) long. The installed length of a joined Contactor® 100HD shall be 7.5 feet (2.29 m).
7. Maximum inlet opening on the chamber end wall is 10 inches (250 mm).
8. The chamber shall have two side portals to accept CULTEC HVLV® SFCx2 Feed Connectors to create an internal manifold. The nominal I.D. dimensions of each side portal shall be 5.75 inches (146 mm) high by 7.5 inches (191 mm) wide. Maximum allowable O.D. in the side portal is 6.9 inches (175 mm).
9. The nominal chamber dimensions of the CULTEC HVLV® SFCx2 Feed Connector shall be 7.6 inches (194 mm) tall, 12 inches (305 mm) wide and 19.7 inches (500 mm) long.
10. The nominal storage volume of the Contactor® 100HD chamber shall be 1.866 ft^3 / ft (0.173 m^3 / m) - without stone. The nominal storage volume of a single Contactor® 100RHD Stand Alone unit shall be 14.93 ft^3 (0.42 m^3) - without stone. The nominal storage volume of a joined Contactor® 100EHD as an Intermediate unit shall be 13.995 ft^3 (0.396 m^3) - without stone. The nominal storage volume of the length adjustment amount per run shall be 0.93 ft^3 (0.09 m^3) - without stone.
11. The nominal storage volume of the HVLV® SFCx2 Feed Connector shall be 0.294 ft^3 / ft (0.027 m^3 / m) - without stone.
12. The Contactor® 100HD chamber shall have fifty-six discharge holes bored into the sidewalls of the unit's core to promote lateral conveyance of water.
13. The Contactor® 100HD chamber shall have 16 corrugations.
14. The end wall of the chamber, when present, shall be an integral part of the continuously formed unit. Separate end plates cannot be used with this unit.
15. The Contactor® 100RHD Starter/Stand Alone unit must be formed as a whole chamber having two fully formed integral end walls and having no separate end plates or separate end walls.
16. The Contactor® 100EHD Middle/End unit must be formed as a whole chamber having one fully formed integral end wall and one fully open end wall and having no separate end plates or end walls.
17. The HVLV® SFCx2 Feed Connector must be formed as a whole chamber having two open end walls and having no separate end plates or separate end walls. The unit shall fit into the side portals of the Contactor® 100HD and act as cross feed connections.
18. Chambers must have horizontal stiffening flex reduction steps between the ribs.
19. Heavy duty units are designated by a colored stripe formed into the part along the length of the chamber.
20. The chamber shall have a raised integral cap at the top of the arch in the center of each unit to be used as an optional inspection port or clean-out.
21. The units may be trimmed to custom lengths by cutting back to any corrugation on the large rib end.
22. The chamber shall be manufactured in an ISO 9001:2008 certified facility.
23. Maximum allowable cover over the top of the chamber shall be 12' (3.66 m) for the Heavy Duty version.
24. The chamber shall be designed to withstand traffic loads when installed according to CULTEC's recommended installation instructions.



SLOAN AVE.
N-910
BEAUMONT CRES.
M-761
REG. PLAN 377
N-884
CITYVIEW DRIVE
B. J. AUTO SALES
STATION 0+660
1+000
MATCH LINE
S-52
2F-53
RIGHT-OF-WAY
400mm DIWM
400mm WM
400mm WATER
150mm PERF. C.S.P.
EASEMENT
MORTARED STONE WALKWAY
Reformatory Ditch
400x250 TEE
YORK ROAD
BASE ASPHALT GRADE
BEAUMONT CRES.
CITYVIEW DRIVE
400mm D.I. WATERMAIN
ROCK OUTLINE OVER WATERMAIN
SUBRAIN DETAIL
NOT TO SCALE
ROAD SUBGRADE
GEOTEXTILE FILTER FABRIC TERRAFIX 270R OR APPROVED EQUAL
150mm DIA. PERFORATED C.S.P., 1.6 mm THICK PLAIN GALVANIZED SUBDRAIN
19mm CLEAR CRUSHED GRANULAR
TYPICAL SECTION @ STA. 0+740 - YORK ROAD
(FROM STATION 0+585 TO STATION 0+805)
NOT TO SCALE
NORTH SIDE
SOUTH SIDE
ROUNDING
GRAVEL SHOULDER
PAVEMENT SURFACE
CLASS 'B' BEDDING
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
271.0m-150mm DIA. C.S.P. PERFORATED SUBDRAIN @ 0.20%
101.405m-675mm SAN.
GENERAL NOTES:
FIELD NOTES:
BENCH MARK No.
ELEVATION:
PLAN REFERENCES: 61R-2173, 61R-4743, 61R-4754
YEAR of CONSTR.
SCHEDULE OF REVISIONS:
No. DATE DESCRIPTION: BY: CH'KD
CITY OF GUELPH
ENGINEERING DEPARTMENT
YORK ROAD
STATION 0+660
TO
STATION 1+000
YORK ROAD RECONSTRUCTION & TRUNK WATERMAIN
DESIGNED BY:
APPROVED BY:
CITY ENGINEER
A. R. FERGUSON
B. J. POULTON
SCALES: H. 1:500 V. 1:50
DATE:
DRAWN:
CHECKED:
CONTRACT No. 88-19
DRAWING No. S-55

S-55



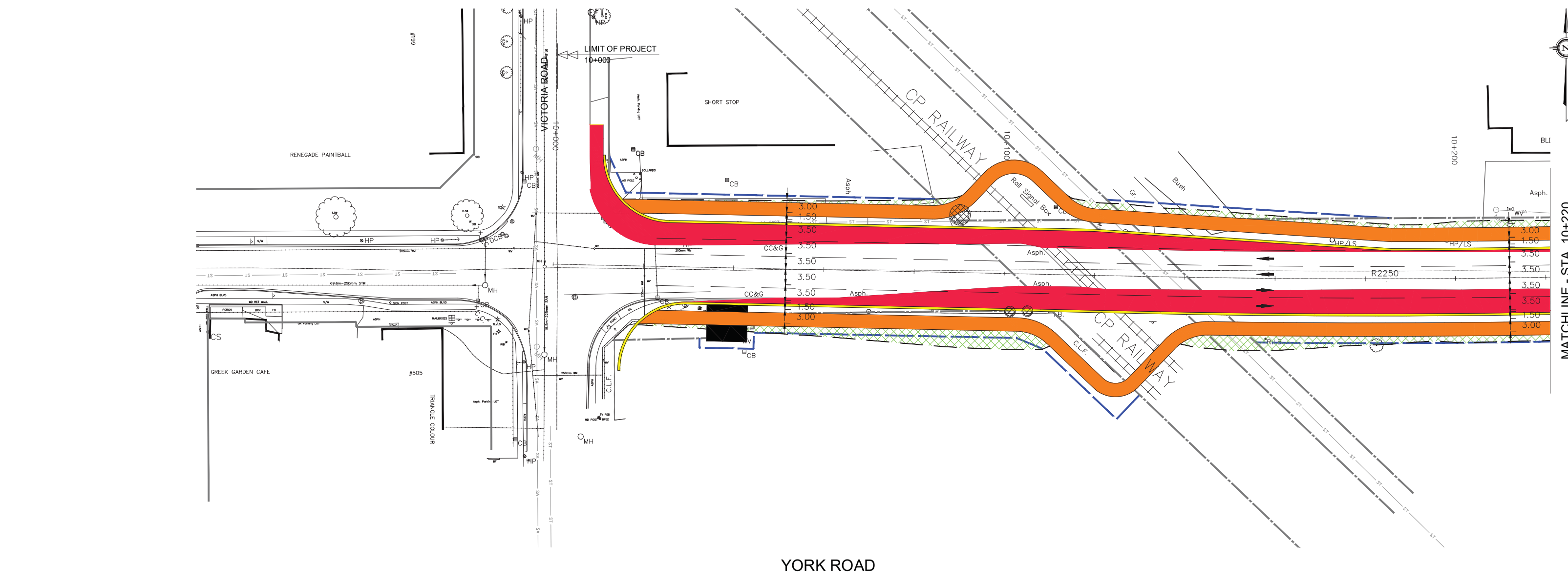
2F-53
KEY PLAN
N.T.S.
STA. 1+000
STATION 1+340
MATCH LINE
S-55
2F-54
400mm WATER
200 mm WATER
93.57 m - 675 mm SAN.
91.44 m - 675mm SAN.
400mm DIWM
PLAZA #800
3 CABLE GUIDE RAIL
GABION BASKETS RETAINING WALL
EASEMENT
ONTARIO REFORMATORY LANDS
YORK ROAD (HIGHWAY No 7 EAST)
BASE ASPHALT GRADE
CLASS 'B' BEDDING
MH TOP 312.305
MH TOP 313.385
MH TOP 314.750
MH TOP 314.085
MH TOP 317.630
675 mm R.CONC. C-76 CL.4 SAN.
675 mm REIN. CONC. C-76 CL.5 SAN.
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
101.41 m - 675 mm REIN. CONC. CL. 3 SAN. @ 0.14%
93.57 m - 675 mm REIN. CONC. CL. 3 SAN. @ 0.18 %
91.44 m - 675 mm REIN. CONC. C-76 CL-4 SAN @ 0.18 %
20.269 m - 675 mm REIN. CONC. C-76 CL.5 SAN. @ 0.35 %
83.06 m - 675 mm R.CONC. C-76 CL.5 SAN. @ 0.19 %
82.30 m - 675 mm R. CONC. C-76 CL.5 SAN. @ 0.19 %
1+000
1+020
1+040
1+060
1+080
1+100
1+120
1+140
1+160
1+180
1+200
1+220
1+240
1+260
1+280
1+300
1+320
1+340
GENERAL NOTES
SCHEDULE OF REVISIONS
CITY OF GUELPH
ENGINEERING DEPARTMENT
YORK ROAD
STATION 1+000 TO STATION 1+340
YORK ROAD RECONSTRUCTION & TRUNK WATERMAIN
DESIGNED BY
APPROVED BY
B. J. POULTON
A. E. FERGUSON
SCALES: H. 1:500 V. 1:50
DATE: AUG.1988
DRAWN: J. KLIMSTRA
CHECKED:
CONTRACT No. 88-19
DRAWING No. 2F-53

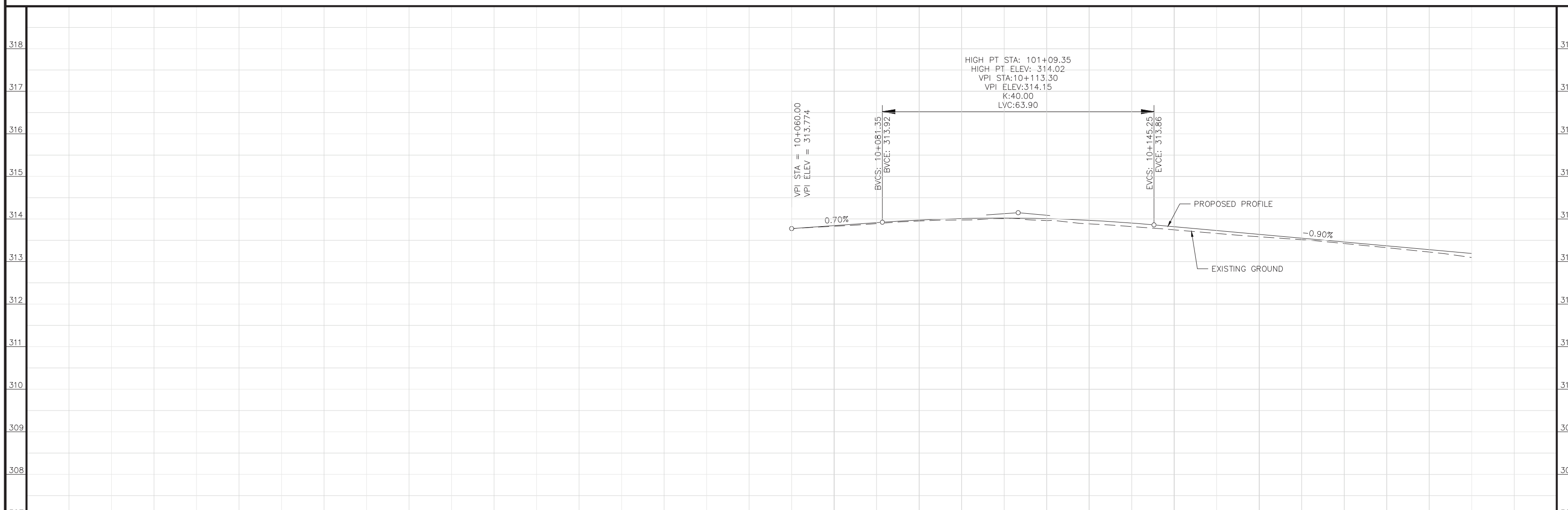
YORK ROAD DRAINAGE

ITEM	DESCRIPTION	EST. QTY.	UNIT	UNIT PRICE	TOTAL
1	600 x 600mm Catchbasins	34	ea	$2,500.00	$ $85,000.00
2	DICB	4	ea	$3,500.00	$14,000.00
3	1200mm CB Manholes OPSD 701.010	17	ea	$5,000.00	$ $85,000.00
4	1500mm CB Manholes OPSD 701.010	2	ea	$7,500.00	$ $15,000.00
5	1800mm CB Manholes OPSD 701.010	1	ea	$8,500.00	$ $8,500.00
6	2400mm CB Manholes OPSD 701.010	3	ea	$10,000.00	$ $30,000.00
7	3000mm CB Manholes OPSD 701.010	1	ea	$12,500.00	$ $12,500.00
8	Manholes (Various Size)	17	ea	$8,500.00	$144,500.00
9	250mm CB Leads PVC SDR 35 Granular Bedding and Backfill	352	m	$150.00	$ $52,800.00
10	300mm Storm Sewer PVC SDR 35 Granular Bedding and Native Backfill	0	m	$200.00	$0.00
11	375mm Storm Sewer PVC SDR 35 Granular Bedding and Backfill	97	m	$225.00	$ $21,825.00
12	450mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$250.00	$ $25,000.00
13	525mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$300.00	$ $30,000.00
14	750 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$780.00	$ $78,000.00
15	825mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$900.00	$ $90,000.00
16	1050 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	33	m	$1,430.00	$ $47,190.00
17	1350 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	200	m	$2,250.00	$ $450,000.00
18	1500 mm Storm Sewer CL 65-D RC Granular Bedding and Backfill	100	m	$2,800.00	$ $280,000.00
19	Chamber System with excavation and bedding	1060	m	$60.00	$ $63,600.00
20	Inspection Ports (1/30m)	35	ea	$250.00	$ $8,750.00
21	Orifice Plates	5	ea	$250.00	$ $1,250.00
22	Weir Plates	3	ea	$500.00	$1,500.00
23	Stone Trench and Lining	1060	m	$175.00	$ $185,500.00
24	Oil/grit Chambers	5	ea	$100,000.00	$ $500,000.00
25	Drainage Outlets	6	ea	$25,000.00	$ $150,000.00
26	Bioretention Systems	3	ea	$25,000.00	$75,000.00
27	Clythe Creek Culvert Replacement 12.81 by 2.74 m Conspan Arch	1	ea	$1,500,000.00	$1,500,000.00
28	Driveway Crossing Culvert Replacement 14.2m by 10.97 m by 2.44 m Conspan	1	ea	$750,000.00	$750,000.00
29	Hadati Creek ?? M by 5.5 m by 1.7 m conc. Box Extenstion by ???m	1	ea	$250,000.00	$250,000.00
30	Contingency of 10%	0.1	LS	$4,954,915.00	$ $495,491.50
				TOTAL PRICE $	**$5,450,406.50**

Appendix N

Preferred Alternative Plans





	10+000	10+020	10+040	10+060	10+080	10+100	10+120	10+140	10+160	10+180	10+200	10+220
EXISTING CENTRELINE												
PROPOSED GRADE												
STORM SEWER												
SANITARY SEWER												

KEY PLAN Scale : NOT TO SCALE

SHEET No.

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA –PROPOSED PROPERTY LIMIT
- YORK ROAD EIS PROPOSED PROPERTY LIMIT
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK
- PROPOSED BUS PAD

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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

SCALES: HOR: 1:500 VER: 1:50

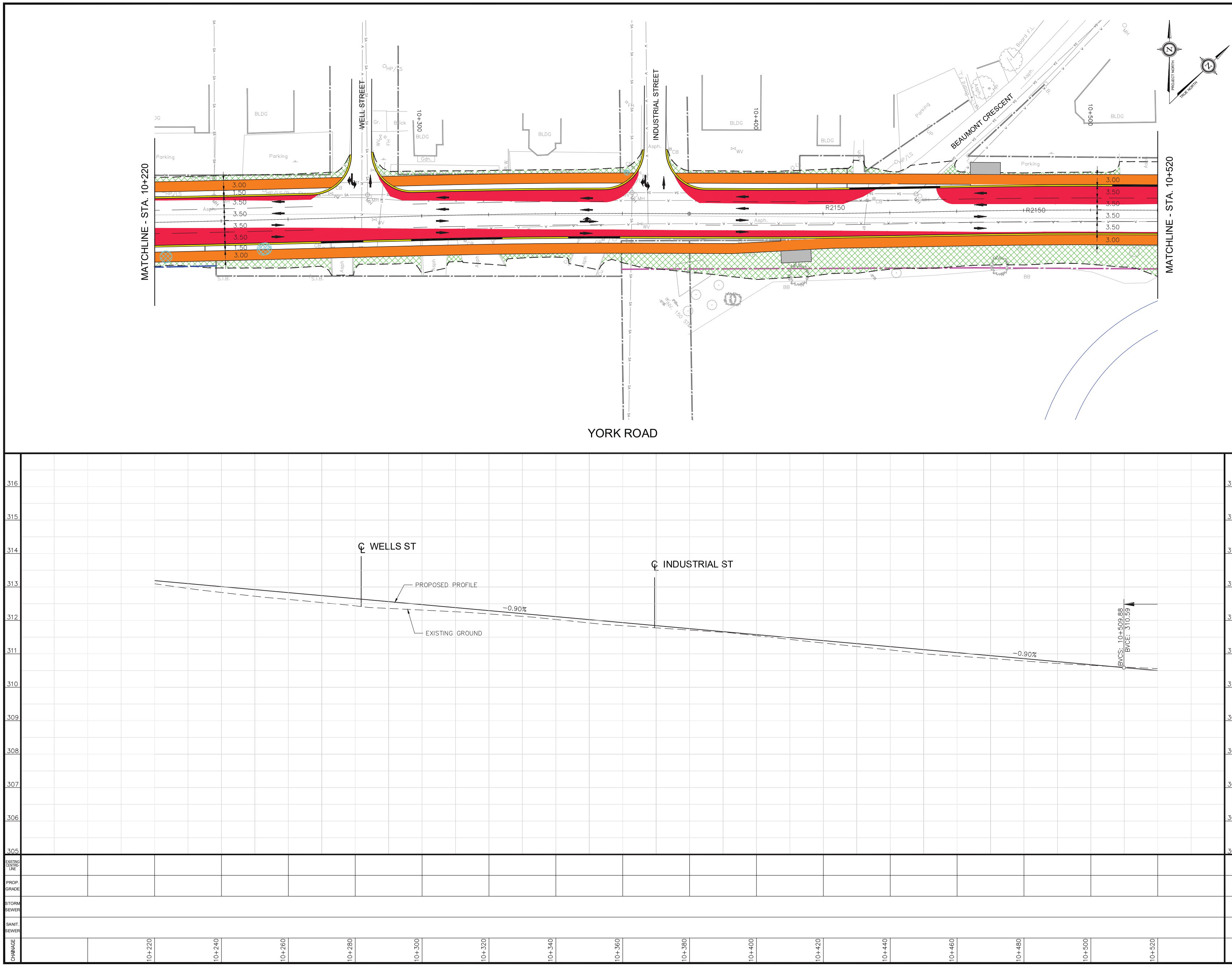
DATE DRAWN: 2018-04-02

DRAWN BY: D.K. CHECKED BY: M.E.K.

CONSULTANT DRAWING No. ALT. 4

CITY CONTRACT No.

CITY REFERENCE No. SHEET 1 OF 9 REV.



SHEET No.

KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
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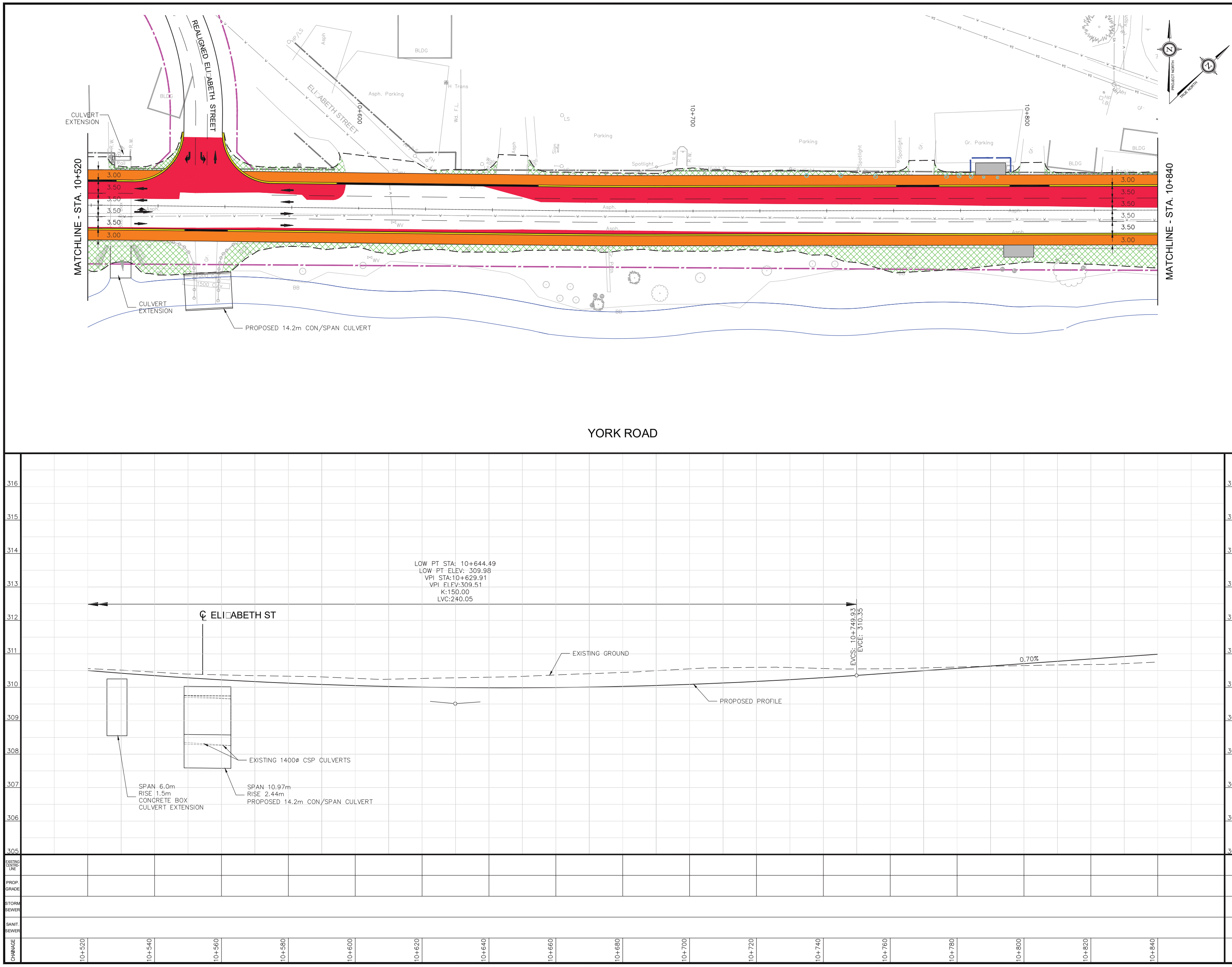
ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2018-04-02
STORM SEWER	DRAWN BY: D.K. CHECKED BY: M.E.K.
SANITARY SEWER	CONSULTANT DRAWING No. ALT. 4
	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 2 OF 9 REV.



SHEET No.

KEY PLAN Scale : NOT TO SCALE

LEGEND

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- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
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ISSUES/REVISIONS

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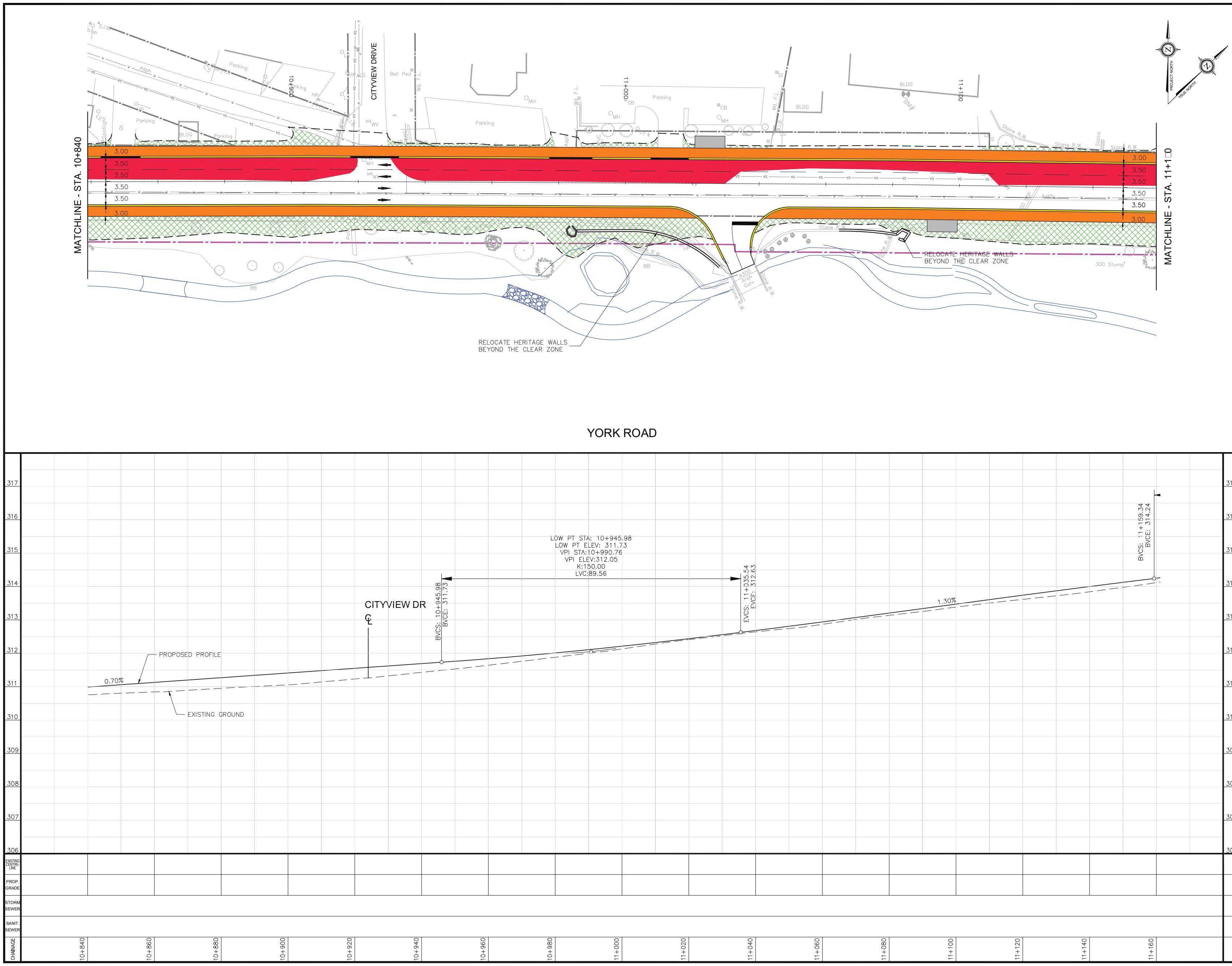
DATE DRAWN: 2018-04-02

DRAWN BY: D.K. CHECKED BY: M.E.K.

CONSULTANT DRAWING No. ALT. 4

CITY CONTRACT No.

CITY REFERENCE No. SHEET 3 OF 9 REV.



SHEET No.

KEY PLAN Scale : NOT TO SCALE

LEGEND

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- EIS–PROPOSED PROPERTY LIMITS
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ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

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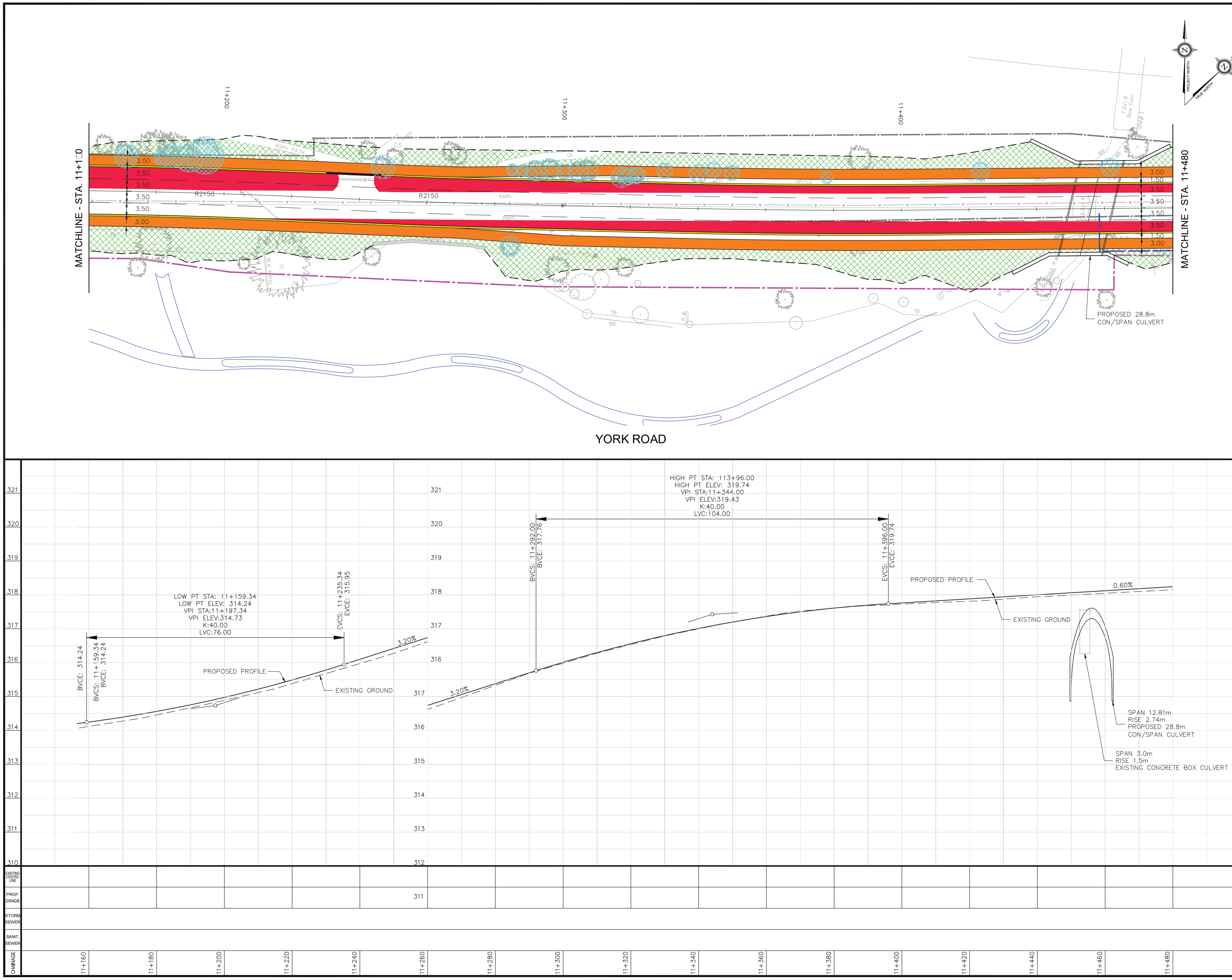
DATE DRAWN: 2018-04-02
DRAWN BY: D.K. CHECKED BY: M.E.K.
CONSULTANT DRAWING No. ALT. 4
CITY CONTRACT No.
CITY REFERENCE No. REV.
SHEET 4 OF 9



SHEET No.

KEY PLAN Scale : NOT TO SCALE

LEGEND

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- CLASS EA PROPOSED PROPERTY LIMIT
- EIS-PROPOSED PROPERTY LIMITS
- PROPOSED CURB
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ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

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DATE DRAWN: 2018-04-02	
DRAWN BY: D.K.	CHECKED BY: M.E.K.
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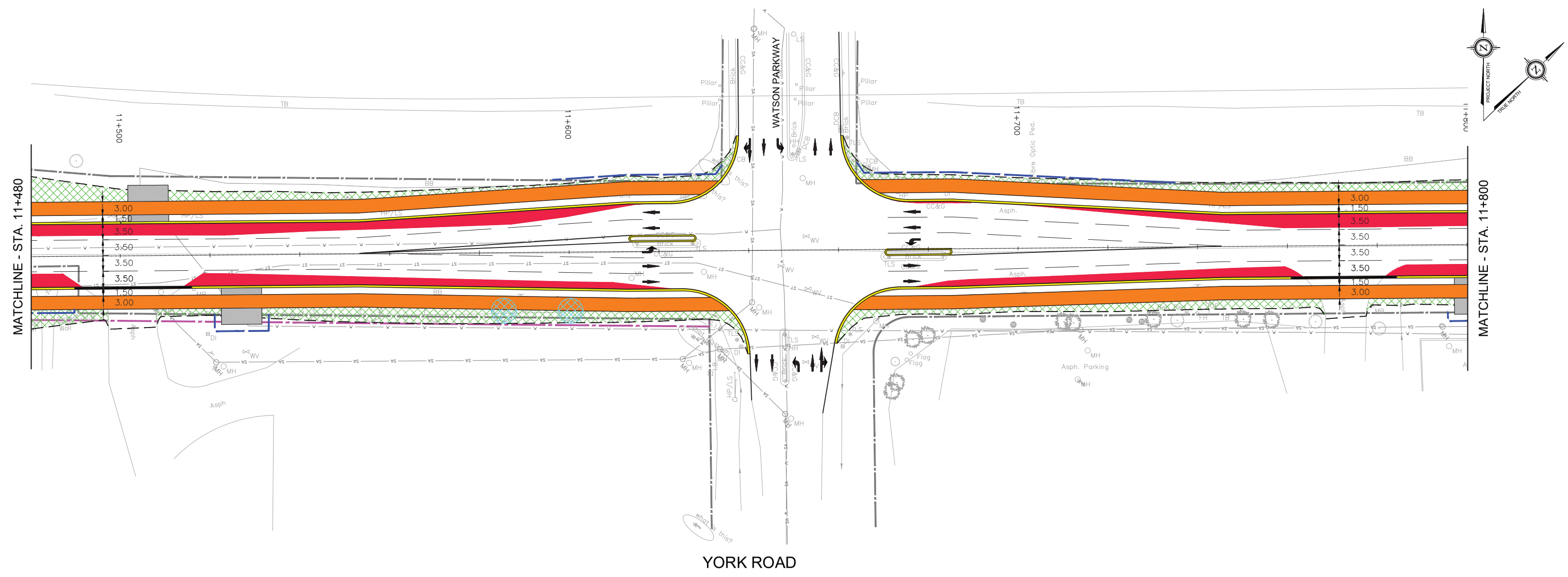
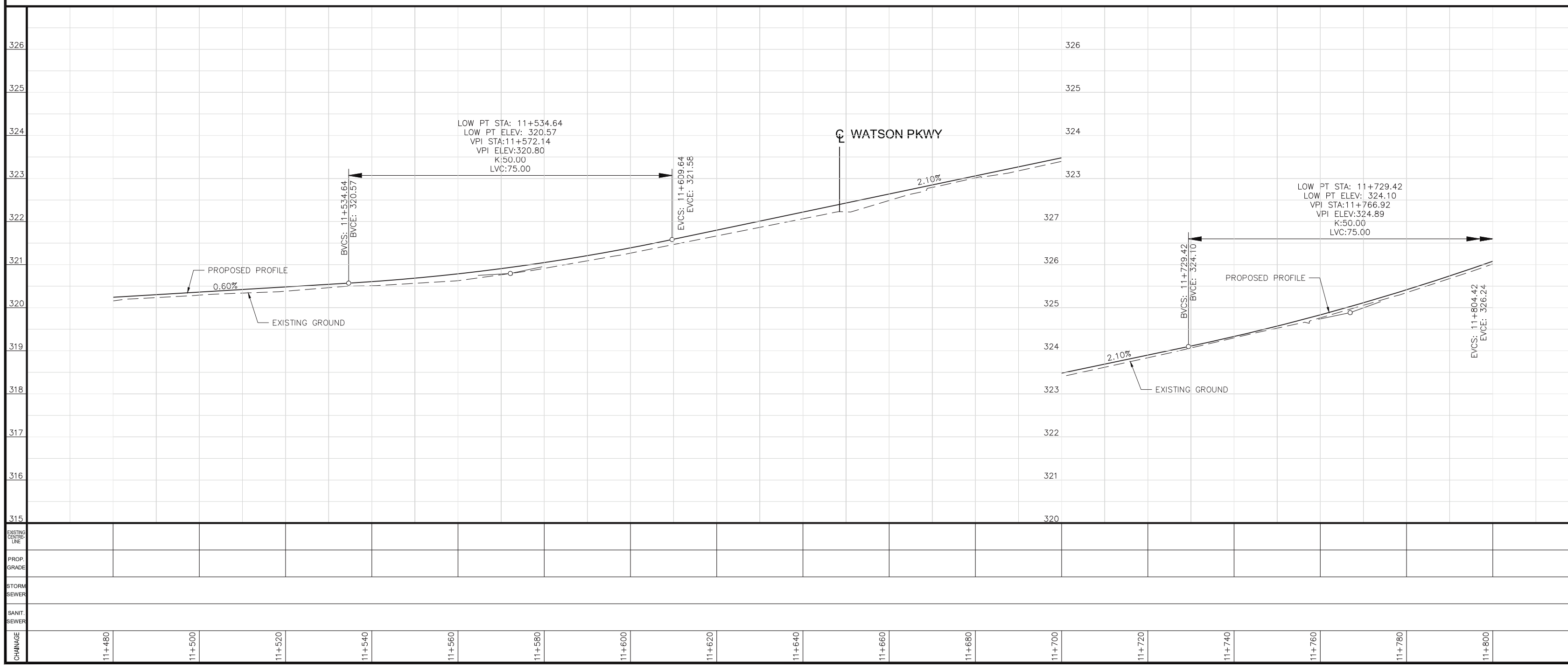
CITY CONTRACT No.	
CITY REFERENCE No. SHEET 5 OF 9	REV.





SHEET No.

KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
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- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

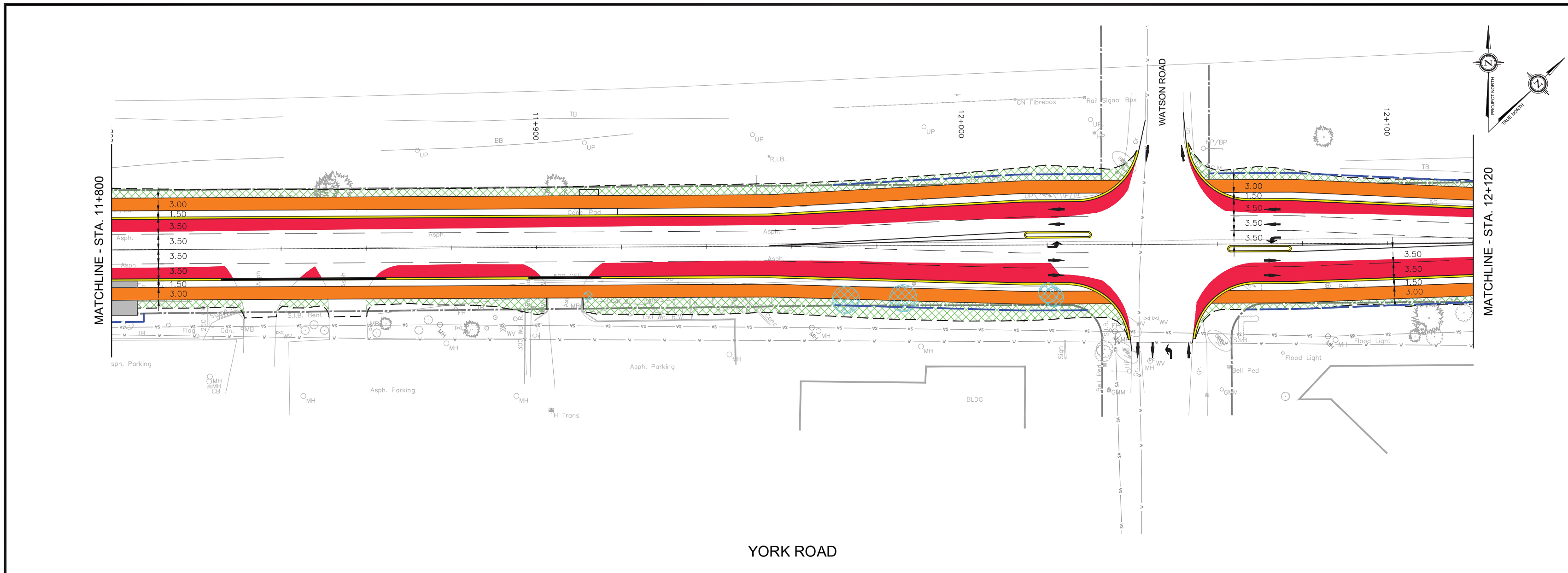
CITY OF Guelph

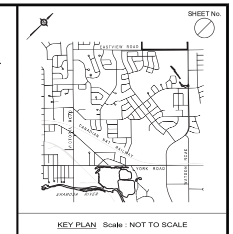
ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2018-04-02
STORM SEWER	DRAWN BY: D.K. CHECKED BY: M.E.K.
SANITARY SEWER	CONSULTANT DRAWING No. ALT. 4
	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 6 OF 9 REV.





LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
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- PROPOSED TREE REMOVAL
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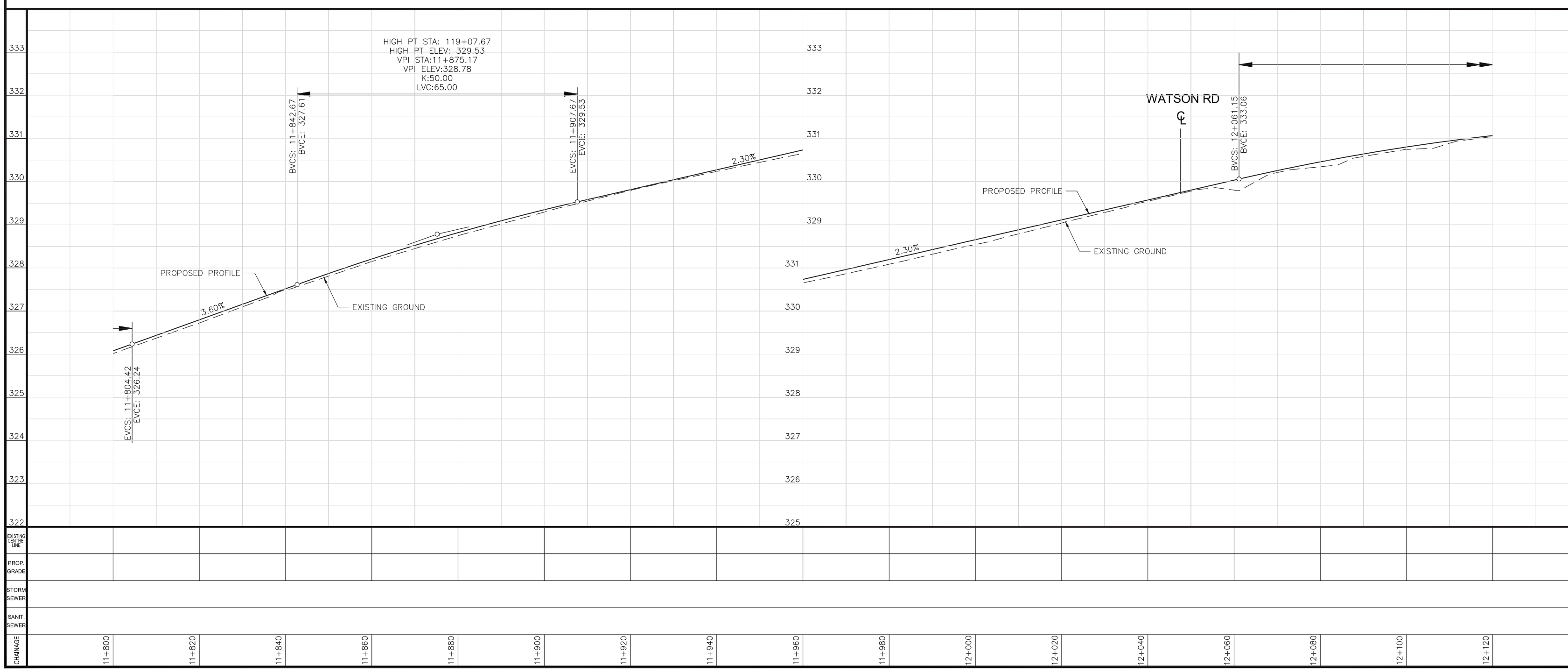
- PROPOSED BUS PAD



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ISSUES/REVISIONS

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ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

SCALES: HOR: 1:500 VER: 1:50

DATE DRAWN: 2018-04-02

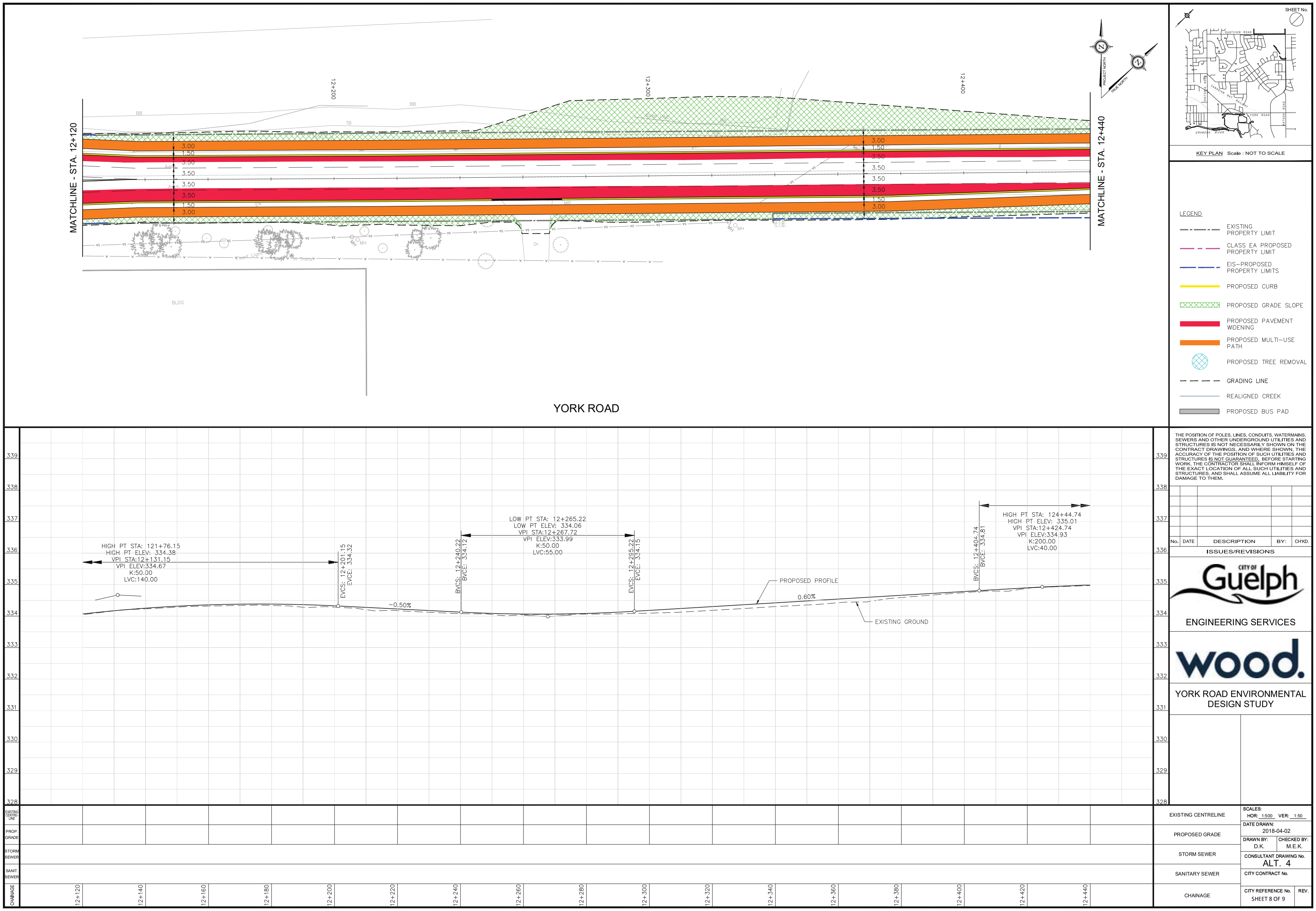
DRAWN BY: D.K. | CHECKED BY: M.E.K.

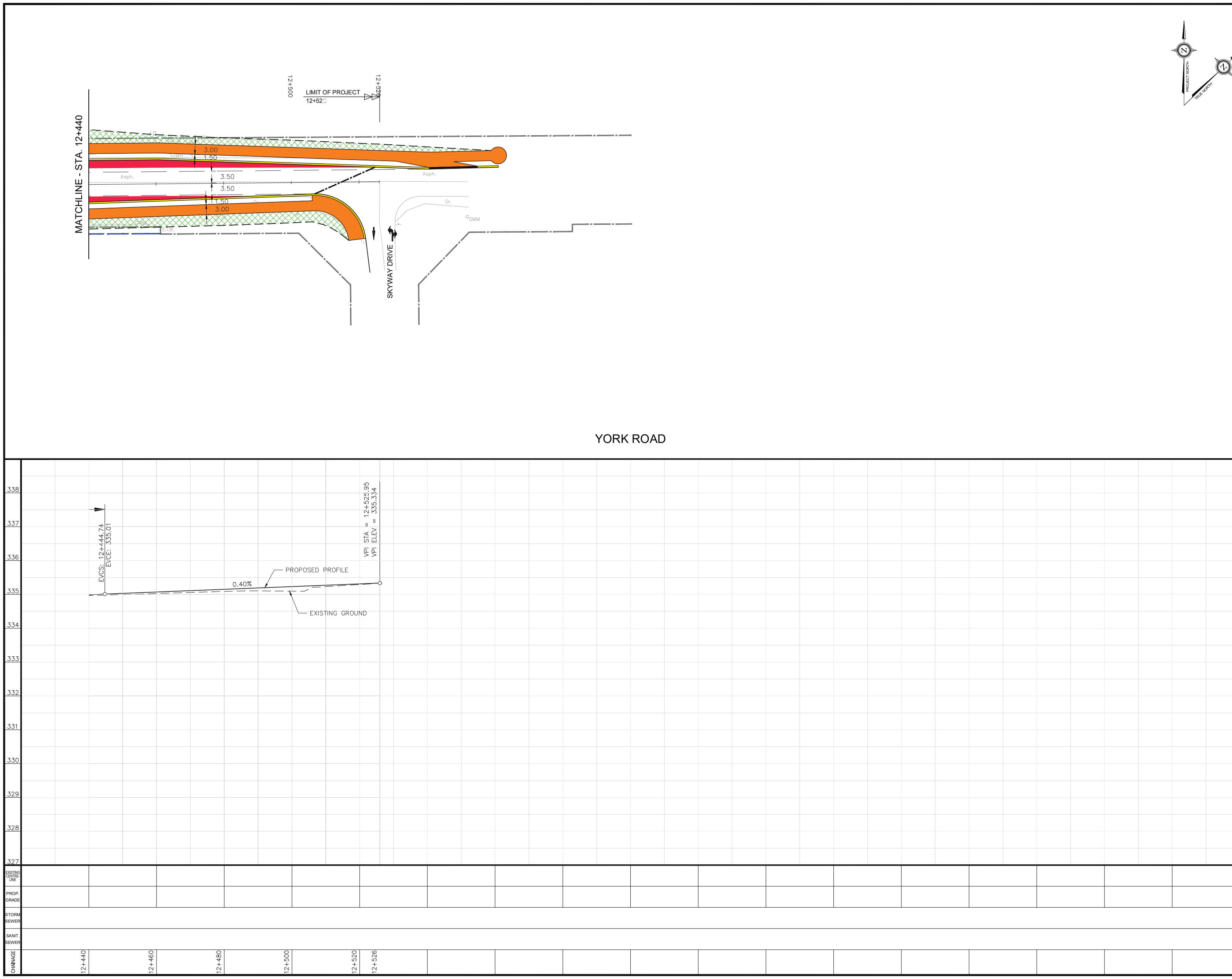
CONSULTANT DRAWING No. ALT. 4

CITY CONTRACT No.

CITY REFERENCE No. | REV.

SHEET 7 OF 9


SHEET No.
KEY PLAN Scale : NOT TO SCALE
MATCHLINE - STA. 12+120
MATCHLINE - STA. 12+440
12+200
12+300
12+400
3.00
1.50
3.50
3.50
3.50
3.50
1.50
3.00
BB
TB
BLDG
YORK ROAD
PROJECT NORTH
TRUE NORTH
LEGEND
EXISTING PROPERTY LIMIT
CLASS EA PROPOSED PROPERTY LIMIT
EIS-PROPOSED PROPERTY LIMITS
PROPOSED CURB
PROPOSED GRADE SLOPE
PROPOSED PAVEMENT WIDENING
PROPOSED MULTI-USE PATH
PROPOSED TREE REMOVAL
GRADING LINE
REALIGNED CREEK
PROPOSED BUS PAD
HIGH PT STA: 121+76.15
HIGH PT ELEV: 334.38
VPI STA:12+131.15
VPI ELEV:334.67
K:50.00
LVC:140.00
EVCS: 12+201.15
EVCE: 334.32
-0.50%
BVCS: 12+240.22
BVCE: 334.12
LOW PT STA: 12+265.22
LOW PT ELEV: 334.06
VPI STA:12+267.72
VPI ELEV:333.99
K:50.00
LVC:55.00
EVCS: 12+295.22
EVCE: 334.15
PROPOSED PROFILE
0.60%
EXISTING GROUND
BVCS: 12+404.74
BVCE: 334.81
HIGH PT STA: 124+44.74
HIGH PT ELEV: 335.01
VPI STA:12+424.74
VPI ELEV:334.93
K:200.00
LVC:40.00
339
338
337
336
335
334
333
332
331
330
329
328
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE
12+120
12+140
12+160
12+180
12+200
12+220
12+240
12+260
12+280
12+300
12+320
12+340
12+360
12+380
12+400
12+420
12+440
THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
No. DATE DESCRIPTION BY: CHKD.
ISSUES/REVISIONS
CITY OF Guelph
ENGINEERING SERVICES
wood.
YORK ROAD ENVIRONMENTAL DESIGN STUDY
SCALES: HOR: 1:500 VER: 1:50
DATE DRAWN: 2018-04-02
DRAWN BY: D.K.
CHECKED BY: M.E.K.
CONSULTANT DRAWING No. ALT. 4
CITY CONTRACT No.
CITY REFERENCE No. SHEET 8 OF 9
REV.



SHEET No.

KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK
- PROPOSED BUS PAD

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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

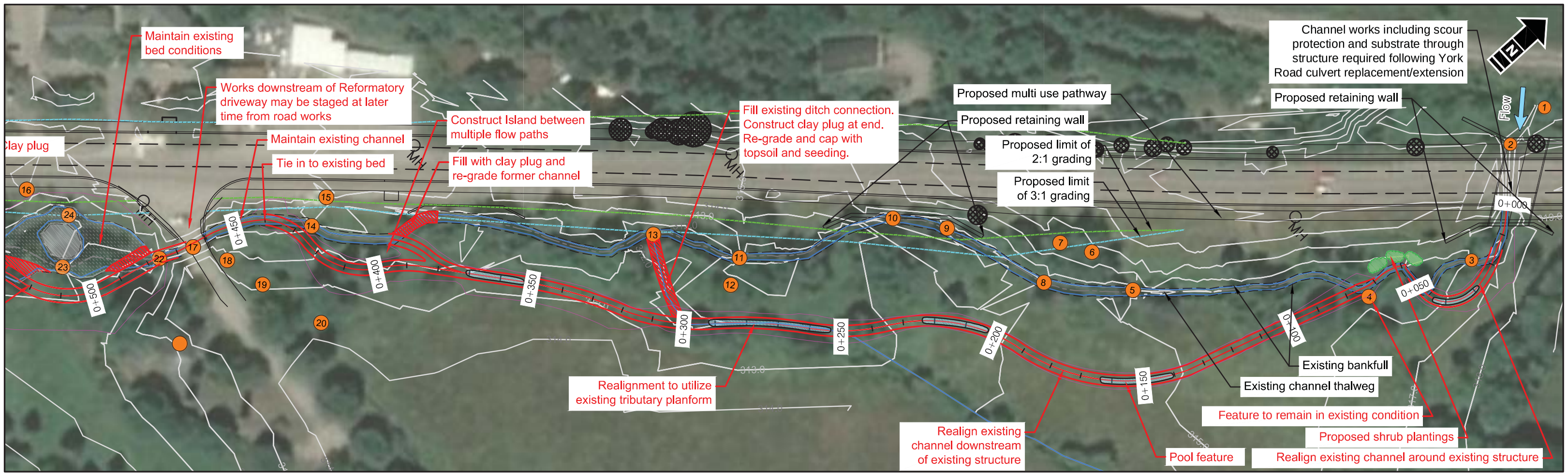
CITY OF Guelph

ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2018-04-02
STORM SEWER	DRAWN BY: D.K. CHECKED BY: M.E.K.
	CONSULTANT DRAWING No. ALT. 4
SANITARY SEWER	CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 9 OF 9 REV.

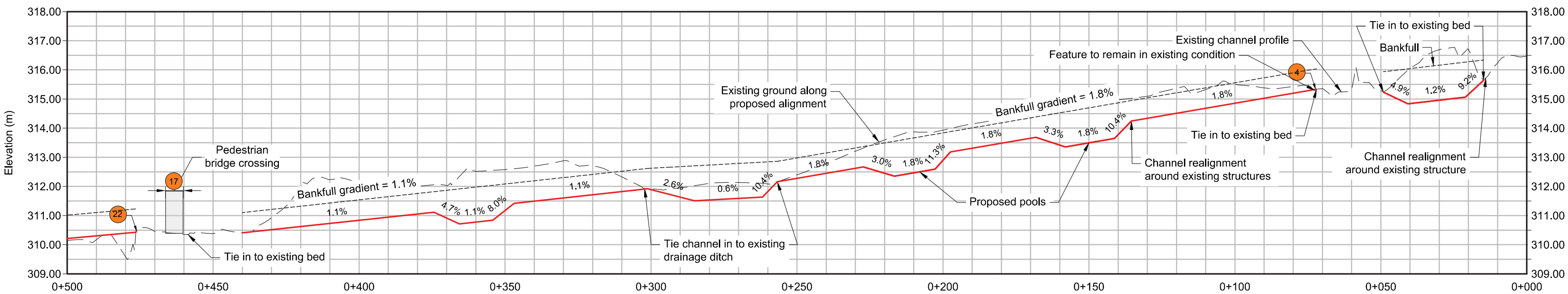


Legend

- Surveyed edge of water
- Surveyed bankfull
- Toe of 2:1 road grading
- Toe of 3:1 road grading
- Proposed realignment
- Proposed fill/bank treatment
- Proposed shrubs and plantings
- Cultural heritage feature/structure
- Maintain existing bed
- Proposed pool
- Approximate grading limit

Notes:

1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
03	03 08 2017	Revised based on client comments	JH	JP	ED
02	01 17 2017	Revised based on client comments	JH	JP	ED
01	12 09 2016	Revised based on client comments	JH	JP	ED
00	09 15 2016	Draft for client review	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

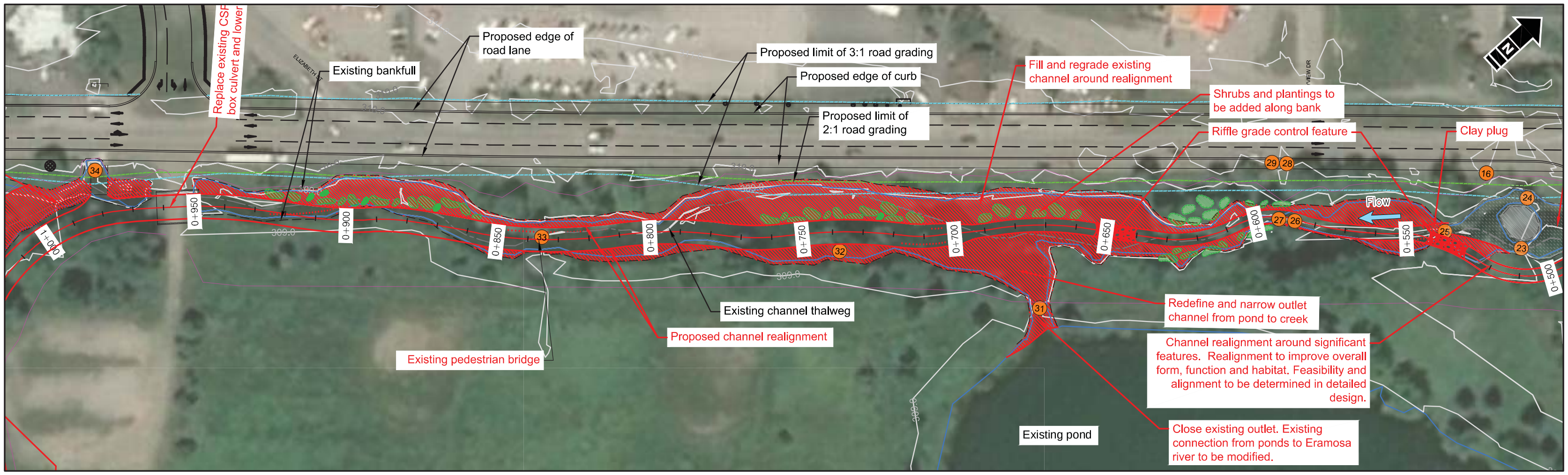
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 0+000-0+500m

Date: 11 22 2017 | Project: 22257 York Road | Technical: J. Henshaw | Reviewer: J. Parish | Drawn: E. Drost

Figure 04



Legend

- Surveyed edge of water
- Surveyed bankfull
- Toe of 2:1 road grading
- Toe of 3:1 road grading
- Proposed realignment
- Proposed fill/bank treatment
- Proposed shrubs and plantings
- Cultural heritage feature/structure
- Maintain existing bed
- Proposed pool
- Approximate grading limit

Notes:

1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
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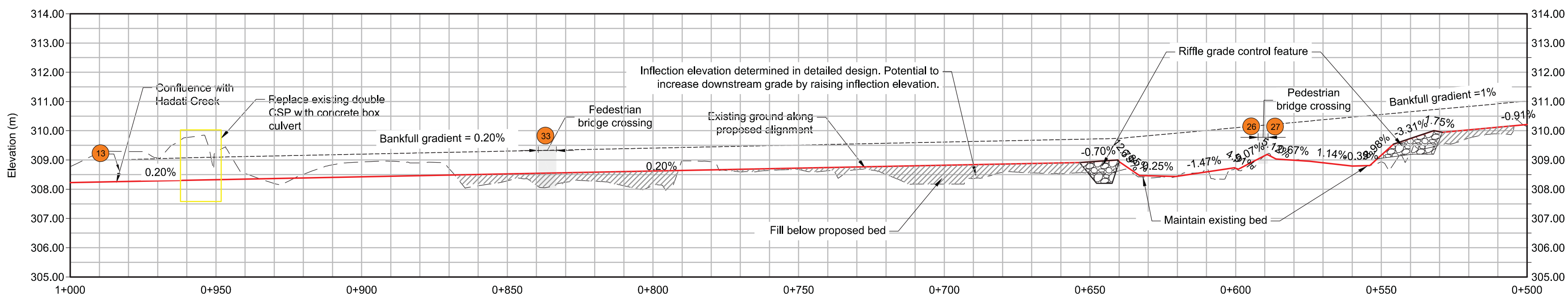
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
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Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 0+500-1+000m

Date: 11 22 2017 | Project: 22257 York Road | Technical: J. Henshaw | Reviewer: J. Parish | Drawn: E. Drost

Figure 05

Legend	
	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
2	Cultural heritage feature/structure
	Approximate grading limit

Notes:

1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
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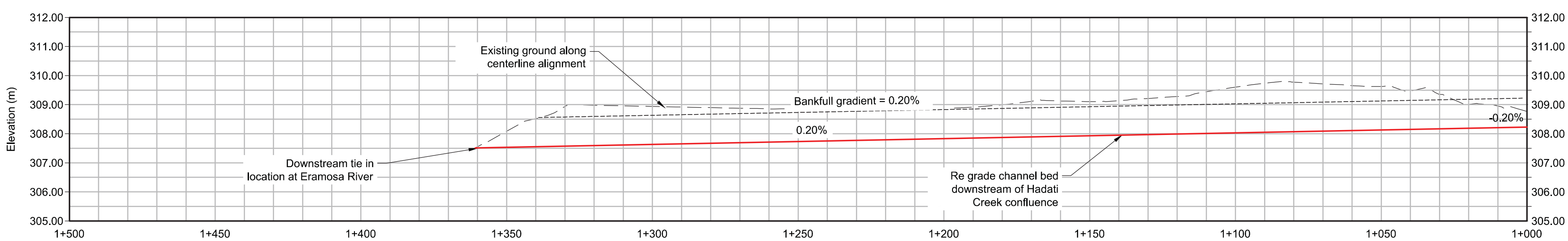

Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
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Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 1+000-1+500m

Date:	Project:	Technical:	Reviewer:	Drawn:
11 22 2017	22257 York Road	J. Henshaw	J. Parish	E. Drost

Figure 06

wood.