Water Quality Improvement Framework

Chedoke Creek Water Quality Study

April 2021

City of Hamilton

1266 South Service Road, Unit C31
Stoney Creek, ON, L8E 5R9
905-643-6688

GMBP Project: 620083

April 26, 2021
Our File: 620083

Christina Cholkan
Project Manager – Water/Wastewater Planning
Public Works
Hamilton Water, City of Hamilton

Re: Chedoke Creek Water Quality Improvement Framework Report

Dear Christina:

We are pleased to submit this Final Project Report for the Chedoke Creek Water Quality Improvement Framework.

If you have any questions or require any additional information, please contact the undersigned.

Yours truly,

GM BLUEPLAN ENGINEERING LIMITED

Per:

Julien Bell, P.Eng.
Infrastructure Planning, Partner

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Infrastructure Planning

Reviewed by:

Chris Hamel, P.Eng.
President

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APPENDICES

EXECUTIVE SUMMARY

The Chedoke Creek watershed is approximately 25 km^2 and is a highly urbanized watershed spanning the western limits of the City of Hamilton including areas south and north of the Niagara Escarpment and ultimately discharging to Cootes Paradise, which flows into the Western Hamilton Harbour and then Lake Ontario. The objective of the Water Quality Improvement Framework Study was to undertake a high-level screening and prioritization of the available options for the Chedoke Creek watershed with the goal of establishing an overall strategy for the watershed's water quality improvement. The framework and prioritization will be used for guidance as the City undertakes subsequent investigations and studies. Due to the limited 5-month project schedule, all analyses and recommendations presented in this Framework are based on the best available information leveraging existing complete studies; no new investigations were completed in support of this study. The completion of additional investigations and/or studies will be needed to address existing data/information gaps and to confirm the scope of major project and/or program recommendations.

As part of this Framework, a wide range of potential options were considered. These potential options explored a range of preventative, mitigative and restorative solutions, and were examined at both a local level along the creek and also within the larger, watershed/City-wide context. The list of potential options was generated based on previously identified solutions, consideration of current industry best practices, and stakeholder engagement and input. The process of developing a framework included a preliminary screening of options with all viable options carried forward for categorization and prioritization. A high-level estimate of the magnitude of contributions from various sources, broken down into 5 groups, was completed to measure the potential effectiveness of various options, as follows:

- **Combined Sewer Overflows (CSOs)** consisting of the combined sewers which can overflow and directly discharge combined sewage into the Chedoke Creek during major storm events.
- **Highway 403** runoff consisting of wash-off and potential spills along the highway.
- **Railway and Railyard** consisting of wash-off and potential spills from the existing railway and railyard.
- **Landfill** consisting of potential leachate infiltration from the Closed West Hamilton Landfill.
- **Urban Stormwater System** consisting of largely untreated stormwater runoff due to minimal stormwater quality management/treatment facilities across the highly urbanized watershed.

Recommendations

The options that were not screened out were considered solutions that potentially meet the project goals and objectives and were further categorized and prioritized into five (5) categories as outlined in the following text and tables.

Near-Term Capital Program

The Near-Term Capital Program consists of projects with a clearly defined scope, do not require extensive study and/or consultation, and can be implemented immediately to address specific concerns. These projects are anticipated to be implemented within the next 3 years.

Near-Term Capital Program Prioritization

Prioritization	Project	Status
0	Highway 403 Trunk Sewer Twinning	Under Planning and Design
1	Rehabilitate existing Highway 403 Culvert (Landfill)	Coordination with MTO
2	Golf Course – Manage Runoff from the Golf Course	Implement Right Away
3	Highway 403 Water Quality Improvements	MTO Led Initiative

Long-Term Capital Program

The Long-Term Capital Program consists of projects that require additional studies or investigations to confirm scope and benefit before being implemented. These projects will likely not be fully implemented in the next 3 years; however, studies to support these long-term projects are either underway or are anticipated to commence within the next 2 years or less. These projects may also be triggered by other City initiatives such as the ongoing Flooding and Drainage Master Plan.

Long-Term Capital Program

Prioritization	Project	Status
1	Aeration System	Dependent on outcomes from Lower Chedoke Combined EA Study
	Constructed Wetland	
	Stream Naturalization	
	Chedoke Creek Targeted Sediment Removal (Underway per MECP Order)	
2	Ainsley Woods Sewer Separation	Dependent on Ainsley Woods Sewer Separation EA Study
3	Inlet Controls in Combined Sewer Areas	Dependent on Flooding and Drainage Master Servicing Study
	Sewer Separation	
4	Golf Course – Stream Naturalization	Dependent on Chedoke Watershed Stormwater Retrofit EA Study
	Golf Course – Retrofit and Treatment Online	
5	Retrofits throughout watershed (End-of-Pipe and Source)	
	Upper Chedoke Creek Stream Naturalization	
6	Expand Storage Elsewhere in System	Dependent on Water/ Wastewater/ Stormwater Master Plan
	Increase Capacity Downstream of Main-King CSO tank	
7	Expand/Fix Leachate Collection System	Collect more data before further recommendations

Near-Term Operations and Maintenance/Program:

The Near-Term Operations and Maintenance/Program consists of the expansion and/or reprioritization of existing programs. There is the potential to provide immediate benefits as these programs and investigations can be implemented within the next 2 years or less.

Near-Term Operations and Maintenance/Program

Prioritization	Project	Status
0	CSO Monitoring Improvements and Active Management	Underway
1	Inspection and Repair – Facilities	Underway / Initiate Inspection
	Inspection and Repair – Trunk Sewers	
2	Cross Connection Program	Prioritize in Chedoke Watershed
3	City Street Management – Enhanced Street Sweeping	Develop and Initiate City Program

Long-Term Operations and Maintenance/Program:

The Long-Term Operations and Maintenance/Program consists of expanding or creating new programs either targeted to the Chedoke Creek watershed or implemented City-wide. There is the potential to provide substantial benefits, but the implementation of these programs will require more time. These programs and investigations may require upfront investigation, policy changes, and new funding and staffing which is not anticipated to be implemented within the next 2 years.

Long-Term Operations and Maintenance/Program

Prioritization	Project	Status
1	Wet Weather Flow in Separated Sewers – Targeted in Chedoke Watershed	Initiate Inflow & Infiltration Monitoring
	Wet Weather Flow in Separated Sewers – Targeted in broader Main-King Catchment	
2	Chedoke Creek Water Quality Program Management and Monitoring	Initiate Now and Continue Long Term
3	City Street Management – Improve snow management within Chedoke Creek Watershed	Enhanced Program
4	Enhanced Salt Management – Highway 403	Enhance Existing Program
	Enhanced Salt Management – City Roads	

Policy and Public Engagement

The Policy and Public Engagement programs involve expanding and creating continued opportunities for engagement to monitor progress and better manage the strategy presented in this framework. These policies and stakeholder engagement will provide long-term benefits as they strengthen over time.

Policy and Public Engagement

Prioritization	Project	Status
1	Engage Residents, Stakeholders, and City	Initiate Now
2	Redevelopment Sites SWM Policy	Develop Policy Now, Implement through Future Projects
3	Retrofits for Road Rehabilitation Projects / LID BMP Policy	Develop Policy Now, Implement through Future Projects
4	LID BMP Policy / Stormwater User Rate	Currently Underway
5	Wet Weather Flow in Separated Sewers – Policy / Future Infrastructure Projects	Develop Policy Now, Implement through Future Projects

Implementation Plan

The Chedoke Creek Water Quality Improvement Framework study seeks to provide an overall framework for the City to adopt to guide its actions in addressing the legacy water quality issues within Chedoke Creek. **Figure ES-1** provides an overview of the program schedule. Further, **Appendix E** provides a breakdown of each recommendation's approximate implementation schedule including general scope, additional studies and fieldwork requirements, estimated timeframe, and budget.

Program Budget

Category	Timeline		
	0-2 Years	3-5 Years	+5 Years
Studies	$3 M	-	-
Projects	$11 M	$23 M	$17 M
Programs	$1 M per year	$1 M per year	$1 M per year
Operations & Maintenance – Potential[(1)]	$0.5 M	$0.5 M	TBD
Study Recommendations - Potential	-	$2 M	>$150 M

[(1)]Costs for potential projects includes the total costs for implementing all proposed projects as part of study recommendations

Stakeholder Engagement and Public Outreach

The recommendations outlined in this Framework represent a diverse set of policies, projects, and programs which will require multi stakeholder input, feedback, and contributions to be successful. As such, it is recommended that a Chedoke Creek Advisory Committee or equivalent be formed with a “working” mandate of:

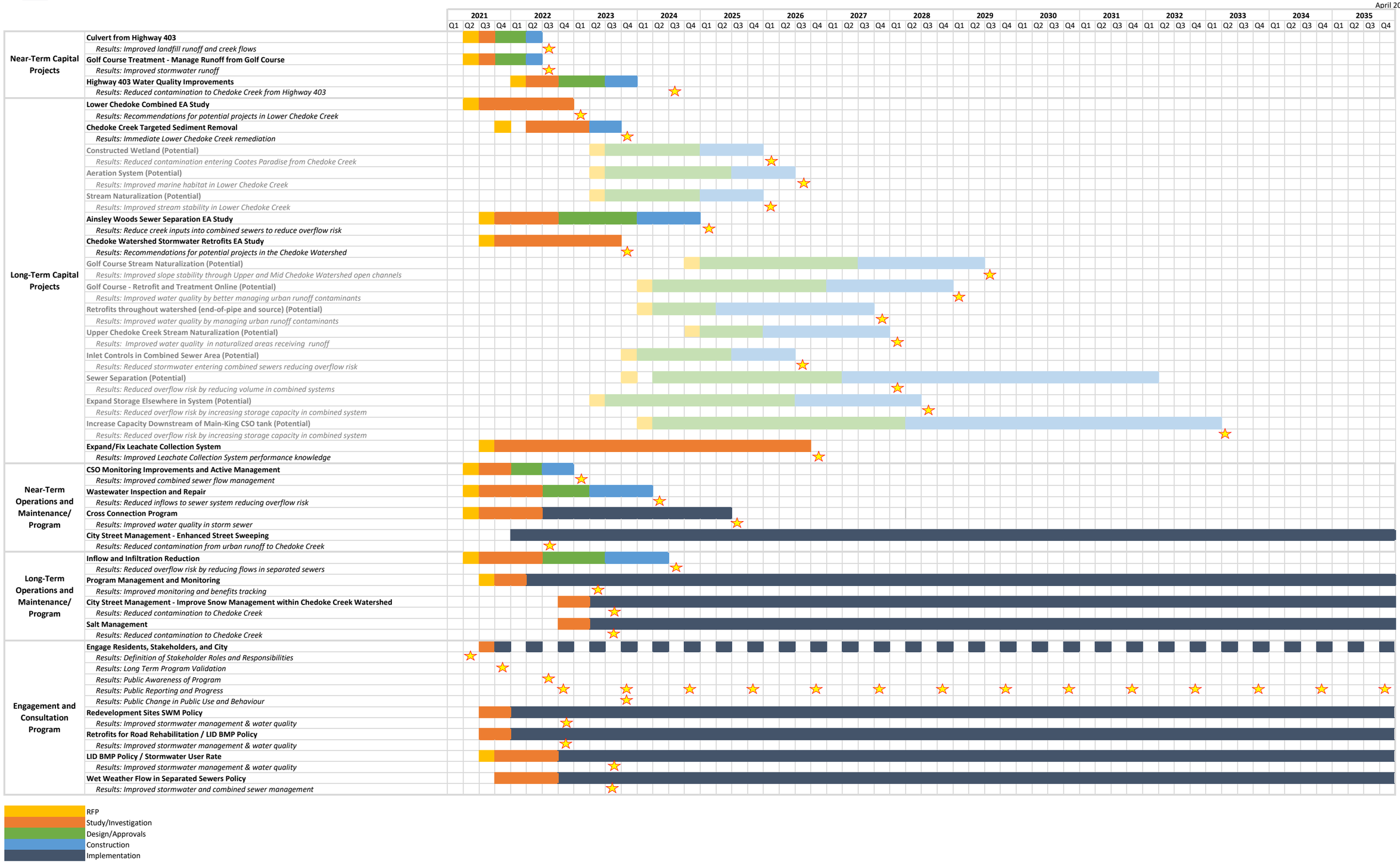
- Confirming the Watershed Management Objectives and establishing the Performance and Monitoring Objectives
- Establishing the Monitoring Program requirements
- Review and comment on proposed Policies and Study Recommendations
- Monitoring the Chedoke Creek Water Quality Framework progress and reporting to Council on a semi-annual basis
- Leading public outreach efforts

Further, it is anticipated that the Chedoke Creek Advisory Committee will serve to streamline public and stakeholder engagement needed to support the implementation of the Framework recommendations.

Monitoring and Management Program

The City will need to establish an appropriate monitoring and management program which will first establish existing baseline conditions, allow for the monitoring of progress overtime, provide additional information to allow for the re-prioritization of recommendations, and ultimately to identify when the Performance and Monitoring Indicators and Measures have been achieved.

Figure ES-1: Program Schedule



1 CHEDOKE CREEK WATERSHED

1.1 Study Introduction

The Chedoke Creek watershed is a significant area spanning the western limits of the City of Hamilton including areas south and north of the Niagara Escarpment and ultimately discharging to Cootes Paradise, then the Western Hamilton Harbour and ultimately Lake Ontario. There have been numerous studies related to the Chedoke Creek watershed over the past few decades, ranging from environmental reviews to infrastructure capacity assessments. Water quality concerns have been identified in the Chedoke Creek, particularly as it relates to Cootes Paradise. Stemming from these concerns, a number of potential solutions have been identified. Following the 2014-2018 discharge event from the Main-King CSO tank, water quality concerns of the Chedoke Creek have been heightened in the broader community.

This study is intended to summarize and consolidate previous and ongoing work, incorporate staff and stakeholder input, and undertake a broad, high level evaluation of potential improvements. Given the wide range of background information, potential solutions, and staff and stakeholder concerns, the Chedoke Creek Water Quality Improvement Study is being undertaken to consolidate this information and bring forward a series of recommendations and an implementation plan to realize the vision for the watershed.

1.2 Chedoke Creek and Watershed Context

The Chedoke Creek watershed is approximately 25 km^2, as depicted in **Figure 1.** With primarily urban uses, the watershed is drained by a highly altered urban watercourse that runs from the west to the north west end of the watershed in the City of Hamilton. The creek collects stormwater runoff from the western part of the Hamilton Mountain, passes over the Niagara Escarpment, and flows through closed pipe and open channels before discharging into Cootes Paradise, at Princess Point. The Chedoke Creek can be divided into three branches; Lower Creek, Mid Creek and Upper Creek. The Upper Chedoke Creek consists of the receiving system which collects runoff from the upper lands south of the Niagara Escarpment. It includes stormwater from primarily urban developments with some local tributaries comprised of natural streams flowing over the Escarpment as waterfalls. Mid Chedoke Creek, north of the Escarpment, consists of an open segment through the Chedoke (Beddoe) Golf Course and then through enclosures and concrete lined systems along Highway 403, conveying stormwater from the Upper Creek and flowing into the Lower Creek. The Lower Chedoke Creek for the purpose of this study, is defined as the segment where the closed pipe system opens up into an open channel north of King Street West. It runs along the west side of Highway 403 and discharges to Cootes Paradise at Princess Point.

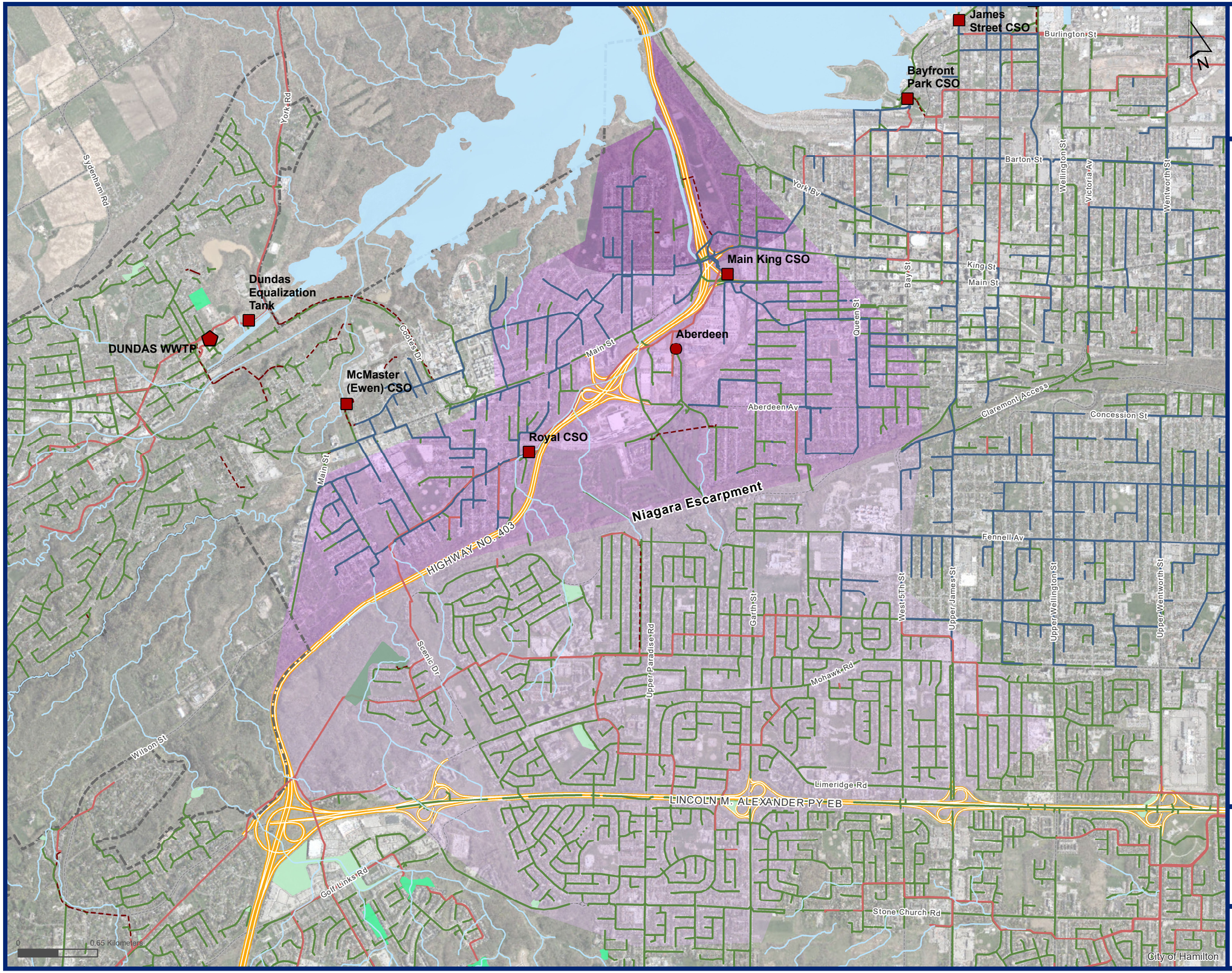
Chedoke Creek is one of the main tributaries entering Cootes Paradise, along with Spencer Creek, Ancaster Creek and Borer's Creek. Cootes Paradise, owned and managed by Royal Botanical Gardens (RBG), is an environmental feature consisting of lake, marsh and wetland features at the western end of Lake Ontario, on the west side of the Hamilton Harbour. Royal Botanical Gardens is a scientific, educational, cultural and tourism institution governed by the Royal Botanical Gardens Act[1]. Cootes Paradise provides an important habitat for fish and is a significant migratory bird stopover. It is also a popular destination for residents, as it provides recreational activities such as paddling in the wetland and hiking in the many walking trails that surround the area.

The Chedoke Creek watershed, depicted in **Figure 2,** is a highly urbanized watershed that has historically applied minimal stormwater management, with most of the development preceding the application of contemporary forms of stormwater management. The watershed consists of residential, industrial and institutional, and commercial land uses. Some of the significant land uses in the watershed include the Kay Drage Park (Closed West Hamilton Landfill located adjacent and to the east of the Lower Chedoke Creek), CPR Aberdeen Rail Yard, Mohawk College, McMaster Innovation Park and the Chedoke Golf Club (located below the escarpment at the transition between the Mid and Lower Chedoke Creek).

[1] Royal Botanical Gardens. (1989). http://www2.hamilton.ca/Hamilton.Portal/Inc/PortalPDFs/ClerkPDFs/Corporate-Administration/2004/Jun23/FCS04019(a)_mem%20of%20understanding%20between%20city%20and%20RBG.pdf

Hamilton

Chedoke Creek Water Quality Improvement Strategy



General Features

- Highways
- Major Roads
- Urban Boundary
- Municipal Boundary
- Waterbody
- Watercourse

Existing Wastewater Infrastructure

- Wastewater Treatment Plants (WWTP)
- CSO Tanks
- Spill Point

Sewermain

- SANITARY
- COMBINED
- STORM
- FORCE

Stormwater Management Facilities

- Dry Pond
- Low Impact Development
- Oil Grit Separator
- Wet Pond
- Wetland

Chedoke Creek Watershed

- Upper Chedoke Creek
- Mid Chedoke Creek
- Lower Chedoke Creek

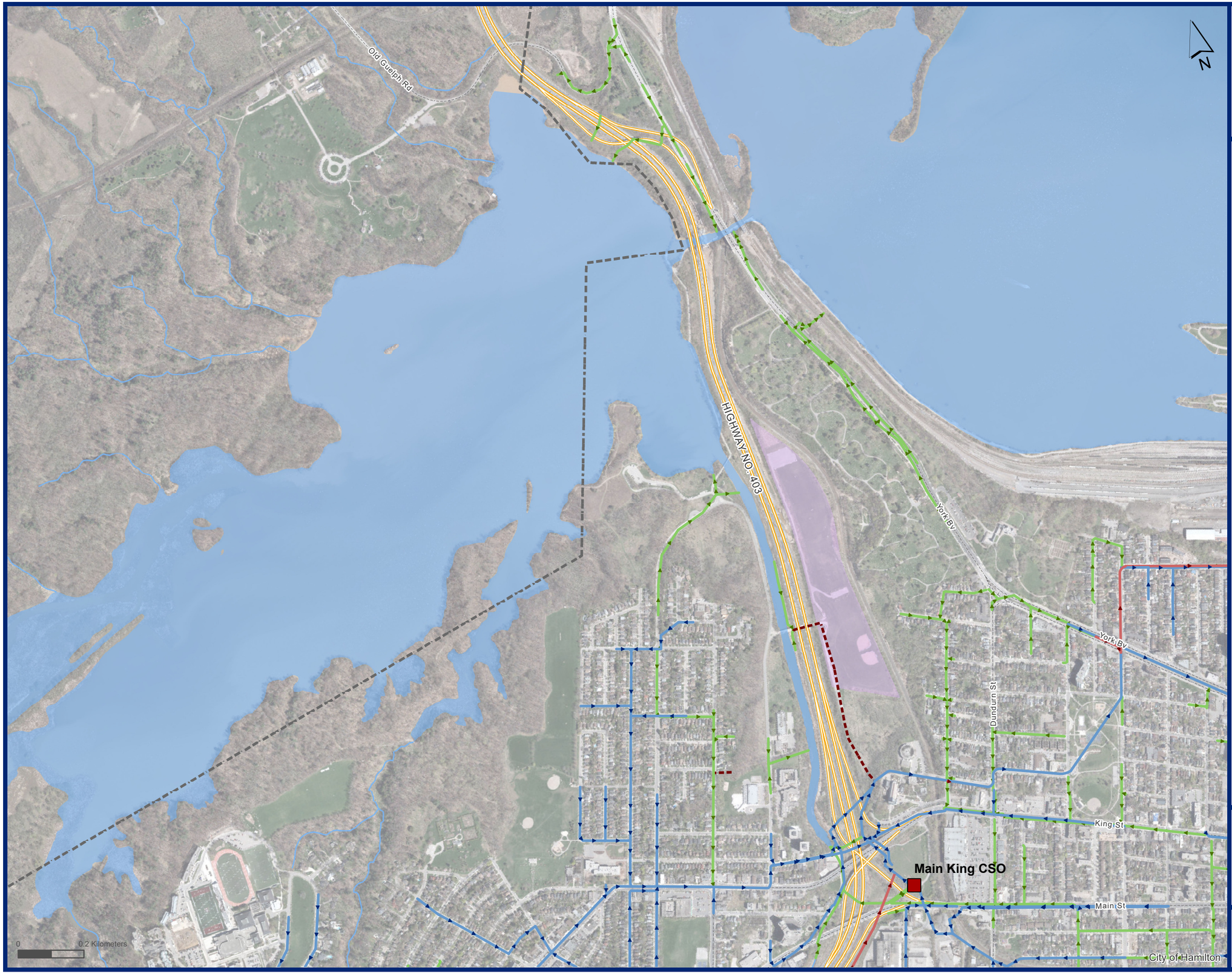
Figure 1
Chedoke Creek Watershed

BluePlan ENGINEERING

April 2021
620083-G-001
NAD 1983 UTM Zone 17N

Hamilton

Chedoke Creek Water Quality Improvement Strategy



General Features

- Highways
- Major Roads
- Urban Boundary
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- Watercourse

Existing Wastewater Infrastructure

- Wastewater Treatment Plants (WWTP)
- CSO Tanks

Sewermain

- SANITARY
- COMBINED
- STORM
- FORCE

Closed West Hamilton Landfill

Figure 2
Chedoke Creek

BluePlan ENGINEERING

January 2021
620083-G-001
NAD 1983 UTM Zone 17N

Within the City of Hamilton and within the Chedoke Creek Watershed, there are two types of sewer systems:

- *Combined sewer systems*: Wastewater and stormwater flows are collected and conveyed within the same sewer system. Under this configuration, during dry weather and smaller volume rain events, stormwater runoff and wastewater are directed toward the City's wastewater treatment plants. During major storm events, surplus stormwater flows within the combined sewer system can cause it to surcharge and then overflow, sending untreated stormwater and wastewater into the creek and lake system.
- *Separated sewer systems*: Wastewater and stormwater flows are collected and conveyed by separate and distinct sewer systems. Wastewater is directed toward the City's wastewater treatment plant and all stormwater is directed to the creek and lake system via a combination of sewers, open channels, and overland flow routes.

Most of the Hamilton Mountain, above the escarpment, (the Upper Chedoke Creek) is serviced by separated sewer systems. In contrast, the lands below the escarpment (Mid and Lower Chedoke Creek), are primarily serviced by combined sewer systems. Combined Sewer Overflow (CSO) tanks have also been built in the watershed to temporarily store surplus sewer flows associated with storm runoff. However, these tanks can also become overwhelmed during large storm events and therefore require combined sewer overflows (CSOs) that discharge directly into the Chedoke Creek. Within the Chedoke Creek watershed, there are three tanks/CSOs/spill points: the Royal CSO tank, the Aberdeen CSO spill point, and the Main-King CSO tank. In addition to the requirements of the Provincial Procedure F-5-5 related to combined sewer overflows, the City is undertaking projects such as the Real Time Control (RTC) Phase 2 project, which supports more stringent objectives related to the control of CSOs to Cootes Paradise. Although RTC Phase 2 is currently in the detailed design stage, the project has established an objective of having no more than one CSO event per year per site, in an average year, for the combined sewer outfalls discharging to Cootes Paradise.

1.3 History and Legacy Issues

Urban buildout within the Chedoke Creek watershed predates modern standards for current contemporary environmental considerations and stormwater management approaches; evidence of this is demonstrated through features such as: the enclosure and channelization of Chedoke Creek at several locations, combined sewers within the Mid and Lower Chedoke Creek, the minimal presence of stormwater management features, and the placement of a landfill and other major transportation corridors adjacent to, and bisecting the natural Chedoke Creek channel and Cootes Paradise.

Due to the legacy infrastructure systems within the Chedoke Creek watershed, the Chedoke Creek experiences significant impacts such as sewage contamination, untreated urban stormwater runoff, and landfill leachate contamination. While these challenges are not uncommon to many legacy systems across Ontario and North America, the legacy water quality issues within Chedoke Creek are of additional interest due to the Creek's location and function within the broader Cootes Paradise and Hamilton Harbour system.

Many recent studies and investigations have been completed to further characterize the existing condition of Chedoke Creek, the performance of local infrastructure, and/or to identify potential short and long-term management solutions to address select legacy issues. These studies and investigations have identified that water quality issues within Chedoke Creek and Cootes Paradise are not the result of any single source but are rather related to multiple contributions from both point and non-point sources throughout the watershed. An overview of the key sources of contamination include:

- Potential leachate infiltration into the Lower Chedoke Creek from the Closed West Hamilton Landfill;
- Wash-off from roads and rails and potential spills along Highway 403 and the railway and railyard;
- Combined sewers throughout much of the Mid and Lower Chedoke Creek, which can overflow and directly discharge combined sewage into the creek during major storm events. Reduction of non-storm (i.e. baseflow) contributions of clean stormwater runoff reaching the creek;
- Low quality stormwater runoff due to minimal stormwater quality management/treatment facilities across the highly urbanized watershed; and,
- Potential sanitary system cross connections from private property entering directly into the stormwater system.

1.4 Recent Discharge Event

On August 2, 2018, the Ministry of Environment, Conservation and Parks (MECP) issued Provincial Officer's Order #1-J25YB (hereinafter referred to as the Order) to the City of Hamilton in relation to the discharge of combined sewage to the environment. The Order required the City to quantify the spill volume and estimate the contaminant loadings associated with the sewage discharged from the Main-King CSO facility to Chedoke Creek between January 28, 2014 and July 18, 2018.

Based on investigative studies completed by consultants on behalf of the City, it was determined that the discharge to the creek was the result of CSO tank outflows. The City staff identified that the CSO tanks outflows were passing through a partially open maintenance by-pass gate in the CSO tank influent well, which occurred in January 2014. Further to this period, sometime in January 2018, a second flow control gate, located outside the CSO tank influent well, failed in the closed position. The failure of this second gate increased the amount of flow diverted towards and under the first gate, thereby increasing the volume of the discharge to the creek. Prior to the second gate failure, based on a review of historical rainfall data, discharge to the creek occurred only during wet weather flow (WWF) conditions, mainly due to rainfall events, or in some cases (in late winter/early spring), due to snowmelt and/or elevated groundwater infiltration entering the contributing sewage collection system. After the second gate failure, discharges to the creek began to also occur during dry weather flow (DWF) conditions.

Based on this information, further studies were completed by engineering and environmental consultants (Hatch and Wood) on behalf of the City, to estimate the overflow amount and to identify the appropriate remedial actions. Hatch estimated the spill volume based on the historical sewage level data collected in the CSO tank wet well by the City's SCADA system. The Total Spill Volume for the period from January 28, 2014 to July 18, 2018 was estimated as 24.0 GL (Giga-Litres), and of this total, 21.1 GL was estimated to have occurred during WWF conditions, and 2.9 GL during DWF conditions. Further, Hatch also estimated Total Contaminant Loadings for selected pollutant parameters. Based on these calculations, Hatch estimated 771 tonnes of Total Suspended Sediments (TSS) during DWF and 1,604 tonnes during WWF, and 13 tonnes of Total Phosphorus during DWF and 34 tonnes during WWF.

Subsequently Wood, on behalf of the City and in response to the Order, conducted scoped short-term studies into the nature and composition of the deposition of contaminants in the Lower Chedoke Creek. From this limited field work conducted over the fall of 2018, Wood concluded that removal of the contamination through hydraulic dredging would be preferred, however it was recommended that a more comprehensive study be conducted into the preferred means of removal, using a Class EA process which would inherently involve broader consultation with agencies, stakeholder and the public, including Indigenous engagement.

Thereafter, the City retained the services of SLR Consulting (SLR) to collect additional field data, conduct a peer review of the earlier work by Hatch and Wood, and undertake a risk assessment with respect to the preliminary recommendations cited earlier. SLR subsequently concluded that an approach of natural recovery ("do nothing" approach) would be preferred given the results of the Ecological Risk Assessment for Chedoke Creek and the Environmental Assessment for Cootes Paradise which were conducted under a further MECP Director's Order issued November 2019.

In November/December 2020, MECP issued follow-up Orders to the City of Hamilton to develop plans for "targeted" dredging of the Lower Chedoke Creek and remediation of Cootes Paradise and the West Harbour. The City is currently in the process of working with MECP to develop these plans accordingly.

While the discharge event described in the foregoing has heightened community awareness of the importance of well-functioning municipal infrastructure and the potential for environmental impacts, it should be clear that the current study is not a direct result of the discharge event only, since work by the City of Hamilton has been on-going for many years prior to, and since the subject event.

2 STUDY OBJECTIVES

2.1 Project Trigger and Objectives

The Chedoke Water Quality Improvement Framework Study is being undertaken to consolidate existing information and bring forward a series of recommendations to develop a strategy framework that outlines an implementation plan to address water quality improvements.

The main purpose of this study is to assemble the legacy work that has been completed and examine this information as a broader system, while reviewing all of the solutions that have been previously considered and/or recommended. The approach has involved assessing the watershed, and specifically non-point sources, point sources and the Creek, to identify the preferred potential solutions for the Chedoke Creek and watershed.

The key objectives of the Water Quality Improvement Framework Study are as follows:

- Complete a holistic review of legacy issues within the Chedoke Watershed to identify the potential and likely contaminant sources, and the relative magnitude of their contributions;
- Explore and identify a range of potential preventative (to prevent something from occurring), mitigative (to make something less severe), and restorative (to restore to a past and more natural state) solutions to help address the legacy issues;
- Identify a preliminary set of management objectives to help guide future infrastructure and policy decisions;
- Engage in Stakeholder Consultation to ensure a comprehensive and common understanding of needs and set the foundation for future consultation and implementation;
- Review the range of potential solutions and provide recommendations for preferred potential solutions; and,
- Develop an Implementation Framework to support the future implementation of management solutions and tracking of progress.

2.2 Overview of Framework Structure

Throughout the development of the Chedoke Creek Water Quality Improvement Framework, it was determined that the preferred approach, as it relates to Chedoke Creek, was to undertake a high-level (less detailed) screening and prioritization of the available options with the goal of establishing an overall strategy for the watershed's water quality improvement. This high-level assessment and evaluation were then used to establish the Framework. The resultant framework and prioritization will then be used for guidance as the City undertakes subsequent investigations and studies to strengthen the understanding of the condition and performance of existing infrastructure (natural and built), develop and confirm the desired project objectives, refine programs, and confirm upgrade needs and/or priority projects. The implementation plan presented in **Section 6** provides a "roadmap" for the specific studies and associated fieldwork required to fill data/information gaps and thereby lead to specific project outcomes.

2.3 Project Limitations

All analyses and recommendations presented in this Water Quality Improvement Framework ("Framework") are based on the best available information leveraging existing complete studies; no new investigations were completed in support of this study. While some additional desktop review of existing reports assessment of solutions was completed, this work was completed at a high-level to assess the relative conditions and the magnitude of contributions and potential effectiveness of various solutions, with the objective of prioritizing potential recommendations; these scoped analyses should not be used as the basis of technical requirements within the subsequent implementation of the Framework. Additional investigations and/or studies will be needed to address existing data/information gaps and to confirm the scope of major project and/or program recommendations.

Due to the limited 5-month project schedule and ongoing COVID-19 protocols, Stakeholder Consultation was limited to predefined stakeholder groups and governmental agencies, with all workshops held virtually. Expanded stakeholder and public consultation, including engagement of Indigenous Nations and Peoples, will be required prior to the implementation of some Framework recommendations.

2.3.1 Studies/Documentation

Appendix A provides a detailed summary of the related studies and background information, as provided to the project team throughout the timeframe of the study, that were reviewed and considered during the development of the Water Quality Improvement Framework.

2.4 Study Consultation

The stakeholder consultation conducted as part of the Framework development, represents the start of an ongoing and collaborative process which will be essential to the successful implementation of the projects considered supportive of the identified Management Objectives.

Through the development of the Framework the following external stakeholders were consulted:

- Bay Area Restoration Council (BARC)
- Conservation Halton (CH)
- Environment Hamilton (EH)
- Hamilton Conservation Authority (HCA)
- Hamilton Harbour Remedial Action Plan (HHRAP)
- MT Planners – involved in the RBG 25-Year Master Plan
- Ontario Ministry of Transportation (MTO)
- Royal Botanical Gardens (RBG) (Cootes Paradise landowner)

Internal City departments were also consulted throughout the project to provide input and help guide the development of the framework.

Appendix B provides an overview of the stakeholder consultation workshops and feedback.

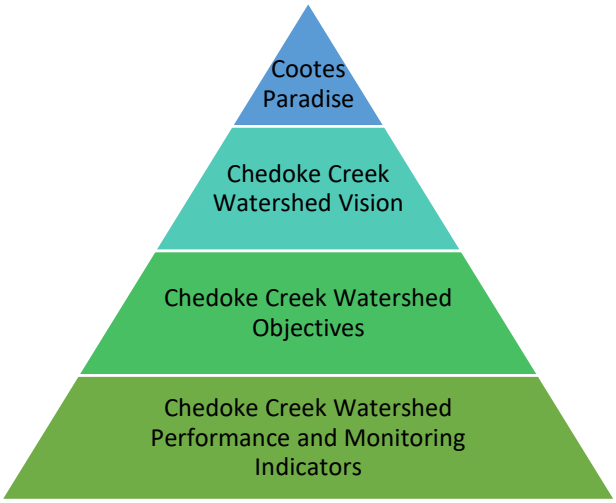
3 CHEDOKE CREEK WATERSHED MANAGEMENT OBJECTIVES

The development and adoption of clear, achievable, and measurable objectives are essential to allow for the proper planning, design, implementation, and monitoring of Water Quality Improvements for the Chedoke Creek. In the absence of objectives, the City and stakeholders are ultimately unable to appropriately define specific needs, prioritize resources, monitor progress, or develop a common consensus.

The Framework seeks to establish the context of the Chedoke Creek Watershed Management objectives in terms of the City's and stakeholders' Global Vision for Chedoke Creek. It also aims to identify appropriate performance indicators to monitor the progress of the strategy through its implementation in the future.

The Framework classifies the objectives in three main categories which are summarized below and outlined in the figure to the right.

- **Watershed Vision (Why):** The Chedoke Creek Watershed Vision represent the "The Goal" of the water quality improvement to the community in broad qualitative description objectives that can be easily interpreted.
- **Chedoke Creek Watershed Objectives (What):** The Objectives represent qualitative measures that help to realize the Watershed Vision.
- **Chedoke Creek Watershed Performance and Monitoring Indicators (How):** The Indicators represent the measures that are used to support the technical evaluation of alternatives, guide the design of infrastructure, and thereby used to measure improvements over time.



The Framework identifies a recommended Chedoke Creek Watershed Vision and Objectives; however, these will ultimately need to be confirmed and endorsed by the City and respective stakeholders and public. Further, the Framework identifies potential Performance and Monitoring Indicators; however, due to the limited scope of this study, no quantitative values have been provided. Following adoption of the project Vision and Objectives, the City and respective stakeholders will need to establish the quantitative aspects Performance and Monitoring Indicators.

3.1 Cootes Paradise and Hamilton Harbour Vision

Similar to Chedoke Creek, there have been ongoing water quality improvement initiatives for both Cootes Paradise and the Hamilton Harbour. One such initiative is "Project Paradise", initiated by RBG and the Hamilton Harbour Remedial Action Plan (HHRAP). Project Paradise includes rehabilitation efforts being undertaken by RBG and its partners to restore the ecosystem and aquatic habitats in Cootes Paradise, as Cootes Paradise represents ~90% of the fish and wildlife habitat of the HHRAP. The HHRAP is a Federal initiative planned to improve water quality and habitat in the Hamilton Harbour, its watershed, and Cootes Paradise. The HHRAP identifies types of pollution entering the harbour, how that pollution will be cleaned up, and who is responsible for the cleanup.

The Ontario Provincial Government has designated Cootes Paradise as a Provincially Significant Class 1 Wetland and an Area of Natural and Scientific Interest (ANSI). It is designated as a National Historic site, a Nationally Important Bird Area (IBA),and a Nationally Important Reptile and Amphibian Area (IMPARA).[2]

[2] City of Hamilton. https://www.hamilton.ca/city-initiatives/our-harbour/cootes-paradise-marsh

The long-term vision for Cootes Paradise as perceived by these efforts and consultation with RBG can be described as:

Fully restored and enhanced Cootes Paradise environment

The Cootes Paradise Vision is supported by multiple initiatives such as the HHRAP, as outlined earlier.

3.2 Chedoke Creek Watershed Vision

As outlined in **Section 1.2**, Chedoke Creek is one of the main tributaries entering Cootes Paradise, along with Spencer Creek, Ancaster Creek and Borer's Creek. As presented in the high-level figure below, Chedoke Creek is only one of the several sources contributing nutrient loads to Cootes Paradise. Solely addressing/managing the Chedoke Creek water quality issues will not achieve the overall Cootes Paradise Vision. **Figure 3**, which is intended to be illustrative rather than absolute, shows an example of average year Total Phosphorus nutrient loading to Cootes Paradise, following the methodology presented in **Appendix C**.

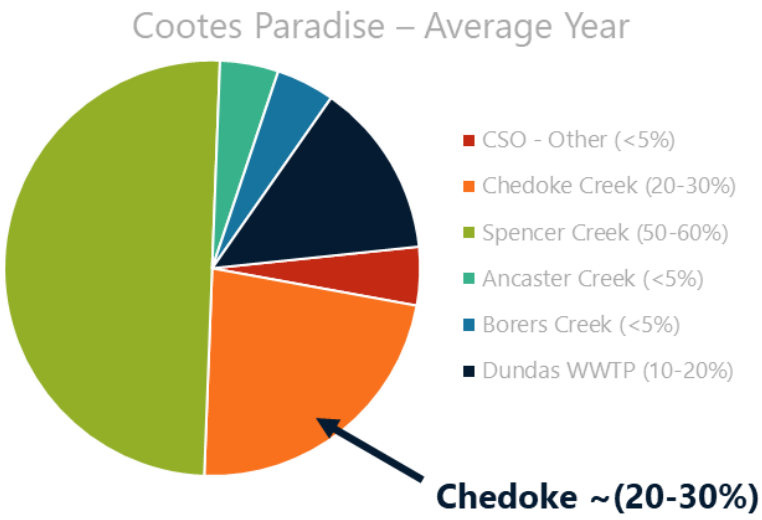


Figure 3: Cootes Paradise Average Year Total Phosphorus Loading

The Chedoke Creek Watershed Vision has been developed to support the Cootes Paradise Vision as improvements in the Chedoke Creek Watershed will directly benefit Cootes Paradise. This Vision is supported by achievable objectives and considers the following:

1. The existing status of the watershed; this includes the existing built environment consisting of a highly urbanized watershed and its legacy systems, consisting of combined sewers throughout most of the lower watershed.
2. Other competing priorities within the Chedoke Creek watershed; this includes ongoing community use and urban growth, transportation needs, etc.
3. Recognition of the significance of Chedoke Creek runoff contribution in the context of the Cootes Paradise system.

The vision for the Chedoke Creek Watershed can be described as:

Improve Chedoke Creek Watershed Water Quality to support:

- *Enhanced wildlife activity and habitat*
- *Safer Recreational Contact*

This is the initial vision for future consideration as a benchmark for improvement. The Framework outlined further in this report, sets a structure for implementation of those recommended actions to achieve the Chedoke Creek Watershed Vision. It is important to note that this study represents the first step in the overall implementation plan that can be further refined through consultation with stakeholders and the City in subsequent steps.

3.3 Chedoke Creek Watershed Management Objectives

Objectives are a qualitative measure intended to support and realize the project vision. These objectives are used to set targets, assess beneficial impacts, and support prioritization. The objectives need to be achievable and supported by stakeholders and by data, and should have the following characteristics:

- Technically feasible
- Align with City, and Stakeholder visions
- Financially feasible
- Implementable timeline
- Complementary to other needs and priorities

For the purposes of the Framework, in consultation with the project stakeholders, the following Chedoke Creek Watershed Objectives have been identified in support of the Chedoke Creek Watershed Vision outlined in **Section 3.2**. The objectives are listed in no particular order of importance:

- Limit sources of high nutrient load to Chedoke Creek to prevent excess nutrient and limit algae blooms
- Limit sources of contaminants to Chedoke Creek
- Eliminate sanitary sewer cross-connections to the stormwater system (in separated sewer systems)
- Minimize the risk of CSO spills to Chedoke Creek including:
    - Reduce the frequency and volume of overflow events
    - Enhanced monitoring and management, to reduce the likelihood of, and reduce the response times to, spill events resulting from infrastructure failures
- Seek opportunities to enhance and naturalize Chedoke Creek

This Framework helps identify the overall objectives but through future and ongoing studies, consultation, and discussions, some of these objectives may be refined and/or new objectives may be added or removed.

3.4 Performance and Monitoring Indicators

Once the Chedoke Creek Watershed Management Objectives have been established in accordance with the agreed vision, suitable targets and performance and monitoring indicators provide a way to measure progress over time and determine if the management objectives are being achieved. Due to the limited scope of this current study, no quantitative targets or indicators have been established. However, a preliminary qualitative list of potential Performance and Monitoring Indicators, that the City and Stakeholders may wish to consider, is provided as follows:

- Water Quality concentrations in annual, peak and low flow events
- Number of annual overflow events
- Percent of contributions from CSO
- Percent of urban runoff receiving treatment
- Percent of leachate captured at the Landfill
- Percent of the creek that is naturalized

Following the adoption of the project Vision and Objectives, the City and respective stakeholders will need to identify the Targets and Performance and Monitoring Indicators that will be used to track progress. Additional studies, assessment, and consultation will be needed to establish these Targets and Performance and Monitoring Indicators. This may be in the form of an annual report, where both technical and non-technical elements are highlighted.

Note, in the context of this study, identification of specific Performance and Monitoring Indicators will not change how various solutions/options are evaluated or prioritized; however, their establishment will be critical to future monitoring of the beneficial impact of projects over time.

4 SOLUTION OPTIONS AND EVALUATIONS

As part of this Water Quality Improvement Framework, a wide range of potential options was considered to address one or multiple of the identified Management Objectives. These potential options explored a range of preventative, mitigative and restorative solutions, and were examined at both a local level along the creek and also within the larger, watershed/City-wide context. The list of potential options was generated based on previously identified solutions, consideration of current industry best practices, and stakeholder engagement and input.

4.1 Screening and Prioritization Methodology

The screening and prioritization of options, with the ultimate goal of shaping an implementation plan and framework for the Water Quality Improvement Framework, generally followed the approach outlined below.

1. **Screening of Options**: A preliminary screening process for the options was developed and undertaken to determine which options should be carried forward, screened out, or will require further investigations/studies. The overall advantages and disadvantages of the options were reviewed to define which options would be screened out versus those that would be carried forward.

   The screening process considered the following:

   - Potential Cost
   - Potential Benefit
   - Technical or Implementation Challenges
   - “No-Regrets” Principles
   - Nutrient Loading Impact (See **Section 4.2**)

   The options that were carried forward, or required further investigations/studies, were then further refined through the categorization and prioritization process.

2. **Prioritization and Categorization of Options:** The next step in determining the preferred framework was to prioritize those options carried forward. This process further refined the advantages and disadvantages, based on the prioritization category. The basis of this approach was to qualitatively evaluate the relative advantages, disadvantages, and potential impacts of each option against the established criteria. The options were generally prioritized based on the following criteria in **Table 1**. Visibility is defined as a project that the City presents to the public as an example of an action being undertaken with the intent of building and/or expanding upon the stakeholder and public dialogue, engagement, and education.

Table 1: Prioritization Criteria

	High	Medium	Low
Cost	<$10 M	$10-$50 M	>$50 M
Timing	Short-Term (<5 Years)	Near-Term (5-10 Years)	Long-Term (>10 Years)
Implementation	Easy	Moderate	Difficult
Visibility	High	Medium	Low

- “High” options generate beneficial impacts; these are depicted in green
- “Medium” options present a mix of positive and negative elements with some impacts; these are depicted in yellow
- “Low” options present negative impacts and/or presents significant technical challenges; these are depicted in red

In addition to the prioritization criteria listed in **Table 1**, the following factors were also considered to aid in the screening and prioritization of options:

1. Functional Effectiveness (Nutrient Loading and Water Quality Improvement)
2. Project Benefit Type: Preventative, Mitigative, Restorative
3. Project Benefit Spatial Extent: Watershed, Upper Chedoke Creek Watershed, Lower Chedoke Creek Watershed, Cootes Paradise
4. Infrastructure Ownership

4.2 Nutrient Loading Methodology

As determined at the outset of this project, multiple concerns were identified for the Chedoke Creek's water quality including:

- High Nutrient Loading
- E-Coli and Solids
- Metals, VOC/Oils, Salts, and other Contaminants

High nutrient loadings have been cited as the most significant concern for many of the stakeholders, as it can lead to algae blooms and other highly visible impacts. To support the screening process, an initial high-level estimate of nutrient loadings was completed based on the best available background data and used as a measure of relative (not absolute) impacts. As nutrient loading is a major concern and historic sampling data are available, success can relatively be measured.

Total Phosphorus, Ammonia + Ammonium as N, and Total Suspended Solids were used as high-level indicators and the predominant screener of the relative contributions from various sources based on the background information available at the time of this scoped study. These nutrient loadings were used as proxies for other major concerns, with the perspective that addressing these nutrient loadings can provide relief and mirrored benefits in terms of other nutrients, metals, oils and salts. The methodology used for this high-level nutrient loading review is outlined in detail in **Appendix C**. This high-level approach was followed for this scoped study to show a relative comparison; however, future studies should include a more stringent and comprehensive review.

4.3 Source Contribution Assessment

Using the Chedoke Creek nutrient loading assessment as a high-level estimate of contaminants, a source contribution assessment was completed to provide guidance in identifying the primary contributors and to assess the potential benefits of addressing specific sources of contaminants. The source contributions were broken down into 5 groups as follows:

- **Combined Sewer Overflows (CSOs)** consisting of the combined sewers throughout much of the Mid and Lower Chedoke Creek, which can overflow and directly discharge combined sewage into the creek during major storm events. Reduction of non-storm contributions of clean stormwater runoff reaching the creek.
- **Highway 403** consisting of wash-off and potential spills along Highway 403.
- **Railway and Railyard** consisting of wash-off and potential spills from the existing railway and railyard.
- **Landfill** consisting of potential leachate infiltration into the Lower Chedoke Creek from the Closed West Hamilton Landfill.
- **Urban Stormwater System** consisting of largely untreated stormwater runoff due to minimal stormwater quality management/treatment facilities across the highly urbanized watershed; and, the potential sanitary system cross connections from private property entering directly into the stormwater system.

Figures 4 and **5** provide an overview of the Average Year and Peak Day Phosphorous contribution to Chedoke Creek, which is representative of the relative impacts of the 5 groups cited. A detailed breakdown of the source contributions is included in **Appendix C**.

The finding of the source contributions assessment indicates that:

- Over the balance of the year, stormwater runoff represents the major source of potential contaminants to Chedoke Creek. Further, during peak loading events, stormwater runoff remains a significant source of potential contaminants. As such, the prioritization of solutions that address stormwater quality will be critical to meeting the Management Objectives.
- During peak loading events, CSOs represent a significant source of potential contaminants. As such, prioritization of solutions that reduce the magnitude and frequency of CSO will be equally critical to meeting the Management Objectives.
- The remaining source contributions represent a comparatively smaller portion of the total potential contaminants; as such, solutions addressing these potential sources were assigned a lower priority.

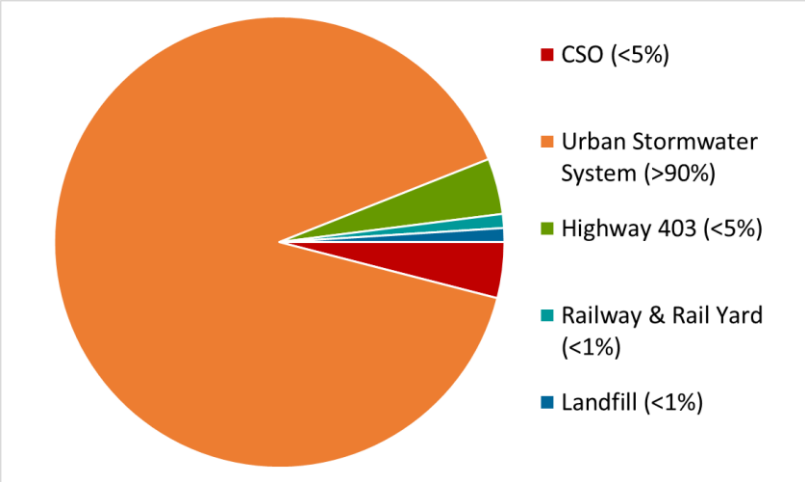


Figure 4: Example Phosphorus Nutrient Loading – Average Year

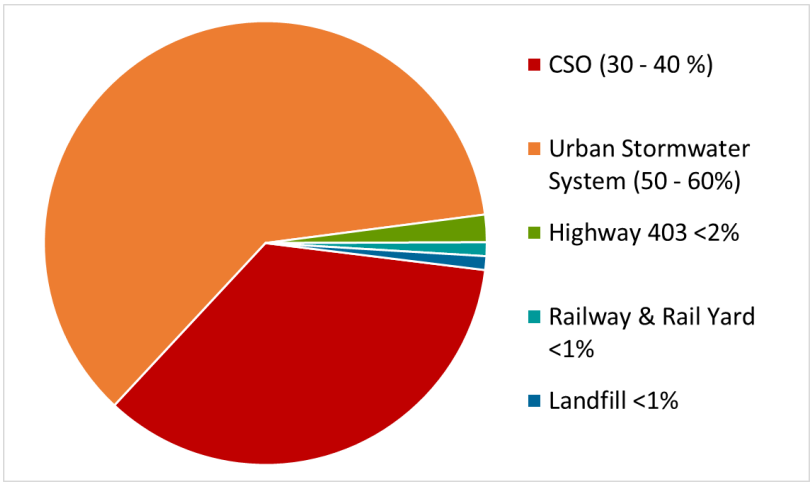


Figure 5: Example Phosphorus Nutrient Loading - Peak Day

4.4 Overview of Management Options and Screening

The following outlines potential management options which have been considered through this study. In the context of this study, the options were categorized into seven main groups consisting of those associated with the following:

- Landfill
- Lower Chedoke Creek
- Wastewater
- Stormwater
- Mid & Upper Chedoke Creek
- Engagement
- Monitoring

The screening process outlined in **Section 4.1** was followed for each option, with the screening and rationale for each option included in **Table 2**. The outcomes of the screening of options could be one of the following:

- **Screen Out**: Option will not be carried forward for any further review.
- **Carry Forward**: Option can be implemented without any further studies.
- **Initiate Inspection / Initiate Monitoring**: Option can be implemented, with final project recommendation to be determined based on inspection and/or monitoring.
- **Future Consideration**: Option will require further studies to determine feasibility.
- **Future Policy / Future Program**: Option will require further investigations and development before initiating future policy or program, if feasible.
- **Evaluate in City's Flooding and Drainage Master Servicing Study (FDMSS)**: City is in the process of completing a Flooding and Drainage Master Servicing Study which will provide recommendations regarding the specified option.
- **Evaluate in City's Water/Wastewater/Stormwater Master Plan (WWSM MP)**: City is in the process of a completing a Water/Wastewater/Stormwater Master Plan which will provide recommendations regarding the specified option.
- **In Progress / Ongoing**: City is already implementing measures related to the option.

All options that were not screened out, are considered part of the City's overall solution, and carried forward to the prioritization and categorization stage of the evaluation.

Table 2: Options Screening

	Option Overview		Option Description	Screening	Rationale
Landfill	Direct Clean Water Away from Landfill		• Prevent local runoff from entering leachate collection system (LCS) and instead allow clean water to directly flow into Chedoke Creek • Reduce total volume pumped from LCS to combined sewers due to reduced leachate generation	Screen Out	• Low effectiveness • High cost • Difficult to implement
	Rehabilitate existing Highway 403 Culvert (Landfill)		• Prevent leachate from contaminating flows from Highway 403 entering the creek via culvert • Prevent leachate from by-passing leachate collection system via this route	Carry Forward	• Low cost • Highly visible • Relatively straight forward
	Expand/Fix Leachate Collection System		• Extend and deepen perforated pipe for leachate collection pipe • Prevent leachate from seeping into creek • Prevent leachate from contaminating runoff entering creek	Future Consideration	• Need to collect more data on effectiveness of recent improvements and reassess before final recommendations
	Landfill Capping/Barrier		• Improve landfill capping/barrier to reduce leachate leaking from boundaries • Enhance the barrier between the contaminated media and the surface • Limit any passage of the contents by restricting surface water infiltration at landfill site thus reducing leaching	Screen Out	• Low effectiveness • High cost • Difficult to implement
Lower Chedoke Creek	Constructed Wetland		• Construct wetland at the outlet of Chedoke Creek where it enters Cootes Paradise (Princess Point) • Capture sediments & pollutant loading from Chedoke Creek before entering Cootes Paradise • Control flow which will enhance natural processes and improve wildlife habitat at outlet of Chedoke Creek	Future Consideration	• Highly visible • Restorative solution • Limited operations required
	Aeration System		• Install Aeration System in Lower Chedoke Creek • System intended to enhance the transfer of dissolved oxygen to Chedoke Creek/Cootes Paradise waters • Improves marine habitat along and downstream of the creek	Future Consideration	• Moderately visible • Mitigative solution • Moderate implementation time

	Stream Naturalization		• Introduce native vegetation for slope stability
			• Reduce stream velocity and sediment buildup downstream
			• Improves marine habitat along and downstream of the creek
				Future Consideration (Lower Chedoke)	• Lower Chedoke
					  ○ Moderate cost
					  ○ Highly visible
					  ○ Mitigative solution

	Physical Capping		• Apply a cover of clean material on top of contaminated creek bed sediment to mitigate risk of contamination • Stabilization of contaminated sediments to prevent resuspension • Prevent benthic community from interacting with and processing the contaminated sediments	Screen Out	• Low effectiveness • Low visibility • Restorative solution
	Chemical Inactivation		• Alternative to physical capping • Chemically treat contaminated sediment	Screen Out	• Low effectiveness • Low visibility
	Chedoke Creek Sediment Removal	Complete Removal	• Remove contaminated sediment via hydraulic dredging • Remediate the creek by removing all existing sediment within creek	Screen Out	• More disruptive • Medium visibility • Quick implementation
		Targeted Removal	• Targeted removal of contaminated sediment via hydraulic dredging (Part of current MECP Order) • Remediate the creek bed by removing targeted sediment • Will immediately reduce contamination	Future Consideration	• More cost effective than complete removal/focuses on most contaminated areas • Medium visibility • Quick implementation

	Option Overview		Option Description	Screening	Rationale
Wastewater	Sewer Separation		• Full implementation of sewer separation in Chedoke Creek watershed • potential implementation challenges/high costs/long timelines • Prevents sanitary waste from overflowing into Chedoke Creek before treatment	Evaluate in Flooding and Drainage MSS	• Implement recommendations from City's MP study for works within Chedoke Creek
	Increase Capacity Downstream of Main-King Combined Sewer Overflow (CSO) tank		• Trunk upgrades from Main-King CSO tank to Woodward Avenue WWTP to accommodate higher storm flows • Reduces volume and frequency of combined sewer overflows	Evaluate in City's Water/ Wastewater/ Stormwater Master Plan	• City-wide benefits • Implement recommendations from City's MP study
	Increase Capacity of Royal CSO tank to Main-King CSO tank (Highway 403 Trunk Sewer Twinning)		• Reduces volume and frequency of combined sewer overflows • Potential elimination of overflows at Aberdeen CSO & reduction in overflows at Royal CSO	In Progress	• Mitigative solution • Design already in process
	Expand Storage at Main-King CSO tank		• Increases holding capacity to accommodate combined sewer flows during high flow events • Reduces volume and frequency of overflows	Screen Out	• High cost • Difficult implementation • Main-King CSO tank is maximized at current site
	Expand Storage Elsewhere in System		• Increases holding system's capacity to accommodate combined sewer flows during high flow events • Reduces volume and frequency of combined sewer overflows • Option upstream of Main-King CSO tank to provide additional system relief	Evaluate in City's Water/ Wastewater/ Stormwater Master Plan	• Implement recommendations from City's Master Plan study for within Chedoke Creek
	Inspection and Repair	Facilities	• Prevent sewer flows from potentially infiltrating into creek due to leaks • Potential opportunity at Royal CSO • Investigation needed to confirm leaks	Initiate Inspection	• Low cost • No regrets • Ensure facilities are in good operating order
		Trunk Sewers	• Prevent sewer flows from potentially infiltrating into creek due to leaks • Potential opportunity within trunk sewers running parallel to stream • Investigation needed to confirm leaks	Initiate Inspection	• Low cost • No regrets, ensure no major I&I in trunk sewers parallel to Chedoke Creek
	CSO Monitoring Improvements and Active Management		• Currently ongoing through Real Time Control (RTC) Program to optimize the performance of the collection system and CSO tanks • Improved inspection and monitoring of CSOs • Quantify overflow volume and overflow conditions	In Progress	• Monitoring and SCADA can better monitor and manage system • Already being implemented through other programs
	Wet Weather Flow (Inflow & Infiltration) in Separated Sewers	Targeted in Chedoke Watershed	• Identify areas of high Inflow and Infiltration (I&I) adjacent to Chedoke Creek • Reduce I&I into sanitary sewers thereby reducing sanitary sewer flows • Potentially reduce CSO overflows	Initiate I&I Monitoring	• Good management practices have benefits for local system and growth capacity in addition to supporting Chedoke Creek
		Targeted in broader Main-King Catchment	• Identify areas of high I&I in Main-King catchment • Reduce I&I into sanitary sewers thereby reducing sanitary sewer flows to the Main-King CSO tank • Potentially reduce CSO overflows	Initiate I&I Monitoring	• Good management practices have benefits for local system and growth capacity in addition to supporting Chedoke Creek
		Policy/Future Infrastructure Projects	• More stringent criteria related to new development to ensure future construction practices address any possible I&I issues • Reduce I&I into sanitary sewers thereby reducing sanitary sewer flows • Potentially reduce CSO overflows	Future Policy	• Good management policies have benefits for local system and growth capacity in addition to supporting Chedoke Creek

	Option Overview		Option Description	Screening	Rationale
Stormwater	Ainsley Woods Sewer Separation		• Separating existing creek inputs from combined sewers that currently enter Royal CSO • Reduce creek flows that are entering combined sewer systems • Reduce volumes directed to CSO tanks; potentially reducing CSO overflows • Increase creek flows reaching Chedoke Creek	Carry Forward	• Low to moderate visibility • Potential for moderate implementation time
	Cross Connection Program		• Ensure sanitary laterals are not connected to stormwater system in separated sewer system • Currently on-going, prioritize within Chedoke Creek catchment, south of Escarpment • Fix storm and sanitary cross-connections from homes • Reduce sanitary contaminants discharged from stormwater outfalls	Ongoing	• Low cost • Quick implementation
	Retrofits throughout the watershed (End-of-Pipe and Source)	City	• Retrofitting existing ponds to wet ponds and outfalls where opportunities exist in Chedoke Creek watershed • Introducing stormwater management practices to areas where there is currently no treatment or management	Future Consideration	• Moderate to high visibility • Short to moderate implementation timelines • Retroactive treatment
		MTO	• Retrofitting existing facilities for Highway 403 • Introducing stormwater management practices along Highway 403 where there is currently no treatment or management	Carry Forward	• Moderate visibility • Potential for short/moderate implementation • MTO led
	Retrofit for Road Rehabilitation Projects / Low Impact Development (LID) BMP Policy		• Best Management Practices (BMPs) to be applied to any road rehabilitation project within the City • Advance City's stormwater management guidance to City infrastructure	Future Policy	• Costs incorporated with other road works • Moderate to High visibility • Ongoing practice
	City Street Management	Enhanced Street Sweeping	• Program to implement enhanced street sweeping within Chedoke Creek Watershed and City • Clean up debris and contaminants that build up on City roads	Carry Forward	• Low cost • Quick implementation for program
		Improve Snow Management within Chedoke Creek Watershed	• Enhance Snow Management practices to prevent contamination (Chlorides) to Chedoke Creek • Review disposal sites for snow that would reduce direct snow melt into urban streams	Future Program	• Low cost • Visible to public • Short implementation time • No regrets
	LID BMP Policy / Stormwater User Rate		• Supports sustainable funding of stormwater management program • Incentive program to encourage private property owners to manage stormwater at source on private properties and implement additional BMP's • LID BMPs will help to provide infiltration, flood management and support creek stability	Ongoing	• Self-Funding • Helps define link between public practices and improvements to Chedoke Creek
	Enhanced Salt Management	Highway 403	• Enhance salt management plan for Highway 403 • Manage salt at stormwater collection points along corridor	Future Program	• Low cost • Short implementation time • No regrets
		City Roads	• Enhance City's salt management plan for City Roads • Manage salt at stormwater collection points along City roads	Ongoing	• Low cost • Short implementation time • No regrets
	Redevelopment Sites Stormwater Management (SWM) Policy		• Policies for BMP's including LID for redevelopment sites in City • Opportunity for large stormwater reduction/treatment on redevelopment sites to comply with new stormwater policy	Future Policy	• Costs incorporated with other works by Others (Developers) • Moderate to High visibility • Ongoing practice
	Highway 403 Water Quality Improvements		• Treat highway runoff at collection points along corridor before it enters Chedoke Creek • Install stormwater management devices such as oil-grit separators at stormwater outfalls	Carry Forward	• Low cost • Short implementation time
	Inlet Controls in Combined Sewer Areas		• Install inlet control devices in combined sewer system • Restricts the amount of stormwater that enters system, reducing the potential of CSO overflows • Requires evaluation of major system (overland) capacity	Evaluate in City's Flooding and Drainage MSS	• Implement recommendations from Flooding and Drainage MSS

	Option Overview		Option Description	Screening	Rationale
Mid & Upper Chedoke Creek	Golf Course	Manage Runoff from the Golf Course	• Improve Golf course water management practices including fertilizers and pesticide use • Provides treatment prior to runoff entering Chedoke Creek	Carry Forward	• Low cost • Quick implementation • Golf course can remain in operation
		Stream Naturalization	• Naturalization of channelized portions of creek within the golf course	Carry Forward	• Highly visible • Golf course can remain in operation
		Retrofit and Treatment Online	• Provide location for external stormwater treatment on-site at Chedoke Golf Course • Treatment to capture large portion of Upper Chedoke Creek catchments that currently flow through Golf Course • Golf Course has available space for runoff capture	Future Consideration	• Golf course can remain in operation with some potential modifications • Part of broader Retrofit Study

	Stream Naturalization		• Naturalization of channelized portions of creek in Mid and Upper Chedoke,
			• Remove concrete channel and introduce native vegetation for slope stability (Mid Chedoke)
			• Reduce stream velocity and sediment buildup downstream
			• Improves marine habitat along and downstream of the creek
			• Introduces native vegetation
				Carry Forward (Upper Chedoke)
				
				Screen Out (Mid Chedoke)
					• Upper Chedoke
					  ○ Highly visible
					• Mid Chedoke
					  ○ Infrastructure constraints
					  ○ Recently re-lined by MTO

Engagement	Engage Residents, Stakeholders, and City		• Educating citizens about water quality issues and benefits of proposed actions • More transparency in water quality monitoring and management • Encourages resident participation in ongoing public initiatives	Carry Forward	• Low cost • High visibility for public • Short implementation time
Monitoring	Chedoke Creek Water Quality Program Management and Monitoring		• Centralized data sharing portal to consist of more sampling and consistent protocols to monitor and track benefits over time • Program will provide a method to quantify water quality benefits of proposed actions • Better identify problems and effectiveness of solutions	Future Program	• Low cost • Will help improve system understanding and support tracking benefits over time

5 RECOMMENDATIONS

The options that were not screened out in the previous section, were considered solutions that can potentially meet the project goals and objectives and were categorized and prioritized based on the methodology presented in **Section 4.1,** as well as stakeholder input received through study workshops. The categorization and prioritization criteria for each project is further outlined in **Appendix D**. The results of the categorization and prioritization process form the basis for the overall Chedoke Creek Water Quality Improvement Framework. More detailed scope recommendations for the various solutions that are considered to require additional studies and fieldwork prior to implementation, are outlined in **Appendix E**.

5.1 Solutions Categorization and Prioritization

The solutions were split between 5 categories as follows:

1. **Near-Term Capital Program**: Capital projects with a short timeline or that are already underway with a clear project scope or limited investigation / study required.
2. **Long-Term Capital Program:** Capital projects with a multi-year process and require additional studies or investigations to confirm the scope and benefit. These projects may also be triggered by other City initiatives such as the ongoing Flooding and Drainage Master Servicing Study.
3. **Near-Term Operations and Maintenance/Program**: Operations and maintenance projects or programs with a quick start up or that are already underway which provide immediate benefit.
4. **Long-Term Operations and Maintenance/Program**: Operations and maintenance projects or programs that may require policy changes and/or new funding and staffing. Benefits are likely to be realized over the long-term.
5. **Policy and Public Engagement:** New policies and expanded public engagement to support the study framework with benefits likely realized over the long-term.

Criteria applied to assist in the prioritization and categorization are those presented in **Table 1**, **Section 4.1**, and include costs, timing, implementation and visibility.

The timeline for all projects is outlined in **Figure 6**.

5.2 Near-Term Capital Program

The Near-Term Capital Program consists of projects with a clearly defined scope, do not require extensive study and/or consultation, and that can be implemented immediately to address specific concerns. These projects are anticipated to be implemented within the next 3 years. These projects along with their prioritization and status are included in **Table 3**.

Table 3: Near-Term Capital Program Prioritization

Prioritization	Project	Status
Underway	Highway 403 Trunk Sewer Twinning	Under Planning and Design
1	Rehabilitate existing Highway 403 Culvert (Landfill)	Coordination with MTO
2	Golf Course – Manage Runoff from the Golf Course	Implement Right Away
3	Highway 403 Water Quality Improvements	MTO Led Initiative

An overview of the project recommendations and area of expected works and benefits are listed below. More detailed scope recommendations for the projects that require additional studies and fieldwork prior to implementation are outlined in **Appendix E**.

5.2.1 Underway: Highway 403 Trunk Sewer Twinning

The Highway 403 trunk sewer twinning project consists of a new trunk sewer running from the Royal CSO tank to the Main-King CSO tank, east of Highway 403. The project consists of four phases with Phase 1 under detailed design, Phase 2 already constructed and Phases 3 and 4 requiring future design and construction. The objective of this trunk sewer is to provide additional sanitary sewer capacity for the catchment upstream of the Main-King CSO tank and provide an outlet for the Aberdeen CSO which will significantly reduce combined sewer overflows from the Aberdeen CSO.

Result: Improve CSO management and reduce overflow risk

5.2.2 Priority 1: Rehabilitate existing Highway 403 Culvert (Landfill)

Consists of rehabilitating the existing Highway 403 Culvert located on the east side of Chedoke Creek, south of the Landfill, to address existing landfill leachate flow entering the culvert and discharging directly to the Lower Chedoke Creek. From an infrastructure perspective, this project is relatively straight forward, requiring an initial inspection followed by rehabilitation measures, which can be implemented immediately. Benefits from this project are anticipated to be realized in the near-term in the Lower Chedoke Creek.

Result: Improve water quality and address contamination contributor

5.2.3 Priority 2: Golf Course – Manage Runoff from the Golf Course

Consists of determining the best stormwater management practice to improve the quality of the runoff from the golf course operations (pesticides and fertilizers) and other golf course infrastructure including parking lots. This project can be implemented immediately at the City-owned Chedoke Golf Course. The stormwater management best practices will help improve the water quality entering the Mid Chedoke Creek by reducing contaminants and sediment produced as part of the golf course operation.

Result: Improve water quality

5.2.4 Priority 3: Highway 403 Water Quality Improvements

Consists of the review, installation, and maintenance of stormwater management measures along Highway 403 in the Chedoke watershed. The objective of the stormwater management measures is to manage contaminants such as oil, grease, pavement deterioration, tire and brake pad wear, vehicle emissions, and spills that are present along highways. Benefits from this project include improved stormwater quality directly entering Chedoke Creek from the Highway stormwater outfalls.

Result: Improve water quality

5.3 Long-Term Capital Program

The Long-Term Capital Program consists of projects that require additional studies or investigations to confirm scope and benefit before being implemented. These projects will likely not be fully implemented in the next 3 years; however, studies to support the long-term projects are either underway or are anticipated to commence within the next 2 years or less. These projects along with their prioritization and status are included in **Table 4**.

Table 4: Long-Term Capital Program

Prioritization	Project	Status
1	Aeration System	Lower Chedoke Combined EA Study
	Constructed Wetland	
	Stream Naturalization	
	Chedoke Creek Targeted Removal (Underway per MECP Order)	
2	Ainsley Woods Sewer Separation	Ainsley Woods Sewer Separation EA Study
3	Inlet Controls in Combined Sewer Areas	Dependent on Flooding and Drainage Master Servicing Study
	Sewer Separation	
4	Golf Course – Stream Naturalization	Chedoke Watershed Stormwater Retrofits EA Study
	Golf Course – Retrofit and Treatment Online	
5	Retrofits throughout watershed (End-of-Pipe and Source)	
	Upper Chedoke Creek Stream Naturalization	
6	Expand Storage Elsewhere in System	Dependent on Water/ Wastewater/ Stormwater Master Plan
	Increase Capacity Downstream of Main-King CSO tank	
7	Expand/Fix Leachate Collection System	Collect more data before further recommendations

An overview of the project recommendations and area of expected works and benefits are listed below. More detailed scope recommendations for the projects that require additional studies and fieldwork prior to implementation are outlined in **Appendix E**.

5.3.1 Priority 1: Lower Chedoke Combined EA Study

A Master Plan through a Class Environmental Assessment is required to evaluate the Lower Chedoke Creek projects listed in **Table 4,** as well as other potential opportunities, not yet identified for remediation in this waterway. The Municipal Class Environmental Assessment process is a prescribed process for projects in the Province of Ontario with specific steps to be followed. The purpose of this Master Plan Class EA is to complete a more comprehensive review of the Lower Chedoke Creek to evaluate the benefits, impacts, and life cycle costs of the various options and consider any other feasible solutions to develop an overall master plan for the system. The final solutions may recommend all, some or none of the projects: Aeration System, Constructed Wetland, and Stream Naturalization. The Chedoke Creek Targeted Removal is underway separate to this Master Plan to address the needs of the Provincial Order and the outcomes will need to be considered as part of Master Plan development.

- The **Aeration System** project consists of the design, installation and ongoing operation and maintenance of a large scale Aeration System along the Lower Chedoke Creek to transfer oxygen to the Chedoke Creek waters. The goal of this system would be to improve the marine habitat along and downstream of the Lower Chedoke Creek.

- The **Constructed Wetland** project consists of the design, installation and maintenance of a Constructed Wetland at the outlet of the Lower Chedoke Creek near Princess Point to capture sediment and pollutant loading from Chedoke Creek before entering Cootes Paradise. A Constructed wetland would support water purification and improve the habitat for wildlife and aquatic life.

- The **Stream Naturalization** project consists of the review, design, installation and maintenance of naturalization measures along the Lower Chedoke Creek. The naturalization process will include improving the creek morphology by introducing native vegetation for slope stability which will help to reduce stream velocity and sediment buildup in the Lower Chedoke Creek.

- The **Chedoke Creek Targeted Sediment Removal** project which has been ordered through the MECP Provincial Officers Order, consists of the design and implementation of hydraulic dredging to remove targeted sediments in the Lower Chedoke Creek. The dredging process will include the transportation of dredged material, dewatering and final placement/management of dredged material, as well as opportunistic enhancement of the creek, and other small scale off-set works feasible within the creek footprint.

The recommendations from this study will directly impact/benefit the water quality within Lower Chedoke Creek and by extension Cootes Paradise and are expected to be of medium to highly visibility to the public.

Result: Improve water quality within Lower Chedoke Creek

5.3.2 Priority 2: Ainsley Woods Sewer Separation EA Study

A Class Environmental Assessment is required to evaluate the existing creek inputs into the combined sewer system within the Ainsley Woods neighbourhood in Mid Chedoke Creek. The purpose of this Class EA is to complete a more comprehensive review of the creek inputs into the combined sewers that run through Ainsley Woods, specifically at the points just upstream of Blackwood Crescent and at the western extent of Iona Avenue. The EA would include identifying an appropriate outlet for this separated flow, including evaluating the benefits, impacts, and life cycle costs of the various feasible solutions. This sewer separation project can be implemented immediately following the recommendations of the EA.

Result: Reduce creek inputs into combined sewers to reduce overflow risk

5.3.3 Priority 3: Dependent on Flooding and Drainage Master Servicing Study

The City is currently undertaking a Flooding and Drainage Master Servicing Study with the goal of reducing flooding risk and improving stormwater drainage across the City's combined sewer system area. It is anticipated that the subject recommendations for the Chedoke Creek Watershed will provide water quality benefits by reducing the total amount of stormwater runoff being directed to the Combined sewer system, thereby reducing the likelihood and frequency of combined sewer overflows. The recommendations of the Flooding and Drainage Master Servicing Study may include the following:

- The **Inlet Controls in Combined Sewer Area** project consists of the installation, operation and maintenance of inlet control devices in the combined sewers, north of the Escarpment. Inlet control devices restrict the amount of stormwater that enters the combined sewers and therefore the amount of potential overloading of CSO tanks. This project will need to consider the influence on the major (overland) system in terms of capacities and risks.

- The **Sewer Separation** project consists of identifying high priority areas for separation in the combined sewer system and constructing new storm sewers to separate storm sewers and wastewater sewers.

The recommendations for both projects will be provided through the ongoing Flooding and Drainage Master Servicing Study. These infrastructure solutions would provide benefit beyond the Chedoke Creek; however, there are associated high costs and medium to long-term implementation timelines.

Result: Reduce stormwater entering combined sewers to reduce overflow risk

5.3.4 Priority 4 and 5: Chedoke Creek Watershed Stormwater Retrofits EA Study

This study is required to evaluate the potential for stormwater management retrofits primarily in the Upper Chedoke Creek Watershed. The purpose of this study is to conduct a more comprehensive review of the locations and benefits associated with those stormwater treatment projects identified in **Table 4** including functional benefits, impacts, and life cycle costs of the projects, leading to a master plan for the watershed.

- The **Golf Course – Stream Naturalization** project consists of the review, design, installation and maintenance of naturalization measures in the Golf Course. The naturalization process will include the use of natural channel design and introducing native vegetation for slope stability.

- The **Golf Course – Retrofit and Treatment Online** project consists of the review, design, and construction for stormwater treatment in the Chedoke Creek, within the Chedoke Golf Course. The installation of an on-line stormwater management retrofit will help improve the downstream water quality and provide treatment for those lands not able to be practically treated through the broader retrofit program.

- The **Retrofits throughout watershed (end-of-pipe and source)** project consists of a comprehensive review of the Chedoke Creek watershed to identify existing facilities that can be retrofitted for improved water quality functions, and areas/outfalls where there are no stormwater management measures and there is opportunity to retrofit. This Master Plan will lead to a set of projects, which following review and identification, will require design, installation, and maintenance of stormwater retrofits throughout the City system.

- The **Upper Chedoke Creek Stream Naturalization** project consists of the review, design, installation and maintenance of naturalization measures in the Upper Chedoke Creek. The naturalization process will include the use of natural channel design and introducing native vegetation for slope stability.

This study will provide the basis for identifying a suite of locations including associated scale and appurtenances to improve stormwater quality in the Chedoke Watershed due to non-point runoff (untreated stormwater), which has been highlighted as one of the most significant contributors to the high nutrient loadings to the Chedoke Creek.

Result: Improved water quality in storm system and naturalized areas receiving runoff within Chedoke Creek Watershed

5.3.5 Priority 6: Dependent on Water/Wastewater/Stormwater Master Plan

The City is currently undertaking an integrated Water/Wastewater/Stormwater Master Plan with the goal of addressing system capacity to support existing and future land uses. It is anticipated that the Master Plan will recommend strategic sewer capacity improvements and potentially additional storage capacity to address high peak flows within the combined sewer systems. These solutions may provide water quality benefits by increasing the capacity of the combined sewer system thereby reducing the likelihood and frequency of combined sewer overflows. The recommendations of the Master Plan, may include the following:

- The **Expand Storage Elsewhere in System** project consists of a comprehensive review of the City's wastewater and combined sewer systems to identify if there are any areas to expand storage for overflow events. Following the review, this project will include the design, construction, operations and maintenance of any new storage facilities.

- The **Increase Capacity Downstream of Main-King CSO tank** project consists of a review of the City's wastewater system's hydraulic capacity downstream of the Main-King CSO tank to determine the benefits and feasibility of adding additional wastewater conveyance capacity. Following the review, this project will include the design, construction, operations and maintenance of the new infrastructure which may consist of new sewers or new facilities.

The recommendations for these projects will be provided through the ongoing Water/Wastewater/Stormwater Master Plan and will be incorporated as operational elements of the overall Water Quality Improvement Framework. These infrastructure solutions will provide benefits beyond the Chedoke Creek watershed; however, they are expected to involve high costs and long-term implementation timelines.

Result: Increase capacity in combined sewer system to reduce overflow risk

5.3.6 Priority 7: Expand/Fix Leachate Collection System (LCS)

This project will require additional data collection consisting of continuous water quality and leachate collection system monitoring to determine the effectiveness of the existing LCS. The collection and analysis of data will determine if further upgrades need to be made to the system. The benefits of the recommendations from this study will directly impact the Lower Chedoke Creek and Landfill.

Result: Improve leachate collection system management and address contamination contributor

5.4 Near-Term Operations and Maintenance/Program

The Near-Term Operations and Maintenance/Program consists of the expansion and/or reprioritization of existing programs. There is the potential to provide immediate benefits as these programs and investigations can be implemented within the next 2 years or less. These projects along with their prioritization and status are included in **Table 5**.

Table 5: Near-Term Operations and Maintenance/Program

Prioritization	Project	Status
0	CSO Monitoring Improvements and Active Management	Underway
1	Inspection and Repair – Facilities	Underway / Initiate Inspection
	Inspection and Repair – Trunk Sewers	
2	Cross Connection Program	Prioritize in Chedoke Watershed
3	City Street Management – Enhanced Street Sweeping	Develop and Initiate City Program

An overview of the project recommendations and area of expected works and benefits are listed below. More detailed scope recommendations for the projects that require additional studies and fieldwork prior to implementation are outlined in **Appendix E**.

5.4.1 Priority 0: CSO Monitoring Improvements and Active Management

This project involves wastewater system monitoring through the City's SCADA system at CSO facilities. Enhanced monitoring and active management will ensure that any potential future failures are identified early and eliminated or resolved quickly. This includes monitoring and understanding the unmonitored CSOs contribution to the CSO volumes and flows. Facilities that may require further inspection will also be identified. The benefits from this project can be realized City wide at all CSO facilities. This project is already underway.

Result: Improved monitoring and reduced risk of failure and impacts

5.4.2 Priority 1: Inspection and Repair

This project consists of the inspection, design, repair and maintenance of trunk sewers and facilities within the Chedoke Creek Watershed. Inspection should be conducted for trunk sewers and facilities within the Chedoke Creek Watershed to identify if there are any areas where significant inflow is coming from the creek or sewers. Results of the inspection will help guide recommendations for repairs if necessary. The benefits from this project will be realized by potentially reducing infiltration to the sewer system and thereby reducing the likelihood of combined sewer overflows.

Result: Better system knowledge, improved targeted maintenance and repair, improved water quality

5.4.3 Priority 2: Cross Connection Program

This program would identify cross connections between the sanitary and storm systems in the Chedoke Creek watershed and lead to separation projects. The City has an ongoing program which can be refocused to prioritizing cross connections identification and separation in the Chedoke Creek watershed. This program will produce benefits throughout the Chedoke Creek watershed where the City is continuing to target and City wide if expanded.

Result: Reduced sewage cross contamination, improved water quality in storm system

5.4.4 Priority 3: City Street Management – Enhanced Street Sweeping

This project consists of developing and implementing an enhanced street sweeping program throughout the Chedoke Creek watershed. Street sweeping reduces the availability of contaminants and thereby improves water quality by removing pollutants that are transferred through urban runoff. Additional sweeping at strategic times throughout the year including in the spring, which will specifically have the increased benefits of cleaning any debris that have built up over the winter months. Benefits will be realized City wide.

Result: Improved water quality in the storm system and naturalized areas receiving runoff within urbanized areas

5.5 Long-Term Operations and Maintenance/Program

The Long-Term Operations and Maintenance/Program consists of expanding or creating new programs either targeted to the Chedoke Creek watershed or implemented City-wide. There is the potential to provide substantial benefits, but the implementation of these programs will require more time due to their scale, complexity and stakeholders involved. These programs and investigations may require upfront investigation, policy changes, and new funding and staffing which is not anticipated to be implemented within the next 2 years. These projects along with their prioritization and status are included in **Table 6**.

Table 6: Long-Term Operations and Maintenance/Program

Prioritization	Project	Status
1	Wet Weather Flow in Separated Sewers – Targeted in Chedoke Watershed	Initiate Inflow & Infiltration Monitoring
	Wet Weather Flow in Separated Sewers – Targeted in broader Main-King Catchment	
2	Chedoke Creek Water Quality Program Management and Monitoring	Initiate Now and Continue Long Term
3	City Street Management – Improve snow management within Chedoke Creek Watershed	Enhanced Program
4	Enhanced Salt Management – Highway 403	Enhance Existing Program
	Enhanced Salt Management – City Roads	

An overview of the project recommendations and area of expected works and benefits are listed below. More detailed scope recommendations for the projects that require additional studies and fieldwork prior to implementation are outlined in **Appendix E**.

5.5.1 Priority 1: Initiate Inflow & Infiltration (I&I) Reduction

A program is required to identify areas of high I&I to implement repair strategies to reduce extraneous flows from entering the sewer system.

- The **Wet Weather Flow in Separated Sewers – Targeted in Chedoke Watershed** project consists of the inspection, identification, recommendation and repair of sewers in the Chedoke Creek Watershed where I&I issues are present. The recommendation will also include the best technology for each repair based on severity, location and other constraints.

- Similarly, the **Wet Weather Flow in Separated Sewers – Targeted in broader Main-King Catchment** project consists of the inspection, identification, recommendation and repair of sewers in the broader Main-King Catchment where I&I issues are present. The recommendation will also include the best technology for each repair based on severity, location and other constraints.

Good management practices will have benefits for the local system, as well as provide growth capacity. I&I should be targeted in the Chedoke Creek and the Main-King catchment to reduce the frequency and magnitude of overflows, or in Waterdown to hold more back from the Dundas WWTP catchment (which reduces total wastewater flows that are conveyed from the Dundas WWTP catchment into the Main-King catchment).

Result: Reduce I&I flows in sanitary sewers to reduce overflow risk

5.5.2 Priority 2: Chedoke Creek Water Quality Program Management and Monitoring

Involves developing a centralized data sharing portal consisting of more water sampling data and robust protocols throughout the Chedoke Creek watershed. This program will provide a data-based approach to quantify water quality improvements/benefits associated with the proposed projects and will help monitor and track benefits over time. The City will need to explore the best approach, which may be accomplished via an enhancement of existing City monitoring program or through the creation of a separate Chedoke Creek Water Quality Monitoring Program.

Result: Better system knowledge, improved project benefit tracking

5.5.3 Priority 3: City Street Management – Improve snow management within Chedoke Creek Watershed

This project consists of improving the ongoing City program for snow management, targeted within the Chedoke Creek watershed. This will include reviewing existing and potential snow disposal sites that would reduce the direct snow melt into urban waterways. This will benefit the Chedoke Creek by reducing urban pollutants, particularly chlorides that are transferred through snow as urban runoff.

Result: Improved water quality in the storm system and naturalized areas receiving runoff within urbanized areas

5.5.4 Priority 4: Enhanced Salt Management

A program is required to better manage salt applications and management along City roads and the Highway 403 corridor.

- The **Enhanced Salt Management – Highway 403** project consists of developing an enhanced program for salt management along Highway 403. This program should be reviewed and updated as necessary to ensure the best practices are in place when dealing with the transportation, storage and use of salt.

- The **Enhanced Salt Management – City** project consists of reviewing, updating and enhancing the existing salt management program for City roads focused in the Chedoke Creek Watershed. This program should be reviewed and updated as necessary to ensure the best practices are in place when dealing with the transportation, storage and use of salt.

The reduction and better management of salt within the Chedoke Creek watershed will have direct benefits by reducing the amount of salt that enters water ways.

Result: Improved water quality in the storm system and naturalized areas receiving runoff within urbanized areas

5.6 Policy and Public Engagement

The Policy and Public Engagement programs involve expanding and creating continued opportunities for engagement to monitor progress and better manage the strategy presented in this framework. These policies and stakeholder engagement will provide long-term benefits as they strengthen over time. The projects along with their prioritization and status are included in **Table 7**.

Table 7: Policy and Public Engagement

Prioritization	Project	Status
1	Engage Residents, Stakeholders, and City	Initiate Now
2	Redevelopment Sites SWM Policy	Develop Policy Now, Implement through Future Projects
3	Retrofits for Road Rehabilitation Projects / LID BMP Policy	Develop Policy Now, Implement through Future Projects
4	LID BMP Policy / Stormwater User Rate	Currently Underway
5	Wet Weather Flow in Separated Sewers – Policy / Future Infrastructure Projects	Develop Policy Now, Implement through Future Projects

An overview of the project recommendations and area of expected works and benefits are listed below. More detailed scope recommendations for the projects that require additional studies and fieldwork prior to implementation are outlined in **Appendix E**.

5.6.1 Priority 1: Engage Residents, Stakeholders, and City

Engagement with residents, stakeholders and the City should continue and be initiated immediately to strengthen the communication of the recommendations of this study, including updates on follow-on actions. The engagement with residents may encourage private property improvements such as downspouts, rain gardens, etc. This may also involve the development of a Chedoke Creek Advisory Committee **(Section 6.2)** consisting of Annual report cards and meetings. This will allow the residents, stakeholders and City to stay involved and updated on all initiatives being taken within Chedoke Creek Watershed and the associated benefits and improvements.

Result: Improved coordination between stakeholders to support implementation plan, improved public knowledge, change in use and behaviour

5.6.2 Priority 2: Redevelopment Sites Stormwater Management Policy

This project involves developing a stormwater management (SWM) policy to be implemented through all future redevelopment site construction. The City is in the process of developing requirements for Low Impact Development (LID) Best Management Practices (BMPs) for redevelopment sites in the City, however it is suggested that the policy be reviewed and strengthened with a particular focus in the Chedoke Creek Watershed. This enhanced SWM policy will provide benefits throughout the City, with the retroactive treatment of stormwater on redevelopment sites, which previously received no water quality treatment.

Result: Improved stormwater management, improved water quality, leveraging development community in the solution

5.6.3 Priority 3: Retrofits for Road Rehabilitation Projects / LID BMP Policy

This policy will require contemporary stormwater management to be implemented through all future road rehabilitation projects. Many other municipalities are retrofitting their roads with SWM source controls and this work is being screened through rigorous cost/benefit tools. The policy and practices will need to be consistent with the City's current standards.

Result: Improved stormwater management, improved water quality, leveraging road program in the solution

5.6.4 Priority 4: LID BMP Policy / Stormwater User Rate

This project consists of developing and prioritizing a LID BMP Policy / Stormwater User Rate. A LID BMP Policy will need to be developed and it could be incorporated into the City's Stormwater User Rate, which is currently under evaluation. This incentive program will encourage private property owners to manage stormwater from private properties and implement BMPs such as rain gardens and permeable pavers. Stormwater User Rates have been implemented in numerous Southern Ontario municipal centres and can provide sustainable funding to stormwater services.

Result: Improved stormwater management, improved water quality, leveraging existing community in the solution, change in public use and behaviour

5.6.5 Priority 5: Wet Weather Flow in Separated Sewers Policy

This program involves the development of a policy and related guidance for new development throughout the City. The policy and practices should include more stringent criteria related to wet weather flow allowances in the infrastructure serving new developments to ensure that all future construction practices address wet weather flows. This could include mandatory flow monitoring in newly installed systems prior to the City's acquisition of the sewer assets.

Result: Improved stormwater management, improved water quality, improved combined sewer flow management, leveraging development community in the solution, change in public use and behaviour

6 IMPLEMENTATION PLAN

This Chedoke Creek Water Quality Improvement Framework study seeks to provide an overall framework for the City to adopt to guide its actions in addressing the legacy water quality issues within the Chedoke Creek watershed. While the project, program, and policy recommendations presented herein are based on a strong foundation of data and information related to legacy studies and investigations, further studies, consultation, and establishment of the appropriate policies and funding, are necessary to support the implementation of the full complement of recommendations.

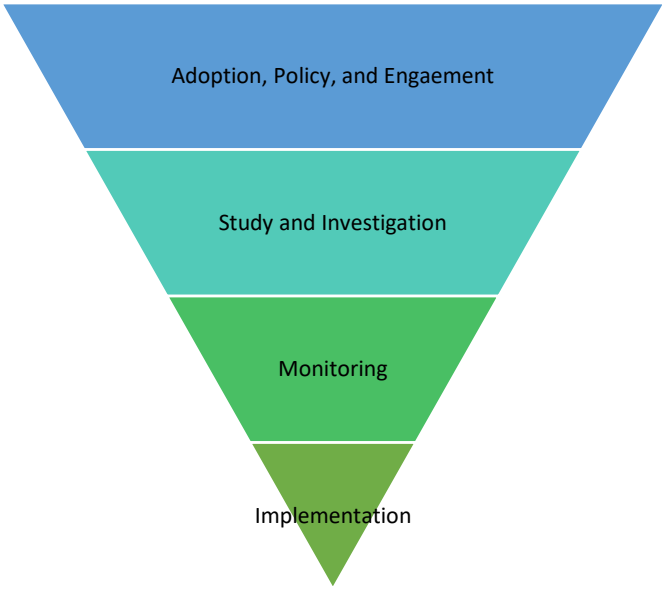
The figure below provides a general overview of the recommended steps which are further discussed in this section:

- **Adoption, Policy, and Engagement:** This first step consists of obtaining City Staff and Council adoption of the Framework recommendations, including the Chedoke Creek Watershed Water Quality Vision and Objectives, as well as appropriate funding on a staged basis to support the project implementation. Also included in this step are the development and adoption of the required Policies needed to support and/or fund the implementation of proposed recommendations. Finally, adoption and policy work will need to be completed concurrently with public and stakeholder engagement.

- **Study and Investigation:** This step consists of completing the required studies and investigations considered necessary to support decision-making related to future projects and actions.

- **Monitoring**: This step consists of confirming the Management Objectives and identifying the Performance and Monitoring Indicators and associated Measures. This step also establishes the methodology by which the Targets, Performance and Monitoring Measures will be collected, reviewed, and progress reported, including the potential for adaptive management based on performance feedback.

- **Implementation:** This step consists of the design, construction, and ongoing operation and maintenance of the recommended infrastructure and related programs including post-implementation monitoring to demonstrate effectiveness.



Recognizing that it will require several years for the City to transition through the **Adoption, Policy, and Engagement**, **Study and Investigation**, **Monitoring,** and **Implementation** before the City can proceed with the more significant recommendations, the Framework has also identified a number of near-term projects and existing City programs that can be expanded or redirected to the Chedoke Creek Watershed to allow the City to start to address the legacy issues immediately.

6.1 Program Schedule and Budget

Figure 6 provides a generalized program schedule and **Table 8** provides a breakdown of expected cost. Further, **Appendix E** provides a breakdown of each recommendation's implementation schedule including general scope, additional studies and fieldwork requirements, estimated timeframe, and budget.

Table 8: Program Budget

Category	Timeline		
	0-2 Years	3-5 Years	+5 Years
Studies	$3 M	-	-
Projects	$11 M	$23 M	$17 M
Programs	$1 M per year	$1 M per year	$1 M per year
Operations & Maintenance – Potential[(1)]	$0.5 M	$0.5 M	TBD
Study Recommendations – Potential	-	$2 M	>$150 M

[(1)]Costs for potential projects includes the total costs for implementing all proposed projects as part of study

6.1.1 2021 to 2023 (0-2 Years)

Initial activities will be focused on the Adoption, Policy and Engagement, and Study and Investigation Phases. The objective will be to establish the appropriate policy and funding necessary to support the implementation of the relevant recommendations, while initiating the required studies and engagement programs necessary to support the more significant initiatives moving forward. Milestones for the first 2 years of the strategy include:

- Council and Stakeholder adoption of the Framework recommendations and endorsement of the Chedoke Creek Watershed Vision and Management Objectives
- Drafting and adoption of the Framework policy recommendations (**Section 5.6**) required to support the Chedoke Creek Watershed Vision and Management Objectives

  Confirmation of the Chedoke Creek Targets, Performance and Monitoring Measures (**Section 3.4**) and establishment of monitoring plan and progress reporting. The Targets should be developed on a subwatershed basis and based on environmental conditions.
- Initiate the Lower Chedoke Combined EA Study, Ainsley Woods Sewer Separation EA Study and Chedoke Watershed Stormwater Retrofits EA Study
- Complete the Flooding and Drainage Master Servicing Study and Water/Wastewater/Stormwater Master Plan, with their related recommendations to be incorporated as elements of the overall Chedoke Creek Watershed Water Quality Improvement Strategy
- Commencement and implementation of expanded Low Impact Development (LID) requirements for road reconstruction and new development
- Establishment of a Chedoke Creek Advisory Committee or equivalent (see **Section 6.2**)
- Continue and enhance the City's public information and education program.

Further, the Framework recommends that the City complete the required investigation, design, and consultation work to implement all the near-term capital program projects (**Section 5.2**) and fully implement/complete the identified near-term Operational and Maintenance programs (**Section 5.4**), including the **CSO Monitoring Improvements and Active Management** program.

It is anticipated that during this timeframe, limited improvements in the Chedoke Creek water quality will be realized as the initial efforts will be focused on completing the required investigations, establishing the supporting policies and funding, and seeking stakeholder buy in. However, the CSO Monitoring Improvements and Active Management program is anticipated to reduce the risk of future spill events, such as the one reported in 2018.

6.1.2 2023 to 2026 (3-5 Years)

Within the first 5 years of the strategy, activities will be focused on completing the various Study and Investigation phases and establishing the Monitoring Plan approach to allow the City to proceed with the implementation of the more significant capital program recommendations. It is also during this timeframe that the City will begin to implement the Long-Term Operations and Maintenance programs. Key milestones for the first 5 years include:

- Completion of the Lower Chedoke Combined EA Study and Chedoke Watershed Stormwater Retrofits EA Study and initiation of the detailed design of various recommendations from each study
- Implementation of Ainsley Woods Sewer Separation
- Implementation of the Inflow and Infiltration (I&I) reduction program
- Continuing a public information and education program

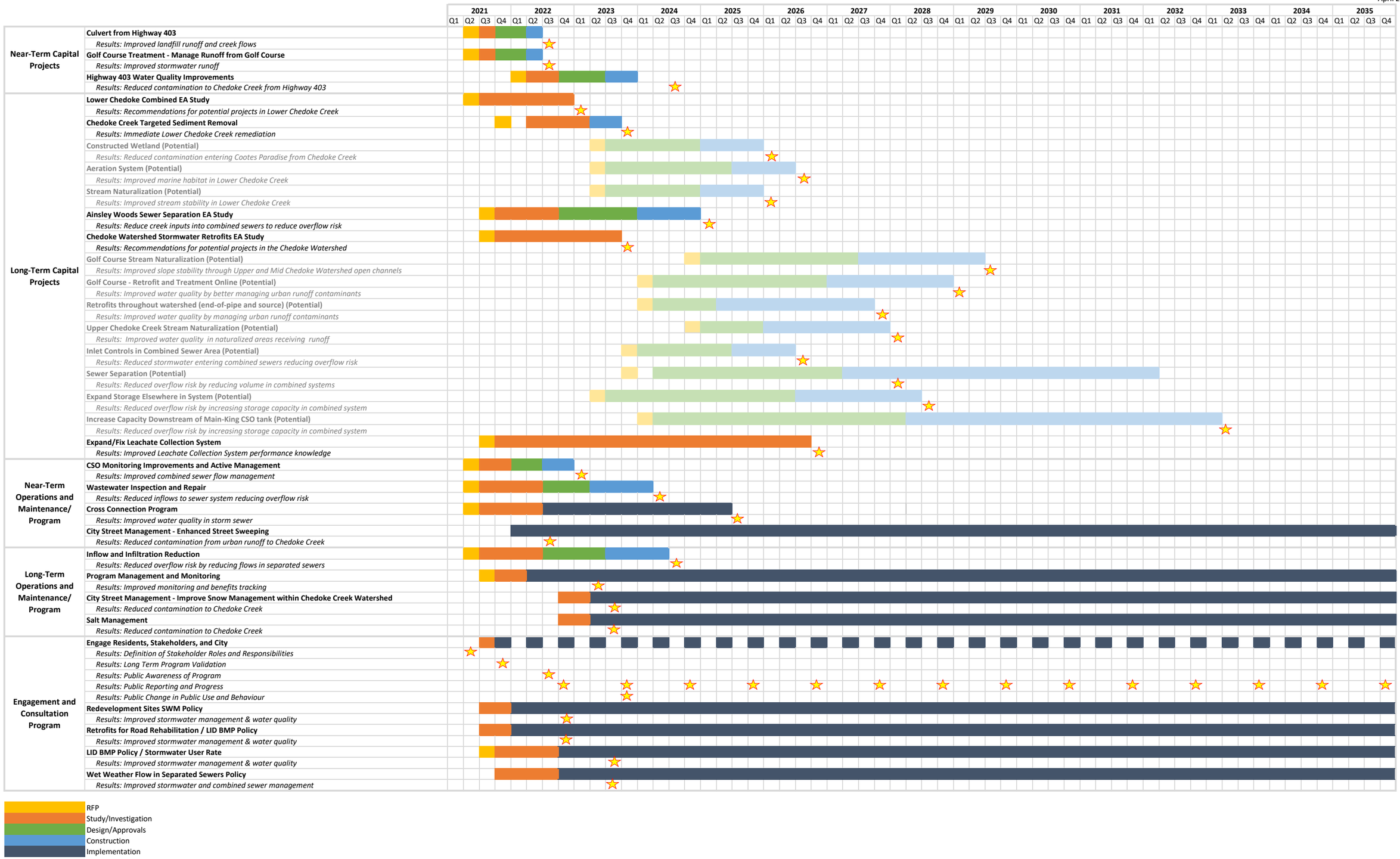
Further, the framework recommends that the City complete the implementation/construction of near-term capital program projects (**Section 5.2**).

It is anticipated that during this timeframe, modest improvements in the Chedoke Creek water quality will be realized and will likely be identifiable through the monitoring program.

6.1.3 2026 and Beyond (+5 Years)

Long-term activities will be focused on completing the construction of the long-term capital projects, based on the findings of the recommended EA studies and other ongoing Master Plans. It is anticipated that the most substantial water quality improvement will occur following the implementation of the long-term capital projects and as the result of the cumulative long-term effects of the new City LID BMP policies and improvements to the Operation and Maintenance programs.

Figure 6: Program Schedule



6.2 Stakeholder Engagement and Public Outreach

The recommendations outlined in this Framework represent a diverse set of policies, projects, and programs which will require multi stakeholder input, feedback, and contributions to be successful. This stakeholder involvement ranges from public input to the EA process and public interaction with the various programs and projects, multiple agency approvals, and joint project partnerships such as those with the MTO or RBG, etc.

As such, it is recommended that a Chedoke Creek Advisory Committee or equivalent be formed consisting of representatives from the Stakeholders listed in **Section 2.4** and others as deemed appropriate, representatives of City Council, and representatives from key City departments.

It is anticipated that the Chedoke Creek Advisory Committee will be chaired by City Staff and will have a “working” mandate of:

- Confirming the Watershed Management Objectives and establishing the Performance and Monitoring Objectives
- Establishing the Monitoring Program requirements
- Review and comment on proposed Policies and Study Recommendations
- Monitoring the Chedoke Creek Water Quality Strategy progress and reporting to Council on a semi-annual basis
- Leading public outreach efforts

The initiatives led by and completed by the Advisory Committee will need to consider the existing ongoing programs through the MECP, Environment Canada and Remedial Action Plan to ensure that all recommendations are in-line with current processes.

Further, it is anticipated that the Chedoke Creek Advisory Committee will serve to streamline public and stakeholder engagement needed to support the implementation of the framework recommendations.

6.3 Monitoring and Management Program

The Framework provides a broad range of recommendations, which may or may not need to be fully implemented to meet the Watershed Management Objectives. The City will need to establish an appropriate monitoring and management program which will need to first establish existing baseline conditions, allow for the monitoring of progress overtime, provide additional information to allow for the re-prioritization of recommendations, and ultimately to identify when the Performance and Monitoring Indicators and Measures have been achieved.

The extent of the monitoring program will be largely dependent on the final Performance and Monitoring Measures. There is the potential that these needs can be accommodated through consolidation and limited expansion of the existing monitoring programs conducted by HCA, RBG and others. However, these programs are currently independently administered by several different groups both internal and external to the City and all being conducted with a variety of different objectives and protocols resulting in a wide range of frequency, duration, coverage of the data collected. The City will need to explore the best Chedoke Creek Water Quality Monitoring Program approach, which may range from a reliance on currently collected information, moderate expansion of City monitoring program, the creation of a separately purposed based monitoring program, or the consolidation of all monitoring activities into a joint initiative.

APPENDIX A: SUMMARY OF SUPPORTING STUDIES

1 INTRODUCTION

The purpose of this Appendix is to provide a summary of the baseline information used to support the Chedoke Creek Water Quality Improvement Framework. A summary of the background reports is included below.

2 DATA SOURCES & RELATED STUDIES

This section summarizes the various data sources that were used to form the basis of understanding for this study.

2.1 Reports

A review of relevant reports was completed and summarized in the following section.

- 20 Year Trends in Water Quality (Cootes Paradise and Grindstone Creek) – Royal Botanical Gardens, April 2012
- 2013 RBG Marsh Sediment Quality Assessment – Royal Botanical Gardens, March 2014
- 2018 Landfill Leachate Collection System Performance Report – SNC-Lavalin, March 2019
- 2019 Landfill Leachate Collection System Performance Report – SNC-Lavalin, March 2020
- 403 Trunk Twinning Analysis – Stantec, April 2008
- Ainslie Wood / Westdale Neighbourhoods Class EA SWM Master Plan – McCormick Rankin, December 2003
- Annual Report 2018-2019 – BARC, August 2019
- Benthic Invertebrate Assessment of RBG Wetlands 2014 and 2015, Royal Botanical Gardens, 2018
- Chedoke Creek Erosion and Slope Stability Improvements Municipal Class EA – Dillon Consulting, September 2006
- Chedoke Creek Natural Environment and Sediment Quality Assessment and Remediation Report – Wood, January 2019
- Chedoke Creek Remediation Project – Various, April 2010
- Chedoke Creek Subwatershed - Stewardship Action Plan – Hamilton Conservation Authority, April 2008
- City of Hamilton B-Line Light Rapid Transit - Appendix B.1 Natural Heritage Features – SNC-Lavalin, n.d.
- Closed West Hamilton Landfill Leachate Quantity Assessment - Urban & Environmental Management Inc., October 2012
- Contaminant Loadings and Concentrations to Hamilton Harbour: 2008-2016 Update - Hamilton Harbour Remedial Action Plan Office, April 2018
- Cootes Paradise Marsh: Water Quality Review and Phosphorus Analysis - Cootes Paradise Water Quality Group, Hamilton Harbour Remedial Action Plan, March 2012
- Cootes Paradise Nature Sanctuary, Lower Chedoke Creek Area, Water Quality & Fisheries – Royal Botanical Gardens, n.d.
- Cootes Paradise Study – MOECC, 1986
- Cootes Paradise: Environmental Impact Evaluation – SLR, February 2020
- CSO Facilities Engineering Feasibility Study – Hatch, April 2020
- CSO Tanks Performance Report 2017 Annual Report – City of Hamilton, 2018
- Ecological Risk Assessment – SLR, February 2020
- Fresh Water Mussel Sampling Cootes Paradise – Fisheries and Oceans Canada, MNR, October 2015
- Freshwater Sediment Toxicity Testing Using Chironomus Dilutus and Hyalella Azteca - Bureau Veritas Laboratories, November 2019
- Hamilton Combined Sewer Overflow Reporting (2018) – Hatch, September 2019
- Hamilton Real Time Control Implementation - Phase 2 - Draft 90% PDR – Stantec, July 2020
- Hydrogeological Review of Design for Expansion of Leachate Collection System at the Closed West Hamilton Landfill – SNC-Lavalin, May 2014
- Kay Drage Park 2013 Annual Leachate Collection System Performance Report – MTE Consultants, March 2014

- Kay Drage Park Annual Performance Report – Urban & Environmental Management Inc., October 2008
- Kay Drage Park Groundwater Monitoring Report (2009-2015) – Urban & Environmental Management Inc., July 2016
- Lower Grindstone Creek, Borer's Creek and North Cootes Paradise Subwatersheds; Preliminary Geomorphological Assessment – Geomorphix, December 2016
- Monitoring Catalogue 2017 – Hamilton Harbour Remedial Action Plan Office, February 2018
- Project Paradise 2016 – Royal Botanical Gardens, May 2017
- RBG 25-Year Master Plan (excerpts 1.3 & 5.13) – MT Planners, 2020
- RTC Ph 1 Conceptual Design Report Update – Stantec, July 2011
- Sediment Quality in Lake Ontario Tributaries – Environment Canada, April 2003
- Updated West Hamilton Landfill Seepage Assessment Report – Dillon Consulting, October 2012
- Urban Runoff Hamilton Report & Recommendations – Hamilton Harbour Remedial Action Plan Office, October 2016
- Water Quality Monitoring of the Chedoke Creek Subwatershed, Subwatersheds of Cootes Paradise, and Red Hill Watershed – Redeemer University College, August 2015
- Water Quality Monitoring Season Summary 2017 – Royal Botanical Gardens, March 2018
- Water Quality Trends in Cootes Paradise Marsh and Grindstone Creek – Royal Botanical Gardens, 2012
- Wetlands Conservation Plan 2016-2021 – Royal Botanical Gardens, May 2016
- WQ in Cootes Paradise and Desjardins Canal RBG 1974 – Royal Botanical Gardens, October 1974
- X Connections Information Report - SLXC 2019 – City of Hamilton, February 2019

2.2 Papers

A review of relevant papers was completed and summarized in the following section.

- Aquatic Vegetation Trends from 1992 to 2012 in Hamilton Harbour and Cootes Paradise, Lake Ontario - K. E. Leisti, T. Theÿsmeÿer, S. E. Doka & A. Court, December 2015
- Cootes Paradise Phosphorus Dynamics - Dong-Kyun Kim, Tianna Peller, Zoe Gozum, Tys Theÿsmeÿer, Tanya Long, Duncan Boyd, Sue Watson, Y. R. Rao & George B. Arhonditsis, December 2016
- Evaluation of stormwater and snowmelt inputs, land use and seasonality on nutrient dynamics in the watersheds of Hamilton Harbour, Ontario, Canada - Long, T. et. Al., 2014
- Potential Contribution of Nutrients and Polycyclic Aromatic Hydrocarbons from the Creeks of Cootes Paradise Marsh - Chow-Fraser, P. et. Al., 1996
- Predicting the likelihood of a desirable ecological regime shift: A case study in Cootes Paradise marsh, Lake Ontario, Ontario, Canada - Yang, C. et. Al., 2020
- Seasonal Fish Community Use of the Great Lakes Coastal Marsh Cootes Paradise as Reproductive Habitat - Theysmeyer, T., 2000
- Water Quality Monitoring of the Chedoke Creek Watershed - Redeemer University College, 2016

2.3 Other

A review of other relevant information was completed and summarized in the following subsections.

2.3.1 Agreement

- Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health, 2020 (Draft) - Provincial and Federal Governments, July 2019

2.3.2 Application

- Letter of Advice F&O Canada – Fisheries and Oceans Canada, August 2014
- Request for Review Submission F&O Canada: Chedoke Creek Bank Stabilization Works and Leachate Collection System Improvements Project - Urban & Environmental Management Inc., 2014

2.3.3 Correspondence

- Chedoke Creek Additional Information / Data - Hamilton Conservation Authority, September 2018

2.3.4 Figures

- MIP Trunk Twinning Sketch – City of Hamilton, May 2019

2.3.5 Guideline

- Catalogue of Public Engagement Techniques and Tools During Covid-19 – City of Hamilton, August 2020
- Public Engagement for City Led Projects during Covid-19 – City of Hamilton, August 2020

2.3.6 Media

- Floating Wetlands: A Sustainable Tool for Wastewater Treatment – Clean Soil Air Water Journal, October 2018
- Sewergate: Royal Botanical Gardens floats cleanup plan for Chedoke Creek – The Hamilton Spectator, March 2020
- What will the City of Hamilton do about pollution-plagued Cootes Paradise? – The Hamilton Spectator, April 2020
- Wetland Science & Practice: Vol. 36, No. 2 – Society of Wetland Scientists, April 2019

2.3.7 Presentation

- An Empirically-Based Regression Method for Estimating TP Loads to Hamilton Harbour from the Four Tributary Inputs – MOECC, January 2015

2.3.8 Sampling Data

- City of Hamilton Sampling Data - Appendix B to Report PW19008 – City of Hamilton, 2018
- Main King CSO 2019 Concentrations – City of Hamilton, 2019
- Main King Grab Samples – City of Hamilton, September 2018
- Microbial Insights Data - Chedoke Creek Sediments – Microbial Insights, September 2018
- RBG Fishway Summary Table – Royal Botanical Gardens, n.d.
- SGS Field Data - Chedoke Creek Sediments – SGS Canada, September 2018
- Water Quality Data from HCA (2014-2018) – Hamilton Conservation Authority, 2018
- Water Quality Data from RBG (1986-2017) – Royal Botanical Gardens, 2017

3 TIMELINE

An issues timeline summary table and a recommendations timeline summary table were developed to help identify the issues related to Chedoke Creek and recommended upgrades. These timelines are presented in **Figure 1** and **Figure 2**.

Figure 1: Chedoke Creek Issues Timeline

Main/King CSO event — MECP order

	Before 2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Future
Chedoke Creek / Cootes Paradise				erosion from Longwood Road to Cootes			erosion around landfill						wetlands are damaged (changes to land use, fertilizer, sediment runoff, sewage)			algae blooms and low DO					Increased precipitation - sewer overflows and urban runoff	
																Lake Ontario water level fluctuation	Lake Ontario water level fluctuation				water clarity is not improving	
Landfill	organic loaded seepage from dump								iron from landfill exceeding sewer limits	water quality issues in nearshore groundwater (upstream of existing LCS on east side of creek)										significant volumes of unimpacted creek water collected by LCS	landfill leachate seeping into creek continuing to add copper	
													Creek water bypassing armour stone wall		surface water impacting LCS							
													excessive LCS pumping									
Wastewater	high nutrient inputs (ammonia & phosphorus) from CSOs												increased precipitation; additional sewer overflows				60 CSO events at Aberdeen; increased E. coli		CSO overflows		surface water quality impacts from CSO limited to E.Coli and TP	
																					increased precipitation causing sewer overflows	
Stormwater	high levels of PAH in sediments from Highway 403 runoff								phosphorus loading and pesticide use in urban area		poor storm water quality; excessive nutrient, sediment and contamination				urban runoff water quality issues	high concentration of nitrate, phosphate and chloride from urban sewage cross connections	cross connections on West Hamilton Mountain; nitrogen and phosphorus		increased precipitation and lake levels; TP and TSS		increased precipitation causing increased urban runoff	
															TP higher during rain/melt events				elevated chloride from road salt on Highway 403		increased chloride from road salt	
Other									contamination from roadway salt				Seep C2 is fed by shallow flow regime recharged									
													phosphorus needs to be reduced									
													water clarity issues									

Figure 2: Chedoke Creek Recommendations Timeline

Main/King CSO event — MECP order

		Before 2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Future
Chedoke/ Cootes	**Recommended**	**Ditch Design** - Chedoke Creek ditch needs to be redesigned to promote flow (RBG)						**Erosion & Slope Stability Class EA** - Address erosion with slope stability and landfill leachate seeps along east bank of creek		**Subwatershed Restoration** - reduce sedimentation and phosphorous loading through urban SW best management practices, increasing natural cover, increased awareness of phosphorous loading and natural channel design (HCA)								**Wetland Conservation** - re-contouring the delta to create a natural riverbank level (berm), followed by replanting cattails. (RBG)			**Remedial Action Plan** - physical capping, chemical inactivation, direct removal, hydraulic dredging of targeted organic material (Wood)	**Remediation Plan** - shoreline wetlands, floating wetlands, mixing weirs, river oxygenation, rock lining, shrub buffer and pedestrian path (RBG - 25 Yr MP)	
	Implemented								**Chedoke Creek Remediation Project** - installation of bank stabilization structure, revegetation and log vanes										**Berm** - RBG started building a berm with Christmas trees				
Landfill	**Recommended**													**LCS pump control logic** - use storage in LCS collection pipe to increase wet storage, modify pump control system to reduce pumped volume and pump on/off cycles (UEM)		**Data Logger** - to record water level to assist in determining whether surface water is impacting the LCS on an ongoing basis (MTE)		**Monitoring** - continue regular groundwater monitoring (UEM) **Groundwater interceptor system** - extension to the south (UEM)					
	Implemented								**Leachate Collection System** - operational										**Leachate Collection System** - Extension to the south				
Wastewater	**Recommended**							**Highway 403 Trunk Sewer** - twinning (KMK)					**RTC Phase 1** - Confirm implementation date (Stantec)					**Remedial Actions** - CSO improvement, cross connection removal, SW management (RGB)		**CSO diversion study** - investigate feasibility of diverting additional flows from uncontrolled CSO basins into facilities (Hatch)	**CSO Diversion Study** - initiate study (Hatch)	**CSO Facilities** - improve monitoring and control (Hatch)	**Real Time Control (RTC) Program** in combined sewer system (Stantec)
	Implemented	**Main/King CSO tank** - operational							**Royal Avenue CSO tank** - operational				Sewer lateral cross connection program										**Highway 403 Twinning** - divert flows from Aberdeen overflow
Stormwater	**Recommended**									**Stormwater Management** - to reduce phosphorus loading, implement SW best management practices including before and after development occurs, increasing natural cover and increased awareness to practices constributing to phosphorus loading								**Urban Runoff Management** - increasing infiltration, evapotranspiration and on-site retention through LIDs can reduce phosphorus loads	**Dye Test** - to locate illegal cross connections				
	Implemented																						
Other	**Recommended**																				**DO index monitoring** - process to monitor targets is needed (RBG)	**Remedial Actions** - re-establish macrophyte species in native marsh habitats through planting efforts and control of invasive plant species (Yang, C. et al)	
	Implemented	**Carp Exclusion Barrier** - Operational																					

Recommended & Implemented

APPENDIX B:CONSULTATION OVERVIEW

Hamilton

BluePlan ENGINEERING

Chedoke Creek Water Quality Improvement Study – Kickoff Meeting

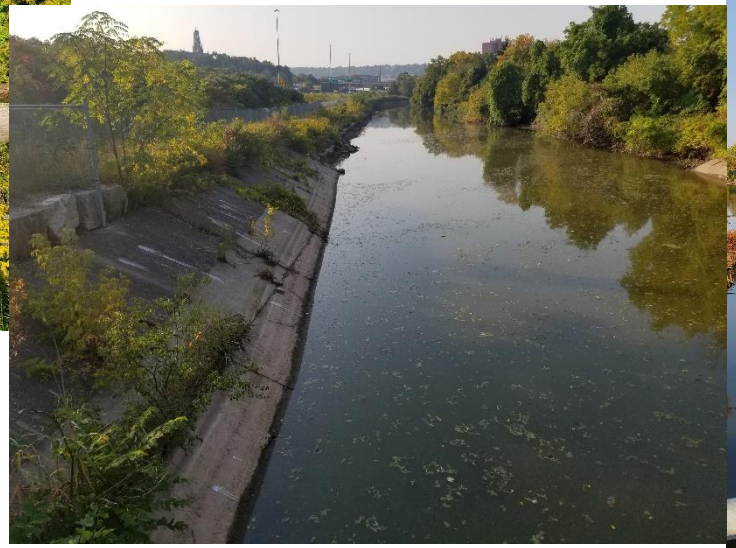
City of Hamilton

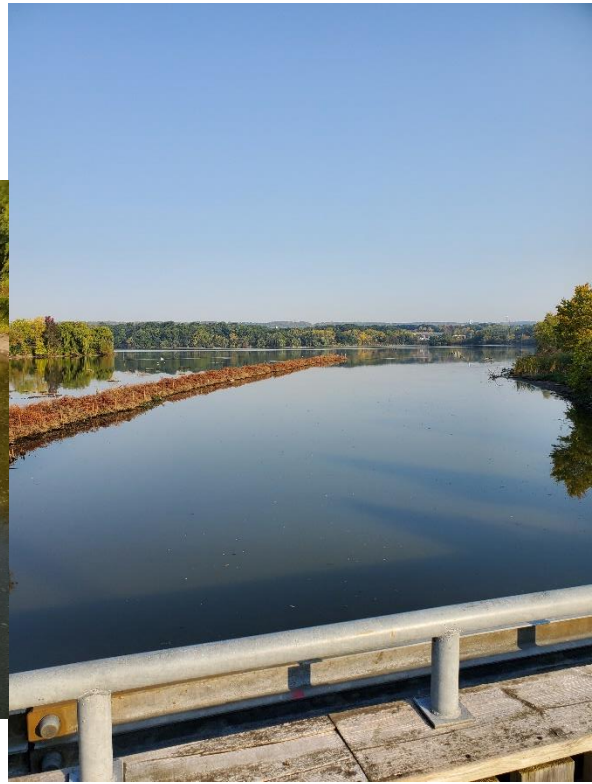
October 27th, 2020

Agenda

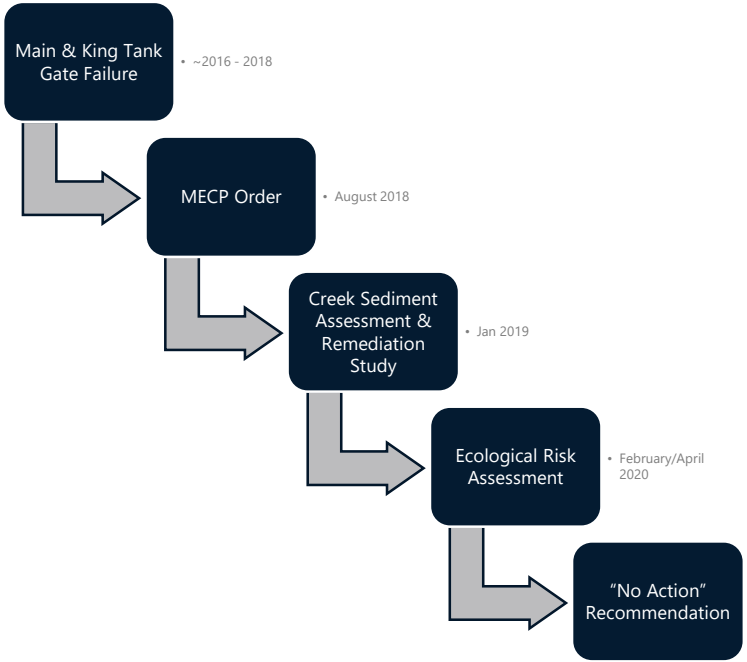
- Introduction/Meeting Objectives
- Project Objectives and Timeline
- Study Area and Key Components
- Historic/Ongoing Studies and Projects
- Scope of Solutions Under Consideration
- Stakeholder Perspective
- Next Steps

Chedoke Creek





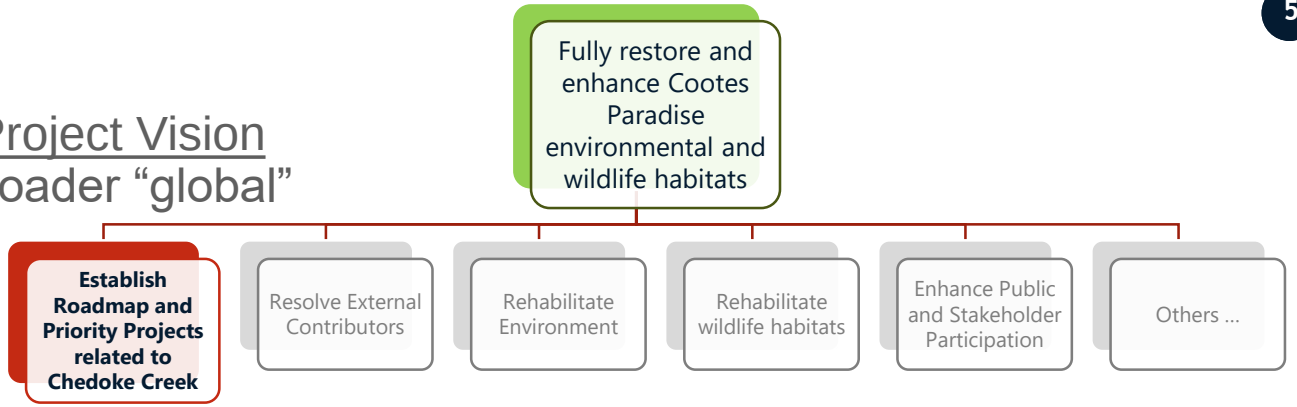
Project Trigger and Timeline



- Chedoke Creek and Cootes Paradise – Legacy issues and long-term remediation needs
- Main & King Overflow → Renewed attention/focus by public and stakeholders
- MECP Order → Short-term and focus on overflow events and remediation
  - Short-timeline → No opportunity for external stakeholder engagement
- Study found contaminants in Creek sediments
  - Likely the result of long-term contributions from point and non-point sources
  - Subject spill alone was unlikely to have contributed to observed conditions
- Legacy issues remain

Project Vision

- Need to focus on Project Vision within context of broader "global" vision



- Project Vision and Global Vision will require time to implement and achieve goals

Project Objectives

Holistic Review of Legacy Water Quality Issues

- Combined sewer overflows
- Urban runoff
- Landfill Leachate
- Historic Sources

Explore a Range of Preventative, Mitigative, and Restorative Solutions

- Within the upstream watershed
- At creek outfall locations
- Within/along the Chedoke Creek to Cootes

Stakeholder Engagement

- Expand understanding of the system, contributors, and potential solutions
- Review and provide comment on potential solutions
- Buy-in to solutions framework and implementation strategy
- Set foundation for future engagement and implementation

Identify Preliminary Best Value Solutions

- Needs to be effective and cost effective
- Need to focus on major sources
- Balance short-term vs. long-term solutions
- Collaboration of multiple partners

Project Outcomes

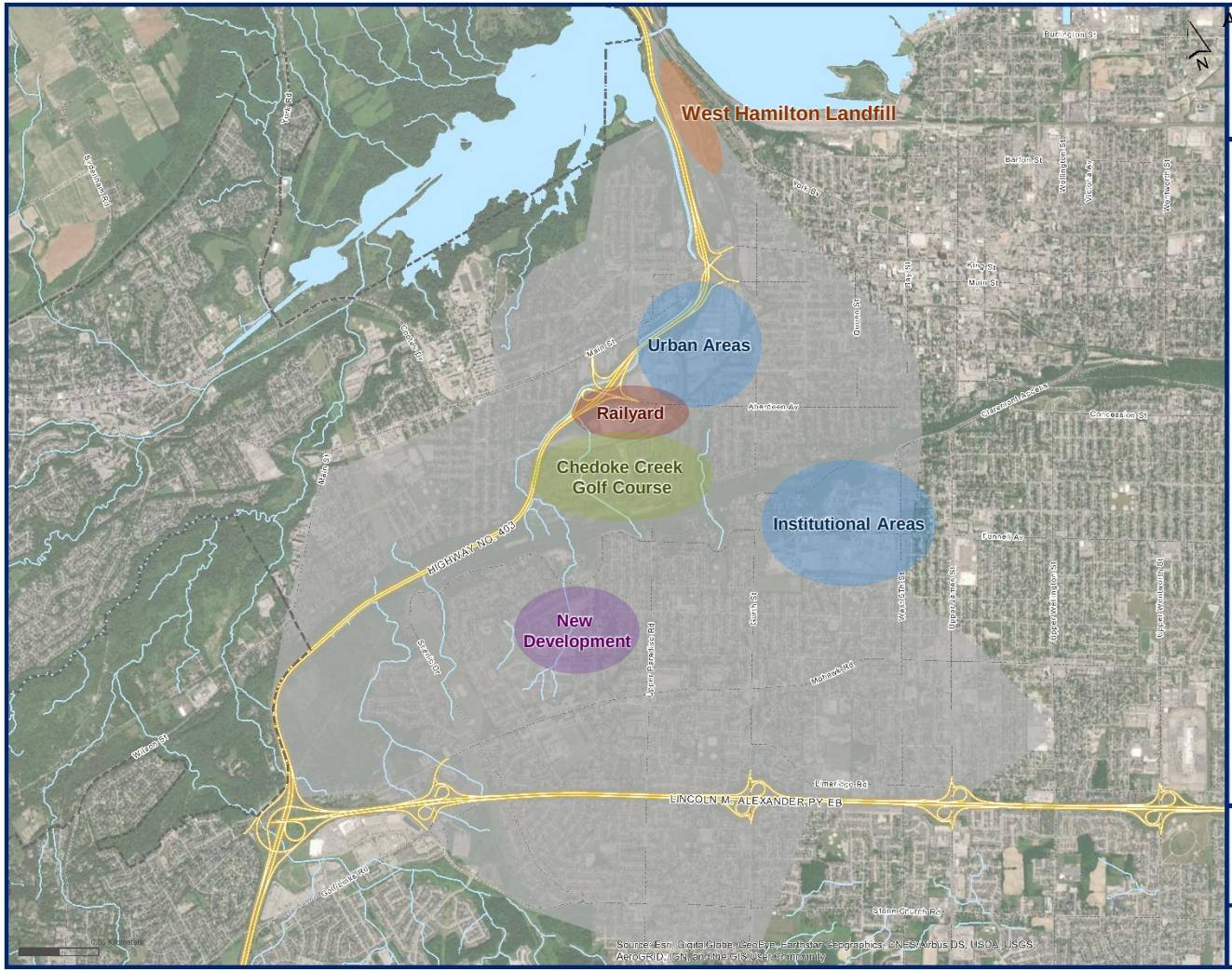
- What Is the End Objective?
  - Outline of the attainable long-term vision for Chedoke Creek
  - Framework and Implementation Plan for future action
  - Identifies a balanced suite of recommendations
    - Objectives,
    - Cost / Benefit,
    - Project Lead
  - Identifies the implementation process
    - Timeline,
    - Needed Studies / Investigations,
    - Triggers / Supporting Projects
  - Identifies potential short-term and quickly implementable solutions

- Project Limitations
  - 4-Month Study
  - Based on best available information → Leveraging existing reports (desktop)
  - Limited new detailed investigation & assessment
  - Additional steps will be needed to implement major components
  - Success dependent on Stakeholder input and collaboration

Project Timeline & Meetings

Historic/Ongoing Studies and Projects

Chedoke/Cootes	Stormwater	Wastewater	Landfill	Other
•Water Quality Monitoring •Creek rehabilitation •Contaminants and sediment testing/monitoring •Species survey and investigation •Watershed management & Cootes remediation •MECP response investigation •RBG Master Plan •Hamilton Harbour Remediation	•Master Plan(s) •Ainslie Wood / Westdale Neighbourhoods Class EA •Annual CSO reporting	•Annual CSO reporting •CSO tank construction •Outfall monitoring feasibility •RTC Phase 1/2 implementation •Sewer upgrades •Master Plan(s) & PPCP •Sewer lateral cross-connection program	•Annual leachate system performance reporting •Ground water monitoring •Slope stability improvements	•Growth and Intensification •LRT •Infrastructure renewal



Hamilton

Chedoke Creek Water Quality Improvement Study

General Features

- Highways
- Major Roads
- Urban Boundary
- Municipal Boundary
- Waterbody
- Watercourse

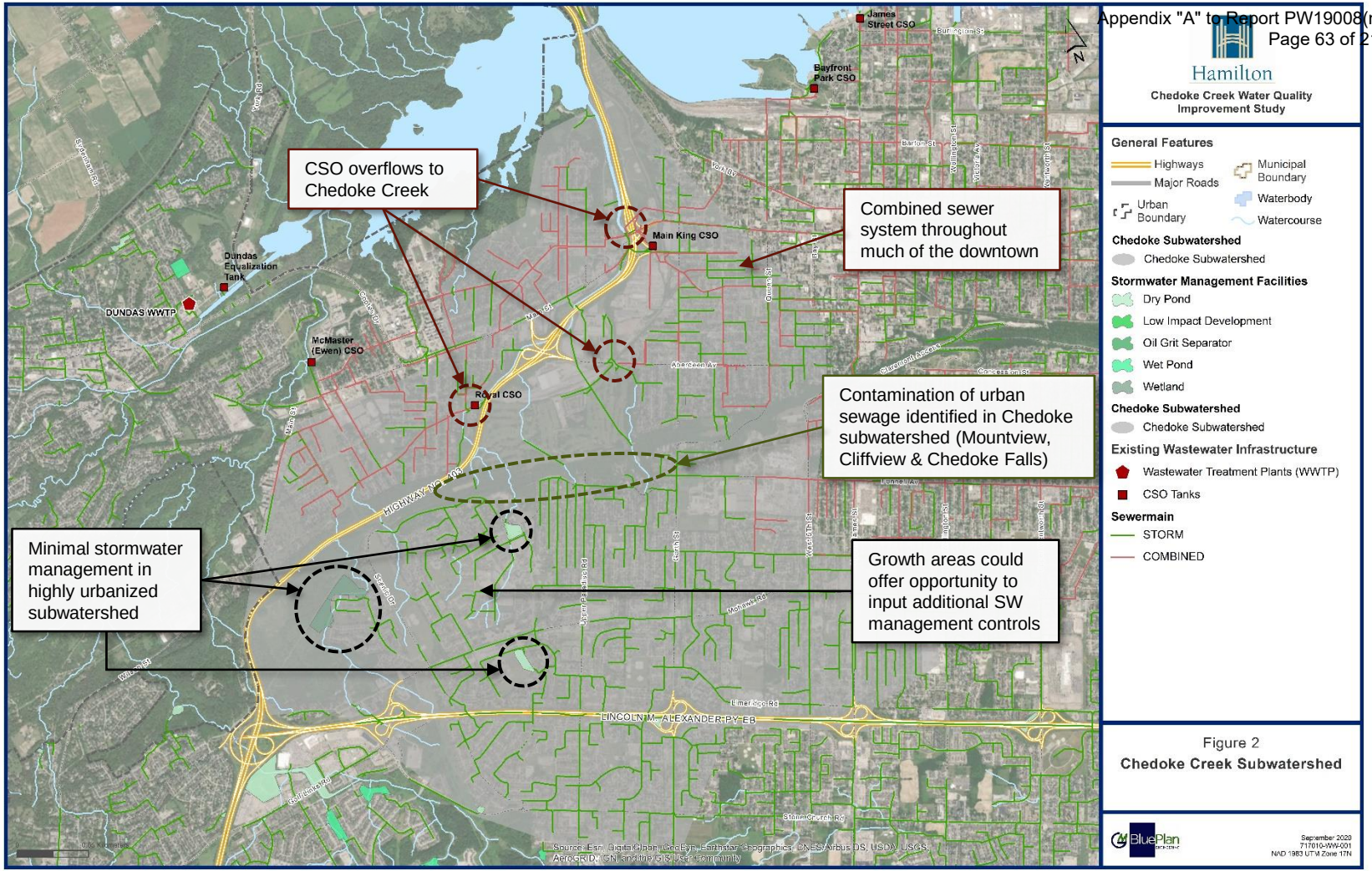
Chedoke Subwatershed

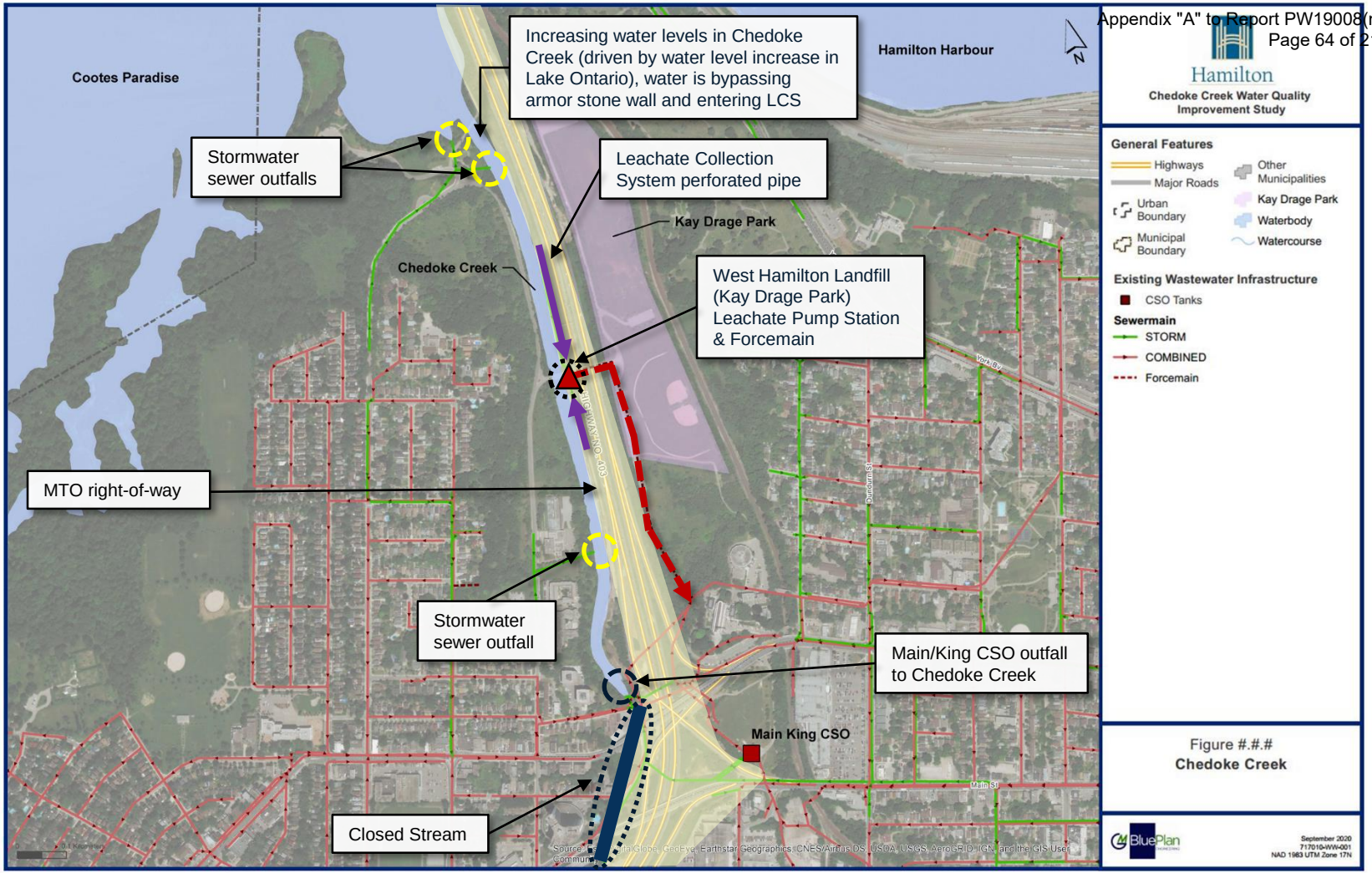
- Chedoke Subwatershed

Figure 1
Chedoke Creek Subwatershed

BluePlan

September 2020
717010-WW-001
NAD 1983 UTM Zone 17N


CSO overflows to Chedoke Creek
Combined sewer system throughout much of the downtown
Contamination of urban sewage identified in Chedoke subwatershed (Mountview, Cliffview & Chedoke Falls)
Minimal stormwater management in highly urbanized subwatershed
Growth areas could offer opportunity to input additional SW management controls
James Street CSO
Bayfront Park CSO
Main King CSO
Dundas Equalization Tank
DUNDAS WWTP
McMaster (Ewen) CSO
Royal CSO
HIGHWAY 403
LINCOLN M. ALEXANDER PY-EB
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Hamilton
Chedoke Creek Water Quality Improvement Study
General Features
Highways
Major Roads
Urban Boundary
Municipal Boundary
Waterbody
Watercourse
Chedoke Subwatershed
Chedoke Subwatershed
Stormwater Management Facilities
Dry Pond
Low Impact Development
Oil Grit Separator
Wet Pond
Wetland
Chedoke Subwatershed
Chedoke Subwatershed
Existing Wastewater Infrastructure
Wastewater Treatment Plants (WWTP)
CSO Tanks
Sewermain
STORM
COMBINED
Figure 2
Chedoke Creek Subwatershed
BluePlan
September 2020
717010-WW-001
NAD 1983 UTM Zone 17N


Increasing water levels in Chedoke Creek (driven by water level increase in Lake Ontario), water is bypassing armor stone wall and entering LCS
Hamilton Harbour
Cootes Paradise
Stormwater sewer outfalls
Leachate Collection System perforated pipe
Kay Drage Park
Chedoke Creek
West Hamilton Landfill (Kay Drage Park) Leachate Pump Station & Forcemain
MTO right-of-way
Stormwater sewer outfall
Main/King CSO outfall to Chedoke Creek
Main King CSO
Closed Stream
Hamilton
Chedoke Creek Water Quality Improvement Study
General Features
Highways
Major Roads
Urban Boundary
Municipal Boundary
Other Municipalities
Kay Drage Park
Waterbody
Watercourse
Existing Wastewater Infrastructure
CSO Tanks
Sewermain
STORM
COMBINED
Forcemain
Figure #.#.#
Chedoke Creek
BluePlan
September 2020
717010-WW-001
NAD 1983 UTM Zone 17N

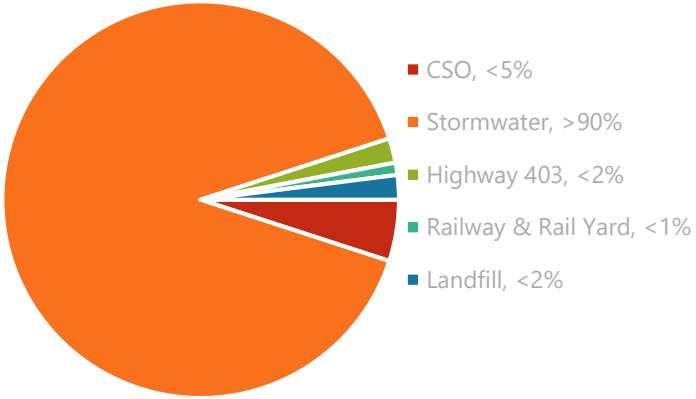
Overview of Potential Contributions

- Multiple Concerns
  - Diversion of Runoff – Reduce clean flow contributions
  - High Nutrient Loading
  - Metals and VOC/Oils
- Focus on Nutrient Loading
  - Trigger for major and sustained issues in Cootes
  - Addressing provides relief to other concerns

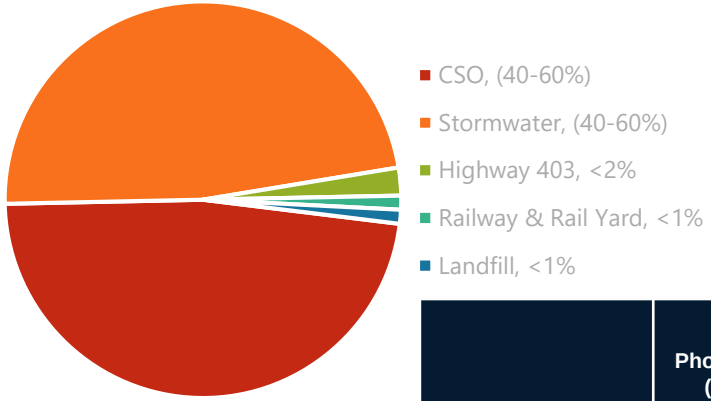
- Potential Nutrient Loading Sources
  - Combined Systems
    - Overflows – Major Point Sources
  - Stormwater Runoff
    - Wash off from residential and other applications
    - Potential cross-connections
  - Landfill
    - Leachate infiltration into the Creek
  - MTO/Railway
    - Wash off from transportation and potential spills

Overview of Potential Contributions (Example)

TP Loading - Average Year



TP Loading - Peak Event



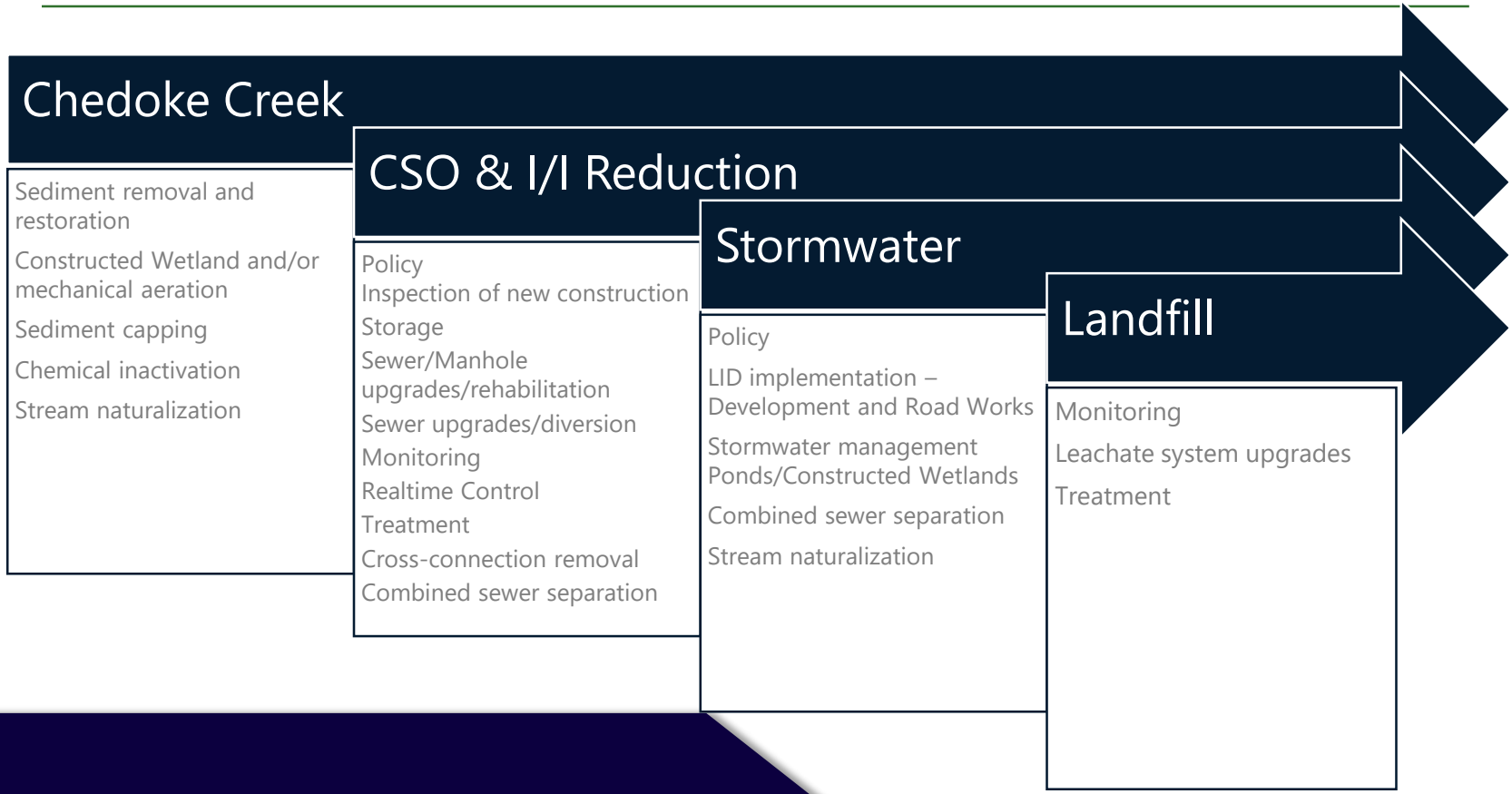
- High level estimate of the relative contributions
- Used to provide guidance to identify priority areas and potential benefits
- Uses existing quality monitoring data and reporting
- Intended to represent a typical year

Data Sources

- CSO Annual Reports (2015-2019)
- WQ Sampling HCA, RBG, and EME (1994-2019)
- Landfill Annual Monitoring Report (2015-2019)

	Total Phosphorus (mg/L)	Ammonia + Ammonium as N (mg/L)	Total Suspended Solids (mg/L)
Combined Sewer Overflows	0.3 – 3.5	0.4 – 1.94	27 - 334
Stormwater Runoff - Residential	0.032 – 2.78	<0.01 – 14.2	2.2 - 104
Stormwater Runoff - Highway 403			
Stormwater Runoff - Railway & Rail Yard			
Landfill Leachate	0.063 – 2.25	0.6 - 220	1.1 - 791

Potential Solutions to Consider



Stakeholder Perspective

Key Elements

- Location/Infrastructure
- Past/Planned monitoring/Improvements
- Past/Planned studies/Investigations
- Performance/Issues over time (improvement/degradation)
- Observations
- What is important?
- What influences water quality to Chedoke Creek

Potential Solutions

- What has been recommended?
- What has been implemented? Was it effective?
- What wasn't implemented? Why?
- What was considered but not recommended? Why?
- What new solutions should be explored?
- What are non-starters?

Next Steps

- GM BluePlan

Identification of Potential Solutions

Assessment of Potential Solutions

Solutions Development Workshop – Late November/Early December

- Your Participation (Email Response by November 6th)

Input on the System

- Do you have any additional information on the Chedoke Creek

Feedback on the Vision

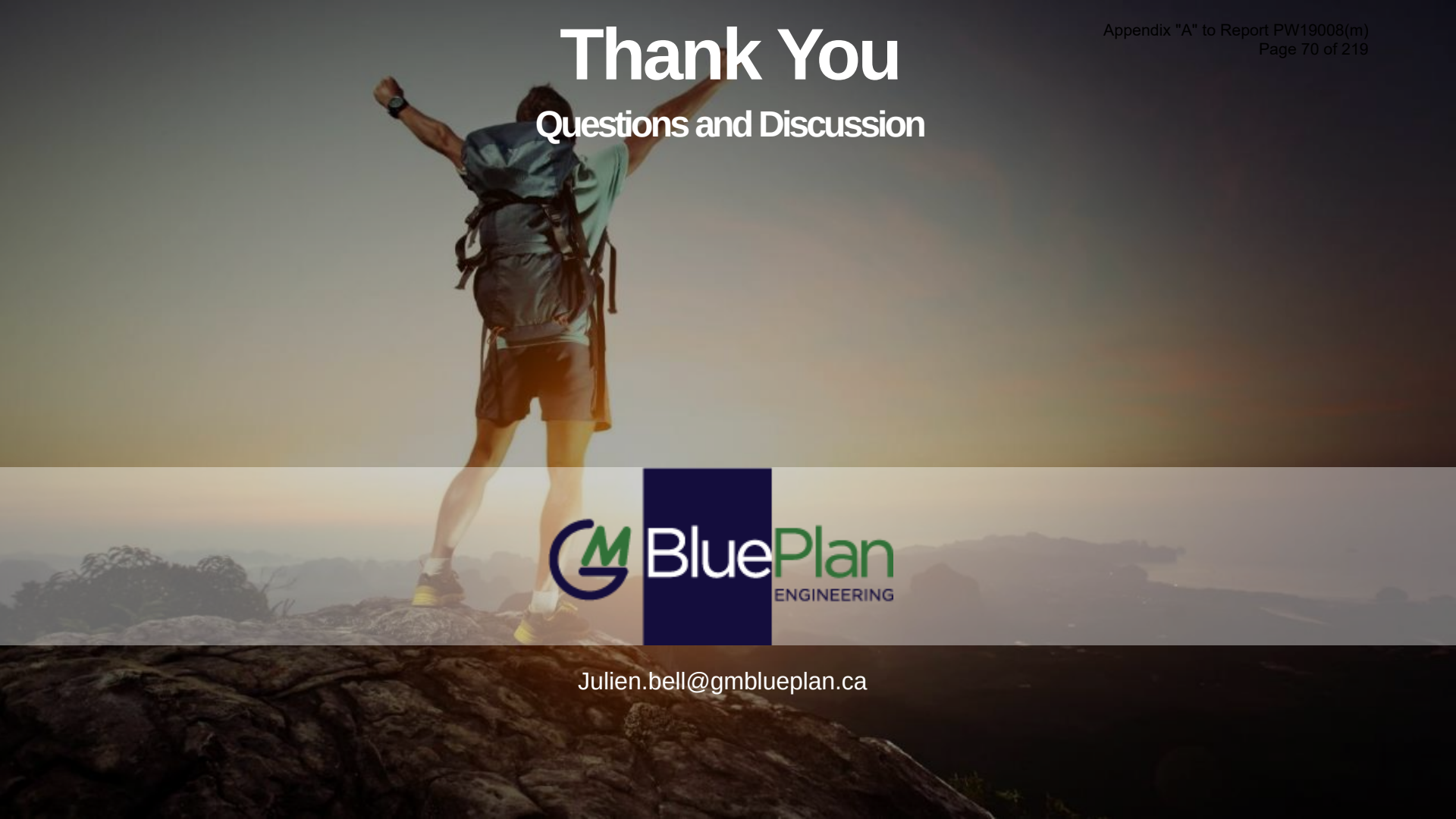
- Do you think any thing is missing from the long-term vision?

Feedback on Potential Solutions

- What options do you think should be considered?
- How should the options be evaluated?

Thank You

Questions and Discussion



GM BluePlan ENGINEERING

Julien.bell@gmblueplan.ca

City of Hamilton
Chedoke Creek Water Quality Improvement Study
GMBP File No. 620083
External Stakeholders Workshop #1

Minutes

DATE: Tuesday, October 27th, 2020
9:00 AM – 12:00 PM
LOCATION: Go-to-Meeting

ATTENDEES:		
	Chris MacLaughlin (CM)	Bay Area Restoration Council
	Christina Cholkan (CC)	City of Hamilton
	Mani Seradj (MS)	City of Hamilton
	Jonathan Bastien (JBa)	Conservation Hamilton
	Scott Peck (SP)	Conservation Hamilton
	Lynda Lukasik (LL)	Environment Hamilton
	Christine Boston (CB)	Fisheries and Oceans Canada
	Julien Bell (JB)	GM BluePlan
	Chris Hamel (CH)	GM BluePlan
	Michelle Klaver (MK)	GM BluePlan
	Kristin O'Connor (KO)	Hamilton Harbour Remedial Action Plan
	Drew Wensley (DW)	MT Planners
	Tara McCarthy (TM)	MT Planners
	Ehab Armanious (EA)	Ontario Ministry of Transportation
	Shahbaz Asif (SA)	Ontario Ministry of Transportation
	Mark Runciman (MR)	Royal Botanical Gardens
	Tys Theysmeyer (TT)	Royal Botanical Gardens
	Ron Scheckenberger (RS)	Wood

COPIES TO: All Attendees

Minutes

1.	**Introduction** **Objectives** • The primary objective of this external stakeholder workshop is to receive feedback and perspective from external stakeholders who have context, experience and insight into the project, that may not otherwise be available to the project team **Introductions** • All stakeholders gave a quick introduction including what organization they are from and their roles at the organization: o Chris MacLaughlin: Director of Bay Area Restoration Council (BARC) - Director o Christine Boston: Hamilton Harbour Remedial Action Plan (HHRAP) – Co-Chair o Drew Wensley: MT Planners - CEO of Planners and involved in the Master Plan for Royal Botanical Gardens (RBG) o Jonathan Bastien: Hamilton Conservation Authority (HCA) - Water Sampling Program Manager o Lynda Lukasik: Environment Hamilton (EH) – Involved with tracking water quality in Redhill Creek and dealing with cross connections in Chedoke Upper Subwatershed o Mark Runciman: RBG – CEO o Scott Peck: HCA – Deputy Chief Executive Manager o Tara McCarthy: MT Planners – Involved in RBG 25 Year Master Plan o Tys Theysmeyer: RBG – Head of Natural Areas o No introductions from Ehab Armanious and Shahbaz Asif who were in and out of the meeting: Ontario Ministry of Transportation	**Actions**

2.	**Project Trigger and Timeline**
	
	• This project builds off the 2018 MECP order related to the dry weather sewage spill to the Chedoke Creek
	  ○ This event brought renewed interest from the public with increased focus on the Chedoke Creek
	  ○ The MECP order had a short time frame which restricted external stakeholder engagement
	  ○ The investigations related to the MECP order were focused on mitigating the impacts of the overflow event and not addressing long term issues within the creek itself
	  ○ From these investigations it was determined that there were contaminant issues within the creek as a result of point and non-point sources
	  ○ The recommendation from the study was to do nothing, which did not resolve legacy issues within the creek and was not well accepted by external stakeholders and the public
	• This study is not specifically related to the overflow event but looking at the long-term vision and road map to addressing water quality in Chedoke Creek	

3.	**Project Vision** • The City's long-term vision is to restore Cootes Paradise; recognizing that to achieve this there are many individual pieces that need to be considered • The focus of this study is on Chedoke Creek piece and not the entire Cootes Paradise • There have been many studies related to Chedoke Creek; however, all studies have been independent of each other • This study is intended to not only establish a short-term implementation plan, but to set out a long-term vision • Our project goal therefore is to look at everything together and establish a road map and long-term plan for Chedoke Creek, with recommendations for short-term actions	
4.	**Project Objectives** • The main objective of this study is to take the legacy work that has been completed in the past and look at it in the context of the broader system. • All past recommended solutions will be reviewed, including looking at the watershed, non-point sources, point sources and the creek solutions. • Solutions could include preventative, mitigative, and restorative measures. • This study will develop a framework/implementation plan to address these long-term legacy issues • Stakeholder engagement will continue to be a key component of this study ensuring the internal & external stakeholders are involved and on board with the final solutions • The overall goal of this study is to identify the best value solutions for the Chedoke Creek as a whole	

5.	**Project Outcomes**
	
	• The Project Team will provide a fresh perspective for the Chedoke Creek Water Quality Study. The following are some of the projected study outcomes:
	  o Outline a long-term vision of the Chedoke Creek
	  o Establish a Framework and Implementation Plan
	  ▪ What actions and studies need to be implemented in what order?
	  ▪ How to prioritize solutions?
	  o Identify a balanced suite of recommendations including:
	  ▪ Cost/Benefit review
	  ▪ Who (City, MECP, MTO, RBG, etc.) is responsible for implementing these solutions?
	  o Identify an Implementation Process
	  ▪ Outline time frame for implementing the suite of solutions
	  ▪ Identify clearly the future studies/investigations required
	  ▪ Based on the legacy work there will be likely be a number of studies that the City will be able to implement in the short-term
	
	• Limitations of this study were also discussed:
	  o This study is being completed in a short timeframe, with the final report to be completed by the end of 2020.
	  ▪ Meeting this schedule will be dependent on the availability of stakeholders, and the ability to set up timely meetings with them.
	  o The project team only has access to the information provided: If the City or external stakeholders have additional information/knowledge it will need to be brought forward initially to be incorporated into the review
	
	• LL Question: How will this relate to the MECP requirements for post-spill remediation. Has MECP accepted the City's consultants report that says 'no remediation required' in response to the spill?
	  o MS Response: Latest status as far as we are aware is that the MECP has not replied back to technical comments.
	  o MS will reach out to the Compliance and Regulations at the City and see what the latest status is on that.
	
	• DW: Indicated that there are concerns with the 'no action' response and a baseline should be established early in this study
	  o JB: The MECP order and recommendations are being considered in this study in establishing the long term vision; if MECP identifies further objectives early they can also be considered in this study
	
	• MS: The past studies were focused on the CSO spill alone; this study takes a broader perspective in that it considers the health of the watershed and looks
		MS – Find out latest status on MECP.

	at other sources of contamination of the creek on a holistic basis. It goes beyond just considering the spill.
	
	• CM identified other study considerations:
	  ○ Does the City have a budget for short term projects?
	  ○ Will Council approval be required?
	  ○ One concern is that the MTO was filling parts of open floodplain with concrete. Is there going to be communication with MTO in this study as to any future works? Are there other stakeholders to be consulted with?
	• The implementation plan identified in this study, will identify the long-term approval requirements need to implement the recommendations (including Council approval and budgetary considerations).
	• GMBP and the City will identify if other stakeholders should be consulted with.	

6.	**Schedule**
	
	• The project schedule was reviewed including:
	  ○ September: Background Review
	  ○ October: Solutions Development
	  ○ November: Solutions Evaluation
	  ○ December: Draft Recommendations
	• To meet this schedule, the project team is reliant on historic studies; stakeholders will need to provide any key reports and feedback that they have early in this process so that they may be incorporated into the review process.	

7.	**Study Area** • Figures of the study area, including subwatershed and the creek channel were presented with key areas and issues highlighted • It was noted that when looking at the Chedoke Creek study area, it is important to consider the Chedoke Creek in the context of watershed as a whole. • There is very limited existing stormwater management within the catchment; very little quality control before discharging into Chedoke Creek • There are multiple potential contributors and multiple factors that need to be considered. Challenges include quantifying solutions to determine if one is more beneficial than another. This study will utilize all current information available and stakeholder input to develop the short-term implementation and long-term vision and will contribute to the goal of restoring Cootes Paradise.	

8.	**Overview of Potential Contributions**
	
	• GMBP presented questions to stakeholders:
	  ○ How do we manage these concerns?
	  ○ How do we quantify in a way that is clear, understandable and measurable?
	  ○ Are we on the right path or do we need to adjust?
	• Going to focus on nutrient loading as they are a good analog for everything (metal, VOCs/oils) as a whole	

9.	**Example**
	
	• GMBP presented an example of nutrient loading involving Total Phosphorus to show a magnitude of the different contributors including:
	  ○ CSO
	  ○ Stormwater
	  ○ Highway 403
	
	• On an average year, >90% is coming from stormwater runoff
	• Need to determine how much should be focused on an average year vs. peak loading events as it related to creek health
	• Dry days will also be beneficial to look at for contributors such as the landfill
	• Through this study, GMBP will consider the magnitude of the potential contributors and the potential reductions in loading that can be achieve in order to identify the costs/benefits of the solution.	

10.	**Potential Solutions to Consider** • There are many potential solutions to consider and it is important to explore all solutions as they relate to the entire watershed and system • All restorative, mitigative and preventative solutions including CSO and I&I reduction, stormwater management and landfill options will be considered • LL: Indicated that the data indicates that Hamilton may wish to consider a stormwater fee program, one that, ideally, incentivizes action to manage stormwater on property (The feasibility of this will be noted in the study).	

11.	**Stakeholder Perspective**
	
	• All of the external stakeholders highlighted key components of the subject area that they are currently involved with, provided input for the study, and posed questions for the project team. These comments and input will be considered in the study.
	
	Chris MacLaughlin – BARC
	
	• What limitations have we been given? Financial or otherwise?
	  o JB: The City hasn't provided limitations, but solutions must be realistic. We are identifying the solution as well as the cost benefit of each. At this stage, nothing is off the table, but as we work through this process and set the framework and plan, we will identify which possible solutions that are and are not achievable and the reasoning behind it.
	• Is November 6th a hard date?
	  o JB: The goal is to have a draft vision by the end of the year which will rely on feedback being provided in a timely manner.
	• People doing things in clean water such collecting wild rice in the mouth of Chedoke River is a remarkable vision that would resonate well with the public. These types of projects are going to generate enthusiasm for public.
	• There has been a history of big infrastructure projects as solutions to all problem, and this is not always the right decision as they don't address water quality problems upstream.
	• Councilors must buy-in to the benefits of the solutions.as they will dictate whether they are implemented or not.
	• There is a role for entire community to play in terms of stormwater.
	• Important for City staff to know there are non-profit groups and citizens that form a community of concern.
	• Must start with the end goal; vision of where we need to be
	
	Drew Wensley – MT Planners
	
	• MT Planners completed the 25-Year Master Plan for RBG
	• MR introduced the RBG 25-Year Master Plan
	• DW walked a group through the RBG 25-Year Master Plan document which was approved in June 2020
	• Key takeaways from the RBG 25 Year Master Plan include:
	  o Looked at Regional perspective
	  o Expanding urban pressures having detrimental effect
	  o Immediate action needed for long term care
	  o Have to achieve this through system understanding
	  o Looked at solutions that deal with long term challenges and immediate needs
	  o An anatomy and geomorphology study was completed that could be important for this Chedoke Creek study
	  o Environmental Enhancement – adding more storm ponds, bioswales, tec.
	  o Completed a water balance study for a bioremediation facility in Riyadh	

	○ Engineered solutions are part of the solution but there are also ecological solutions ○ RBG is planning a lot in the next few years in terms of trails ○ Study after study is not the solution; need action to follow implementation ○ Need commitment of money to use towards environment ○ Lake level is important to water quality as it impacts the shoreline ○ Lake levels in broader view is important to tie into study Tys Theysmeyer – RBG • How much of Chedoke is infilled – can you tear back? Or do you start from scratch at the mouth • Paradise Point is the access to the water • What are shorter term solutions so that people can trust the water again? • As much as 1/3 of water is piping through Chedoke Creek area – get a handle of that area and see what can do; this wastewater is crossing Chedoke Creek • Have completed projects with local Indigenous groups; if we deal with Chedoke properly – the Princess Point would be a prime time wild rice area • From Water Quality – in the case of phosphorus it needs to get treated differently; how it gets presented is relatively important • Seasonality is quite significant as even the worst of worst events could present minor impacts on Cootes Paradise in March but the same event in summer is the whole impact on Cootes Paradise • Iroquoia Heights is a significant contributor of stormwater that goes into combined sewer; look into this to have more clean water directed to Cootes • Great Lakes Fishery – watching fish spawn will draw people to the area • HCA is best available data for water quality sampling • Has the project team reviewed any Redeemer College data? • Community engagement need to be within top 10 of priorities. Tara McCarthy – MT Planners • Public trust is an important piece of this study • Personal accountability for what people can do upstream to help with the solutions if they admire the water • Economic gains realized from improved water aesthetics Jonathan Bastien – CH • In charge of the watershed management including water quality monitoring • HCAs monitoring provides a good indication of where we were, where we're at, where we will end up in terms of water quality • High level overview of Kay Drage Park sampling ○ 2014, 2015 and 2016: elevated levels of E.coli, phosphorus (TP) ○ 2017, 2018: significantly elevated levels of E.coli, phosphorus ○ 2019, 2020: levels are lowered and are in the long-term average range; TP was 0.2-0.3 mg/L and objective is 0.03 mg/L • Increased monitoring program in 2018 with 4 additional sites in Chedoke Creek • In 2019-2020, the upstream sites have significantly higher concentrations than downstream, and these sites are much higher in these concentrations than any other sites. E.coli and TP fluctuate significantly in all of these sites based on the	JBa - Provide Coles Notes for water quality sampling

	week. E.coli elevated in wet compared to dry events, which was not the case for TP. Take away from sampling is there is a baseline WQ issue throughout Chedoke Creek that is not a storm event related problem but all the time related problem. • In 2019-2020, CP-11 is more in the range of the long-term average with improvements from 2014-2018 which is due to the lack of spill, but this isn't necessarily the end goal. • Want to expand monitoring program into more sites in Chedoke Creek including tracer for what kinds of E.coli are present. • Will provide Coles Notes in email by Nov 6th deadline Kristin O'Connor - HHRAP • MTO needs to be engaged or else there are solutions above or below MTO corridor; HHRAP doesn't attempt to engage them anymore • E.coli is the more important nutrient for public trust, phosphorus is great, and scientists love it but E.coli is for public trust to identify safety. It should be an element of this for what we look at • Long term ownership is an issue – who owns it, who is going to be responsible for maintenance 30 years from now. No one will want to take responsibility for future fixes so we need to be clear about who owns these things and who will be responsible for paying these and how it will be funded. • Bigger broader concept – It is important that the staff from City of Hamilton understand stakeholder issues and concerns, and address these concerns, so that it does not become an "us vs. them" scenario. • Great lakes is really focused on fixes and projects so there could be opportunity for grant. If we can tie this into this into restoration of Hamilton Harbour there is opportunity to get funding. Will forward on in email. • Will forward on in email • Important to look at solutions that are implementable and manageable • I would want to see those pie charts for parameters beyond phosphorus. Yes, the rail yards and landfills might be low for phosphorus, but are they having impacts for potentially concerning elements? Lynda Lukasik - EH • Climate and climate issues are important and should be a driving force, need to use climate lens • This study should take into account policy challenges that the City is dealing with including: o A stormwater fee for the City of Hamilton that incentivizes stormwater management on properties should be considered; urge everyone to push this o Green development standard. Need to pay more attention in watersheds (eg. green roofs) o Positive changes in Chedoke watershed are changes that should be sustained • If we do a good job in Chedoke watershed, there is a better chance to have it carried throughout the City (i.e. Redhill: positive lessons learned swiftly applies to other watersheds) • We are at a critical point in the growth management which could have huge implications. The City needs to plan growth as there is pressure to expand	KO - Forward on Great Lakes funding information.

	urban boundary. This will create challenges and we need to speak to how we accommodate growth to make urban waterways healthier. Scott Peck - CH • Water monitoring program is ongoing and done in partnership with MECP when funding is available. We see this as ongoing and increasing for Chedoke Creek and for wherever it is needed in Cootes Paradise watershed. • Watershed health perspective is to identify restoration and hotspots • Looking forward through the current mapping, there are opportunities for stormwater retrofits such infiltration instead of combined systems • Retrofits are very important • Look at overall functioning of system – are the combined sewers doing what we want them to be doing. partnership and working together is incredibly important. • MTO missed huge opportunity when doing channel. CH was not approached for permits.	
12.	**Discussion** JB to group: What are key sensitivities for the overall importance to health and importance to Chedoke and Cootes? What is the most important design scenario? Is there one we should be focusing on? • TT response: o Peak events are much more dramatic than the average year stormwater o Ongoing variability in terms of water sampling, sorting out the variability deals with day to day water quality JB: were financials completed for the RBG 25-Year Master Plan? • MR: Financial Plan is included in the Master Plan which can be provided – this includes aeration system, etc. JB: Is this only in the RBG lands or are there other solutions related to the broader upstream in the RBG 25-Year Master Plan? • DW: there is a zone of influence and principles piece that looks at water quality as it is related to beyond the boundary, but the actual MP looks at boundary. This includes recommendations and stormwater strategies beyond border. JB: How critical are RBG solutions relative to overall solutions. Are aerators still critical if upstream improvements are achieved? • DW: Built infrastructure is still important; City agreed that aerators are an element of the solution. Aerators are seen as restorative and need support from the City as preventative/mitigative upstream.	MR to provide RBG MP financials

13.	**Next Steps** • GMBP to consolidate issues, potential solutions, what other possible solutions there could be • Next step is a solutions development workshop with Internal Stakeholders. • Stakeholders to provide feedback and any relevant information by November 6th • External stakeholders to meet again to discuss solutions evaluation.	

Hamilton

BluePlan ENGINEERING

Chedoke Creek Water Quality Improvement Study – Solutions Evaluation

City of Hamilton

December 2nd, 2020

Agenda

Last Workshop:

- Study Area and Key Components
- Historic/Ongoing Studies and Projects
- Stakeholder Perspective and Solutions Under Consideration

Today:

- Introduction/Meeting Objectives
- Framework Vision and Objectives
- Evaluation Process and Considerations
- Preliminary Solutions Discussion
- Next Steps

Introduction

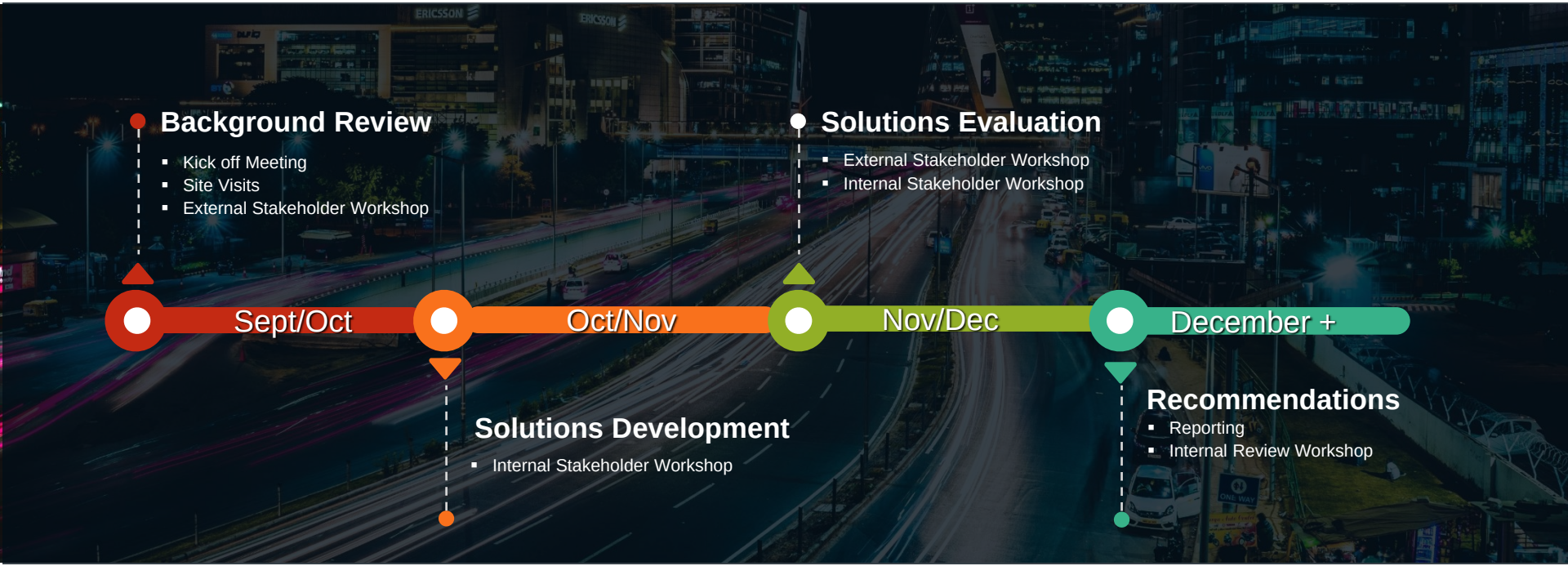
Attendees

- Chris MacLaughlin: Director of Bay Area Restoration Council (BARC) - Director
- Christine Boston: Hamilton Harbour Remedial Action Plan (HHRAP) – Co-Chair
- Drew Wensley: MT Planners - CEO of Planners and involved in the Master Plan for Royal Botanical Gardens (RBG)
- Jaydene Lavallie: Indigenous Water Walkers
- Jonathan Bastien: Hamilton Conservation Authority (HCA) - Water Sampling Program Manager
- Kim Barrett: Conservation Halton (CH)
- Kristin O'Connor: HHRAP
- Lynda Lukasik: Environment Hamilton (EH)
- Mark Runciman: RBG – CEO
- Scott Peck: HCA – Deputy Chief Executive Manager
- Shahbaz Asif: Ontario Ministry of Transportation (MTO)
- Tara McCarthy: MT Planners – Involved in RBG 25 Year Master Plan
- Tys Theysmeyer: RBG – Head of Natural Areas

Today's Objectives

- Present **Preliminary** Framework of Vision and Solutions
- To seek input and feedback on
  - Vision
  - Evaluation Approach
  - Preliminary Findings
- Support refinement before preparation of final Framework of Vision and Solutions
- Discuss next steps for this project and the Framework

Project Timeline & Meetings



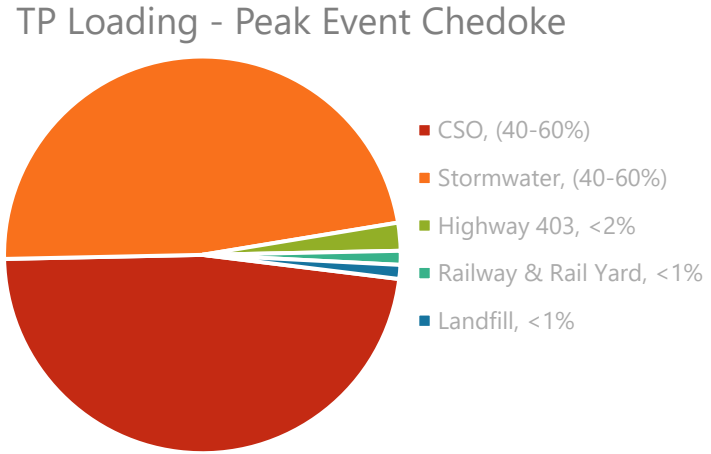
Project Outcomes

- What Is the Project Outcome?
  - Outline of the preliminary long-term vision for Chedoke Creek
  - Framework and Implementation Plan for future action
  - Balanced suite of recommendations based on:
    - Objectives,
    - Cost / Benefits,
    - Project Leads and Partnerships
  - Implementation process
    - Timeline,
    - Needed Studies / Investigations,
    - Triggers / Supporting Projects
  - Potential short-term and quickly implementable solutions

- Project Limitations
  - 4-Month Study
  - Based on best available information → Leveraging existing reports (desktop)
  - Limited new detailed investigation & assessment
  - Additional steps will be needed to implement major components
  - Success dependent on Stakeholder input and collaboration

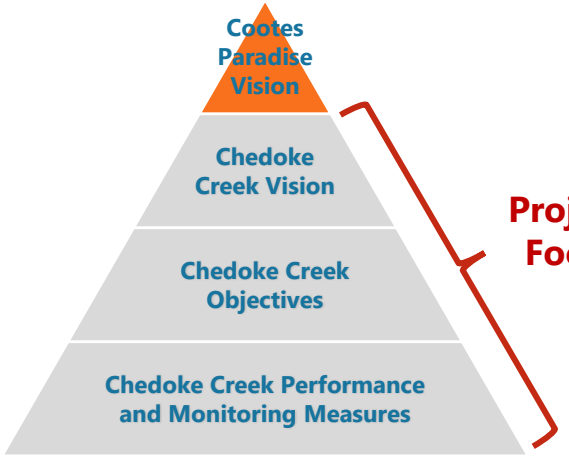
How to Evaluate Options

- Multiple Concerns
  - Diversion of Runoff (Combined Sewer) – Reduce clean flow contributions
  - High Nutrient Loading
  - E-Coli and solids
  - Metals, VOC/Oils, and other Contaminants
- High-Level Focus on Nutrient Loadings
  - Broadest inventory of available data
  - Can be used as analog for other concerns / Addressing provides relief to other concerns
  - Trigger for major and sustained issues in Cootes



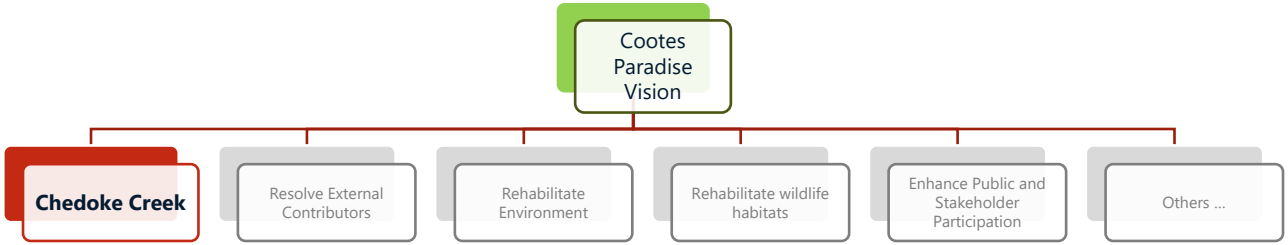
- High level estimate of the relative contributions from various sources
- Used to provide guidance to identify priority areas and potential benefits
- Uses existing quality monitoring data and reporting

Cootes Paradise Vision

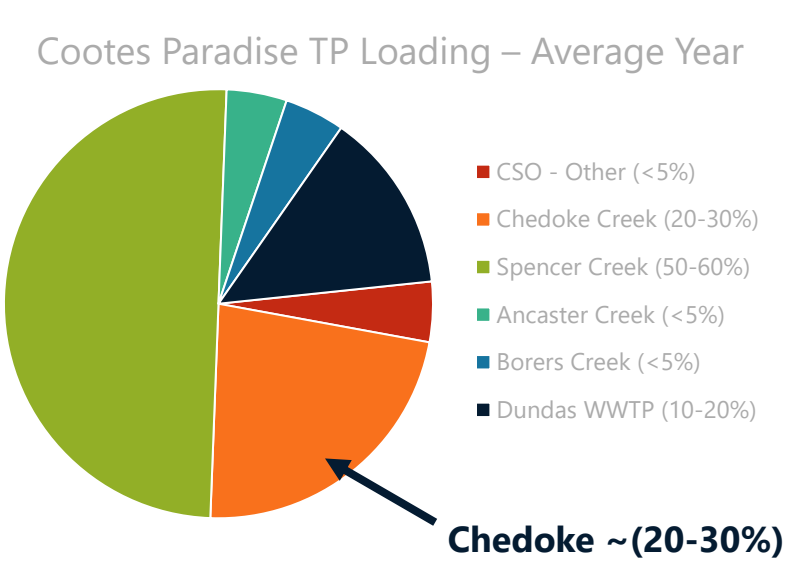


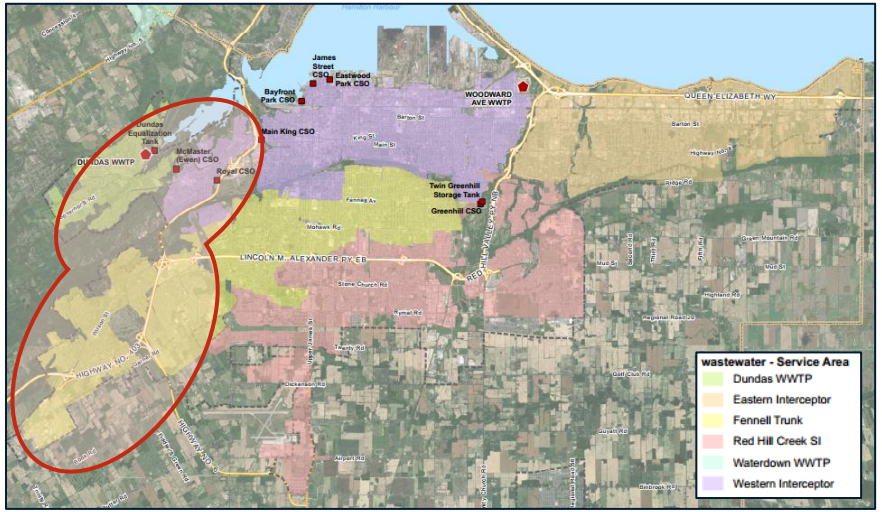
Project Focus

Fully restored and enhanced Cootes Paradise environmental and wildlife habitats



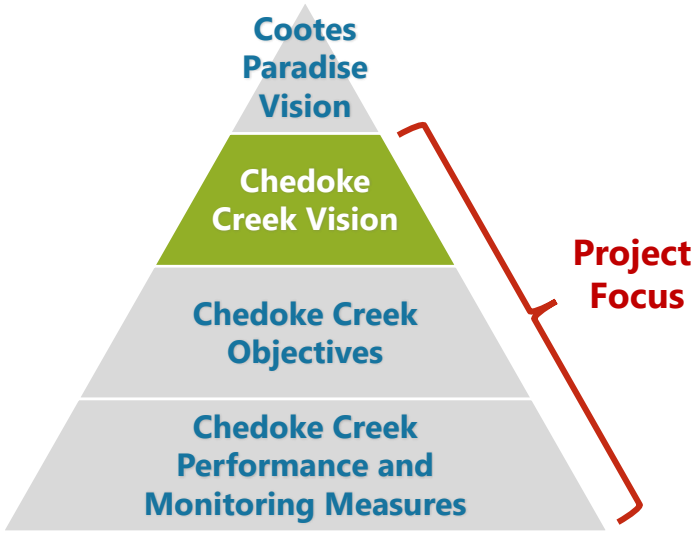
Overview of Contributions to Cootes Paradise





- 10-20% of City's wastewater directed through Main/King Tank ultimately draining to interceptor and Woodward WWTP

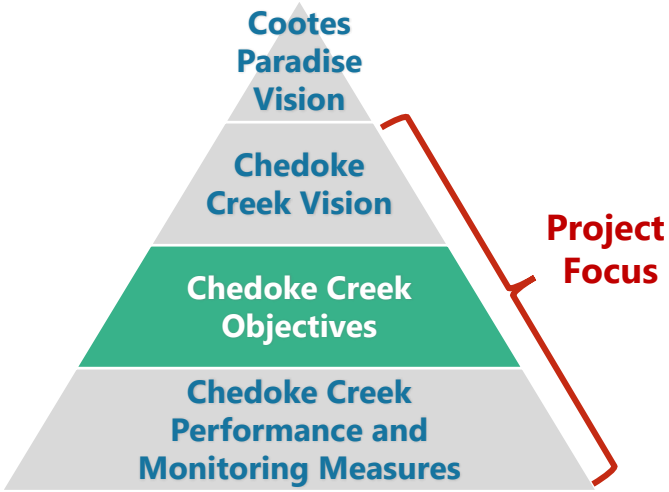
Chedoke Creek Watershed Vision



Improve Chedoke Creek Water Quality to support:

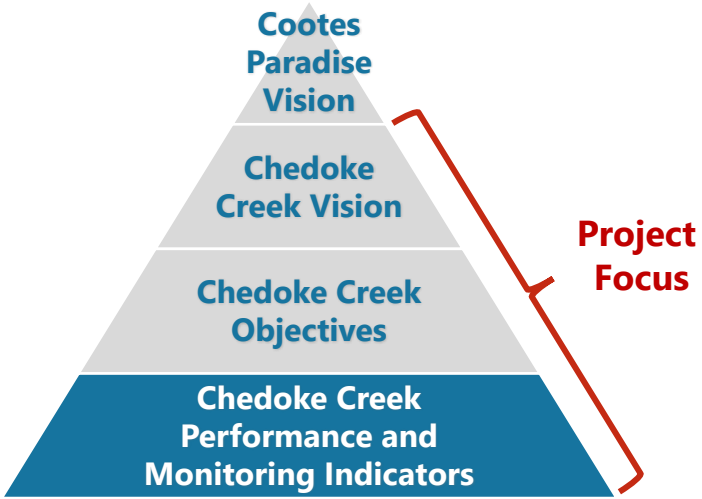
- Enhanced wildlife activity and habitat
- Safer Recreational Contact

Chedoke Creek Objectives



- Limit sources of high nutrient load to Chedoke Creek to prevent excess nutrient and limit algae blooms
- Limit sources of contaminants to Chedoke Creek
- Eliminate sanitary sewer cross connections to the stormwater system and limit the frequency of sewer overflows to Chedoke Creek
- Minimize the risk of major CSO spills to Chedoke Creek
- Seek opportunities to enhance and naturalize Chedoke Creek

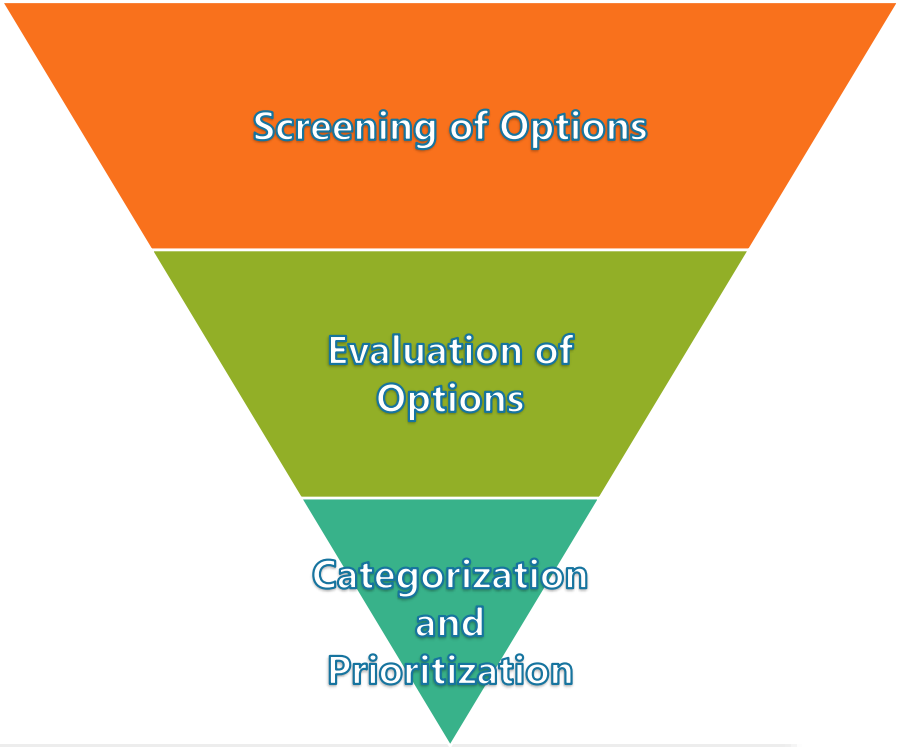
Chedoke Creek Performance and Monitoring Measures



- Potential Indicators
  - **WQ concentration levels annual and peak events**
  - **Number of annual overflow events**
  - % of contributions from CSO
  - % Runoff of urban receiving treatment
  - % of leachate captured
  - % of creek naturalized

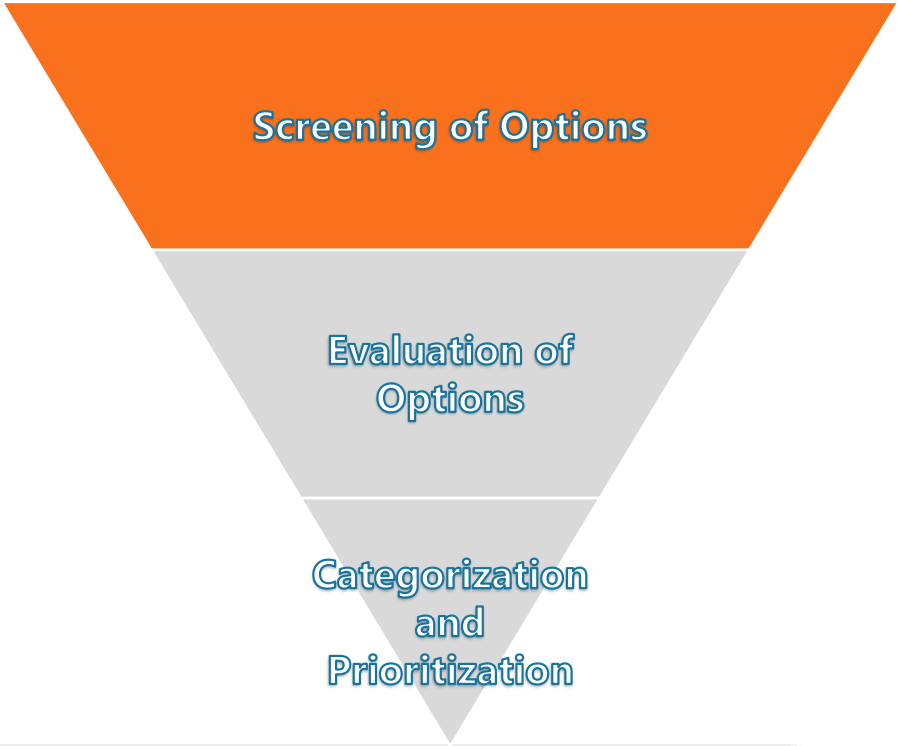
Solutions evaluation will consider these at a high level

How to Evaluate Options



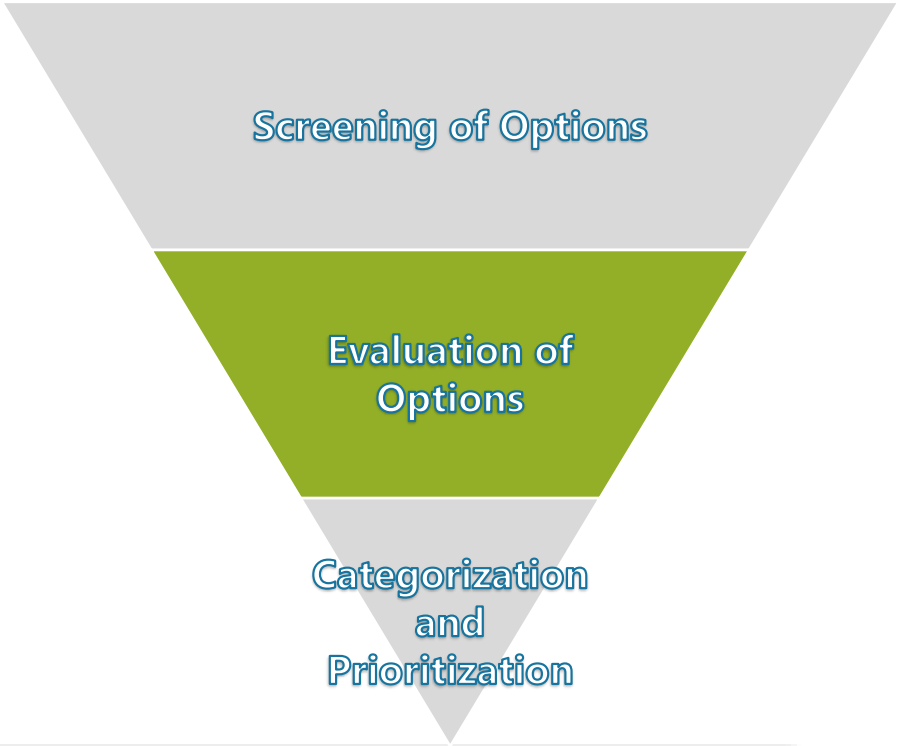
- Multiple Concerns
  - Diversion of Runoff (Combined Sewer) – Reduce clean flow contributions
  - High Nutrient Loading
  - E-Coli and solids
  - Metals, VOC/Oils, and other Contaminants
- Initial High-Level Focus on Nutrient Loadings
  - Broadest inventory of available data
  - Can be used as analog for other concerns / Addressing provides relief to other concerns
  - Trigger for major and sustained issues in Cootes

Options Screening



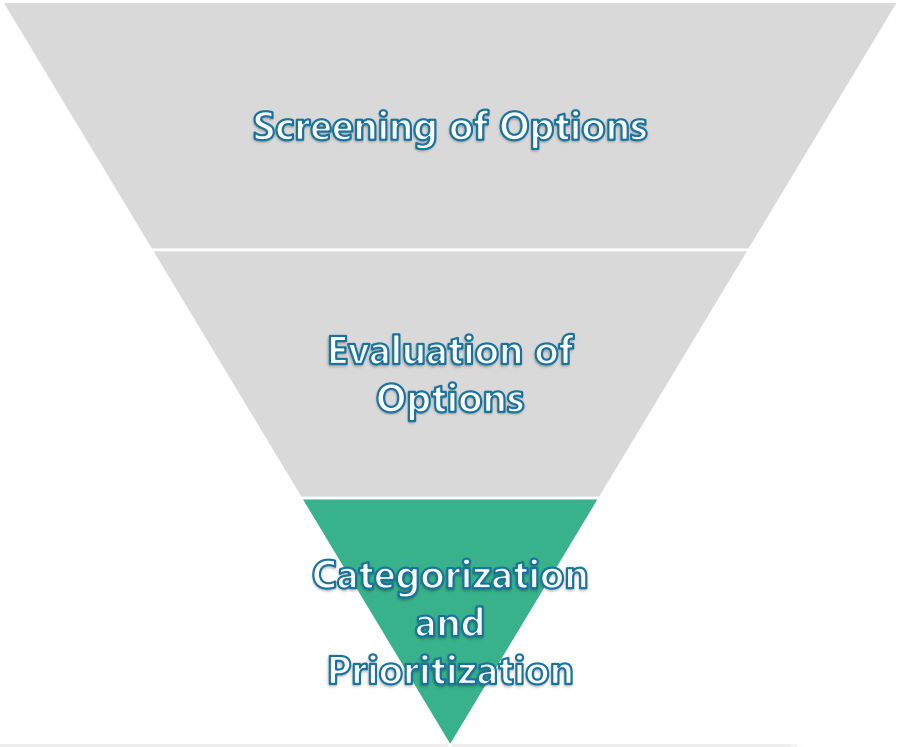
- Broad Review of Potential Options
  - Leverage past studies
  - Use of industry best practices
  - Stakeholder Engagement / Input
- Screening Level Review
  - Potential Cost
  - Potential Benefit
  - Technical or Implementation Challenges
  - “No-Regrets” Principles
- Carry Forward of Viable Options

Concepts Evaluation



- Cost
- Timing
- Implementation Difficultly
- Ownership
- Viability
- Project Benefit
  - Preventative, Mitigative, Restorative
  - Watershed, Upper Chedoke, Lower Chedoke, Cootes
- Project Effectiveness

Option Prioritization



- Near-Term Capital
- Long-Term Capital
- Near-Term O&M/Programs
- Long-Term O&M/Programs
- Policy and Engagement

Options Screening – *Landfill & Lower Chedoke Creek*

	Project		Evaluation
Landfill	Direct Clean Water Away from Landfill		Screen Out
	Culvert from Highway 403		**Carry Forward**
	Expand/Fix Leachate Collection System		Future Consideration
	Capping/Barrier		Screen Out
Lower Chedoke Creek	Constructed Wetland		Study
	Aeration System		Study
	Stream Naturalization		Study
	Physical Capping		Screen Out
	Chemical Inactivation		Screen Out
	Direct Removal	Complete Removal	Screen Out
		Targeted Removal	Study

Options Screening - *Wastewater*

	Project		Evaluation
Wastewater	Sewer Separation		Evaluate in Flooding & Drainage MP
	Increase Capacity Downstream of Main/King		Evaluate in W/WW/SW MP
	403 Trunk Sewer Twinning		**In Progress**
	Expand Storage at Main/King		Screen Out
	Expand Storage elsewhere in System		Evaluate in W/WW/SW MP
	State of Good Repair / Operational	Facilities	**Initiate Inspection**
		Chedoke Creek Trunk Sewers	**Initiate Inspection**
	Monitoring and Active Management		**In Progress**
	Wet Weather Management - Wet Weather Flow in Separated Sewers	Targeted in Chedoke	**Initiate I&I Monitoring**
		Targeted in broader Main/King	**Initiate I&I Monitoring**
		Policy/Future Infrastructure Projects	Future Policy

Options Screening - *Stormwater*

	Project		Evaluation
Stormwater	Cross Connection Program		**Carry Forward**
	Retrofits throughout Watershed (end-of-pipe and source)	City	Study
		MTO	Study
	Retrofits for Road Rehabilitation Projects / LID		Future Policy
	City Street Management	Enhanced Street Sweeping	**Carry Forward**
		Improve Snow Management within Chedoke Creek	Future Program
	LID Policy / Stormwater User Rate		**Ongoing**
	Salt Management	Highway 403	Future Program
		City Roads	Future Program
	Redevelopment Sites – SWM Policy		Future Policy
	Highway 403 Water Quality Improvements (ie. Oil-Grit Separators or Equivalent)		**Carry Forward**
	Inlet Control in Combined Sewers		Evaluate in Flooding & Drainage MP

Options Screening

	Project		Evaluation
Upper Chedoke Creek	Golf Course Treatment	Treat golf course runoff	**Carry Forward**
		Stream Naturalization – Inline Treatment with Creek	**Carry Forward**
		Retrofit and Treatment Online	Study
Engagement	Engage Residents, Stakeholders, and City		**Carry Forward**
Monitoring	Program Management and Monitoring		Future Program

10 Minute Break

Project Prioritization and Categories

Identifies a balanced suite of recommendations

- Objectives,
- Cost/Benefits,
- Project Leads and Partnerships

Identifies the implementation process

- Timeline,
- Needed Studies / Investigations
- Triggers / Supporting Projects

Identifies potential short-term and quickly implementable solutions

Solutions Timeline

Mix of Short-Term Capital Projects (<3 Years)	•Address specific concerns •Can be implemented immediately
Long-Term Capital Projects (>3 Years)	•Require additional study to confirm scope and benefit •Require substantial investment and needs to be validated •Studies to support long-term projects either underway or to commence <2 years
Short-Term Programs (<2 Years)	•Existing programs that can be re-directed to prioritize Chedoke •Opportunity to address major risk points
Long-Term Programs (>2 Years)	•Expansion or new programs •Potential to provide substantial benefit but require long-term to implement
Policy and Engagements	•Expanded and ongoing engagement to monitor progress and manage the strategy •Policies to support Framework

Solutions Recommendations: Near-Term Capital Projects

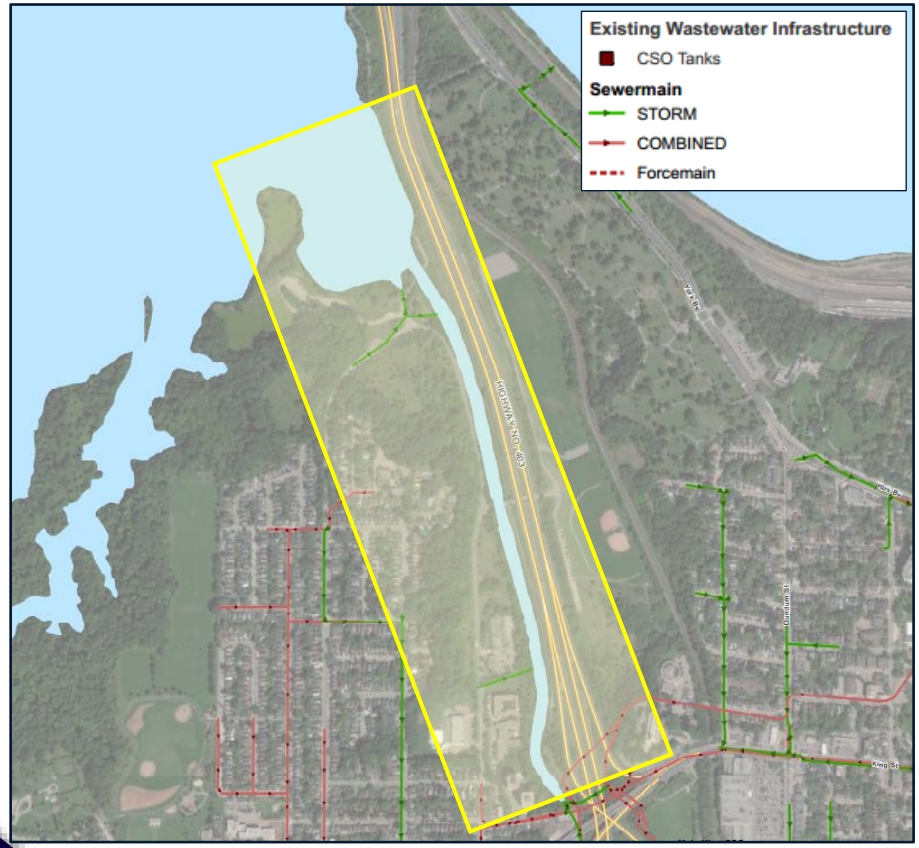
Prioritization	Project	Status
N/A	Highway 403 Trunk Sewer Twinning	In Progress
1	Culvert from Highway 403 (Landfill)	Implement Right Away
2	Golf Course Treatment – Capture Runoff from the Golf Course	Implement Right Away
3	Highway 403 Water Quality Improvements (ie. Oil-Grit Separators or Equivalent)	MTO Led Initiative

Solutions Recommendations: Long-Term Capital Projects

Priority	Project	Status
1	Aeration System	Combined EA
	Constructed Wetland	
	Stream Naturalization	
	Chedoke Creek Targeted Removal	
2	Inlet Controls in Combined Sewer Areas	Dependent on Flooding and Drainage Study
	Sewer Separation	
3	Golf Course Treatment: Stream Naturalization	Combined EA Study
	Golf Course Treatment: Retrofit and Treatment Online	
4	Retrofits throughout watershed (end-of-pipe and source) - City	
	Retrofits throughout watershed (end-of-pipe and source) - MTO	
5	Expand Storage Elsewhere in System	Dependent on W/WW/SW Master Plan
	Increase Capacity Downstream of Main/King	
6	Expand/Fix Leachate Collection System	Collect More Data before further Recommendations

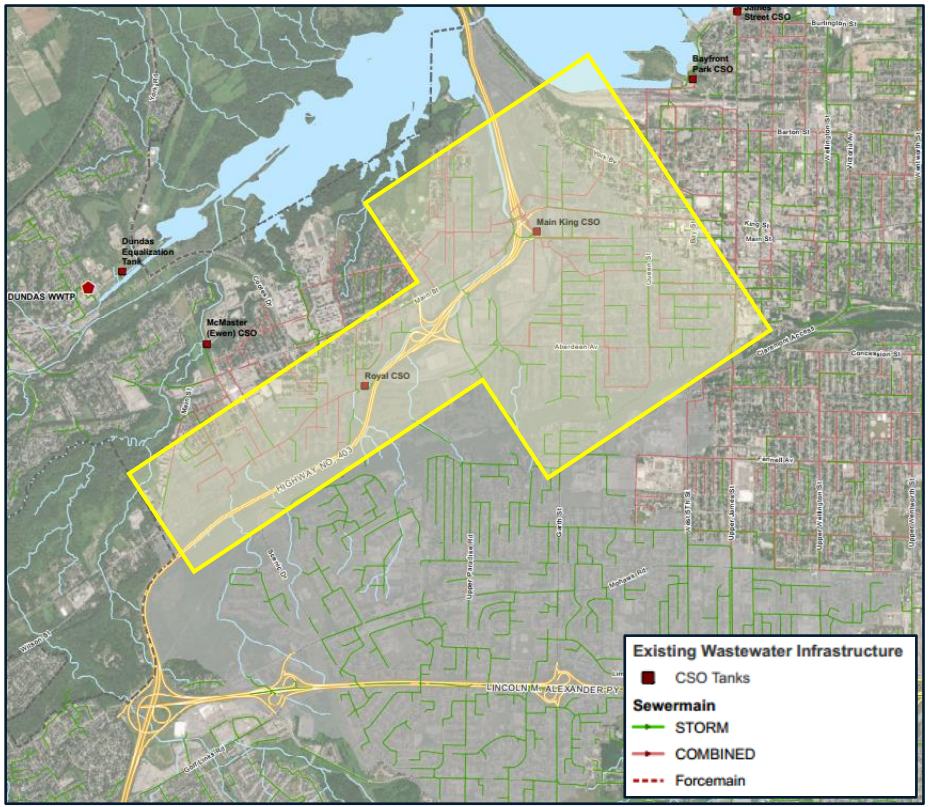
Solutions Recommendations: Lower Chedoke EA Study

- Study to evaluate Lower Chedoke Creek solutions:
  - Aeration System
  - Constructed Wetland
  - Stream Naturalization
  - Targeted Removal
  - Other?
- Evaluate benefits, impacts, and life cycle cost
- Study may recommend all/ some/none of the solutions



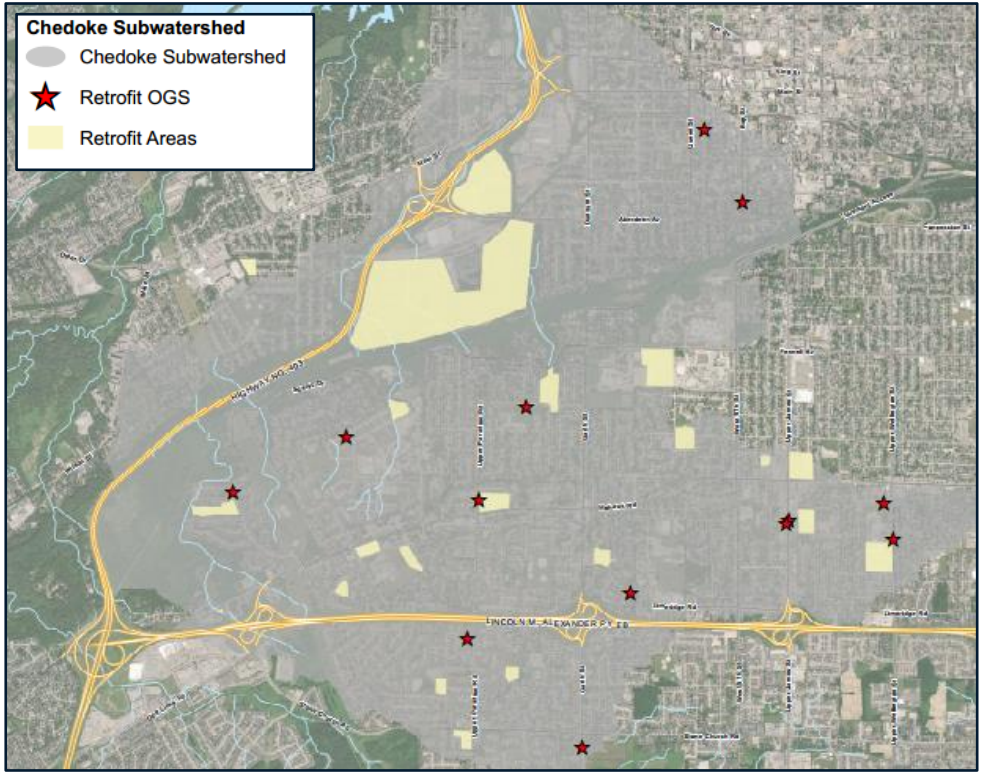
Solutions Recommendations: Sewer Separation

- Infrastructure solutions provide benefit beyond Chedoke
- High costs and medium to long-term implementation
- Recommendation through the on-going Flooding and Drainage Master Plan
  - Targeted sewer separation within Chedoke Catchment recommended



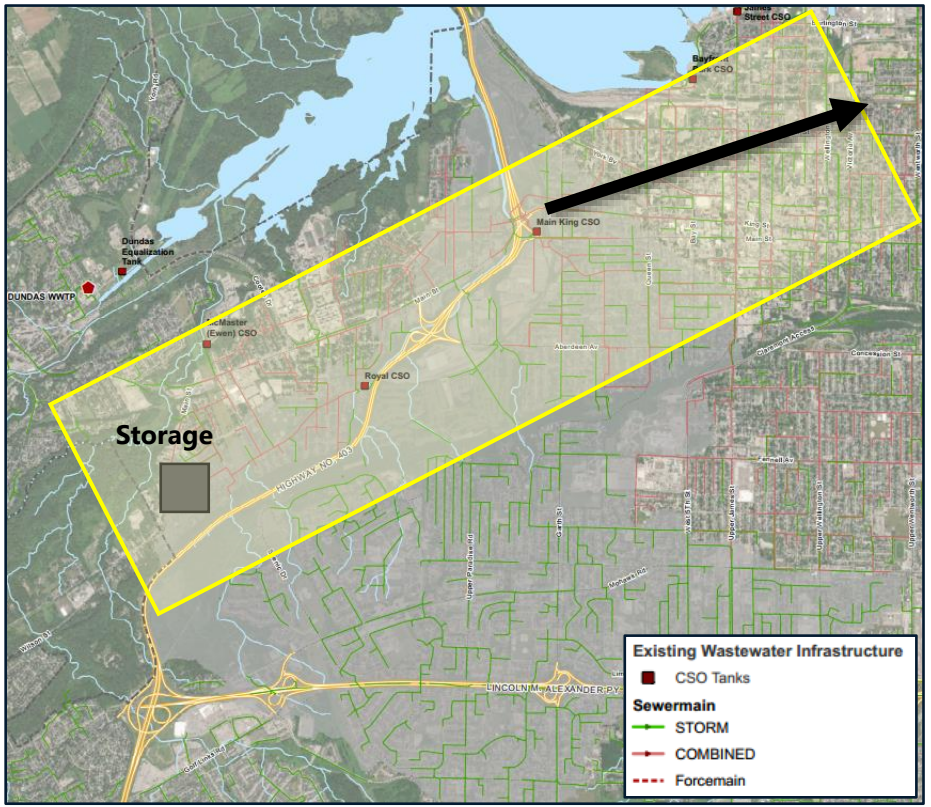
Solutions Recommendations: Chedoke Watershed Stormwater Retrofits EA

- Study to evaluate stormwater management retrofits in the Upper Chedoke Watershed:
  - Includes options at the Chedoke Golf Course
  - Retrofits throughout the watershed (end-of-pipe and source) for City and MTO roads
- Evaluate benefits, impacts, and life cycle cost
- Focus on stormwater treatment



Solutions Recommendations: Storage and Combined Sewer Upgrades

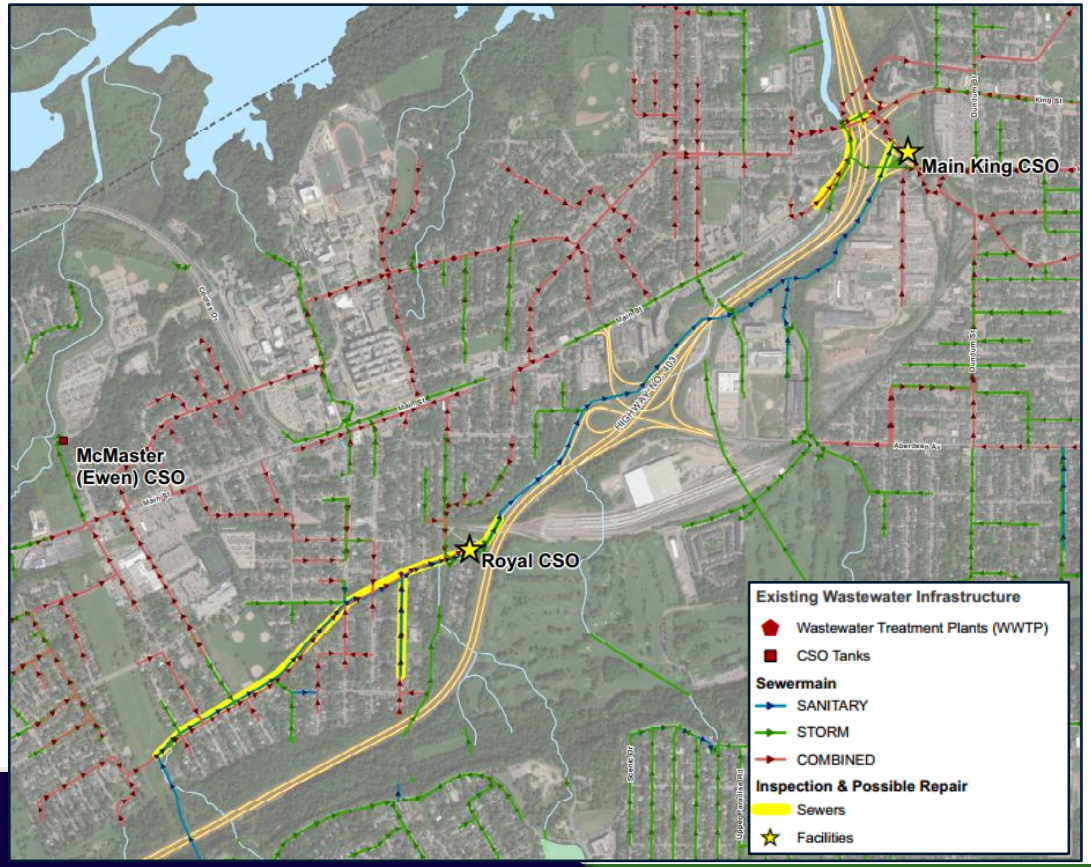
- Infrastructure solutions provide beyond Chedoke
- High costs and long-term implementation
- Recommendation through the on-going W/WW/SW Master Plan
- Pathway to success independent of Storage and Sewer Upgrades



Solutions Recommendations: Near-Term O&M / Program

Prioritization	Project	Status
1	CSO Monitoring Improvements and Active Management	Underway
2	Inspection and Repair - Facilities	Underway / Initiate Inspection
	Inspection and Repair – Trunk Sewers	
3	Cross Connection Program	Prioritize in Chedoke Watershed
4	City Street Management – Enhanced Street Sweeping	Develop & Initiate City Program

Solutions Recommendations: Inspection and Repair



Solutions Recommendations: Long-Term O&M / Program

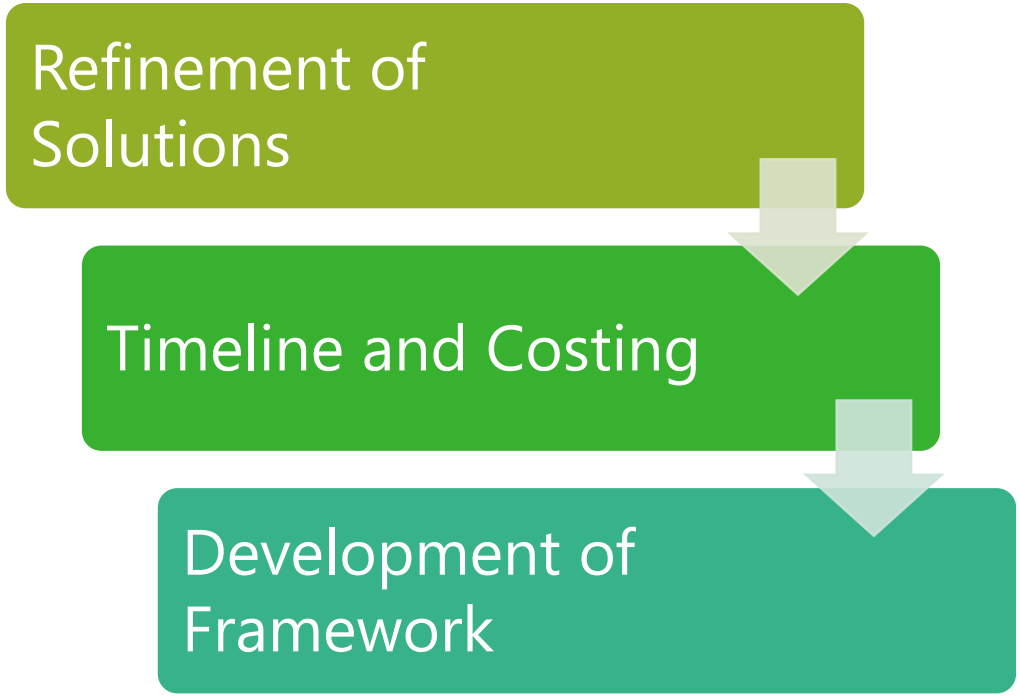
Prioritization	Project	Status
1	Wet Weather Flow in Separated Sewers – Targeted in Chedoke	Initiate Inflow & Infiltration Monitoring
	Wet Weather Flow in Separated Sewers – Targeted in broader Main/King	
2	Program Management and Monitoring	Initiate Now and Continue Long Term
3	City Street Management – Improve snow management within Chedoke Creek Watershed	New Program
4	Salt Management – Highway 403	Enhance Existing Program
	Salt Management – City Roads	Enhance Existing Program

Solutions Recommendations: Policy and Engagement

Prioritization	Project	Status
1	Engage Residents, Stakeholders, and City	Initiate Now
2	Redevelopment Sites SWM Policy	Develop Policy Now, Implement through Future Projects
3	Retrofits for Road Rehabilitation Projects / LID Policy	Develop Policy Now, Implement through Future Projects
4	LID Policy / Stormwater User Rate	Currently Underway
5	Wet Weather Flow in Separated Sewers – Policy / Future Infrastructure Projects	Develop Policy Now, Implement through Future Projects

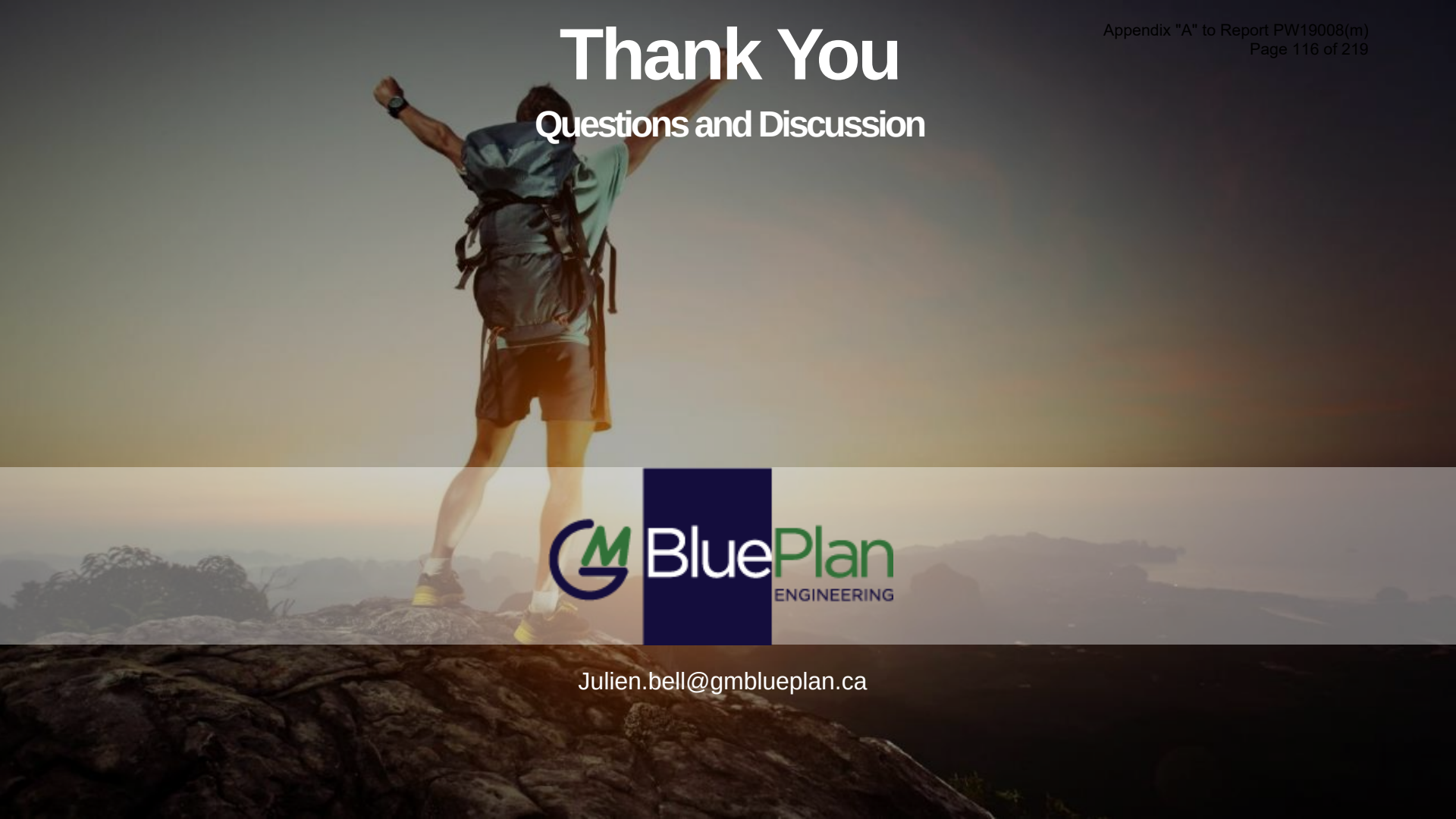
Next Steps

- Your Feedback is needed (before December 18th)
  - Vision Statements
  - Objectives
  - Evaluation
  - Timeframe



Thank You

Questions and Discussion



Julien.bell@gmblueplan.ca

City of Hamilton
Chedoke Creek Water Quality Improvement Study
GMBP File No. 620083
External Stakeholders Workshop #2

Minutes

DATE: Wednesday, December 2nd, 2020
10:30 AM – 1:00 PM
LOCATION: Microsoft Teams Meeting

ATTENDEES:	Chris McLaughlin (CM)	Bay Area Restoration Council
	Andrew Grice (AG)	City of Hamilton
	Bert Posedowski (BP)	City of Hamilton
	Cari Vanderperk (CP)	City of Hamilton
	Christina Cholkan (CC)	City of Hamilton
	Dave Alberton (DA)	City of Hamilton
	Mani Seradj (MS)	City of Hamilton
	Mark Bainbridge (MB)	City of Hamilton
	Jonathan Bastien (JBa)	Conservation Hamilton
	Scott Peck (SP)	Conservation Hamilton
	Lynda Lukasik (LL)	Environment Hamilton
	Julien Bell (JB)	GM BluePlan
	Chris Hamel (CH)	GM BluePlan
	Michelle Klaver (MK)	GM BluePlan
	Kristin O'Connor (KO)	Hamilton Harbour Remedial Action Plan
	Drew Wensley (DW)	MT Planners
	Tara McCarthy (TM)	MT Planners
	Shahbaz Asif (SA)	Ontario Ministry of Transportation
	Mark Runciman (MR)	Royal Botanical Gardens
	Tys Theysmeyer (TT)	Royal Botanical Gardens
	Matt Senior (MSen)	Wood
	Ron Scheckenberger (RS)	Wood

COPIES TO: All Attendees

Minutes

1.	**Introduction**
	
	Agenda
	
	• Reviewed what was covered in the last external stakeholder's workshop which included:
	  o Study Area and Key Components
	  o Historic/Ongoing Studies and Projects
	  o Stakeholder Perspective and Solutions Under Consideration
	• Reviewed the intent of the meeting which included:
	  o Introduction/Meeting Objectives
	  o Framework Vision and Objectives
	  o Evaluation Process and Considerations
	  o Preliminary Solutions Discussion
	  o Next Steps
	
	Introductions
	
	• City stakeholders who were not at the last external stakeholders workshop introduced themselves:
	  o Andrew Grice
	  o Dave Alberton
	  o Mark Bainbridge
	  o Cari Vanderperk
	
	Meeting Objectives
	
	• Purpose of this meeting is for the project team to present the preliminary framework for the vision including the recommended solutions
	• The solutions and prioritization presented are preliminary with the goal of seeking input and feedback from the external stakeholders
		Actions

2.	**Project Timeline**
	
	• The project schedule was reviewed including:
	  o September/October: Background Review
	  o October/November: Solutions Development
	  o November/December: Solutions Evaluation
	  o December +: Recommendations	

3.	**Project Outcomes** • It is important to recognize that although this project was triggered as an outcome of the spill, the intent of this project is not specifically to address the consequences of that particular spill but to address the legacy of	

	Chedoke Creek to come up with the overall vision and plan for the long term • The goal is to improve the quality of water coming into Chedoke and address historic issues outside of the spill event • This is a short study and it is important to consider the following: o Focus on using the best available information o Not undertaking a detailed analysis o Leveraging what has been done with some additional review and context to develop an overall framework and vision plan o Looking at the costs/benefits o Short study will lead to quick implementation of some of the recommendations	
4.	**How to Evaluate Options** • There are multiple concerns including diversion of runoff, high nutrient loading, metals and VOC/Oils and trying to evaluate all these concerns becomes an analysis • Through discussions, have decided to look at nutrient loadings as a gauge for relative impacts. High nutrient loadings are the largest concern for some of the proponents as it causes algae blooms, etc. As nutrient loading is a major concern and data is available, success can relatively be measured. • Total Phosphorus has been used as a high level estimate and predominant screener of the relative contributions from various sources; however, there will be commentary on how other nutrients have also been acknowledged • Nutrient loadings give a good general perspective • Many of the solutions provide similar or mirrored benefits to other nutrients/metals/oils/salts	
5.	**Cootes Paradise Vision** • To set the framework of this study, need to establish an overall vision • The vision has been presented as a pyramid; with this study being the top of the pyramid or first step in the overall implementation plan that can be further refined between stakeholders and the City in subsequent steps • It is important to acknowledge the overall Cootes Paradise Plan but need to focus on Chedoke Creek, which only accounts for 20-30% of the entire Cootes Paradise and fixing Chedoke alone will not fix all of this issues in Cootes Paradise • Vision for Chedoke Creek fits into the Cootes Paradise vision but there are limitations in the current state that need to be recognized • The Main/King tank was showcased to recognize that Main/King represents a substantial portion of the City's wastewater system; however, it is not as large as some people may perceive with 10-20% of the City's wastewater directed through the Main/King Tank and ultimately draining to the interceptor and Woodward WWTP	

6.	**Chedoke Creek Watershed Vision**
	
	• Need to focus on Project Vision within the context of broader “global” vision for Cootes Paradise
	• The Chedoke Creek Vision should support the Cootes Paradise Vision and Objectives
	• Vision needs to be supported by achievable objectives. Will need to consider:
	  ○ The existing status of the watershed
	  ▪ Existing built environment and legacy systems
	  ○ Other competing priorities of Chedoke Creek watershed
	  ▪ Ongoing community use and growth
	  ▪ Transportation needs, etc.
	• Framework will outline the plan to achieve the Chedoke Creek Watershed Vision
	  ○ Further studies and consultation will be needed to set detailed Performance and Monitoring Measures
	• As this study moves forward through the implementation of projects, this is the vision that everything is being measured against	

7.	**Chedoke Creek Objectives**
	
	• Objectives are a qualitative measure that help to realize the project vision
	• Objectives are used to:
	  o Set targets
	  o Assess beneficial impacts
	  o Support prioritization
	• Objectives need to be achievable and supported by stakeholders and by data, need to be:
	  o Technically feasible
	  o Align with City and Stakeholder vision
	  o Financially feasible
	  o Implementable – Timeline and Stakeholders
	  o Complementary to other needs/priorities
	• Five objectives were presented (in no particular order or importance) and include:
	  o Limit sources of high nutrient load to Chedoke Creek to prevent excess nutrient and limit algae blooms
	  o Limit sources of contaminants to Chedoke Creek
	  o Eliminate sanitary sewer cross connections to the stormwater system and limit the frequency of sewer overflows to Chedoke Creek
	  ▪ This is related to areas where there are already separated sewers; work to ensure any sanitary sewer connections are eliminated
	  o Minimize the risk of major CSO spills to Chedoke Creek
	  ▪ This looks at reducing the frequency of overflows and enhanced monitoring and management, so the likelihood of overflow events do not happen again or are quickly identified and addressed
	  o Seek opportunities to enhance and naturalize Chedoke Creek
	• CM: These are not numbered – could you rank these from top to bottom in terms of cost involved? What is the direction you've been given in seeking to address these objectives? What limitations have been put on you in terms of what we investigate? Or if not, are you tasked with providing a menu of items at a given price point that can be addressed? Does this process provide a sketch of what this looks like and potential workplan? What is the extent of what we are trying to do?
	  o JB: These are qualitative objectives at this point as we haven't defined numbers yet. In this study we identify these general objectives and they are measured somewhat equally. We will be giving recommendations on criteria or performance targets to measure progress but at this point, cannot quantify those but as the City moves forward this framework will give an idea of cost.
	  o CM: Joining a process of wishful thinking, everyone has developed their own wish list. The idea of naturalizing the creek can mean different things to many different people and attaching a budget is important. (ie. Some may see it as adding more plantings along the bank, whereas others may see it as re-routing the creek and even removing built infrastructure (Macklin St.))
		GMBP – ensure definition of naturalization in report is clear

	○ AG: The City is in the process of developing the approach for continuing the works that come as the outcome of this study. Will not stop once this project is done and it is not a quick fix. • This framework helps identify the overall objectives but through future ongoing studies, consultation, and discussions, some of these values will be better quantified	
8.	**How to Evaluate Options** • The starting point for this study evaluation included putting everything on the table • The project team went through the screening, evaluation and then categorization and prioritization based on all of the feedback received up to this point	

9.	**Options Screening**
	
	• The first step involved presenting a full suite of all of the options that were considered through the screening process. From there, we flagged which projects were screened out, carried forward (for either implementation or further study) or already underway.
	• The options were broken into components including:
	  ○ Landfill
	  ○ Lower Chedoke Creek
	  ○ Wastewater
	  ○ Stormwater
	  ○ Upper Chedoke Creek
	  ○ Engagement
	  ○ Monitoring
	
	All of the projects and their evaluation were presented to the group for input and are included below with the corresponding discussion.
	
	Landfill
	
	1. **Direct Clean Water Away from Landfill:** Screened Out
	  • Low effectiveness, difficult to implement, high cost
	  • TT: For the landfill project, Direct Clean Water Away from Landfill, can foresee a significant challenge.
	  ○ JB: Looked at where clean water was coming into the landfill and where we have options to direct it away. The potential costs and challenges vs. the overall pie chart of how much we could potentially remove from that. The cost compared to the potential benefit was very high and the land acquisition and construction challenges ultimately screened this option out.
	2. **Culvert from Highway 403:** Carried Forward for Implementation
	  • Highly visible, low cost, relatively straight forward
	  • SA: Received a request for the 900 CSP culvert and are in the process of digging out information from planning and development department and will provide information. Will also look into MTO projects. Generally, MTO stays away from oil/grit separators for safety issues but can determine If there are any opportunities.
	3. **Expand/Fix Leachate Collection System:** Carried Forward for Future Consideration
	  • Need to collect more data and reassess before final recommendations
	4. **Capping/Barrier:** Screened Out
	  • High cost, low effectiveness, difficult to implement
	
	Lower Chedoke Creek
	
	1. **Constructed Wetland:** Carried Forward for Further Study
	  • Mitigative solution, highly visible
	2. **Aeration System:** Carried Forward for Further Study
	  • Mitigative solution, moderately visible
	3. **Stream Naturalization:** Carried Forward for Further Study
	  • Mitigative solution, highly visible
	4. **Physical Capping:** Screened Out
		MTO – to provide 900 CSP culvert information

- Low effectiveness, low visibility

5. **Chemical Inactivation:** Screened Out
   - Low effectiveness, low visibility
6. **Direct Removal**
   A. **Complete Removal:** Screened Out
      - Low effectiveness, low visibility
   B. **Targeted Removal:** Carried Forward for Further Study
      - Mitigative solution, quick implementation, low visibility

Wastewater

1. **Sewer Separation:** Evaluated through ongoing Flooding and Drainage Master Plan
   - Implement recommendations from City's study for works within Chedoke Creek
2. **Increase Capacity Downstream of Main/King:** Evaluated through ongoing W/WW/SW Master Plan
   - City-wide benefits, Implement recommendations from City's MSP study
3. **403 Trunk Sewer Twinning:** Underway
   - Design already in process, will eliminate Aberdeen CSO overflows
   - TT: Is this project from Royal CSO or from Ancaster?
     - JB: This is the project between Royal and Main/King aimed at reducing overflows from Aberdeen.
     - TT: Does this bypass Main/King or enter Main/King?
     - MS: Enters Main/King. This project is an outcome from the 2006 Master Plan. It is divided into 4 sections that will be constructed.
     - TT: When system is on overload, will it be observed at Main/King?
     - JB: Yes. Aberdeen overflows much more frequently than Main/King. This project doesn't help capture the largest events but manages the mid-range overflows.
4. **Expand Storage in Main/King:** Screened Out
   - Main/King CSO is maximized at current site
5. **Expand Storage elsewhere in System:** Evaluated through ongoing W/WW/SW Master Plan
   - Implement recommendations from City's MSP study for within Chedoke Creek
6. **State of Good Repair / Operational**
   A. **Facilities:** Carried Forward for Inspection Implementation
   - No regrets, ensure facilities are in good operating order, low cost
   B. **Chedoke Creek Trunk Sewers:** Carried Forward for Inspection Implementation
   - No regrets, ensure no major I/I in trunk sewers parallel to Chedoke Creek, low cost
7. **Monitoring and Active Management:** Underway
   - Monitoring and SCADA can better monitor and manage system, already being implemented through other programs
8. **Wet Weather Management – Wet Weather Flows in Separated Sewers**
   - Good management practices and policies have benefits for local system and growth capacity in addition to supporting Chedoke Creek

A. **Targeted in Chedoke:** Carried Forward for I&I Monitoring Implementation
B. **Targeted in broader Main/King:** Carried Forward for I&I Monitoring Implementation
C. **Policy/Future Infrastructure Projects:** Carried Forward for Future Policy

Stormwater

1. **Cross Connection Program:** Carried Forward for Implementation
   - Low cost and quick implementation for program
2. **Retrofits throughout Watershed (end-of-pipe and source)**
   A. **City:** Carried Forward for Further Study
   - Opportunities within watershed
   B. **MTO:** Carried Forward for Further Study
   - Opportunities within MTO corridor
3. **Retrofits for Road Rehabilitation Projects / LID:** Carried Forward for Future Policy
   - An ongoing practice, can include BMP's, High visibility, Costs incorporated with other works
   - SP: Curious about road retrofits and LIDs – what would the timing be for the future policy. There are real opportunities in Chedoke and then the broader Hamilton Harbour watershed. Would be nice to have timeframe.
     - JB: Future policy means these are all recommendations that the framework suggests City move forward, how quickly these are implemented are driven by the City.
4. **City Street Management**
   A. **Enhanced Street Sweeping:** Carried Forward for Future Program
   - No regrets, visible to public. Short implementation time and low cost.
   - TT: This could be much more significant than appreciated. While the City will run it on the street, what about private properties such as mall parking lots?
     - JB: That will be determined by the City, could potentially be something that comes up in the stormwater user rate. Through framework, want to identify these but we don't have the ability to get into the minutia of those policies.
     - TT: Would the current policy have the ability to get at that issue?
     - MB: Don't have anything that could go on private property but in the future could have a partnership with private owners. There is a lot of effort and resourcing needs required from the City's end. There is no commitment at this point in time, but it is possible in the future.
     - MS: Regarding malls, for site plan approvals, the newer ones would have to have stormwater quality and quantity control.
   - TT: For the pie chart, would you be able to separate private from City owned streets with the information at hand?
     - JB: Could do a high level volumetric analysis but not from a loading perspective; there is a lack of detailed information.

   B. **Improve Snow Management within Chedoke Creek:** Carried Forward for Future Program
   - No regrets, visible to public. Short implementation time and low cost
5. **LID Policy / Stormwater User Rate:** Underway

- Helps define link between Public practices and improvements to Chedoke Creek. Self-Funding.
- AG: The City has been updating the sewer use by-law; enhancing parameters and monitoring of construction sites, results will start to be captured.
    - CV: The City is looking at revisions that could allow management of stormwater leaving sites such as malls; however, there are restrictions around being able to monitor. A program is needed.
    - KO: We are hopeful; however, it feels like some of this has come up before and the political support isn't there. What will make the stormwater rate different this time? Chedoke Creek being under microscope? So much is tied to it if this rate is possible. Feels like it has constantly been ongoing/on hold.
    - AG: Received direction in 2019, then COVID, then budget changes. Have done further evaluation and have it ready to review again. Trying to get council to carry it forward is difficult and it is not well received in the community.

6. **Salt Management**
    - **A. Highway 403:** Carried Forward for Future Program
    - No regrets. Short implementation time and low cost.
    - **B. City Roads:** Carried Forward for Future Program
    - No regrets. Short implementation time and low cost.
7. **Redevelopment Sites – SWM Policy:** Carried Forward for Future Policy
    - Opportunity for large stormwater reduction/treatment.
8. **Highway 403 Water Quality Improvements (ie. Oil-Grit Separators or Equivalent):** Carried Forward for Implementation
    - Short implementation time and low cost.
9. **Inlet Control in Combined Sewers:** Evaluated through ongoing Flooding and Drainage Master Plan
    - Implement recommendations from Flooding and Drainage MP.

Upper Chedoke Creek

1. **Golf Course Treatment**
    - **A. Treat Golf Course Runoff:** Carried Forward for Implementation
    - Can be implemented immediately for low cost. Golf course can remain in operation.
    - **B. Stream Naturalization – Inline Treatment with Creek:** Carried Forward for Further Study
    - Doesn't need a study and golf course can remain in operation.
    - **C. Retrofit and Treatment Online:** Carried Forward for Further Study
    - Opportunity for stormwater treatment. Golf course can remain in operation with some potential modifications. Part of broader Retrofit Study.

Engagement

1. **Engage Residents, Stakeholders, and City:** Carried Forward for Implementation
    - Short implementation time at low cost. High visibility for public.

	Monitoring 1. **Program Management and Monitoring:** Carried Forward for Future Program • Will help improve system understanding and support tracking benefits over time. Low cost.	
10.	**Project Prioritization and Categories** • All of the projects presented in previous section were prioritized based on the following: o Identifies a balanced suite of recommendations ▪ Objectives, ▪ Cost/Benefits, ▪ Project Leads and Partnerships o Identifies the implementation process ▪ Timeline, ▪ Needed studies / Investigations ▪ Triggers / Supporting Projects o Identifies potential short-term and quickly implementable solutions	
11.	**Solutions Timeline** • Solutions were broken out into 5 categories including the following: **1. Mix of Short-Term Capital Projects (<3 Years)** o Address specific concerns o Can be implemented immediately **2. Long-Term Capital Projects (>3 Years)** o Require additional study to confirm scope and benefit ▪ Require substantial investment and needs to be validated o Studies to support long-term projects either underway or to commence <2 years **3. Short-Term Programs (<2 Years)** o Existing programs that can be re-directed to prioritize Chedoke o Opportunity to address major risk points **4. Long-Term Programs (>2 Years)** o Expansion or new programs o Potential to provide substantial benefit but require long-term to implement **5. Policy and Engagement** o Expanded and ongoing engagement to monitor progress and manage the strategy o Policies to support framework	

12.	**Solutions Recommendations** • The solutions recommendations were reviewed for the 5 categories including the corresponding priority and status for each project. • The prioritization, project and status are listed below. **Near-Term Capital Projects** 0. Highway 403 Trunk Sewer Twinning: *In Progress* 1. Culvert from Highway 403 (Landfill): *Implement Right Away* 2. Golf Course Treatment – Capture Runoff from the Golf Course: *Implement Right Away* 3. Highway 403 Water Quality Improvements (ie. Oil-Grit Separators or Equivalent): *Initiatives recommended to be led by MTO* **Long-Term Capital Projects** 1. Aeration System, Constructed Wetland, Stream Naturalization, Chedoke Creek Targeted Removal: *Combined EA* 2. Inlet Controls in Combined Sewer Areas, Sewer Separation: *Dependent on Flooding and Drainage Study* 3. Golf Course Treatment - Stream Naturalization, Golf Course Treatment – Retrofit and Treatment Online: *Combined EA Study (with #4)* 4. Retrofits throughout watershed (end-of-pipe and source) – City, Retrofits throughout watershed (end-of-pipe and source) – City: *Combined EA Study (with #3)* 5. Expand Storage Elsewhere in System, Increase Capacity Downstream of Main/King: *Dependent on W/WW/SW Master Plan* 6. Expand/Fix Leachate Collection System: *Collect More Data before further Recommendation* **Near-Term O&M / Program** 1. CSO Monitoring Improvements and Active Management: *Underway* 2. Inspection and Repair – Facilities, Inspection and Repair – Trunk Sewers: *Underway / Initiate Inspection* 3. Cross Connection Program: *Prioritize in Chedoke Watershed* 4. City Street Management – Enhanced Street Sweeping:	

Develop and Initiate City Program

Long-Term O&M / Program

1. Wet Weather Flow in Separated Sewers – Targeted in Chedoke,
   Wet Weather Flow in Separated Sewers – Targeted in broader Main/King:
   Initiate Inflow and Infiltration Monitoring
2. Program Management and Monitoring:
   Initiate Now and Continue Long Term
3. City Street Management – Improve snow management within Chedoke Creek Watershed:
   New Program
4. Salt Management – Highway 403,
   Salt Management – City Roads:
   Enhance Existing Program

Policy and Engagement

1. Engage Residents, Stakeholders, and City:
   Initiate Now
2. Redevelopment Sites SWM Policy:
   Develop Policy Now, Implement through Future Projects
3. Retrofits for Road Rehabilitation Projects / LID Policy:
   Develop Policy Now, Implement through Future Projects
4. LID Policy / Stormwater User Rate:
   Currently Underway
5. Wet Weather Flow in Separated Sewers – Policy / Future Infrastructure Projects:
   Develop Policy Now, Implement through Future Policies

The following discussion related to solutions recommendations occurred:

- LL: I thought Chedoke was already a priority area regarding cross connections?
  - CC: Yes, some of these are ongoing programs and this framework is helping to continue prioritizing them
  - KO: With the cross connection program, assuming you've been speaking with the City about this? Thought the City was close to maximizing what they can do in Chedoke.
  - AG: There is still some opportunity in Chedoke, they have moved back over to focusing on Chedoke and still targeting the area
- AG: Didn't see RTC in here? Sterling outlet is a hotspot.
  - JB: The CSO Monitoring Improvements and Active Management – Priority #1 under Near-Term O&M / Program covers the RTC.
- AG: Keeping in mind the order out there now for Chedoke and Cootes, what we do here will be in line with that. City will be giving a report to public works next Monday about this study, putting together a brief presentation for next Monday for council to summarize the highlights presented in this workshop.
- LL: How will this project fit in with the provincial order? Will the two timelines be aligned, or will there be work that proceeds more quickly from this?

	○ AG: Walking through the order with the Ministry, hope these will be fairly aligned. Can update this group after the meeting with the Ministry. • TT: The Vision will require input from different groups. Want to confirm the way one provides perspective; for the current total loadings, are we using the Hamilton loading data? ○ JB: Yes, historic values from HCA provides the best relative comparative for this assignment. ○ TT: Total loadings is an easy way to do math but is fairly misleading as Spencer is a larger watershed than the other contributing watersheds. Will have to determine appropriate performance measures. • KO: Can you clarify the prioritization? Is this suggesting implementing priority 1 before looking into the next one? ○ JB: Haven't fully flushed out the recommendations; however, short-term will likely include recommending multiple priorities concurrently, whereas long term will more likely be stepped implementation.	City – To update external stakeholder group after meeting with Ministry
13.	**Next Steps** • Stakeholders to provide additional feedback by December 18th including any comments related to the vision statements, objectives, evaluation and timeframe • Next steps for project team include the refinement of solutions timeline and costing to work towards development of framework reporting	Stakeholders

APPENDIX C: ASSESSMENT METHODOLOGY

1 INTRODUCTION

The purpose of this Appendix is to summarize the Assessment Methodology that was used to evaluate the impacts of the sources contributing to the Chedoke Creek Water Quality nutrient loading. The assessment methodology analyzed the relative impacts of the various sources to help determine the benefit of projects presented in the Water Quality Improvement Framework.

2 DATA SOURCES

The following reports and data sources were used to complete the Cootes Paradise Water Quality nutrient loading exercise:

- Cootes Paradise Marsh: Water Quality Review and Phosphorus Analysis - Cootes Paradise Water Quality Group, Hamilton Harbour Remedial Action Plan, March 2012
- Hamilton Combined Sewer Overflow Reporting – Hatch Mott MacDonald, 2015-2019
- Towards a Phosphorus Budget and Model for Cootes Paradise – JEMSys Software Systems Inc., 2005
- Tributary Phosphorus Loadings to Cootes Paradise – Aquafor Beech Limited, 2005

The following reports and data sources were used to complete the Chedoke Creek Water Quality nutrient loading exercise:

- Chedoke Creek Water Quality Monitoring Program – Hamilton Conservation Authority (HCA), 2014-2018
- Hamilton Combined Sewer Overflow Reporting – Hatch Mott MacDonald, 2015-2019
- HHRAP Water Quality Monitoring – Environmental Monitoring and Enforcement (EME), 2018-2020
- Historical Precipitation Data for RBG – Government of Canada, 2015-2019
- Landfill Leachate Collection System Performance and Groundwater Monitoring and Sampling Report – SNC Lavalin, 2015-2019
- Water Quality Data Cootes Paradise – Royal Botanical Gardens (RBG), 1986-2017

3 CHEDOKE CREEK NUTRIENT LOADING METHODOLOGY

The Chedoke Creek nutrient loading assessment was completed in order to provide a high-level estimate of the relative contributions from various sources contributing to the Chedoke Creek. This was used to provide guidance to identify priority areas for project recommendations and the associated potential benefits. The sources were broken down into 5 groups and included: Combined Sewer Overflows (CSOs), Urban Stormwater System, Highway 403, Railway & Railyard and Landfill.

Figure 1: Total Nutrient Loading

4 NUTRIENT LOADING CALCULATION

The nutrients considered in this report include:

- Total Phosphorus
- Ammonia + Ammonium
- Total Suspended Solids

The nutrient loadings to the creek from each of the five contributing sources listed above were calculated for an Average Year, a representative peak precipitation day (Peak Day), and a low precipitation day (Low Day). The total loading to Chedoke Creek was considered to be the sum of the five sources. The calculation steps are provided in the following subsections.

4.1 Combined Sewer Overflows (CSOs)

The nutrient loading was calculated for the three CSOs with outfalls into the Chedoke Creek which include:

- Royal CSO
- Aberdeen CSO
- Main-King CSO

For each CSO, the average year total nutrient loading was calculated by multiplying the 5-year average annual overflow volume with the 5-year average nutrient concentration based on data from 2015-2019. The calculation process is shown in **Figure 2.**

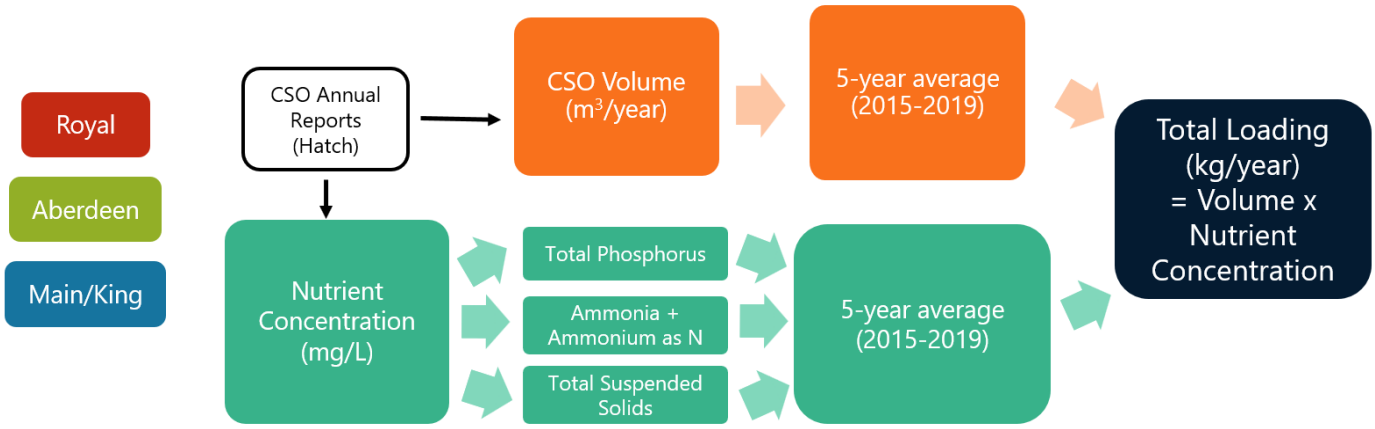


Figure 2: CSO Total Loading - Average Year

The Peak Day total loading was calculated based on the event that occurred on July 6, 2019, representing a peak precipitation day. The calculation process is shown in **Figure 3.**

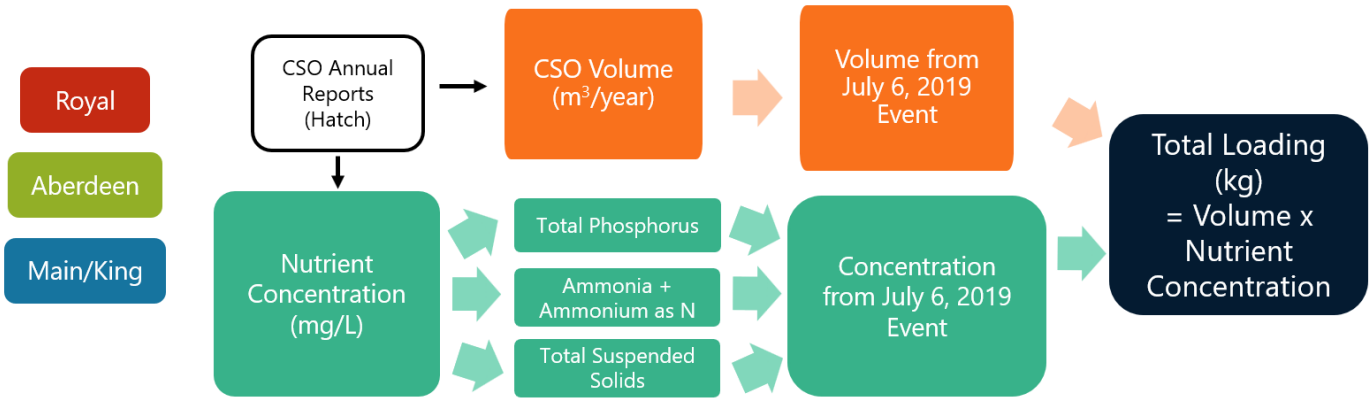


Figure 3: CSO Total Loading – Peak Event

The total loading on the Low Day scenario was assumed to be zero, under the reasonable assumption that there are no combined sewer overflows during low precipitation events.

4.2 Stormwater Catchments

The Chedoke Creek Watershed was broken into seven catchments based on the sampling data points. The catchments are shown in **Figure 4**.

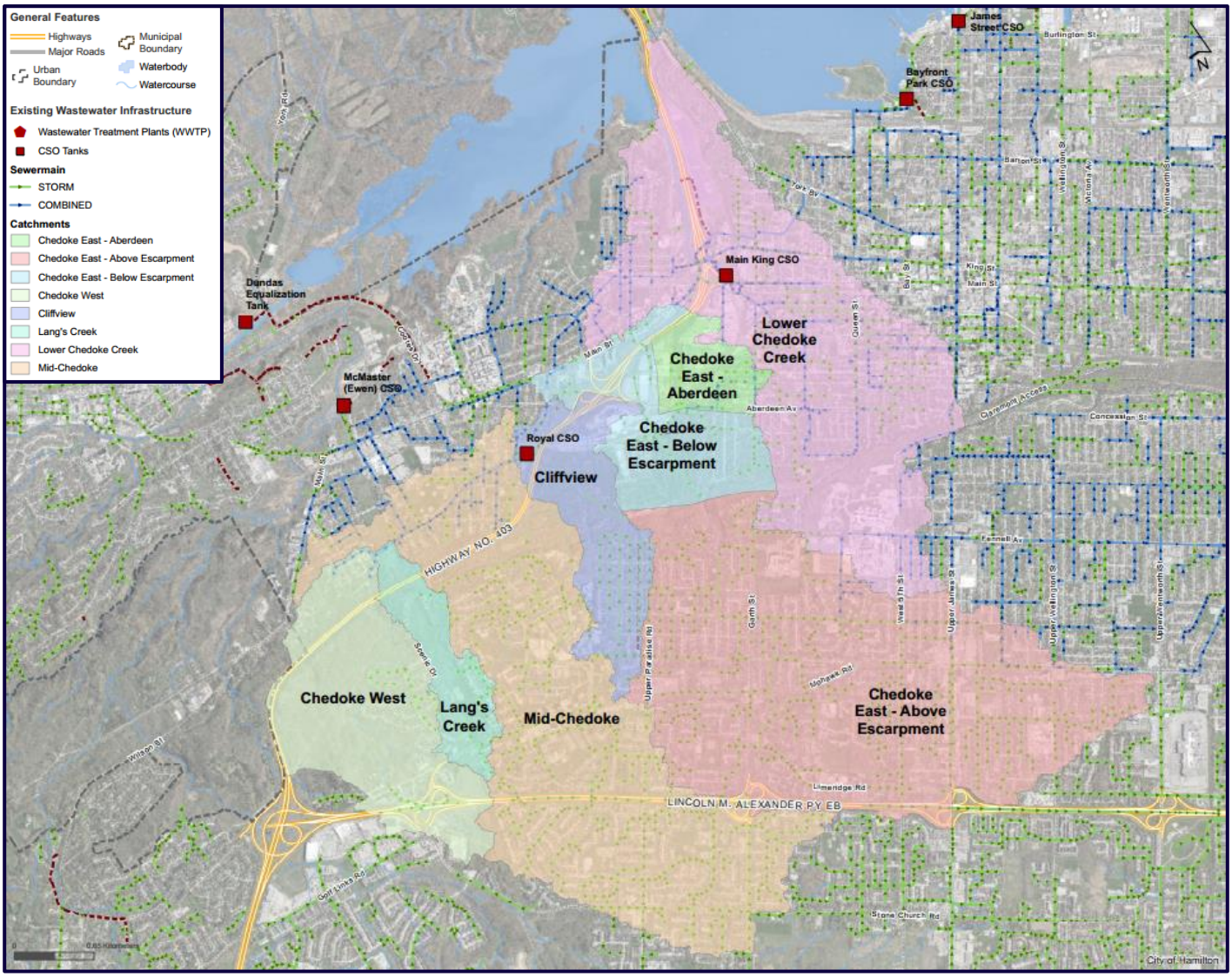


Figure 4: Chedoke Creek Watershed Catchments

The following assumptions were made when calculating the urban stormwater system nutrient loadings:

- 30% of the precipitation volume was assumed to be direct runoff;
- 10% of the precipitation volume was assumed to be baseflow;
- Only 30% of the Lower Chedoke Creek Catchment was included in the urban stormwater system calculations due to combined sewers throughout the catchment;
- Areas of each catchment do not include the areas of other contributors (e.g. Railway and Railyard, Highway 403, Landfill)
- Stream nutrient concentration is a proxy for runoff water quality—calculations give higher bound estimations of nutrient loadings;

- Baseflow contribution is negligible on Peak Day as runoff volume is significantly higher; and,
- Snowpack accumulation and spring freshet flows are not considered.

The Average Year total loading was calculated using precipitation and nutrient concentration data over a span of 2015 to 2019 for each stormwater catchment **(Figure 4)**. The Average Year stormwater volume from runoff and baseflow was determined by multiplying the catchment area by 30% of the average annual precipitation for direct runoff, and 10% for baseflow. Note that the areas of other contributing sources within a catchment (e.g. Railway and Railyard, Highway 403, and Landfill) are subtracted to isolate the effects of urban runoff. The average annual nutrient concentration was determined using data from Hamilton Conservation Authority's (HCA) bi-weekly stream sampling program. An annual average concentration for each nutrient for runoff (Wet Days) and baseflow (Dry Days) was estimated using sampling data spanning 5 years and Environment Canada's Daily Precipitation data to classify Wet Days (>4mm/day) and Dry Days (<4mm/day). The total annual loading is the sum of the Wet Day and Dry Day annual loadings, which were calculated as the volume multiplied by the respective nutrient concentration. Note that since stream concentrations are used as a proxy for stormwater quality and stormwater generally has lower nutrient concentrations than other contributing sources, the calculated loading to stream is an upper bound estimate. The calculation process is shown in **Figure 5.**

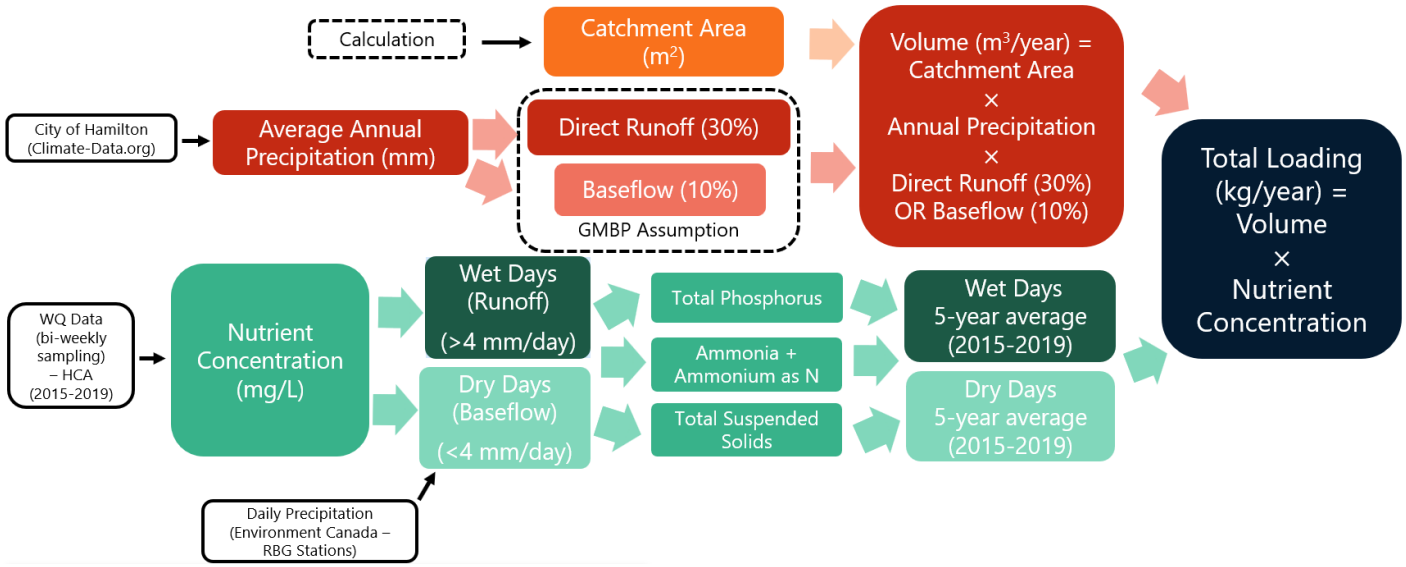


Figure 5: Stormwater Catchment Total Loading – Average Year

The Peak Day loading for each stormwater catchment was calculated by determining the volume and nutrient concentration for a representative peak rainfall day. The precipitation from July 6, 2019 was used. Since the rainfall exceeded 4mm, the contributing volume was calculated by multiplying the catchment areas by 30% of the daily precipitation to account for direct runoff. It was assumed that contributions by baseflow was negligible compared to the runoff. The nutrient concentrations used were the annual average concentrations for Wet Days. The total loading was calculated as the volume multiplied by the nutrient concentration, shown in **Figure 6**.

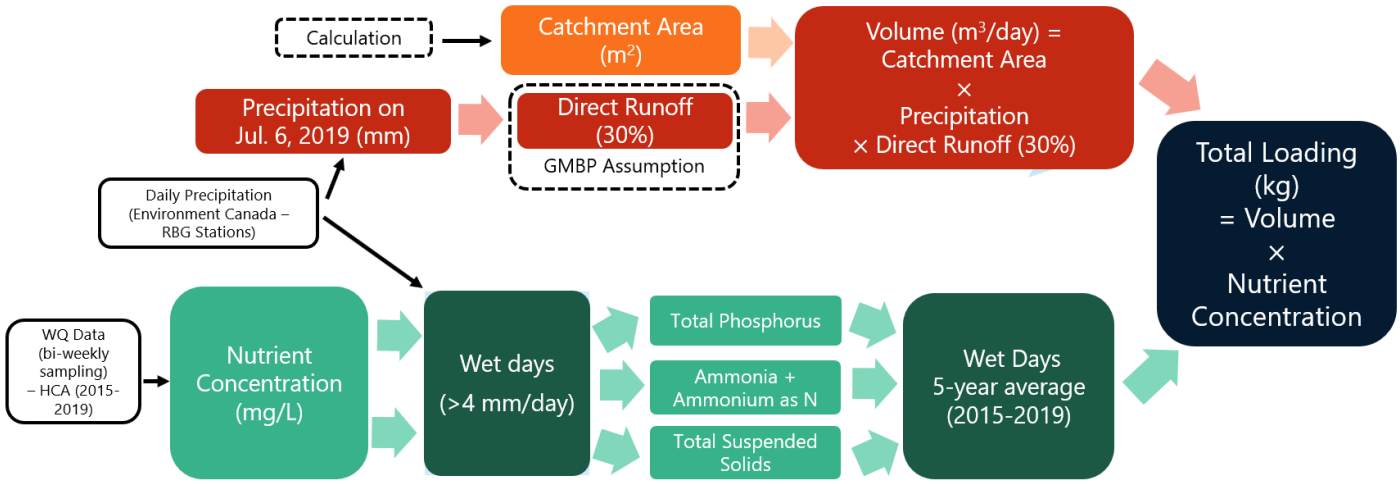


Figure 6: Stormwater Catchment Total Loading – Peak Day

Likewise, the Low Day loading for each stormwater catchment was calculated by determining the volume and nutrient concentration for a representative low rainfall day. The precipitation from November 21, 2019 was used. Since the volume was less than 4mm, it was assumed that no direct runoff was generated. Therefore, the contributing volume was calculated by multiplying the catchment areas by 10% (baseflow) of the daily precipitation. The nutrient concentrations used were the annual average concentrations for Dry Days. The total loading was calculated as the volume multiplied by the nutrient concentration, shown in **Figure 7**.

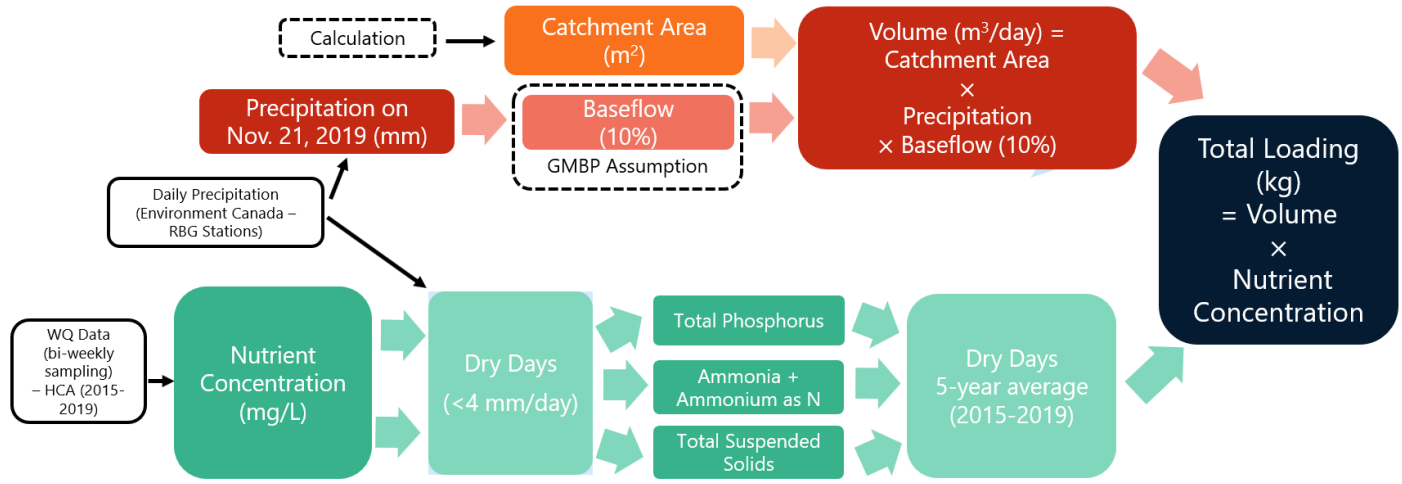


Figure 7: Stormwater Catchment Total Loading – Low Day

4.3 Highway 403

Estimations of nutrient loading contributed by Highway 403 follows the same approach as the calculations done for Stormwater Catchments for Average Year, Peak Day, and Low Day.

4.4 Railway & Rail Yard

Similarly, the Railway and Rail Yard also followed the same approach as the Stormwater Catchment calculation for the Average Year, Peak Event, and Low Event. The areas for the Railway and Rail Yard were also subtracted from the applicable stormwater catchments.

4.5 Landfill

The following assumptions were made when calculating the average year landfill nutrient loadings:

- 20% of the leachate volume reaches the creek; and,
- 80% of the leachate volume is captured by the leachate collection system.

The nutrient loading was calculated for the Kay Drage Park, Closed West Hamilton Landfill. The volume was calculated by multiplying the 5-year average annual pumped leachate volume by 20%. The nutrient concentration was calculated based on a 5-year average of nutrients from all sampling points along the Chedoke Creek. The total loading was the volume multiplied by the nutrient concentration. The calculation process is shown in **Figure 8**.

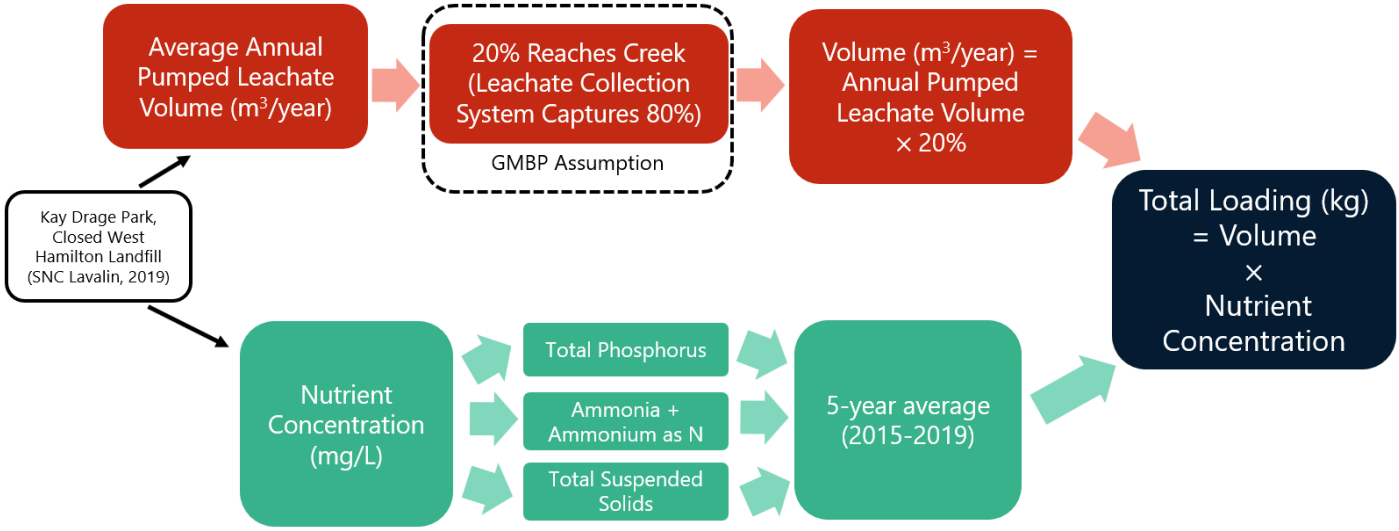


Figure 8: Landfill Total Loading – Average Year

The following assumptions were made when calculating the peak day landfill nutrient loadings:

- 50% of the leachate volume reaches the creek; and,
- 50% of the leachate volume is captured by the leachate collection system.

The Peak Day volume was calculated by multiplying the pumped leachate volume measured at the Landfill Pumping Station on July 6, 2019 by 50%. The nutrient concentration was calculated based on a 5-year average of nutrients from all sampling points along the Chedoke Creek. The total loading was the volume multiplied by the nutrient concentration. The calculation process is shown in **Figure 9**.

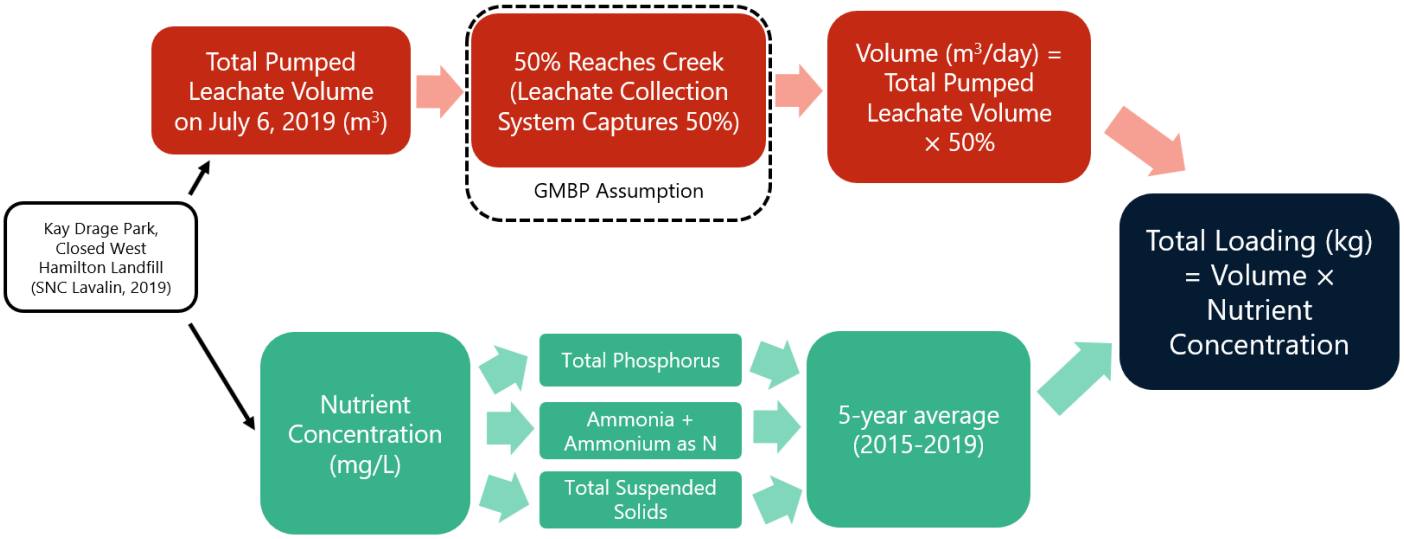


Figure 9: Landfill Total Loading – Peak Day

The Low Day volume was calculated by multiplying the pumped leachate volume measured at the Landfill Pumping Station on November 21, 2019 by 20%. The nutrient concentration was calculated based on a 5-year average of nutrients from all sampling points along the Chedoke Creek. The total loading was the volume multiplied by the nutrient concentration. The calculation process is shown in **Figure 10**.

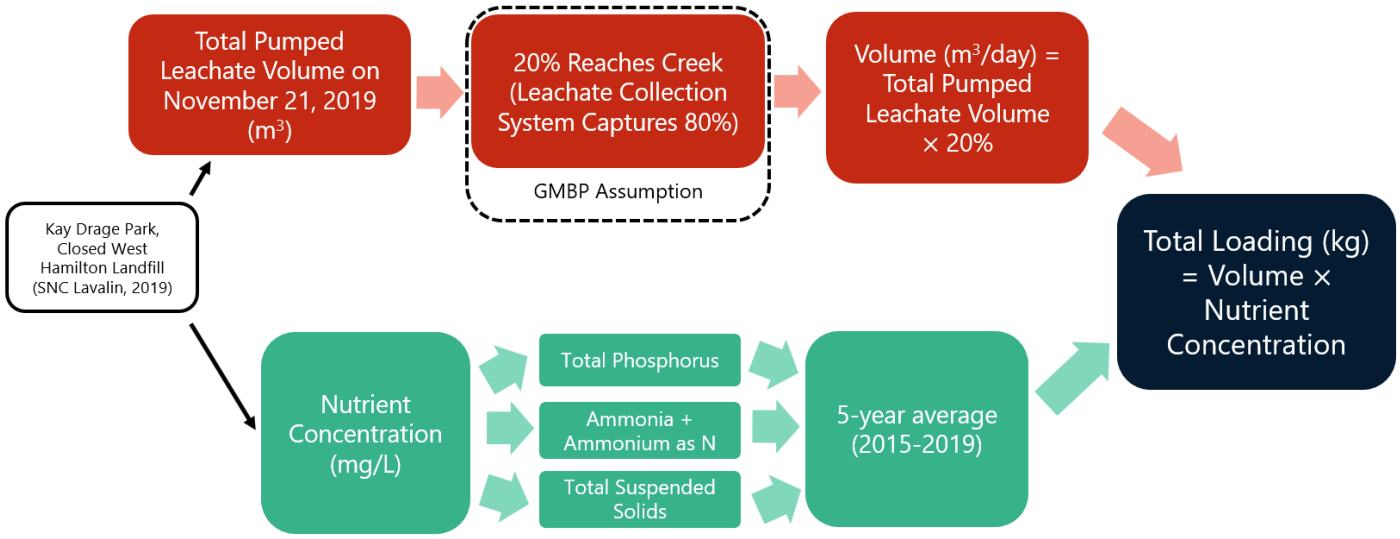


Figure 10: Landfill Total Loading – Low Day

5 OVERVIEW OF POTENTIAL CONTRIBUTIONS

Based on the total loadings calculated for the sources in the previous sections, an overview of the relative potential contributions was developed. As mentioned above, this is a high-level estimate of the range of relative contributions and a more comprehensive analysis should be completed for future studies. An example of the Average Year and Peak Day are shown in **Figures 11** and **12**. These overviews were used to provide guidance to identify project priority areas and potential benefits. They are not an accurate representation of actual loading amounts and are not meant to be used for detailed analysis.

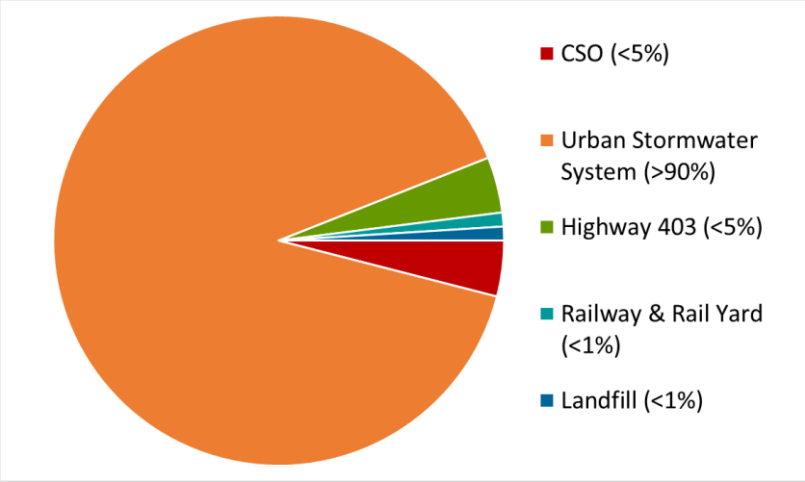


Figure 11: Example Nutrient Loading – Average Year

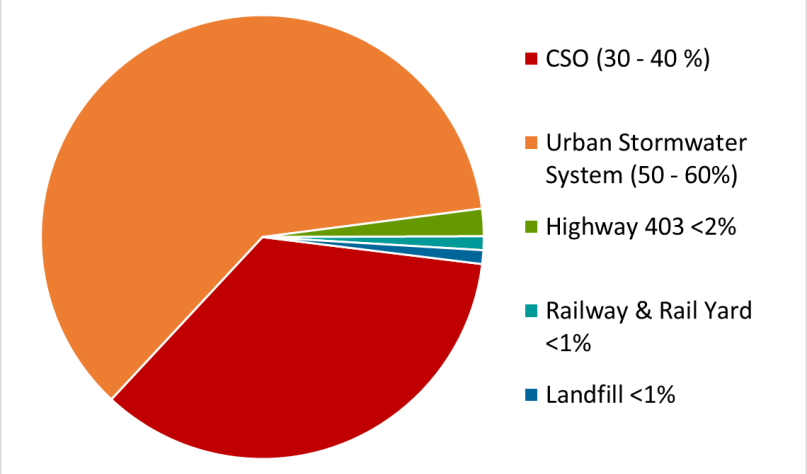
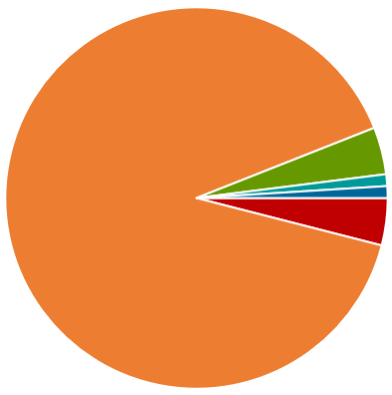
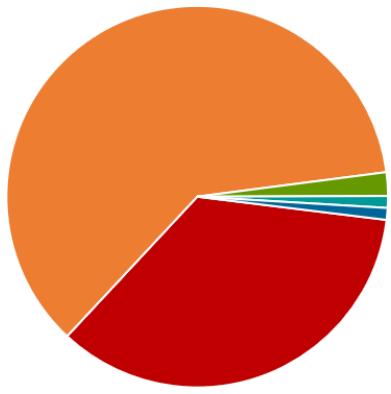
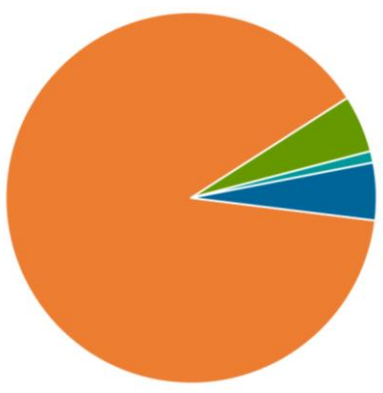
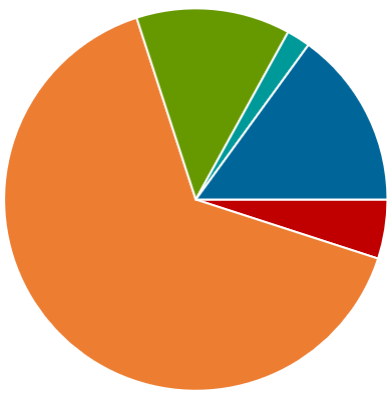
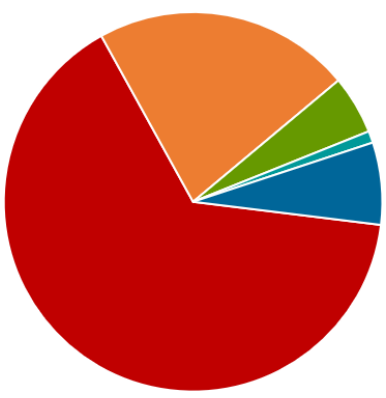
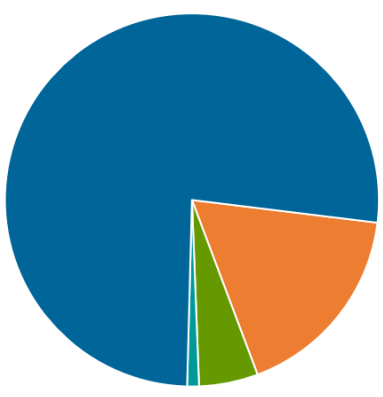
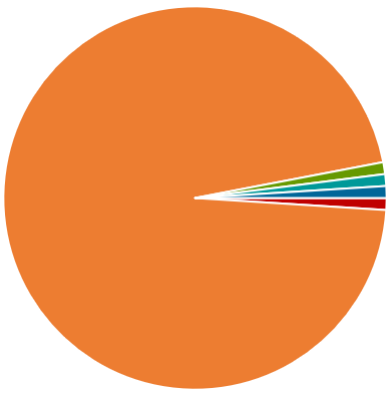
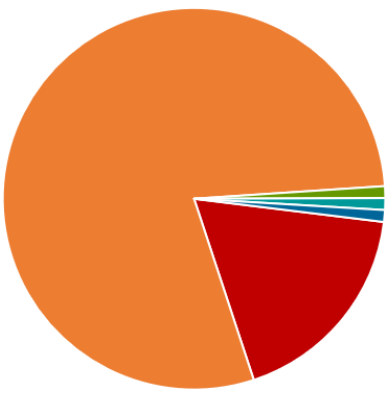
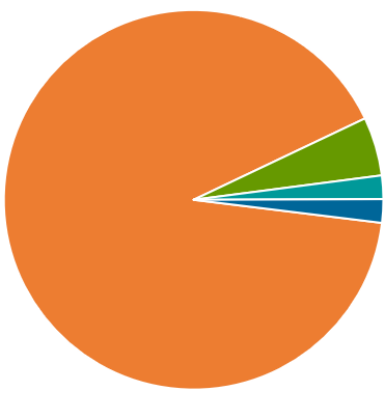


Figure 12: Example Nutrient Loading - Peak Day

APPENDIX D: OPTION REVIEW

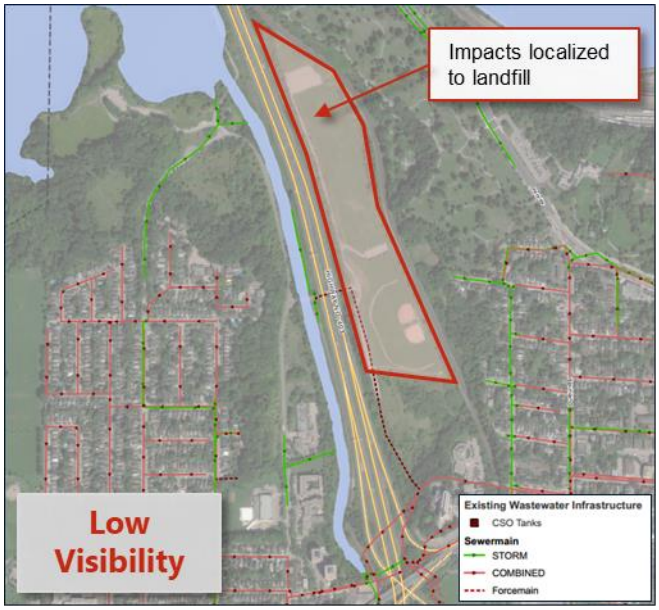
The purpose of this Appendix is to give an overview of the high-level estimations of nutrient loadings to the Chedoke Creek, and the potential benefits from the solutions examined in this report. The nutrients that were reviewed include Total Phosphorus (TP), Ammonia + Ammonium (NH_3) and Total Suspended Solids (TSS). Each project sheet summarizes the project description, expected cost, timeframe, project implementation responsibility and potential benefits. All estimations are high level and should only be used for identifying priority areas and solution screening. Further detailed studies are needed to determine more accurate expectations of project implementation benefits. For the methodology of how these estimations were made, please refer to **Appendix C**.

Table 1: Contribution of Major Nutrient Sources to Chedoke Creek

Total Phosphorus			
	Average Year	**Peak Event**	**Low Event**
			
CSO	<5%	30% - 40%	0%
Urban Stormwater System	>90%	50% - 60%	>90%
Highway 403	<5%	<2%	<5%
Railway & Railyard	<1%	<1%	<1%
Landfill	<1%	<1%	<5%
Ammonia + Ammonium as N			
	Average Year	**Peak Event**	**Low Event**
			
CSO	<5%	65% - 75%	<1%
Urban Stormwater System	60% - 70%	20% - 25%	10% - 20%
Highway 403	10% - 15%	<5%	5% - 10%
Railway & Railyard	<2%	<1%	<1%
Landfill	15% - 20%	5% - 10%	70% - 80%
Total Suspended Solids			
	Average Year	**Peak Event**	**Low Event**
			
CSO	<1%	15% - 20%	<1%
Urban Stormwater System	>95%	75% - 85%	>90%
Highway 403	<1%	<1%	<5%
Railway & Railyard	<1%	<1%	<2%
Landfill	<1%	<1%	<2%

1) Direct clean water away from landfill

- Prevent local runoff from entering leachate collection system (LCS) and instead allow clean water to directly flow into Chedoke Creek
- Reduce total volume pumped from LCS to combined sewers due to reduced leachate generation



Cost	$5 - $10 M
Timing	Near-Term (5-10 Years)
Implementation	Difficult
Capital	City
Maintenance	City
Type	Preventative

Nutrient Loading Impacts

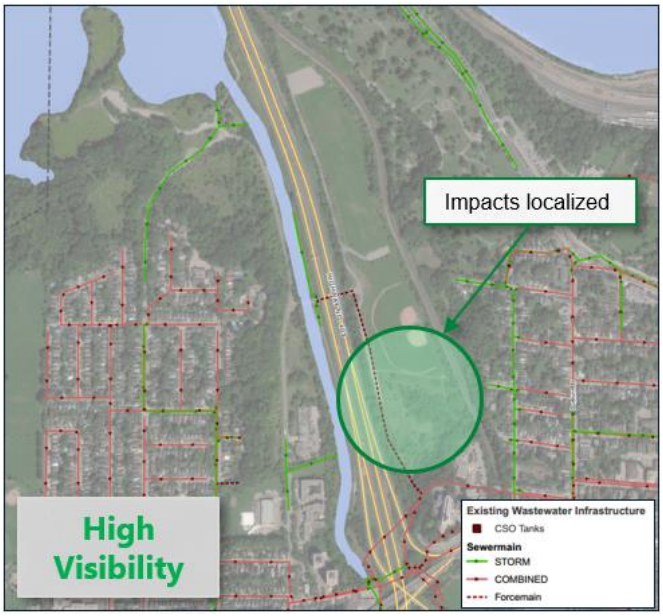
- Reduced total volume of leachate overflowing into the creek during high flow events
- Leachate contamination can contribute to elevated levels of total phosphorus, ammonia
- Leachate may also lead to elevated levels of iron, boron, zinc, and biological oxygen demand

Pie Chart Contribution	Landfill
Reduction Assumptions	• Volume reaching creek from landfill (not captured by LCS) is reduced by 50%

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<1%	15 – 20%	<1%
	Source Reduction	40 – 60%	40 – 60%	40 – 60%
Peak	Current % Contribution	<1%	5 – 10%	<1%
	Source Reduction	40 – 60%	40 – 60%	40 – 60%
Low	Current % Contribution	<5%	70 – 80%	<2%
	Source Reduction	40 – 60%	40 – 60%	40 – 60%

2) Rehabilitate existing Highway 403 Culvert (Landfill)

- Prevent leachate from contaminating flows from Highway 403 entering the Chedoke Creek via culvert
- Prevent leachate from by-passing LCS via this route



Cost	$1 - $5 M
Timing	Short-Term (<5 Years)
Implementation	Moderate
Capital	City, MTO
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

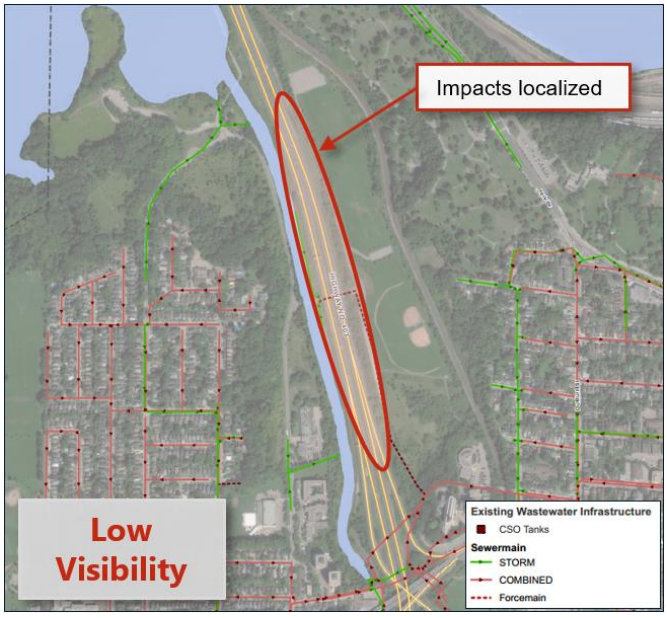
- Prevents leachate contamination of runoff from Highway 403
- Leachate can contribute to elevated levels of total phosphorus, ammonia
- Leachate may also lead to elevated levels of iron, boron, zinc, and biological oxygen demand

Pie Chart Contribution	Landfill
Reduction Assumptions	• Landfill nutrient concentration is reduced by up to 75%

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<1%	15 - 20%	<1%
	Source Reduction	65 - 75%	65 - 75%	65 - 75%
Peak	Current % Contribution	<1%	5 - 10%	<1%
	Source Reduction	65 - 75%	65 - 75%	65 - 75%
Low	Current % Contribution	<5%	70 - 80%	<2%
	Source Reduction	65 - 75%	65 - 75%	65 - 75%

3) Expand/Fix Leachate Collection System (LCS)

- Extend and deepen perforated pipe for leachate collection pipe
- Prevent leachate from seeping into creek
- Prevent leachate from contaminating runoff entering creek



Cost	$10-$25 M
Timing	Near-Term (5-10 Years)
Implementation	More data needed
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

- Reduce leachate seeping or contamination of runoff potentially entering the stream
- Leachate can contribute to elevated levels of total phosphorus, ammonia
- Leachate may also lead to elevated levels of iron, boron, zinc, and biological oxygen demand

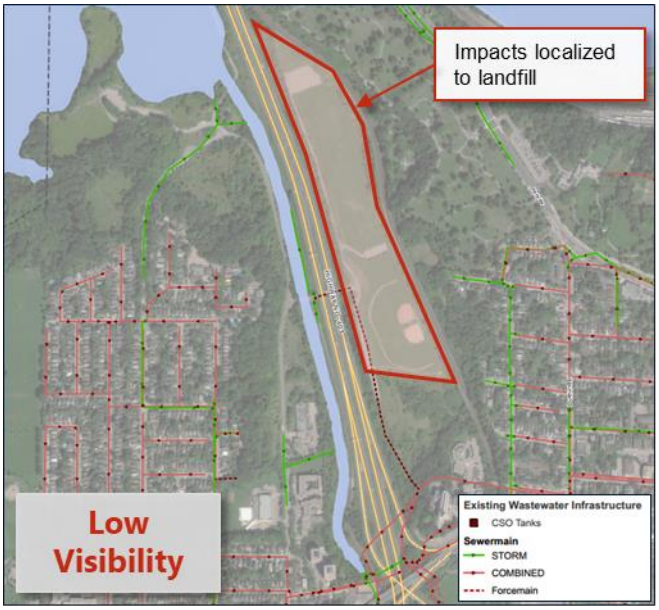
Pie Chart Contribution	Landfill
Reduction Assumptions	• Volume reaching creek from landfill (not captured by LCS) is reduced by 75% for average year and low event • Volume reaching creek from landfill (not captured by LCS) is reduced by 80% for peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<1%	15 - 20%	<1%
	Source Reduction	65 - 75%	65 - 75%	65 - 75%
Peak	Current % Contribution	<1%	5 – 10%	<1%
	Source Reduction	70 - 80%	70 - 80%	70 - 80%
Low	Current % Contribution	<5%	70 – 80%	<2%
	Source Reduction	65 - 75%	65 - 75%	65 - 75%

4) Landfill Capping/Barrier

- Improve landfill capping/barrier to reduce leachate leaking from boundaries
- Enhance the barrier between the contaminated media and the surface
- Limit any passage of the contents by restricting surface water infiltration at landfill site thus reducing leaching

Cost	$50-$100 M
Timing	Long-Term (>10 years)
Implementation	Difficult
Capital	City
Maintenance	City
Type	Preventative



Nutrient Loading Impacts

- Reduce leachate from escaping landfill boundaries where it can potentially enter the stream
- Leachate can contribute to elevated levels of total phosphorus, ammonia
- Leachate may also lead to elevated levels of iron, boron, zinc, and biological oxygen demand

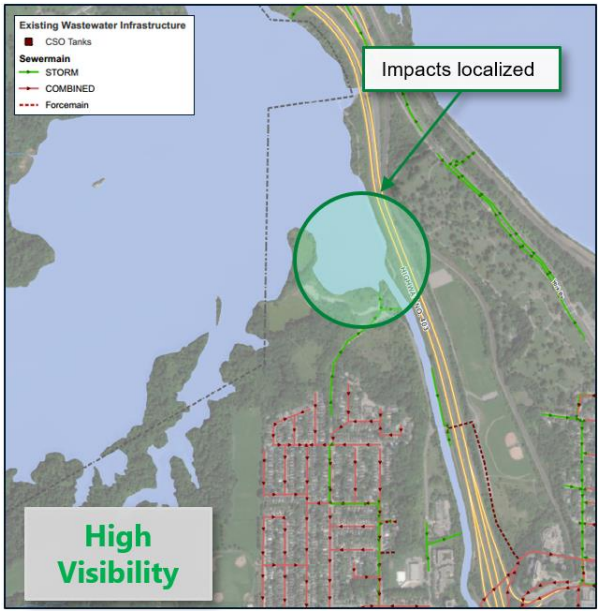
Pie Chart Contribution	Landfill
Reduction Assumptions	• Volume reaching creek from landfill (not captured by LCS) is reduced by 90%

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<1%	15 – 20%	<1%
	Source Reduction	80 - 90%	80 - 90%	80 - 90%
Peak	Current % Contribution	<1%	5 – 10%	<1%
	Source Reduction	80 - 90%	80 - 90%	80 - 90%
Low	Current % Contribution	<5%	70 – 80%	<2%
	Source Reduction	80 - 90%	80 - 90%	80 - 90%

5) Constructed Wetland

- Construct wetland at the outlet of Chedoke Creek where it enters Cootes Paradise
- Capture sediments & pollutant loading from Chedoke Creek before entering Cootes Paradise
- Control flow which will enhance natural processes and improve wildlife habitat at outlet of Chedoke Creek

Cost	$10-$25 M
Timing	Near-Term (5-10 Years)
Implementation	Moderate
Capital	RBG, City
Maintenance	RBG, City
Type	Restorative



Nutrient Loading Impacts

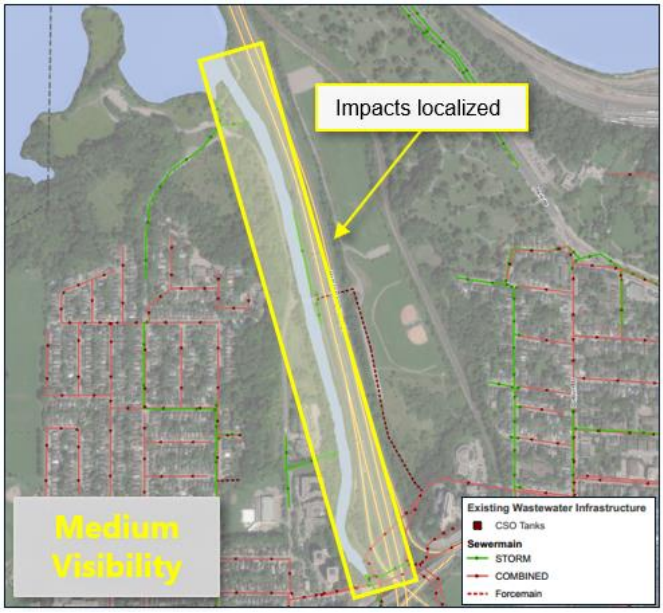
No impacts on nutrient loading into stream, however potential benefits include:

- Reduced TP, ammonia, and TSS loadings into Cootes Paradise
- Dampened peak flow velocities at the stream outlet
- More regulated runoff temperature entering Cootes Paradise

Pie Chart Contribution	N/A: Increased ability to assimilate nutrients

6) Aeration System

- Install Aeration System in Lower Chedoke Creek
- System intended to enhance the transfer of dissolved oxygen to Chedoke Creek/Cootes Paradise waters
- Improves marine habitat along and downstream of the creek



Cost	$5-$10 M (RBG estimate)
Timing	Short (<5 years)
Implementation	Moderate
Capital	RBG, City
Maintenance	RBG, City
Type	Mitigative

Nutrient Loading Impacts

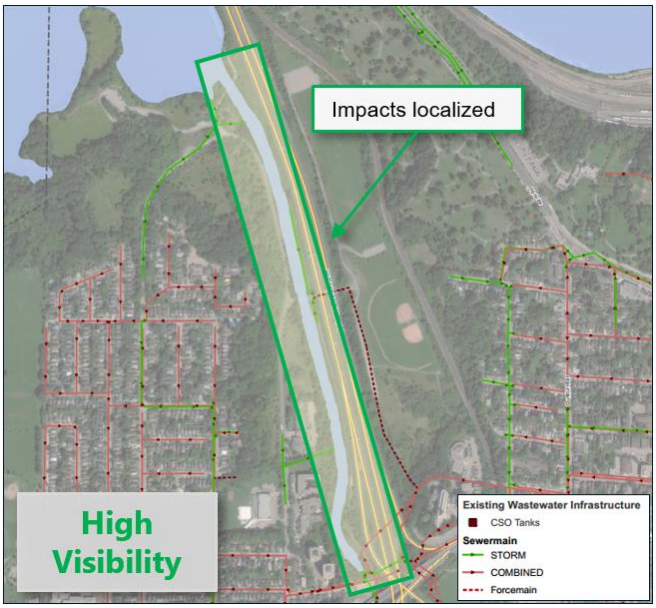
No impacts on nutrient loading into stream, however potential benefits include:

- In-stream removal of ammonia and TP due to greater stream metabolism
- Encourages phosphorus to remain sediment-bound rather than bioavailable to algae and other opportunistic microorganisms

Pie Chart Contribution	N/A: Increased ability to assimilate nutrients

7) Stream Naturalization

- Remove concrete channel and introduce native vegetation for slope stability
- Reduce stream velocity and sediment buildup downstream
- Improves marine habitat along and downstream of the creek



Cost	$1-$5 M
Timing	Near-Term (5-10 Years)
Implementation	Difficult
Capital	RBG, City
Maintenance	RBG, City
Type	Restorative

Nutrient Loading Impacts

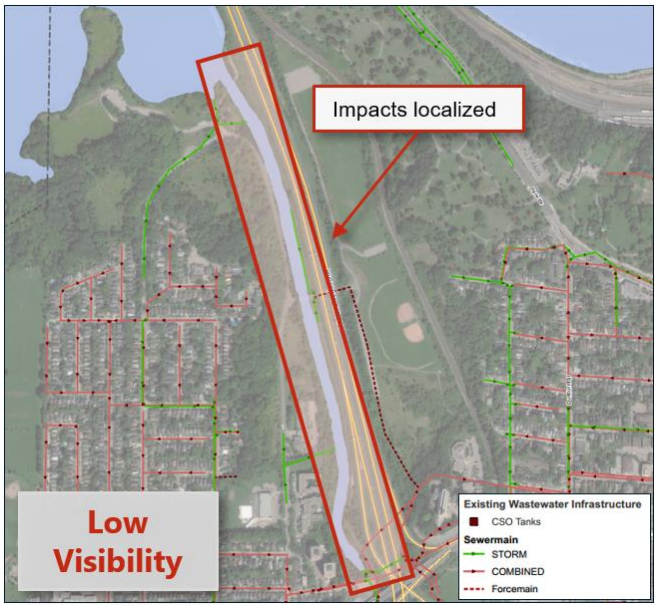
No impacts on nutrient loading into stream, however potential benefits include:

- Reduced TSS loading from entering Cootes Paradise due to lower stream velocities
- Greater potential of in-stream removal of ammonia and TP due to greater stream metabolism

Pie Chart Contribution	N/A: Some increased ability to assimilate nutrients

8) Physical Capping

- Apply a cover of clean material on top of contaminated sediment to mitigate risk of contaminated sediment
- Stabilization of contaminated sediments to prevent resuspension
- Prevent benthic community from interacting with and processing the contaminated sediments



Cost	$5-$10 M (RBG estimate)
Timing	Short (<5 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Restorative

Nutrient Loading Impacts

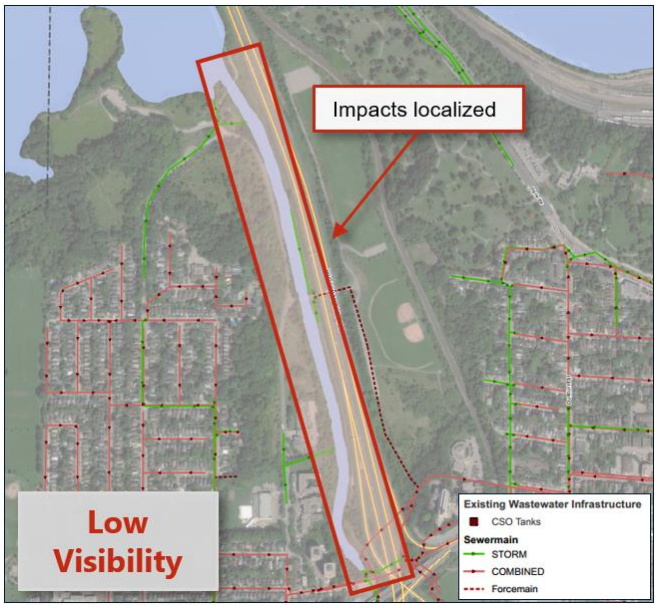
No impacts on nutrient loading into stream, however:

- Prevents re-mobilization of contaminants in sediments
- Sediment contaminants of concern include phosphorus, nitrogen, heavy metals (mercury, copper, iron, lead, manganese, nickel, zinc)

Pie Chart Contribution	N/A: No changes

9) Chemical Inactivation

- Alternative to physical capping
- Chemically treat contaminated sediment



Cost	$1-$5M
Timing	Short (<5 years)
Implementation	Easy
Capital	City
Maintenance	City
Type	Restorative

Nutrient Loading Impacts

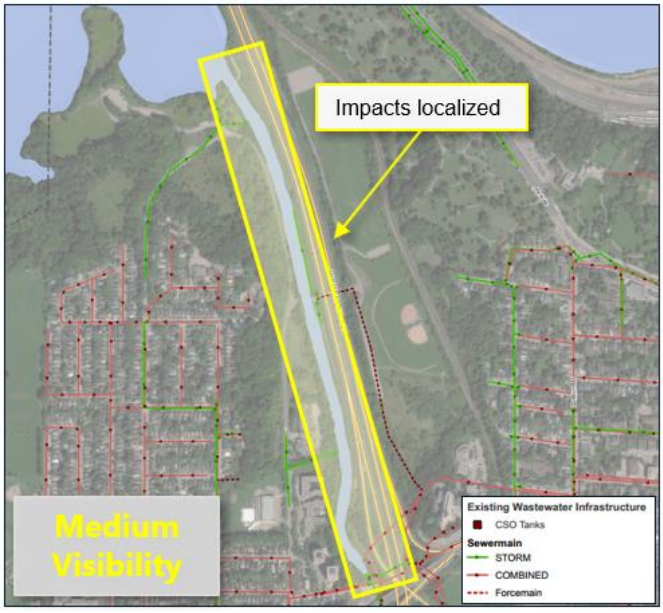
No impacts on nutrient loading into stream, however:

- Prevents re-mobilization of contaminants in sediments
- Sediment contaminants of concern include heavy metals (mercury, copper, iron, lead, manganese, nickel, zinc), phosphorus, nitrogen

Pie Chart Contribution	N/A: No changes

10A) Chedoke Creek Complete Sediment Removal

- Remove contaminated sediment via hydraulic dredging
- Remediate the creek by removing all existing sediment within creek



Cost	$5-$10M
Timing	Short (<5 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Restorative

Nutrient Loading Impacts

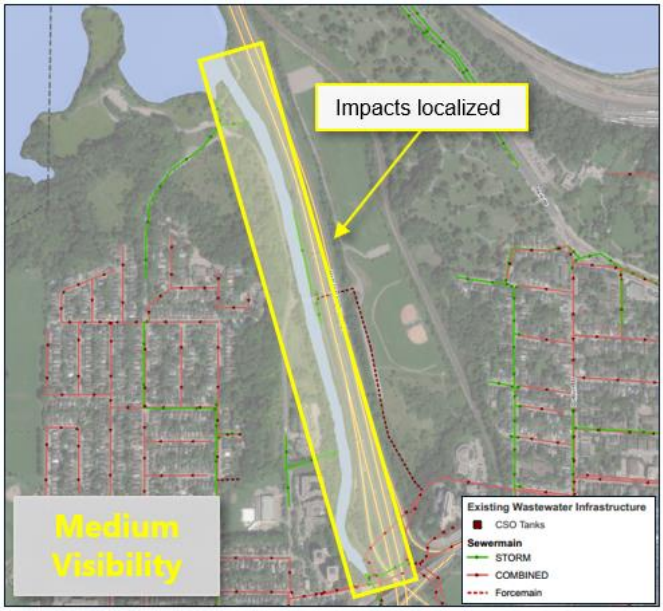
No impacts on nutrient loading into stream, however:

- Prevents re-mobilization of contaminants in sediments
- Sediment contaminants of concern include heavy metals (mercury, copper, iron, lead, manganese, nickel, zinc), phosphorus, nitrogen

Pie Chart Contribution	N/A: No changes

10B) Chedoke Creek Targeted Sediment Removal

- Targeted removal of contaminated sediment via hydraulic dredging (Part of current MECP Order)
- Remediate the creek bed by removing targeted sediment
- Will immediately reduce contamination



Cost	$1-$5M
Timing	Short (<5 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Restorative

Nutrient Loading Impacts

No impacts on nutrient loading into stream, however:

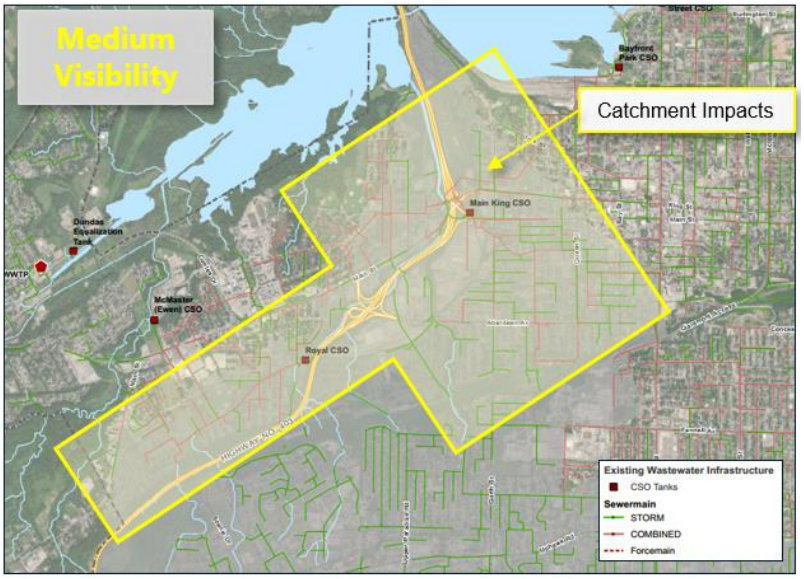
- Prevents re-mobilization of contaminants in sediments
- Sediment contaminants of concern include phosphorus, nitrogen, heavy metals (mercury, copper, iron, lead, manganese, nickel, zinc)

Pie Chart Contribution	N/A: No changes

11) Sewer Separation

- Full implementation of sewer separation in Chedoke watershed
- Prevents sanitary waste from overflowing into Chedoke Creek before treatment
- Potential implementation challenges/high costs/long timelines

Cost	$50-$100 M
Timing	Long-Term (>10 years)
Implementation	Difficult
Capital	City
Maintenance	City
Type	Preventative



Nutrient Loading Impacts

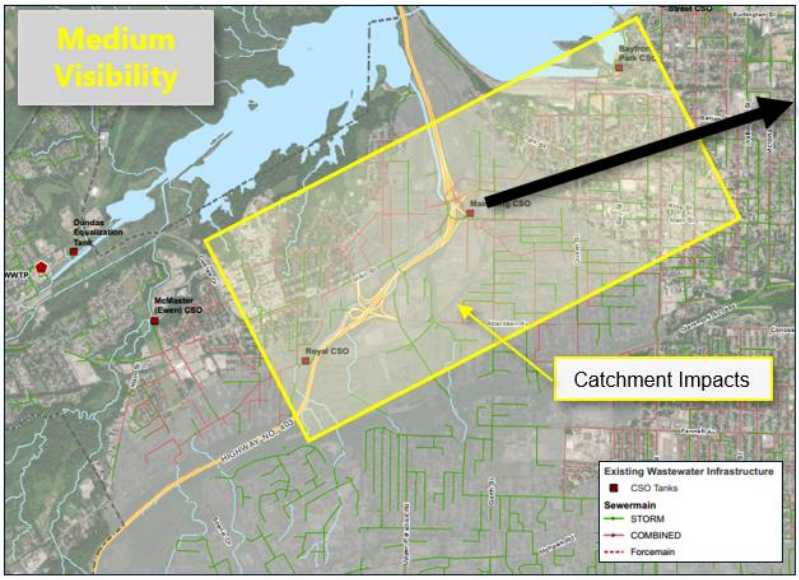
- Prevent contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams during high flow events

Pie Chart Contribution	CSO
Reduction Assumptions	• Reduce CSO volume by 90% and increase nutrient concentration by 50% for average year and peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	80 – 90%	80 – 90%	80 – 90%
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	80 – 90%	80 – 90%	80 – 90%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

12) Increase Capacity Downstream of Main-King CSO Tank

- Trunk upgrades from Main-King CSO tank to Woodward Avenue WWTP to accommodate higher storm flows
- Reduces volume and frequency of combined sewer overflows



Cost	>$100 M
Timing	Long-Term (>10 years)
Implementation	Difficult
Capital	City
Maintenance	City
Type	Preventative

Nutrient Loading Impacts

- Reduces frequency of contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams during high flow events

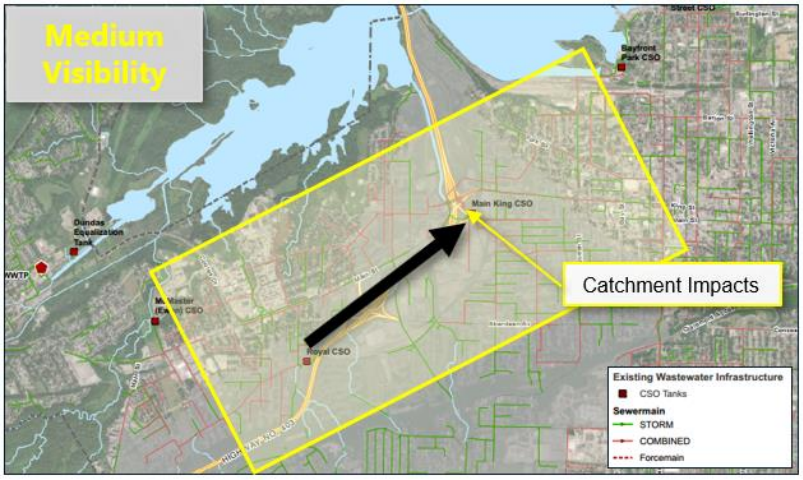
Pie Chart Contribution	CSO
Reduction Assumptions	• Assume 90% of overflow volume from Main-King CSO tank doesn't occur during average year and 75% doesn't occur during peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	35 - 45%	70 - 80%	20 - 30%
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	30 - 40%	60 - 70%	5 - 10%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

13) Increase Capacity of Royal CSO tank to Main-King CSO tank (Highway 403 Trunk Sewer Twinning)

- Reduces volume and frequency of combined sewer overflows
- Potential elimination of overflows at Aberdeen CSO & reduction in overflows at Royal CSO

Cost	$25-$50 M
Timing	Near-Term (5-10 Years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative



Nutrient Loading Impacts

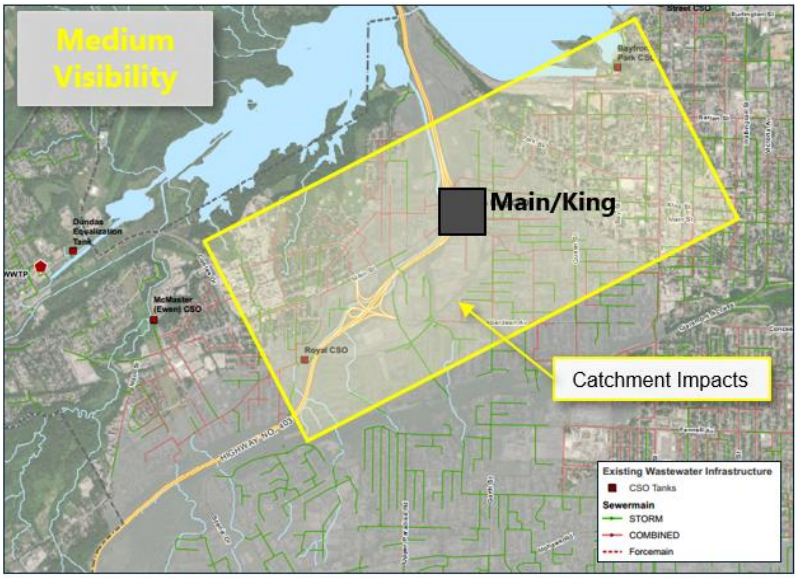
- Reduces frequency of contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams during high flow events

Pie Chart Contribution	CSO
Reduction Assumptions	• Assume 50% of overflow volume from Main-King and Royal CSO tanks, and all overflows from Aberdeen don't occur during average year, and • 25% of overflow volume from Main-King and Royal CSO tanks, and all overflows from Aberdeen don't occur during peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	60 – 70%	50 – 60%	70 – 80%
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	20 - 30%	20 - 30%	20 - 30%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

14) Expand Storage at Main-King CSO tank

- Increases holding capacity to accommodate combined sewer flows during high flow events
- Reduces volume and frequency of overflows



Cost	>$100 M
Timing	Long-Term (>10 years)
Implementation	Difficult
Capital	City
Maintenance	City
Type	Preventative

Nutrient Loading Impacts

- Reduces frequency of contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams during high flow events

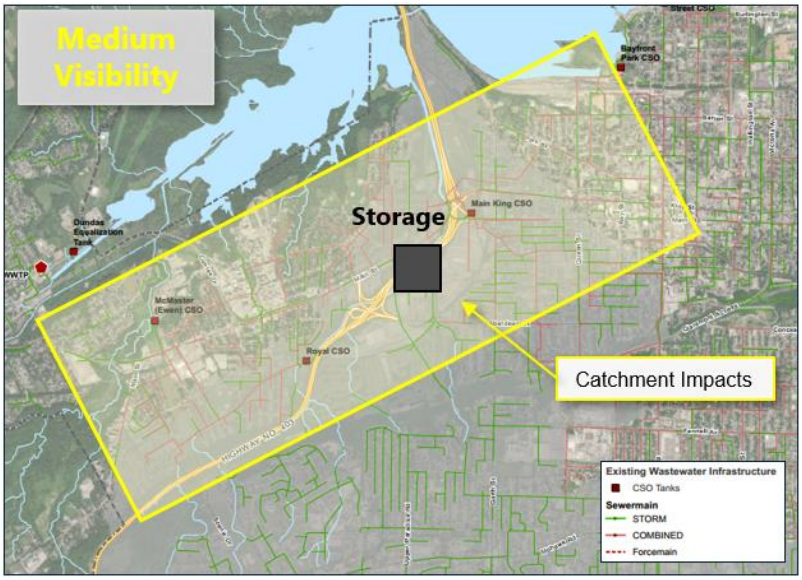
Pie Chart Contribution	CSO
Reduction Assumptions	• Assume 98% of overflow volume from Main-King CSO tank doesn't occur during average year • Assume 95% of overflow volume from Main-King CSO tank doesn't occur during peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	40 - 50%	80 - 90%	20 - 30%
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	45 - 55%	75 - 85%	<10%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

15) Expand Storage Elsewhere in System

- Increases holding system's capacity to accommodate combined sewer flows during high flow events
- Reduces volume and frequency of combined sewer overflows
- Option upstream of Main-King CSO tank to provide additional system relief

Cost	$25-$50 M
Timing	Long-Term (>10 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative



Nutrient Loading Impacts

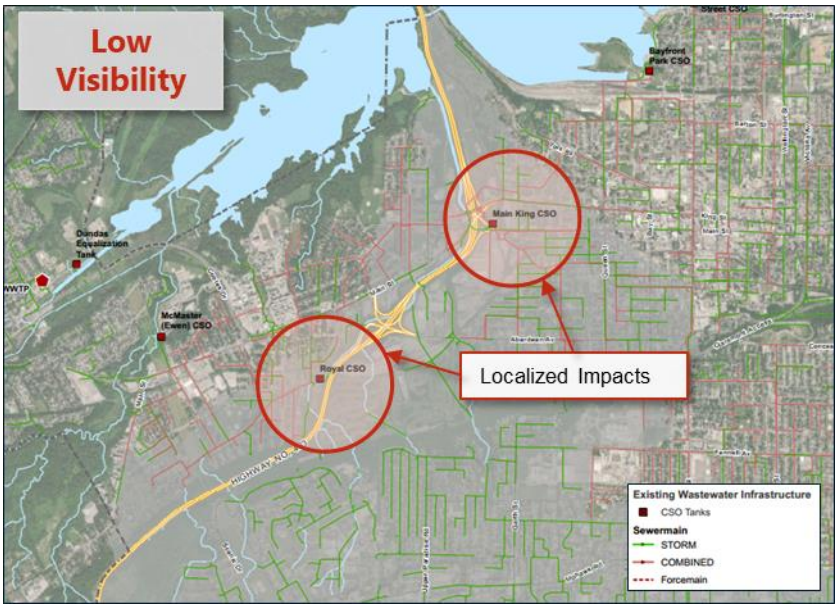
- Reduces frequency of contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams during high flow events

Pie Chart Contribution	CSO
Reduction Assumptions	• Assume 50% of total overflow volume doesn't occur during average year • Assume 25% of total overflow volume doesn't occur during peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	45 - 55%	45 - 55%	45 - 55%
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	20 - 30%	20 - 30%	20 - 30%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

16A) Inspection and Repair - Facilities

- Prevent sewer flows from potentially infiltrating into stream due to leaks
- Potential opportunity at Royal CSO
- Investigation needed to confirm leaks



Cost	$1 - $5 M
Timing	Short (<5 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

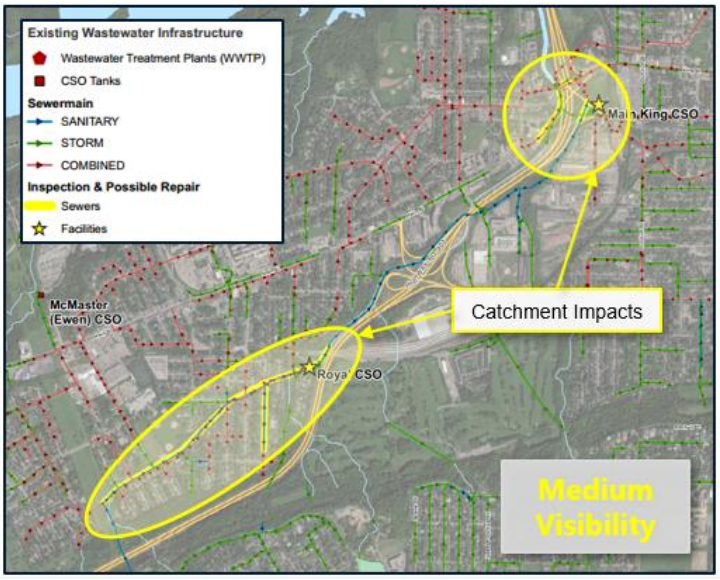
- Reduces contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from infiltrating into streams

Pie Chart Contribution	CSO
Reduction Assumptions	• Assume 10% of total overflow volume doesn't occur during average year • Assume 5% of total overflow volume doesn't occur during peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	<10%	<10%	<10%
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	<5%	<5%	<5%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

16B) Inspection and Repair – Trunk Sewers

- Prevent sewer flows from potentially infiltrating into stream due to leaks
- Potential opportunity within trunk sewers running parallel to stream
- Investigation needed to confirm leaks



Cost	$1 - $5 M
Timing	Short (<5 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

- Reduces contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from infiltrating into streams

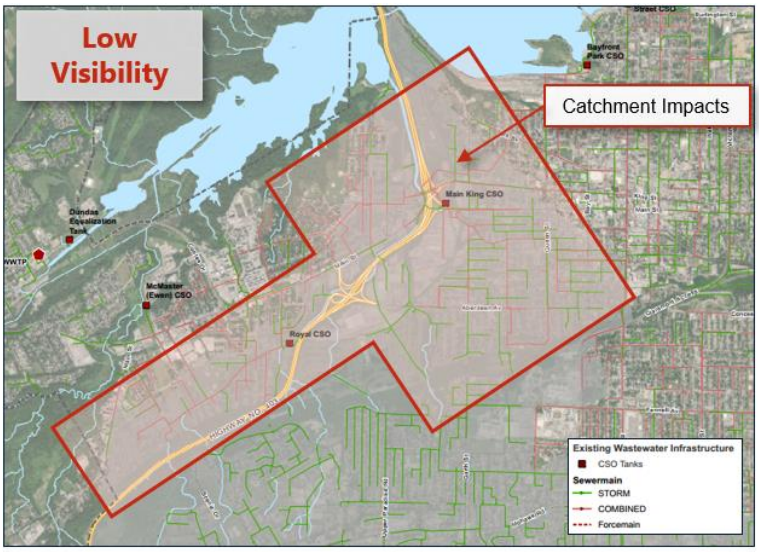
Pie Chart Contribution	CSO
Reduction Assumptions	• Assume 10% of total overflow volume doesn't occur during average year • Assume 5% of total overflow volume doesn't occur during peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	<10%	<10%	<10%
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	<5%	<5%	<5%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

17) CSO Monitoring Improvements and Active Management

- Currently ongoing through Real Time Control (RTC) Program to optimize the performance of the collection system and CSO tanks
- Improved inspection and monitoring of CSOs
- Quantify overflow volume and overflow conditions

Cost	$5 - $10 M
Timing	Short (<5 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative



Nutrient Loading Impacts

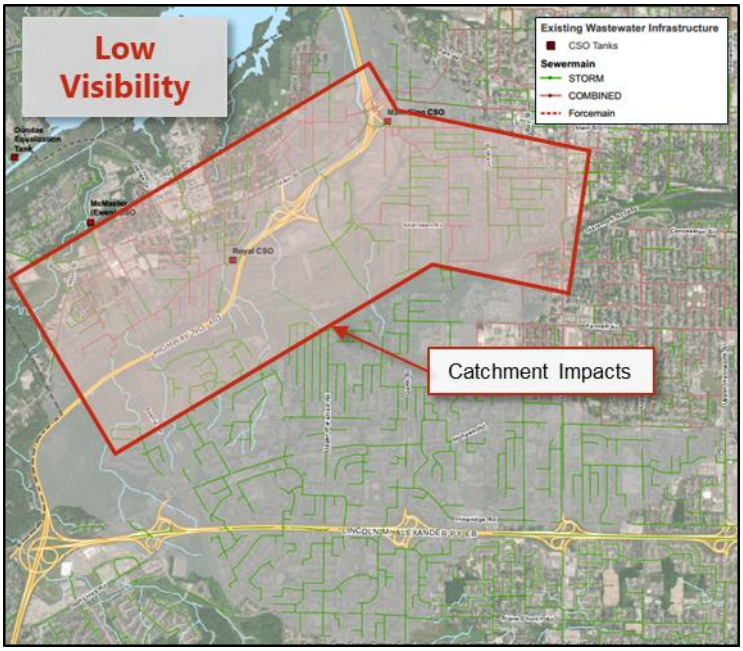
- Reduces frequency of contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams during high flow events

Pie Chart Contribution	CSO
Reduction Assumptions	• Assume 10% of total overflow volume doesn't occur during average year • Assume 5% of total overflow volume doesn't occur during peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	<10%	<10%	<10%
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	<5%	<5%	<5%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

18A) Wet Weather Flow (Inflow & Infiltration) in Separated Sewers – Targeted in Chedoke Watershed

- Identify areas of high Inflow and Infiltration (I&I) adjacent to Chedoke Creek
- Reduce I&I into sanitary sewers thereby reducing sanitary sewer flows
- Potentially reduce CSO overflows



Cost	$5 - $10 M
Timing	Short (<5 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

- Reduces contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams

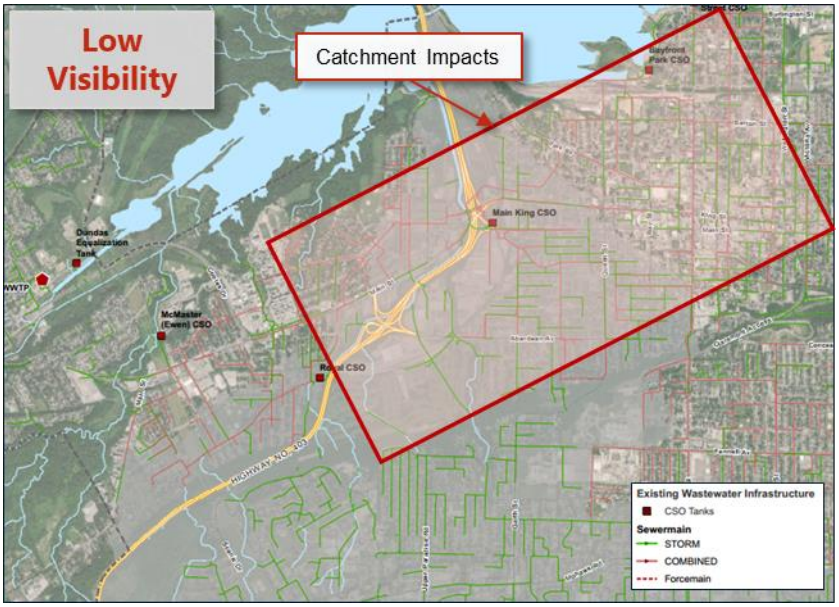
Pie Chart Contribution	CSO
Reduction Assumptions	• Reduce CSO volume by 20% and increase nutrient concentration by 10% for average year and peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	10 - 20%	10 - 20%	10 - 20%
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	10 - 20%	10 - 20%	10 - 20%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

18B) Wet Weather Flow (Inflow & Infiltration) in Separated Sewers – Targeted in broader Main-King Catchment

- Identify areas of high inflow and infiltration (I&I) in Main-King
- Reduce I&I into sanitary sewers thereby reducing sanitary sewer flows to the Main-King CSO tank
- Potentially reduce CSO overflows

Cost	$10-$25 M
Timing	Near-Term (5-10 Years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative



Nutrient Loading Impacts

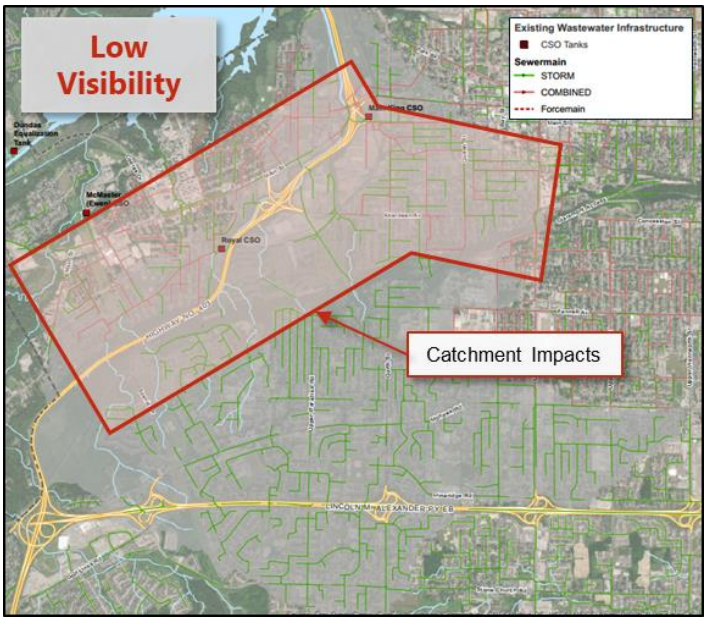
- Reduces contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams

Pie Chart Contribution	CSO
Reduction Assumptions	• Reduce CSO volume by 25% and increase nutrient concentration by 15% for average year and peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	10 - 20%	10 - 20%	10 - 20%
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	10 - 20%	10 - 20%	10 - 20%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

18C) Wet Weather Flow (Inflow & Infiltration) in Separated Sewers – Policy/Future Infrastructure Projects

- More stringent criteria related to new development to ensure future construction practices address any possible I&I issues
- Reduce I&I into sanitary sewers thereby reducing sanitary sewer flows
- Potentially reduce CSO overflows



Cost	<$1 M
Timing	Long-Term (>10 years)
Implementation	Easy
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

- Reduces contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams

Pie Chart Contribution	CSO
Reduction Assumptions	• Reduce CSO volume by 10% and increase nutrient concentration by 5% for average year and peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	<5%*	<5%*	<5%*
Peak	Current % Contribution	30 - 40%	65 - 75%	15 - 20%
	Source Reduction	<5%*	<5%*	<5%*
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

*Reduction assumptions are a high-level estimate and will depend on level of uptake or how widespread the measures are implemented

19) Ainsley Woods Sewer Separation

- Evaluate the existing creek inputs into the combined sewer system within the Ainsley Woods neighbourhood in Mid Chedoke Creek
- Identify an appropriate outlet for the separated flow

Cost	$1 - $5 M
Timing	Short (<5 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

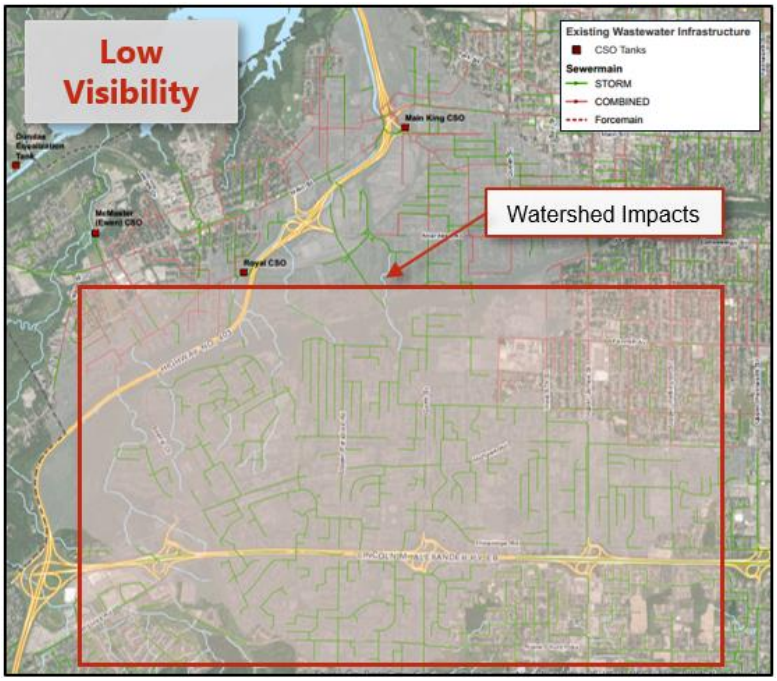
- Reduces creek inputs from entering combined sewer system; reducing volume and frequency of combined sewer overflows
- Improves water quality by increasing creek input into stormwater system

Pie Chart Contribution	Urban Stormwater System
Reduction Assumptions	• Increase stormwater volume by 10% for Chedoke West catchment and reduce concentration by 25% for average year, peak event and low event for Chedoke West catchment

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	<5%	<5%	<5%
Peak	Current % Contribution	50 - 60%	20 - 25%	75 - 85%
	Source Reduction	<5%	<5%	<5%
Low	Current % Contribution	>90%	10% - 20%	>90%
	Source Reduction	<5%	<5%	<5%

20) Cross Connection Program

- Ensure sanitary laterals are not connected to stormwater system in separated sewer system
- Currently on-going, prioritize within Chedoke Creek catchment, south of Escarpment
- Fix storm and sanitary cross-connections from homes
- Reduce sanitary contaminants discharged from stormwater outfalls



Cost	$1 - $5 M
Timing	Short (<5 years)
Implementation	Moderate
Capital	City, Private
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

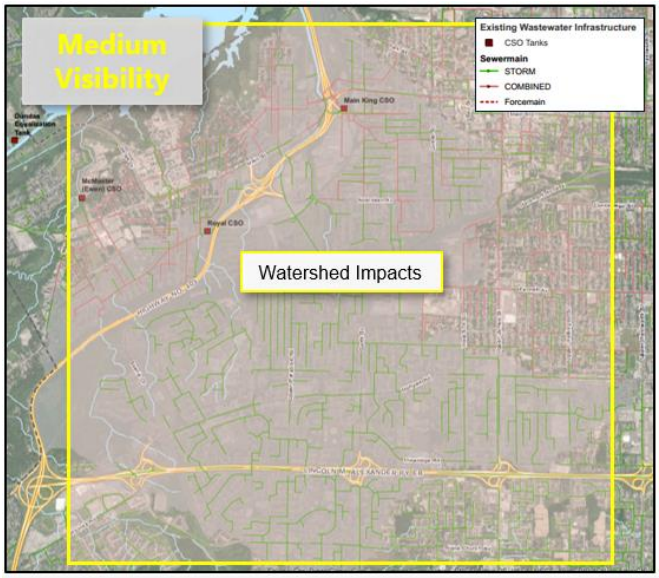
- Reduces sanitary flows from entering stormwater system
- Reduces contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams through stormwater inflows

Pie Chart Contribution	Urban Stormwater System
Reduction Assumptions	• Reduce stormwater volume by 2% and reduce concentration by 15% for average year, peak event and low event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	10 - 20%	10 - 20%	10 - 20%
Peak	Current % Contribution	50 - 60%	20 - 25%	75 - 85%
	Source Reduction	10 - 20%	10 - 20%	10 - 20%
Low	Current % Contribution	>90%	10% - 20%	>90%
	Source Reduction	10 - 20%	10 - 20%	10 - 20%

21) Retrofits throughout the watershed (End-of-Pipe and Source)

- Retrofitting existing ponds to wet ponds where opportunity in Chedoke watershed
- Retrofitting existing facilities for Highway 403
- Introducing stormwater management practices to areas where there is currently no treatment or management



Cost	$5-$50 M
Timing	Near-Term (5-10 Years) with Potential for Short Term
Implementation	Moderate
Capital	City, MTO
Maintenance	City, MTO
Type	Mitigative

Nutrient Loading Impacts

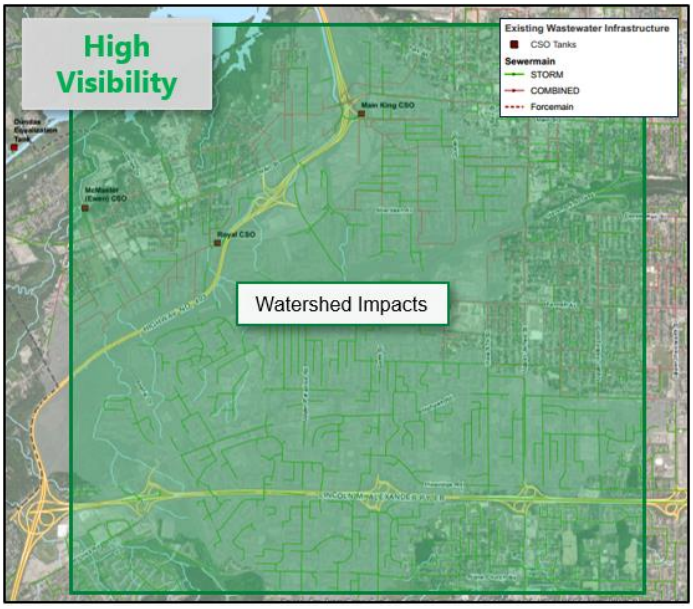
- Potential removal of urban runoff contaminants (phosphorus, nitrogen, TSS, chloride, heavy metals, e-coli, other pathogens)

Pie Chart Contribution	Urban Stormwater System
Reduction Assumptions	• Reduce stormwater concentration by 15% for average year and low event and 5% for peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	10 - 20%	10 - 20%	10 - 20%
Peak	Current % Contribution	50 - 60%	20 - 25%	75 - 85%
	Source Reduction	5 - 10%	5 - 10%	5 - 10%
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	10 - 20%	10 - 20%	10 - 20%

22) Retrofit for Road Rehabilitation Projects / Low Impact Development (LID) BMP Policy

- Best Management Practices (BMPs) to be applied to any road rehabilitation project within the City
- Advance City's stormwater management guidance to City infrastructure



Cost	$5-$10 M (Costs incorporated with other works)
Timing	Long-Term (>10 years)
Implementation	Easy
Capital	City, DC
Maintenance	City, Private
Type	Mitigative

Nutrient Loading Impacts

- Potential removal of urban runoff contaminants (phosphorus, nitrogen, TSS, chloride, heavy metals, e-coli, other pathogens)
- Potential reduction of stormwater flows

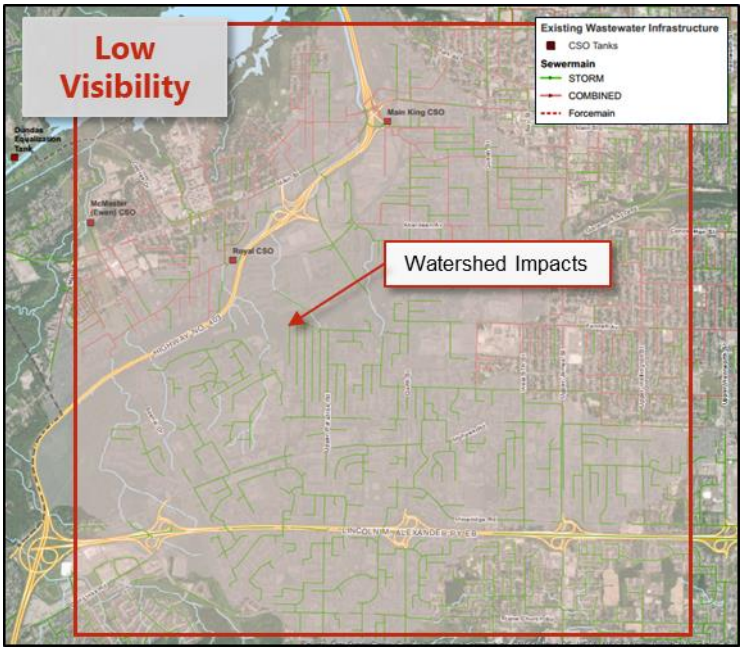
Pie Chart Contribution	Urban Stormwater System
Reduction Assumptions	• Reduce stormwater concentration by 10% and reduce direct runoff from 30% to 25% for average year and peak event • Reduce stormwater concentration by 10% and no change to base flow for low event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	15 - 25%*	15 - 25%*	15 - 25%*
Peak	Current % Contribution	50 - 60%	20 - 25%	75 - 85%
	Source Reduction	20 - 30%*	20 - 30%*	20 - 30%*
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	10 - 20%*	10 - 20%*	10 - 20%*

*Reduction assumptions are a high-level estimate and will depend on level of uptake or how widespread the measures are implemented

23A) City Street Management – Enhanced Street Sweeping

- Program to implement street sweeping within Chedoke Creek Watershed and City
- Clean up debris and contaminants that build up on City roads



Cost	$1-$5 M
Timing	Short (<5 years)
Implementation	Easy
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

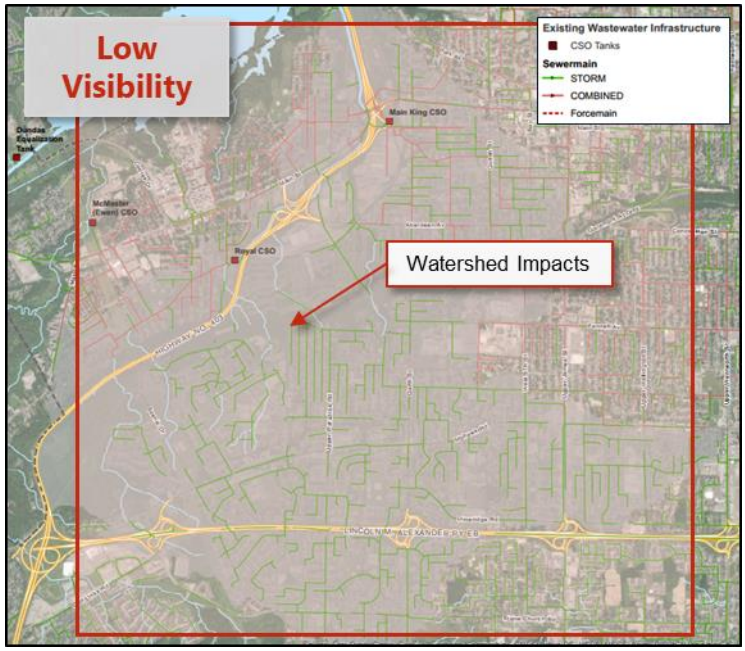
- Improves water quality by removing pollutants that are transferred through the urban runoff
- Manage contaminants such as salt, oil, grease, metals and pesticides that build up on urban surfaces

Pie Chart Contribution	Urban Stormwater System
Reduction Assumptions	• Reduce stormwater concentration by 5% for average year, peak event and low event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	<10%	<10%	<10%
Peak	Current % Contribution	50 - 60%	20 - 25%	75 - 85%
	Source Reduction	<10%	<10%	<10%
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	<10%	<10%	<10%

23B) City Street Management – Improve Snow Management within Chedoke Creek Watershed

- Enhance Snow Management practices to prevent contamination (Chlorides) to Chedoke Creek
- Review disposal sites for snow that would reduce direct snow melt into urban streams



Cost	$1-$5 M
Timing	Short (<5 years)
Implementation	Easy
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

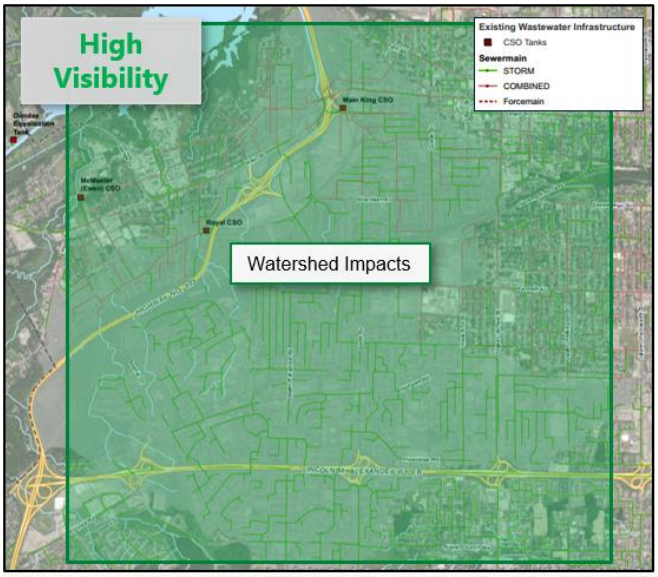
- Improves water quality by removing pollutants that are transferred through the urban runoff
- Manage contaminants such as salt, oil, grease, metals and pesticides that build up on urban surfaces
- High chloride levels can inhibit aquatic species' growth and reproduction

Pie Chart Contribution	Urban Stormwater System
Reduction Assumptions	• Reduce stormwater concentration by 5% for average year and peak event and by 2% for low event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	<5%	<5%	<5%
Peak	Current % Contribution	50 - 60%	20 - 25%	70 - 80%
	Source Reduction	<5%	<5%	<5%
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	<5%	<5%	<5%

24) LID BMP Policy / Stormwater User Rate

- Supports sustainable funding of stormwater management program
- Incentive program to encourage private property owners to manage stormwater at source on private properties and implement additional BMP's
- LID BMPs will help to provide infiltration, flood management and support creek stability



Cost	Self-Funding
Timing	Long-Term (>10 years)
Implementation	Moderate
Capital	City, Private
Maintenance	Private
Type	Mitigative

Nutrient Loading Impacts

- Potential removal of urban runoff contaminants (phosphorus, nitrogen, TSS, chloride, heavy metals, e-coli, other pathogens)
- Potential reduction of stormwater flows

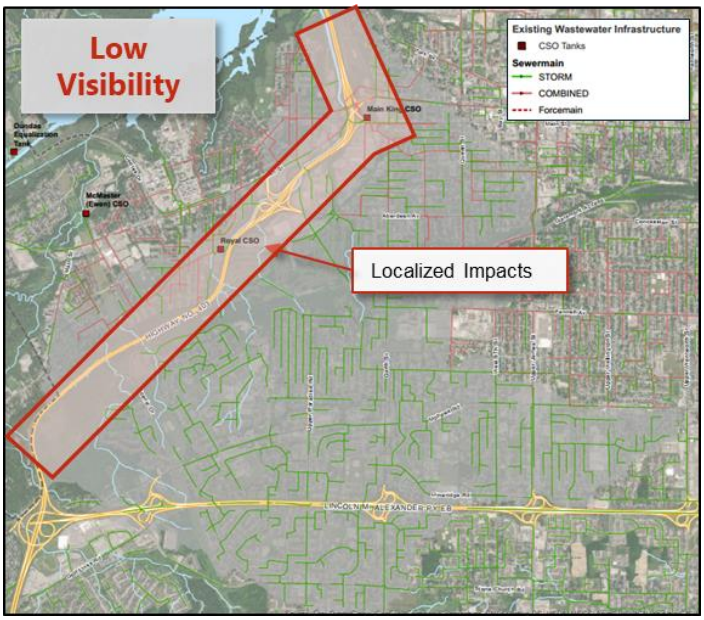
Pie Chart Contribution	Urban Stormwater System
Reduction Assumptions	• Reduce stormwater concentration by 15% and direct runoff from 30% to 25% for average year • Reduce stormwater concentration by 20% and direct runoff from 30% to 25% for peak event • Reduce stormwater concentration by 15% and no change to base flow for low event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	20 – 30%*	20 – 30%*	20 – 30%*
Peak	Current % Contribution	50 - 60%	20 - 25%	70 - 80%
	Source Reduction	30 - 40%*	30 - 40%*	30 - 40%*
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	15 - 25%*	15 - 25%*	15 - 25%*

*Reduction assumptions are a high-level estimate and will depend on level of uptake or how widespread the measures are implemented

25A) Enhanced Salt Management – Highway 403

- Enhance salt management plan for Highway 403
- Manage salt at stormwater collection points along corridor



Cost	$1-$5 M
Timing	Short (<5 years)
Implementation	Moderate
Capital	MTO
Maintenance	City
Type	Mitigative

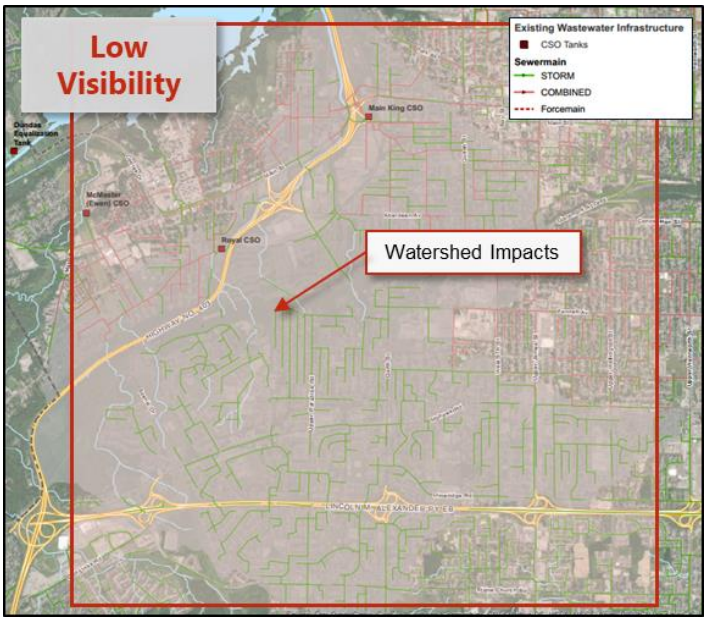
Nutrient Loading Impacts

- Potential removal of highway runoff contaminants (phosphorus, nitrogen, TSS, chloride, heavy metals)

Pie Chart Contribution	Highway 403
Pie Chart Contribution	• N/A: Some increased ability to assimilate nutrients

25B) Enhanced Salt Management – City Roads

- Enhance City's salt management plan for City Roads
- Manage salt at stormwater collection points along City roads



Cost	$5-$10 M
Timing	Short (<5 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative

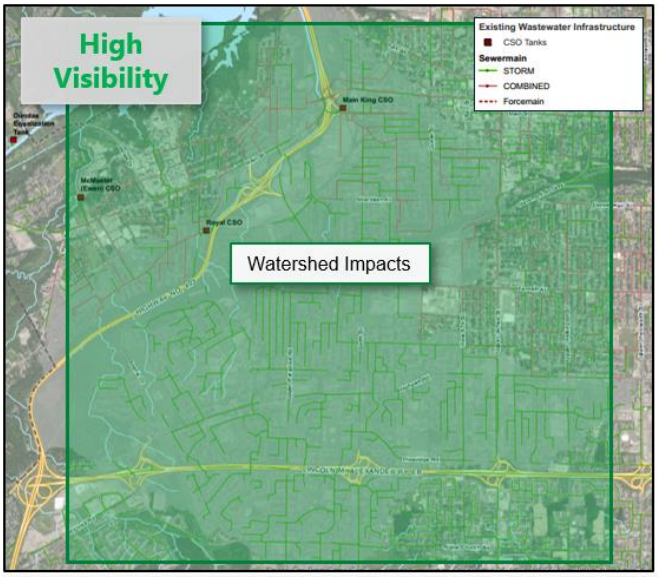
Nutrient Loading Impacts

- Potential removal of urban runoff contaminants (phosphorus, nitrogen, TSS, chloride, heavy metals, e-coli, other pathogens)

Pie Chart Contribution	Urban Stormwater System
Pie Chart Contribution	N/A: Some increased ability to assimilate nutrients

26) Redevelopment Sites SWM Policy

- Policies for BMP's including LID for redevelopment sites in City
- Opportunity for large stormwater reduction/treatment on redevelopment sites to comply with new stormwater policy



Cost	Self-Funding
Timing	Long-Term (>10 years)
Implementation	Moderate
Capital	City, Private
Maintenance	Private
Type	Mitigative

Nutrient Loading Impacts

- Potential removal of urban runoff contaminants (phosphorus, nitrogen, TSS, chloride, heavy metals, e-coli, other pathogens)
- Potential reduction of stormwater flows

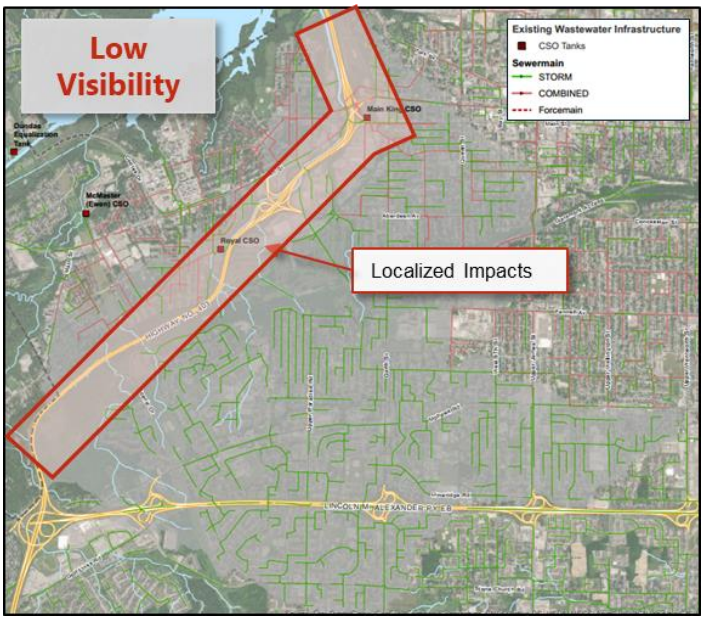
Pie Chart Contribution	Urban Stormwater System
Reduction Assumptions	• Reduce stormwater concentration by 10% and reduce direct runoff from 30% to 28% for average year and peak event • Reduce stormwater concentration by 10% and no change to base flow for low event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	10 – 20%*	10 – 20%*	10 – 20%*
Peak	Current % Contribution	50 - 60%	20 - 25%	75 - 85%
	Source Reduction	10 – 20%*	10 – 20%*	10 – 20%*
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	<10%*	<10%*	<10%*

*Reduction assumptions are a high-level estimate and will depend on level of uptake or how widespread the measures are implemented

27) Highway 403 Water Quality Improvements

- Treat highway runoff at collection points along corridor before it enters Chedoke Creek
- Install stormwater management devices such as oil-grit separators at stormwater outfalls



Cost	$1-$5 M
Timing	Short (<5 years)
Implementation	Moderate
Capital	MTO
Maintenance	MTO
Type	Mitigative

Nutrient Loading Impacts

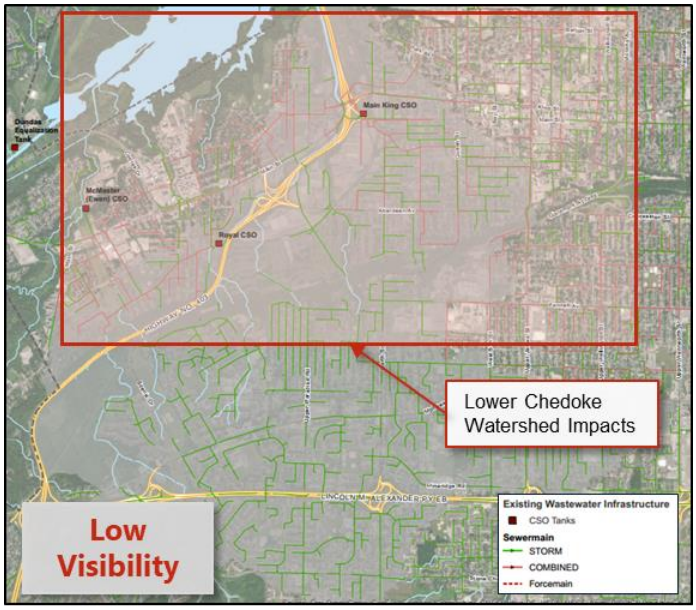
- Potential removal of highway runoff contaminants (phosphorus, nitrogen, TSS, chloride, heavy metals)

Pie Chart Contribution	Highway 403
Reduction Assumptions	• Reduce TSS concentration by 30% for average year and low event • Reduce TSS concentration by 20% for peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	10 - 15%	<1%
	Source Reduction	0%	0%	20 - 30%
Peak	Current % Contribution	<2%	<5%	<1%
	Source Reduction	0%	0%	10 - 20%
Low	Current % Contribution	<5%	5 - 10%	<5%
	Source Reduction	0%	0%	20 – 30%

28) Inlet Controls in Combined Sewer Areas

- Install inlet control devices in combined sewer system
- Restricts the amount of stormwater that enters system, reducing the potential of CSO overflows
- Requires evaluation of major system (overland) capacity



Cost	$5-$10 M
Timing	Near-Term (5-10 Years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Preventative

Nutrient Loading Impacts

- Reduces contaminants associated with sanitary waste (phosphorus, nitrogen, heavy metals, e-coli, other pathogens) from entering streams

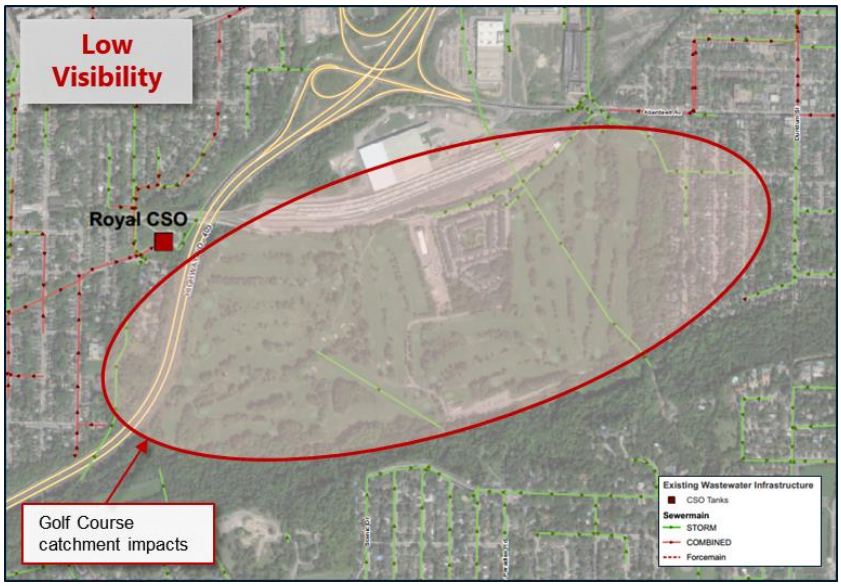
Pie Chart Contribution	CSO
Reduction Assumptions	• Assume 30% reduction in overflow volume and 10% increase in nutrient concentration for average year and peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	<5%	<5%	<1%
	Source Reduction	<10%	<10%	<10%
Peak	Current % Contribution	30 – 40%	65 – 75%	15 – 20%
	Source Reduction	10 – 20%	10 – 20%	10 – 20%
Low	Current % Contribution	0%	0%	0%
	Source Reduction	0%	0%	0%

29A) Golf Course – Manage Runoff from the Golf Course

- Improve Golf course water management practices including fertilizers and pesticide use
- Provides treatment prior to runoff entering Chedoke Creek

Cost	$1-$5 M
Timing	Short (<5 years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative



Nutrient Loading Impacts

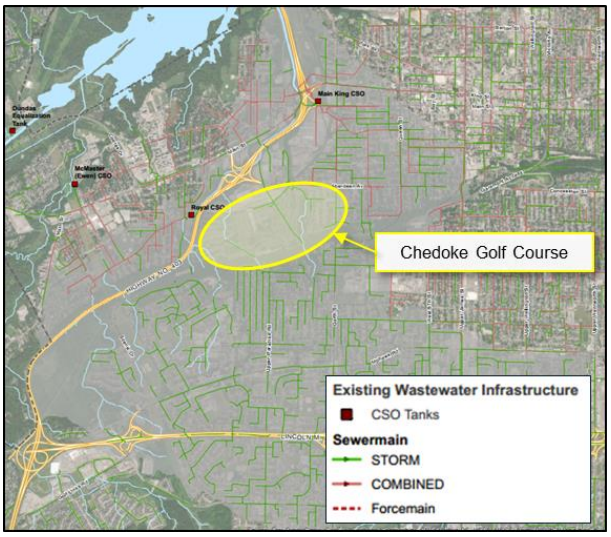
- Reduced contaminants associated with golf course catchment runoff (phosphorus, nitrogen, e-coli, other pathogens) from entering stream or sewers

Pie Chart Contribution	Urban Stormwater System
Reduction Assumptions	• Reduce nutrient concentration by 40% for golf course catchment for average year, peak event and low event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	<2%	<2%	<1%
Peak	Current % Contribution	50 - 60%	20 - 25%	75 - 85%
	Source Reduction	<1%	<2%	<1%
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	<2%	<1%	<1%

29B) Golf Course - Stream Naturalization

- Naturalization of channelized portions of creek and introducing native vegetation



Cost	$10-$25 M
Timing	Near-Term (5-10 Years)
Implementation	Difficult
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

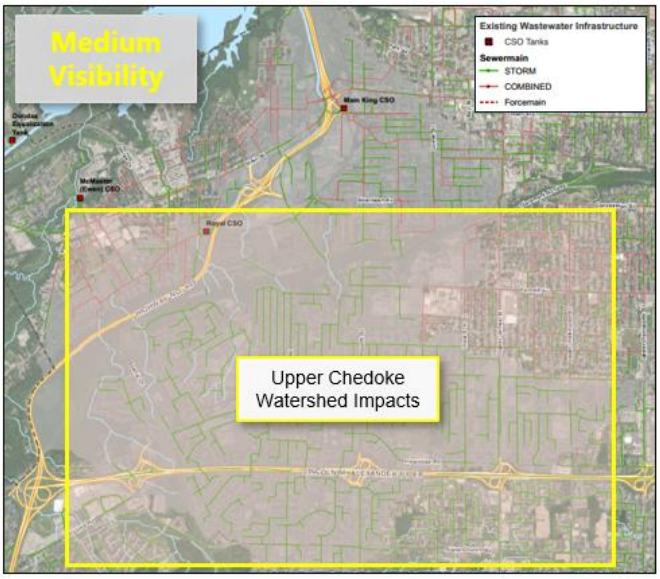
- Reduced TSS loading from entering Lower Chedoke Creek due to lower stream velocities
- Greater potential of in-stream removal of ammonia and TP due to greater stream metabolism
- Potential reduction of highway and railway runoff contaminants (phosphorus, nitrogen, TSS, chloride, heavy metals)

Pie Chart Contribution	Urban Stormwater System Note: There are also potential nutrient reductions from Highway 403 and Railway & Rail Yard sources.
Reduction Assumptions	• Reduce nutrient concentration by 5% for stormwater catchments, highway and railway & rail yard for average year and low event • Reduce nutrient concentration by 1% for stormwater catchments, highway and railway & rail yard for peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	<5%	<5%	<5%
Peak	Current % Contribution	50 - 60%	20 - 25%	75 - 85%
	Source Reduction	<1%	<1%	<1%
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	<5%	<5%	<5%

29C) Golf Course – Retrofit and Treatment Online

- Provide location for external stormwater treatment on-site at Chedoke Golf Course
- Treatment to capture large portion of Upper Chedoke Creek catchments that currently flow through Golf Course
- Golf Course has available space for runoff capture



Cost	$10-$25 M
Timing	Near-Term (5-10 Years)
Implementation	Moderate
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

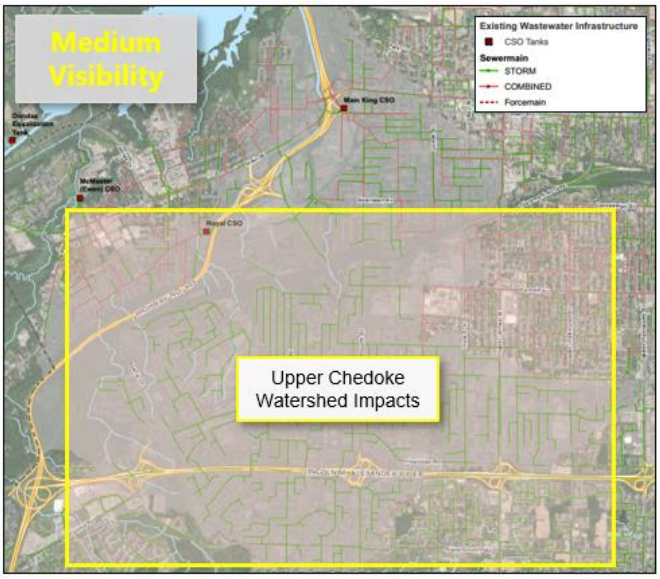
- Reduced contaminants associated with golf course runoff (phosphorus, nitrogen, e-coli, other pathogens) from entering stream or sewers
- Potential removal of highway and railway runoff contaminants (phosphorus, nitrogen, TSS, chloride, heavy metals)

Pie Chart Contribution	Urban Stormwater System Note: There are also potential nutrient reductions from Highway 403 and Railway & Rail Yard sources
Reduction Assumptions	• Reduce nutrient concentration by 10% for stormwater catchments, highway and railway & rail yard for average year and low event • Reduce nutrient concentration by 5% for stormwater catchments, highway and railway & rail yard for peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	<10%	<10%	<10%
Peak	Current % Contribution	50 - 70%	20 - 25%	75 - 85%
	Source Reduction	<5%	<5%	<5%
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	<10%	<10%	<10%

30A) Stream Naturalization – Upper Chedoke

- Naturalization of channelized portions of creek in Upper Chedoke
- Reduce stream velocity and sediment buildup downstream
- Improves marine habitat along and downstream of the creek
- Introduces native vegetation



Cost	$5-$10 M
Timing	Near-Term (5-10 Years)
Implementation	Difficult
Capital	City
Maintenance	City
Type	Mitigative

Nutrient Loading Impacts

- Reduced contaminants associated with golf course runoff (phosphorus, nitrogen, e-coli, other pathogens) from entering stream or sewers
- Potential removal of highway and railway runoff contaminants (phosphorus, nitrogen, TSS, chloride, heavy metals)

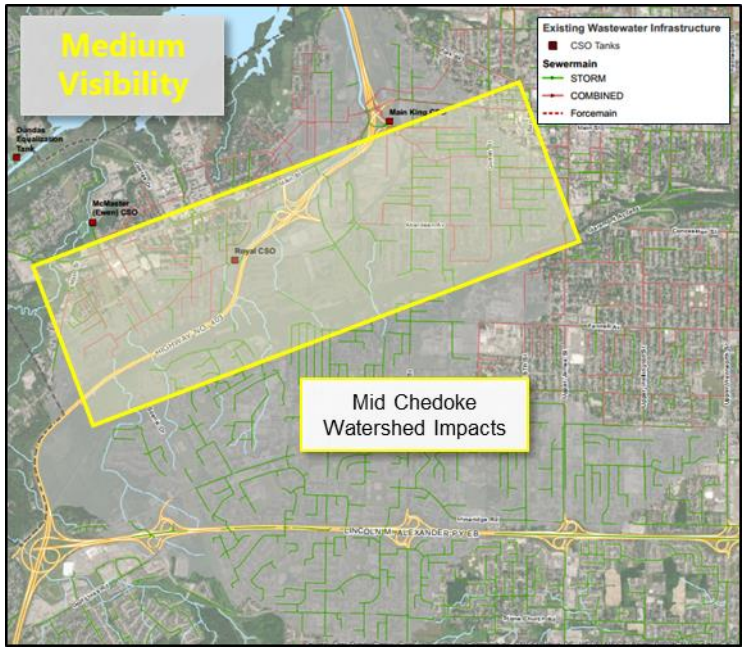
Pie Chart Contribution	Urban Stormwater System Note: There are also potential nutrient reductions from Highway 403 and Railway & Rail Yard sources
Reduction Assumptions	• Reduce nutrient concentration by 5% for stormwater catchments, highway and railway & rail yard for average year and low event • Reduce nutrient concentration by 1% for stormwater catchments, highway and railway & rail yard for peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	<5%	<5%	<5%
Peak	Current % Contribution	50 - 60%	20 - 25%	75 - 85%
	Source Reduction	<1%	<1%	<1%
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	<5%	<5%	<5%

30B) Stream Naturalization – Mid Chedoke

- Naturalization of channelized portions of creek in Mid Chedoke
- Remove concrete channel and introduce native vegetation for slope stability
- Reduce stream velocity and sediment buildup downstream
- Improves marine habitat along and downstream of the creek

Cost	$10-$25 M
Timing	Near-Term (5-10 Years)
Implementation	Difficult
Capital	City
Maintenance	City
Type	Mitigative



Nutrient Loading Impacts

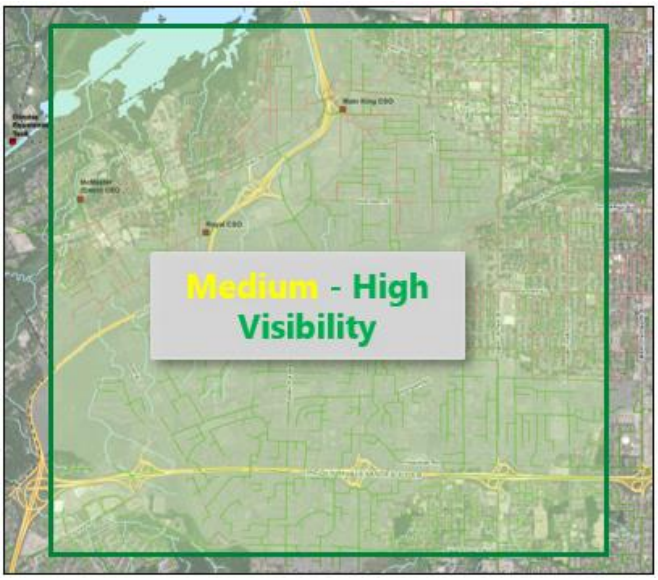
- Reduce nutrient concentration by 5% for stormwater catchments, highway and railway & rail yard for average year and low event
- Reduce nutrient concentration by 1% for stormwater catchments, highway and railway & rail yard for peak event

Pie Chart Contribution	Urban Stormwater System Note: There are also potential nutrient reductions from Highway 403 and Railway & Rail Yard sources
Reduction Assumptions	• Reduce nutrient concentration by 10% for stormwater catchments, highway and railway & rail yard for average year and low event • Reduce nutrient concentration by 5% for stormwater catchments, highway and railway & rail yard for peak event

		Total Phosphorus	Ammonia + Ammonium	Total Suspended Solids
Average	Current % Contribution	>90%	60 - 70%	>95%
	Source Reduction	<5%	<5%	<5%
Peak	Current % Contribution	50 - 60%	20 - 25%	75 - 85%
	Source Reduction	<1%	<1%	<1%
Low	Current % Contribution	>90%	10 - 20%	>90%
	Source Reduction	<5%	<5%	<5%

31) Engage Residents, Stakeholders, and City

- Educating citizens about water quality issues and benefits of proposed projects
- More transparency in water quality monitoring and management
- Encourages resident participation in ongoing public initiatives



Cost	<$1 M
Timing	Short (<5 years)
Implementation	Easy – Moderate
Capital	City
Maintenance	N/A
Type	Preventative

Nutrient Loading Impacts

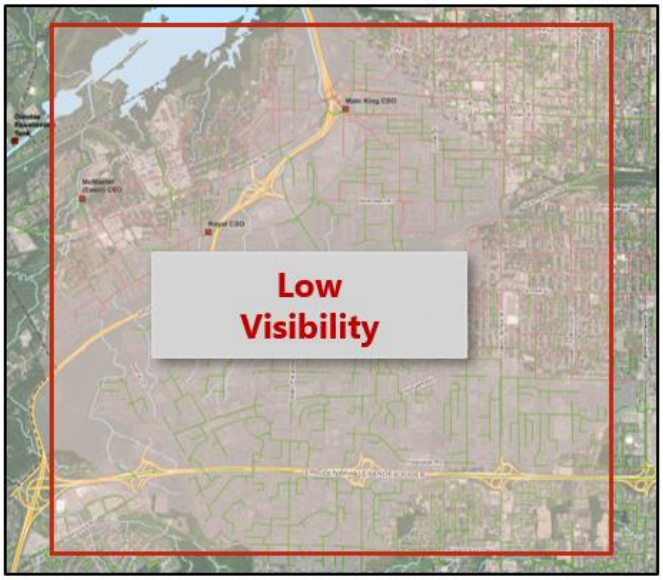
- Improved public education and support for funding projects
- Increased monitoring and reporting of water quality impacts by public and stakeholders

Pie Chart Contribution	N/A – No changes

32) Program Management and Monitoring

- Centralized data sharing portal to consist of more sampling and consistent protocols to monitor and track benefits over time
- Program will provide a method to quantify water quality benefits of proposed actions
- Better identify problems and effectiveness of solutions

Cost	$1-$5 M
Timing	Long-Term (>10 years)
Implementation	Easy
Capital	City
Maintenance	City
Type	N/A



Nutrient Loading Impacts

- More data will better inform decision making for continued water quality management

Pie Chart Contribution	N/A – No changes

Solution Screening Overview

#		Type	Name	Evaluation	Rationale	Tier	Priority (in tier)	Visibility	Cost	Timing	Implementation	Capital	Maintenance	Type	Impacts
1		Landfill	Direct Clean Water Away from Landfill	Screen Out	Low effectiveness, difficult to implement, high cost			Low	$5-$10 M	Near-Term (5-10 Years)	Difficult	City	City	Preventative	Lower Chedoke Creek
2		Landfill	Rehabilitate existing Highway 403 Culvert	Carry Forward	Highly visible, low cost, relatively straight forward	1. Capital: Near-Term	1	High	$1-$5 M	Short (<5 years)	Moderate	City, MTO	City	Mitigative	Lower Chedoke Creek
3		Landfill	Expand/Fix Leachate Collection System	Future Consideration	Need to collect more data and reassess before final recommendations	2. Capital: Long-Term	7	Low	$10-$25 M	Near-Term (5-10 Years)	More data needed	City	City	Mitigative	Lower Chedoke Creek
4		Landfill	Capping/Barrier	Screen Out	High cost, low effectiveness, difficult to implement			Low	$50-$100 M	Long-Term (>10 years)	Difficult	City	City	Preventative	Lower Chedoke Creek
5		Lower Chedoke Creek	Constructed Wetland	Study	Restorative solution, highly visible, limited operations required	2. Capital: Long-Term	1	High	$10-$25 M	Near-Term (5-10 Years)	Moderate	RBG, City	RBG, City	Restorative	Cootes Paradise
6		Lower Chedoke Creek	Aeration System	Study	Mitigative solution, medium visibility, moderate implementation time	2. Capital: Long-Term	1	Medium	$5-$10 M (RBG estimate)	Short (<5 years)	Moderate	RBG, City	RBG, City	Mitigative	Lower Chedoke Creek
7		Lower Chedoke Creek	Stream Naturalization	Study	Mitigative solution, highly visible, low cost	2. Capital: Long-Term	1	High	$1-$5 M	Near-Term (5-10 Years)	Difficult	RBG, City	RBG, City	Mitigative	Lower Chedoke Creek
8		Lower Chedoke Creek	Physical Capping	Screen Out	Low effectiveness, low visibility, restorative solution			Low	$5-$10 M (RBG estimate)	Short (<5 years)	Moderate	City	City	Restorative	Lower Chedoke Creek
9		Lower Chedoke Creek	Chemical Inactivation	Screen Out	Low effectiveness, low visibility			Low	$1-$5 M	Short (<5 years)	Easy	City	City	Restorative	Lower Chedoke Creek
10	B	Lower Chedoke Creek	Sediment Removal - Targeted Removal	Study	More cost effective than complete removal, medium visibility, quick implementation	2. Capital: Long-Term	1	Medium	$1-$5 M	Short (<5 years)	Moderate	City	City	Restorative	Lower Chedoke Creek
10	A	Lower Chedoke Creek	Sediment Removal - Complete Removal	Screen Out	Low effectiveness/ more disruptive, medium visibility, quick implementation			Medium	$5-$10 M	Short (<5 years)	Moderate	City	City	Restorative	Lower Chedoke Creek
11		Wastewater	Sewer Separation	Evaluate in Flooding & Drainage MP	Implement recommendations from City's MP study for works within Chedoke Creek	2. Capital: Long-Term	3	Medium	$50-$100 M	Long-Term (>10 years)	Difficult	City	City	Preventative	Lower Chedoke Creek Watershed
12		Wastewater	Increase Capacity Downstream of Main-King Combined Sewer Overflow (CSO) tank	Evaluate in W/WW/SW MP	City-wide benefits, Implement recommendations from City's MP study	2. Capital: Long-Term	6	Medium	>$100 M	Long-Term (>10 years)	Difficult	City	City	Preventative	Lower Chedoke Creek Watershed
13		Wastewater	Increase Capacity of Royal CSO tank to Main-King CSO tank (Highway 403 Trunk Sewer Twinning)	In Progress	Design already in process, mitigative solution	1. Capital: Near-Term	0	Medium	$25-$50 M	Near-Term (5-10 Years)	Moderate	City	City	Mitigative	Lower Chedoke Creek Watershed
14		Wastewater	Expand Storage at Main-King CSO tank	Screen Out	Main/King CSO is maximized at current site, high cost, difficult implementation			Medium	>$100 M	Long-Term (>10 years)	Difficult	City	City	Preventative	Lower Chedoke Creek Watershed
15		Wastewater	Expand Storage Elsewhere in System	Evaluate in W/WW/SW MP	Implement recommendations from City's MP study for within Chedoke	2. Capital: Long-Term	6	Medium	$25-$50 M	Long-Term (>10 years)	Moderate	City	City	Mitigative	Lower Chedoke Creek Watershed
16	A	Wastewater	Inspection and Repair - Facilities	Initiate Inspection	No regrets, ensure facilities are in good operating order, low cost	3. O&M/ Program: Near-Term	1	Low	$1-$5 M	Short (<5 years)	Moderate	City	City	Mitigative	Entire Chedoke Creek Watershed
16	B	Wastewater	Inspection and Repair - Trunk Sewers	Initiate Inspection	No regrets, ensure no major I&I in trunk sewers parallel to Chedoke Creek, low cost	3. O&M/ Program: Near-Term	1	Medium	$1-$5 M	Short (<5 years)	Moderate	City	City	Mitigative	Lower Chedoke Creek Watershed
17		Wastewater	Combined Sewer Overflow (CSO) Monitoring Improvements and Active Management	In Progress	Monitoring and SCADA can better monitor and manage system, already being implemented through other programs	3. O&M/ Program: Near-Term	0	Low	$5-$10 M	Short (<5 years)	Moderate	City	City	Mitigative	Lower Chedoke Creek Watershed
18	A	Wastewater	Wet Weather Flow (Inflow & Infiltration) in Separated Sewers - Targeted in Chedoke Watershed	Initiate I&I Monitoring	Good management practices and policies have benefits for local system and growth capacity in addition to supporting Chedoke Creek	4. O&M/ Program: Long-Term	1	Low	$5-$10 M	Short (<5 years)	Moderate	City	City	Mitigative	Lower Chedoke Creek Watershed
18	B	Wastewater	Wet Weather Flow (Inflow & Infiltration) in Separated Sewers - Targeted in broader Main-King Catchment	Initiate I&I Monitoring	Good management practices and policies have benefits for local system and growth capacity in addition to supporting Chedoke Creek	4. O&M/ Program: Long-Term	1	Low	$10-$25 M	Near-Term (5-10 Years)	Moderate	City	City	Mitigative	Lower Chedoke Creek Watershed
18	C	Wastewater	Wet Weather Flow (Inflow & Infiltration) in Separated Sewers - Policy/Future Infrastructure Projects	Future Policy	Good management practices and policies have benefits for local system and growth capacity in addition to supporting Chedoke Creek	5.Engagement/Policy	5	Low	<$1 M	Long-Term (>10 years)	Easy	City	City	Mitigative	Entire Chedoke Creek Watershed

Solution Screening Overview

#		Type	Name	Evaluation	Rationale	Tier	Priority (in tier)	Visibility	Cost	Timing	Implementation	Capital	Maintenance	Type	Impacts
19		Stormwater	Ainsley Woods Sewer Separation	Carry Forward	Low to moderate visibility, potential for moderate implementation	2. Capital: Long-Term	2	Low	$1-$5 M	Short (<5 years)	Moderate	City	City	Mitigative	Upper Chedoke Creek Watershed
20		Stormwater	Cross Connection Program	Carry Forward	Low cost, quick implementation	3. O&M/Program: Near-Term	2	Low	$1-$5 M	Short (<5 years)	Moderate	City, Private	City	Mitigative	Upper Chedoke Creek Watershed
21		Stormwater	Retrofits throughout the watershed (end-of-pipe and source)	Study	Retroactive treatment, moderate to high visibility, short to moderate implementation timelines, MTO led for Highway 403 projects	2. Capital: Long-Term	5	Medium-High	$5-$50 M	Near-Term (5-10 Years) with Potential for Short Term	Moderate	City, MTO	City, MTO	Mitigative	Entire Chedoke Creek Watershed
22		Stormwater	Retrofit for Road Rehabilitation Projects / Low Impact Development (LID) BMP Policy	Future Policy	Ongoing practice, moderate to high visibility, costs incorporated with other road works	5.Engagement/Policy	3	High	$5-$10 M (Costs incorporated with other works)	Long-Term (>10 years)	Easy	City, DC	City, Private	Mitigative	Entire Chedoke Creek Watershed
23	A	Stormwater	City Street Management: Enhanced Street Sweeping	Carry Forward	Low cost, quick implementation	3. O&M/Program: Near-Term	3	Low	$1-$5 M	Short (<5 years)	Easy	City	City	Mitigative	Entire Chedoke Creek Watershed
23	B	Stormwater	City Street Management: Improve snow management within Chedoke Creek Watershed	Future Program	No regrets, visible to public, short implementation time, low cost	4. O&M/Program: Long-Term	3	Low	$1-$5 M	Short (<5 years)	Easy	City	City	Mitigative	Lower Chedoke Creek
24		Stormwater	LID BMP Policy / Stormwater User Rate	Ongoing	Helps define link between public practices and improvements to Chedoke Creek, self-funding	5.Engagement/Policy	4	High	Self-Funding	Long-Term (>10 years)	Moderate	City, Private	Private	Mitigative	Entire Chedoke Creek Watershed
25	A	Stormwater	Enhanced Salt Management - Highway 403	Future Program	No regrets, short implementation time, low cost	4. O&M/ Program: Long-Term	4	Low	$1-$5 M	Short (<5 years)	Moderate	MTO	City	Mitigative	Lower Chedoke Creek
25	B	Stormwater	Enhanced Salt Management - City Roads	Ongoing	No regrets, short implementation time, low cost	4. O&M/ Program: Long-Term	4	Low	$5-$10 M	Short (<5 years)	Moderate	City	City	Mitigative	Entire Chedoke Creek Watershed
26		Stormwater	Redevelopment Sites Stormwater Management (SWM) Policy	Future Policy	Ongoing practice, moderate to high visibility, costs incorporated with other works by Others (Developers)	5.Engagement/Policy	2	High	Self-Funding	Long-Term (>10 years)	Moderate	City, Private	Private	Mitigative	Entire Chedoke Creek Watershed
27		Stormwater	Highway 403 Water Quality Improvements (i.e. Oil-Grit Separators or Equivalent)	Carry Forward	Short implementation time and low cost.	1. Capital: Near-Term	3	Low	$1-$5 M	Short (<5 years)	Moderate	MTO	MTO	Mitigative	Lower Chedoke Creek
28		Stormwater	Inlet Control in Combined Sewer Areas	Evaluate in Flooding &	Implement recommendations from Flooding and Drainage MP	2. Capital: Long-Term	3	Low	$5-$10 M	Near-Term (5-10 Years)	Moderate	City	City	Preventative	Lower Chedoke Creek Watershed
29	B	Mid & Upper Chedoke Creek	Golf Course Treatment - Stream Naturalization	Carry Forward	highly visible, golf course can remain in operation	2. Capital: Long-Term	4	Medium	$10-$25 M	Near-Term (5-10 Years)	Difficult	City	City	Mitigative	Entire Chedoke Creek Watershed
29	C	Mid & Upper Chedoke Creek	Golf Course Treatment - Retrofit and Treatment Online	Study	golf course can remain in operation with some potential modifications,	2. Capital: Long-Term	4	Medium	$10-$25 M	Near-Term (5-10 Years)	Moderate	City	City	Mitigative	Upper Chedoke Creek Watershed
29	A	Mid & Upper Chedoke Creek	Golf Course Treatment - Manage Runoff Quality from the Golf Course	Carry Forward	Quick implementation, low cost, golf course can remain in operation	1. Capital: Near-Term	2	Low	$1-$5 M	Short (<5 years)	Moderate	City	City	Mitigative	Upper Chedoke Creek Watershed
30	A	Mid & Upper Chedoke Creek	Stream Naturalization - Upper Chedoke	Carry Forward	Highly visible	2. Capital: Long-Term	5	Medium	$5-$10 M	Near-Term (5-10 Years)	Difficult	City	City	Mitigative	Entire Chedoke Creek Watershed
30	B	Mid & Upper Chedoke Creek	Stream Naturalization - Mid Chedoke	Screen Out	Recently re-lined by MTO, infrastructure constraints			Medium	$10-$25 M	Near-Term (5-10 Years)	Difficult	RBG, City	RBG, City	Restorative	Mid Chedoke Creek
31		Engagement	Engage Residents, Stakeholders, and City	Carry Forward	Short implementation time, low cost, high visibility for public	5.Engagement/ Policy	1	Medium-High	<$1 M	Short (<5 years)	Easy - Moderate	City	N/A	Preventative	N/A
32		Water Quality	Chedoke Creek Water Quality Program Management and Monitoring	Future Program	Will help improve system understanding and support tracking benefits over time. Low cost.	4. O&M/ Program: Long-Term	2	Low	$1-$5 M	Long-Term (>10 years)	Easy	City	City	N/A	N/A

APPENDIX E: RECOMMENDATIONS SCOPE OUTLINES

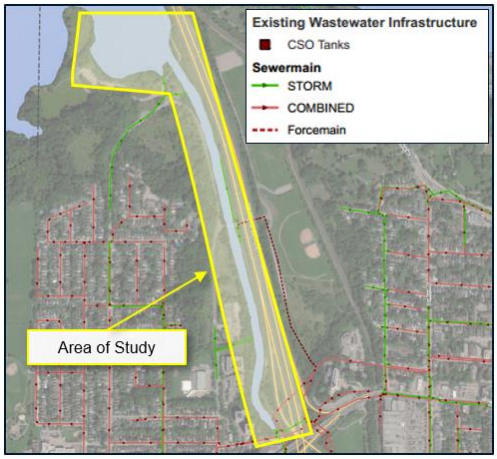
This Appendix provides outlines of the anticipated scope for the projects that require additional studies and fieldwork prior to implementation. The following table outlines the projects, studies and policies/practices included in the Framework.

Table 1: Scope Outlines

Type	Number	Project
Study	1	Lower Chedoke Combined EA Study
	2	Chedoke Watershed Stormwater Retrofits EA Study
	3	Ainsley Woods Sewer Separation EA Study
Project	1	Rehabilitate existing Highway 403 Culvert (Landfill)
	2	Golf Course – Manage Runoff from the Golf Course
	3	Highway 403 Water Quality Improvements
	4	Constructed Wetland
	5	Aeration System
	6	Stream Naturalization
	7	Chedoke Creek Targeted Removal
	8	Inlet Controls in Combined Sewer Areas
	9	Sewer Separation
	10	Golf Course – Stream Naturalization
	11	Golf Course – Retrofit and Treatment Online
	12	Retrofits throughout watershed (End-of-Pipe and source)
	13	Upper Chedoke Creek Stream Naturalization
	14	Expand Storage Elsewhere in System
	15	Increase Capacity Downstream of Main-King CSO tank
	16	Expand/Fix Leachate Collection System
	17	CSO Monitoring Improvements and Active Management
	18	Inspection and Repair
	19	Cross Connection Program
	20	Wet Weather Flow (Inflow & Infiltration) in Separated Sewers
	21	Chedoke Creek Water Quality Program Management and Monitoring
	22	City Street Management – Enhanced Street Sweeping
	23	City Street Management – Improve Snow Management within Chedoke Creek Watershed
	24	Enhanced Salt Management
Policy/Practices	1	Engage Residents, Stakeholders, and City
	2	Redevelopment Sites SWM Policy
	3	Retrofits for Road Rehabilitation / LID BMP Policy
	4	LID BMP Policy / Stormwater User Rate
	5	Wet Weather Flow in Separated Sewers Policy

Study #1: Lower Chedoke Combined EA Study

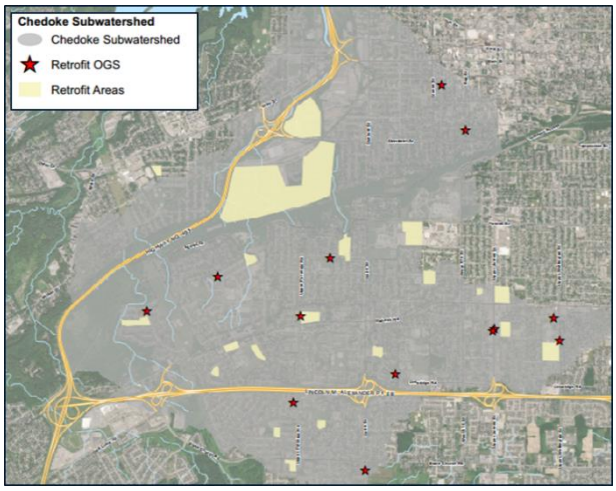
Overview	This study consists of a comprehensive review of the Lower Chedoke Creek to evaluate the benefits, impacts, and life cycle costs of the proposed projects and any other feasible solutions to develop a master plan for this system.
Relevant Projects	• Constructed Wetland (Project #4) • Aeration System (Project #5) • Stream Naturalization (Project #6) • Chedoke Creek Targeted Sediment Removal (Project #7) - per Order



Scope of Work	The scope of the study will include the following: • Adopt Class EA process for assessment and selection of preferred solutions • Confirm feasibility and effectiveness of proposed projects including Constructed Wetland, Aeration System, Stream Naturalization and Chedoke Creek Targeted Removal (underway per MECP Provincial Order) • Confirm other possible projects for the Lower Chedoke Creek • Provide final recommendation for Lower Chedoke Creek projects • Meet all consultation and engagement requirements of MEA Class EA process • Confirm timing, capital budget, and design details of preferred recommendation
Objectives	The RBG 25 Year Master Plan recommends constructing floating wetlands, installing an aeration system and improved stream naturalization measures within the Lower Chedoke Creek. An EA specific to the Lower Chedoke Creek will expand on and confirm if any or all of these measures should be implemented, including other potential improvement. The level of uncertainty due to the complexity and cost of the projects requires a more in-depth investigation in the form of an EA to confirm and determine various opportunities including those highlighted in the final recommendations from the RBG 25 Year MP.

	Study	Design	Approvals	Construction	Implementation
Project Lead	City	-	-	-	-
Timeframe	18 months	-	-	-	-
Projected Completion	2022	-	-	-	-
Cost Estimate	<$0.5 M	-	-	-	-

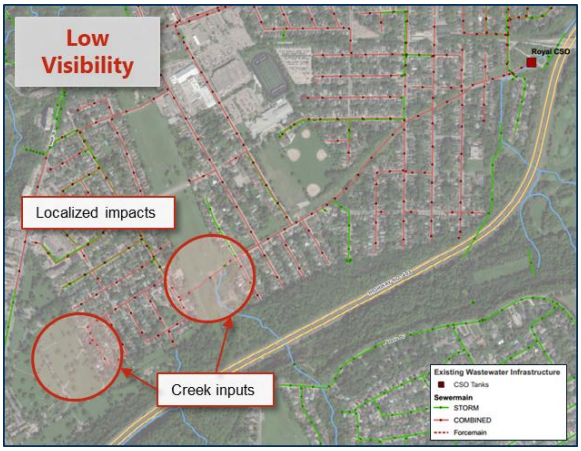
Study #2: Chedoke Watershed Stormwater Retrofits EA Study

Overview	This Master planning study consists of determining the feasibility and effectiveness of proposed projects to treat stormwater generated in the Upper Chedoke Creek.	
Relevant Projects	• Golf Course – Stream Naturalization (Project #10) • Golf Course – Retrofit and Treatment Online (Project #11) • Retrofits throughout watershed (end-of-pipe and source retrofits) (Project #12) • Upper Chedoke Creek Stream Naturalization (Project #13)	
Scope of Work	The scope of the study will include the following: • Adopt Class EA process for assessment and selection of preferred solutions • Develop a long-list of potential retrofits throughout the watershed, including oil/grit separator units, SWM facilities, and Golf Course works • Confirm feasibility and effectiveness of proposed projects in Chedoke Creek Watershed by evaluating benefits, impacts, and life cycle costs • Confirm other possible stormwater management projects • Provide final recommendation and prioritization for stormwater retrofits • Meet all consultation requirements of the Master plan EA project • Confirm timing, capital budget, and design details of preferred recommendation	
Objectives	The City and numerous legacy studies have identified the lack of stormwater management in the Chedoke Creek watershed. A Master Plan EA study specific to the Upper Chedoke Creek will develop a long-list of potential retrofits and determine which should be implemented. The level of uncertainty due to the complexity and cost of the projects requires a more in-depth investigation in the form of a Master Plan EA to confirm and determine the final recommendations.	

	Study	Design	Approvals	Construction	Implementation
Project Lead	City	-	-	-	-
Timeframe	24 months	-	-	-	-
Projected Completion	2023	-	-	-	-
Cost Estimate	<$0.5 M	-	-	-	-

Study #3: Ainsley Woods Sewer Separation

Overview	This project consists of the separation of the creek inputs into the combined sewers that run through Ainsley Woods, specifically at the points just upstream of Blackwood Crescent and at the western extent of Iona Avenue in Mid Chedoke Creek. A Class Environmental Assessment is required to identify an appropriate outlet for the separated flow, including evaluating the benefits, impacts, and life cycle costs of the various feasible solutions.
Relevant Projects	N/A



Scope of Work	The scope of the project will include the following: • Adopt Class EA process for assessment and selection of preferred solution • Meet all consultation and engagement requirements of MEA Class EA process • Complete fieldwork and inspection required to determine existing site conditions and areas of focus • Complete sewer design work & construct new stormwater sewers, if recommended • Confirm timing, capital budget, and design details of the project • Coordinate with the City of Hamilton
Objectives	By reducing the creek inputs into the combined sewer system, the frequency and volume of combined sewer overflows into the creek will be reduced and increased baseflow will reach the creek.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	City	City	City	City	City
Timeframe	12 months	12 months	6 months	12 months	Ongoing
Projected Completion	2022	2023	2023	2025	-
Cost Estimate	<$0.5 M	<$0.5 M	<$0.1 M	<$4 M	<$0.1 M

Project #1: Rehabilitate existing Highway 403 Culvert (Landfill)

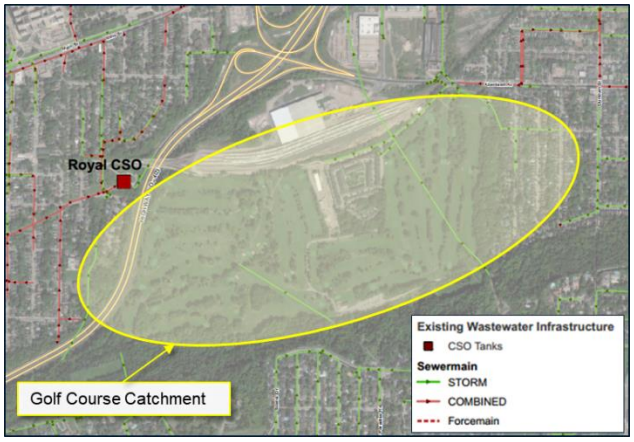
Overview	Project consists of the work required to complete the condition assessment, design, and repair works at the existing culvert from Highway 403, south of the West Hamilton Landfill and east of the Chedoke Creek.
Relevant Projects	N/A

Scope of Work	The scope of the project will include the following: • Complete fieldwork required to survey linear underground infrastructure and determine condition (CCTV, etc.) • Complete design work required to repair culvert • Complete repair works based on results of inspection
Objectives	Based on discussions with the City, there is leachate that flows through the existing culvert from Highway 403 at the West Hamilton Landfill on dry days, suggesting ongoing maintenance issues. A condition assessment, design, and repair works are needed to determine the current state of the culvert and fix the issues.

	Study/ Investigation	Design	Approvals	Construction	Operation & Maintenance
Project Lead	City/MTO	City/MTO	City/MTO/HCA	City/MTO	City/MTO
Timeframe	3 months	2 months	3 months	1 month	Ongoing
Projected Completion	2021	2021	2021/2022	2021/2022	-
Cost Estimate	<$50,000	<$25,000	<$25,000	<$250,000	-

Project #2: Golf Course – Manage Runoff from the Golf Course

Overview	Project consists of determining the best management practices to reduce contaminants (fertilizers and pesticides) and also treat the runoff from the golf course infrastructure including parking lots on-site.
Relevant Projects	N/A

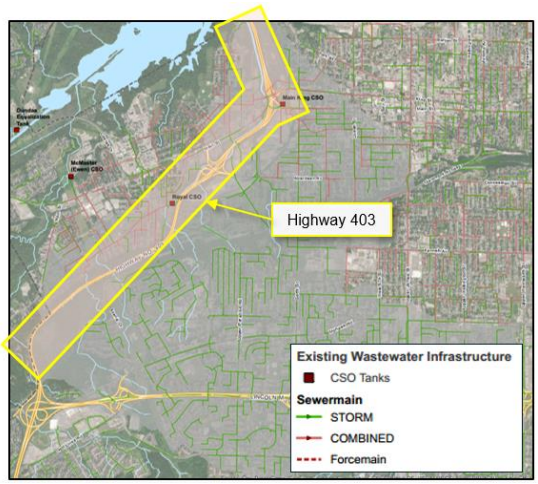


Scope of Work	The scope of the project will include the following: • Complete feasibility review for best practices for managing golf course runoff • Improve current practices; Design of preferred strategy • Confirm timing, capital budget, and design details of the proposed upgrades • Coordinate with the City of Hamilton to implement upgrades
Objectives	Based on the outcome of the recommended projects from the Chedoke Creek Water Quality Improvement Framework, improvements can be made at the Chedoke Golf Course to reduce and manage fertilizer and pesticide use and also capture runoff from the golf course hard surfaces. A review specific to the Chedoke Golf Course will expand on possible strategies that can be implemented in the short term to help improve the water quality entering the Mid Chedoke Creek by reducing sediments and contaminants (nutrients in particular) produced as part of the golf course operation.

	Study/ Investigation	Design	Approvals	Construction	Operation & Maintenance
Project Lead	City	City	City	City	City
Timeframe	3 months	3 months	3 months	3 months	Ongoing
Projected Completion	2021	2021	2022	2022	-
Cost Estimate	<$50,000	<$50,000	<$25,000	<$500,000	<$100,000

Project #3: Highway 403 Water Quality Improvements

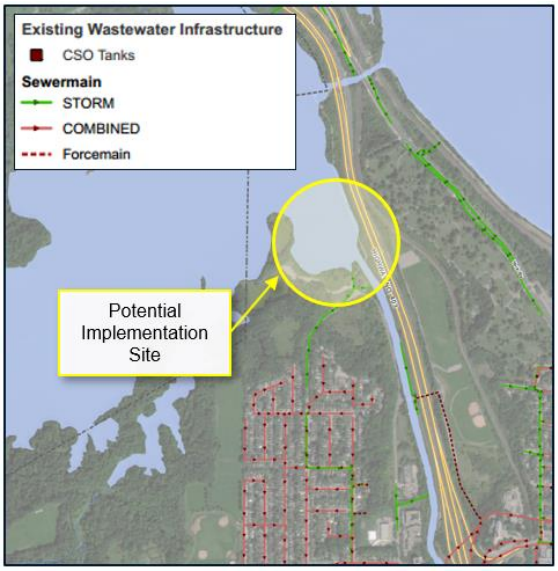
Overview	This project consists of the review, installation, and maintenance of stormwater management measures at or upstream of the stormwater outfalls along Highway 403 in the Chedoke watershed.
Relevant Projects	N/A



Scope of Work	The scope of the project will include the following: • Review and recommend the best strategy for managing and treating stormwater along the corridor • Confirm timing, capital budget, and design details of the proposed upgrades • Coordinate with the City of Hamilton and MTO to implement upgrades
Objectives	Based on the outcome of the recommended projects from the Chedoke Creek Water Quality Improvement Framework, treatment options can be implemented along Highway 403 to better treat and capture stormwater runoff. A review specific to the MTO corridor will expand on possible strategies that can be implemented in the short term to better manage contaminants present along highways.

	Study/ Investigation	Design	Approvals	Construction	Operation & Maintenance
Project Lead	MTO	MTO	MTO	MTO	MTO
Timeframe	6 months	3 months	6 months	6 months	Ongoing
Projected Completion	2022	2022	2022/2023	2023	-
Cost Estimate	<$50,000	<$100,000	<$50,000	<$1 M	<$200,000

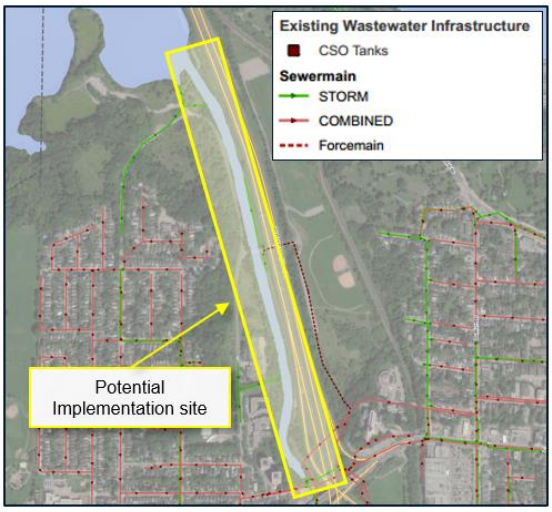
Project #4: Constructed Wetland

Overview	Project consists of the work required to complete a detailed design, installation and required maintenance to construct a Constructed Wetland in the Lower Chedoke Creek outlet to Cootes Paradise.	
Relevant Projects	Subject to outcomes from Lower Chedoke Combined EA Study (Study #1).	
Scope of Work	The scope of the project will be subject to the recommendations of Lower Chedoke Combined EA Study and may include the following: • Complete fieldwork required to determine existing site conditions (survey, etc.) prior to completing design work • Complete design work required for the construction of a Constructed Wetland • Confirm timing, capital budget, and design details of the proposed upgrades • Coordinate with the City of Hamilton and RBG to implement upgrades	
Objectives	Project is subject to the outcome of Study #1: Lower Chedoke Combined EA Study. Project to include the design and construction of a constructed wetland to capture sediments and pollutants in Lower Chedoke Creek before entering Cootes Paradise to support water purification and improve the habitat for wildlife and aquatic life.	

	Study / Investigation	**Design**	**Approvals**	**Construction**	**Operations & Maintenance**
Project Lead	-	City	City/RBG	RBG/City	RBG
Timeframe	-	12 months	6 months	12 months	Ongoing
Projected Completion	-	2024	2024	2025	-
Cost Estimate	-	<$500,000	$100,000	<$2 M	TBD

Project #5: Aeration System

Overview	This project consists of the design, installation and ongoing operation and maintenance plan of an Aeration System along the Lower Chedoke Creek. This may be accomplished through the use of mechanical blowers as identified in the RBG 25 Year Master Plan or may be implemented through other methods, potentially incorporated as part of potential stream naturalization and/or constructed wetlands at the mouth of the creek.
Relevant Projects	Subject to outcomes from Lower Chedoke Combined EA Study (Study #1).

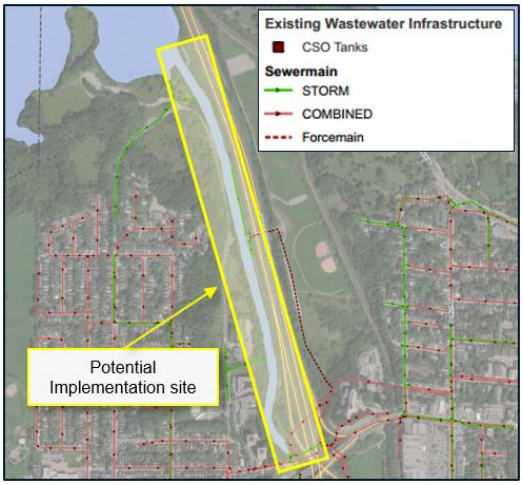


Scope of Work	The scope of the project will be subject to the recommendations of Lower Chedoke Combined EA Study and may include the following: • Complete fieldwork required to determine existing site conditions (survey, etc.) prior to completing design work to determine strategic locations for aerators • Complete design work required for the installation of the Aeration System • Confirm timing, capital budget, and design details of the proposed upgrades • Coordinate with the City of Hamilton, RBG, HCA and MTO to implement upgrades • Monitor condition and effectiveness of aerators over time
Objectives	Project is subject to the outcome of Study #1: Lower Chedoke Combined EA Study. Project to include the Construction of aerator system along the Lower Chedoke Creek to transfer dissolved oxygen to the Chedoke Creek waters to improve the marine habitat along and downstream of the creek.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	-	City	City/RBG	City	City
Timeframe	-	18 months	6 months	12 months	20 Years
Projected Completion	-	2024	2025	2026	-
Cost Estimate	-	<$1.5 M	<$100,000	<$5 M	TBD

Project #6: Stream Naturalization

Overview	Project consists of the review, design, installation and maintenance of naturalization measures along the Lower Chedoke Creek.
Relevant Projects	Subject to the outcomes from Lower Chedoke Combined EA Study (Study #1) as well as the MECP Provincial Officer's Order related to the 2014-2018 spill.

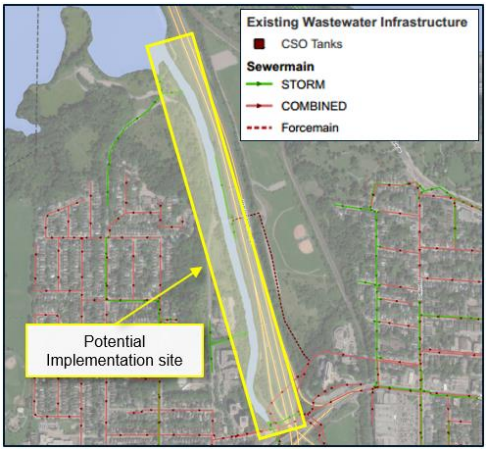


Scope of Work	The scope of the project will be subject to the recommendations of Lower Chedoke Combined EA Study as well as the MECP Provincial Officer's Order related to the 2014-2018 spill and may include the following: • Build from the targeted dredge database of field work and construction • Complete fieldwork required to determine existing site conditions (survey, etc.) prior to completing design work to determine naturalization measures • Complete design work required for the installation of naturalization • Confirm timing, capital budget, and design details of the proposed upgrades • Coordinate with the City of Hamilton, HCA and RBG to implement upgrades • Monitor condition and complete necessary upkeep and maintenance over time
Objectives	Project is subject to the outcomes of Study #1: Lower Chedoke Combined EA Study as well as the MECP Provincial Officer's Order related to the 2014-2018 spill. The project will include the design and construction of naturalization efforts to reduce erosion and improve stream stability in the Lower Chedoke Creek before entering Cootes Paradise.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	-	City	City/RBG	City	City
Timeframe	-	12 months	6 months	12 months	20 Years
Projected Completion	-	2024	2025	2026	-
Cost Estimate	-	<$200,000	<$100,000	<$3 M	TBD

Project #7: Chedoke Creek Targeted Sediment Removal

Overview	Project consists of the assessment, design and implementation of hydraulic dredging to remove contaminated sediments in the Lower Chedoke Creek currently in the planning stages in response to Provincial Officer's Order.
Relevant Projects	MECP Provincial Officer's Order related to the 2014-2018 spill.

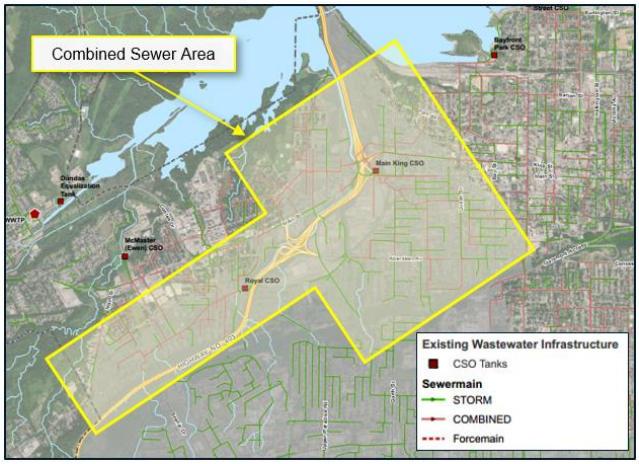


Scope of Work	The scope of the project is subject to the recommendations the plan being developed in response to the MECP Provincial Officer's Order related to the 2014-2018 spill and is expected to include the following: • Complete fieldwork required to determine existing site conditions and targeted removal areas (bathymetry, sediment, SAR) • Complete design work including dredging process including transportation of dredged material, dewatering and location for final placement of dredged material • Confirm timing, capital budget, and design details of the project • Coordinate with the City of Hamilton. MECP and other stakeholders through permitting to complete dredging • Coordinate with appropriate approval agencies before initiating work
Objectives	Project is subject to the MECP Provincial Officer's Order related to the 2014-2018 spill. The project will consist of fieldwork, design and permitting for the removal of sediment to remediate the creek. Ultimately, this project will have an immediate effect on the health of the creek but will require the implementation of other projects to prevent contaminants from entering the stream to prolong the benefits of this project.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	-	City	City	City	-
Timeframe	-	6 months	6 months	6 months	-
Projected Completion	-	2022	2022/2023	2023/2024	-
Cost Estimate	-	<$0.5 M	<$200,000	<$5 M	-

Project #8: Inlet Controls in Combined Sewer Areas

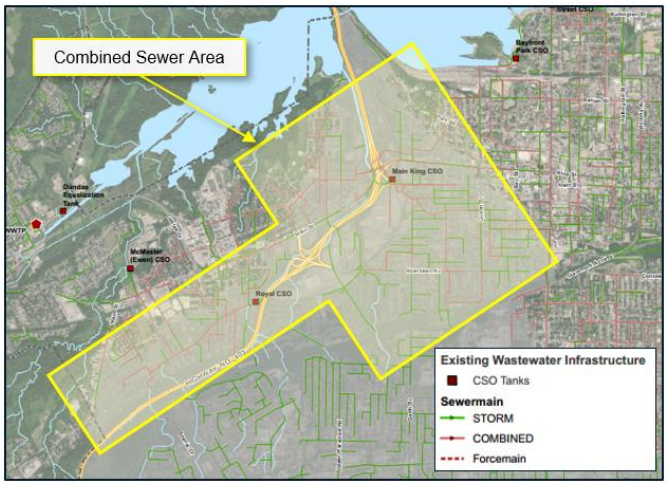
Overview	This project consists of the installation, operation and maintenance of inlet control devices in the combined sewers, north of the Escarpment in the Chedoke Creek watershed.
Relevant Projects	Flooding and Drainage Master Servicing Study



Scope of Work	The scope of the project will be subject to the recommendations of the Flooding and Drainage Master Servicing Study but may include: • Conduct technical assessments for major (overland) system to ensure locations do not exacerbate flood risks • Complete fieldwork and inspection required to determine existing site conditions and areas of focus • Complete design work including device recommendation, installation procedure and location for devices • Complete installation of devices • Confirm timing, capital budget, and operation and maintenance procedures and requirements of the project • Coordinate with the City of Hamilton
Objectives	Based on the recommendations made by the on-going Flooding and Drainage Master Servicing Study, inlet controls may be installed in targeted areas within combined sewers. Inlet control devices restrict the amount of stormwater that enters the combined sewers and therefore the amount of potential overloading on CSO tanks.

	Study / Investigation	**Design**	**Approvals**	**Construction**	**Operations & Maintenance**
Project Lead	-	City	City	City	City
Timeframe	-	12 months	6 months	12 months	Ongoing
Projected Completion	-	2024	2025	2026	-
Cost Estimate	-	<$50,000	<$25,000	<$500,000	<$100,000

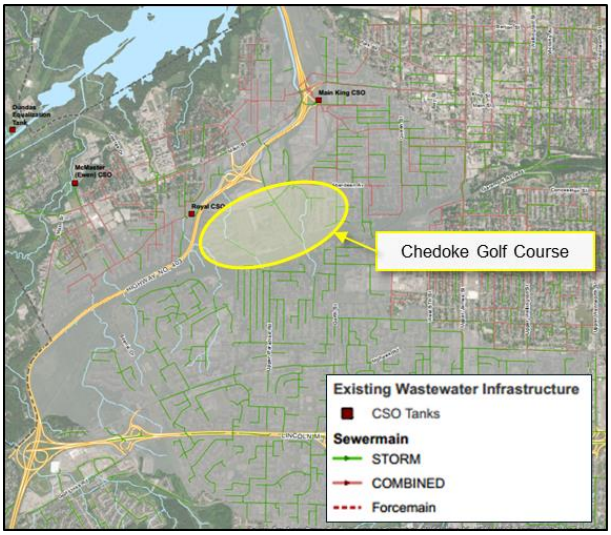
Project #9: Sewer Separation

Overview	Project consists of identifying high priority areas in the combined sewer system and constructing new storm sewers to implement separation between stormwater and wastewater.	
Relevant Projects	Flooding and Drainage Master Servicing Study	
Scope of Work	The scope of the project will be subject to the recommendations of the Flooding and Drainage Master Servicing Study but may include: • Complete fieldwork and inspection required to determine existing site conditions and areas of focus • Complete sewer design work • Construct new stormwater sewers • Confirm timing, capital budget, and design details of the project • Coordinate with the City of Hamilton	
Objectives	Sewer separation works will be based on recommendations made by the on-going Flooding and Drainage Master Servicing Study. By replacing combined sewers with separated sewers, the frequency and volume of combined sewer overflows into the creek will be reduced.	

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	-	City	City	City	City
Timeframe	-	24 months	12 months	5 years	Ongoing
Projected Completion	-	2026	2027	2032	-
Cost Estimate	-	$5 M	$1 M	>$50 M	TBD

Project #10: Golf Course – Stream Naturalization

Overview	This project consists of the review, design, installation and maintenance of naturalization measures of channelized portions of the creek within the golf course.
Relevant Projects	Chedoke Watershed Stormwater Retrofits EA Study (Study #2)

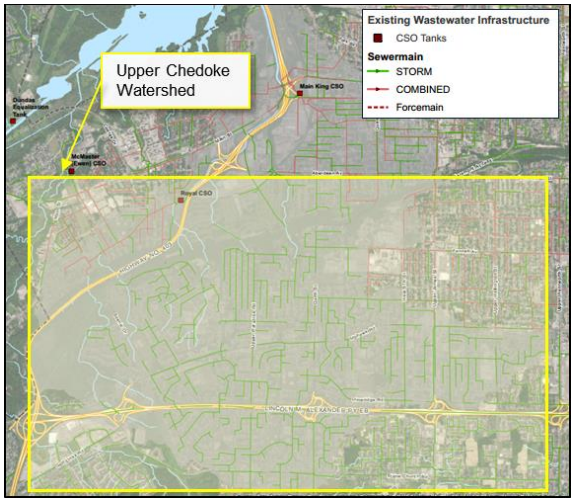


Scope of Work	The scope of the project will be subject to the recommendations of the Chedoke Watershed Stormwater Retrofits EA Study but may include: • Complete fieldwork required to determine existing site conditions (survey, etc.) prior to completing design work • Complete design work required for stream naturalization • Confirm timing, capital budget, and design details of the proposed upgrades • Coordinate with the City of Hamilton and appropriate authorities to implement upgrades
Objectives	Project is subject to the outcome of Study #2: Chedoke Watershed Stormwater Retrofits EA Study. The naturalization process will include the use of natural channel design and introducing native vegetation for slope stability.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	-	City	City	City	City
Timeframe	-	12 months	18 months	2 years	Ongoing
Projected Completion	-	2025	2027	2029	-
Cost Estimate	-	<$250,000	<$25,000	<$1 M	TBD

Project #11: Golf Course – Retrofit and Treatment Online

Overview	This project consists of the review, design, construction and operation and maintenance for a stormwater management retrofit for treatment of runoff from the Upper Chedoke Creek, on the Chedoke Golf Course.
Relevant Projects	Chedoke Watershed Stormwater Retrofits EA Study (Study #2)

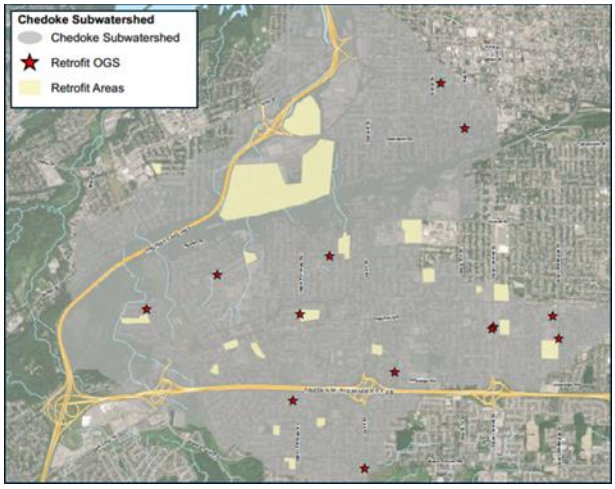


Scope of Work	The scope of the project will be subject to the recommendations of the Chedoke Watershed Stormwater Retrofits EA Study but may include: • Complete fieldwork required to determine existing site conditions (survey, etc.) prior to completing design work; coordinate with golf course operations • Complete design work required for recommended retrofits and treatment • Confirm timing, capital budget, and design details of the proposed upgrades • Coordinate with the City of Hamilton and appropriate authorities to implement upgrades
Objectives	Project is subject to the outcome of Study #2: Chedoke Watershed Stormwater Retrofits EA Study. The installation of the on-line stormwater management retrofit will help improve the water quality entering Mid Chedoke Creek by managing contaminants for lands unable to be treated at source (Upstream of the facility) .

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	-	City	City	City	City
Timeframe	-	18 months	12 months	2 years	Ongoing
Projected Completion	-	2025	2026	2028	-
Cost Estimate	-	<$250,000	<$50,000	<$1 M	$1 M

Project #12: Retrofits throughout watershed (End-of-Pipe and Source)

Overview	This project consists of the design and construction of the recommendations from the Master Plan which involved a comprehensive review of the Chedoke Creek watershed to identify existing ponds that can be retrofitted to wet ponds, and areas where there are no stormwater management measures but opportunity to retrofit.
Relevant Projects	Chedoke Watershed Stormwater Retrofits EA Study (Study #2)



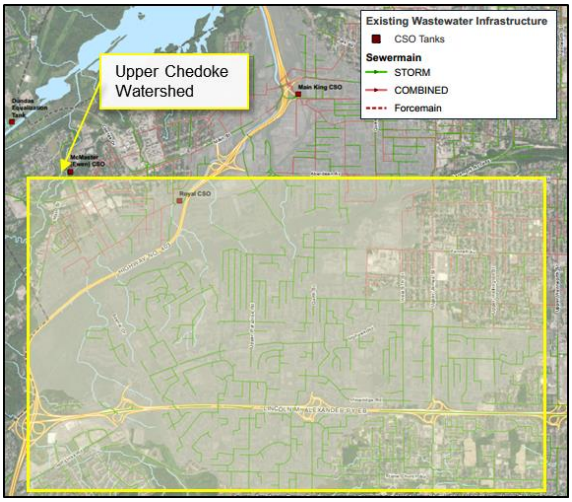
Scope of Work	The scope of the project will be subject to the recommendations of the Chedoke Watershed Stormwater Retrofits EA Study but may include: • Complete fieldwork required to determine existing conditions (survey, etc.) prior to completing design work • Complete preliminary and detailed design work required for retrofits • Coordinate with the City of Hamilton and appropriate authorities (MECP) to implement upgrades
Objectives	Project is subject to the outcome of Study #2: Chedoke Watershed Stormwater Retrofits EA Study.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	-	City	City	City	City
Timeframe	-	12 months	6 months	+2 years	Ongoing
Projected Completion	-	2025	2025	+2027	-
Cost Estimate*	-	$1 M	>$100,000	$10 M	$1 M

*Cost estimate reflective of approximately 5 retrofits and 10 OGS installations

Project #13: Upper Chedoke Creek Stream Naturalization

Overview	This project consists of the review, design, installation and maintenance of naturalization measures in the Upper Chedoke Creek. The naturalization process will include the use of natural channel design and introducing native vegetation for slope stability.
Relevant Projects	Chedoke Watershed Stormwater Retrofits EA Study (Study #2)

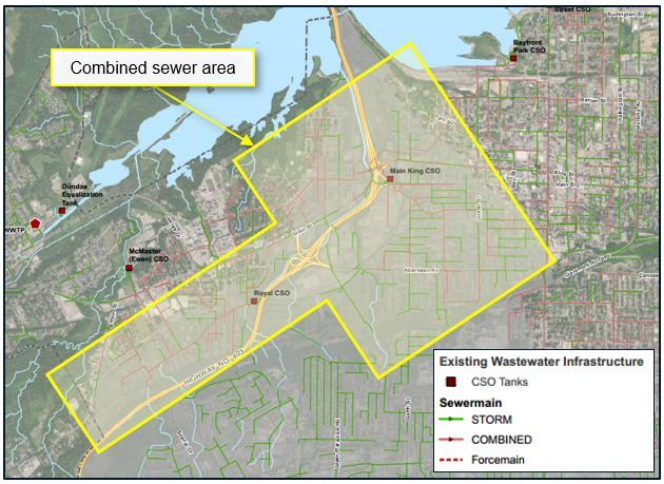


Scope of Work	The scope of the project will be subject to the recommendations of the Chedoke Watershed Stormwater Retrofits EA Study but may include: • Complete fieldwork required to determine existing site conditions (survey, etc.) prior to completing design work to determine naturalization measures • Complete design work required for the installation of naturalization • Confirm timing, capital budget, and design details of the proposed upgrades • Coordinate with the City of Hamilton and HCA to implement upgrades • Monitor condition and complete necessary upkeep and maintenance over time
Objectives	Project is subject to the outcome of Study #2: Chedoke Watershed Stormwater Retrofits EA Study. The naturalization process will include the use of natural channel design and introducing native vegetation for slope stability.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	-	City	City	City	City
Timeframe	-	12 months	6 months	+2 years	20 Years
Projected Completion	-	2025	2025	+2027	-
Cost Estimate*	-	<$500,000	>$100,000	<$3 M	TBD

Project #14: Expand Storage Elsewhere in System

Overview	Project consists of a comprehensive review of the City's wastewater and combined sewer systems to identify if there are any areas to expand storage for overflow events. This project includes the design, construction, operations and maintenance of any new storage facilities.
Relevant Projects	Water, Wastewater, and Stormwater Master Plan

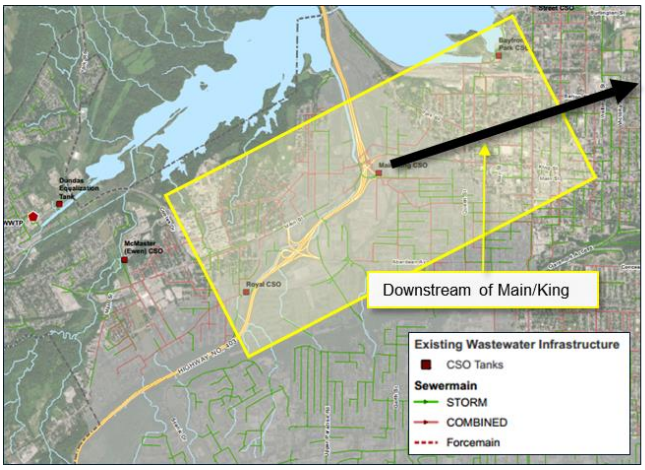


Scope of Work	The scope of the project will be subject to the recommendations of the Water, Wastewater, and Stormwater Master Plan but may include: • Complete fieldwork and inspection required to determine existing site conditions and areas of focus • Complete storage design work • Construct new storage facilities • Confirm timing, capital budget, and design details of the project • Coordinate with the City of Hamilton
Objectives	Project is subject to the outcome of the City's ongoing Water/Wastewater/Stormwater Master Plan with the goal of addressing system capacity to support existing and future users.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	-	City	City	City	City
Timeframe	-	2 Years	12 months	2 years	25 years
Projected Completion	-	2025	2026	2028	-
Cost Estimate	-	$1.5 M	$100K	$10 M	$2 M

Project #15: Increase Capacity Downstream of Main-King CSO tank

Overview	Project consists of the review of the City's wastewater system downstream of the Main-King CSO tank to determine the benefits and feasibility of adding additional wastewater Capacity. Following the review, the project includes the design, construction, operations and maintenance of the new infrastructure which may consist of new sewers or new facilities.
Relevant Projects	Water, Wastewater, and Stormwater Master Plan

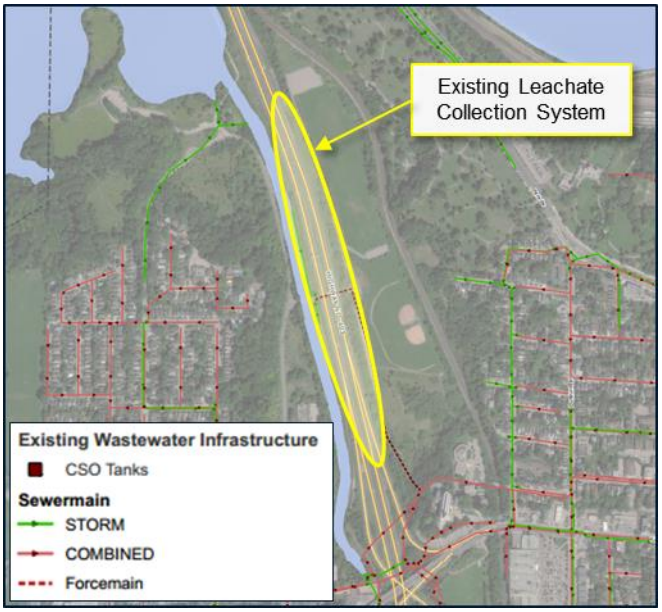


Scope of Work	The scope of the project will include the following: • Complete fieldwork and inspection required to determine existing site conditions and areas of focus • Complete sewer and storage design work • Construct new sewers and storage facilities • Confirm timing, capital budget, and design details of the project • Coordinate with the City of Hamilton
Objectives	Project is subject to the outcome of the City's ongoing Water/Wastewater/Stormwater Master Plan with the goal of addressing system capacity to support existing and future users.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	-	City	City	City	City
Timeframe	-	3 years	1 years	5 years	Ongoing
Projected Completion	-	2028	2025	Before 2040	-
Cost Estimate	-	$5 M	$1 M	$85 M	-

Project #16: Expand/Fix Leachate Collection System

Overview	Project consists of the continuous water quality and leachate collection system monitoring to determine the effectiveness of the LCS. The collection and analysis of data will determine if further upgrades need to be made to the system.
Relevant Projects	N/A

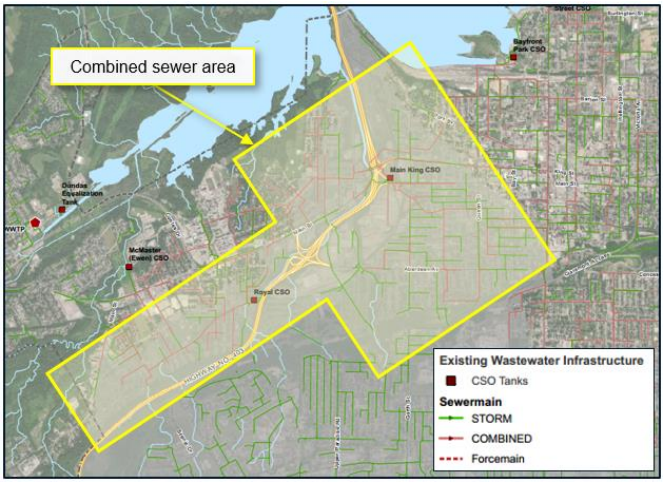


Scope of Work	The scope of the project will include the following: • Complete water quality monitoring and leachate collection system monitoring • Complete data review to determine effectiveness of LCS • Provide recommendation for future upgrades at the LCS
Objectives	Project is subject to the outcome of additional data collection at the existing Leachate Collection System. Final recommendations related to further upgrades aren't suggested until sufficient data has been collected and analyzed.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	City	-	-	-	-
Timeframe	5 years	-	-	-	-
Projected Completion	Mid 2026	-	-	-	-
Cost Estimate	<$100,000	-	-	-	-

Project #17: CSO Monitoring Improvements and Active Management

Overview	Project consists of wastewater system monitoring through the City's SCADA system at CSO facilities to flag facilities that require further inspection.
Relevant Projects	N/A

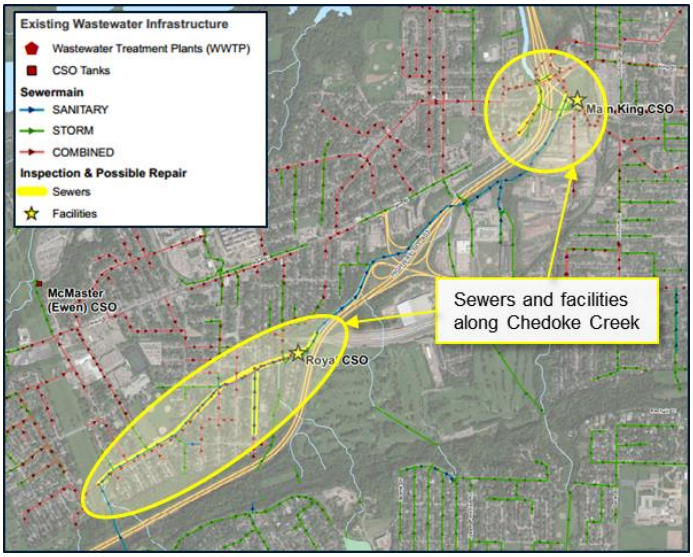


Scope of Work	The scope of the project will include the following: • Expanded monitoring at CSO facilities as part of the City's ongoing program • Monitor unmonitored CSO facilities • Identify any additional strategic locations for monitoring • Monitor combined and wastewater flows within the conveyance system and at facilities • Identify any problem areas that require further inspection
Objectives	Enhanced monitoring and active management will ensure that future failures are eliminated or recognized and resolved quickly. Future repairs will be the outcome of this monitoring program.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	City	City	-	City	-
Timeframe	6 Months	6 Months	-	6 Months	-
Projected Completion	2021	2022	-	2022	-
Cost Estimate	<$100,000	<$250,000	-	<$1M	-

Project #18: Inspection and Repair

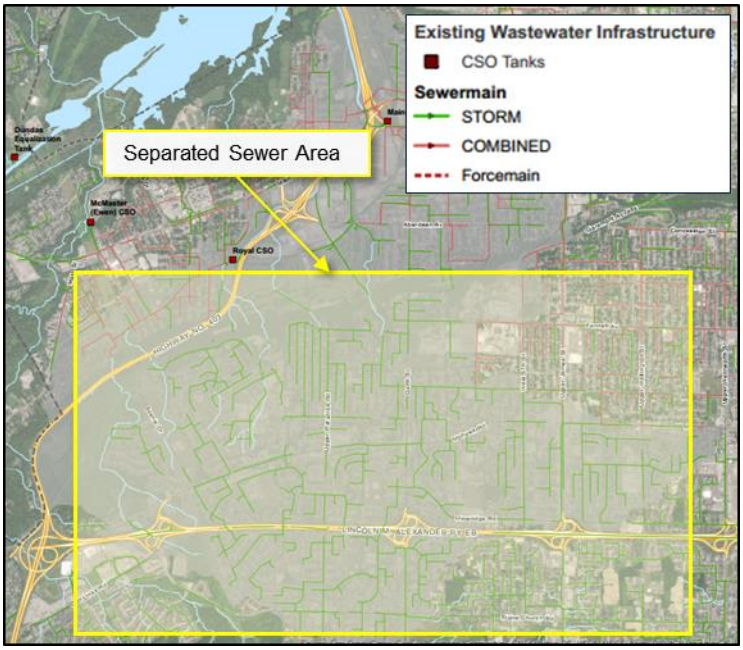
Overview	This project consists of the inspection, design, repair and maintenance of trunk sewers and facilities along the Chedoke Creek.
Relevant Projects	• Inspection and Repair – Facilities • Inspection and Repair – Trunk Sewers



Scope of Work	The scope of the project will include the following: • Complete fieldwork required to survey linear infrastructure and storage facilities along Chedoke Creek to determine condition (CCTV, etc.) • Identify areas of inflow and infiltration coming from the creek or sewers to provide recommendations for repairs if necessary • Summarize data to support future repair projects
Objectives	Inspection should be implemented for trunk sewers and storage facilities along the Chedoke Creek to identify any areas of significant inflow. Imitate design and repair if necessary, based on findings.

	Study / Investigation	Design	Approvals	Construction	Operations & Maintenance
Project Lead	City	City	City	City	City
Timeframe	12 months	6 months	3 months	12 months	Ongoing
Projected Completion	2022	2022	2023	2024	--
Cost Estimate	<$250,000	<$500,000	<$50,000	<$2 M	

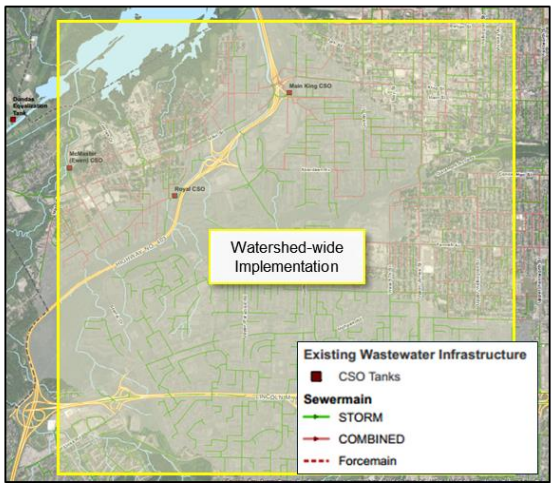
Project #19: Cross Connection Program

Overview	Project consists of the inspection and construction required to identify cross connections in the Chedoke Creek watershed and separate sewers.	
Relevant Projects	N/A	
Scope of Work	The scope of the project will include the following: • Complete fieldwork and inspection required to flag cross connections in the separated sewer system, south of the Escarpment in the Chedoke Creek watershed • Complete sewer separation for identified cross connections • Coordinate with the City of Hamilton	
Objectives	The City has an ongoing program which is prioritizing cross connection identification and separation in the Chedoke Creek watershed. The separation of any cross connections will eliminate wastewater that is currently entering the stormwater system.	

	Study / Investigation	Design	Approvals	Construction	Implementation
Project Lead	City	-	-	-	City
Timeframe	12 months	-	-	-	3 years
Projected Completion	2022	-	-	-	2025
Cost Estimate	<$0.5 M	-	-	-	<$2 M

Project #20: Wet Weather Flow (Inflow & Infiltration) in Separated Sewers

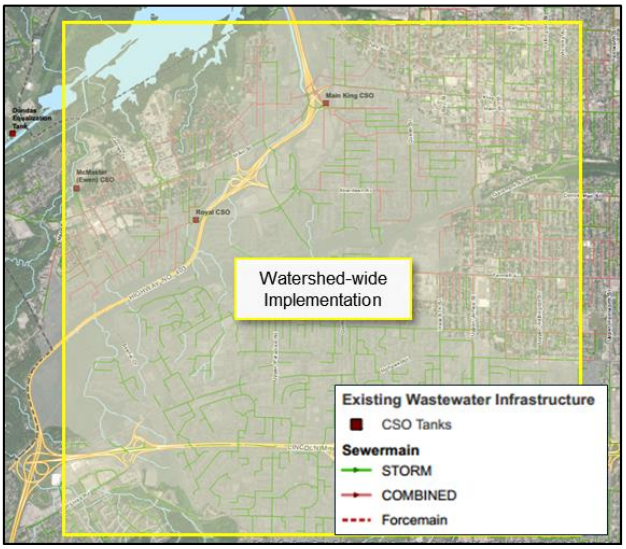
Overview	This project consists of the inspection, identification, recommendation and repair of separated sewers in the City.
Relevant Projects	• Wet Weather Flow in Separated Sewers – Targeted in Chedoke Watershed • Wet Weather Flow in Separated Sewers – Targeted in broader Main-King catchment



Scope of work	The scope of the project will include the following: • Complete fieldwork required to survey linear infrastructure to determine areas of inflow and infiltration (CCTV, flow monitoring, street level surveys, etc.) • Provide recommendations for remediation to address sources of inflow and infiltration including sewer repairs, service lateral repair, foundation and downspout disconnection, etc. • Provide final report with findings and recommendations • Implement investigation recommendations • Coordinate with the City of Hamilton
Objectives	An I&I program should be targeted in the Chedoke Creek watershed and Main-King catchment to reduce the frequency and magnitude of overflows by reducing any wet weather flows that are currently entering sewers and utilizing existing sewer capacity. Design and repair to be initiated based on recommendations of study.

	Study / Investigation	**Design**	**Approvals**	**Construction**	**Operations & Maintenance**
Project Lead	City	City	City	City	City
Timeframe	1 year (Per area)	6 months (Per area)	6 months (Per area)	1 year (Per area)	Ongoing
Projected Completion	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
Cost Estimate	-	-	-	-	-

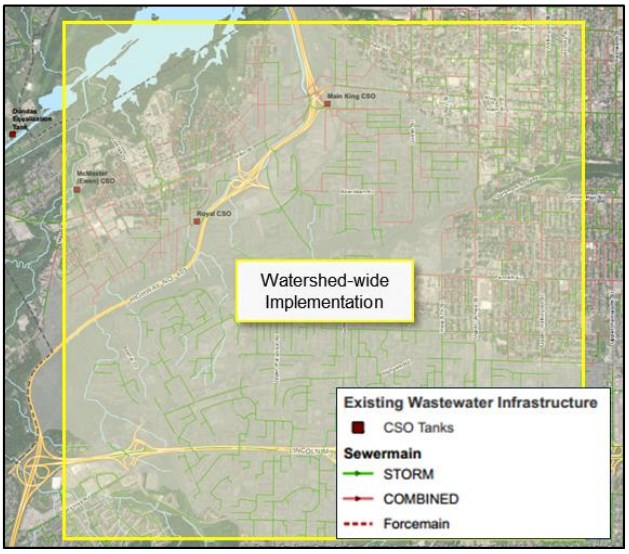
Project #21: Chedoke Creek Water Quality Program Management and Monitoring

Overview	Project consists of developing a centralized and coordinated data sharing portal for ongoing water sampling to guide the use of consistent protocols.	
Relevant Projects	N/A	

Scope of Work	The scope of the project will include the following: • Monitor water quality throughout the Chedoke Creek watershed • Analyze data to set baseline for Chedoke Creek water quality at multiple locations throughout watershed
Objectives	The absence of a coordinate, continuous, and widely accessible monitoring program and data reduces the accuracy of analytical tools and hampers informed decision making. Consist of enhancing and expanding existing monitoring activities and establishing measures to support the coordinated management of the data collection and distribution of information. This may be achieved through the exiting City and HCA programs, or reorganized under a new program specific to Chedoke Creek

	Study	Design	Approvals	Construction	Implementation
Project Lead	City	-	-	-	City
Timeframe	6 months	-	-	-	Ongoing
Projected Completion	2022	-	-	-	Ongoing
Cost Estimate	$100,000	-	-	-	$250,000/Year

Project #22: City Street Management – Enhanced Street Sweeping

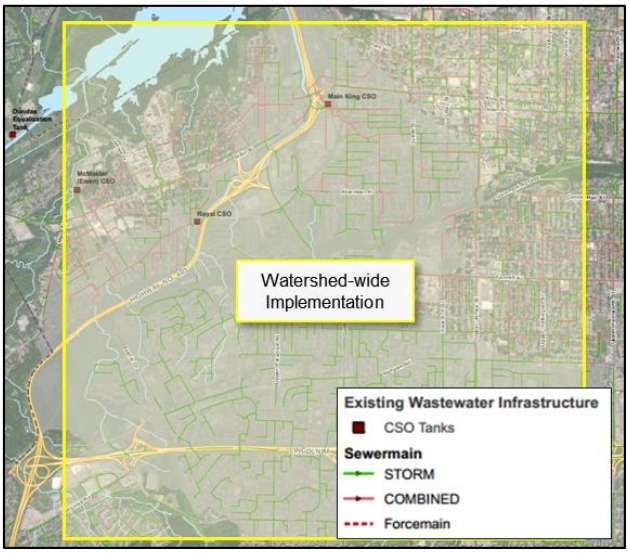
Overview	This project consists of developing and implementing an enhanced street sweeping program through the Chedoke Creek watershed.	
Relevant Projects	N/A	

Scope of Work	The scope of the project will include the following: • Develop enhanced street sweeping program • Implement street sweeping program • Ongoing City of Hamilton management to implement street sweeping
Objectives	Street sweeping improves water quality by removing pollutants that are transferred through urban runoff. Additionally, sweeping in the spring will have the increased benefits of cleaning any debris that built up over the winter months.

	Study / Investigation	Design	Approvals	Construction	Implementation
Project Lead	City	-	-	-	City
Timeframe	6 months	-	-	-	Ongoing
Projected Completion	2023	-	-	-	-
Cost Estimate	<$25,000	-	-	-	<$500,000

Project #23: City Street Management – Improve Snow Management within Chedoke Creek Watershed

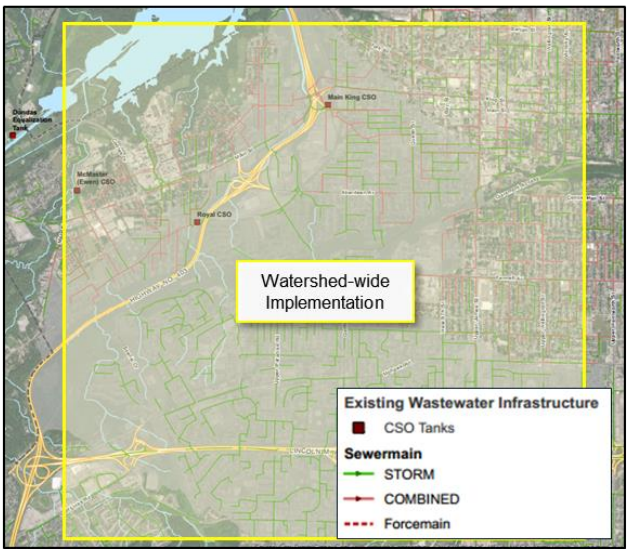
Overview	This project consists of developing and implementing an enhanced program for improved snow management within the Chedoke Creek watershed. This will include reviewing existing and potential snow disposal sites that would reduce the direct snow melt into urban streams.
Relevant Projects	N/A



Scope of work	The scope of the study will include the following: • Review appropriate City management policies, and programs implemented throughout other municipalities • Develop program for snow management in Chedoke Creek watershed • City to implement ongoing program
Objectives	The better management of snow within the Chedoke Creek watershed will benefit the Chedoke Creek by reducing pollutants that are transferred to the creek through the urban runoff.

	Study	Design	Approvals	Construction	Implementation
Project Lead	City	-	-	-	City
Timeframe	6 months	-	-	-	Ongoing
Projected Completion	2023	-	-	-	Ongoing
Cost Estimate	<$50,000	-	-	-	-

Project #24: Enhanced Salt Management

Overview	This project consists of developing and implementing an enhanced program for improved salt management within the Chedoke Creek watershed. This program should be reviewed and updated as necessary to ensure the best policies are in place when dealing with the transportation, storage, and use of salt.	
Relevant Projects	• Enhanced Salt Management – City • Enhanced Salt Management – Highway 403	
Scope of Work	The scope of the project will include the following: • Review current City and MTO management policies, and programs implemented throughout other municipalities • Develop enhanced program for salt management along roads Chedoke Creek Watershed and along Highway 403 • City to implement ongoing program	
Objectives	The better management of salt within the Chedoke Creek watershed will benefit the Chedoke Creek by reducing pollutants that are transferred to the creek through the urban runoff.	

	Study	Design	Approvals	Construction	Implementation
Project Lead	City/MTO	-	-	-	City/MTO
Timeframe	6 months	-	-	-	Ongoing
Projected Completion	2023	-	-	-	Ongoing
Cost Estimate	<50,000	-	-	-	-

Policy #1: Engage Residents, Stakeholders, and City						
Overview	Project consists of developing a program for engagement with residents, stakeholders, and the City that should be initiated immediately building from the engagement in the Framework study.					
Relevant Projects	• N/A					
Scope of work	The scope of the program will include the following: • Develop communication plans to update the residents, stakeholders and City on all initiatives being taken as part of the Chedoke Creek Water Quality Improvement Framework • Form a Chedoke Creek Advisory Committee or equivalent that will meet semi-annually or annually to review items related to this study					
Objectives	Based on recommendations from the Chedoke Creek Water Quality Improvement Strategy, engagement with residents, stakeholders and the City should be initiated immediately to support the implementation of the framework recommendations.					
	Study	**Design**	**Approvals**	**Construction**	**Implementation**	
Project Lead	-	-	-	-	City	
Timeframe	-	-	-	-	6 months	
Projected Completion	-	-	-	-	Late 2021	
Cost Estimate	-	-	-	-	$25,000/Year	

Policy #2: Redevelopment Sites SWM Policy						
Overview	Project consists of developing an updated redevelopment Sites SWM Policy for the Chedoke Watershed. The policy will contain prescription of Best Management Practices (BMPs) including Low Impact Development measures for redevelopment sites within the City.					
Relevant Projects	• City Stormwater and Development Guidelines					
Scope of work	The scope of the policy will include the following: • Review appropriate Conservation Authority and existing City stormwater management policies • Develop updated policy for future City redevelopment sites to improve existing stormwater management					
Objectives	Based on recommendations from the Chedoke Creek Water Quality Improvement Framework and communication with stakeholders, a Stormwater Management Policy for Redevelopment Sites in the City should be implemented. It is important to develop a policy that is consistent with Conservation Authority and City recommendations.					
	Study	**Design**	**Approvals**	**Construction**	**Implementation**	
Project Lead	City	-	-	-	-	
Timeframe	6 months	-	-	-	-	
Projected Completion	2021	-	-	-	-	
Cost Estimate	<$25,000	-	-	-	-	

Policy #3: Retrofits for Road Rehabilitation / LID BMP Policy						
Overview	Project consists of developing a stormwater management policy to be implemented through all future road rehabilitation projects.					
Relevant Projects	• City Stormwater and Development Guidelines N/A					
Scope of work	The scope of the policy will include the following: • Review appropriate Conservation Authority and existing City stormwater management policies • Develop policy to prepare for future City road redevelopment sites to improve existing stormwater management					
Objectives	Based on recommendations from the Chedoke Creek Water Quality Improvement Framework and communication with stakeholders, a Stormwater Management Policy for road rehabilitation sites in the City should be implemented. It is important to develop a policy that is inline with Conservation Authority and City recommendations.					
	Study	**Design**	**Approvals**	**Construction**	**Implementation**	
Project Lead	City	-	-	-	City	
Timeframe	6 months	-	-	-	6 months	
Projected Completion	2021	-	-	-	2021	
Cost Estimate	<$25,000	-	-	-	5 – 10% premium on road jobs	

Policy #4: LID BMP Policy / Stormwater User Rate						
Overview	Project consists of enhancing and prioritizing the City's existing LID Policy / Stormwater User Rate.					
Relevant Projects	• N/A					
Scope of work	The scope of the policy will include the following: • Review appropriate Conservation Authority and existing City stormwater user rate • Update City's Stormwater User Rate policy to improve existing stormwater management • Develop LID BMP Policy to be incorporated into the City's Stormwater User Rate					
Objectives	Based on recommendations from the Chedoke Creek Water Quality Improvement Framework and communication with stakeholders, the City's existing LID Policy / Stormwater User Rate should be re-prioritized. This incentive program will encourage private property owners to manage stormwater from private properties and implement additional BMP's.					
	Study	**Design**	**Approvals**	**Construction**	**Implementation**
Project Lead	City	-	-	-	City
Timeframe	12 months	-	-	-	18 months
Projected Completion	2022	-	-	-	2022
Cost Estimate	<$500,000	-	-	-	<$500,000

Policy #5: Wet Weather Flow in Separated Sewers Policy						
Overview	Project consists of the development of a Wet Weather Flow policy that will be implemented through new development throughout the City.					
Relevant Projects	• City Stormwater and Development Guidelines N/A					
Scope of work	The scope of the policy will include the following: • Review appropriate Conservation Authority and existing New Development policies • Update City's policy to eliminate wet weather flow allowance in new construction					
Objectives	Based on recommendations from the Chedoke Creek Water Quality Improvement Framework and communication with stakeholders, a Wet Weather Flow in Separated Sewers Policy should be implemented. The policy will include more stringent criteria related to wet weather flow allowance in new developments to ensure that all future construction practices address wet weather flows.					
	Study	**Design**	**Approvals**	**Construction**	**Implementation**	
Project Lead	-	-	-	-	City	
Timeframe	-	-	-	-	12 months	
Projected Completion	-	-	-	-	2022	
Cost Estimate	-	-	-	-	<$50,000	