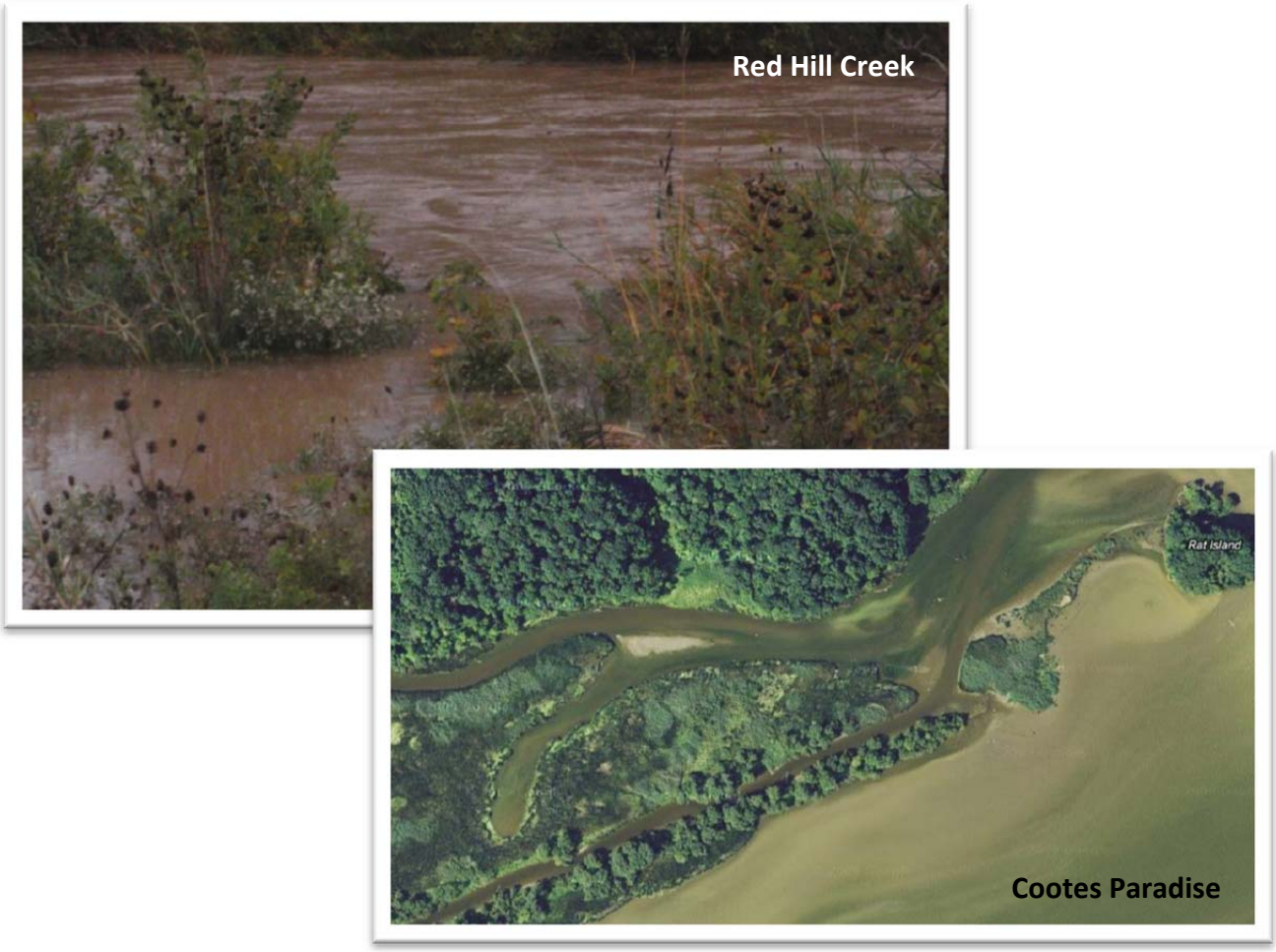
Hamilton Harbour Remedial Action Plan

Urban Runoff Hamilton
Report and Recommendations



Prepared by: Urban Runoff Hamilton Task Group

Dated: October 20, 2016

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Urban Runoff Hamilton Report

Executive Summary

For the first time in 100 years the quality of the water in Hamilton Harbour will soon be determined by its watershed runoff. By 2021 upgrades to wastewater treatment plants will be complete and no longer will impacts from the watershed be masked by wastewater effluent. The hundreds of millions of dollars invested in wastewater treatment upgrades will not on their own be enough to make sustainable changes in Harbour water quality. If Hamilton Harbour is to delist as an Area of Concern, urban runoff will also need to lower phosphorus and sediment levels.

For this reason the Hamilton Harbour Remedial Action Plan (HHRAP) set up Urban Runoff Task Groups for Hamilton and Burlington with municipal, conservation authority, provincial, federal, RBG, and community stakeholder representatives. This report is the collective overview of local stormwater management practice and contains recommendations for opportunities to change. The recommended change is not unique to this area, but is in line with changes already occurring in the understanding, practice, and resourcing of stormwater management throughout Ontario and North America.

Stormwater management is undergoing an evolution. Historically conveyance was the main focus of stormwater management - efficiently collecting rain water and moving it quickly through pipes and channels to enter creeks and larger water bodies. It is now recognized that using ways to mimic a natural landscape and infiltrate rain where it falls will slow it down, provide opportunities for removal of excess nutrients and sediment, and decrease the potential for flooding. This practice is referred to as Low Impact Development or LID.

The key categories of recommendations from the Urban Runoff Hamilton Task Group include:

- updating guidance and manuals;
- providing training;
- expanding implementation and maintenance of public and private stormwater facilities; and
- creating a stable and equitable financial model for stormwater.

Underpinning many of the necessary changes will be the need for the City of Hamilton to stabilize revenues and ensure sustainability for the municipal stormwater infrastructure including its operations and maintenance requirements through a dedicated, equitable rate structure.

This evolution in stormwater management is in line with the visions of the City of Hamilton, Hamilton Conservation Authority, Conservation Halton, and the Hamilton Harbour Remedial Action Plan. When stormwater management is done well, flooding will be reduced and nature will thrive with cleaner streams; when it fails, basements flood and streams will struggle to sustain health. **Hamilton Harbour, the City of Hamilton, Hamilton Conservation Authority, and Conservation Halton will benefit from this evolution to stormwater management as the Harbour continues to strive to achieve delisting and become a vibrant centrepiece for the community.**

Recommendations for Evolution of Stormwater Management Approach and Design

REPORTS & MANUALS

B1) It is recommended that the Province of Ontario complete development of the Low Impact Development (LID) Guidance Manual to complement the current MOECC Stormwater Planning and Design Manual.

B2) It is recommended that the Province of Ontario provide guidance with respect to the stormwater volume reduction that may be possible through crediting LID techniques as part of a treatment train approach to stormwater management, particularly implications for designing stormwater management wet ponds.

B3) It is recommended that the Province of Ontario review the existing building code to include recommendations that support and/or promote implementing LID techniques for buildings and structures subject to the building code.

B4) It is recommended that the City of Hamilton, in consultation with the Hamilton Conservation Authority and Conservation Halton, develop or update a stormwater management manual and Master Plans for development in Hamilton based on the Province of Ontario's LID Guidance Manual, the 2003 MOECC Stormwater Planning and Design Manual, and other relevant references.

B5) It is recommended that the City of Hamilton develop LID guidance for reconstruction of urban roads based on LID stormwater management techniques developed by the Province, other municipalities, and Conservation Authorities.

B6) It is recommended that the City of Hamilton, the Hamilton Conservation Authority, and Conservation Halton review their watershed basin reports and develop a list to identify updates and priorities.

PROGRAMS

B7) It is recommended that the Hamilton Conservation Authority water quality monitoring program and the associated aquatic monitoring and terrestrial monitoring program continue and be expanded to ensure a thorough understanding of water quality issues from headwaters to Cootes Paradise/Hamilton Harbour.

TRAINING & EDUCATION

B8) It is recommended that the City of Hamilton, the Hamilton Conservation Authority, Conservation Halton, and the Province of Ontario develop a local workshop/conference for the development industry and practitioners to share new LID guidelines, LID construction and design tools, LID maintenance, and resources.

B9) It is recommended that the City of Hamilton, with support from the Province of Ontario, create and implement a training program in LID, SWM, and maintenance for municipal engineers, planners, building department staff, and maintenance operations staff (Parks and Rec, Roads and Parks Maintenance, etc.) involved in all stages of development to ensure full integration of changes/updates to LID and SWM guidelines and manuals.

B10) It is recommended that the Hamilton Conservation Authority and Conservation Halton, with support from the Province of Ontario, create and implement a training program in LID, SWM, and maintenance for its engineers, planners, enforcement, and ecology staff involved in all stages of development to ensure full integration of changes/updates to LID and SWM guidelines and manuals.

Recommendations for Maintenance and Opportunities to Improve the Existing Stormwater System

REPORTS & MANUALS

C1) It is recommended that the Province of Ontario include guidance regarding the frequency of quantity and/or quality monitoring of stormwater management infrastructure.

PROGRAMS

C2) It is recommended that the City of Hamilton inventory the area to confirm and update location and ownership of all stormwater management infrastructure and OGS on municipal and where possible private lands.

C3) It is recommended that the City of Hamilton establish a new monitoring procedure for the accumulation of sediment within City owned stormwater management ponds. This would provide information beyond a visual inspection to assist with forecasting dredging work.

C4) It is recommended that the City of Hamilton, in collaboration with the Hamilton Conservation Authority and Conservation Halton, develop a monitoring program to examine the functioning of stormwater management facilities to determine if they are addressing water quality requirements, functioning as designed, and if their performance can be optimized.

C5) It is recommended that the City of Hamilton continue the practice of updating its catchbasin inventory and cleanout maintenance program.

C6) It is recommended that the City of Hamilton, within the Hamilton Harbour watershed, explore opportunities to improve the efficiency of their catchbasin cleaning program with the use of new sediment capturing technologies.

C7) It is recommended that the City of Hamilton, Hamilton CA, and Conservation Halton update and maintain an inventory of erosion sites within the City and CA owned creek blocks and prioritize appropriate remedial actions.

C8) It is recommended that the City of Hamilton continue with the program for optimization and improvements in their combined sewer system.

Recommendations for Evolution of Stormwater Infrastructure Funding

D1) It is recommended that the Province of Ontario provide guidance and direction for new financial models that allow stormwater infrastructure to be separately and predictably funded.

D2) It is recommended that the City of Hamilton create a municipal financial model for stormwater management based on an equitable rate structure for a stable funding source.

Recommendations for Evolution of Stormwater Management on Private Properties

REPORTS & MANUALS

E1) It is recommended that the City of Hamilton investigate and explore measures to ensure maintenance is carried out by private industrial, commercial, and institutional landowners to ensure the efficiency of all private stormwater management facilities and private OGS systems are maintained.

E2) It is recommended that the Province of Ontario provide updated guidance for storm sewers and include requirements related to nutrients for incorporation into municipal sewer use bylaws.

E3) It is recommended that the City of Hamilton review their Sewer Use Bylaw regarding including a limit for total phosphorus discharged into storm sewers.

PROGRAMS

E4) It is recommended that the City of Hamilton, the Hamilton Conservation Authority, Conservation Halton, and local community groups provide and/or expand programs for social incentives to recognize community participation in sustainable stormwater management and the adoption of LIDs (e.g. awards, recognition programs).

E5) It is recommended that a neighbourhood based stormwater stewardship program be delivered in the communities of Ancaster, Upper and Lower Hamilton, and Flamborough and ensure that collaboration in these initiatives occurs between local organizations and governments.

E6) It is recommended that the numerous existing outreach and education programs being delivered currently by Hamilton Conservation Authority, Conservation Halton, the City of Hamilton, and local non-profit agencies be enhanced and ensure that collaboration in these initiatives occurs.

E7) It is recommended that the City of Hamilton, in collaboration with Hamilton Conservation Authority and Conservation Halton, investigate the opportunity to develop an incentive program to encourage the use of LIDs on private lands.

E8) It is recommended that the City of Hamilton continue to provide additional staffing and funding to accelerate the identification and remediation of cross connections from the sanitary to separated storm sewer system.

TRAINING & EDUCATION

E9) It is recommended that local government and community groups in the Hamilton Harbour Watershed collaborate on stormwater stewardship outreach and education initiatives to maximize effectiveness of messaging to urban residents to promote acceptance and implementation at the lot level to address urban stormwater runoff.

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Sewer Use Bylaw

Individual actions (car washing, pet feces, lawn fertilizer, etc.)

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Introduction

The delisting of Hamilton Harbour as an Area of Concern under the Great Lakes Water Quality Agreement between Canada and the United States requires that various water quality and natural habitat requirements are achieved for Hamilton Harbour (HH) and its associated coastal wetlands of Cootes Paradise and the mouth of the Grindstone Creek. With upgrades to the Harbour's wastewater treatment plants underway it is anticipated that by 2021 the main determinant of water quality in the Harbour will be runoff from its watersheds (Kim et al., 2014, Ramin et al., 2012, Gudimov et al., 2011). As the two major wetland complexes are located at the mouths of Spencer and Grindstone Creeks the effect of runoff is even more critical to restoring these areas. With this in mind, in April of 2013 the Bay Area Implementation Team (BAIT) hosted a day long watershed workshop to identify rural and urban runoff issues. Recommendations by participants highlighted the need for further work in: a) stormwater management and b) erosion and sediment control on active construction sites.

One of the actions included in the workshop report was the formation of a multi-agency senior staff advisory group. This group, Chaired by the Director of Hamilton Water, City of Hamilton was established in September 2014 and identified four task groups to be formed:

- Urban Runoff – Burlington
- Urban Runoff – Hamilton
- Sediment Control on Active Construction Sites
- Rural Runoff

The terms of reference (Appendix 1) directing the Task Groups identified a process for: sharing information on the transport of nutrients and sediments to HH and its coastal wetlands (Cootes Paradise and mouth of the Grindstone Creek); analysing current stormwater management practices; and providing recommendations for improvement in stormwater management practice and sediment control. This report addresses findings related solely to urban stormwater management. Sediment control on active construction sites is addressed in a separate report. It is not meant to be a comprehensive science document, but a general understanding of the issues.

The following report represents the work of the Urban Runoff Hamilton Task Group during 12 meetings from December 2014 through to August 2016. The participating members of the Task Group are listed in Appendix 2 with meeting summaries provided electronically in Appendix 6.

A. Background Information on Hamilton Harbour and its Watershed Inputs

There are two data sets that currently provide watershed analysis of concentrations and loadings of nutrients and sediments relevant to the City of Hamilton and its portion of the Hamilton Harbour watershed.

The Hamilton Harbour Contaminant Loadings and Concentrations report was first produced in 1998, with updates in 2004 and 2010, comparing various sources of inputs into the Harbour. The method used in these reports to estimate creek loadings was developed from the Draper Report (1993). In support of the RAP, between November 1991 and April 1992, D. W. Draper and Associates Ltd. monitored seven HH creeks during five wet-weather events, but did not include base flow events. Flows were divided then into high and low with corresponding concentration values assigned to each grouping allowing future estimates to be based on these flow divisions for each creek.

The second data set was from the Ontario Ministry of Environment and Climate Change (MOECC), a rigorous analysis of total phosphorus (TP) and sediment generated within the Hamilton Harbour Watershed based on a peer-reviewed published study (Long et al., 2014 and 2015). The MOECC sampled 87 runoff events including rain, snowmelt, and base flows between July 2010 and May 2012. This spanned both the relatively cold winter of 2010-11 and the mild winter of 2011-12. Sampling was carried out in 1 hour intervals over 24 hour periods for all events that were monitored in order to provide a realistic understanding of nutrient and sediment concentrations during the rising and falling limbs of runoff events (Figure 1).

From the MOECC work, which focused on phosphorus, the following general conclusions can be reached:

- The highest seasonal load of total phosphorus (TP) and sediment often occurs through the spring freshet, falling into either the winter season or the spring season depending on snowpack melt (Figure 2)(*corresponding sediment graphs were not available*);
- Maximum loads of phosphorus are approximately 12 times greater than inputs from HH wastewater treatment plants (WWTPs). After WWTP upgrades are fully completed in 2021 the maximum phosphorus loads from creeks, with no improvements, could be as much as 20 times greater than wastewater effluent (Table 1);

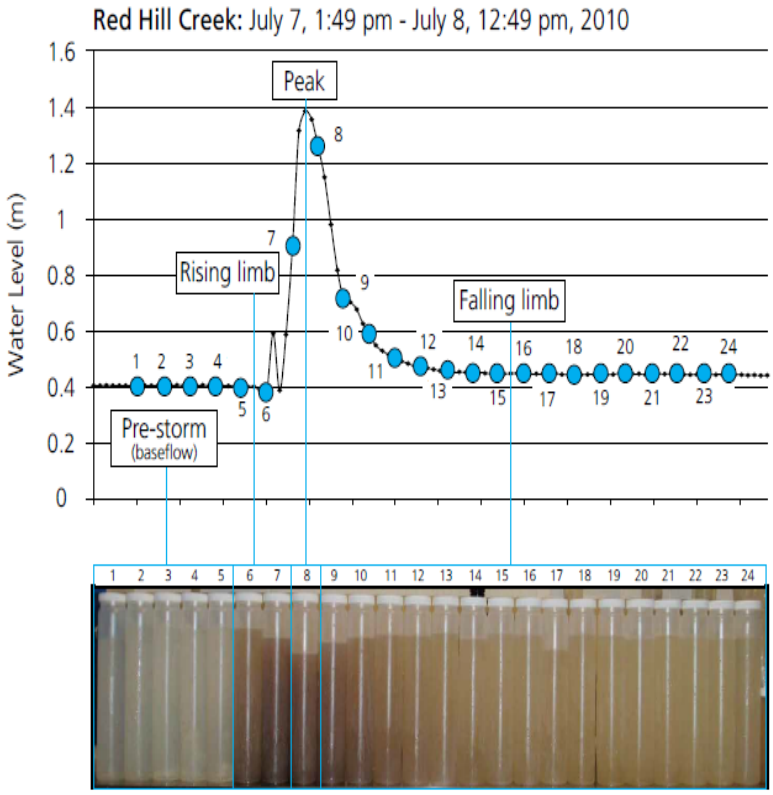

Figure 1: Example of results from the once per hour sampling over 24-hours of a storm on Red Hill Creek. Source: T. Long, MOECC

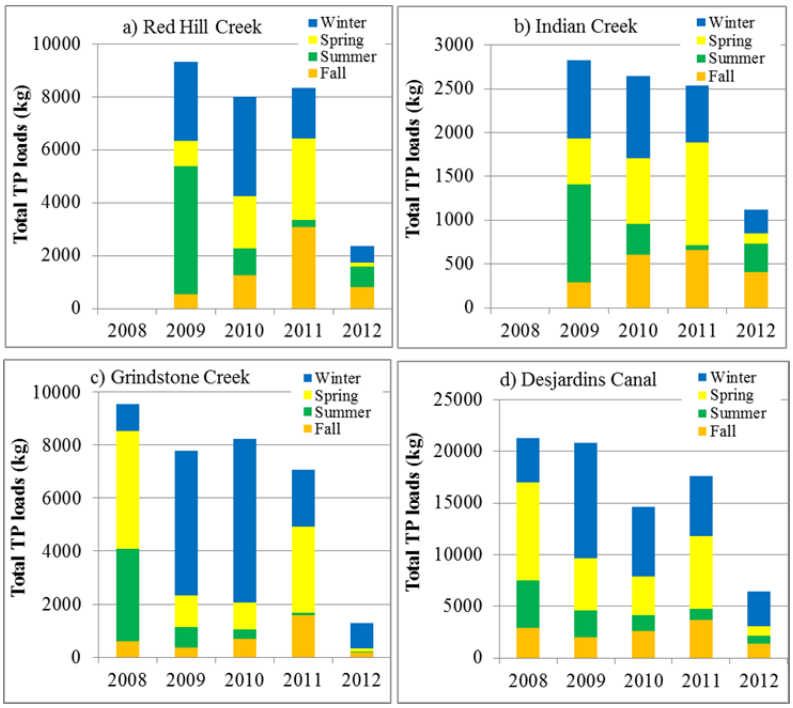

Figure 2: Largest seasonal phosphorus loads often occurs in winter and spring. Source: T. Long, MOECC

CREEKS	Min daily load (kg/d)	Max daily load (kg/d)	Event of maximum loading
Red Hill Creek	0.1	841	Sep 28-29, 2010 (54.8 mm)
Indian Creek	0.1	152	Nov 29-30, 2011 (40.2 mm)
Grindstone Creek	0.2	334	Mar 10-11, 2011 (22.1 mm + melt)
Desjardins Canal	1.8	704	Mar 11-12, 2011 (9.6 mm + melt)
Total	**2.2**	**2031**	

WWTPs	Skyway	Woodward + CSO	**Total**	**Max creek loads** (2031 kg/d) **relative to WWTP loads**
Current load (kg/d)	20	156	**176**	12 times greater
Final load (kg/d)	17	82	**99**	20 times greater

Table 1: Comparison of potential maximum daily loads from HH Creeks vs WWTPs. Source: T. Long, MOECC

In the past, phosphorus from combined sewer overflows (CSOs) and wastewater treatment plants (WWTPs) tended to mask the effect of phosphorus coming from creeks flowing into Hamilton Harbour. The upgrades to tertiary treatment will reduce levels of phosphorus and sediment in WWTP effluent to as low as technologically possible. Once upgrades to the Woodward WWTP are completed in 2021, for the first time in about 100 years the quality of water in Hamilton Harbour will be dictated by inflow from the watershed, both urban and rural, rather than the WWTPs that discharge to the Harbour.

Therefore, unless improvements are made to also reduce the amount of phosphorus coming in from the creeks, the benefits from the hundreds of millions of dollars invested in WWTP upgrades will not be fully realized. Although improvements at the WWTPs are modelled to bring the Harbour close to the target of 20 µg/L total phosphorus under base flow conditions, rain/snow melt events will continue pushing that value much higher (Kim et al., 2014, Ramin et al., 2012, Gudimov et al., 2011).

The following simple equation for calculating total phosphorus loading can assist in understanding how to reduce TP loading (Source: T. Long, MOECC):

TP Load = (TP concentration) x (runoff volume)

Reduce sediment input, P sources, etc.

Increase infiltration, low impact development (LID)

Reducing sediment inputs and other phosphorus sources will reduce phosphorus supplied to watercourses. Increasing infiltration, evapotranspiration and on-site retention of phosphorous laden waters through source based stormwater management controls generally known as low impact development (LID) techniques can also reduce phosphorous loads. These LID techniques also have the added benefit of reducing runoff volumes and peak flows which may prevent bank erosion (an additional source of phosphorus) in the downstream watercourse.

Note, the Task Group did not explore in detail a number of topics that could continue to inform this discussion: the expected frequency and intensity of major storm events in light of climate change; the relative magnitude of expected impacts on HH water quality resulting from watercourse loadings during such storm events (which may be seasonally dependent); and the average daily loads and the relative magnitude of expected impacts of such day-to-day events on HH water quality.

Targets Required to Restore Hamilton Harbour and its Coastal Wetlands

The total phosphorus water quality target measured within Hamilton Harbour (HH) at Centre Station is <20 µg/L. This target is set at a level required to prevent excessive algal blooms. This is also the MOECC guideline for lakes and represents a mesotrophic or "middle of the road" ecological water quality target.

Major upgrades to the WWTPs discharging to HH are presently being carried out by the Region of Halton and City of Hamilton. Effluent targets for the WWTPs were based on this Harbour target of <20 µg/L. Once WWTP upgrades are complete, the combination of WWTP effluent and creek base-flows is expected to allow < 20 µg/L phosphorus to be achieved in the Harbour (Kim et al., 2014, Ramin et al., 2012, Gudimov et al., 2011). It must be remembered that the flow input to the Harbour is approximately 50% from WWTPs and 50% from the watershed. As a result, if the Harbour is at 20 µg/L under base flow conditions then watershed runoff events from storms can create spikes in the Harbour TP levels leading to algal blooms. As mentioned previously TP increases positively with sediment as much of the TP is attached to sediment.

In a presentation provided by the Royal Botanical Gardens it was pointed out that the situation is amplified for the Cootes Paradise Marsh and mouth of the Grindstone Creek as they are more directly influenced by watershed runoff. The Cootes Grindstone Water Quality Targets Subcommittee is in the process of considering final targets of 30-50 µg/L phosphorus for these marshes down from initial targets of 60-70 µg/L to encourage a diverse marsh plant community. The upper tolerable concentration of suspended sediment identified for fish species is between 25-80 ppm (Birtwell, 1999) and 25 ppm is presently the preliminary level used as a maximum in Cootes Paradise. It should be recognized that this level is frequently greatly exceeded during runoff events, for example the maximum TSS for Cootes Paradise Marsh in 2013 was 97.6 ppm (Gillespie et al., 2014).

B. Evolution of Stormwater Management Approach and Design

Summary of Highlighted Recommendations

- *Provincial guidance on Low Impact Development through creation of manuals, crediting LID techniques, and reviewing the building code*
- *Updates to internal guidance and manuals to incorporate low impact development in new and retrofit construction*
- *Develop LID guideline manual for urban redevelopment/road reconstruction*
- *Provide LID training to staff of a wide range of departments and professions*
- *Encourage LID education for development industry and practitioners*

Evolution of Stormwater Management to Low Impact Development (LID)

Low Impact Development (LID) is considered to represent the next stage in a continuum of improvements to stormwater management practice (SWM) since the 1980s (Figure 3). LID looks to better replicate the natural hydrologic cycle of rain or snowfall, evaporation, infiltration and runoff by allowing precipitation to infiltrate where it falls (Figure 4). This differs from past practice that focused on managing the conveyance of runoff to prevent flooding, reduce erosion and improve water quality. Unfortunately, as progressive as past practice may have been it has not delivered the results required by modern urban areas and met necessary ecological outcomes.

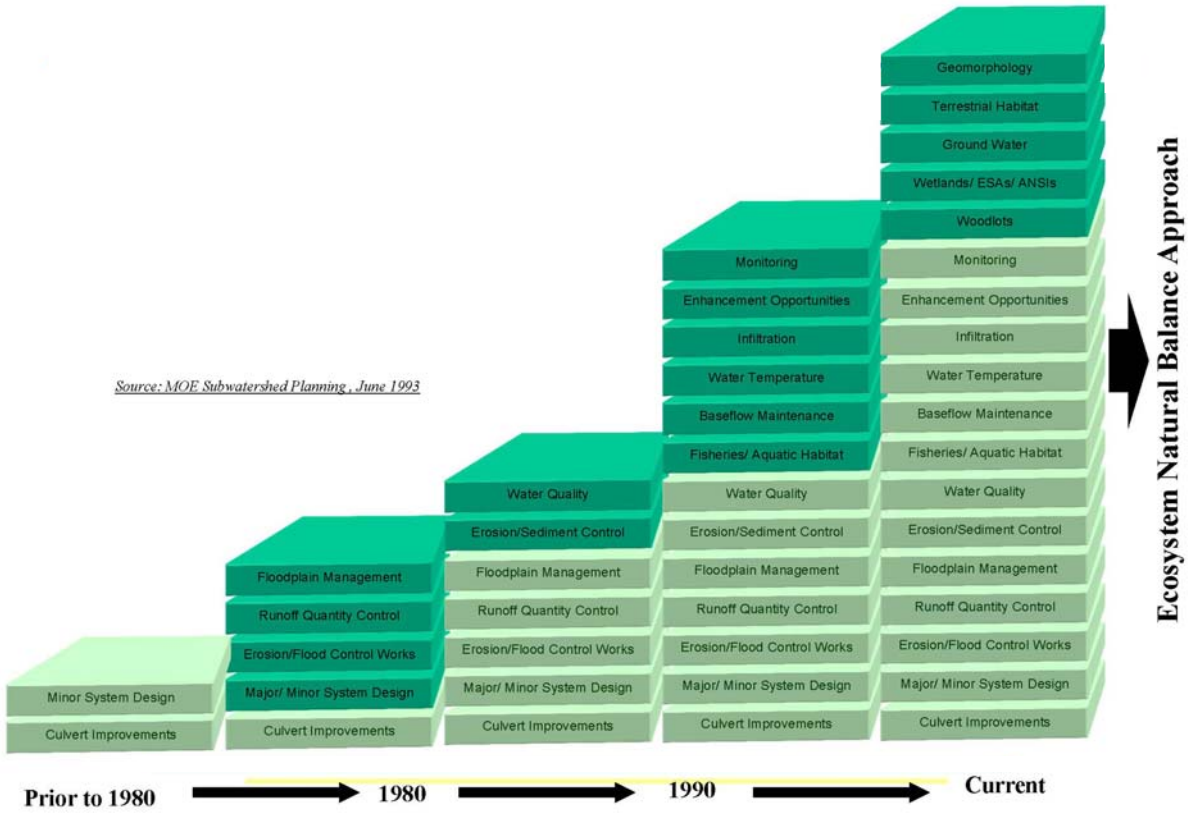

Figure 3: Evolution of Stormwater Management (Source: MOE Subwatershed Planning, 1993)

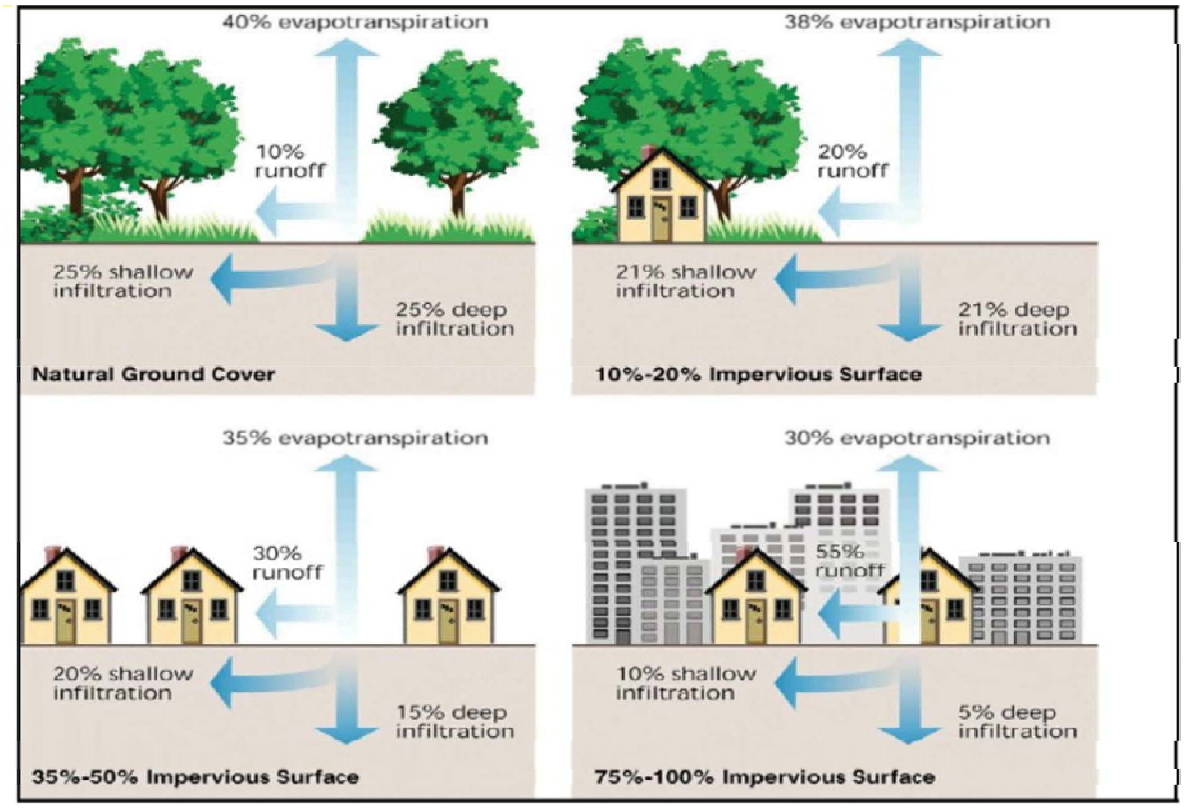

Figure 4: The Impact of Urbanization on the Hydrologic Cycle (Provided by: N. Ghbn, City of Hamilton)

Traditionally, centralized, or end-of-pipe, SWM facilities treat runoff in one area by detaining the water and releasing it slowly. For larger development areas, this is achieved within a SWM pond or treatment wetland. Low flow velocities within the ponds allow pollutants bonded to sediments to settle out in the ponds. The controlled release of stormflows also reduces downstream velocities to better approximate pre-development discharge and prevent excessive streambed erosion. Ponds also provide the opportunity for biological uptake of the nutrients, as well as potential for some filtration. For smaller development sites, treatment is often provided through oil grit separators, which rely on velocity reductions and centrifugal forces to separate and contain oil and sediments in the lower chambers of a manhole-like structure.

Given growing recognition of the impact of SWM on the environment, there has been a strengthening movement to adopt the integrated treatment train approach advocated by MOECC in their 2003 Stormwater Management Planning and Design Manual. The treatment train approach, involving lot level and conveyance controls, as well as end of pipe controls, is encouraged, to increase pollutant removal, and better mimic pre-development hydrology. This allows for a multi-barrier approach that:

- reduces sediment transport and prevents 'first flush' runoff from reaching end of pipe controls;
- reduces the land area required to implement end of pipe solutions only;
- decrease total costs for SWM systems (when land value is factored in); and
- increases public awareness in SWM initiatives.

One of the challenges for municipalities is to define SWM practices that are efficient for meeting flood, erosion and water quality objectives while being socially acceptable and cost effective. As LID practice is proving to meet these varied demands, it is therefore seen as the next logical step in the progression of SWM practice. The control of flooding from various storm frequencies may be improved by utilizing LIDs, but each technique will have its limitations. The combined infiltration of multiple LIDs will reduce the total volume which may reduce maximum flood levels in some storm events. Erosion can be reduced by increasing infiltration into underlying soils thereby reducing the volume of runoff. This is a principal factor in causing erosion and transporting pollutants.

Ontario Based LID Leadership

A growing body of practice and monitoring of results in similar climate zones as Hamilton is showing significant benefits from the proper utilization of LIDs. The science has gone beyond the need for smaller scale pilot studies in each municipality.

Examples of leadership in the use and understanding of LIDs in Ontario include: municipalities such as Metro Toronto, Kitchener, Waterloo, Mississauga, London, Lake Simcoe area; and conservation authorities such as Toronto and Region Conservation Authority (TRCA), Credit Valley Conservation Authority (CVC), Lake Simcoe Region Conservation Authority (LSRCA), and Upper Thames River Conservation Authority (UTRCA).

LID Guidance Document and Training

The MOECC 2003 Stormwater Management Planning and Design Manual does address the treatment train approach and refers to LIDs. The 2014 Provincial Policy Statement, pursuant to the Planning Act, does state that stormwater management planning shall promote best practices, including stormwater attenuation and re-use, and low impact development.Now, a separate LID guidance document is being developed by the MOECC and is expected to be released in late 2016. Documents identifying LID current practice are available through TRCA's Sustainable Technologies Evaluation Program website and the CVC's Low Impact Development website. Training in LID design, utilization, and maintenance is also provided through links on these sites and each year a major conference (TRIECA) is held in Toronto hosted by TRCA. Website links are listed within the references of Appendix 3.

Locally, a full day LID workshop was held in Burlington in May 2015. Topics included: LID 101 (TRCA), LID in Ontario (Aquafor Beech), LID Project Examples (City of Mississauga), Stormwater Rate Example (City of Waterloo), and a Development Perspective. Plans are underway to bring to Burlington in 2017 detailed training offered through three Greater Toronto Conservation Authorities (TRCA, CVC, LSRCA) on LID design, construction, maintenance, and monitoring training.

One aspect of LID that became clear to the Task Group was the need to involve a wide variety of departments and professions from the municipality, region, and conservation authorities including: engineers, planners, building department staff, enforcement, ecology, and maintenance operations staff in training. For example, unless sediment is controlled during construction, many LID features may not

work as designed without immediate maintenance. Also, general maintenance for some LID features will be different and something as simple as locating snow piles in a different location from previous years will be key to long term success. Most engineering consultants in Ontario that specialize in stormwater management are familiar with LID techniques and have initiated practice in this area; however, extending training opportunities beyond agency staff to the development industry and practitioners through local workshops or conferences will help to strengthen the uptake and success of LID.

Barriers to LID Implementation

The Task Group identified several stumbling blocks to the implementation of LIDs, including how LID implementation may be credited to developers so that they are not required in addition to traditional SWM techniques? Since LIDs may be integrated into high density and low density development and are part of buildings and landscaping, how can a municipality assure they will be kept and properly maintained? Are there any restrictions in existing building codes to limit the opportunity for incorporating LID? How is training in LIDs to be spread among urban designers, planners and engineers to ensure it is integrated into developments from the beginning and not additive as is now the practice?

Reconstruction and Intensification Incorporating LID

Practice from other Ontario municipalities is showing that LID techniques can often be more easily integrated into "intensification" than traditional SWM options. The integration of LID into road reconstruction, intensification, or community reconstruction represents one of the best possibilities for reducing nutrient and sediment outputs from existing urban areas.

Examples were presented to the Task Group from throughout the province where LIDs have been used to mitigate flooding and drainage problems, where downstream sewer connections lacked capacity, or where fragile ecosystems could be impacted by traditional SWM.

- Sustainable Neighbourhood Retrofit Action Program (SNAP) used by the Upper Thames River Conservation Authority in the City of London (e.g. Glen Cairn community). This program works with the community to retrofit and install new LID features in local neighbourhoods to improve downstream water quality.
- Elm Drive, City of Mississauga. Road right-of-way retrofit includes permeable parking laybys and sidewalks, a series of rain gardens (on school property).
- Central Parkway, City of Mississauga. Incorporation of LID into a major road reconstruction using the centre median for collection and infiltration of runoff. This area feeds into a sensitive redside dace stream (a species at risk).

LID Opportunities in Hamilton

It was noted that LID infiltration techniques have been used successfully in the past in Hamilton where outlets for runoff from development were insufficient (e.g. Waterdown west escarpment area development).

Discussions with senior City of Hamilton staff outside of the Task Group has led to a basic working premise for the road reconstruction group. It was decided that changes from traditional SWM to the use of LIDs would be made on the basis that LIDs provided improved environmental outcomes, lower capital and/or operating costs and would be socially acceptable to the neighborhoods where implemented ie. the triple bottom line analysis. While specific project locations could be identified for arterial road reconstruction (e.g. Wilson Street in Ancaster) the need for developing LID practices through providing guidelines, manuals and providing training to staff across disciplines is required.

It is important to note that while LID opportunities may be easiest to recognize in sandy soils associated with glacial Lake Iroquois, techniques developed in other jurisdictions across North America allow infiltration into tighter clay soils.

Stream Monitoring Programs

Hamilton Conservation Authority has an existing water quality monitoring program within the Spencer Creek and Red Hill watersheds. The Royal Botanical Gardens has a long established program of monitoring in the Cootes Paradise Marshes, which as nursery habitat for fish species, are sensitive to inputs from the watershed. All of this information will help provide information on how the environment is responding to this evolution in stormwater management.

Annotated Bibliography of Key Reports

The Task Group reviewed the state of watershed and subwatershed plans, guidance manuals, and studies using an annotated bibliography (Appendix 6). These watershed plans are key to the current and future practice of SWM as they set the approach, criteria and identify particular issues that need to be met for particular watersheds. The intent of the annotated bibliography was for it to become an ongoing working document that staff from the Conservation Authorities and City of Hamilton can refer to and update in the future.

C. Maintenance and Opportunities to Improve the Existing Stormwater System

Summary of Highlighted Recommendations

- *Update inventories of stormwater management infrastructure, oil and grit separators, catchbasins, erosion sites*
- *Expand inspection procedures for stormwater management facilities*
- *Increase maintenance frequency*

Any improvements gained in the evolution of stormwater management to low impact development can only be realized in the long term with proper maintenance and opportunities to improve existing stormwater infrastructure.

The City of Hamilton's stormwater infrastructure was rated at a "C+" based on the Life-Cycle State of the Infrastructure Report on Public Works Assets completed in 2016, but with a downward trend forecasted.

Current Maintenance Overview

The City of Hamilton has many facilities dealing with the collection and conveyance of storm runoff throughout the City. The responsibility for planning, constructing and maintaining these facilities rests with different groups and Departments within the City. New residential and commercial developments are generally responsible for the introduction of new services to the City. The Planning Department is responsible for the approval and administration of these developments. Once the services are assumed by the City there is a hand off of responsibility for maintenance and capital repair/ replacement to the Public Works Department. Within Public Works the sewers, including OGS, are monitored and maintained by Hamilton Water. The responsibility for maintenance of catch basins, stormwater management ponds and natural watercourses rests with the Operations Division. Data presented in the following sections current to approximately May 2016.

Catchbasins

The City currently has in the order of 46,000 catch basins including ditch inlets. This number changes regularly as new subdivisions are assumed. The target for cleaning these catchbasins is every two years. Currently the City engages a contractor to clean approx 23,000 each year. In addition to these scheduled units, cleaning and/or repair is carried out at any location where flooding is reported. The catch basin cleaning budget is $560,000 annually.

The sediment that is removed from the catch basins as part of the cleaning contract is the responsibility of the contractor. The present contractor has a licence to process the sediment and the sand that is recovered in this process is sold for winter operations.

One issue that has to be dealt with at the City is making sure that all of the catchbasins are included in the inventory. It is necessary to make sure that all of the City catchbasins located in ditches, back yards, open spaces under the responsibility of Public Works are cleaned in a regular schedule.

Oil & Grit Separators

Hamilton Water is responsible for the maintenance of City owned OGS. Currently there are 46 OGS units located in the road right of way that are maintained by the City. These units are inspected monthly, except during winter months; however, if there is rain in the winter then the units are again inspected.

The OGS units are cleaned as required. Material that is removed as part of the cleaning operation is currently taken to the Water Treatment Plant on Woodward Ave for treatment/disposal.

An additional 13 OGS units owned by the City are located at various facilities throughout the City. These units are monitored by the City of Hamilton Facilities Division.

Stormwater Management Ponds

Stormwater Management Ponds are inventoried and maintained by the Operations Division. Currently there are 117 assumed SWM ponds in the City. Of these 58 are wet facilities and 53 are dry. In addition to these facilities there are 36 ponds unassumed which will require maintenance by Operations once the developers satisfy the requirements of their development agreements. SWM facilities are constantly being designed and constructed as development proceeds throughout the City.

With the emphasis by the Urban Runoff Task Group on storm facilities discharging into Hamilton Harbour the inventory was reviewed and it is estimated that approx 57% of ponds (67 ponds) are within the drainage area for the Hamilton Harbour. Of the unassumed ponds approximately 64% (23 ponds) are in this area.

The City has a dedicated crew working on the maintenance of the SWM ponds for most of the year. During the winter period this crew is split up and works on winter maintenance and control. There are six full time staff members in this crew which is currently based in the Dundas Operations Yard.

The SWM crew undertakes two inspections each year on each pond. An inspection log is filled out which covers the operation of the SWM facility including the condition of the inlet and outlet structures and the sediment loading. The sediment loading is based on a visual inspection. Grass cutting and general maintenance is carried out by the SWM crew. Any major works outside the capabilities of this crew, including sediment removal is referred to the project manager in the Capital Rehabilitation & technical Operations Section (CRTO) of the Division.

Other duties performed by the SWM crew include dealing with encroachment by residents adjacent to the SWM facility, performing unscheduled maintenance, as requested by a councillor or resident, and inspecting and monitoring SWM facilities before and after large storm events.

With regard to programming the dredging work for the SWM ponds the SWM crew provides their ranking following the inspections. The CRTO Section reviews this information and develops the

necessary contract for undertaking the work. The sediment in each of the ponds to be dredged is tested and a disposal plan is established. Generally the sediment is disposed of by the contractor undertaking the dredging work.

The City would like to develop a more comprehensive monitoring system to establish the rate of TSS loading on the individual ponds and thereby a program of forecasted dredging work.

Stormwater Sewer Outlets

There are a total of 13 direct and 17 indirect outlets into Hamilton Harbour from the City of Hamilton. Cootes Paradise, which outlets into the Harbour, has an additional 24 outlets draining into it. The urban core is serviced by storm sewers that either outlet directly into the Harbour or indirectly by discharging into storm channels or natural watercourses which ultimately outlet into the Harbour. These outlets are inspected where access is possible, and maintained when required. Outlets that are within the road allowance and labelled as "hot spots" by the City, are inspected before and after a large rain event by Operations staff. Minor maintenance such as grate clearing and blockage removal is completed during this time in an effort to ensure the unobstructed flow of water and flood mitigation.

The western les-urban portion of the Hamilton Harbour watershed is serviced by vegetated roadside ditches. This network of roadside ditches is inspected annually. These ditches are re-established when found deficient to provide proper water conveyance.

Watercourses

Within the City there is ~ 190 km of City owned watercourses. The map below (Figure 5) shows the areas that drain to the Hamilton Harbour; note that Spencer Creek Watershed shaded on the map includes Chedoke, Boers, and Ancaster Creeks. Approximately 93 km of City owned watercourses are in this area. Maintenance work carried out by Operations includes litter and debris removal, bank repair, minor erosion protection, clearing and cutting fallen trees. The City has a contract with a local contractor for any emergency maintenance work to be carried out within the waterway.

Many studies are carried out on the watercourses by the Infrastructure Planning and System Design Section of Hamilton Water. These studies lead to rehabilitation of watercourses by contract especially dealing with major items such as erosion. In the past the Operations Division has not undertaken planned inspections and maintenance on the watercourses. Inspections and maintenance were carried out in response to issues reported by roads supervisors, councillors and residents.

In 2016 seasonal inspectors have been hired to walk the watercourses and document any deficiencies. This is a new program for the City and the extent of remedial work will be reviewed as the inspections proceed in order to assist in developing appropriate budgets for the next year.

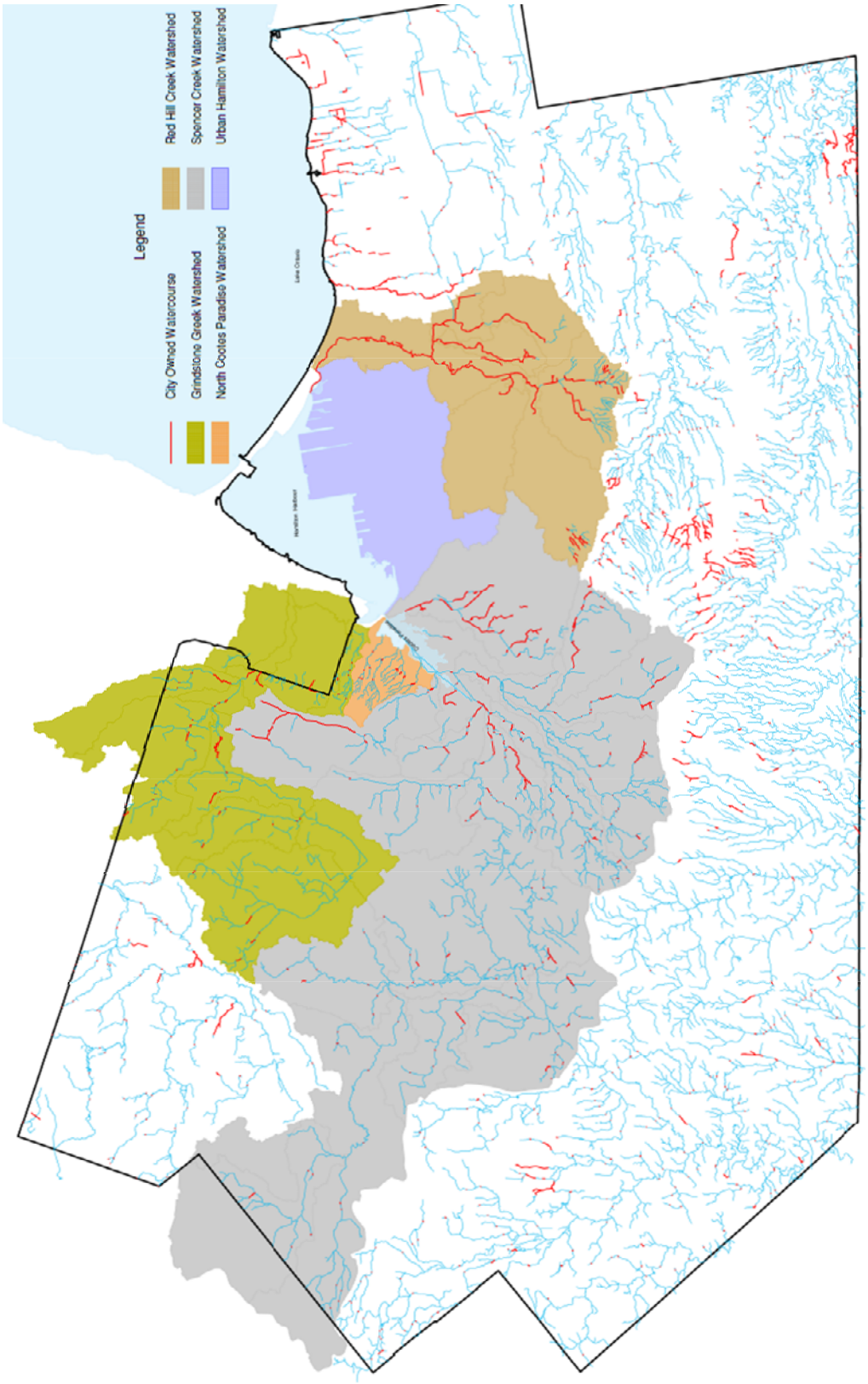

Figure 5: Shaded areas indicate watercourses draining to Hamilton Harbour. Source: B. Hughes (City of Hamilton)

Combined Sewer System

The Task Group received an information presentation on the City of Hamilton's combined sewer system containing over 760 km of sewers. In much of the lower City street catchbasins mix runoff with sewage and it is treated at the Woodward Wastewater Treatment Plant (WWTP). Optimization and improvements are continuously being made to find ways to best use the existing capacity to hold back excess stormwater inputs from overwhelming the WWTP during heavy rain events. To protect the WWTP, combined sewer overflows (CSO) can direct untreated sewage directly into the Harbour. The Hamilton Harbour RAP Technical Team has worked with the City of Hamilton on this issue for a number of years, so this report does not explore this topic in detail. Phosphorus and TSS targets, 8 kg/day and 329 kg/day respectively, for the CSO system outlined in the 2012 RAP Stakeholder Forum decisions are now calculated as part of a global wastewater contribution by the WWTPs and CSOs to HH.

Opportunities to Improve Existing Infrastructure

As most of Hamilton's urban area within the Hamilton Harbour watershed is developed, the application of LID techniques is recognized as an opportunity to assist in reducing existing storm sewer capacity issues and local flooding. The integration of LID into intensification or road or community reconstruction represents one of the best possibilities for reducing nutrient and sediment outputs from existing urban areas.

In order for successful incorporation of LID, targeted training and education is required of staff involved in all stages of development such as: municipal engineers, planners, building department staff and maintenance operations staff (Parks and Recreation, Roads and Parks Maintenance).

Stormwater Ponds Example

A 2011 Lake Simcoe Region Conservation Authority investigation into stormwater pond maintenance and anoxic conditions found over 50% of individual ponds were no longer performing as designed and that over 10% were at the lowest level of efficiency. They also discovered that over 40% of all ponds showed daytime hypoxic or anoxic conditions which was turning the pond into a nutrient source instead of a nutrient sink. It is still not known how much effect nutrient releases are having on receiving waters during low oxygen conditions. A number of implementable maintenance and anoxia recommendations were made in this report and are likely transferable to the City of Hamilton situation (i.e. requiring as-built drawings accompany ponds upon assumption, enhanced street cleaning, monitoring for low oxygen conditions, etc.). Currently the City of Hamilton does not have a monitoring program to examine the function of their stormwater management facilities beyond a visual sediment accumulation inspection.

Recommendations for Maintenance and Opportunities to Improve the Existing Stormwater System

REPORTS & MANUALS

C1) It is recommended that the Province of Ontario include guidance regarding the frequency of quantity and/or quality monitoring of stormwater management infrastructure.

PROGRAMS

C2) It is recommended that the City of Hamilton inventory the area to confirm and update location and ownership of all stormwater management infrastructure and OGS on municipal and where possible private lands.

C3) It is recommended that the City of Hamilton establish a new monitoring procedure for the accumulation of sediment within City owned stormwater management ponds. This would provide information beyond a visual inspection to assist with forecasting dredging work.

C4) It is recommended that the City of Hamilton, in collaboration with the Hamilton Conservation Authority and Conservation Halton, develop a monitoring program to examine the functioning of stormwater management facilities to determine if they are addressing water quality requirements, functioning as designed, and if their performance can be optimized.

C5) It is recommended that the City of Hamilton continue the practice of updating its catchbasin inventory and cleanout maintenance program.

C6) It is recommended that the City of Hamilton, within the Hamilton Harbour watershed, explore opportunities to improve the efficiency of their catchbasin cleaning program with the use of new sediment capturing technologies.

C7) It is recommended that the City of Hamilton, Hamilton CA, and Conservation Halton update and maintain an inventory of erosion sites within the City and CA owned creek blocks and prioritize appropriate remedial actions.

C8) It is recommended that the City of Hamilton continue with the program for optimization and improvements in their combined sewer system.

D. Evolution of Stormwater Infrastructure Funding

Summary of Highlighted Recommendations

- *City of Hamilton create a stable and equitable financial model for stormwater*
- *Province of Ontario provide guidance and direction for a full cost stormwater program*

The evolution of stormwater management is not limited to the technologies and techniques used. Municipalities across Ontario are adopting new financial models that allow stormwater infrastructure to be separately and predictably funded. This is consistent with the Province of Ontario's goal in the Water Opportunities Act (2010) to enact a full cost stormwater program.

City of Hamilton Council considered this issue in 2013 and 2015, but did not support the initiatives. It is understood that implementing a user fee represents additional costs to residents and businesses within the community; however, this issue also presents an opportunity to address stormwater costs.

Current Resource Situation and Challenges

The City of Hamilton's management of stormwater is currently funded through a combination of water/wastewater rate, property taxes and development charges. The water and wastewater/stormwater rates apply equally to all residential, multi-residential, institutional, commercial and industrial customers despite that this is disproportionate to the load that each property type (within and across types) contributes to the public waste/stormwater system. There is no relationship between the volume of potable water used by a resident or business and the volume of stormwater generated from a given property. There are many properties that benefit from stormwater service who are not being charged for water/wastewater services, such as parking lots.

In 2016, Hamilton is projecting to receive $212 million in revenue but expects to recover only $173 million due to declining water usage – at a time when 90% of the cities' water and wastewater department costs are fixed. Add to these fixed or declining revenues the problem of old and aging infrastructure and the uncertainty of climate change and intensifying wet weather events, and the system becomes financially unsustainable to maintain or renew.

Alternative Resourcing in Ontario

Municipalities in Ontario that wish to make the change to an equitable rate structure for stormwater now have the benefit of the experience of other municipalities who have been leaders in this area – Kitchener, Waterloo, Mississauga, London, Aurora, St. Thomas, Richmond Hill, and Markham. Lessons learned can be gathered to help determine which structure will suit the needs of the City of Hamilton and its residents and business owners.

A more transparent and fair alternative is to fund the cost of managing stormwater through charges proportionate to the volume of stormwater generated by each property. User fees are typically utilized to finance services that provide a direct benefit to the user and allow consumers to pay for a service in

accordance with the benefit that they receive (compared to taxes which do not necessarily hold a direct relationship to the benefits of the goods or services received). A dedicated, sustainable funding mechanism for stormwater management would address both the City of Hamilton's fairness and equity objective as well as the financial sustainability objective.

A stormwater rate structure to provide dedicated funding for stormwater management in Hamilton would provide a fairer and more transparent method of charging for stormwater management and would create a financial incentive for property owners to increase pervious surfaces on their properties. For example, Kitchener and Waterloo offer a reduction in stormwater fees for both residential and non-residential properties utilizing stormwater LIDs where up to 45% is available for both land uses. Residential credits are given based solely on stormwater volume reductions, while the non-residential credits are broken down by category.

A user pay approach would stabilize revenues and ensure sustainability for the municipal stormwater infrastructure, and operations and maintenance requirements.

Considerations

Implementing an equitable rate structure in the City of Hamilton could also assist in addressing:

- issues surrounding an aging infrastructure system (maintenance, replacement, emergencies) leading to an increase in flooding claims from intense, localized storms occurring more frequently with climate change;
- without funding other recommendations will not have the resources to be implemented; and
- sustained improvements to Hamilton Harbour from the significant investment by the City of Hamilton into the Woodward Wastewater Treatment Plant tertiary upgrades will not be fully realized unless watershed inputs are also addressed.

The main goal of this report is to reduce phosphorus and sediment inputs to Hamilton Harbour. A well maintained, upgraded, and sustainable stormwater infrastructure system resulting from stable funding will be key to achieving this goal while at the same time reducing flooding impacts within the City of Hamilton.

Recommendations for Evolution of Stormwater Infrastructure Funding

D1) It is recommended that the Province of Ontario provide guidance and direction for new financial models that allow stormwater infrastructure to be separately and predictably funded.

D2) It is recommended that the City of Hamilton create a municipal financial model for stormwater management based on an equitable rate structure for a stable funding source.

E. Evolution of Stormwater Management on Private Properties

Summary of Highlighted Recommendations

- *Implement measures to ensure maintenance on private oil and grit separators and stormwater management facilities*
- *Include limits for nutrients in storm sewers through Sewer Use Bylaw*
- *Programs for neighbourhood based stormwater stewardship, including recognition, outreach and education*

As stormwater management continues to evolve, the use of low impact development (LID) methods and techniques on privately owned lands becomes essential. It is recognized that a substantial portion of nutrient and sediment laden stormwater runoff discharging into Hamilton Harbour originates from private lands. Although individual impacts may be minor, the cumulative impact of multiple actions could be significant. A critical mass of property owners will be needed in order to reduce the quantity and improve the quality of stormwater runoff discharging through the various watersheds into Cootes Paradise Marsh and Hamilton Harbour.

The category of private lands spans many land uses: residential, commercial, industrial, and institutional. Runoff quality and quantity varies greatly amongst and within each land use. Factors which include but are not limited to: lot size, type and amount of impervious surface cover (roads, roofs, driveways, and parking lots), slope / terrain, adjacent land uses, quality and amount of green space all contribute to each sites unique contribution to the larger stormwater management system. This is a complex situation and Ontario municipalities are presently struggling with various approaches to improve runoff conditions from private lands. Policies and programs must be developed or enhanced to educate private property owners about the impact of hardened urban surfaces on the health of Hamilton Harbour with the goal of incentivizing them to take action.

In Hamilton, programs to educate and encourage private property owners to adopt LID best practices for stormwater management have already been initiated. The City of Hamilton has the benefit of learning from these and a variety of additional programs offered by municipalities across and beyond Ontario. A multi-dimensional and comprehensive approach to urban stormwater management will be required to realize positive changes within privately owned lands.

<u>Community Outreach and Education</u>

The goal of outreach and education is to increase public appreciation of the limitations in the funding and operations of traditional existing stormwater infrastructure, increase the collective need for changes in how we deal with stormwater, and increase public understanding of the benefits of LID installation on private property. These measures will all be necessary to motivate property owners to partner in achieving water quality improvement goals. An informed and motivated community is more likely to undertake LID projects.

Non-profit and government organizations including the Bay Area Restoration Council, Green Venture, Hamilton Conservation Authority, and Hamilton Naturalists' Club already provide public education and support on various aspects of water conservation, installation and maintenance of low impact development (LIDs), climate change links to stormwater management and erosion control, and the reduction of contaminants into water. There are a limited number of education and outreach activities occurring in Hamilton that promote the importance of reducing phosphorus and sediment or promote the opportunity to implement LID techniques on private property.

- Green Venture offers the RAIN program educating residents about the effects of stormwater runoff and ultimately tries to motivate behavioural change amongst private homeowners.
- Green Venture also delivers the De-Pave Paradise program which focuses on reducing the amount of asphalt on school grounds, ultimately increasing infiltration of stormwater.
- The Bay Area Restoration Council (BARC) produces report cards that evaluate progress of the Remedial Action Plan and conducts other evaluative techniques and informative forums to increase public understanding.
- BARC provides information about Rain Gardens on their website and has implemented a demonstration rain garden at Princess Point in partnership with the Royal Botanical Gardens to raise awareness of their aesthetic value and functionality.
- Green Venture and BARC have begun a three-year collaboration to install LIDs with institutional partners and provide complementary educational programming and volunteer management.
- Hamilton Conservation Authority delivers a neighbourhood based stormwater stewardship program in the Town of Dundas which encourages the implementation of LIDs. They are working on developing their first demonstration LID project at the Dundas Valley Conservation Area which will serve as an example to private landowners in the community.
- Hamilton Conservation Authority also provides private landowner consultations where a technician visits a private property with the landowner to make recommendations on techniques that could be applied. With the proper resources, this program could be expanded to include assistance for urban homeowners.
- There are several physical and digital education and outreach tactics (websites, interactive online tools) that can be applied to achieve community education and engagement.

Based on the recommendation of implementing a stormwater rate structure, there will need to be specific outreach and education completed to make the general public aware of the concept and understand why there is a need to move to such a system. Based on the recommendation of implementing an incentives program for encouraging stormwater, there will need to be specific outreach and education completed to make the general public aware of the opportunity to have projects subsidized.

<u>Financial Incentives</u>

In Hamilton, several financial incentive programs have been developed and are directed at the small "single" users in an effort to educate residents about the opportunities and need for action.

Grants

Hamilton has numerous granting programs from which to create programs to encourage LID installation. Developing the terms of reference for an LID grant program, including amounts, costing and eligibility, could be undertaken and worked into a program proposal. The City of Hamilton's Protective Plumbing Program is an example where residents are reimbursed with municipal funds to install sewer back flow valves and disconnect downspouts from roof leaders.

Hamilton Conservation Authority has a private landowner stewardship granting program from which a program to encourage LID installation could be created. Developing the terms of reference for an LID grant program, including amounts, costing and eligibility, could be undertaken and worked into a program proposal. Funding to support such a program would need to be secured from the City of Hamilton.

Other municipalities and conservation authorities (CA) have partnered to develop LID grant programs delivered through the CA landowner assistance programs. For example, Lake Simcoe Region Conservation Authority offers funding for homeowners who would like to install a rain garden. The Landowner Environmental Assistance Program (LEAP) will fund up to 60% of the project cost to a maximum grant of $5,000.

Rebates

As outlined in the previous section on the evolution of stormwater infrastructure resources, one way to encourage private landowner buy-in to incorporating LID techniques on their own property is to offer a rebate on their stormwater user rate. This sort of incentive has been shown to be popular in the Cities of Kitchener and Waterloo, but was not used by the City of Mississauga due to perceived low uptake and high implementation costs.

<u>Social Incentives and Recognition</u>

Social incentives are intended to recognize citizen investment in LIDs and commitment to playing an active community role in stormwater management and to demonstrate the versatility and effectiveness of LIDs. It will be important for property owners to not only experience financial benefits but social and environmental benefits as well. Incentives can be effective in overcoming barriers to LID implementation such as tradition, lack of understanding and conflicting social values or preferences. These additional benefits can take the form of public recognition (awards, recognition programs, yard signs, etc.), advancing/sharing of knowledge, and physical improvements in the health of Hamilton Harbour.

Property owners using LID landscaping techniques and practices to reduce the quantity and improve the quality of stormwater leaving their properties may qualify if the measures used should operate to slow, store and/or infiltrate stormwater during wet weather and/or snow melt events.

Existing awards such as the Watershed Stewardship Award acknowledges landowners who are managing their land in a way that protects or enhances the health of their watershed. A similar award which focuses on stormwater management could be created to highlight property owners who are taking proactive steps to manage their stormwater in a way that produced ecological benefits to a specific area. Award winners can help to become ambassadors in their neighbourhood to expand the reach of educational programming.

Maintenance of Stormwater Management Infrastructure on Private Lands

At the present time a disconnect appears to exist between implementing and sustaining treatment train and SWM facilities on private properties. Various planning approvals such as subdivision and site plan controls allow the municipality, through MOECC environmental compliance approval (ECA, formerly certificates of approval), the ability to require SWM infrastructure to be constructed at the time of development. What is less clear is how these same mechanisms ensure the infrastructure operating on private lands is maintained and in fact remains in place over a long period of time.

There are 279 oil and grit separator (OGS) units located on privately owned property (condo developments, shopping centres, etc.). No monitoring of these privately owned OGS units are carried out by the City of Hamilton. The property owner is advised of their responsibility at the time of the approval of their development; however, there is no current mechanism to ensure maintenance is being carried out to ensure their efficiency.

Additional Pathways for Nutrients from Private Lands

The Task Group discussed some additional pathways for nutrients to enter water from private lands including: cross connections, sewer use bylaws, individual actions (car washing, pet feces, etc), and lawn fertilizer.

Cross Connections

While the City of Hamilton is also concerned about cross connections which connect stormwater to sanitary sewers, for example weeper drains around a basement, the Task Group focused only on sanitary sewage cross connected to storm sewers and eventually finding its way into HH.

In 2001 the MOECC ordered the City to investigate high E-coli levels documented in some storm sewers within the Redhill Creek. This led to a program of testing that defined sewer outfalls of concern within the Redhill Creek, Chedoke Creek and Dundas Valley. A program to further investigate cross connections was carried out between 2005 and 2009. In 2009 a pilot project to determine the most efficient methods to identify cross connections and the most effective way to work with residential home owners was developed. Of particular importance to the Cootes Paradise Marsh was the finding that a number of cross connections existed within the Chedoke watershed. To date over 100 cross connections have been corrected in this watershed. As a result of the success of the pilot project two additional staff were added to the program for a two-year period after which the program will be re-evaluated.

Sewer Use Bylaw

The Task Group also noted that while Hamilton's sewer use bylaw contains a limit for total suspended solids (TSS), it is silent with respect to a total phosphorus limit (TP). This however is consistent with the provincial model sewer use bylaw and CCME (Canadian Council of Ministers of the Environment). Toronto's 2016 bylaw is looked to as a best practice with storm sewer discharge limits of 0.4 mg/L TP and 15 mg/L TSS (City of Toronto, 2016). The Task Group did discuss that a storm sewer limit would be difficult to enforce as it is not monitored except in a complaint based situation.

Individual actions (car washing, pet feces, lawn fertilizer, etc.)

Individual residents are also contributors to nutrients in the watershed. Residential inputs into the stormwater system such as detergents from washing cars in driveways, chemicals such as fertilizers or road salts in storm drains, or pet feces around stormwater systems are contributors to nutrients in the watershed. For example, bags of pet feces have been discarded near stormwater outlets and creeks, particularly noted in Chedoke Creek. Programs like Trout Unlimited's Yellow Fish Road program delivered by BARC have helped to educate residents about their impacts on places like Hamilton Harbour.

It was noted that most lawn fertilizer now contains no or little phosphorus in its formulation. This likely has to do with the rising price of phosphorus as a commodity and the realization that most lawns don't really benefit from the excessive phosphorus in past formulations. As a diminishing source of phosphorus it likely represents an unexpected reduction in TP in urban runoff.

Recommendations for Evolution of Stormwater Management on Private Properties

REPORTS & MANUALS

E1) It is recommended that the City of Hamilton investigate and explore measures to ensure maintenance is carried out by private industrial, commercial, and institutional landowners to ensure the efficiency of all private stormwater management facilities and private OGS systems are maintained.

E2) It is recommended that the Province of Ontario provide updated guidance for storm sewers and include requirements related to nutrients for incorporation into municipal sewer use bylaws.

E3) It is recommended that the City of Hamilton review their Sewer Use Bylaw regarding including a limit for total phosphorus discharged into storm sewers.

PROGRAMS

E4) It is recommended that the City of Hamilton, the Hamilton Conservation Authority, Conservation Halton, and local community groups provide and/or expand programs for social incentives to recognize community participation in sustainable stormwater management and the adoption of LIDs (e.g. awards, recognition programs).

E5) It is recommended that a neighbourhood based stormwater stewardship program be delivered in the communities of Ancaster, Upper and Lower Hamilton, and Flamborough and ensure that collaboration in these initiatives occurs between local organizations and governments.

E6) It is recommended that the numerous existing outreach and education programs being delivered currently by Hamilton Conservation Authority, Conservation Halton, the City of Hamilton, and local non-profit agencies be enhanced and ensure that collaboration in these initiatives occurs.

E7) It is recommended that the City of Hamilton, in collaboration with Hamilton Conservation Authority and Conservation Halton, investigate the opportunity to develop an incentive program to encourage the use of LIDs on private lands.

E8) It is recommended that the City of Hamilton continue to provide additional staffing and funding to accelerate the identification and remediation of cross connections from the sanitary to separated storm sewer system.

TRAINING & EDUCATION

E9) It is recommended that local government and community groups in the Hamilton Harbour Watershed collaborate on stormwater stewardship outreach and education initiatives to maximize effectiveness of messaging to urban residents to promote acceptance and implementation at the lot level to address urban stormwater runoff.

Appendix 1: Terms of Reference for Task Group *(dated November 5, 2014)*

TERMS OF REFERENCE AND TASK GROUPS

Watershed Nutrient & Sediment Management Advisory Group (WNSMAG)

It is recognized that reductions in nutrients (principally phosphorus) and sediment concentrations and loads during runoff events from urban and rural watersheds are required to meet Hamilton Harbour Remedial Action Plan (HHRAP) environmental conditions to delist the Harbour as an Area of Concern.

Reporting to the Bay Area Implementation Team (BAIT) the WNSMAG will be developed from the attached list of agencies and groups.

WNSMAG will meet two to three times per year to share information and educate its members, analyze existing conditions and prepare recommendations for actions.

WNSMAG will be composed of senior staff who will direct various task groups to address:

- sedimentation from active construction sites
- urban watersheds and
- rural watersheds

Staff will be assigned to the task groups by the senior staff participants of WNSMAG.

In carrying out their work the groups will recognize the implications of climate change and coordinate, whenever possible, actions to reduce flooding with those actions reducing phosphorus and sediments.

All group members should work in an environment of mutual respect, mutual dependence and adaptive management. Their work should be action-oriented resulting in both short-term and long-term action plans.

Task groups may be established as per the wishes of the WNSMAG as set out below. This includes the option of establishing task groups based on municipal jurisdictions, e.g. an Urban Runoff Task Group for Hamilton and an Urban Task Group for Burlington, etc.

A. Sediment Control on Active Construction Sites Task Group

- audit and better define the existing erosion and sediment control practice utilized in Burlington and Hamilton for public and private sector projects
- develop methods to measure sediment coming from construction sites – need to measure to manage approach
- implement a priority project of ongoing inspection, reporting and enforcement of erosion and sediment control for development sites for the Cootes Paradise watershed

B. Urban Runoff Task Group for Nutrient and Sediment Management

Share information and develop a common understanding of our current knowledge with respect to:

- existing nutrient (phosphorus) and sediment concentrations occurring during runoff events;
- nutrient and sediment targets required to restore Hamilton Harbour and its coastal wetlands;
- existing best management practices in Hamilton Harbour's urban watersheds used to reduce nutrient and sediment discharges;
- potential additional pathways for nutrients to find their way to sewers and watercourses; and
- existing maintenance activities and their effectiveness for reducing nutrients and sediment from the urban storm-water management (SWM) system.

Analyse the Situation to Determine:

- how new practices in SWM and low impact development (LID) may be applied to reduce nutrient and sediment discharges for new development;
- where opportunities may exist to retrofit the SWM system to reduce nutrients and sediment for existing development ;
- where reductions can occur for private properties (homes, commercial, institutional and industries).

Prepare Recommendations for:

- existing maintenance activities to reduce nutrients and sediment from the urban SWM system;
- new development practices in SWM and LID to reduce nutrient and sediment discharges;
- existing development to retrofit the SWM system to reduce nutrients and sediment discharges;
- private properties (homes, commercial, institutional and industries) on how reductions may be implemented effectively and/or enforced.

C. Rural Runoff Task Group for Nutrient and Sediment Management

Share information and develop a common understanding of our current knowledge with respect to:

- existing nutrient and sediment concentrations occurring during runoff events;
- nutrient and sediment targets required to restore Hamilton Harbour and its coastal wetlands;
- existing maintenance activities and their effectiveness for reducing nutrients and sediment from rural roads;
- existing rural land uses and their potential to discharge nutrients and sediments.

Analyse the Situation to Determine:

- where reductions in nutrients and sediment may occur for the rural roads system;
- where reductions in nutrients and sediment may occur for agricultural/rural lands.

Prepare Recommendations for:

- reducing nutrients and sediments from the rural roads system;
- reducing nutrients and sediment from agricultural/rural lands.

Appendix 2: Task Group Participating Membership *(as of Aug 2016)*

Bay Area Restoration Council	Chris McLaughlin
City of Hamilton	Brian Hughes Monir Moniruzzama Nahed Ghbn Ryan Moore
Conservation Halton (CH)	Amy Mayes
Environment and Climate Change Canada	Rimi Kalinauskas
Green Venture	Michael Albanese
Hamilton Conservation Authority	Jonathan Bastien Scott Peck *[Chair]* Sheila O'Neal
Hamilton Harbour Remedial Action Plan	John Hall Kristin O'Connor
Hamilton Industrial Environmental Association (HIEA)	Karen Logan
Ontario Ministry of the Environment and Climate Change	Cheriene Vieira
Royal Botanical Gardens	Jennifer Bowman

Other key participants with various levels of participation over the length of the Task Group included: Wayne Song (City of Hamilton)

Other Agencies invited to participate and included in all emails about Task Group: Environment Hamilton, Hamilton Halton Homebuilders' Association

Appendix 3: References *(Organized by Chapter Heading)*

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Appendix 4: Acronyms

BAIT	Bay Area Implementation Team
BARC	Bay Area Restoration Council
CA	conservation authority
CCME	Canadian Council of Ministers of the Environment
CSO	combined sewer overflow
CVC	Credit Valley Conservation Authority
ECA	Environmental Compliance Approval
HH	Hamilton Harbour
HHRAP	Hamilton Harbour Remedial Action Plan
LEAP	Landowner Environmental Assistance Program
LID	low impact development
LSRCA	Lake Simcoe Region Conservation Authority
MOECC	Ontario Ministry of Environment and Climate Change
OGS	oil and grit separator
RBG	Royal Botanical Gardens
RPM	Roads and Parks Maintenance
SNAP	Sustainable Neighbourhood Action Program
SWM	stormwater management
SWMF	stormwater management facility
TP	total phosphorus
TRCA	Toronto and Region Conservation Authority
TSS	total suspended solids
UTRCA	Upper Thames River Conservation Authority
WNSMAG	Watershed Nutrient & Sediment Management Advisory Group
WWTP	wastewater treatment plant