Guelph Innovation District

Stormwater Management Study

City of Guelph

Prepared for:

City of Guelph
Guelph, Ontario

Prepared by:

Amec Foster Wheeler
3215 North Service Road
Burlington, ON L7N 3G2
(905) 335-2353

September 2015

Project No. TP109088

Guelph Innovation District
Stormwater Management Study

City of Guelph

Submitted to:

City of Guelph
Guelph, Ontario

Submitted by:

Amec Foster Wheeler Environment & Infrastructure
3215 North Service Road
Burlington, ON L7N 3G2
Tel: (905) 335-2353
Fax: (905) 335-1414

September 2015

TP109088

TABLE OF CONTENTS

PAGE

LIST OF APPENDICES

1.0 INTRODUCTION

The Guelph Innovation District (GID) comprises of approximately 436 ha (1,077 acres) on Guelph's east side (ref. Drawing 1). It is bounded by York Road, Victoria Road South, the York-Watson Industrial Park and the City's southern boundary. The GID is located in the south-eastern end of the Eramosa River watershed area where Torrance Creek, Clythe Creek and Hadati Creek confluence with the Eramosa River. The GID is also located within the Guelph Drumlin Field physiographic region (Chapman and Putman, 1984).

The Guelph Innovation District 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 City identified objectives for the development of these lands, including:

- To provide employment lands;
- To meet the goals of the Growth Plan;
- To continue to host the Waste Resource Innovation Centre;
- To conserve natural and cultural heritage resources;
- To put the Community Energy Initiative into practice;
- To build partnerships with the Province and those with an interest in the lands.

Amec Foster Wheeler Environment & Infrastructure, a division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler) has been retained to address stormwater management for the Guelph Innovation District and provide guidance and policies to ensure these services meet the needs of the GID.

2.0 BACKGROUND

Background information has been provided by the City of Guelph, the Grand River Conservation Authority and other agencies. The following mapping and drawings have been provided:

i) Storm Sewers, 2008;
ii) 2008 Aerial and 0.5 m topographic mapping;
iii) Boundary mapping (Municipality, Property, Study Area Limits);
iv) Transportation Mapping (Roadway and Railways);
v) Wellington County Soils Mapping (Agriculture Canada)
vi) Natural Heritage System, Regulatory floodplain stormwater management facilities and creeks.

The following reports have been provided by the City of Guelph.

1. Grand River Source Protection Plan, Volume II, March 2015

   The Grand River Guelph Source Protection Plan provides policies regarding the protection of groundwater systems from contamination based on an assessment of the level of risk within each geographic area depicted as a vulnerability scoring. For the GID area, Schedule E, Map D of the Source Protection Plan each significant drinking water threat category has been scored as either and 8 or 10 out of a maximum score of 10. As such, the GID area groundwater resources are at a significant risk to contamination from both existing development and future development, unless appropriate stormwater management measures are implemented.

2. Elizabeth Street Reconstruction, Victoria Road to Industrial Avenue, Amec Foster Wheeler, March 2015

   A new trunk sewer is being proposed for Elizabeth Street that would outlet to Hadati Creek north of York Road under interim conditions with an ultimate outlet to Clythe Creek opposite Industrial Avenue. The new storm sewer is proposed to reduce flooding issues within Ward 1. The interim storm sewer outlet is proposed to be constructed in 2015, while the ultimate outlet requires further assessment.

3. Envision Guelph: Official Plan Amendment Number 42: Natural Heritage System, July 2010

3a. Natural Heritage Strategy Phase 2 Reports, Dougan & Associates, March 2009.

3b. Natural Heritage Strategy Phase 1 Final Report, Dougan & Associates, March 2005

   The City of Guelph's Natural Heritage System identifies Significant Natural Areas for protection and includes policies for Natural Areas were development may by permitted once an Environmental Impact Study has been approved that demonstrates no negative impacts to existing natural heritage features and associated ecological and hydrological functions.

4. "Guelph Stormwater Management Master Plan", Amec, February 2012

   The Stormwater Management (SWM) Master Plan provides a long-term plan for the safe and effective management of stormwater runoff from Guelph's urban areas while improving the ecosystem health and ecological sustainability of the Eramosa and Speed Rivers and their tributaries. The SWM Master Plan integrates aspects of flood control, groundwater and surface water quality, natural environment and system drainage issues into a cohesive City-wide strategy. As part of the strategy prioritized recommendations were provided for improving the capacity of existing drainage systems, conducting water quality retrofits and low impact development pilot studies.

5. "Stormwater Management Facility Inventory, Assessment and Maintenance Needs Plan, Final Report", Totten Sims Hubicki, October 2008.

   Based on the 2008 inventory, there are two existing stormwater management facilities, Facility No. 38 located on Watson Parkway South and Facility No. 96 located at the intersection of Watson Road and Stone Road. Facility No. 38 was constructed in 1996 and has a catchment area of 18.7 ha is a dry quantity facility with a 100 year quantity control volume of 54,100 m^3. Facility No. 96 constructed in 2005 is a dry quantity/ quality facility with a catchment area of 8.57 ha.

6. “Rehabilitation of Clythe Creek Phase II Design Report, York Road between Watson Parkway and Elizabeth Street Speed Valley Watershed, Guelph, Ontario”, UW 4th Year Engineering Students, March 28, 2008.

   This is a follow-up to the Phase 1 report and provides additional information regarding the creek characterization and creek improvement alternative evaluation.

7. “Assessment and Remedial Activities for Clythe Creek Phase I Report, York Road between Watson Parkway and Elizabeth Street Speed Valley Watershed, Guelph, Ontario”, UW 4th Year Engineering Students, November 23, 2007.

   This document prepared by University of Waterloo students, assessed the existing Clythe Creek condition and evaluated alternatives for improving the creek. The report notes that York Road widening works would be conducted in the near future. Clythe Creek which has a 21 km^2 drainage area is noted as being approximately 1 km in length from the crossing at York Road to the confluence with the Eramosa River. The creek has been classified by MNRF as being a cool water fishery with the potential of being a coldwater fishery with appropriate improvements. Water quality testing of BOD, nitrate, phosphate, dissolved oxygen and temperatures resulted in parameters being below the PWQOs for a coldwater classification.

   The report recommends that the creek on the south side of York Road be realigned and lowered by removing the existing 20 +/- drop structures or weirs. Fish passage and habitat would be improved due to existing obstacles being eliminated and the creek being designed using natural channel techniques with riparian plantings.

8. “Storm & Sanitary Drainage Assessment Report for the City of Guelph Waste Resources Innovation Centre”, Gartner Lee Limited, August 2007

   The report provides a detailed hydrologic assessment of the existing stormwater management facilities within the Waste Resources Innovation Centre. Two stormwater management facilities are assessed for stormwater quantity and quality requirements to ensure no offsite impacts result. The report also documents how the pumping station pumps stormwater collected onsite.

9. “York Road Improvements Wyndham Street South to East City Limits Class EA, Environmental Study Report, Volume Two: Appendices”, TSH Engineers, Architects, Planners, February 2007.

   This report provides the details for stormwater management for the future road works and discusses opportunities for both Clythe Creek and Hadati Creek. Stormwater management has been noted as a combination of grassed swales and oil/grit chambers discharging to dry cells.

Approximately 135 m of Clythe Creek has been proposed to be realigned where the creek is currently lined with gabion baskets. The existing weirs within the 135 m creek reach have been proposed to be eliminated. The existing Clythe Creek 3 m by 2 m concrete culvert under York Road has been proposed to be extended by 6.5 m +/- when York Road is widened.

The Hadati Creek 5.5 m by 1.5 m concrete culvert has been recommended not to be extended.

10. "Victoria Road (Clair Road to York Road) Class EA Study, Environmental Study Report", McCormick Rankin Corporation, Gamsby and Mannerow Limited in association with Ecoplans Limited and Archaeological Services Inc., January 2005.

    Stormwater management for the proposed Victoria Road works would consist of the following:

    - Future stormwater management facility at the north east corner of Stone Road and Victoria Road intersection to provide Enhanced water quality control for the intersection.
    - Linear ditch system to provide stormwater quality control from Stone Road to vicinity of Eramosa River south bank.
    - Stormwater quality measures (unknown) to be constructed at the storm sewer outlets draining Victoria Road from the Eramosa River to York Road.

11. "Grand River Tailwater Fisheries Management Plan: 2005-2010", Ontario Ministry of Natural Resources – Guelph District, 2004

12. "Phase I Environmental Site Assessment, Victoria Road and York Road, Guelph, Ontario", McCormick Rankin Corporation, Gamsby and Mannerow Limited in association with Ecoplans Limited and Archaeological Services Inc., August 2003.

13. "The City of Guelph Official Plan", June 2002.

    The City of Guelph's *Official Plan* has incorporated stormwater management policies consistent with the recommendations within the listed reports. The *Official Plan* requires the watershed planning process established by the Provincial government to be used in determining stormwater management requirements for development.

14. "Stone Road Class EA, Environmental Study Report", McCormick Rankin Corporation, Gamsby and Mannerow Limited in association with Ecoplans Limited and Archaeological Services Inc., March 2002.

    This report provides the background on the stormwater management proposed for the Stone Road resurfacing (Stage 1) which has been conducted prior to 2009 and the future road widening (Stage 2), yet to be conducted.

- Victoria Road to Detention Centre lands: Stage 1 – linear wetland providing Enhanced water quality control. Stage 2 – a future wetland quality facility located at the north east corner of Victoria Road and Stone Road would provide Enhanced water quality control with quantity control.
- Detention Facility lands to Eramosa River: Stage 1, linear wetland providing Enhanced water quality control. Stage 2 (west of rail tracks) a future wetland quality facility would provide Enhanced water quality control with quantity control.
- Railway tracks to Eramosa River, stormwater quality control would be provided by oil/grit chambers discharging to stilling basins.
- Eramosa River to 420 m west of Watson Road: Stage 1 – a linear stormwater management facility would provide Enhanced stormwater quality control. For Stage 2 a future wet pond/ wet land stormwater management facility would be built.
- 420 m west of Watson Road to Watson Road: Stage 1 – linear wetland. Stage 2 would require a wetland/ wet pond. It should be noted that a stormwater management facility has already been constructed on the north west corner of the intersection of Stone Road and Watson Road (Facility No. 96)

15. "Victoria Road and Watson Road Class EA Study, Detailed Work Plan", McCormick Rankin Corporation, Gamsby and Mannerow Limited in association with Ecoplans Limited and Archaeological Services Inc., December 2001.

16. "City of Guelph Stone Road Class EA Study, Study Design Draft", McCormick Rankin Corporation, Gamsby and Mannerow Limited in association with Ecoplans Limited and Archaeological Services Inc., October 16, 2000.

17. "Eramosa-Blue Springs Watershed Study", Beak International Incorporated and Aquafor Beech Limited et al, September and October 1999.

    The Eramosa-Blue Springs Watershed includes the York District study area and established general stormwater management recommendations for the watershed. Recommendations within the York District include restoration of the Clythe Creek to a complete coldwater fisheries habitat through stream corridor restoration. The York District is subdivided by part of the Eramosa River's Guelph-Eden Mills Reach'. General recommendations for this reach include groundwater recharge area protection and stream corridor restoration.

18. "Torrance Creek Subwatershed Study", Totten Sims Hubicki et al, November 1998.

    Torrance Creek outlets to the Eramosa River, immediately north of Stone Road East, within the southern area of the York District. The subwatershed study establishes a management strategy for stormwater management servicing. Stormwater management within the Torrance Creek portion of the York District would comprise the Ministry of Environment's Enhanced Level of water quality treatment and would have to consider infiltration measures to maintain or augment baseflows. Water quality control is required for flows entering infiltration devices. In the local recharge areas adjacent to the creek, the report recommends that fish barriers be removed along Torrance Creek.

19. "Clythe Creek Subwatershed Overview", Ecologistics Limited and Blackport & Associates, April 1998.

    Clythe Creek is a tributary of the Eramosa River. The subwatershed overview established recommendations for creek management corridor and groundwater management.

    With respect to the York District, recommendations include retaining and enhancing existing natural areas. The report recommends that the existing wetlands should be evaluated using the Ministry of Natural Resources Evaluation System. Fisheries habitat is to be improved by the removal of fish barriers and by the use of stormwater management practices that maintain low water temperatures. Recommendations, with respect to groundwater, include maintaining existing groundwater recharge quantity and quality. In addition, the impacts and mitigation of potential groundwater withdrawals within the York District would have to be established.

20. Evaluation of the Hadati-Clythe Creek Wetland Complex, Ecologistics Limited, 1992

21. Environmental Study of Hadati Creek Wetlands in the Eastview Planning Area

2.1 Background Summary

The above noted documents have been reviewed specifically for information related to stormwater management criteria and study area characteristics. Given the current focus on developing an existing land use hydrologic model, particular interest has been given to information related to detailed soils characterization (i.e. borehole logs or other direct field data) and drainage features, in particular stormwater management facilities. While detailed information has been found related to the design of SWM facilities and general drainage characteristics, very limited field data has been found related to soils conditions. Given the importance of accurately representing infiltration characteristics, observed data would be preferred; however other sources of data can be applied as required.

3.0 PHOTOGRAPHIC RECONNAISSANCE

A photographic inventory has been conducted as of September 2009 and December 2012 of existing drainage systems including Clythe Creek, Hadati Creek, Eramosa River crossings and existing stormwater management facilities (ref. Appendix A).

4.0 EXISTING SYSTEMS

4.1 Overview of Existing Drainage System

Based on the background, along with discussions with City Staff, and general understanding of the existing servicing infrastructure has been obtained and is described below:

The GID includes part of the Clythe Creek and Torrance Creek Subwatersheds, which are both tributary to the Eramosa River (ref. Drawing 1). Both the Clythe and Torrance Creeks have been studied within respective Subwatershed studies and the Eramosa River has been studied within the Eramosa-Blue Springs Watershed Study.

The City of Guelph's *Official Plan* has, based on the foregoing studies and the "Stormwater City of Guelph River Systems Management Study", considered the entire City to be a groundwater recharge area for public and private water supply (ref. Drawing 3 – Hydrogeology). The York District is part of the 'Arkell Springs Water Resources Protection Area', which the *Official Plan* requires both ground and surface water protection. The Grand River Source Protection Plan for the GID area, has determined that each significant drinking water threat category is either an 8 or 10 out of a maximum score of 10, therefore groundwater needs to be protected from contamination. In addition, the Clythe and Torrance Creek Subwatershed Studies have also identified the majority of the York District to be a significant groundwater recharge/discharge area. Both the York District's surface and ground water quality and quantity are to be protected.

Clythe Creek is considered a coolwater fisheries habitat while Torrance Creek is both a warm water and coldwater fisheries habitat with Type 1 fish habitat located only at the outlet to the Eramosa River. Clythe Creek has been recommended for either partial or complete realignment when the future York Road widening occurs.

Existing stormwater management works within the York District are limited to the existing stormwater management facilities Nos. 38, 96 and 104, which service the Watson Parkway industrial area, a section of Stone Road east of the Eramosa River and the Victoria Road and Stone Road intersection (ref. Drawing 2). Stormwater management facility 38 has a drainage area of 83.3 ha, while facilities 96 and 104 provide stormwater quality treatment for the local Stone Road intersection improvements at Watson Parkway and Victoria Road respectively. The Waste Resource Innovation Centre (WRIC) has three (3) stormwater management facilities that provide stormwater quality and quantity controls in addition to infiltration ditches that reduce site runoff prior to discharge to the stormwater management facilities. In the northwest area of the GID at 256 Victoria Road South a private stormwater management facility exists at the PDI Plant; no details are available for the existing stormwater management facility based on discussions with City staff, who have pursued information about the PSI site from the land owners.

Stormwater quality management in way of swales, oil grit chambers and other best management practices have been proposed within the Victoria Road (Clair Road to York Road) Class EA Study, Environmental Study Report, 2005 for future Victoria Road and York Road improvements.

There are a number of on-line ponds located within the Clythe and Torrance Creek Subwatersheds and the York District study area, which have been determined, by the Natural Heritage Strategy as a Significant Wetland, with wetland boundaries based on ELC communities mapping. Within the Clythe Creek Subwatershed, the Royal City's Jaycee's Bicentennial Park wetland area shown as the East and West On-line Ponds (ref. Drawing 2), located southeast of the York Road and Victoria Road intersection, requires an updated wetland evaluation to verify feature boundaries based on the Ontario Wetland System (OWES). As part of the Block Plan process, there would be opportunity to refine the wetland mapping. It should be noted that stormwater management facilities are not permitted within provincially or City classified significant wetlands, but may be permitted in the outer half of a wetland buffer if an Environmental Impact Study (EIS) has been conducted demonstrating no impact under Section 6A.2.5 of the City's Official Plan.

Along the Torrance Creek both the Mill and Barber Ponds, located south of Stone Road East beyond the GID study area, have been identified as fish barriers and should be removed.

The Clythe Creek has tributaries of Hadati Creek and Watson Creek. Part of the Hadati Creek subwatershed outlets to the downstream limit Clythe Creek at the Eramosa River via a 1650 mm diameter storm sewer. The storm sewer drains an area comprising residential, commercial and industrial land uses, which does not receive storm sewer treatment based on the Clythe Creek subwatershed study (ref. Drawing 2). This storm sewer system has also been assessed by AMEC in 2012 as part of the Victoria Road Drainage Assessment.

4.2 Hydrology

Separate to this Stormwater Management Study, a PCSWMM hydrologic model of the GID study area is being developed for the City of Guelph. The purpose of the model will be to develop infiltration and peak flow targets for the GID area. The hydrologic model would be executed in both the event-based mode, using City of Guelph design storms, and continuous mode using the meteorological dataset compiled for the Stormwater Management Master Plan, 2012. Soils information for the study area would be reviewed from available local Class EA's soil mapping and the City of Guelph Source Water Protection Plan and Assessment Report. As the hydrologic modelling cannot be calibrated due to a lack of local flow data, the hydrologic modelling results will be reviewed on a peak flow unitary basis compared with other similar watersheds.

5.0 STORMWATER MANAGEMENT FOR THE GUELPH INNOVATION DISTRICT (GID)

In consultation with the City of Guelph the following objectives and policies have been established for the GID stormwater management.

5.1 Objectives

- To implement a groundwater infiltration strategy that maximizes the infiltration of clean water without impacts to adjacent servicing infrastructure.
- To protect the most significant groundwater recharge areas in order to protect and enhance the municipal water supply.
- To minimize chloride infiltration into the groundwater system.

- To mitigate negative impacts to peak flows, water balance and water quality resulting from urbanization.
- To prevent increased erosion within Clythe, Hadati, Torrance Creeks and the Eramosa River.

5.2 Policies

- Guelph Innovation District development shall comply with the City of Guelph polices for servicing, storm water management, including water quality and quantity and temperature and water balance. The City of Guelph's Official Plan policies introduced through OPA 48, under appeal, on Water Resources, Source Water Protection and related stormwater management policies should be adhered to.
- The City of Guelph's Natural Heritage System policies (OPA 42) are for Natural Areas were development may by permitted once an Environmental Impact Study has been approved that demonstrates no negative impacts to existing natural heritage features and associated ecological and hydrological functions.
- GID development shall comply with the recommendations and requirements of the Proposed Grand River Source Protection Plan.
- Stormwater management criteria should meet the water quality, water quantity and natural environment objectives of the City of Guelph's Stormwater Management Master Plan.
- Reference monitoring requirements and targets to be established in subsequent management plans.
- 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 as a minimum an Enhanced Level of water quality treatment are also to minimize temperature impacts to runoff discharging to Clythe Creek.
- As per the 1998 Torrance Creek Subwatershed Study, infiltration measures should be implemented to maintain or augment baseflows. Enhanced stormwater quality treatment of drainage considered not to be clean would be required prior to runoff entering infiltration best management practices. To improve fish habitat, fish barriers along Torrance Creek should be removed.
- As per the 1999 Eramosa Blue Springs Watershed Study, the Eramosa River corridor should be enhanced through stream corridor restoration.
- The City of Guelph should conduct studies to determine stormwater management requirements for the proposed GID development. Should the studies not be approved by the required agencies prior to development being implemented, the City of Guelph will require stormwater management infrastructure for GID to be flexible and adaptive in design in order to allow for recommendations from future studies to be incorporated. For instance, stormwater management blocks should incorporate an appropriate land buffer to implement potential additional storage requirements resulting from future study's stormwater storage requirement recommendations.
- 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 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.

- Snow storage design within the GID will have to be designed for protection of water quality, including the associated melt water. Snow storage areas would be subject to the Source Water Protection Plan (SWPP) policies (ref. policy CG-MC-32.1 & 32.2 from the proposed SWPP). This report should encourage designs that would meet/address the requirements in the SWPP.
- 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 system would be required to try to meet the infiltration targets. .
- Infiltration stormwater best management practices (BMPs) (other than increased topsoil depth) that are to be located on private lands are to be listed on land title agreements. The City should have easements for rights to access and maintenance over BMPs located on private lands.
- 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.
- 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 Haditi 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.
- Stormwater management measures to be implemented within the GID should include gray water reuse systems and green rooftop technologies for all industrial, commercial and institutional land uses. Development proponents may need to demonstrate that implementation of green roof and gray water reuse systems continue to result in balanced water budgets for area systems.
- Stormwater management facilities should be considered local focal points of interest, to be integrated where feasible into the planned open space, with functional compatible landscape features incorporated into the facility design.

- 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.

6.0 STORMWATER MANAGEMENT OPPORTUNITIES

Future development within the GID will have to provide Enhanced stormwater quality control. Stormwater quantity control would have to be examined on a site by site basis to maintain existing peak flows and the water budget. Stormwater management measures will have to consider Source Water Protection Plan requirements in protecting surface and groundwater resources.

For larger size developments (i.e. greater than 5 ha), end-of-pipe wet ponds, wetlands, or hybrid facilities are considered appropriate, due to the drainage area limitations associated with other techniques.

Using traditional on-site stormwater management alternatives, development or redevelopment or infill and/or a group of neighbouring development sites, would provide stormwater management including but not limited to using wetlands, wet ponds, oil/grit separators (OGS), enhanced grassed swales or combinations, depending upon impervious area and the total drainage area to the facility.

6.1 Conventional Stormwater Management

Wet ponds, Wetlands, Hybrids

These systems generally require the dedication of land that is typically located adjacent to creek systems. For the GID, there are a number of opportunities to consider the placement of an end-of-pipe stormwater management facility. Typically, these systems provide an excellent level of treatment and as end-of-pipe systems, the management and performance is more visible, hence less prone to failure. For groundwater protection, stormwater management facilities should be lined with an impermeable liner if drainage from parking areas and roadways is received. An alternative to this approach is to line the forebay where most of the sediments settle out, and then allow infiltration within the main cell of the stormwater management facility.

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 or small developable areas. It is generally conceded that treatment levels are at a minimum, Normal (formerly Level 2) treatment, and when combined with other practices can provide Enhanced treatment. Grassed swale application in linear corridors is also particularly appropriate and can be further enhanced through the introduction of check dams to provide additional on-line storage.

The application in urbanized roadway cross-sections (i.e. curb and gutter) often requires alternative grading and roadway configurations which can compromise the function of the roadway itself, and are therefore typically not preferred. Notwithstanding, gutter outlets along outside lanes have functioned effectively in the past where the right-of-way can accommodate the design. Enhanced swales receiving direct runoff from roads and parking lots would not prevent contaminants from being infiltrated, as such pre-treatment should be provided.

Filter Strips
Filter strips typically are designed for small drainage areas less than 2 ha, and are applied as part of a treatment train. Filter strips require flat areas with slopes ranging from 1 to 5% and are usually in the range of 10 to 20 m in length in the direction of flow. Flow leaving filter strips should be a maximum of 0.10 m depth, based on a 10 mm storm event.

Oil and Grit Separators
These systems tend to serve limited drainage areas and provide levels of treatment (less than Enhanced, formerly Level 1). They are typically encouraged as part of a "treatment train" approach. Disadvantages include the need for frequent maintenance, and the ability to serve relatively small drainage areas.

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, municipalities have proposed the contribution of cash-in-lieu of on-site stormwater management, to be directed towards other environmental enhancement projects. These can either be identified in subwatershed planning studies or addressed on a site-specific basis. The priority of application usually relates first to improving watershed conditions in the directly affected watershed. This approach is supported by both Provincial and Municipal policy. That said, due to the requirement to provide stormwater quantity, quality and a balanced water budget, cash-in-lieu is considered not appropriate for the GID.

Provide On-site Stormwater Quality Management for Re-development & Infills
Traditionally, stormwater management for small areas has been designed for each separate development area, as the development applications and engineering submissions are completed for the individual sites. Approved techniques for the provision of on-site stormwater quality control are provided in the Stormwater Management Practices Planning and Design Manual (MOE, 2003). Various techniques for stormwater quality control include:

- Soakaway pits
- Infiltration trenches
- Grassed swales
- Pervious pipe systems
- Pervious catchbasins
- Vegetated filter strips
- Buffer strips
- Oil/Grit separators
- Wet ponds
- Wetlands
- Hybrids wet pond/wetland system

The application of grassed swales or oil/grit separators is generally the most common BMP for smaller size developments (i.e. less than 2 ha) due to reduced land requirements compared to the other alternatives, as well as their applicability regardless of soil conditions (i.e. infiltration technologies require relatively permeable soil conditions). Of these two options, oil/grit separators are commonly used for commercial/industrial applications, where the impervious coverage for the site is relatively high (i.e. greater than 85%) and the site plan is developed such that the maximum developable area is utilized. On-site stormwater management measures will have to consider groundwater protection as per the proposed SWPP, while also considering infiltration to maintain the water balance.

6.2 Stormwater Quality Retrofits

Existing/Planned SWM Facilities

This method of stormwater quality control involves modifying existing stormwater management facilities (quantity or quality control) to provide targeted water quality control. Although this method is primarily intended for existing stormwater facilities, it can also be considered during the planning stages for new quantity facilities, if it is expected that upstream stormwater runoff (i.e. pond outflow) would adversely affect downstream watercourses and habitat through water quality degradation. When possible, retrofitting existing/planned facilities is considered to be a cost-effective approach since land costs (if any) would generally be less than that required for a new facility. Also, the majority of the infrastructure of an existing facility is already in place (headwalls, access paths, berms) and hence would only require modification. A reduction in future maintenance costs could be realized since both quantity and quality control functions have been consolidated into one facility, therefore, the number of facilities requiring maintenance would be reduced.

There are four (4) methods generally considered available for the retrofitting of an existing or planned SWM facility:

i. Construct a permanent pool, or in the case of an existing quality facility, deepen or expand the existing permanent pool
ii. Modify the facility to provide for extended detention storage
iii. Provide longer, extended, flow paths through the facility to promote settling of suspended solids
iv. Provide additional, or enhanced vegetation within the facility to promote nutrient uptake, water polishing, and temperature control (shading)

In determining the feasibility of retrofitting an existing or planned stormwater management facility, a number of factors must be considered:

- Ability to physically enlarge/retrofit a facility. Is land available (i.e. public lands, parks etc.) adjacent to the facility? Is it possible to implement retrofits within the confines of the existing/planned facility?
- No impact to the existing NHS
- Tributary area draining to the facility
- Type of upstream land use

- Facility location versus groundwater resources sensitive to infiltrated contaminated runoff
- Sensitivity of downstream (receiving) watercourses and the need for improved stormwater quality
- Cost-benefit of retrofit. Is maximum benefit being realized from monies spent, or should monies be directed elsewhere to realize greater water quality benefits?

The retrofit design approach would be unique for each existing/planned stormwater management facility under consideration. Whenever possible, designs should work toward the “Water Quality Storage Requirements based on Receiving Waters” (MOE Stormwater Management Planning and Design Manual, 2003). However, given that limitations may exist in providing water quality storage volumes in strict compliance with the SWMP Manual, facilities can still be retrofitted to provide some level of stormwater quality control, as this would likely remain beneficial, subject to an economic review. The “criteria” in such cases when full quality volumes cannot be realized will take the form of runoff volumes expressed in millimetres (mm) of runoff; this would follow the equivalent removal principle.

Existing Storm Outfalls

Existing storm outfalls provide opportunities to implement online treatment of various upstream land uses within the context of new retrofit facilities typically constructed on existing available public lands. Water quality facilities in the form of wetlands, wet ponds or hybrids would provide both permanent pool and extended detention volumes. Possible sites would be evaluated on factors similar to those listed in the foregoing for retrofit of existing/ planned SWM facilities. Candidate sites for providing stormwater quality control at existing storm outfalls are generally evaluated based upon the following additional criteria (in no particular order):

i. Land availability, land use flexibility and ownership
ii. Storm outfall location within the available land
iii. Storm outfall tributary drainage area and respective characteristics
iv. Storm outfall location versus sensitive groundwater resources
v. Potential outlet location with respect to receiving waters
vi. Downstream aquatic resource benefit potential and water quality requirements
vii. Financial resource allotment and potential cost/benefit ratio

6.3 Low Impact Development (LID) Best Management Measures (BMPs)

Low Impact Development represents the application of a suite of BMPs normally related to source and conveyance stormwater 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. General design guidelines and considerations for source and conveyance controls have been advanced since the early 1990’s as part of the MMAH “Making Choices” and in 1994 as part of the Ministry of the Environment’s Best Management Practices Guidelines.

Subsequent to the 1994 MOE Guidelines, technologies and standards have been developed further for the application of source and conveyance controls. These have evolved into a class of Best Management Practices (BMPs) referred to as Low Impact Development (LID) practices, which have advanced as an integrated form of site planning and storm servicing to maintain water balance and providing stormwater quality control for urban developments. Initial results from studies in other settings have demonstrated that LID practices may also provide benefits by way of reducing the erosion potential within receiving watercourses and thereby reducing the total volume of end-of-pipe stormwater erosion control requirements. In addition, due to volumetric controls afforded by LID BMP's, water quality is also improved through a reduction in mass loading. The benefits from LID stormwater management practices are generally focused on the more frequent storm events (e.g. 2 year storm) of 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 practices which promote infiltration or filtration through a granular medium provide thermal mitigation for storm runoff.

Guidelines regarding the application of LID practices and techniques have been developed within various jurisdictions in the United States and Canada. Recently, the Toronto and Region Conservation Authority and Credit Valley Conservation have released the 2010 Low Impact Development Stormwater Management Manual, for the design and application of LID measures. Various LID techniques, as well as their function, are summarized in Table 6.1. While LID includes additional planning to implement and can require changing of urban design standards, the information provided in Table 6.1 specifically addresses those techniques and technologies related to stormwater management practices.

Table 6.1: LID Source And Conveyance Controls

Technique	Function
Bio-retention Cell	► Vegetated technique for filtration of storm runoff ► Stormwater quality control provided through filtration of runoff through soil medium and vegetation ► Infiltration/water balance maintenance and additional erosion control may be achieved if no subdrain provided
Cistern	► Rainwater harvesting technique ► Storm runoff volume reduced through capture/interception of runoff ► Stormwater quality provided for captured runoff ► Effectiveness is contingent upon available volume within cistern
Downspout Disconnection	► Effectiveness dependent upon soils and supplemental conveyance techniques ► Storm runoff volume reduced by promoting infiltration through reducing direct connections of impervious surfaces ► Benefits to stormwater quality control and erosion control are informal.
Grassed Swale	► Vegetated technique to provide stormwater quality control ► Stormwater quality control provided by filtration through vegetated system ► Runoff volume reduction may be achieved by supplementing with soil amendments
Green Roof	► Vegetated technique for reducing storm runoff volume ► Informal stormwater quality control provided through reduction in runoff volume ► No benefits provided by way of infiltration
Infiltration Trench	► Infiltration technique to provide stormwater quality control and maintain water balance ► Erosion controls may be achieved depending upon soil conditions

Table 6.1: LID Source And Conveyance Controls

Technique	Function
Permeable Pavers/Pavement	▸ Infiltration technique to reduce surface runoff volume ▸ Benefits to stormwater quality and erosion control are informal
Rain Barrel	▸ Rainwater harvesting technique ▸ Storm runoff volume reduced through capture/interception of runoff ▸ Stormwater quality provided for captured runoff ▸ Effectiveness is contingent upon available volume within rain barrel
Soil Amendments	▸ Technique for reducing runoff volume through increased depth of topsoil ▸ Stormwater quality control provided through increased soil storage and associated interception of storm runoff ▸ Increases water balance compared to existing conditions when applied in areas with low permeability soils ▸ Possible erosion control benefits
Reduced Lot Grading	▸ Reduction in lot grading increases contact time between storm runoff and vegetation, also increases time of concentration for runoff (some reduction in peak flow rate) ▸ Technique reduces runoff volume and improves on stormwater quality on an informal basis ▸ Additional informal benefits to maintaining water balance and erosion control may be achieved depending upon soil conditions
Pervious Pipes	▸ Technique to reduce storm runoff through the implementation of perforated pipes within storm sewers ▸ Promotion of infiltration maintains water balance and provides stormwater quality and erosion control benefits

6.4 Future Land Use Stormwater Management Assessment

Stormwater management has been assessed for both the proposed development and the existing development should redevelopment occur and retrofits could be considered (ref. Drawing 4). For all development LID BMPs should be considered as a method of meeting the GID stormwater objectives and policies. That being said, the following should be considered when incorporating LID into GID stormwater management servicing.

i. The City of Guelph based on GID OPA 54 policy 11.2.3. 4 will not account for LID on private property when sizing stormwater management facilities, as the City cannot ensure that privately owned LID BMP measures are operating and being maintained as required. Should the City of Guelph in the future implement a stormwater fee, similar to the existing City of Kitchener and City of Mississauga system, then through a fee credit program developers may receive incentives for implementing and maintaining LID on private lands, should the LID BMP measures be designed according to current guidelines such the Toronto and Region Conservation Authority and Credit Valley Conservation 2010 Low Impact Development Stormwater Management Manual.
ii. Drainage from road or parking lots within the GID could be directed to infiltrative LID BMPs, as long as a salt management program is in place and some form of pre-treatment is provided. More specifically the salt management programs should be in line with Source Water Protection Plan policies CG-MC-28 to 31 that require consideration of salt handling, storage, distribution and application.
iii. Green Roofs could be considered in the GID, although GID OPA 54 Policy 11.2.3.2.4 states that "Within the GID, a majority of the available roof area for new development will

be encouraged to be dedicated to roof top solar technologies such as photovoltaic or solar thermal."

iv. The City of Guelph will consider the benefit of LID BMPs within City right-of-ways or property when sizing end-of-pipe stormwater management measures.
v. The City of Guelph will consider end-of-pipe infiltration facilities, without winter drainage bypass systems when a comprehensive salt management program is in place The City of Guelph will require a geotechnical investigation to determine the feasibility of implementing infiltrative BMPs.
vi. The City of Guelph will require as a minimum within the GID, total suspended solids (TSS) removal at 80% Enhanced Level using stormwater management measures.

Drainage areas for the GID future land use scenario have been developed and depicted on Drawing 4. The GID has been sub-divided into areas draining to the Eramosa River, Torrance Creek and Clythe Creek. External drainage areas to each watercourse system have also been determined. Locations of proposed end-of-pipe stormwater management facilities have been determined based on existing topography, future grading, land use and existing stormwater management measures.

The future stormwater management facilities sizing on Drawing 4 has been established based on using approximately 6% of the drainage area for a conventional wet pond design. That said, conventional wetlands could also be considered. To maintain the existing water balance within the GID, the City of Guelph is willing to consider end-of-pipe infiltration facilities instead of wet ponds, and/or LID BMPs within City owned lands. Infiltration facilities typically require 8 to 11% +/- of the drainage area based on existing facilities in other municipalities, which has the negative result of reducing the available land for development. Infiltrative LID BMPs within City owned lands such as road right-of-ways could reduce the end-of-pipe stormwater management facility sizing, but may increase infrastructure capital costs. As such, a high level assessment of capital costs for five (5) stormwater management options, (Option 1) conventional (wet ponds), (Option 2) conventional (wetlands), Option (3) at source and/or conveyance infiltrative LID BMPs (full capture and post to pre scenarios), (Option 4) end-of-pipe infiltration facilities (full capture) and (Option 5) end-of-pipe infiltration facilities with post to pre-development control versus (

The cost assessment has been based on 100 ha of development at 55% impervious coverage, for each stormwater management measure. The 55% impervious coverage has been selected for a medium density residential area for the purpose of illustrating the cost differences between the three (5) stormwater management scenarios.

The MOE's 2003 Stormwater Management Planning and Design Manual, and unitary storage rates for erosion control and the 100 year storm from various AMEC past projects have been used as a guide for sizing each type of stormwater management measure (ref. Appendix 'B').

The LID option volume is based on full capture of a 15 mm storm event from all impervious areas. The conventional wet pond volumetric requirements have been reduced from 250 m^3/imp. ha to 150 m^3/imp. ha for erosion control and 900 m^3/imp. ha to 750 m^3/imp. ha for the 100 year storm based on 15 mm capture from impervious areas through LID BMP measures. Costs for the LID are based on a 4 m wide by 3 m deep stone infiltration trench system (40% void ratio) with 1.2 m cover.

The end-of-pipe infiltration facility (Option 4) is sized based on full capture the difference between post development to pre-development runoff volume for the 100 year storm, with an overflow. For Option 5, the end-of-pie infiltration facility has incorporated a discharge for pre-development flow and infiltration.

Capital costs include land costs at $1,250,000/ha, with the remaining item unitary costs based on recent construction projects costing. No land cost has been designated for the LID BMP, as this would be within City lands, such as a road right-of-way system. Table 6.2 summarizes the cost and land implications for each stormwater management option. Based on the capital costs and land requirements in Table 6.2, Option 3 with the LID and the wet pond facility with post to pre–development control would be the most economical and have the minimum land requirements.

Table 6.2. Comparison of Stormwater Quantity and Quality Management Measures Capital Costs and Land Requirements

Option	Facility Volume (100 Year)[1] (m^3)	LID Volume (m^3)	Capital Cost	Unitary Cost	Land Requirement (ha)
1. Conventional Wet Pond	78,250	N/A	$9,649,800	$123	6
2. Conventional Wetland	69,750	NA	$9.392,300	$139	6
3. LID with Conventional Wet Pond	61,750	8,250	$7,839,322	$112	4
4. End-of-Pipe Infiltration Facility (Full Capture)	33,880	N/A	$10,845,104	$320	8
5. End-of-Pipe Infiltration Facility (Post to Pre-development)	21,533	N/A	$8,075,447	$375	6

1. Includes Permanent Pool

The capital costs within Table 6.2 do not include operation and maintenance (O&M) costs, needless to say, based on current understanding of O&M costs for the five options, Option 3 LID should remain the most economical of options.

6.4.1 West and South of the Eramosa River

The proposed land use west and south of the Eramosa River is a mixture of employment, residential and mixed use corridors. Existing development within this area is limited to the Turf Grass Institute and agri-foresty research. Through discussions with City of Guelph staff, end of pipe stormwater management facilities and Low Impact Development Best Management Measures have been considered appropriate for the proposed land use. Based on the foregoing six (6) stormwater management facilities locations have been determined based on proposed land use and road layout and existing topography (ref. Drawing 4). The proposed conceptual stormwater management facility locations have not been assessed using all City of Guelph requirements including NHS requirements and as such each facility location will have to be further assessed within either Environmental Impact Assessments or Class Environmental Assessments.

Proposed stormwater management facilities that would be located adjacent to the NHS would have to adhere to the minimum NHS buffers and would have to demonstrate that there would be no impact to the NHS.

Proposed stormwater management facilities 1 to 6 would receive drainage from development to be located west and south of the Eramosa River. The existing stormwater management facility No. 104 could be replaced and accounted for within proposed stormwater management facility No. 3.

6.4.2 East and North of the Eramosa River

South of Stone Road the existing residential area along Glenholm Drive will remain an estate style residential area on interim private services (individual wells and septic systems) until full municipal services become available. An employment strip is located along the south side of Stone Road. To address the planned employment development, due to the limited development area and its form, it is proposed that onsite stormwater management be provided (ref. Drawing 4).

East of Watson Parkway the employment land use strip is approximately 3 ha, as such onsite stormwater management is proposed. External drainage from the east should bypass the development to reduce stormwater management requirements. The bypassed drainage would be directed northerly along the eastern development limit to the existing drainage feature that crosses Watson Parkway (ref. Drawing 4).

North of Stone Road and west of Watson Parkway within the major utility and employment lands, two (2) stormwater management facilities Nos. 7 and 9 have been proposed, one discharging to the Eramosa River (stormwater management facility No. 9) with the other one discharging indirectly to Clythe Creek (stormwater management facility No. 7). The existing stormwater management facility No. 96 could be integrated into the proposed stormwater management facility No.7. External drainage from the Watson Parkway and Stone Road intersection should bypass the proposed stormwater management facility No. 7. As both of the proposed stormwater management facilities would be located adjacent to an NHS area, additional assessment of the facilities and locations would be required at the Block Plan stage.

The existing Waste Resource Innovation Centre has three stormwater management facilities providing quantity and quality controls. Should either redevelopment or intensification occur within the City owned lands stormwater management would have to be assessed and development impacts mitigated.

At the west limit of Dunlop Drive, the Cargill (Better Beef) plant drains directly to the Eramosa River through a series of storm sewer outlets (ref. Drawing 4). It is unclear as to the existing level of stormwater controls within the plant. The site is considered privately owned, but there could be potential for storm sewer outfall retrofits to be implemented. Discussions regarding the potential to improve water quality draining from the Cargill site and funding mechanisms should occur between Cargill, the City of Guelph, GRCA and the MOECC.

The York-Watson Industrial Park is located along the east limit of the GID. The Watson Industrial stormwater management facility (Facility No. 38) provides both quantity and quality controls for the industrial area east of Watson Parkway. The stormwater management facility discharges indirectly to Clythe Creek via the Correctional Facility property. Opportunities to improve the water quality from the pond should be investigated. The existing pond does not have permanent pool and a permanent pool/ wetland could be created within part or all of the facility.

The existing development located on the southwest side of the York Road and Watson Parkway intersection is within the service commercial land use area. The two (2) parcel existing development drains indirectly to Clythe Creek. It is uncertain if stormwater quantity and quality controls are exist for the private properties. Both properties drain to existing vegetated areas and/or roadside grass swales which would provide informal stormwater quality management. Should redevelopment or intensification of either property be proposed, stormwater management controls would be required to offset impacts to Clythe Creek.

The Correctional Facility property is proposed to be partially redeveloped with the lands north of the main building recognized as a cultural heritage landscape (ref. Drawing No. 4). The property has several existing drainage features such as the two (2) ponds located either side of the entrance driveway which are fed by a tile drain and surface runoff (ref. Drawings 2, 4). The two ponds drain directly to the south pond in the Royal City Jaycee Park. A third pond is located to the east and it also receives drainage from the tile drain.

To provide stormwater quantity and quality controls for the redevelopment of the Correctional Facility it is proposed that a new stormwater management facility be constructed, Facility No. 8 that could receive drainage from the potential redevelopment area. This facility could be located at the easterly pond site and would require the existing tile drain to be realigned around the facility. This alternative would reduce the facility size as external drainage would not enter the facility. The facility would as a minimum provide stormwater quantity and quality controls for new development within the Correctional Facility property.

here has also been public interest for potentially day lighting and rehabilitating the buried (tiled) drainage system downstream of stormwater management facility No. 38 and connecting the day lighted system to Clythe Creek (ref. Drawing No. 4). Similar to realigning the tile drain around the proposed stormwater management facility, the day lighted watercourse would be routed around the stormwater management facility, to reduce the facility size.

The Province has identified a large cultural heritage landscape area within the Correctional Facility property that is to be protected through the GID Secondary Plan. The proposed stormwater management facility No. 8 would be located within the cultural heritage landscape area. Any proposal to alter any aspect or element within the cultural heritage landscape area will be required to undergo a Cultural Heritage Resource Impact Assessment to assess the proposed development / site alteration and to make recommendations on options that would avoid or minimize negative impact to the cultural heritage resources.

The final location of stormwater management for the Correctional Facility redevelopment would be determined based on consultation with the eventual land owner, the City of Guelph and approval agencies.

Proposed stormwater management facility No. 9 to be located within the employment lands just east of the Eramosa River would be adjacent to a Provincially Significant Area of Natural and Scientific Interest (ANSI) – Earth Science, Significant Valleyland and Cultural Woodland. As such, as per the other proposed stormwater management features located adjacent to a NHS area, an EIS or Class Environmental Assessment would be required to assess the proposed SWM facility in terms of impacts to the adjacent natural heritage features.

The remaining development area within the GID is the southeast corner of Victoria Road and York Road. The area is already developed with a mixture of commercial and employment land uses. Apart from the private stormwater management facility at the PDI Plant at 256 Victoria Road South, no other stormwater management is known for the existing development. The commercial plaza adjacent to PDI drains to the Eramosa River on the west side of Victoria Road via a storm sewer system. The storm sewer outlet to the Eramosa River could be retrofitted with an oil/grit separator to provide a Normal Level of water quality treatment. The same approach could be applied to the storm sewer outlet for the existing Cargill Plant located east of the tracks and south of York Road.

i. Nine (9) end-of-pipe stormwater management facilities are required in GID.
ii. LID BMPs to be implemented within City lands as a minimum, with additional consideration for LID to be implemented with privately held property.
iii. At source stormwater management for select areas of development that cannot feasible drain to an end-of-pipe stormwater management facility.
iv. Retrofit the existing Watson Industrial stormwater management facility #38
v. Potential Retrofit of North and South Ponds as an alternative to proposed stormwater management facility #8.
vi. Removal of existing stormwater management facility #96 located northwest of the Watson Parkway South and Stone Road East to be replaced by proposed stormwater management facility #7
vii. Storm sewer outfall retrofits at Cargill using oil/grit separators.

7.0 CLYTHE CREEK REHABILITATION

Within the Guelph Innovation District opportunities exist to improve the Clythe Creek as recommended within several current studies. The creek has been recommended to be either partially or completely realigned with possibilities of the 20 +/-on-line structures to be removed. Fishery habitat may be improved by riparian plantings along the creek corridor. In addition the potential to take ponds off-line would have to be assessed. This assessment of Clythe Creek would have occur within a separate Class Environmental Assessment, to be integrated with other City projects such as York Road improvements. GRCA has noted that it encourages the rehabilitation of Clythe Creek including opportunities to improve fish passage, fish habitat and the thermal regime.

8.0 STORMWATER MANAGEMENT QUANTITY CONTROL CRITERIA

Criteria for stormwater management controls within the GID are in the process of being established by AMEC in a separate project with the City of Guelph. The intent of the project is to develop hydrologic modelling for the GID area in order to establish stormwater management controls for future development. While this includes both stormwater quality and quantity controls, the main focus of the assessment is upon quantity controls; specifically peak flow targets, and also a water balance\water budget assessment related to infiltration given the high existing infiltration rates in this area and the associated concerns with respect to source water protection.

To date, an existing land use hydrologic model has been developed using PCSWMM. Model development has included the following:

- Background review
- Existing conditions catchment discretization and parameterization (ref. Drawing 2)
- Existing conditions modelled within PCSWMM using City of Guelph design storms and a 50 year continuous meteorological data set (1962 to 2011)
- Future conditions catchment discretization (ref. Drawing 4)

The next steps in developing the GID stormwater management criteria include the following:

- Determine future land use catchment parameterization
- Execute PCSWMM future land use conditions model
- Determine impact (peak flows, water budget) of future land use conditions
- Establish stormwater management criteria using the PCSWMM model, including end-of-pipe facilities and LID BMPs.

9.0 CONCLUSIONS

The following conclusions have been developed:

i. A full background review of the GID drainage features, patterns and existing stormwater management has been conducted.
ii. Stormwater management objectives and policies have been established to mitigate the impacts of the proposed GID development and redevelopment.
iii. GID stormwater management will need to meet all City of Guelph policies including NHS and SWPP policies.
iv. Preliminary locations for stormwater management facilities have been determined.
v. Low Impact Development Best Management Measures will be required to meet the GID water budget objectives and policies.
vi. Assessment of Stand Alone Conventional Wet pond (Option 1), versus Conventional Wetland (Option 2), versus Conventional Wet pond and LID (Option 3), versus an End-of-Pipe Infiltration Facilities (Options 4 and 5), has determined that Option 3 would be the most economical.
vii. Stormwater management criteria will be established for the GID proposed land use using a continuous PCSWMM hydrologic model.

10.0 RECOMMENDATIONS

The following recommendations have been made:

i. Preliminary locations for stormwater management facilities should be assessed within the Block Plan stage, using all relevant City policies and GRCA and provincial requirements.
ii. Discussions regarding the potential to improve water quality draining from the Cargill site and funding mechanisms should occur between Cargill, the City of Guelph, GRCA and the MOECC.
iii. Opportunities to improve the water quality from the existing Watson Industrial stormwater management facility (facility No. 38) should be investigated. The existing facility does not have permanent pool and a permanent pool/ wetland could be created within part or all of the facility.
iv. Initiate discussions with the PID site owner to determine if opportunities exist for improving the site's stormwater management.
v. The City of Guelph should consider assessing the day lighting opportunity for the tile drain system between stormwater management facility No. 38 and connecting the opened watercourse to Clythe Creek.
vi. The City should consider opportunities to rehabilitate Clythe Creek by removing the existing fish barriers and reducing water temperatures from coolwater to coldwater.
vii. The City should consider easements for access, operation and maintenance of privately owned LID BMPs.

11.0 REFERENCES

Chapman, L: J. and D. F. Putman, 1984. The Physiography of Southern Ontario, Ontario Geological Survey.

Respectfully submitted,
Yours truly,

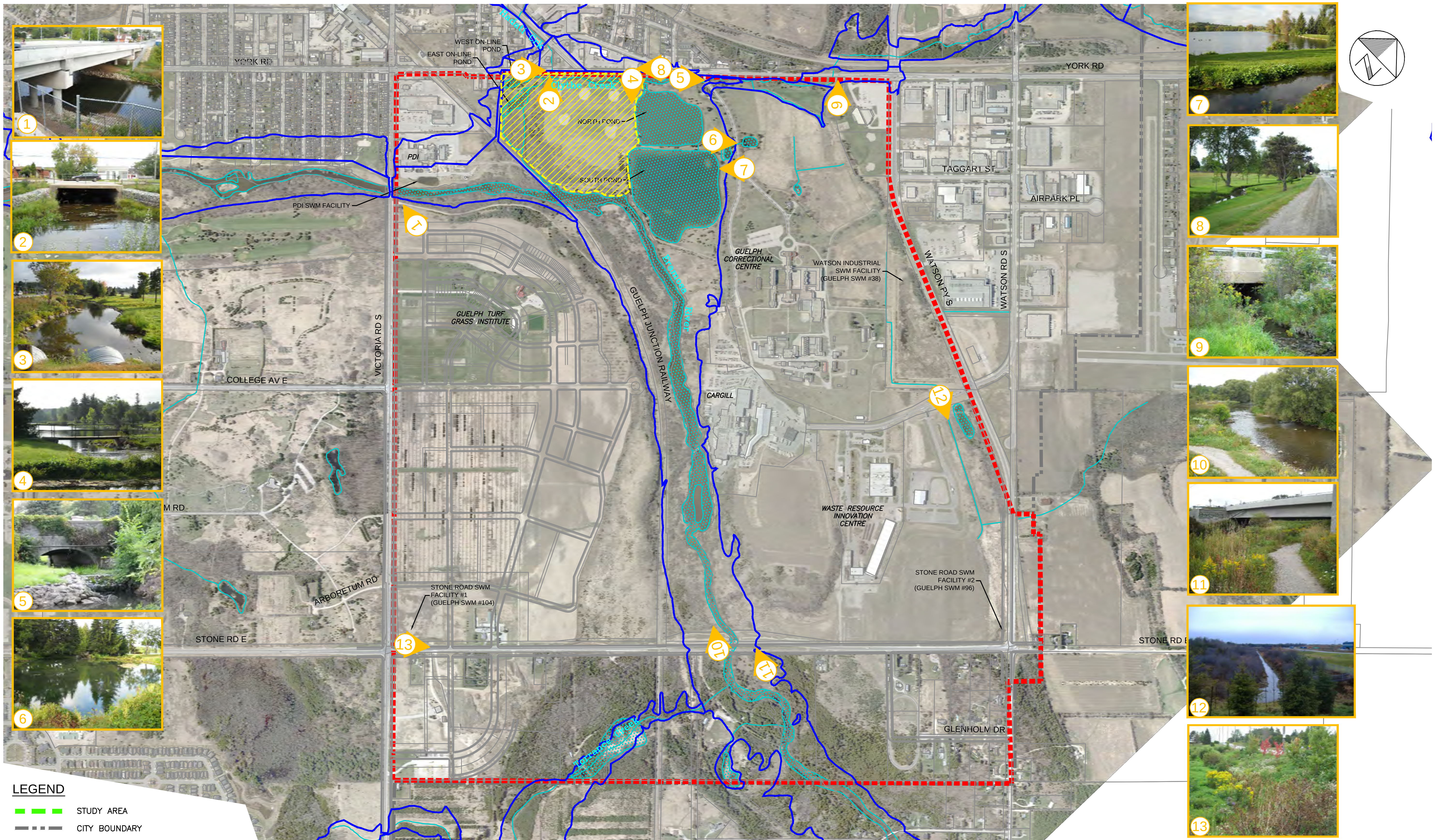
Amec Foster Wheeler Environment & Infrastructure
a Division of Amec Foster Wheeler Americas Limited

Per: Steve Chipps, P.Eng.
Senior Engineer

Per: Matt Senior, M.A.Sc., P.Eng.
Project Engineer

LICENSED PROFESSIONAL ENGINEER
09/30/2015
S. CHIPPS
PROVINCE OF ONTARIO

SC/ll/cc



LEGEND

- STUDY AREA
- CITY BOUNDARY
- SURFACE WATER
- GRCA REGULATORY LIMIT
- SWM FACILITY (EXISTING)
- EXISTING POND OR RIVER
- ROYAL CITY JAYCEES PARK BOUNDARY
- 1 PHOTO LOCATION AND REFERENCE ID

SCALE VALID ONLY FOR 24"x36" VERSION

GUELPH INNOVATION DISTRICT
STORMWATER MANAGEMENT
CRITERIA STUDY
PLANNING ALLIANCE

STUDY AREA, AERIAL PHOTOGRAPHY, SITE RECONNAISSANCE AND EXISTING REGULATORY FLOODPLAIN MAPPING

amec foster wheeler

Scale 1:6000
0 50 100 200

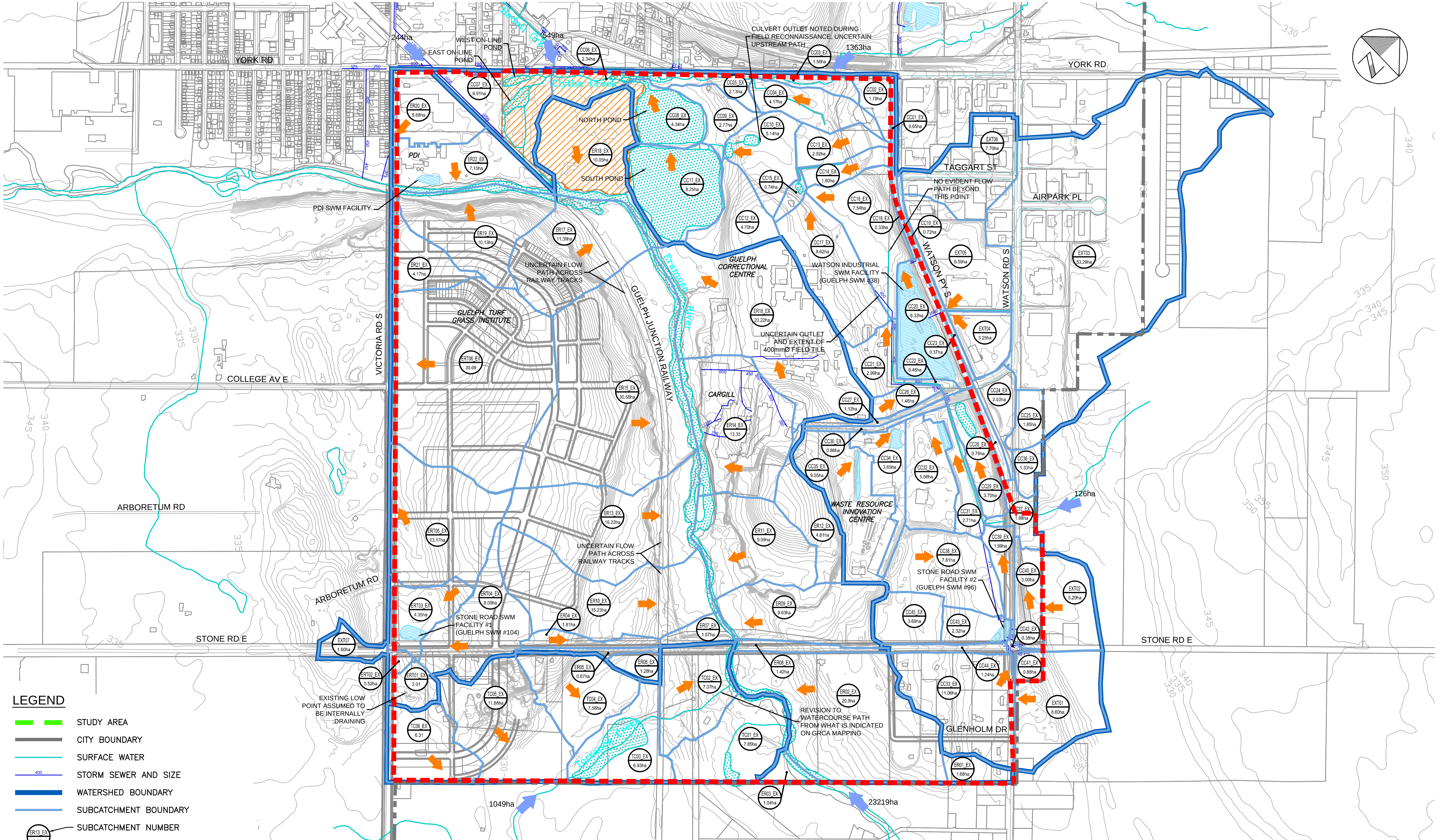
Consultant File No. TP109088

Drawing No. 1

Path: P:\Work\109088\Water\Dwg\15-09\Dwg-1 ExFloodline.dwg

Plotted By: josh.seraj Last Saved By: josh.seraj

Plotted: 2015-09-29 Last Saved: 2015-09-18



LEGEND

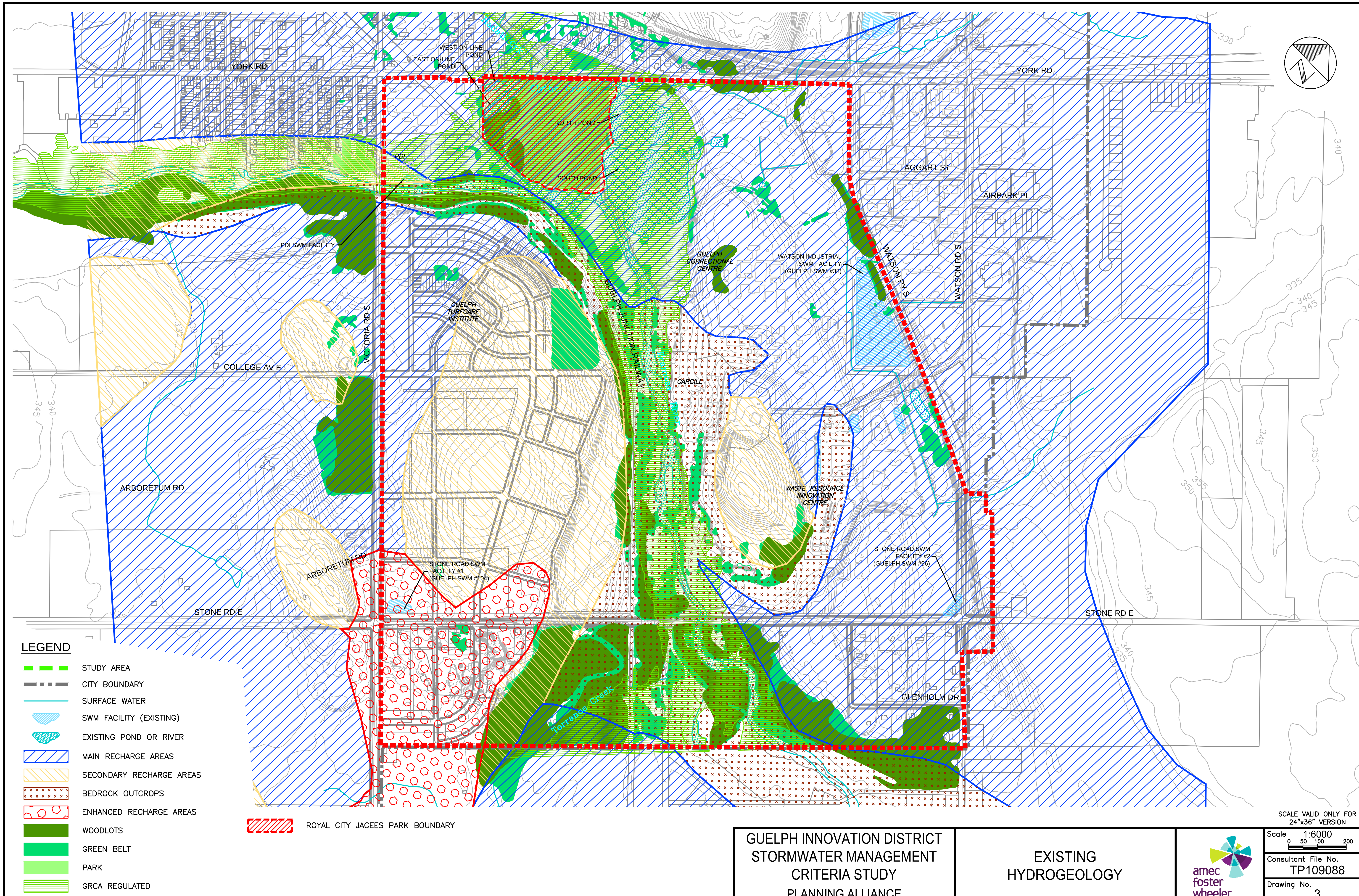
- STUDY AREA
- CITY BOUNDARY
- SURFACE WATER
- STORM SEWER AND SIZE
- WATERSHED BOUNDARY
- SUBCATCHMENT BOUNDARY
- ER13_EX — SUBCATCHMENT NUMBER
- 16.22ha — SUBCATCHMENT AREA (Ha)
- SWM FACILITY (EXISTING)
- EXISTING POND OR RIVER
- DRAINAGE DIRECTION
- EXTERNAL CONTRIBUTING DRAINAGE AREA (NOT MODELED)
- ROYAL CITY JACEES PARK BOUNDARY

Path: P:\Work\109088\Water\Dwg\MAY2015\Dwg-2 ExSubcatchment.dwg

Plotted: 2015-09-29 Plotted By: josh.seraj
Last Saved: 2015-05-01 Last Saved By: josh.seraj

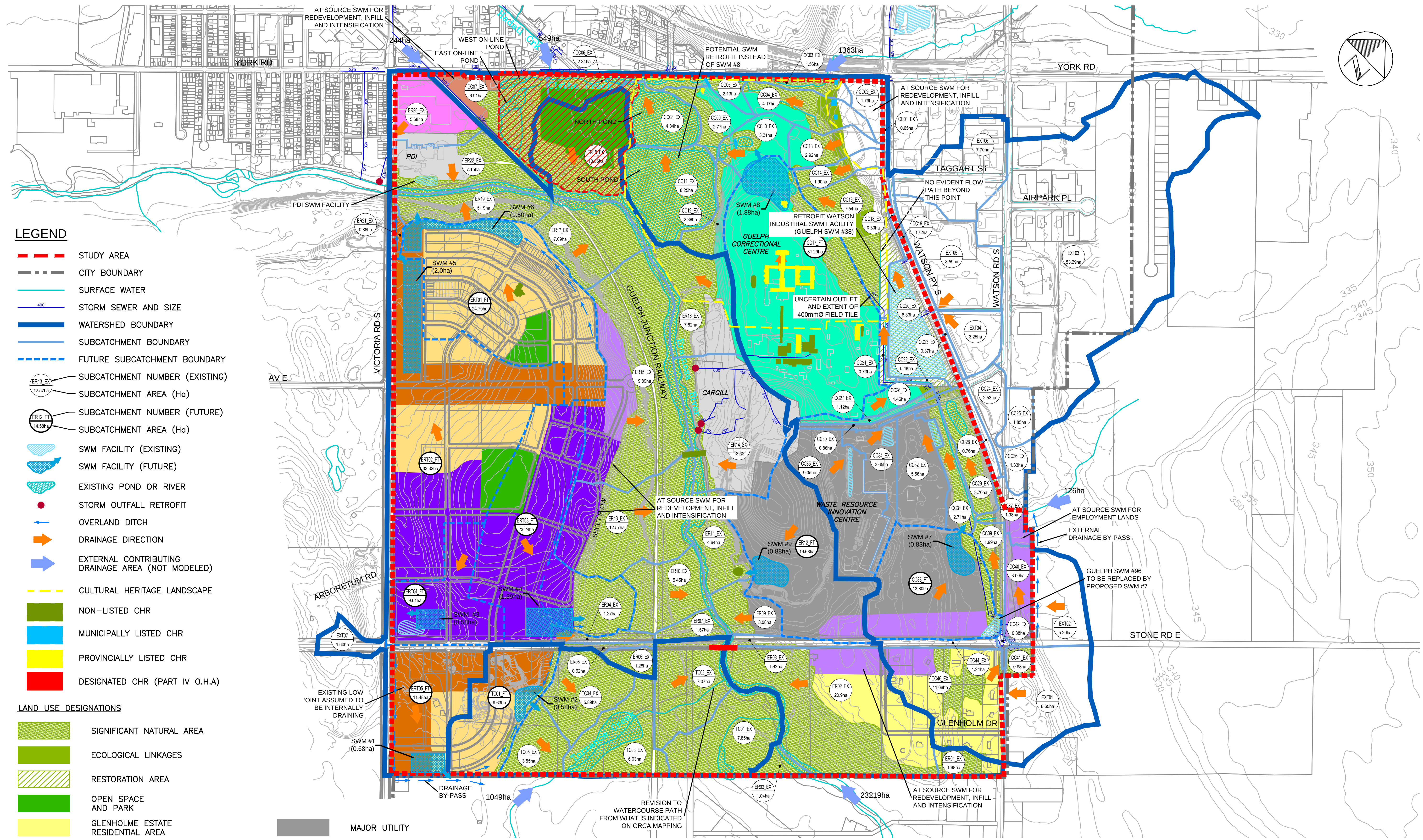
SCALE VALID ONLY FOR 24"x36" VERSION

GUELPH INNOVATION DISTRICT STORMWATER MANAGEMENT CRITERIA STUDY PLANNING ALLIANCE	EXISTING CONDITIONS SUBCATCHMENT BOUNDARY PLAN	amec foster wheeler	Scale 1:6000 (0 50 100 200) Consultant File No. TP109088 Drawing No. 2



Path: P:\Work\109088\Water\Dwg\MAY2015\dwg-3 Floodplain.dwg

Plotted: 2015-09-29 Plotted By: josh.seraj
Last Saved: 2015-05-01 Last Saved By: josh.seraj



GUELPH INNOVATION DISTRICT STORMWATER MANAGEMENT CRITERIA STUDY

PLANNING ALLIANCE

FUTURE SUBCATCHMENT BOUNDARY AND LAND USE PLAN

amec foster wheeler

Scale	1:6000 (0 50 100 200)
Consultant File No.	TP109088
Drawing No.	4

Appendix A

Photo Reconnaissance

Victoria Road over the Eramosa River

Victoria Road over the Eramosa River

Haditi Creek confluence with Clythe Creek

Royal City Jaycees Park driveway over Clythe Creek

Haditi Creek confluence with Clythe Creek

Drop structure on Clythe Creek

Drop structure on Clythe Creek

Clythe Creek upstream of park entance


Pedestrian bridge over Clythe Creek


North and South ponds


York Road drainage outlet to Clythe Creek


North and South ponds

Pedestrian bridge and drop structure in Clythe Creek

Lined reach of Clythe Creek

Lined reach of Clythe Creek

Lined reach of Clythe Creek


Drop structure and driveway to Correctional Facility


Clythe Creek upstream of Correctional Facility entrance


Drop structure on Clythe Creek


Pond east of Correctional Facility driveway

Pond east of Correctional Facility driveway

Correctional Facility bridge over connection between east & west ponds

Unnamed Tributary to north pond in Royal City Jaycees Park

Unnamed Tributary to north pond in Royal City Jaycees Park

Unnamed Tributary to north pond in Royal City Jaycees Park

Clythe Creek next to York Road

York Road drainage outlet to Clythe Creek

Clythe Creek next to York Road

Clythe Creek next to York Road

Clythe Creek next to York Road

Clythe Creek under York Road

Watson Industrial SWM Facility No. 38

Watson Industrial SWM Facility No. 38 entrance to Cargill & Waste Resource Innovation Centre

Stone Road and Watson Parkway SWM Facility No. 96

SWM Facility No. 96 Outlet

Eramosa River at Stone Road

Eramosa River at Stone Road

Old Stone Road crossing of Eramosa River

Victoria Road and Stone Road SWM Facility No. 104

Victoria Road and Stone Road SWM Facility No. 104


Looking east from Correction Facility lands to Watson Parkway


Looking east from Correction Facility lands to Watson Parkway


Looking east from Correction Facility lands to Watson Parkway


Clythe Creek online pond

Bridge over Clythe Creek at Royal City Jaycees Park

Clythe Creek online pond

Channel around SWM Facility No 38

Channel around SWM Facility No 38

Channel adjacent to Watson Parkway south of Dunlop Drive

Dry pond adjacent to Waste Resource Innovation Centre

Appendix B

Stormwater Management Measures Unitary Costing

Assessment of Unitary Stormwater Management Costs

Conventional

Option 1: Wet Pond Stormwater Management Facility

Drainage Area	100	ha		
Impervious Level (Typical)	55	%		
Permanent Pool (MOECC rate)	150	m3/ha	15,000.00	m3 volume
Water Quality and Erosion Unitary Storage (Typical)	250	m3/imp. Ha	13,750.00	m3 volume
100 Year Unitary Storage (Typical)	900	m3/imp. Ha	49,500.00	m3 volume

Permanent Pool	15,000	m^3	Depth	2 m	Elev	200 m	Area	7,500.00	m^2
Extended Detention	13,750	m^3	Depth	1.5 m	Elev	201.5 m	Area	9,166.67	m^2
100 Year Quantity Control (Above Erosion Control)	49,500	m^3	Depth	1 m	Elev	202.5 m	Area	49,500.00	m^2
Regional Control	-	m^3	(could be on top of 100 year control)						
					Add Area around sides for access etc.			60,000.00	m^2

Cost Based on Standard $60/$m^3$	$3,870,000	(for 100 year storm)

Cost Based on Construction Costs (100 Year Storm)

ITEM NO.	ITEM DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	TOTAL
1	Excavation Offsite	m^3	78,250	$20	$1,565,000
2	Dewatering	LS	1	$15,000	$15,000
2	Landscaping	m^2	52,500	$10	$525,000
4	Inlet Structure	LS	1	$15,000	$15,000
5	Outlet Structure	LS	1	$20,000	$20,000
6	Fencing	m	980	$10	$9,800
7	Land Cost	Ha	6	$1,250,000	$7,500,000
				Total	**$9,649,800**
				Unitary Cost	**123 $/$m^3$**
				Area Required	**6.00 ha**

Assessment of Unitary Stormwater Management Costs

Conventional and LID

Option 3: Wet Pond Stormwater Management Facility and LID

Drainage Area	100 ha		LID Capture	15 mm/imp.ha
Impervious Level (Typical)	55 %		(Full site)	8,250.00 volume
Permanent Pool (MOECC rate)	150 m3/ha	15,000.00 m3 volume		150 m3/imp.Ha
Water Quality and Erosion Unitary Storage (Typical)	100 m3/imp. Ha	5,500.00 m3 volume		
100 Year Unitary Storage (Typical)	750 m3/imp. Ha	41,250.00 m3 volume		

Permanent Pool	15,000	m^3	Depth	2 m	Elev	200 m	Area	7,500.00	m^2
Extended Detention	5,500	m^3	Depth	1.5 m	Elev	201.5 m	Area	3,666.67	m^2
100 Year Quantity Control (Above Erosion Control)	41,250	m^3	Depth	1.5 m	Elev	202.24 m	Area	27,500.00	m^2
Regional Control	-	m^3	(could be on top of 100 year control)						
							Add Area around sides for access etc.	40,000.00	m^2

Cost Based on Standard $60/m^3$	$3,375,000	(for 100 year storm)

Cost Based on Construction Costs (100 Year Storm)

ITEM NO.	ITEM DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	TOTAL
1	Excavation Offsite	m^3	61,750	$20	$1,235,000
2	Dewatering	LS	1	$12,500	$12,500
2	Landscaping	m^2	32,500	$10	$325,000
4	Inlet Structure	LS	1	$15,000	$15,000
5	Outlet Structure	LS	1	$20,000	$20,000
6	Fencing	m	800	$10	$8,000
7	Land Cost	Ha	4	$1,250,000	$5,000,000
				Total	**$6,615,500**
				Unitary Cost	**107 $/m^3**

LID Cost

LID Volume 8,250.00 m3

ITEM NO.	ITEM DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	TOTAL
1	Excavation Offsite (Trench)	m^3	8,250	$20	$165,000
2	Excavation Offsite (Above Trench)	m^3	3,300	$20	$66,000
3	Dewatering	LS	1	$5,000	$5,000
4	Underground Stone System (Stone 40% void)	t	49,500	$16	$792,000
5	Filter Cloth	m^2	9,649	$3	$28,947
6	Mainteance Chambers	each	21	$5,000	$105,000
7	Overflow System (200 mm perforated pipe)	m	2,063	$30	$61,875
				Total	**$1,223,822**

length	687.5 m
width	4 m
depth	3 m

Unitary Cost **148 $/m^3**

Total Cost with LID	**$7,839,322**	**Cost without LID**	**$ 9,649,800**	**Cost Difference**	**-$1,810,478 OR -18.8 %**
Unitary Cost	**111.99 $/m^3**	**Unitary Cost**	**123 $/m^3**	**Unitary Cost Diff**	**- 11.33 $/m^3**
SWM Facility Land Requirement	**4 ha**	**SWM Facility Land Requirement**	**6 ha**	**Land Difference**	**-2 ha**

Assessment of Unitary Stormwater Management Costs

Conventional

Option 2: Wetland Stormwater Management Facility

Drainage Area	100	ha		
Impervious Level (Typical)	55	%		
Permanent Pool (MOECC rate)	65	m3/ha	6,500.00	m3 volume
Water Quality and Erosion Unitary Storage (Typical)	250	m3/imp. Ha	13,750.00	m3 volume
100 Year Unitary Storage (Typical)	900	m3/imp. Ha	49,500.00	m3 volume

Permanent Pool	6,500	m^3	(Include Forebay)	Depth	0.4 m	Elev	200 m	Area	16,250.00	m^2
Extended Detention	13,750	m^3		Depth	1.5 m	Elev	201.5 m	Area	9,166.67	m^2
100 Year Quantity Control (Above Erosion Control)	49,500	m^3		Depth	1 m	Elev	202.5 m	Area	49,500.00	m^2
Regional Control	-	m^3		(could be on top of 100 year control)						
								Add Area around sides for access etc.	60,000.00	m^2

Cost Based on Standard $60/m^3 $3,360,000 (for 100 year storm)

Cost Based on Construction Costs (100 Year Storm)

ITEM NO.	ITEM DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	TOTAL
1	Excavation Offsite	m^3	69,750	$20	$1,395,000
2	Dewatering	LS	1	$15,000	$15,000
2	Landscaping	m^2	43,750	$10	$437,500
4	Inlet Structure	LS	1	$15,000	$15,000
5	Outlet Structure	LS	1	$20,000	$20,000
6	Fencing	m	980	$10	$9,800
7	Land Cost	Ha	6	$1,250,000	$7,500,000
				Total	**$9,392,300**
				Unitary Cost	**135 $/m^3**
				Area Required	**6.00 ha**

Assessment of Unitary Stormwater Management Costs

Conventional

Option 4: End of Pipe Infiltration Facility **(Based on 100% infiltration or full capture of all events up to 100 Year Storm Post to Pre-Development with Overflow)**

Drainage Area	100	ha	
100 Year Rainfall Depth	88	mm	
Impervious Runoff Coeff	0.95		
Pervious Runoff Coeff	0.25		
Impervious Level (Typical)	55	%	
100 Year Runoff Volume (Pre-development)	22,000.00	m3	
100 Year Runoff Volume (Post-development)	55,880.00	m3	
100 Year Runoff Volume Difference	33,880.00	m3	
Soils Infiltration Rate	15	mm/hr	
Maximum Facility Depth	0.5	m	
Facility Volume	33,880.00	m3	
Area Required	6.78	ha	(based on vertical area)
Area Required	7.04	ha	(with 5:1 slopes)

Permanent Pool (MOECC rate)	0	m3/ha	-	m3 volume
Water Quality and Erosion Unitary Storage (Typical)	0	m3/imp. Ha	-	m3 volume
100 Year Unitary Storage	616	m3/imp. Ha	33,880.00	m3 volume

Permanent Pool	-	m^3	Depth	0	m	Elev	N/A	m	Area	N/A	m^2
Extended Detention	-	m^3	Depth	0	m	Elev	N/A	m	Area	N/A	m^2
100 Year Quantity Control	33,880	m^3	Depth	0.6	m	Elev	N/A	m	Area	70,363	m^2
Regional Control	-	m^3	(could be on top of 100 year control)								
			Add Area around sides for access etc and for bypass system between forebay and main cell).							80,000	m^2

Cost Based on Standard $60/m^3$ $2,032,800 (for 100 year storm)

Cost Based on Construction Costs (100 Year Storm)

ITEM NO.	ITEM DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	TOTAL
1	Excavation Offsite	m^3	33,880	$20	$677,600
2	Dewatering	LS	1	$15,000	$15,000
2	Landscaping	m^2	10,610	$10	$106,104
4	Inlet Structure	LS	1	$15,000	$15,000
5	Outlet Structure	LS	1	$20,000	$20,000
6	Fencing	m	1140	$10	$11,400
7	Land Cost	Ha	8	$1,250,000	$10,000,000
				Total	**$10,845,104**
				Unitary Cost	**320 $/m^3**
				SWM Facility Land Requirement	**8.00 ha**

33% additional land vs. conventional

Total Cost with LID	**$7,839,322**	**Cost without LID**	**$ 9,649,800**
Unitary Cost	**111.99 $/m^3**	**Unitary Cost**	**123 $/m^3**
SWM Facility Land Requirement	**4 ha**	**SWM Facility Land Requirement**	**6 ha**

Assessment of Unitary Stormwater Management Costs

Conventional

Option 5: End of Pipe Infiltration Facility **(Based on 100% infiltration of all events up to 100 Year Storm Post to Pre-Development with Overflow)**

Drainage Area	100	ha
100 Year Rainfall Depth	88	mm
Impervious Runoff Coeff	0.95	
Pervious Runoff Coeff	0.25	
Impervious Level (Typical)	55	%
100 Year Runoff Volume (Pre-development)	22,000.00	m3
100 Year Runoff Volume (Post-development)	55,880.00	m3
100 Year Runoff Volume Difference	33,880.00	m3
Soils Infiltration Rate	10	mm/hr
Maximum Facility Depth	0.5	m
Facility Volume (Full detention)	33,880.00	m3
Facility Volume (Reduced for post to pre and infiltration)	**21533.0**	m3
Area Required	4.31	ha (based on vertical area)
Area Required	4.51	ha (with 5:1 slopes)

Flow at 24 hours		
Q=CiA/360	Pre 100	Post 100
Q (m3/s)	0.29	1.12
$I = a/(t+b)^c$	4.231	4.231
a	4688	4688
b	17	17
c	0.9624	0.9624
Qave	0.15	0.56

Facility is sized based on Post - Pre volumes, with no account for infilration of discharge. Using 10 mm/hr and 5% of drainage area.
Using 5 mm/hr average (10/2) and 5% of drainage area and 24 hours discharge

Permanent Pool (MOECC rate)	0	m3/ha	-	m3 volume
Water Quality and Erosion Unitary Storage (Typical)	0	m3/imp. Ha	-	m3 volume
100 Year Unitary Storage	616	m3/imp. Ha	33,880.00	m3 volume

Permanent Pool	-	m^3	Depth	0	m	Elev	N/A	m	Area	N/A	m^2
Extended Detention	-	m^3	Depth	0	m	Elev	N/A	m	Area	N/A	m^2
100 Year Quantity Control	21,533	m^3	Depth	0.6	m	Elev	N/A	m	Area	45,141	m^2
Regional Control	-	m^3	(could be on top of 100 year control)								

Add Area around sides for access etc and for bypass system between forebay and main cell). 60,000 m^2

Cost Based on Standard $60/m³ $1,291,983 (for 100 year storm)

Cost Based on Construction Costs (100 Year Storm)

ITEM NO.	ITEM DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	TOTAL
1	Excavation Offsite	m^3	21,533	$20	$430,661
2	Dewatering	LS	1	$15,000	$15,000
2	Landscaping	m^2	8,499	$10	$84,986
4	Inlet Structure	LS	1	$15,000	$15,000
5	Outlet Structure	LS	1	$20,000	$20,000
6	Fencing	m	980	$10	$9,800
7	Land Cost	Ha	6	$1,250,000	$7,500,000
				Total	**$8,075,447**
				Unitary Cost	**375 $/m³**
				SWM Facility Land Requirement	**6.00 ha**

0% additional land vs. conventional

Total Cost with LID	**$7,839,322**	**Cost without LID**	**$ 9,649,800**
Unitary Cost	**111.99 $/m³**	**Unitary Cost**	**123 $/m³**
SWM Facility Land Requirement	**4 ha**	**SWM Facility Land Requirement**	**6 ha**

Summary of Costs and Lands

Option	Faciltiy Volume (100 Year)	LID Volume	Facility Capital Cost	Unitary Cost	Land Requirement
	(m^3)	(m^3)			(ha)
1 Conventional Wet Pond	78,250	N/A	$9,649,800	$123	6
2. Conventional Wetland	69,750	NA	$9,392,300	$135	6
3. LID with Conventional Wet Pond	61,750	8250	$7,839,322	$112	4
4. End-of-Pipe Infiltration Facility	33,880	N/A	$10,845,104	$320	8
4. End-of-Pipe Infiltration Facility	21,533	N/A	$8,075,447	$375	6