STORMWATER MANAGEMENT AND STREAMFLOW

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

5.0 STORMWATER MANAGEMENT AND STREAMFLOW

Stormwater is rainwater and/or snowmelt that is either absorbed into the ground (becoming interflow or groundwater) or flows along the surface (direct runoff) into storm sewers, streams and lakes. When natural areas are converted to impervious surfaces (such as rooftops and pavement), less area is available for infiltration and more rainwater becomes direct runoff. Urbanization in a watershed, without adequate stormwater management systems, leads to degraded water quality, increased channel erosion, increased runoff volumes, and a more rapid response of water levels in river systems after rainfall or snowmelt events.

Stormwater management within a given drainage area, may be comprised of a number of different measures that act to control volume, reduce erosion and treat the quality of stormwater. The approach, which has been utilized for several decades in urban areas in Ontario, strives to allow for urban growth while preserving the health of our water systems (including river systems and groundwater systems). Over time, as knowledge has increased, the practice of stormwater management has evolved to address watershed based management strategies and to include new technology. As a result, the urban landscape within the Etobicoke and Mimico Creeks watersheds supports varying degrees of stormwater management controls, associated with the age of development. **Box 1** provides a brief history of stormwater management, which summarizes the main stormwater management objectives and typical practices employed in each era.

This **Stormwater Management and Streamflow Section** presents an updated summary of existing stormwater management practices and streamflow conditions in the Etobicoke and Mimico Creeks watersheds, and has been reviewed in conjunction with other components in the Technical Update to identify issues and recommend management considerations.

Box 1: Brief History of Stormwater Management

The history of stormwater management can be characterized by three eras. Each era reflects an approach to managing stormwater issues of that time.

Storm Sewer Era (1880 – 1970)
Between the periods of 1880 to 1970, increased stormwater volumes and streamflows in urban areas resulted in localized flooding. The management of this issue involved the creation of a sewer network (also referred to as the minor storm sewer system), which conveyed stormwater from urbanized areas to downstream receiving waters. The storm sewers were sized to accommodate frequent storm events, typically in the range of 2 to 10 year return periods. This reduced localized flooding during frequent storm events, however, during less frequent storm events localized flooding remained an issue and flooding often occurred in areas downstream of the sewer systems. During this era, conveyance of water away from flood prone areas was the main concern, and contamination of receiving waters was not a priority.

Stormwater Management Era (1970 – 1990)
Between the periods of 1970 to 1990, increased volumes and flows from urbanized areas were mainly treated using two common practices: 1) end-of-pipe stormwater management ponds which were constructed at the downstream end of the storm sewer network; and 2) major storm sewer systems (typically incorporated into the design of roadways) which were designed to convey flows that exceeded the capacity of the minor storm sewer system (e.g., flows above the 10 year storm in some areas).

Stormwater management ponds typically controlled post development peak flows to pre development levels for all storm events up to and including the 100-year storm event. On site storage was utilized for some large industrial and commercial areas. The stormwater management controls in this era still only addressed flooding (water quantity) issues. The contamination of receiving waters was generally acknowledged but there were few measures designed to address water quality issues. Also, concerns for erosion control began to arise during this time.

Urban Stormwater Best Management Practices Era (1990 - present)
In the 1990s, deteriorating water quality in watercourses led to the introduction of urban stormwater best management practices (BMPs). It was recognized that the stormwater management (SWM) ponds built in the 1970s and 1980s neither provided water quality treatment nor erosion control. Thus requirements for stormwater management were expanded to include quantity, quality and erosion controls. Stormwater management ponds in this era were constructed with a wet component, where a predetermined volume of water could be retained within the pond allowing sediment and other contaminants to settle out of the body of water prior to release of the clean water to the receiving stream. The sediment would then be collected and removed during maintenance and cleanout operations on the pond.

For a quality control SWM pond (wet pond) to function properly a minimum drainage area of five hectares is required. Smaller sites (less than five hectares) require other measures. However, some of these measures only provide a limited level of quality treatment, and may account for sediment removal only and not for other contaminants.

Recent studies have shown that traditional SWM ponds of this era are able to maintain the pre development peak flow rates to the receiving waters effectively. However the pre development volume of runoff cannot be reproduced using ponds alone, and the increased runoff volume coupled with longer duration of flows entering the receiving watercourse after a storm event has resulted in significant stream erosion downstream of development. This research has reinforced the need for source controls (i.e., treatment and retention of increased flows due to development on site) and the promotion of Low Impact Development (LID) techniques.

5.1 WATERSHED OBJECTIVES, INDICATORS AND TARGETS

The watershed objectives, indicators and targets relevant to Stormwater Management and Streamflow are listed in **Table 5-1**. This section of the Technical Update report focuses on stormwater management, peak flow and flooding. Baseflow and surface water withdrawals are addressed in the **Baseflow and Water Use Section**.

Table 5-1: Watershed Objective, Indicators and Targets

Surface Water Quantity Objective: Creek hydrology is restored to a more natural flow pattern	
Indicator	**Targets**
Stormwater Management [1]	• Maintain or reduce annual stream volume (based on long-term stream gauge measurements); • Increase the percentage of urban area treated by stormwater management facilities (baseline as per Technical Update, TRCA, 2010); • By 2012, set target for desired level of source controls [2] • By 2025, complete all identified end-of-pipe stormwater retrofits to control quality and quantity of stormwater (*9 stormwater management ponds and 23 outfall retrofit opportunities as per Stormwater Retrofit Plans of each municipality*).
Streamflow • Peak flow • Flooding	 • Maintain or reduce baseline peak flows for 2 to 100 year return period events (baseline values derived from the reports: Etobicoke Creek Hydrology, Fred Schaeffer and Associates, 1996 and Mimico Creek Hydrology, James F. MacLaren Limited, 1978) • Maintain or reduce the number of flood vulnerable areas and roads (baseline as per TRCA FVA/FVR Database, reported in *Greening Our Watersheds*, TRCA, 2002)

[1] Stormwater management targets have been defined as per recommendations in *Turning over a new leaf: The Etobicoke and Mimico Creeks Watersheds Report Card 2006* (TRCA, 2006) as follows: New targets have been set for erosion-related concerns as part of the new Fluvial Geomorphology theme in this Technical Update; Other SWM targets have been set or refined based on new water budget science and to address previously identified gaps, as explained in additional footnotes.

[2] Source controls - It is premature to set a target at this time, because several municipalities are currently undertaking studies that may result in the establishment of databases that would inform this target and enable future monitoring and reporting. The desired direction is for an increase in the proportion of urban area treated by source controls and achievement of a target by 2025. Note: This target will replace the previous Report Card target “By 2025, complete all identified lot level and source controls…”(because the reference source is unclear) and the target “By 2025 construct five additional green roofs in each watershed” (because there are numerous source control technologies now available and the emphasis should be on management strategies to promote opportunities for testing innovative approaches).

5.2 OBJECTIVES OF TECHNICAL UPDATE

The Technical Update will provide an overall picture of existing stormwater management controls (i.e. quality, erosion and quantity controls) within the watersheds. Information from the study will be used to examine how existing stormwater management practices have influenced peak flows and floodlines.

The principle objectives of the Stormwater Management and Streamflow component of this Technical Update are as follows:

- Collect and review available background data and reports;
- Document the existing stormwater management ponds in the watersheds;
- Identify areas where additional treatment may be required;
- Identify changes in the hydrologic regime in these watersheds; and
- Provide preliminary recommendations.

Previous watershed strategy and report card documents have summarized the state of stormwater management and streamflow conditions, based on available information at the time of writing. Substantial additional work has been completed as part of this Technical Update to improve the stormwater pond infrastructure database and to identify where minor modifications to the sewershed and hydrologic sub-basin boundaries are needed, to more accurately reflect existing drainage conditions. This work will provide a more accurate basis for future hydrological studies, stormwater retrofit designs and analysis of streamflow conditions.

5.3 DATA SOURCES AND METHODS

5.3.1 Data Sources

The following data and background reports were used in developing the Technical Update:

- 2005 ortho aerial photography (to determine stormwater management pond locations)
- Land use based on 2002 ortho aerial photography
- Watershed and sub-catchment drainage boundaries
- TRCA Pond database
- TRCA water management pond files
- Various stormwater management plans (see section 5.4.2)
- Continuous streamflow gauging data from two streamflow monitoring stations operated and maintained by the Water Survey of Canada (Mimico Creek at Islington and Etobicoke Creek at QEW)
- *Etobicoke Flood Study* (Fred Schaeffers, 1996)
- *Etobicoke and Mimico Hydrology* (MacLaren, 1978)
- *Etobicoke Creek Hydrology Study* (Totten Sims Hubicki, 2007)
- *Draft Mimico Creek Hydrology Study* (MMM Group, 2008)
- *Wet Weather Flow Management Master Plan* (Totten Sims Hubicki, 2003)
- *Turning over a new leaf: The Etobicoke and Mimico Creeks Watersheds Report Card* (TRCA, 2006)
- *City of Brampton Stormwater Retrofit Study* (Aquafor Beech, 2003)
- *Mississauga Storm Water Quality Control Strategy* (Winter & Associates, 1995)
- *GTAA Living City Project, Etobicoke Creek, Stormwater Management* (TRCA, 2006)

5.3.2 Method

Subwatersheds
The Technical Update established management units (subwatersheds) for the Etobicoke and Mimico Creek watersheds. The Etobicoke Creek watershed was divided into eight subwatersheds including the Etobicoke Headwaters, Etobicoke Main Branch, Etobicoke West Branch, Little Etobicoke Creek, Lower Etobicoke Creek, Spring Creek, Tributary 3 and Tributary 4. The delineation of the subwatershed boundaries is consistent with other studies conducted for the watershed and was determined with consideration for the hydrologic model sub-basin boundaries. The Mimico Creek watershed was treated as one management unit for the purposes of the overall Technical Update.

Existing Land Use
This layer was digitized based on the 2002 ortho photography and updated by TRCA in 2009. Through the review of the data for the current study, some areas were identified that were incorrectly delineated as being within the Humber River watershed. Based on this review, an updated land use map was created for the Etobicoke and Mimico Creeks watersheds.

Existing Stormwater Management Practices
Characterization of the existing stormwater management practices involved compilation of the TRCA pond database and available stormwater management reports and data provided by the Cities of Toronto, Mississauga and Brampton. Based on this review, a series of figures was created to present the existing urban areas that have comprehensive stormwater management plans, the location and drainage areas of the ponds, and the level of controls provided by each pond. The percentage of controlled urban areas was calculated for both watersheds (in total), as well as for each of the subwatersheds of Etobicoke Creek.

Surface Flows, Streamflow, Peak Flows
The hydrological model for the Etobicoke Creek watershed was developed by Fred Schaeffer and Associates in 1996 and updated by Totten Sims Hubicki (TSH) in 2007. The hydrological model for the Mimico Creek watershed was completed by James F. MacLaren Limited in 1978 and MMM Group is currently undertaking an update of the model.

The 2 to 100 year design storms and the Regional Storm were simulated based on calibrated models to estimate peak flows at key locations throughout the watersheds. The updated hydrological models for Etobicoke Creek (TSH) and Mimico Creek (MMM) were calibrated using historical precipitation and observed flow data. The 5-year, 100-year, and the Regional Storm surface flows calculated in the TSH and MMM studies were compared with previous design flows estimated by Fred Schaeffer and Associates (1996) and James F. MacLaren Limited (1978), respectively. Five flow nodes in the Etobicoke Creek watershed and three nodes in the Mimico Creek watershed were selected for comparison, as design flows at these locations were available in both the updated studies and original hydrology studies.

A separate exercise was undertaken using the continuous streamflow gauging datasets from two streamflow monitoring stations in the Etobicoke and Mimico Creeks watersheds. These gauges are operated and maintained by the Water Survey of Canada (WSC) section of Environment Canada's Meteorological Services. In Etobicoke Creek, the gauge is located south of the Queen Elizabeth Way Highway (QEW) and the streamflow data from this gauge are available from 1966 to 2006. In Mimico Creek, the gauge is located at Bloor Street and

Islington Avenue, and the streamflow data from this gauge are available from 1965 to 2006. The mean annual streamflow data at both gauges were plotted for the entire data series as well as for the last 10-year period. A streamflow trend analysis was carried out for the streamflow data to assess the impacts on the quantity of flows due to urban development in the watershed and climate trends.

5.4 EXISTING CONDITIONS AND INTERPRETATION

5.4.1 Existing Land Use

Etobicoke and Mimico Creeks watersheds are highly urbanized and impervious. The imperviousness of these watersheds has direct impacts on the quantity and quality of surface water runoff. Therefore characterization of the existing land use was deemed important to understand how the river system would respond to existing and proposed development.

The land use types were grouped into four major land use categories: 1) urban, 2) rural, 3) natural and 4) open water. A breakdown of the components of the four major land use categories is provided in **Table 5-2**. A more detailed breakdown of land uses for the watersheds and subwatersheds can be found in **Appendix 5- A**. On average, 70% of the two watersheds have been urbanized, as illustrated in **Figure 5-1**. A summary of the land use conditions within the watersheds follows:

- Industrial lands are concentrated in a swath of land (approximately 12 km wide) in the central portion of the two watersheds, which spans the Cities of Brampton, Mississauga and Toronto. Institutional land is scattered in smaller blocks throughout the two watersheds, with the exception of headwater areas of Etobicoke Creek which remain predominantly rural.
- Residential land is concentrated in the Cities of Brampton (over 50%) and Toronto (over 60%), while Mississauga has over 20% residential areas.
- Canada's largest transportation facility, the Lester B. Pearson International Airport is located within the City of Mississauga, and while it is predominantly in the Etobicoke Creek watershed, a portion of its land drains to Mimico Creek. Not surprisingly, the airport is surrounded by the majority of industrial lands in the centre of the watersheds referred to above.
- The watersheds are dominated by a series of provincially significant roadways (400 series highways), with approximately 2% of the Etobicoke Creek watershed and 3% of the Mimico Creek watershed classified as roadway.
- Rural (agricultural) lands are concentrated in the upper portion of the Etobicoke Creek watershed within the Town of Caledon and the northeast portion of Brampton (Spring Creek and Headwaters subwatersheds). There are no remaining rural lands within the Mimico Creek watershed.
- Natural lands and Open Water lands represent only 15% and 12% the Etobicoke and Mimico Creeks watersheds respectively. Unlike the coverage of rural lands, which are located in only one remaining subwatershed, each subwatershed has roughly 10-20% coverage of natural land.

Table 5-2: Land Use Categories

Category	Land Use
Urban	Vacant
	Cemetery
	Urban Open Space
	Recreational
	Golf Course
	Utility
	Commercial
	Industrial
	Institutional
	High Density Residential
	Medium Density Residential
	Low/Medium Density Residential
	Airport
	Highway
	Railway
Rural	Agricultural
Natural	Beach/Bluff
	Forest
	Meadow
	Parkway Belt
	Successional
	Wetland
Open Water	Open Water

Figure 5-2 and **Figure 5-3** present a comparison of land uses for the watersheds and subwatersheds. From a stormwater management perspective, it is important to note the high degree of land use alteration from a natural landscape to urban land use within these watersheds. As the surface cover within the watersheds has drastically changed, so has the behaviour of stormwater and the resulting hydrologic cycle. These impacts will be discussed further in this report (see **Sections 5.4.2 to 5.4.7**).

Figure 5-1: Land Use (based on 2002 ortho aerial photography)

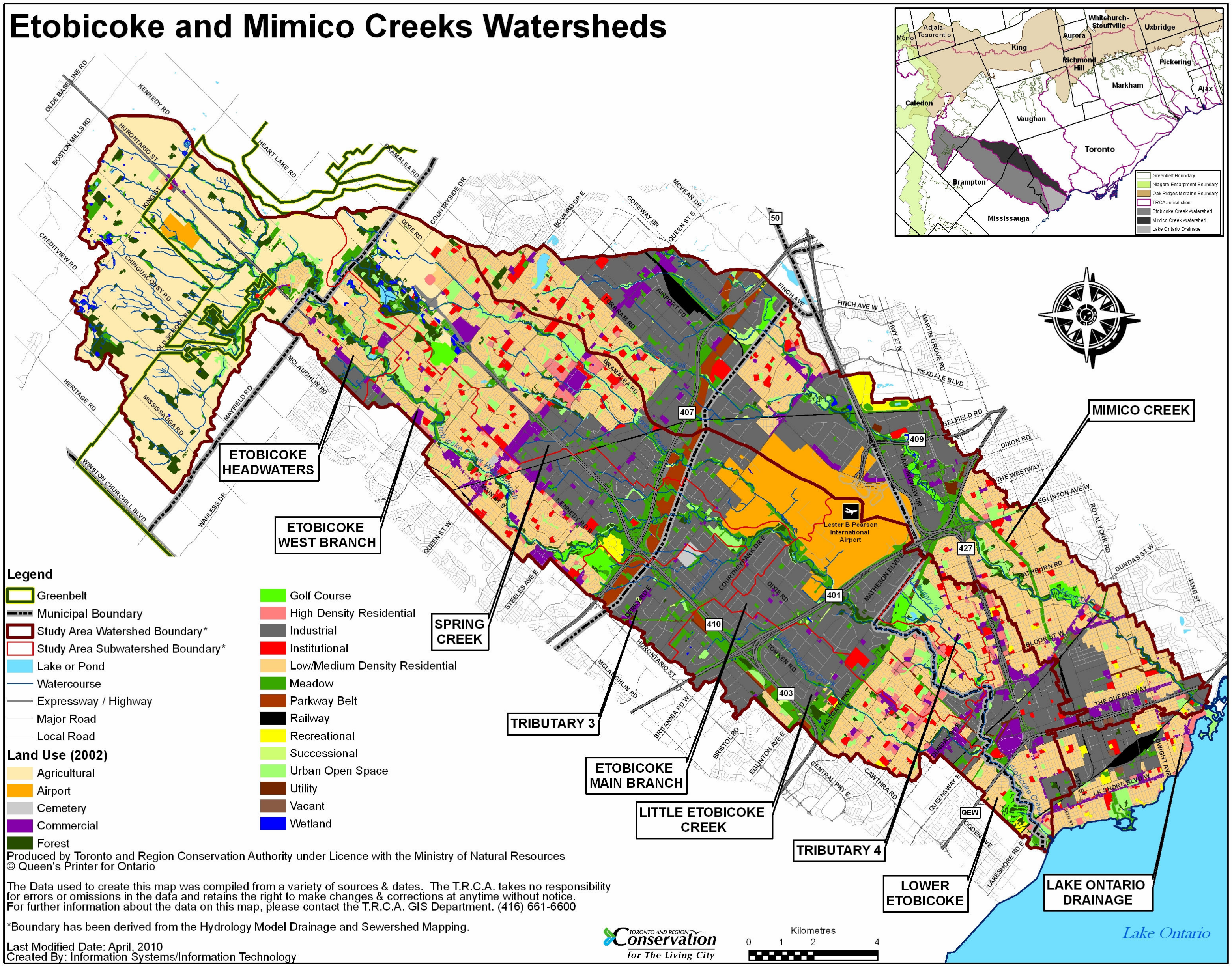


Figure 5-2: Etobicoke and Mimico Creeks Watersheds - Comparison of Land Uses by Watershed

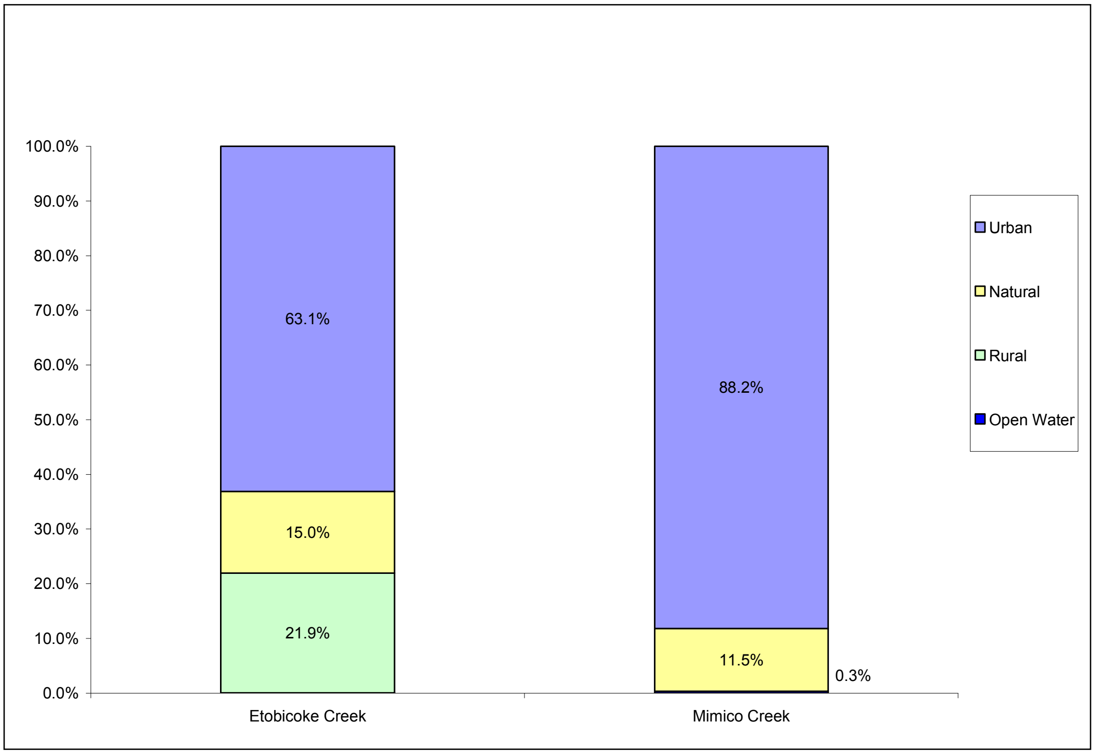
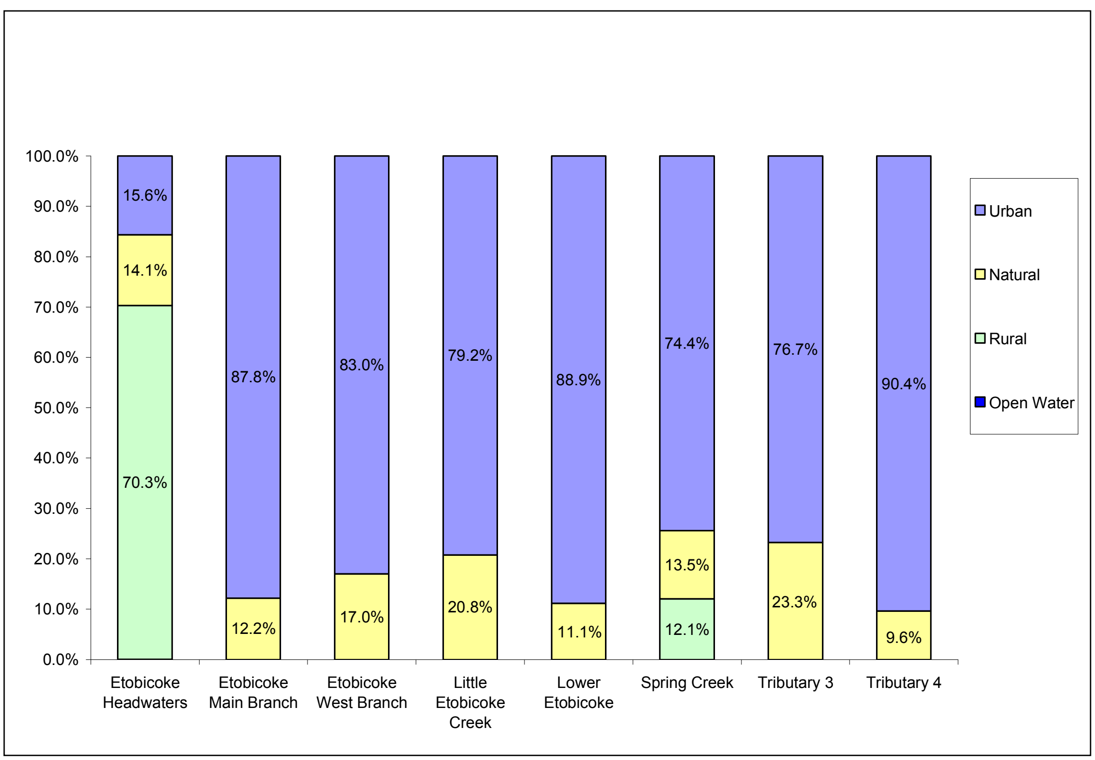


Figure 5-3: Etobicoke Creek Watershed - Comparison of Land Uses by Subwatersheds



Mimico Creek watershed
The Mimico Creek watershed supports two major land uses including 88% urban and 12% natural. Within the urban areas, the industrial, commercial and institutional (ICI) and residential areas occupy approximately 71% of the watershed. Areas devoted to transportation, such as airport and highways, take up approximately 11% of the watershed. Other land uses, such as urban space, recreational and golf course lands, occupy the remaining 6% of the urban lands.

Etobicoke Creek Watershed
The Etobicoke Creek watershed supports three major land uses including 63% urban, 22% rural and 15% natural. Within the urban areas, the ICI and residential areas occupy approximately 49% of the watershed. Areas devoted to transportation take up approximately 8% of the watershed and approximately 6% of the watershed is dedicated to other urban lands, such as urban space and golf course lands.

Etobicoke Creek Subwatersheds
The Etobicoke Main Branch, Etobicoke West Branch, Lower Etobicoke and Tributary 4 subwatersheds are over 80% urban with only less than 20% remaining as natural cover. The ICI and residential land uses make up a substantial part of the urban area in these subwatersheds (ranging from 56 to 74% of the area). The Etobicoke Main Branch subwatershed contains the highest percentage of urban land use (88%) which is not surprising given that it houses the international airport (24% airport land) and supporting industry (36% industrial land). The Etobicoke Headwaters and Spring Creek subwatersheds are relatively less urbanized, although are undergoing land use changes.

The Etobicoke Headwaters subwatershed supports the majority of the rural areas remaining within the Etobicoke Creek watershed. Rural lands account for approximately 70% of the subwatershed, however 5% of these areas are currently under development (i.e. Mayfield West Phase I), or are scheduled for development in the near future (i.e. Mayfield West Phase II). Therefore, the rural areas within the subwatershed will be reduced to approximately 65% from 70%. Urban areas within this subwatershed account for 16% of the total area (9% of which is residential) and 14% of the subwatershed lands are designated as natural.

The Spring Creek subwatershed is 74% urbanized. A portion of the airport lands and industrial operations are supported by this subwatershed which is reflected in the land use breakdown (ICI 24% and 12% airport lands). The remaining lands are 28% residential, 12% rural and 14% natural. The rural lands in the subwatershed are being considered for future development (the proposed Mayfield West Phase I and Springdale North Subdivision developments are partially located in this subwatershed). It is expected that the rural areas in the subwatershed will decrease to approximately 4% from 12%, once the proposed developments are complete.

5.4.2 Areas Covered by Comprehensive Stormwater Management (SWM) Plans

Today, a comprehensive stormwater management plan is required for all new development. However, the majority of the lands within the two watersheds were developed prior to the adoption of current standards. Therefore, the majority of the lands were developed without stormwater management plans, and as a result there are many areas within the watersheds where stormwater does not receive any treatment before reaching the receiving watercourse. The deficiencies in the management of stormwater have led to increased risk in flooding, degraded stream water quality and habitats, as well as extensive channel erosion (resulting in loss of land in some areas). In order to mitigate these effects, the Cities of Toronto, Mississauga, Brampton and the Town of Caledon have undertaken comprehensive reviews of their current best management practices in coordination with TRCA and in keeping with the Ministry of the Environment's Stormwater Management Planning and Design Manual (March 2003) for stormwater management. Individual stormwater management strategies, in various forms, were produced to achieve the goals set out by each municipality to guide future developments, in addition to the requirements of the conservation authority and the Ministry of the Environment. The most current guiding documents produced by each municipality for addressing stormwater management are:

- City of Toronto's Toronto Wet Weather Flow Management Master Plan (2003)
- City of Mississauga Water Quality Strategy (in progress, 2010)
- City of Brampton's Stormwater Management Strategy (in progress, 2010)
- Town of Caledon's Stormwater Management Retrofit Study, Phases I and II (2001)

Implementation of the recommendations of these strategies will go a long way toward improving existing conditions where no previous stormwater management existed (retrofit opportunities) and will reinforce the current requirements for stormwater management in new areas. A number of other technical studies related to stormwater management have also been completed since the last state of the watershed report was produced. Information from these studies was also drawn upon for this report.

Figure 5-4 illustrates areas that were developed with comprehensive stormwater management plans. **Figure 5-5** and **Figure 5-6** illustrate the proportion of urban area with comprehensive plans for each of the watersheds and subwatersheds. **Figure 5-4** shows that the majority of lands developed with stormwater management plans in place are concentrated in four main areas: the areas in and around the airport, the north end of the Mimico Creek watershed, the north end of Spring Creek and the north end of Tributary 3. A few smaller developments benefitting from stormwater management are scattered throughout the Etobicoke Creek watershed. A list of existing plans by watershed follows.

Mimico Creek

- *Sandringham/Wellington Community Development, Secondary Plan No. 28 Area* (Rand Engineering Corp., 1987).
- *Stormwater Management Study, Official Plan Amendments Number 6 and 57* (Paul Theil Associates, 1983).
- *Master Stormwater Implementation Plan for Lester B. Pearson International Airport* (a thorough review of stormwater management practices with study results and recommendations) (Winter Environmental Consulting, 2003).

Etobicoke Headwaters

- *Comprehensive Environmental Impact Study and Management Plan, Mayfield West Community Plan Area* (Dillon Consulting Limited, David Schaeffer Engineering Limited, Shaheen and Peaker Limited, and Valcoustics, 2006).
- *Mayfield West Phase I, Functional Servicing and Stormwater Management Study* (David Schaeffer Engineering Limited, 2006).
- *Final Stormwater Management Plan Snell's Hollow Secondary Plan Town of Caledon* (MMM Group, 2004).

<u>*Etobicoke Main Branch*</u>

- *Master Stormwater Implementation Plan for Lester B. Pearson International Airport* (Winter Environmental Consulting, 2003).

<u>*Etobicoke West Branch*</u>

- *Bovaird – Kennedy Stormwater Management Plan for the City of Brampton* (Cosburn Patterson and Associates Limited, 1984).
- *Phase 1 Stormwater Management Master Plan for Lester B. Pearson International Airport* (CH2M Hill Engineering Limited, 1995).
- *Master Stormwater Implementation Plan for the Greater Toronto Airports Authority at Lester B. Pearson International Airport* (Winter Environmental Consulting, 2003).

<u>*Little Etobicoke Creek*</u>

- *Derry East Business Park Storm Servicing Report for Watershed 2* (R. E. Winter & Associates, 1987).
- *Retrofit of the Derry East Ponds (Watersheds #3 and #4)* (Greenland International Consulting, 2005).
- *Functional Storm Drainage Report, Hurontario Secondary Planning Area, Neighbourhood 5D* (R.E. Winter & Associates, 1992).
- *Neighbourhood 5D Stormwater Management Facility Design Brief* (Cosburn Patterson Wardman Limited, 1995).

<u>*Lower Etobicoke*</u>

All urbanized areas in this subwatershed were developed without stormwater management plans.

<u>*Spring Creek*</u>

- *Mayfield West Phase I* (area is still in the planning phase therefore lands are currently shown as undeveloped in Figure 1)
- *Springdale North* (area is still in the planning phase therefore lands are currently shown as undeveloped in Figure 1)
- *Sandringham/Wellington Master Drainage Plan* (Rand Engineering Corporation, 1987).
- *Master Servicing Plan, Phase I Study, Sandringham/ Wellington Community* (Rand Engineering Corporation, 1991).
- *Master Servicing Plan, Phase II Study, Sandringham/ Wellington Community* (Rand Engineering Corporation, 1991).
- *Esker Lake South Secondary Plan, Background Study* (Glen Schnarr & Associates, 1994).
- *Esker Lake North Secondary Plan, Conceptual Stormwater Management Plan* (Rand Engineering Corporation, 1996).
- *Esker Lake North Secondary Plan, Background Study & Development Concept* (Kentridge Johnston Limited, 1996).

<u>*Tributary 3*</u>

- *Derry East Business Park Storm Servicing Report for Watershed 2* (R. E. Winter & Associates, 1987).
- *Retrofit of the Derry East Ponds (Watersheds #3 and #4)* (Greenland International Consulting, 2005).
- *Storm Servicing Reports for the Upper Nine Property* (R. E. Winter & Associates,1982).

<u>*Tributary 4*</u>

All urbanized areas in this subwatershed were developed without stormwater management plans.

Figure 5-4: Areas with Comprehensive Stormwater Management Plans

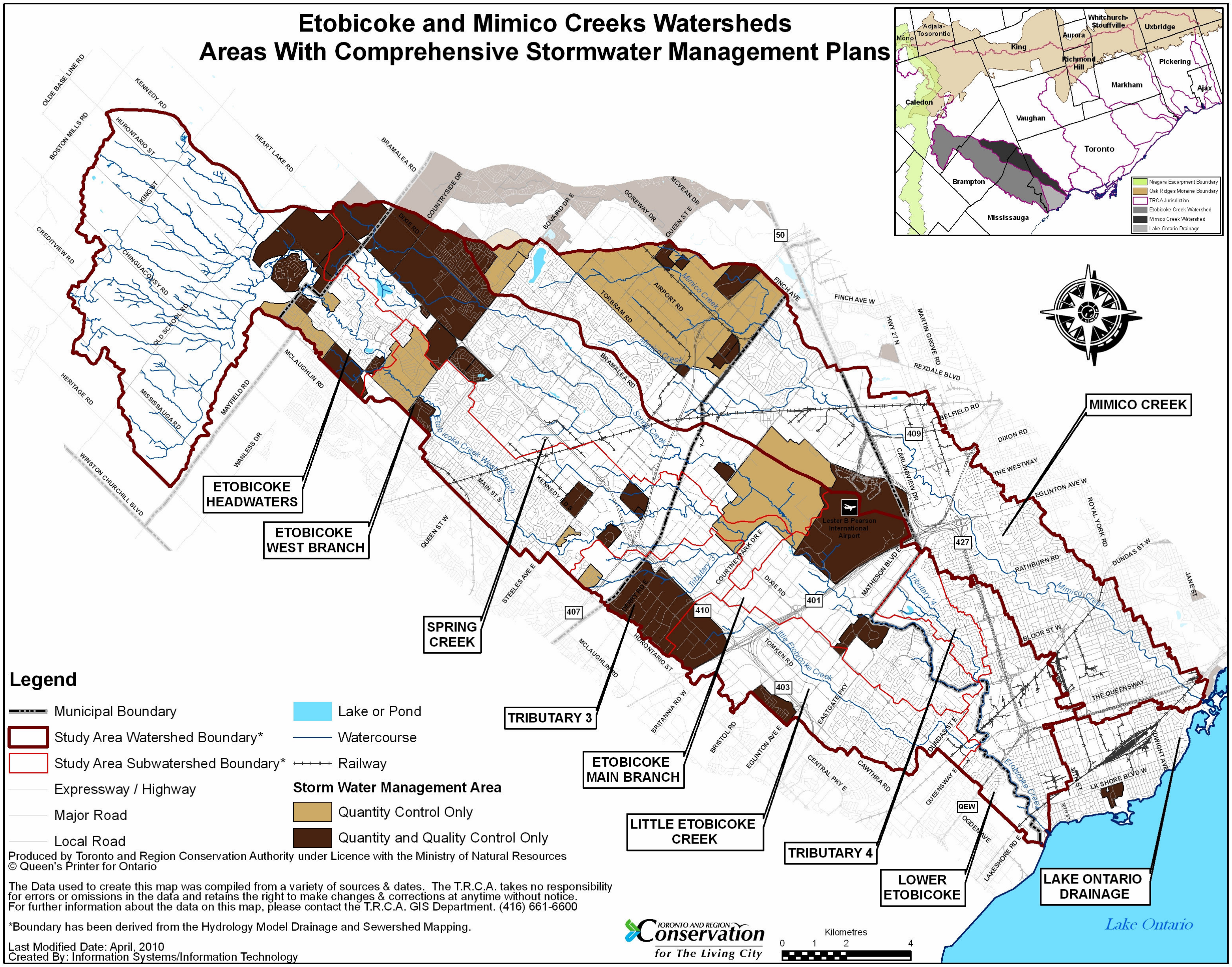


Figure 5-5: Etobicoke and Mimico Creeks Watersheds - Proportion of Urban Area with Comprehensive SWM Plans

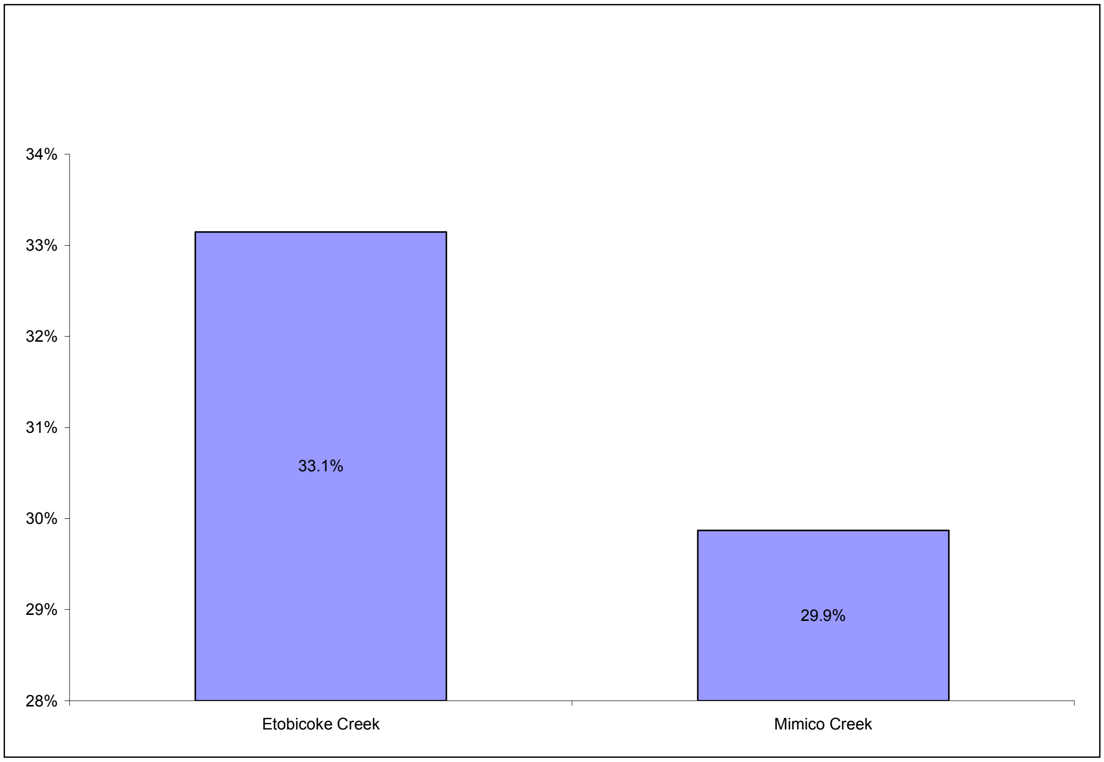
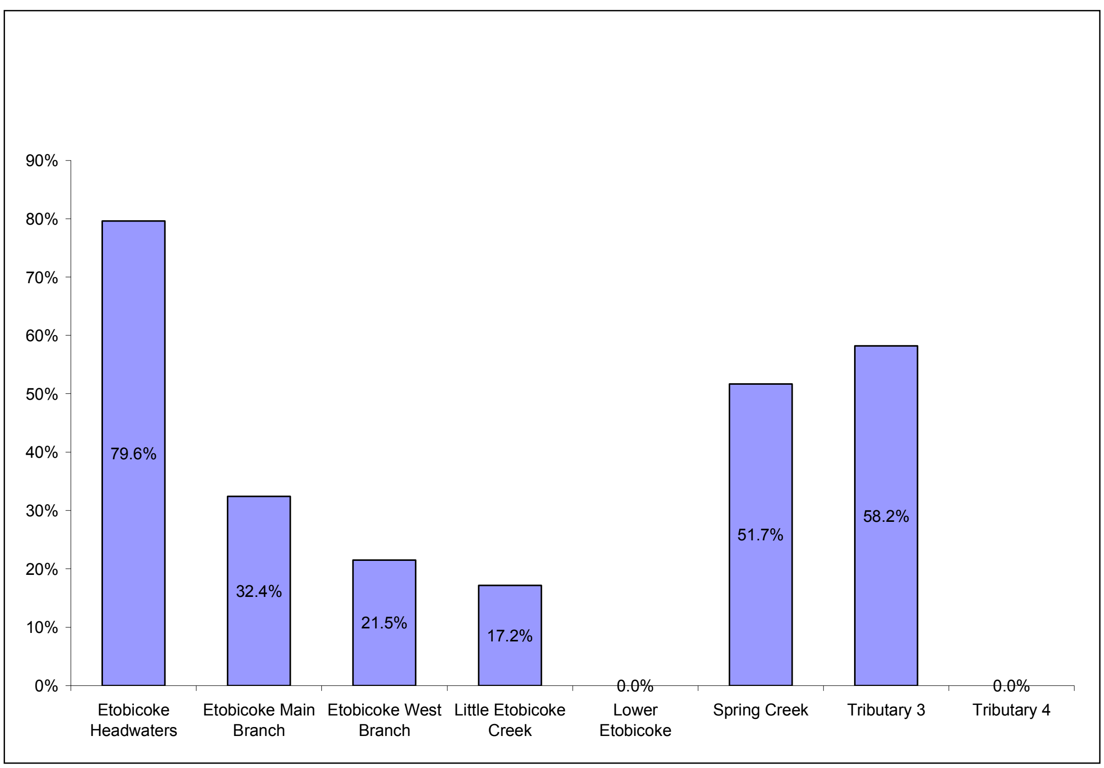


Figure 5-6: Etobicoke Creek Subwatersheds - Proportion of Urban Area with Comprehensive SWM Plans



5.4.3 Existing SWM Controls

Overview of SWM Ponds

There are 46 stormwater management ponds in the Etobicoke Creek watershed , 25 stormwater management ponds in the Mimico Creek watershed, and 2 stormwater management ponds in the Lake Ontario Drainage Area, as illustrated in **Table 5-3**. The location of the ponds and their contributing drainage areas are shown on **Figure 5-7**.

Table 5-3: Summary of Stormwater Management Ponds by Type

Pond Type	Etobicoke Creek	Mimico Creek	Lake Ontario
Wet Pond	27	10	1
Dry Pond	18	13	1
Wetland	0	1	0
Underground	1	1	0
Total	**46**	**25**	**2**

Existing Stormwater Management Practices

Current stormwater management practices have three main components, including:

- stormwater quantity control
- stormwater quality treatment
- stormwater erosion control

Figure 5-8 shows the level of stormwater management controls provided by the existing stormwater management ponds. The stormwater management controlled areas are mainly coincident with areas having comprehensive stormwater management plans. A comparison of the extent of developed areas having various levels of stormwater management controls is presented in **Figure 5-9** and **Figure 5-10**. Five stormwater management ponds are located within the City of Toronto, as shown in Figure 5-7. Due to the lack of design information of these ponds, they are not included as part of the analysis in the subsequent sections of the Technical Update.

Only about 30% of each watershed's urban area has some level of stormwater management. Of this, even fewer areas have the ideal level of control (that is, quantity, quality and erosion): only slightly more than half of the urban areas in Etobicoke Creek (i.e., 17% out of 30%) and only about 10% of the urbanized area of Mimico (i.e., 3% out of 31%).

Figure 5-7: SWM Pond Location Plan

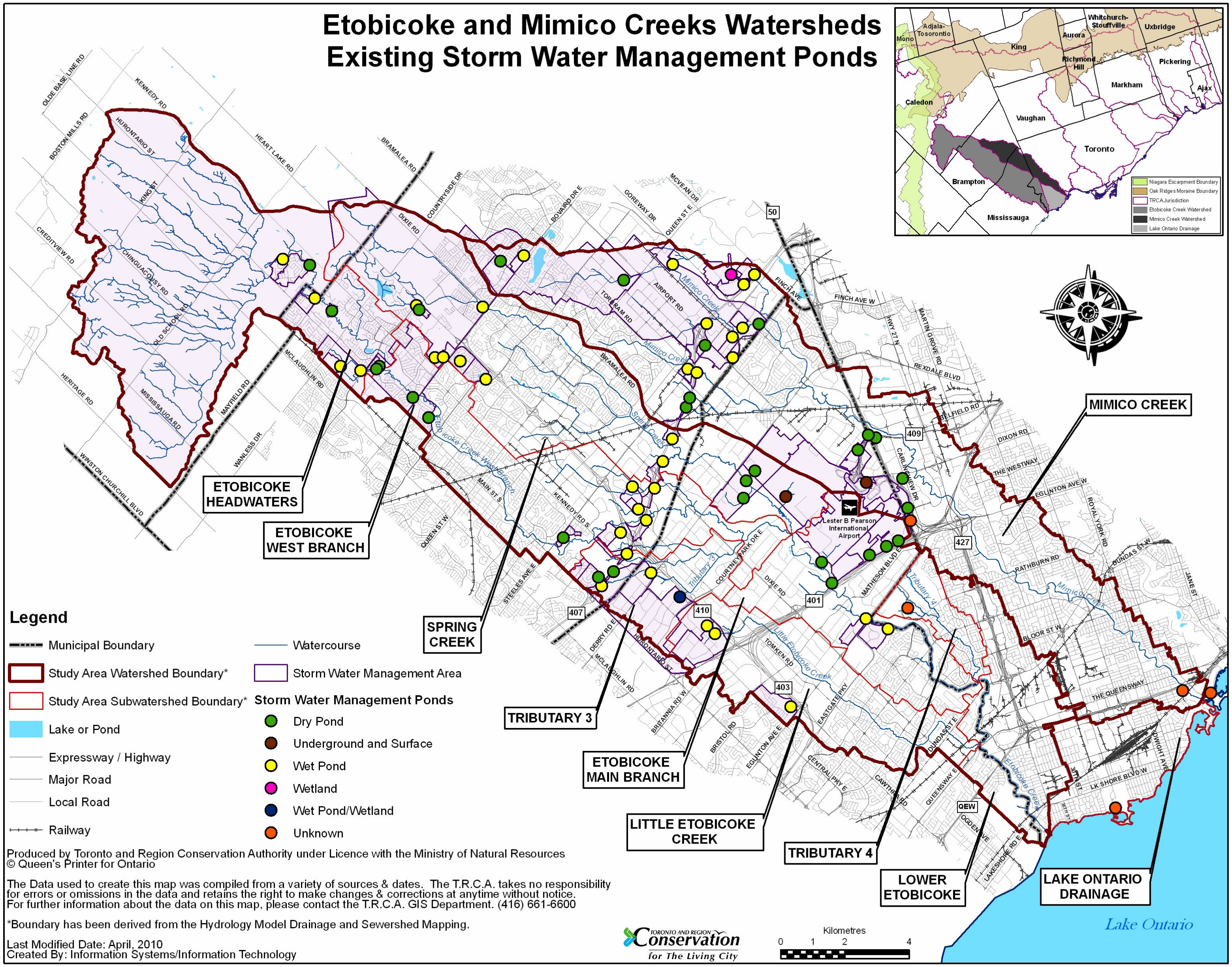


Figure 5-8: SWM Controls within Etobicoke and Mimico Creeks Watersheds

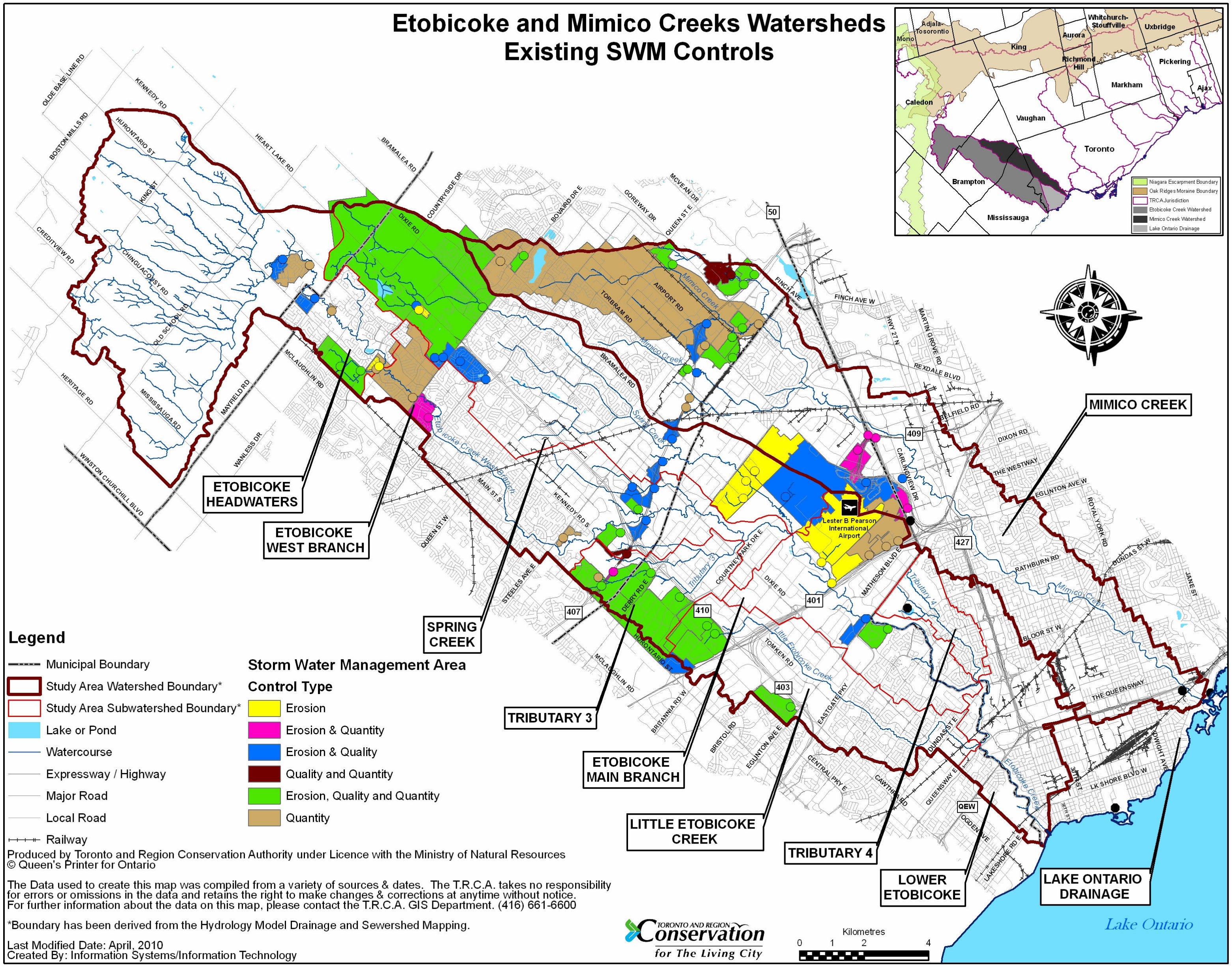


Figure 5-9: Etobicoke and Mimico Creeks Watersheds - Proportion of Urban Area having SWM Controls

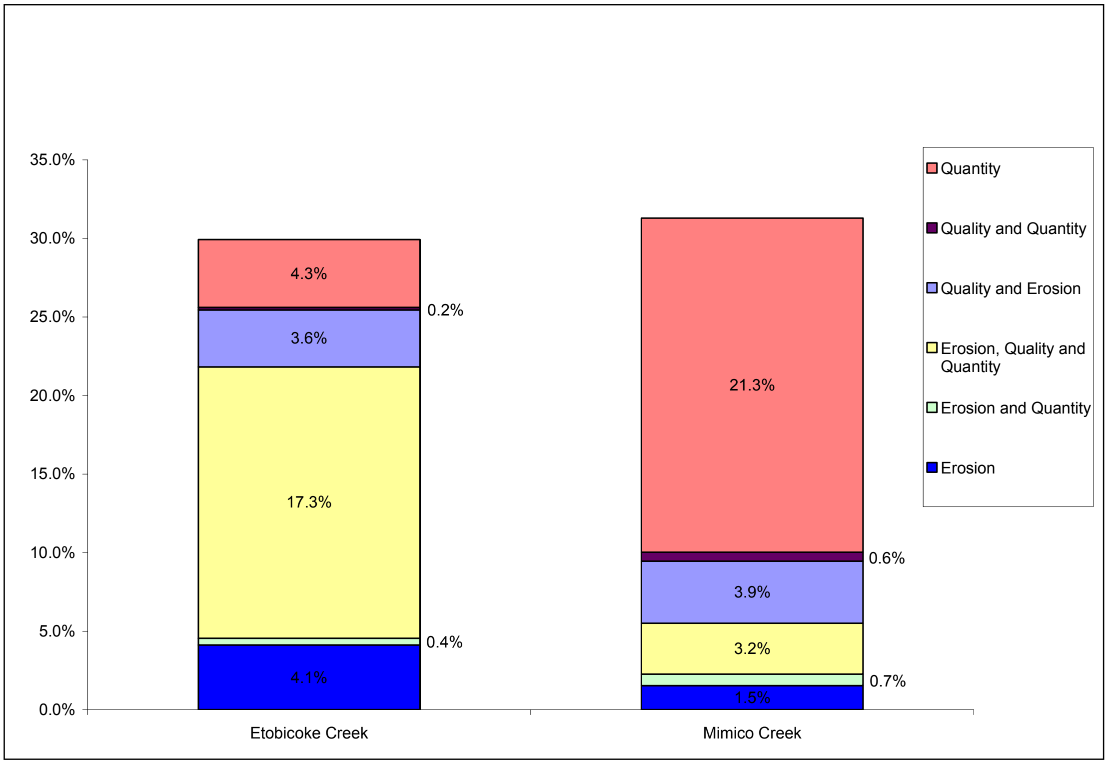
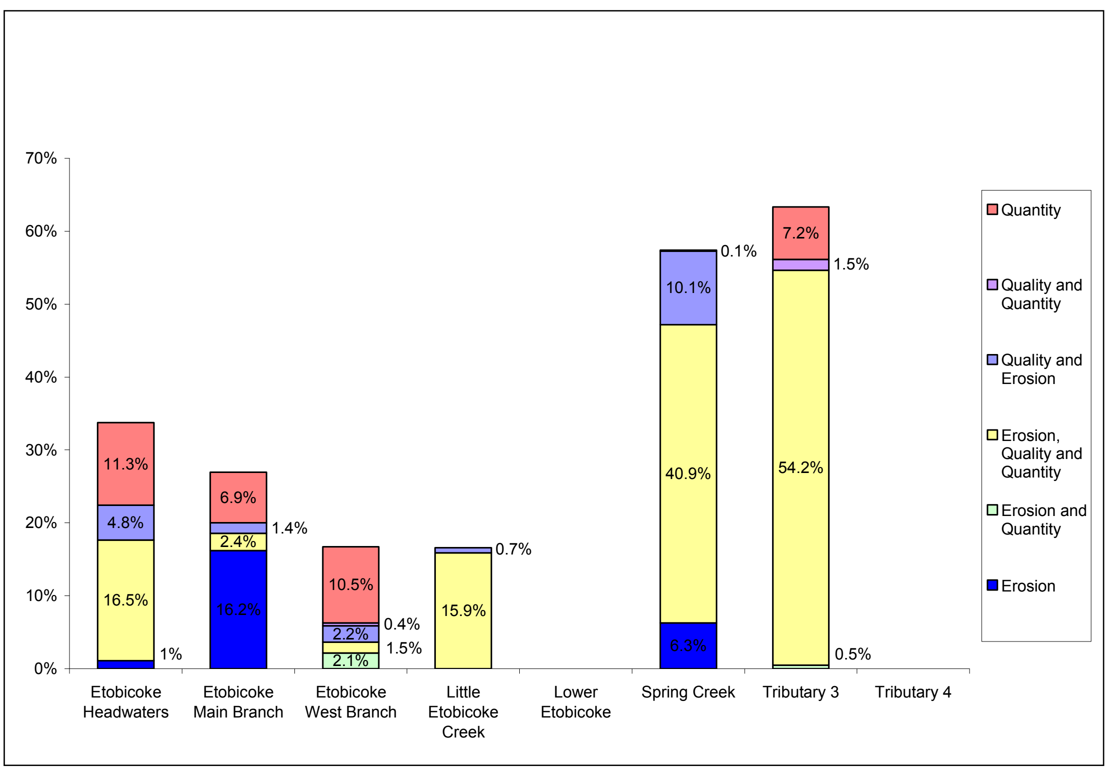


Figure 5-10: Etobicoke Creek Subwatersheds – Proportion of Urban Area having SWM Controls



<u>Cross-Boundary Issue</u>

Figure 5-7 shows that some contributing drainage areas to stormwater management controlled areas extend beyond the watershed or subwatershed boundary. When areas around the watershed and subwatershed boundaries are developed, the drainage pattern may be modified slightly to accommodate the new development. If the boundaries are not updated as development proceeds, or adequate information is not available when the boundary was delineated, it can create cross-boundary issues. This issue may cause jurisdictional conflict when managing the watersheds and add uncertainties when preparing updated hydrological models for the watersheds.

This study has not sought to modify the original watershed and subwatershed boundaries. It is expected that minor inconsistencies in drainage boundaries would not change the outcome of the watershed analysis, although it is recommended that drainage boundaries be confirmed through further studies.

Some of the areas that appear to be extending beyond the watershed or subwatershed boundaries include, but are not limited to, the following:

- Areas that were previously draining to the Humber River might have been redirected to the headwaters of Spring Creek (see **Figure 5-7**), due to modifications of the existing topography that were made to accommodate the proposed development. All related calculations in the Technical Update were based on the drainage boundary prior to the development of the areas.
- A small tributary in the headwaters of the Tributary 3 subwatershed is currently, incorrectly, included in the Etobicoke West Branch subwatershed in the hydrologic model (insignificant impact for the purposes of this study).
- Drainage for the airport lands is complicated by the fact that certain lands within the Mimico Creek watershed are serviced by stormwater management ponds that actually lie within the Etobicoke Creek watershed. This condition is not accurately represented in the current drainage boundary mapping.

<u>On-line Stormwater Management Ponds</u>

On-line stormwater management ponds typically consist of weir outlet structures and are built to provide peak flow controls for upstream areas. However, this type of pond has significant impacts on stream habitat because they act as barriers for fish movement. The outlet structures of the ponds only allow the fine material to pass through, but intercept the coarser bed loads. The loss of the sediment supply will add stream power to the downstream reach and may cause erosion immediately downstream of the stormwater management ponds. Today's standards do not allow for the construction of on-line ponds, however 10 on-line ponds exist in the Etobicoke and Mimico Creeks watersheds. The need to retrofit exiting on-line ponds to create an off line component for quality treatment was identified in previous studies.

Three on-line stormwater management ponds can be found in the Mimico Creek watershed (Ponds #20, 20.1 and 332.3). The Kenfask pond (Pond #20) has been identified by the City of Brampton as a candidate for retrofit and the TRCA is currently managing the retrofit study for this pond.

There are seven on-line stormwater management ponds in Etobicoke Creek (Ponds #13, 23, 33, 96.1, 96.2, 96.3 and 129.1). Although the majority of the headwater areas of Etobicoke Creek is conveyed through an on-line pond located immediately north of Bovaird Drive (Pond #13), the pond was designed to provide treatment for only 700 hectares of the contributing area. The pond will provide conveyance for the remaining undeveloped areas, but drainage from these areas will receive no treatment and therefore these areas are categorized as uncontrolled.

Monitoring and Maintenance of Stormwater Management Ponds
Monitoring and maintenance of stormwater management ponds are important practices that ensure that ponds maintain their function as designed. The cities of Toronto, Mississauga and Brampton and the Town of Caledon have annual maintenance and inspection programs for existing ponds. Mississauga carries out these activities as part of their Flow Control Performance Monitoring program. The program provides recommendations for future dredging and rehabilitation of the ponds. At this time, no stormwater management ponds have been identified as having operational problems, with the exception of SWM Pond 5D in Mississauga (an EA study is currently underway to address this issue).

5.4.4 Stormwater Management Quality Treatment

The design of the water quality treatment component of a stormwater management facility depends on the selected level of treatment (i.e., the amount of pollutants to be removed) and the imperviousness of the contributing area. Three levels of protection are recommended in the Ministry of the Environment's Stormwater Management Practices Manual based on the level of TSS removal: 1) Enhanced, 2) Normal and 3) Basic. Since the primary negative impacts of stormwater runoff can be related to sediment (total suspended solids, or TSS), the design of facilities is typically based on the long-term removal of TSS from stormwater flows. The required storage volumes for each level of water quality treatment are shown in **Table 5-4**. The unit storage volume presented in **Table 5-4** includes 40 m^3/ha for the extended detention and the remainder represents the minimum required storage in the permanent pool (MOE, March 2003).

Table 5-4: MOE Table 3.2 Water Quality Storage Requirements based on Receiving Waters

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level			
		35%	55%	70%	85%
Enhanced 80% long-term TSS. removal	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250
Normal 70% long-term TSS. removal	Infiltration	20	20	25	30
	Wetlands	60	70	80	90
	Hybrid Wet Pond/Wetland	75	90	105	120
	Wet Pond	90	110	130	150
Basic 60% long-term TSS. removal	Infiltration	20	20	20	20
	Wetlands	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

The current TRCA standard for quality control is Enhanced Level (Level 1) for all new and infill developments. A quality treatment level between Normal and Basic (referred to as Hybrid) was implemented by the Ministry of Transportation for Highway 407 lands. A separate level of treatment (referred to as Airport Standard) was applied for airport lands as they are Federal lands and are not subject to Provincial regulations.

Areas with stormwater quality treatment, along with the level of treatment, are identified in **Figure 5-11**. **Figure 5-12** and **Figure 5-13** provide a comparison of various levels of quality treatment for the developed areas.

The majority of the Mimico Creek watershed was built-up before quality controls were required for development, and as a result only 7.8% of the developed areas in this watershed have stormwater quality treatment. Only 0.2% of the area provides an Enhanced level of quality treatment. Similarly, only 21% of the developed areas in the Etobicoke Creek watershed have stormwater quality treatment. Of this, only 2% represents an Enhanced level of quality treatment. Even at a subwatershed scale, the areas controlled to this level are well less than half of the total urban areas with quantity control.

Figure 5-11: SWM Quality Controls within Etobicoke and Mimico Creeks Watersheds

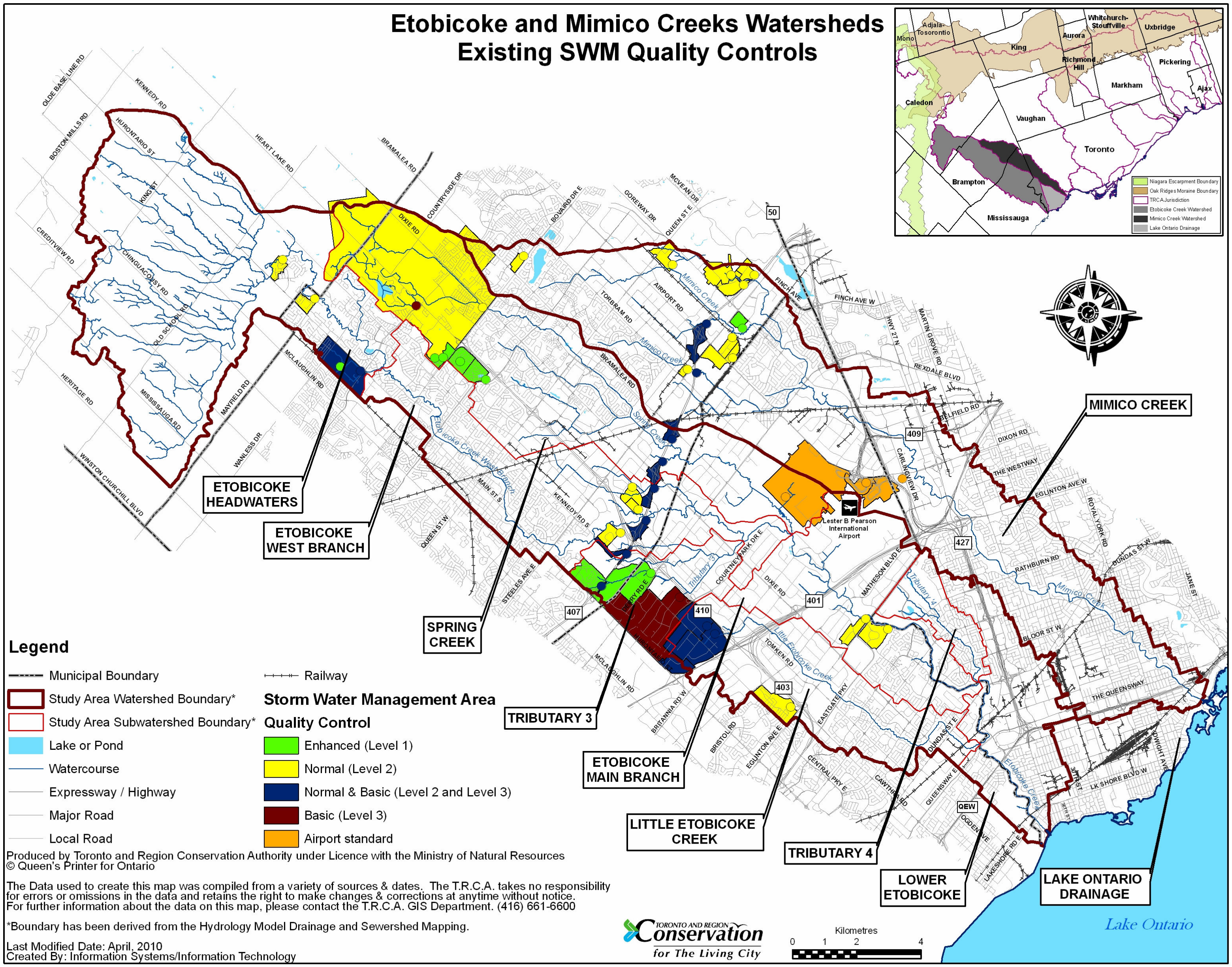


Figure 5-12: Etobicoke and Mimico Creeks Watersheds – Proportion of urban area having SWM Quality Control

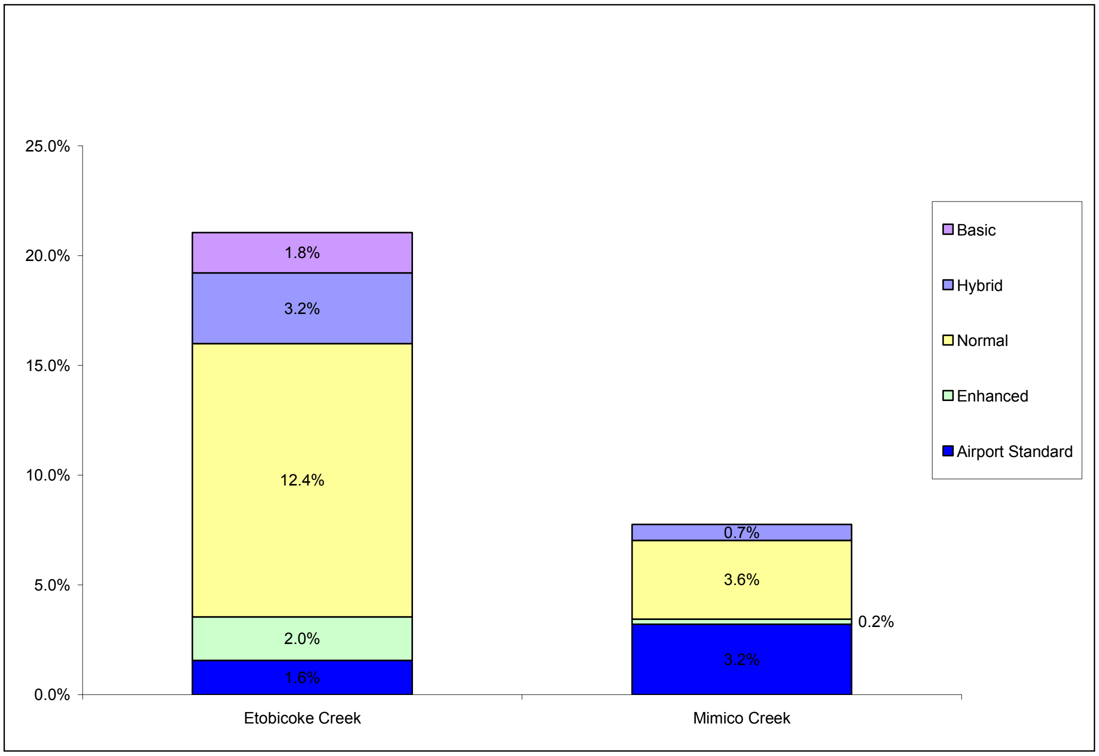
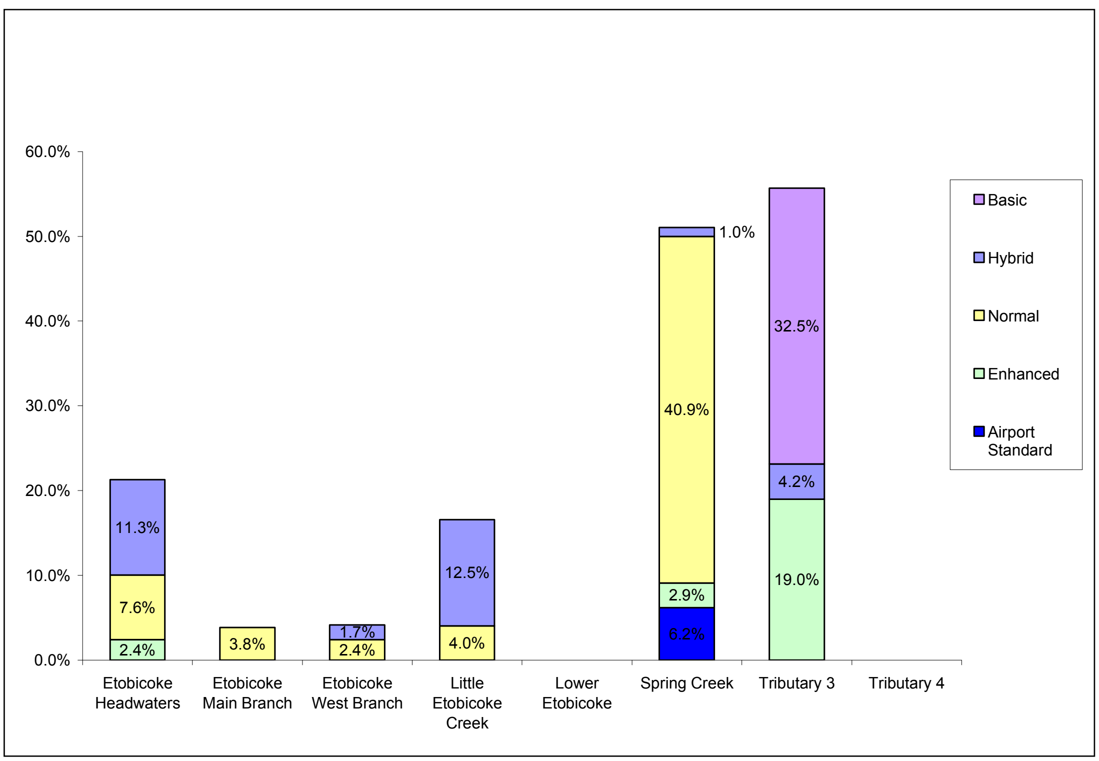


Figure 5-13: Etobicoke Creek Subwatersheds – Proportion of urban area having SWM Quality Control



5.4.5 Stormwater Management Erosion Control

Inadequate control of surface runoff can increase erosion along a river system. The erosion storage of a stormwater management pond is designed to preserve or enhance a stable, sustainable and healthy river system. TRCA requires that continuous modelling be conducted to determine the required storage volume for erosion control. As a minimum, the erosion control storage should be able to detain stormwater runoff from a 25 mm storm event for at least 48 hours. **Figure 5-14** shows the existing urban areas with erosion control. **Figure 5-15** and **Figure 5-16** provide a comparison of erosion controls within the developed areas.

Only 9% of the developed areas in the Mimico Creek watershed have erosion control. Typical erosion control methods involve the detention of stormwater runoff from a 25 mm rainfall for 24 hours (hereafter referred to as 25mm/24 hour). This treatment type services 8.5% of the developed areas. Only 0.2% of the developed areas are able to provide 48 hours of detention time for a 25 mm storm event (hereafter referred to 25mm/48 hour). Approximately 0.7% of the urban areas are subject to Distributed Runoff Control (DRC). DRC is a method that allows for maintenance of the erosion potential of a channel to less than the pre development level.

Only 25% of the developed areas in the Etobicoke Creek watershed have erosion control. Approximately 20% of the developed area has 25mm/24 hour control and only 2% of the developed area has 25mm/48 hr control. A fluvial geomorphological study (Parish, 2009) identified three sites that are experiencing accelerated rates of erosion (i.e. GET-5, GET-6 and GET-10) along Etobicoke Creek. Two of the sites (GET-5, GET-6) are located where the majority of the upstream drainage areas do not incorporate erosion controls or the existing erosion practices may not be adequately designed to support a dynamic stable river system.

Within the developed portions of the Etobicoke Creek subwatersheds having erosion control measures, the predominant level of control is 25mm/ 24hour. Less than 22% of urban areas within most subwatersheds, except Tributary 3 and Spring Creek, have erosion controls. Approximately, 55% of Tributary 3 and 57% of Spring Creek subwatershed have erosion controls owing to their relatively new developments. Still the predominant levels of control are 12mm and 25mm/24hr.

Figure 5-14: SWM Erosion Controls within Etobicoke and Mimico Creeks Watersheds

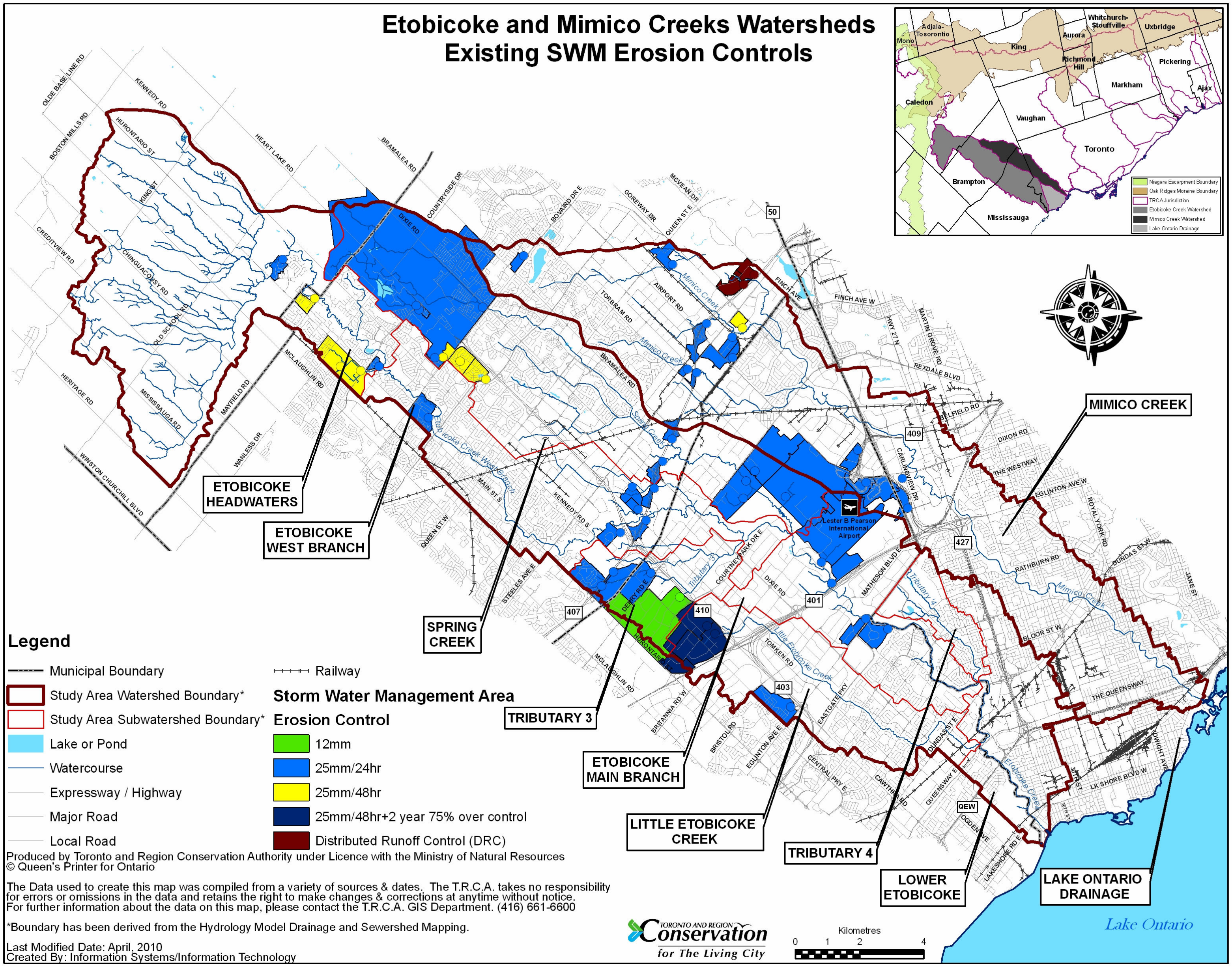


Figure 5-15: Etobicoke and Mimico Creeks Watersheds – Proportion of urban area having SWM Erosion Control

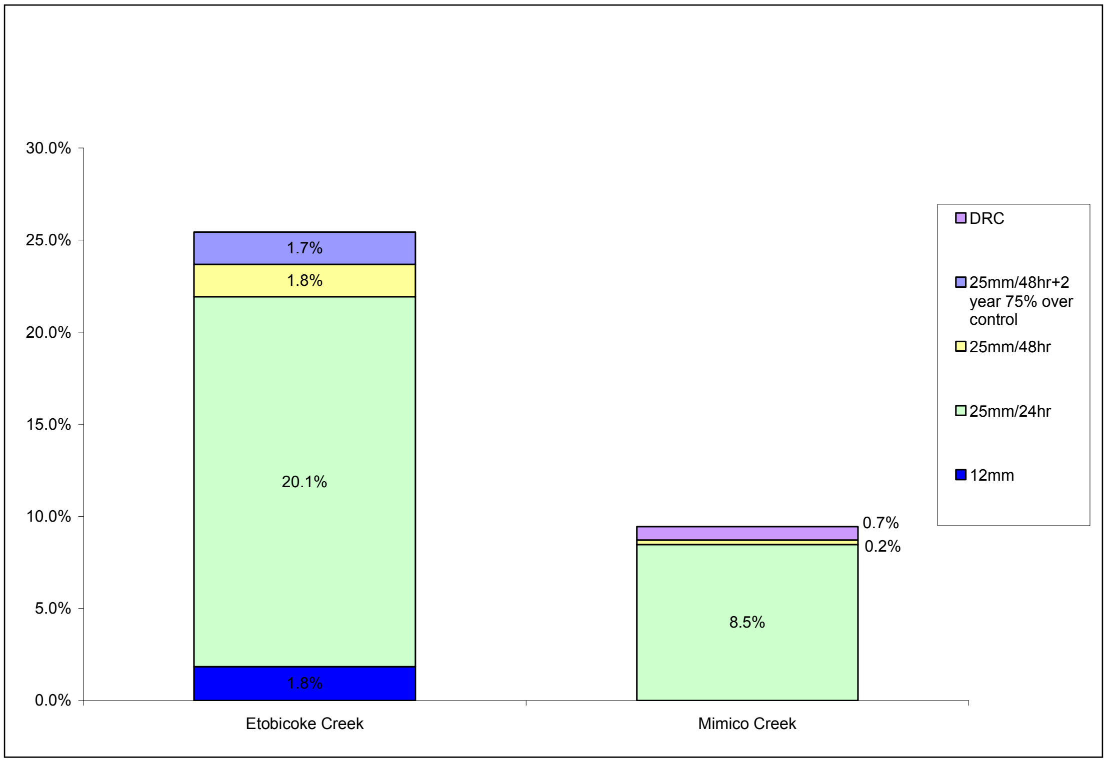
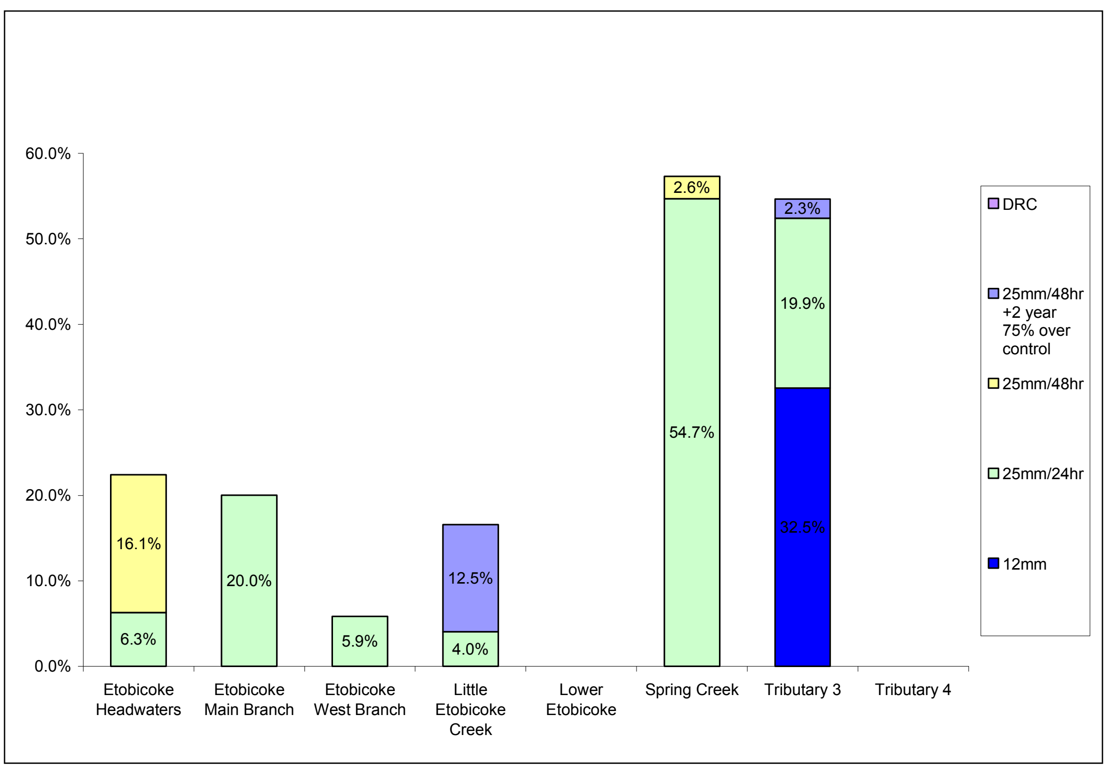


Figure 5-16: Etobicoke Creek Subwatersheds – Proportion of urban area having SWM Erosion Control



5.4.6 Stormwater Management Quantity Control

As catchments become urbanized, opportunities for infiltration are reduced and precipitation becomes direct surface water runoff. Consequently, more water is conveyed to streams overland and river systems become more "flashy", particularly during the summer and fall months. In order to minimize the potential for flooding due to the increased flows, stormwater quantity control that reduces post-development flows to pre-development levels and hydrographs were implemented across TRCA's jurisdiction where necessary.

The current stormwater quantity control criteria for the Etobicoke Creek watershed was established based on the 1996 Etobicoke Creek Hydrology Study (Schaeffers & Associates, 1996) and are summarized below:

- 2 year to 100 year over control for post development flows for the headwater areas;
- 2 year to 100 year controls for post development flows for the central portion of the watershed;
- no quantity control required for the lower portion of the watershed

The general concept is to reduce the peak flow rate to the receiving water after development so that peak flows match pre-development levels. Due to the long, linear shape of the watershed, timing or the routing of flows through the channel becomes a factor. It was found that runoff from the lower portions of the watershed were able to clear the area before flows from higher up in the watershed made their way down. Therefore, quantity controls in these lower areas were not required.

Within the Mimico Creek watershed, the current standard is to control the 2 year through 100 year return period post development flows to the pre development levels. These criteria were based on the 1978 Mimico Creek Hydrology Study (McLaren, 1978).

Updates to both the Etobicoke and Mimico Creeks watersheds hydrology were recently completed. The quantity control criteria should now be re-assessed to reflect the updated flow information and may include Regional flow controls or other new ways of approaching stormwater management in the headwater areas. Figure 5-17 shows the existing stormwater quantity control areas in the watersheds and subwatersheds. Figure 5-18 and Figure 5-19 provide a comparison of stormwater quantity controls for the developed areas.

Approximately 26% of the developed areas in the Mimico Creek watershed have stormwater quantity controls. Approximately 24% of the developed areas provide attenuation of 2 to 100 year post development flows to pre development levels (hereafter referred to as 2-100 year controls).

Approximately 22% of the developed areas in the Etobicoke Creek watershed have stormwater quantity controls, with 17% of developed area having 2-100 year controls.

Within the developed portions of the Etobicoke Creek subwatersheds having stormwater quantity control measures, the predominant level of control is 2-100 year controls. Quantity controls are found in over 28-63% of the subwatersheds supporting relatively newer developments, such as Etobicoke Headwaters, Tributary 3 and Spring Creek subwatersheds. The predominant levels of control are 2-100 year controls, as per TRCA requirements. Less than 15% of urban areas within the Etobicoke Main Branch, Etobicoke West Branch and Little Etobicoke Creek subwatersheds have any quantity controls. Lower Etobicoke and Tributary 4 subwatersheds have no quantity controls.

Figure 5-17: Existing SWM Quantity Controls within Etobicoke and Mimico Creeks Watersheds

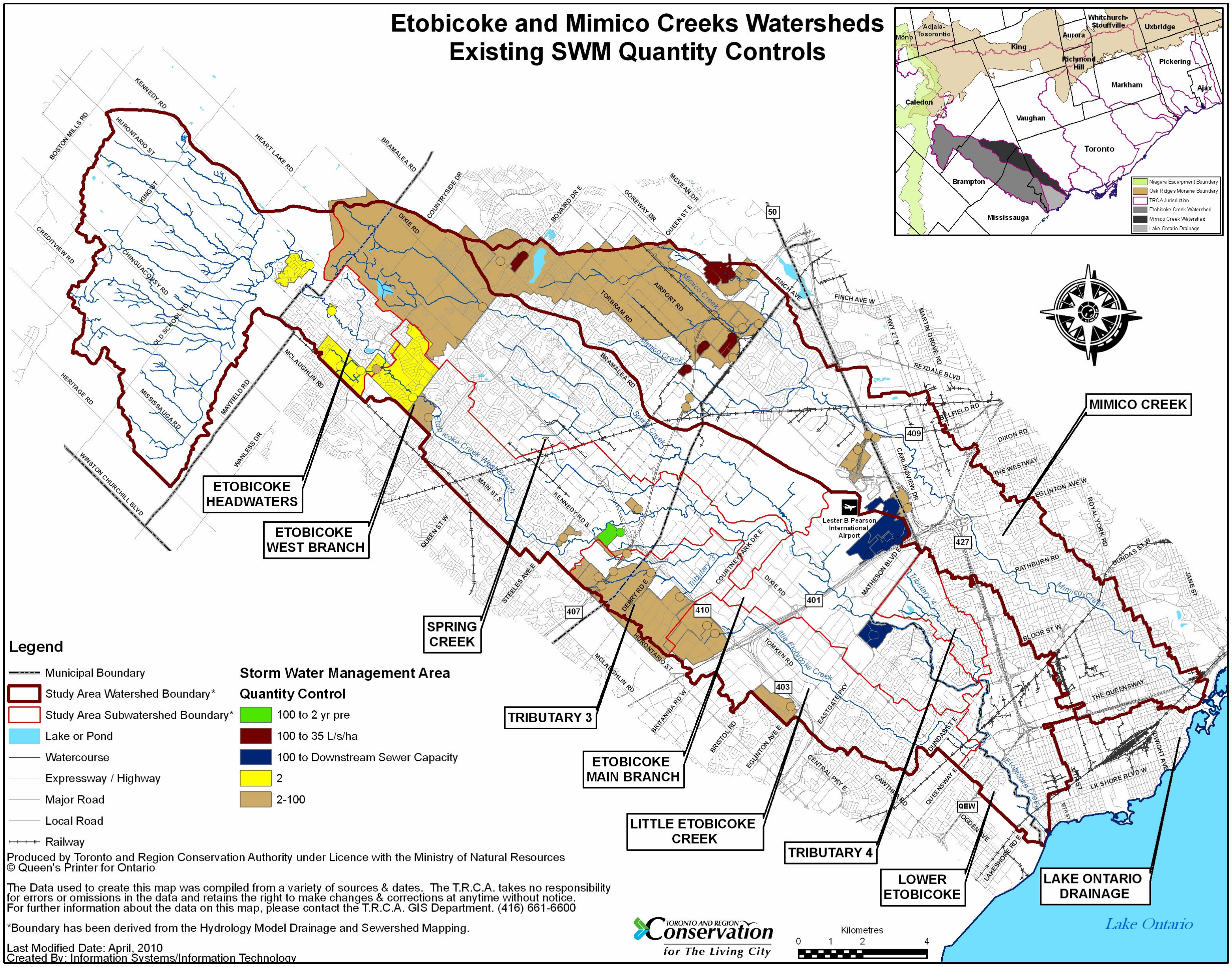


Figure 5-18: Etobicoke and Mimico Creeks Watersheds – Proportion of urban area having SWM Quantity Controls

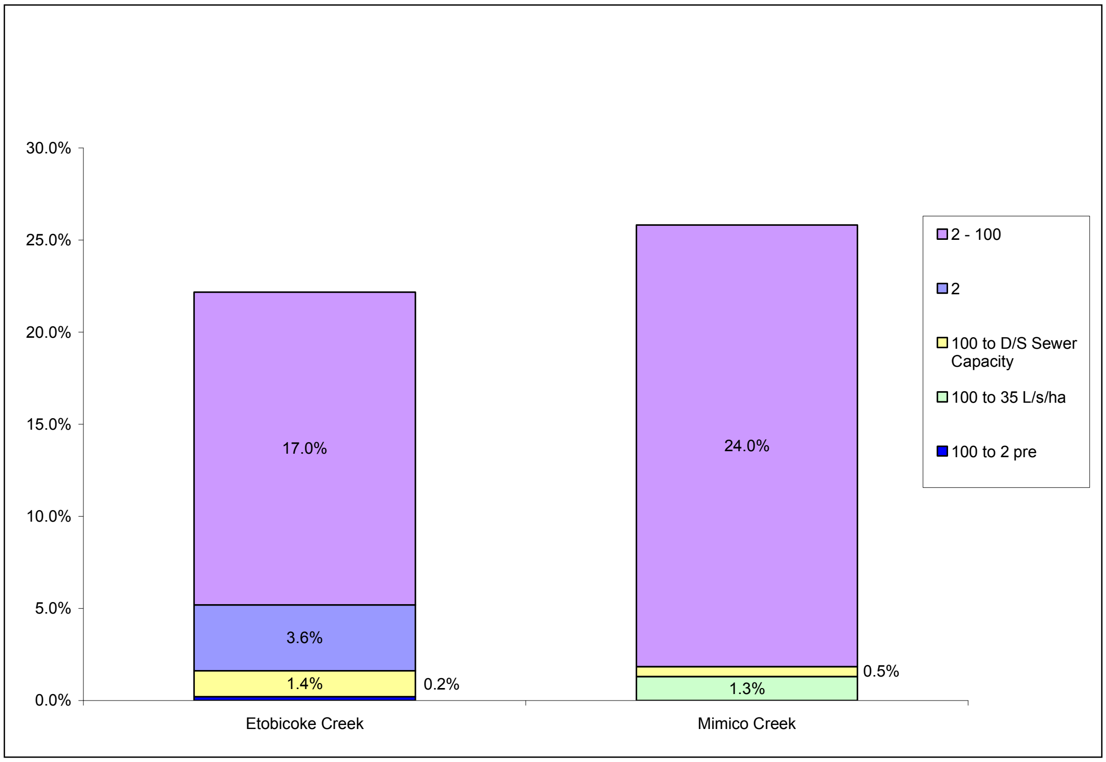
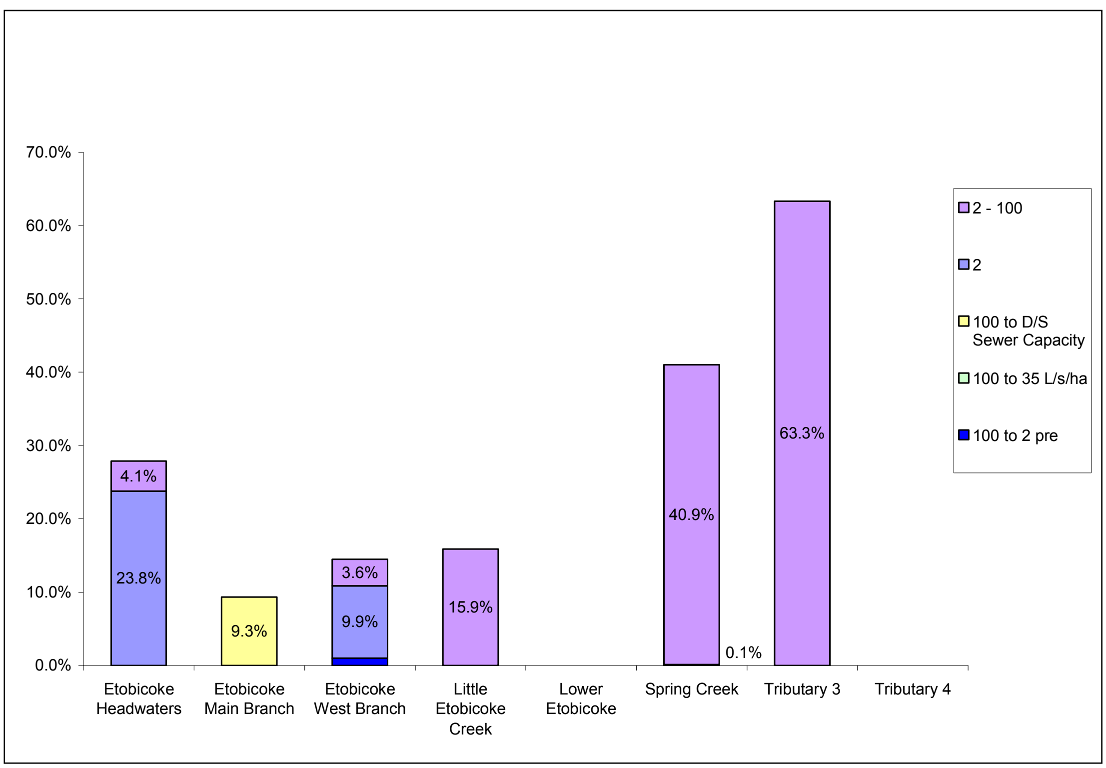


Figure 5-19: Etobicoke Creek Subwatersheds – Proportion of urban area having SWM Quantity Controls



5.4.7 Stormwater Management Retrofit Plans/ Strategies

As discussed in **Section 5.4.2 and 5.4.3**, about 30% of each watershed's urban area has some level of stormwater management. Areas which have the ideal level of control (that is, quantity, quality and erosion) are even less (i.e. 17% out of 33% for Etobicoke Creek and 3% out of 30% for Mimico Creek).

In order to improve stormwater management for treated areas, the City of Mississauga, the City of Brampton and the Town of Caledon each undertook comprehensive reviews of the state of their stormwater management facilities in coordination with TRCA. Individual "Retrofit Opportunity Studies" were produced for each municipality and priorities for undertaking retrofit projects were developed. A retrofit of a pond would involve re-grading of an existing "dry quantity control pond" to allow for a permanent pool that provides quality control, and increased storage capacity to provide erosion control. Modifications to the pond outlet structure would also be required. A storm sewer outfall retrofit would occur in areas where sewer systems discharge directly to a river or stream. Where land permits, there are opportunities to intercept this discharge and provide treatment in a newly constructed pond or wetland, prior to flows entering the receiving watercourse.

Figure 5-20 illustrates the location of existing ponds (with land area serviced), as well as the retrofit opportunities for ponds and existing storm sewer outfalls in Peel Region. **Table 5-5** summarizes the stormwater retrofit opportunities identified in the Peel Region studies. In 2010 the Region of Peel Council has directed that the Region facilitate a collaborative working group between the three area Municipalities and Conservation Authorities in order to develop a Regional Stormwater Management Strategy. This Strategy would define mandates, roles and next steps in stormwater management among the partners.

Opportunities to improve water quality within the City of Toronto were investigated as part of the Wet Weather Flow Management Master Plan, 2003. No opportunities were identified in the 25 year plan to retrofit existing stormwater management facilities or outfalls, therefore the City's study went further to identify strategies locations for the implementation of new facilities to improve stormwater management in existing urban areas. **Figure 5-21** illustrates the general location and type of the proposed End of Pipe Facilities within the City of Toronto. **Table 5-6** summarizes the proposed End of Pipe Facilities identified as the 25-year strategy in the City of Toronto's Wet Weather Flow Management Master Plan, 2003.

Figure 5-20: Stormwater Management Retrofit Plans/ Strategies in Peel Region

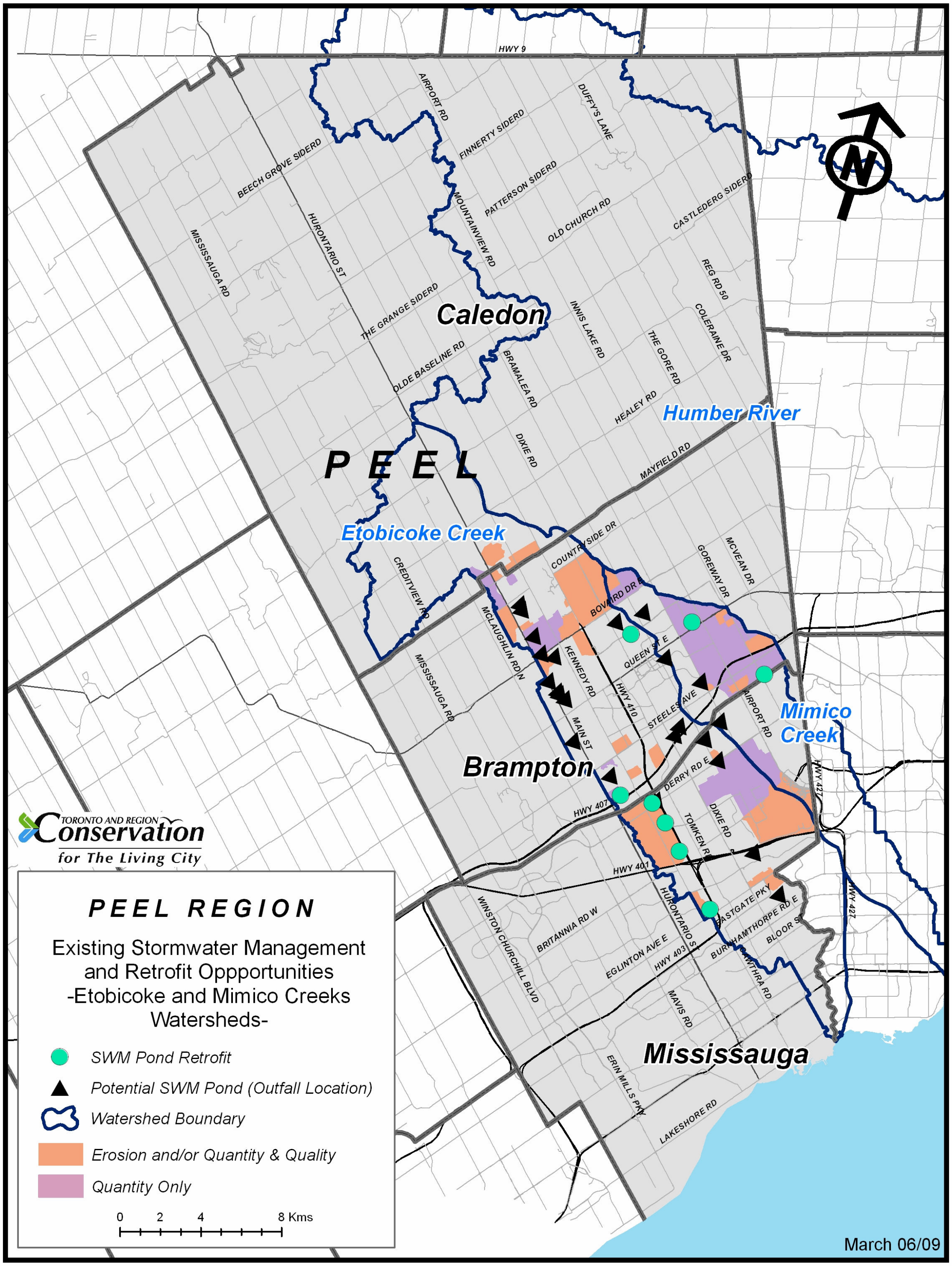


Figure 5-21: Proposed End of Pipe Facilities within the City of Toronto

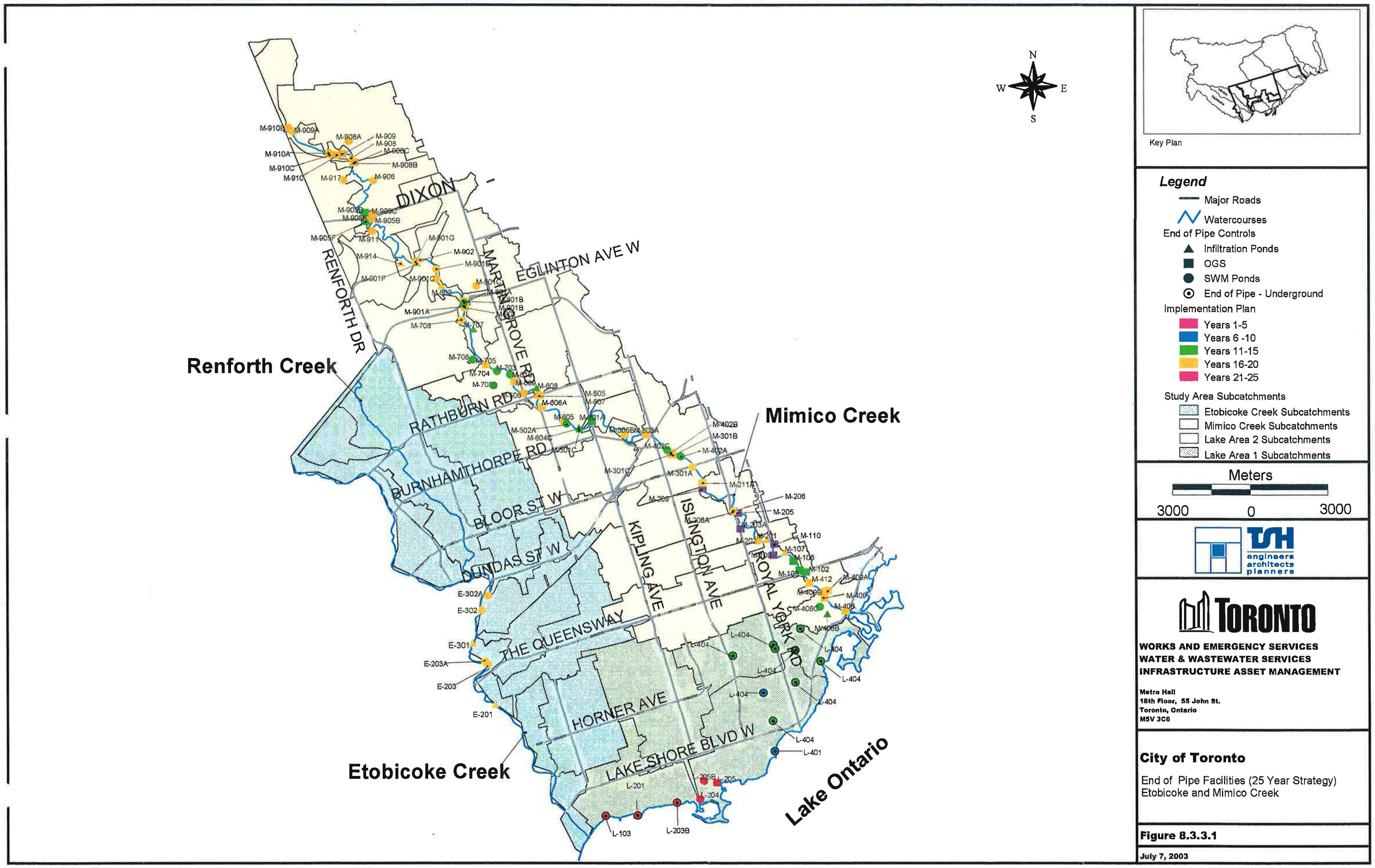


Table 5-5: Summary of SWM Retrofit Opportunities in Peel Region

Municipality	# of Ponds Total in TRCA area	# of Potential Pond Retrofits within Etobicoke and Mimico Creek	# of Potential Outfall Retrofits within Etobicoke and Mimico Creek	# Retrofits Completed	# Retrofits Currently Underway
Mississauga	7 (not including GTAA ponds)	4 [3]	5	3	0
The Mississauga Water Quality Strategy Update is underway (expected completion 2010)					
Brampton	85	5	18	1	1 pond 1 outfall
Brampton is currently developing a Stormwater Management Strategy (expected completion in 2010)					
Caledon	41	0	1	0	0
Phase III: Implementation Strategy to be completed to determine preliminary costs of retrofit projects					

Table 5-6: Summary of Proposed End of Pipe Facilities within the City of Toronto (25 Year Strategy)

Watershed	Pond	Underground Tank	OGS	Infiltration
Etobicoke Creek	4	0	0	2
Mimico Creel	22	0	43	14
Lake Ontario	6	26	23	
Total	**32**	**26**	**66**	**16**

The typical construction costs for a new stormwater management pond are $0.5 million to $2 million, and $0.3 million to $0.5 million for a typical outfall. In addition to the construction cost, approximately $90,000 is required for each project to carry out a municipal Environmental Assessment study. It is expected that more areas will have ideal treatment (i.e. quality, erosion and quantity) once the identified ponds and outfalls are retrofitted.

5.4.8 Streamflow

The Surface Water Quantity objective, as identified earlier in this report, is to restore the creeks to a more natural flow pattern. This section will address two of the indicators listed under "streamflow": i) peak flows and ii) flooding. The baseflow and water taking indicators are addressed in the **Baseflow and Water Use Section**. As previously described, the physical characteristics of the watersheds have changed considerably over the past few decades, resulting in an altered hydrologic regime. Although significant effort has been put into managing stormwater to mitigate the impacts of development, changes in the flows, and consequently changes in the extent of the floodplain have occurred.

The targets that were identified for each of these indicators are:

[3] Based on Mississauga's 1995 Storm Water Quality Control Study and preliminary results of the 2009 update.

- Maintain or reduce baseline peak flows for 2 to 100 year return period events (baseline values derived from the reports: Etobicoke Creek Hydrology, Fred Schaeffer and Associates, 1996 and Mimico Creek Hydrology, James F. MacLaren Limited, 1978)
- Maintain or reduce the number of flood vulnerable areas and roads (baseline as per TRCA FVA/FVR Database, reported in *Greening Our Watersheds*, TRCA, 2002)

Peak Flows: Analysis of Original versus Updated Hydrology Models

The hydrologic models used in the analysis of peak flows for the Etobicoke Creek watershed are the original model, prepared by Fred Schaeffer and Associates (1996), and the updated model, by Totten Sims Hubicki (2007). The hydrologic models used in the analysis of peak flows for the Mimico Creek watershed are the original model, prepared by James F. MacLaren Limited (1978), and the updated model, by MMM Group (2009). Hydrologic models were used to determine the change in peak flows at selected locations throughout the watersheds. **Figure 5-22** illustrates the flow node locations that were assessed; five nodes within Etobicoke Creek watershed and 3 nodes within the Mimico Creek watershed were selected based on the availability of data for comparison. Although the target for the streamflow indicator is to maintain or reduce baseline peak flows for the 2 to 100 year return periods, the original hydrologic models did not contain a 2-year return period analysis. Therefore, a comparison of original versus updated peak flows was undertaken for the 5-year, 100-year and Regional storm events, and the results are illustrated in **Figure 5-23** through **Figure 5-29.**

Figure 5-22: Node Locations for Comparison of Peak Flow Changes (original vs. updated)

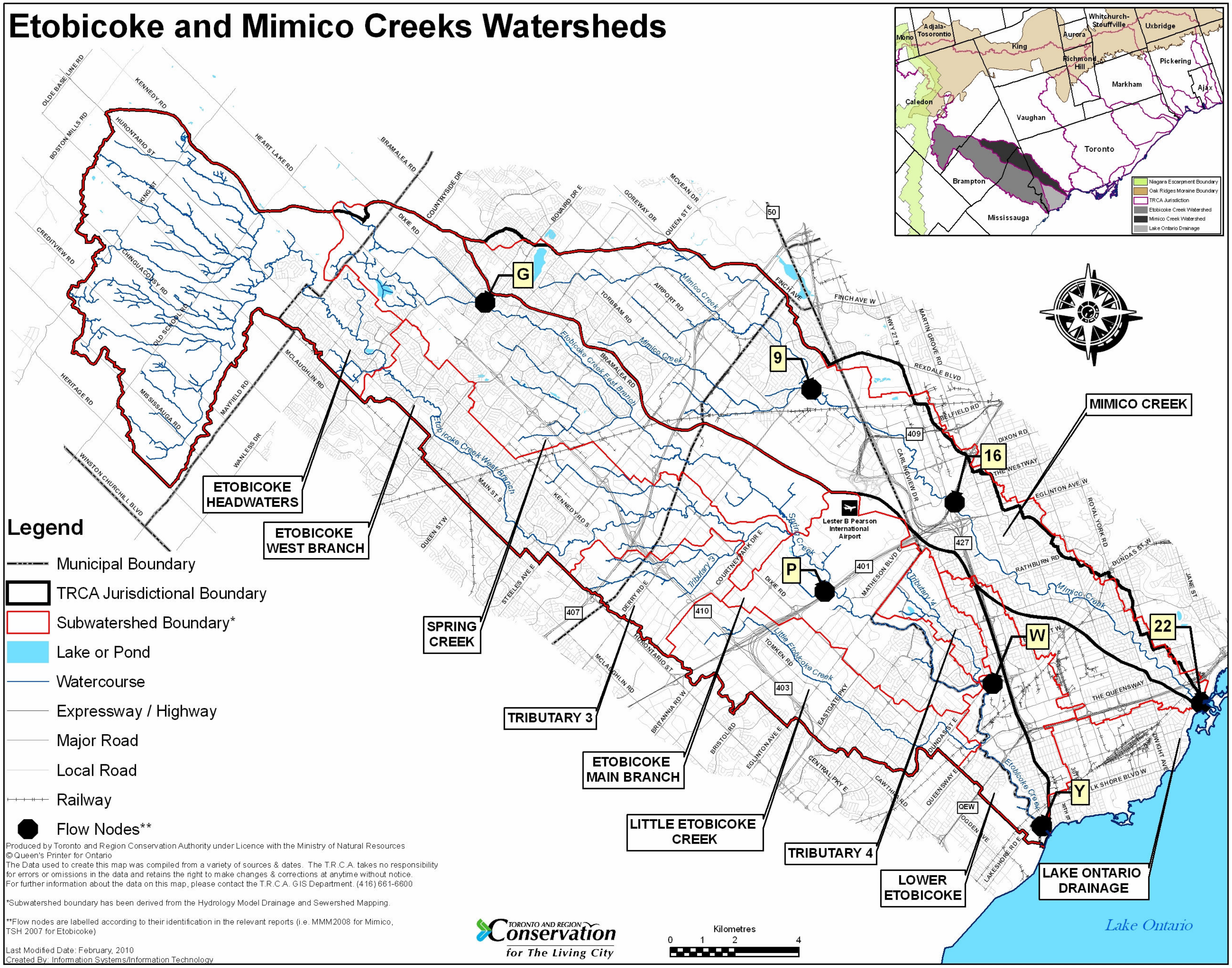


Figure 5-23: Comparison of Mimico Creek Peak Flows at Node 9 (Drainage of the upper 1/3 of the watershed to Derry Road)

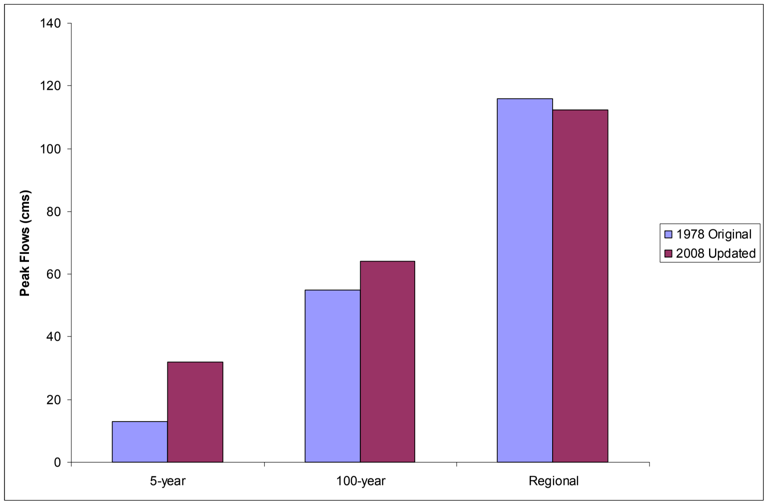


Figure 5-24: Comparison of Mimico Creek Peak Flows at Node 16 (Drainage of the upper 2/3 of the watershed to Highway 27)

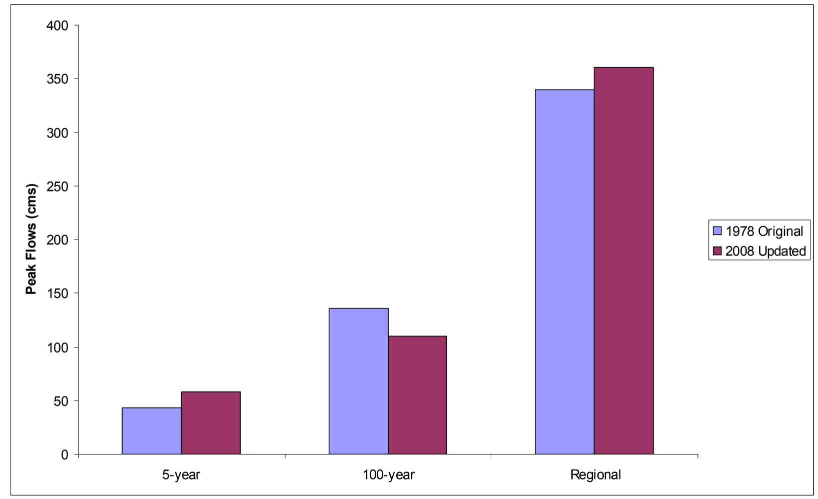


Figure 5-25: Comparison of Mimico Creek Peak Flows at Node 22 (Drainage of total watershed to the mouth of Lake Ontario)

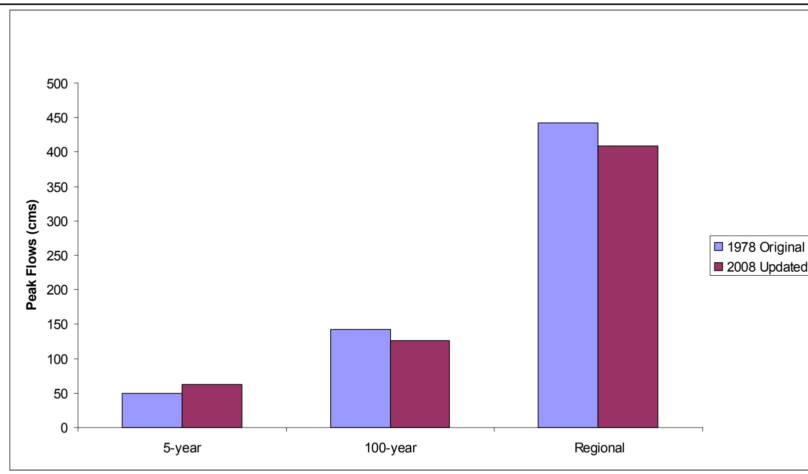


Figure 5-26: Comparison of Etobicoke Creek Peak Flows at Node G (Drainage of the Headwater areas of Spring Creek to Bovaird Drive)

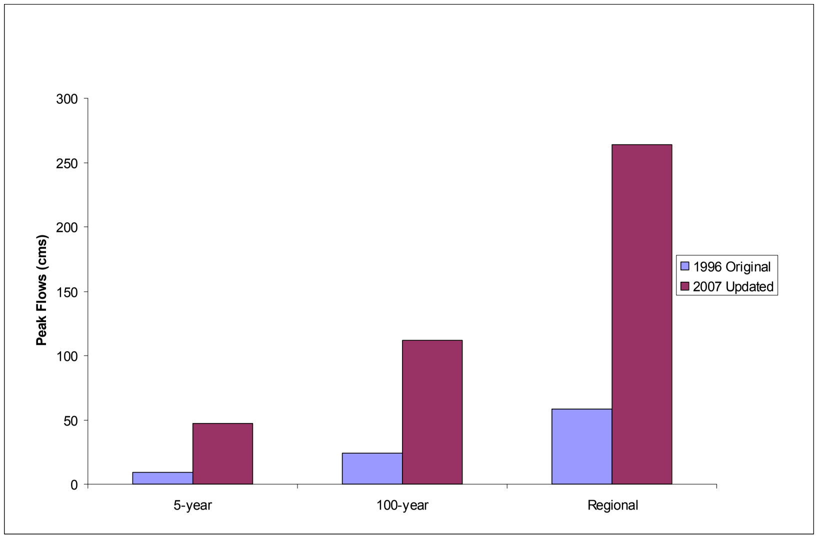


Figure 5-27: Comparison of Etobicoke Creek Peak Flows at Node P (Etobicoke Creek watershed – including Spring Creek and Main Creek - to Highway 401)

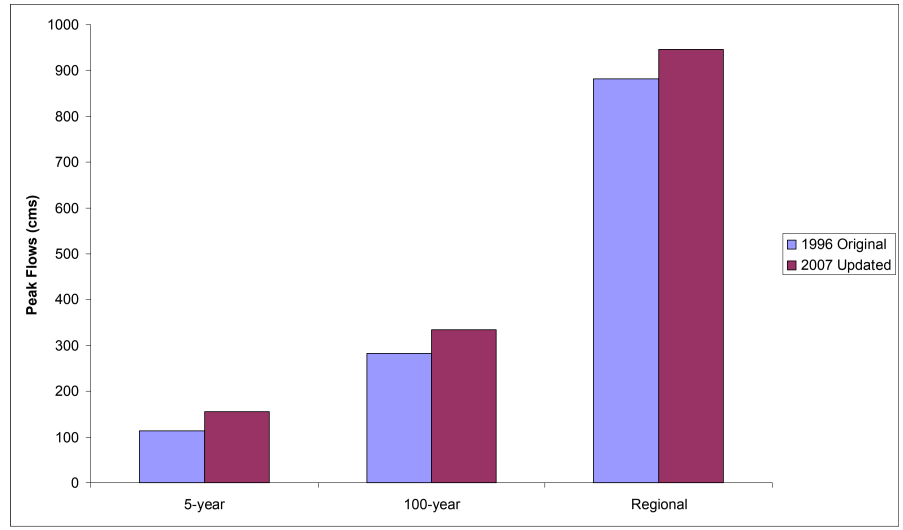


Figure 5-28: Comparison of Etobicoke Creek Peak Flows at Node W (Drainage of Etobicoke Creek to Dundas Street)

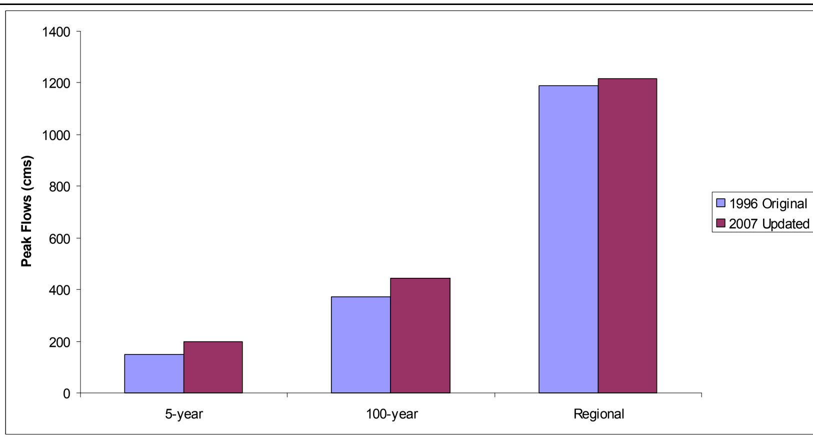
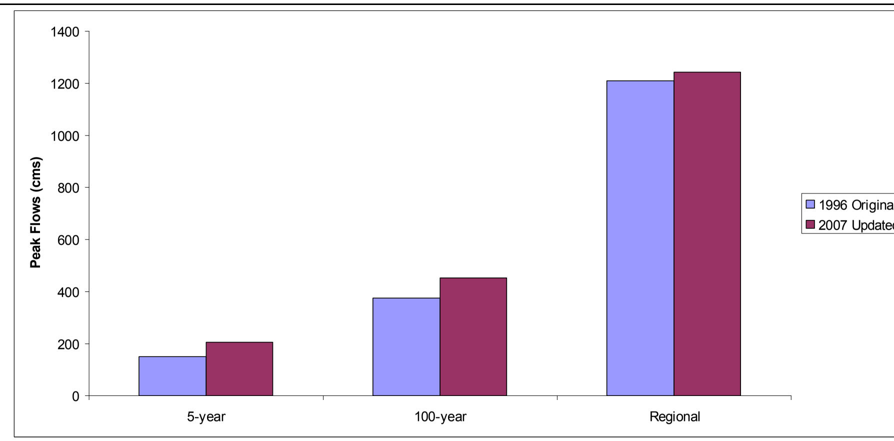


Figure 5-29: Comparison of Etobicoke Creek Peak Flows at Node Y (Drainage of total Etobicoke Creek watershed to Lakeshore Avenue near the mouth of Lake Ontario)



One would intuitively expect peak flows to increase over time, to some degree, given land use changes and development pressures that are typically imposed on watersheds (resulting in increased runoff). As mentioned, stormwater management practices have been put in place to mitigate some of these effects. However, areas treated by stormwater management within the Etobicoke and Mimico Creeks watersheds account for less than 30% of the total urban area.

It is important to note that for the more frequent storm events (i.e., the 5-year through 100-year storms) the analysis is approached from a different perspective than the analysis for the Regional storm event. The runoff from the larger storm events is typically generated by precipitation that falls on a landscape that is already “saturated”, meaning that most of the water that falls becomes direct runoff and reaches the creek via overland flow. However, a greater percentage of the precipitation that falls during a smaller, more frequent event has an opportunity to infiltrate into the ground. These factors were considered during the evaluation of the results.

Minor variations in the peak flows can be accounted for by the modelling technique itself. That is to say, the methodology for modelling, or predicting peak flows, has improved over the past 3 decades since the original work was initiated. This leads to a more precise delineation of drainage areas through the use of Geographical Information System (GIS) tools, greater computing power allowing for more refined and detailed modelling and a greater understanding of the watersheds. Limitations to the calibration could be also a contributing factor to differences in results. The programs which are used to model the hydrology of the watersheds also contain some variances between them with respect to how they calculate formulae and manipulate data. While programs used for all of the models are based on the same HYMO platform (and modelling approach) each may yield somewhat different results than the other with the same input data. It is also important to note that the 5-year through 100-year storms were estimated based on different types of storm distributions in the original and updated hydrological studies, which may result in difference in peak flows. For example, the 24 hour SCS Type II storms were used in the original studies for Etobicoke and Mimico Creek. The 6 hour and 12 hour AES storms were used for Etobicoke and Mimico Creek, respectively, in the updated studies.

With this in mind, a comparison of the original versus updated peak flows was undertaken and the results did not consistently show an increase in peak flows. Within Mimico Creek, a significant increase in peak flows was shown for all nodes during the 5-year storm event (24-146% increase). However, only the upper portion of the watershed showed an increase in peak flows for the 100-year storm event, and the two nodes in the lower portion of the watershed actually showed decreases in peak flows for the 100-year storm event. Although the peak flows during the Regional storm event did not change significantly between the original and updated models for the selected flow nodes (values remained within 10%) a decrease in peak flows was actually calculated for the nodes at the upper and lower portion of the watershed, and not an increase as expected.

Within the Etobicoke Creek watershed, a 50% decrease in peak flows was calculated for the upper portions of the Spring Creek watershed for the 5-year and 100-year storm events (this can be attributed to the construction of a large stormwater management facility at the corner of Dixie and Bovaird that provides quantity control for the 2-100 year events). The pond is currently oversized as the majority of the contributing areas have not been developed. It is expected that peak flows from the pond will increase once the upstream areas are urbanized.

The remaining 3 nodes all showed an increase in peak flows (between 19-37% increases) when comparing the original values to updated values for the 5-year and 100-year events. The increases on the main branch of Etobicoke creek are relatively small and can be accounted for by the general reasons for increases described earlier in this section. The Regional peak flows in Etobicoke Creek increased by 2-19% throughout the watershed in the updated model.

In addition to the general factors that may contribute to changes in peak flows when comparing two different models, the following are factors specific to the Etobicoke and Mimico Creeks watersheds that can also validate the findings:

- significantly more development has occurred in the upper portion of these watersheds since the original hydrology updates were completed which would explain why the most substantial increases were calculated at the upper nodes.

- the on-line pond at Dixie and Bovaird (Pond #13) was constructed after the 1996 hydrology study was undertaken. However, it was included in the 2007 updated model. This stormwater management pond was designed to provide peak flow attenuation for the 2 year to the 100 year storm event. As a result, the 5 year and 100 year peak flows at Node G are reduced as this node is located immediately downstream of the pond. It does not, however, provide any quantity control during the Regional storm event.

It should be noted that both the original and updated hydrologic studies utilized the same land use data based on the same Official Plans (OPs). The municipalities of Mississauga, Brampton and Caledon are currently in the process of updating their Official Plans, so the future land use designations are expected to change. As the flow rates that are used to calculate the regulated floodlines take future land use into account, it is standard practice for the Authority to update hydrologic models in due time, once an update to an Official Plan is complete. It is important to incorporate the findings of hydrologic studies wherever possible, into land use planning exercises (i.e. provide input to the selection of growth areas) in order to protect areas that may be at the threshold of flooding from future increased risks. The Mimico Creek watershed is essentially fully built out at this time, so there will be limited opportunities for additional urban growth in this watershed. Therefore, it is recommended that the hydrologic model for the Etobicoke Creek watershed (only) be revisited in the near future, pending completion of the OP updates.

Peak Flows: Trends
Historical stream flows were collected at two stream gauge locations: i) Mimico Creek at Islington and ii) Etobicoke Creek at QEW. Approximately 40 years of data were available for analysis at each of the gauges. An analysis of the mean annual flow data was undertaken to see if any trends could be identified over the past 40 years, and also for the past 10 years. The results for both scenarios are illustrated in **Figure 5-30** through **Figure 5-33**.

It should be noted that the observed mean annual stream flows are sensitive to the weather conditions of the year. For example, very dry years will record lower mean annual flows, however during that same year a storm with a significant amount of precipitation may have occurred. The analysis presented herein will not capture the maximum peaks during this type of year, however it does provide some understanding of the general trends with respect to whether average flows are increasing or decreasing and it also shows the variability in flows over time. Over the past 40 years, the mean annual flows have varied from 0.3 m^3/s to 1.4 m^3/s

at the Mimico Creek gauge and from 1.4 m^3/s to 3.8 m^3/s at the Etobicoke Creek gauge. In order to gain an overall understanding of the flow pattern, the observed flows for both watersheds were analyzed based on the absolute difference between the trend lines.

As shown in **Figure 5-30** and **Figure 5-32** streamflows in both watersheds have shown a steady increase over the past 40 years (27% increase in Mimico Creek and 44% increase in Etobicoke Creek).

Figure 5-31 and **Figure 5-33** which illustrate the trend over the past 10 years, show a steeper trend line than shown in the 40 year analyses, indicating that the increase in mean annual streamflows has accelerated in both watersheds within the past 10 years. The increase is over 60% in each watershed. For this study, only two stream flow stations with 40 years of data were available for the analysis. In order to confirm if the increase in flows is due to climate change, more flow stations and a longer period of data will be required.

One of the main purposes of stormwater management is to provide quantity control, and to reduce post development peak flows for the 2-100 year storm events to the pre development rates. Therefore, with stormwater management controls in place, stream flows should become stable (or in other words, the increasing trends shown in the previous analysis would not occur). However, the analysis shows that stream flows have increased, especially within the last 10 years. This suggests that:

- current stormwater management practices are not adequate to sustain a desired hydrograph for both watersheds. Therefore, erosion and quantity control criteria should be re-assessed to determine if more stringent stormwater management controls are required for both watersheds, such as quantity controls for the Regional storm event.

- areas currently treated by stormwater management ponds are not sufficient to achieve quantity control targets for the watersheds. As a result, the percentage of treated areas should be increased for both watersheds. This can be achieved through a) retrofitting of existing urbanized areas, and b) providing adequate erosion and quantity controls for new developments.

Figure 5-30: Mimico Creek at Islington Avenue – Streamflow for 40 year period

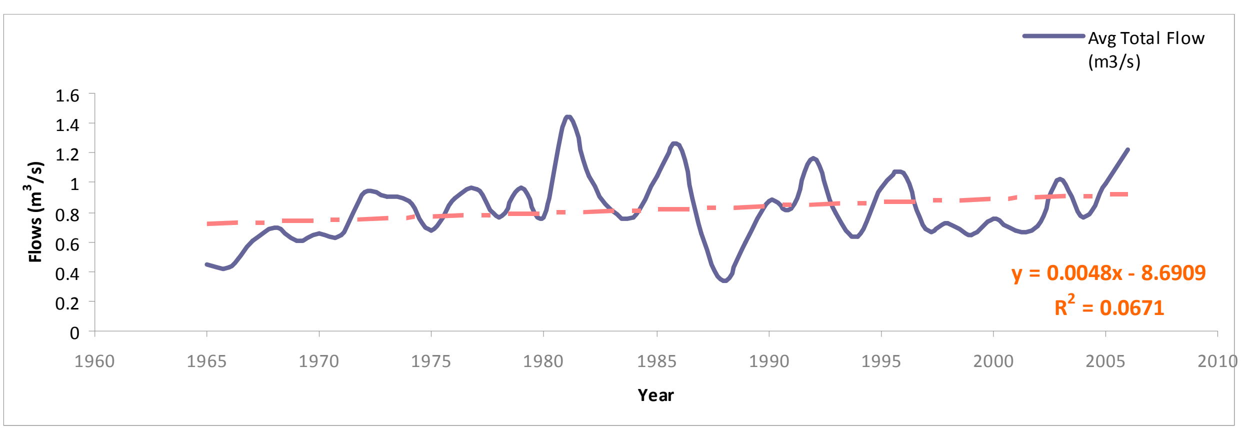


Figure 5-31: Mimico Creek at Islington Avenue – Streamflow for 10 year period

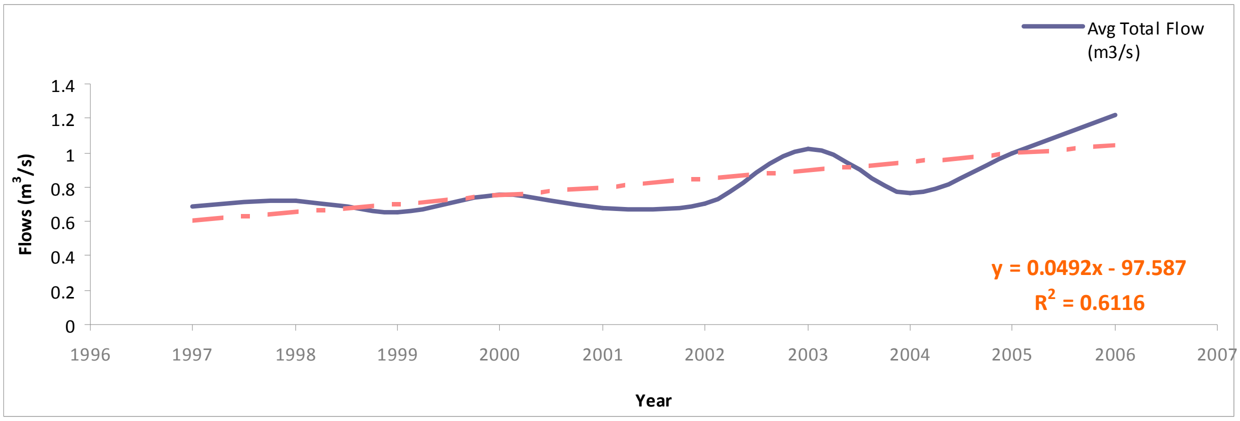


Figure 5-32: Etobicoke Creek at QEW – Streamflow for 40 year period

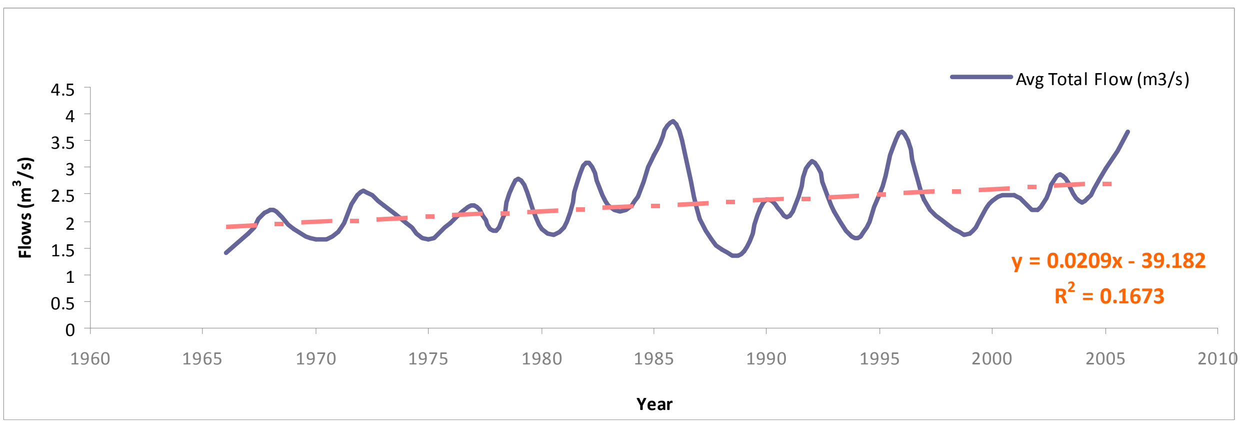
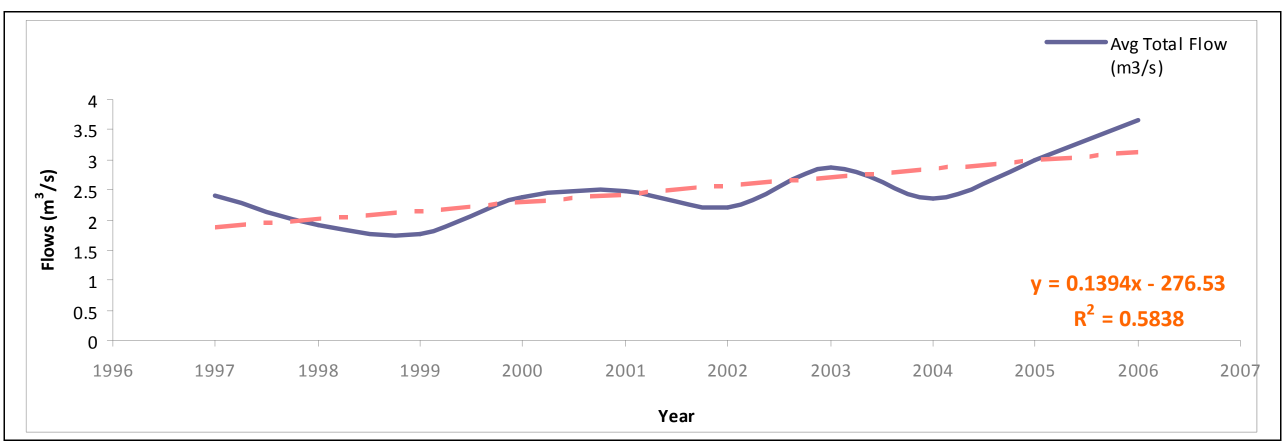


Figure 5-33: Etobicoke Creek at QEW – Streamflow for 10 Year period



Flooding: Flood Vulnerable Areas

During significant rainfall events, both the Etobicoke and Mimico Creeks experience rapid increases in water levels due to their physical nature (highly urbanized, relatively steep and narrow watersheds). The history of flooding indicates a susceptibility to severe summer thunderstorms and late fall tropical storms. Ice jamming at the mouth of the river systems can also be an issue. Generally, it takes a large flow to create significant flooding along the Etobicoke and Mimico Creeks, due to previous flood protection works and the success of flood plain planning regulations which limit development within a floodplain. To date, there are 8 flood control structures within the two watersheds (including the Brampton Diversion Channel which protected the City from flooding during the regional event (1954 Hurricane Hazel).

In 1980, TRCA developed a Flood Control Program that identified flood vulnerable areas within the watersheds. At that time, areas that were prone to flooding were identified as Flood Damage Centres (FDCs), many of which were later given the Provincial Special Policy Area designation. Six flood damage centres were identified within the Etobicoke Creek watershed, and 5 flood damage centres were identified in the Mimico Creek. The FDCs are listed below:

1. Etobicoke Creek East Branch (Peel - north of Steeles to Avondale Blvd., Brampton)
2. Etobicoke Creek West Branch (Peel – vicinity of Clarence St., Brampton)
3. Etobicoke Creek West Branch (Peel – vicinity of Church St., Brampton)
4. Etobicoke Creek Main Branch (Toronto – vicinity of Dundas St.)
5. Little Etobicoke Creek (Peel – vicinity of Dixie Rd., Mississauga)
6. Etobicoke Creek Main Branch (Toronto – east side at Lake Shore Blvd.)
7. Mimico Creek (Peel – west of Airport Rd., Brampton)
8. Mimico Creek (Toronto – west of Islington Rd.)
9. Mimico Creek (Toronto – north of the Queensway)
10. Mimico Creek (Toronto – vicinity of Royal York Rd.)
11. Mimico Creek (Toronto – between Lakeshore Blvd and C.N.R.)

A database of flood vulnerable structures was developed in 2006 which identified individual flood susceptible transportation routes and structures based on the latest hydraulic floodline mapping available. Based on the elevation of the structure, the associated risk of flooding of the flood vulnerable roads (FVRs) and flood vulnerable areas (FVAs) was determined and related to the frequency of flooding based on design storms (2, 5, 10, 25, 50 and 100 year returns) and the regional storm flow. That is to say, the number of structures at risk of flooding was determined based on the severity of the storm event. *Turning over a new leaf: The Etobicoke and Mimico Creeks Watersheds Report Card 2006,* documented 23 FVAs and 41 FVRs in the two watersheds. This information was based on the 1996 regulatory flood elevations, and was based on “clustered” individual structures.

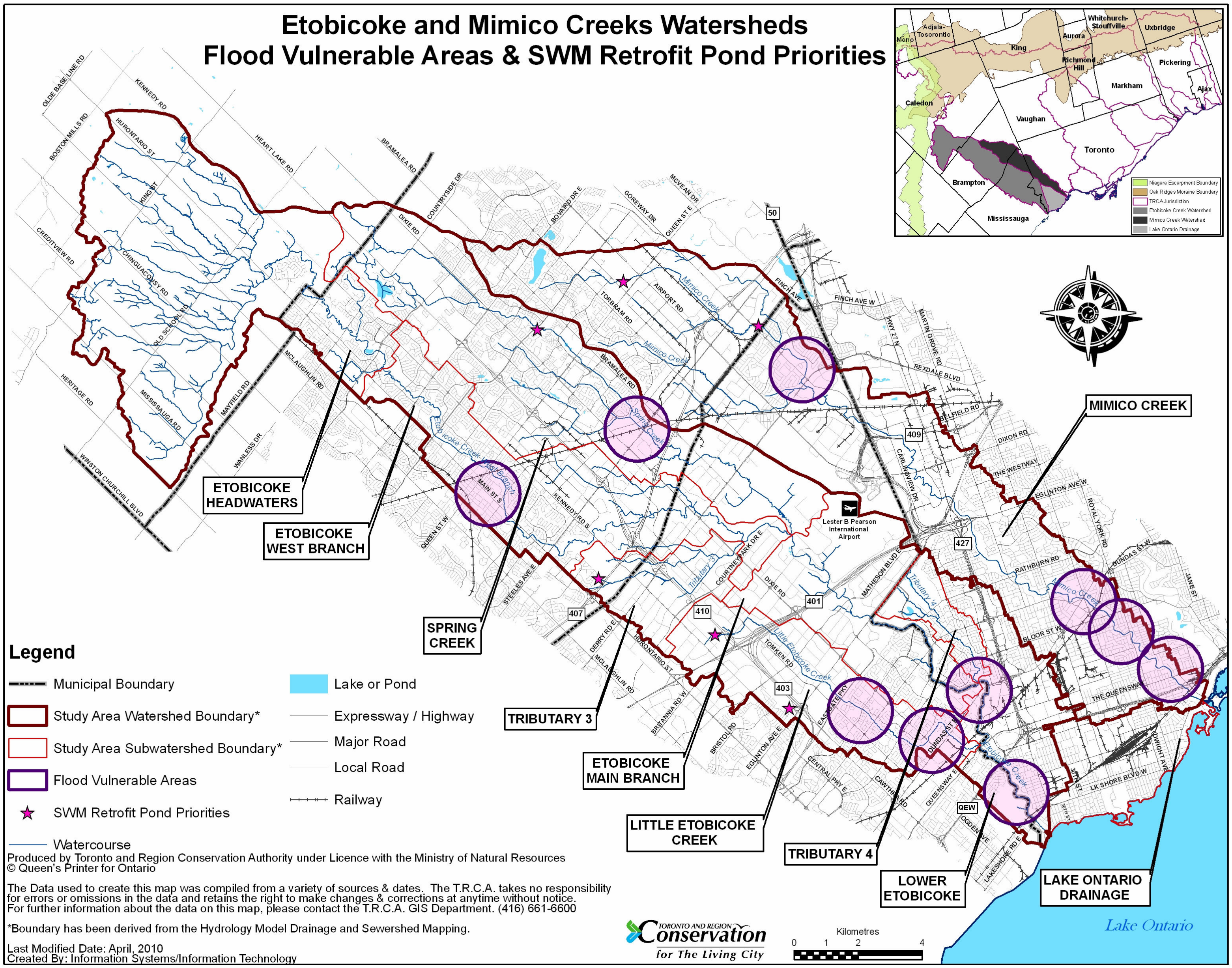
Updated floodline mapping for both watersheds will be completed in 2010, however this information was not available for analysis at the time of writing of this report and subsequently a comparison of current conditions to the 2006 conditions is not possible. Nonetheless, significant changes to the flood vulnerable area database have been realized since it was created in 2006. Previously, “cluster” areas were defined, however, it is now possible to identify individual structures and the total number of flood vulnerable areas and roads. It is, therefore, difficult to compare new data to existing inventories.

Current information within the TRCA database (based on draft floodines for Etobicoke Creek and existing floodlines for Mimico Creek) shows that under a Stage 5 flood (100 year return / Regional Storm) there are 6 significant FVA/FVR cluster areas in the Etobicoke Creek watershed and 4 significant clusters in the Mimico Creek watershed. The locations of the flood vulnerable clusters are displayed in **Figure 5-34**. While it is difficult to compare the 1980 FDCs to the current FVA clusters, the general location and number of flood prone areas remains consistent. Although the general locations of flooding remain consistent, the draft information also indicates there have been significant changes in floodlines, which may result in increased risk to structures within the floodplain. Further analysis and consultation with municipalities and landowners will continue into 2011. Upon completion of the new floodline mapping for both watersheds the FVA/FVR database will be updated (and will provide information on individual structures) and a new baseline will be established and documented.

The sensitivity of the Etobicoke Creek watershed to flooding was demonstrated in a recent analysis of "ultimate scenario" floodlines (which were derived based on a hydrologic model that assumed 50% build-out beyond the current Official Plan designations). This scenario resulted in more FVAs and FVRs within the watershed than under current conditions. The implications for this scenario, in terms of risk to life and property, as well as the restrictions it would impose on new development, illustrate how important it is to manage flows within the watersheds from a flooding perspective.

In addition to flow management, TRCA is currently developing a Flood Protection and Remedial Capital Works Strategy which analyzes existing flood vulnerable areas within TRCA's jurisdiction and identifies areas where flood risk may be reduced through remedial works projects. The Strategy will also establish a priority ranking for the areas and associated remedial projects. This Strategy updates and builds upon the TRCA's 1980 Flood Control Program. A number of developments have occurred since the 1980 Flood Control Program was prepared which necessitate the update, including: new Policies and Legislation (Provincial, Municipal and Authority); the construction of many of the flood control facilities recommended in the 1980 plan; numerous development applications which affect the hydrology (flows) within the watersheds; advances in technology allowing for more accurate modelling and greater coverage of floodline mapping; and the need to prepare for climate change. The implementation of the flood protection strategy will require a coordinated effort between the Conservation Authority, our municipal partners and the provincial government (in some cases) due to the large scale nature of the works and the high costs associated with them. All works would be carried out under the Environmental Assessment process.

Figure 5-34: Flood Vulnerable Clusters



Special Policy Areas
As mentioned above, many of the Flood Damage Centres that were identified by TRCA under the 1980 Flood Control Program were designated as Special Policy Areas (SPAs). These areas, and their associated policies, are administered by the Province (Ministry of Municipal Affairs and Housing and Ministry of Natural Resources). The intent behind designating certain flood prone areas as SPAs was to recognize that historical development existed within floodplains and that some provisions must be made to allow for the continued viability of the area (through limited development opportunities). Today, increasing pressures to develop and intensify within these Special Policy Areas are materializing across the province.

Flood control works, that permanently reduce the extent of the floodplain, will allow for development on lands that were previously designated as SPA (with fewer policy restrictions). While some development is allowed within an SPA, certain floodproofing requirements must be met and intensification is not permitted.

A number of SPAs exist within the Etobicoke and Mimico Creeks watersheds, including the Downtown Brampton SPA and the Dixie/Dundas SPA. Both of these areas are in a period of active growth, and policy management that allows for growth while upholding the TRCA's mandate to implement hazard protection policies (floodplain management) is required.

Major Oaks Pond in the Brampton Esker System, Spring Creek Subwatershed
Major Oaks Park is located northwest of Williams Parkway and Highway 410. Major Oaks Pond receives water from the Brampton Esker Lakes system; a lake system created by the excavation of the Brampton Esker. This unique feature within the Spring Creek subwatershed flows in a northwest to southeast direction. **Figure 5-35** shows the connectivity of the system. For a detailed description and history of the Esker Lakes, see the **Groundwater Quantity and Quality Section.**

Although the Major Oaks pond is not a stormwater management facility (i.e., it does not provide quantity, quality or erosion control), it is discussed in the update for the following reasons:

- it receives storm runoff from four stormwater management ponds (Ponds #214, 381, 281 and 281.1);
- it connects the physically significant Brampton Esker system to Spring Creek;
- the function and operation of the pond has an impact on the risk of flooding to the properties adjacent to the pond.

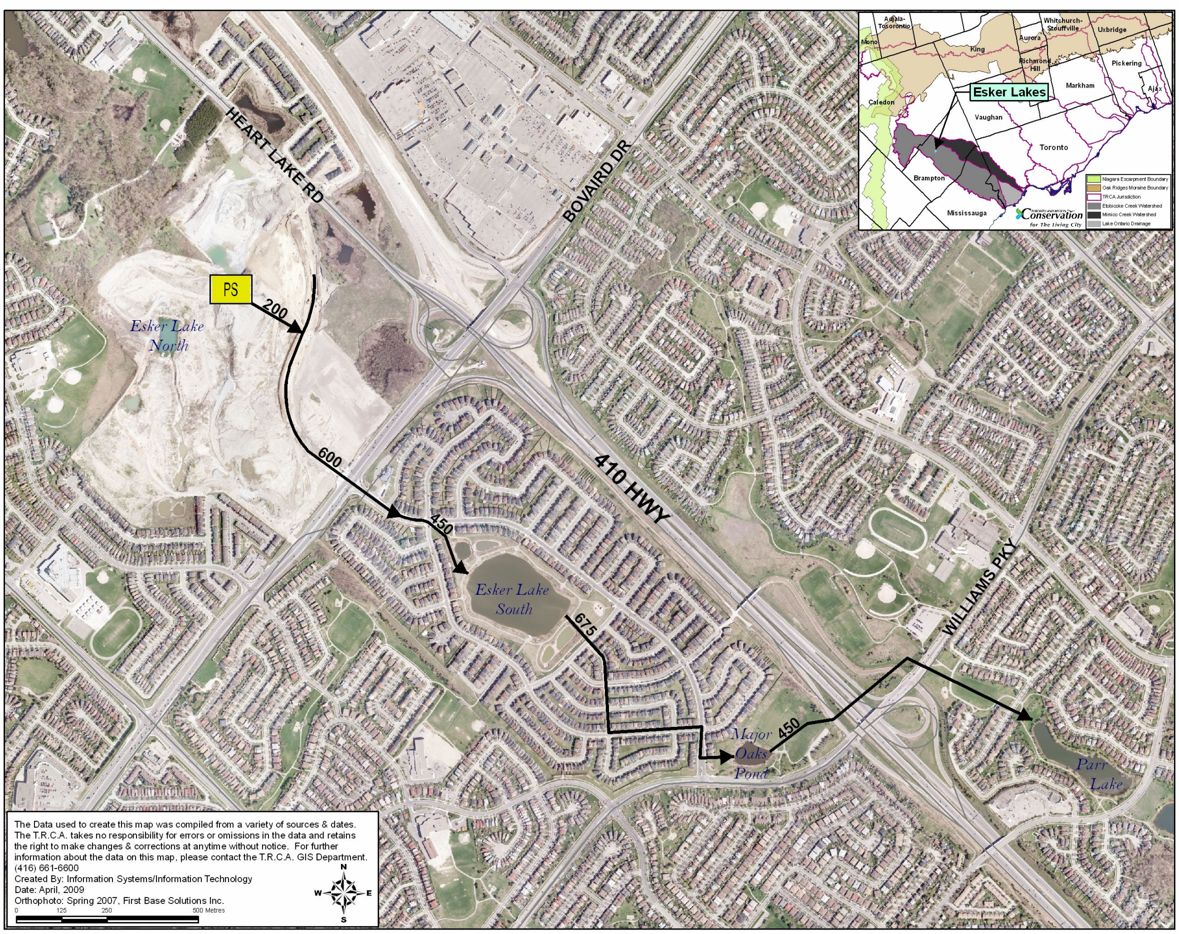
Esker Lake North is located northwest of Bovaird Drive and Heart Lake Road. Two stormwater management ponds (Ponds #214 and 381) have been constructed to treat stormwater from a golf course and outflows from the ponds discharge to a channel that ultimately drains to Esker Lake North. An underground pumping station was recently constructed to continuously divert water from Esker Lake North to Esker Lake South. Over the past 10 years, a large portion of Esker Lake North has been backfilled with impervious material; the implications of this activity are not clear at this stage. However, the groundwater level monitored in a well near Heart Lake has risen significantly and has shown no signs of stabilization to date. The ground water level at properties adjacent to Esker Lake North may have gone up even more than levels measured at the Heart Lake well, which may cause basement flooding during more frequent storms.

Esker Lake South is located south of Bovaird Drive and it receives water from Esker Lake North as well as surrounding subdivisions (Ponds #281 and 281.1). Water levels in Esker Lake South are balanced through a pipe that connects to Major Oaks Pond located in Major Oaks Park. Outflows from the Major Oaks pond are conveyed under Highway 410. Flows are then directed southeasterly to the Parr Lakes and ultimately drain to a tributary of Spring Creek.

As shown in **Figure 5-35**, the connectivity of the entire Esker Lake system relies on a single 450 mm diameter outlet pipe from Major Oaks Pond. The backfilling of Esker Lake North may result in more groundwater contribution to this outlet pipe and may potentially reduce the design capacity of the pipe for stormwater conveyance purposes. A site visit in March 2009 during dry weather conditions found that this outlet pipe was running approximately 40% full, and also that the pipe is in a degraded condition. If this pipe is blocked or the capacity of the pipe is exceeded, water levels in the pond will continue to rise and may spill southerly through a pedestrian underpass beneath Williams Parkway to an existing development.

This situation demonstrates the delicate balance between the natural system (groundwater interaction with surface water systems), and the effect of human disturbance on flood risk. Further monitoring of this area is required to determine whether or not a mitigation plan will be required in the future.

Figure 5-35: Brampton Esker Systems



5.4.9 Summary of Recent Studies Relating to Stormwater Management

A Modelling Assessment of Runoff Water Quality Management in Etobicoke Creek Catchment 219, EBNFLO Environmental, 2005

This study looked at a typical industrial catchment area within the Etobicoke Creek watershed and assessed the potential for improving water quality through the implementation of various treatment scenarios. Catchment 219 is a largely industrial subcatchment of Etobicoke Creek which is approximately bounded by Highway 407 in the north, Courtney Park Drive East in the south, Hurontario Street on the west and Dixie Road on the East. The 960 ha catchment is located upstream and to the west of the Lester B. Pearson International Airport (LBPIA) lands, has a history of industrial spills and visibly poor water quality in recent years (Li, 2003). While no site specific water quality data exists for the area, it was suspected of producing relatively poor quality runoff and may be occasionally responsible for poor surface water quality observed in Etobicoke Creek downstream on the airport lands. Inasmuch as the Greater Toronto Airports Authority (GTAA) redevelopment of the airport involved an extensive SWM program, the benefits may be obscured by poor runoff from Catchment 219 and other upstream catchments.

SWM measures assessed included a wide array of source, conveyance and end-of-pipe control measures packaged into several scenarios. Scenarios represented various levels of adoption and cost. Assessments were conducted on flow and eleven water quality parameters. HSP-F is a deterministic model that simulates runoff and associated water quality from watersheds, delineated into many unique land elements, and delivers these to stream or pond elements. This model was used to simulate the following 8 stormwater management schemes (comprised of source, conveyance and end-of-pipe controls) to assess their effectiveness in improving water quality. Detailed cost estimates for each scenario are also included in the report.

1. Downspouts connected to storm sewer, footers connected to sanitary sewer, no ditch;
2. Downspouts connected to storm sewer, footers disconnected, no ditch;
3. Downspouts connected to storm sewer, footers connected to storm sewers, no ditch;
4. Downspouts disconnected, footers connected to sanitary sewer, no ditch;
5. Downspouts disconnected, footers disconnected, no ditch;
6. Downspouts disconnected, footers connected to storm sewers, no ditch;
7. Downspouts disconnected, footers connected to sanitary sewer with roadside ditches;
8. Downspouts disconnected, footers disconnected with roadside ditches.

The study found that the way in which measures are packaged influences the overall effectiveness of a SWM program. For example, wet ponds are one of the most effective measures for water quality improvement, however, their removal efficiency is somewhat reduced when preceded by other elements of a program, such as conveyance system controls or on site devices (i.e., Oil Grit Separators). The Operations and Maintenance (O&M) program provides reductions of about 10 to 15%. Minimum source controls provide an additional reduction in the range of 4 to 10%. Maximum source controls increase the benefit by a factor of 2 to 3. Copper reductions are higher with a strategic program to eliminate site runoff from dirtier industrial sites. Therefore with an O&M program and maximum source controls the contaminant reductions are in the range of 25 to 35%.

Conveyance and end-of-pipe systems are viewed in conjunction with source controls in effect since source control is likely to be included in a SWM program. Full servicing of the catchment with conveyance systems is not as effective as completing the full servicing by normal (Level II) wet ponds or the equivalent. The most aggressive system (Scenario #9), including chemical treatment and ultraviolet disinfection, is capable of reducing loads after maximum source control and O&M by an additional 70 to 80% (except TKN at 63% and NOx at 23%).

A comprehensive summary of the modelling results is provided in the report along with recommendations for future studies/actions. Recommendations are provided for developing a conceptual SWM program in Catchment 219 that will control pollutant runoff and hazardous material spills. The first priority in formulating these recommendations is the need to improve water quality and hydrologic conditions in the catchment and the second priority is cost to implement and operate the program.

In general, conveyance systems are recommended for new road works where suitable in terms of soils, drainage area and absence of existing controls (i.e., wetponds). End-of-pipe controls, such as wetponds were found to provide several advantages in terms of pollution abatement, spills control and flow rate reduction. It was recommended that all residential and industrial areas be serviced with wet ponds (and that existing dry ponds be retrofitted). All ponds in the catchment should be considered for chemical and bacteria removal if monitoring reveals that instream water quality targets cannot otherwise be achieved. Residential area recommendations also included: an education program regarding downspout disconnections, rain barrels, plantings and porous pavement. Industrial source control measures included: roof gardens, rerouting parking area runoff to grass and installation of green roofs and oil and grit separators where appropriate.

A monitoring system should be installed at strategic sites to facilitate spills controls. The report recommends appropriate site locations (such as the inlets to the Everlast and Derry East ponds as well as others). Wet ponds provide an opportunity to capture and retain spills, and oil and grit separators have been recommended for all higher risk industries as a way to contain spills onsite.

GTAA Living City Project, TRCA 2006
As previously mentioned, the Lester B. Pearson International Airport has a significant presence within the Etobicoke and Mimico Creeks watersheds. In 2006, a major study was undertaken that examined four components of a watershed management plan in detail: Terrestrial Natural Heritage, Aquatic Ecosystems, Stormwater Management and Integration and Priority Implementation Recommendations. As part of the Stormwater Management component, a review of the stormwater management facilities on the LBPIA lands was conducted.

At the time of writing of the report, approximately $150 million had been spent on numerous water quality enhancement projects, including three underground treatment tanks, a two-celled treatment wetland, and many other associated structures. No feasible retrofit opportunities for effective stormwater management were identified during the study on LBPIA lands. In fact, the GTAA is a world leader in stormwater management amongst airport facilities.

The TRCA stormwater management criteria states that quantity control is not required on Etobicoke Creek in this section of the watershed, however some peak flow facilities were found to be necessary to reduce discharge rates to meet the capacity limit of the receiving Mississauga storm sewers. Water quality control facilities were sized to treat runoff from a 13mm rainfall event (based on MOEE and MNR Interim Stormwater Quality Control criteria, 1991). Erosion control is achieved through controlling runoff from a 25mm event. Also, areas subject to contamination by glycol are fitted with facilities that will store the volume of runoff from the average two week period including snowmelt during the de-icing season.

Within the GTAA property boundary there are 10 ponds. All of the ponds are sized for the 25mm rainfall event with 24 hour detention, with the exception of three, which were sized to accommodate the 100 year storm and have controlled discharge rates. Stormwater management data for the LBPIA lands has been incorporated into the analyses in **Sections 5.4.3-5.4.6 (**existing stormwater management statistics).

Other Studies Currently Underway
A number of studies are currently underway that will add to the body of knowledge regarding stormwater management in the two watersheds. The TRCA has undertaken a stream inventory of both the Mimico and Etobicoke Creeks, entitled “The Peel Channels Study” and a database has been created to document the conditions of the channels (e.g., concrete lined, natural channel, channel stability, infrastructure at risk etc). As previously mentioned, two municipal studies relating to stormwater are well underway: the Mississauga Water Quality Strategy Update and the Brampton Stormwater Management Master Plan.

5.4.10 Summary of Findings

The stormwater management practices were reviewed for the Etobicoke and Mimico Creeks watersheds, along with the historical and modelled surface flows. The findings of the study are summarized below:

- Both watersheds are highly urbanized resulting in a high degree of imperviousness. Based on TRCA 2002 land use data, approximately 88% of the Mimico Creek watershed and 63% of the Etobicoke Creek watershed are designated as urban.
- The Etobicoke Headwater subwatershed contains the only remaining rural lands; however, much of these areas are under development or are slated for future development.
- There are 46 stormwater management ponds within the Etobicoke Creek watershed, 25 ponds within the Mimico Creek watershed and 2 stormwater management ponds in the Lake Ontario Drainage Area. The majority of the existing stormwater management ponds within the watersheds do not meet current standards as they were developed prior to the implementation of water quality and erosion control. In addition, there are 10 online ponds within the two watersheds (although an Environmental Assessment to retrofit the Kenfask Pond in Mimico Creek is currently underway).
- Only 30% of the urbanized areas within the watersheds were developed with the benefit of stormwater management plans, and consequently 70% of urban areas do not have stormwater management controls.
- Approximately 8% of the urbanized areas in the Mimico Creek watershed have quality treatment and only 0.2% of the developed areas provide an Enhanced level of quality treatment, as defined by the Ministry of the Environment’s *Stormwater Management Planning and Design Manual* (2003). Similarly, approximately 21% of the developed areas in the Etobicoke Creek watershed have quality treatment and only 2% represents an Enhanced level of treatment. Less than 50% of the urbanized areas within the subwatersheds of Etobicoke Creek have quality treatment.

- Only 9% of the developed areas in the Mimico Creek watershed and 25% of the developed areas in the Etobicoke Creek watershed have erosion controls. Less than 20% of the urbanized areas within most of the subwatersheds of Etobicoke Creek have erosion controls. The predominant level of erosion controls is 25 mm/24 hour.
- Currently the majority of the watershed areas do not require quantity control, while some areas require the control of post development flows to the pre development levels (2-100 year events only). In all, only 22% of the developed areas in Etobicoke Creek watershed and 26% of developed areas in the Mimico Creek watershed require quantity controls. This generally reflects current requirements at the time of development. It is time to review and confirm quantity control criteria
- Opportunities to improve the level of treatment of stormwater (by retrofitting existing stormwater management facilities and outfalls as well as constructing new end of pipe facilities) have been identified through studies undertaken by TRCA and individual municipalities. However, given the limited area that is currently treated by SWM facilities, and the highly urbanized nature of the watersheds (with limited opportunity to construct new ponds) innovative approaches to stormwater management should be considered.
- Design flows from the original and updated hydrology models were compared for both watersheds. For Mimico Creek, models showed an increase in flows for the 5 year event at 3 nodes within the watershed. Modelling indicated an increase in flow during the 100 year event at the upper portion of the watershed only, and a decrease at the lower nodes. The Regional event showed a decrease in flow, although for both the Regional and 100 year, results may be attributed to variations in the modelling techniques as no substantial change in land use or other model parameters occurred.
- Etobicoke Creek modelled design flows showed a 50% reduction for both the 5 year and 100 year events at the top end of Spring Creek. This is due to the fact that the Dixie Bovaird pond was not yet constructed at the time of the original model and is now providing flow attenuation. Further down in the watershed, the impact of the pond dissipates and flows were shown to increase for both events. The Regional event (which is not affected by the Bovaird pond) showed an increase by 2-19% throughout the watershed.
- Historical streamflow data were analyzed, and the results showed that mean annual streamflow in both watersheds has increased over the past 40 years (27% increase in Mimico Creek and 44% increase in Etobicoke Creek), and the increase has been accelerating for the past 10 years (with a 60% increase measured over this time period).
- Current stormwater management practices within the watersheds are not adequate to achieve the overall quantity control targets. As a result, more stringent stormwater management controls are required for both watersheds (i.e. maintain or reduce baseline peak flows for 2 to 100 year return periods).
- While updated flood vulnerable area data were not available for analysis, draft information indicated that the number of flood vulnerable "clusters", or broad scale areas, has not increased since the 1980 Flood Control Study. However, funding for undertaking flood protection capital works has not been available and therefore no flood vulnerable clusters have been eliminated since 1980. New data management tools will allow for more refined analyses of flood vulnerable areas when updated floodline mapping is available (expected in 2010).
- Several "critical" areas with respect to flood risk have been identified through this study that may or may not become flood vulnerable areas. The properties in the vicinity of

Major Oaks Pond in Brampton are at a potential risk of flooding due to recent modifications to the Brampton Esker system. The future impacts of this activity are unknown at this time; further study to assess the risks and to determine appropriate actions is recommended. The situation highlights the often delicate balance between the groundwater system, surface water system and flood risk. In addition, development potential of the special policy areas within the watersheds, and in particular, the Downtown Brampton SPA and the Dixie/Dundas SPA will require harmonizing of the planning policies with hazard management policies.

- The detailed review of the existing information for the watersheds has revealed the need to update certain information (e.g., delineation of drainage boundaries). The need to update the hydrology models in keeping with the timing of updates to the various Official Plan updates, and to reassess stormwater management criteria based on the findings of the study has also been identified. It is recommended that updates to the data as required be addressed during the future updates.

5.5 MANAGEMENT RECOMMENDATIONS

The urbanization of the Etobicoke and Mimico Creeks watersheds without adequate stormwater management controls, has led to deteriorating water quality, channel erosion and flooding along the river system. The main purpose of the Watershed Technical Update is to develop a strategy that will support the long-term sustainability of these watersheds. In order to achieve this goal, the following approaches to managing the watersheds are recommended:

SWM Policy, Criteria and Program Maintenance:

- Given the limited opportunities to build new stormwater management facilities, implementation of source controls and conveyance controls (i.e. low impact development techniques) should be encouraged for all new development and infill developments. These may include infiltration systems, green roofs, bioretention facilities etc. This approach will lead to reduced volumes of runoff and will improve water quality, provide quantity control and reduce instream erosion.
- A substantial portion of the watersheds is not subject to any quantity controls due to the current criteria. This criteria is not necessarily appropriate for current conditions (as it was developed in 1978). Based on the findings of the most recent hydrology updates (2007 TSH study for Etobicoke Creek and 2009 MMM study for Mimico Creek) new quantity control criteria should be developed. Peak flows within the Etobicoke Creek have shown significant increases over previous models and therefore more stringent quantity control criteria may be required to minimize downstream impacts.
- TRCA should undertake timely updates to the hydrology models for both watersheds. Timing should coincide with the Official Plan updates of our member municipalities (approximately every 5 years).
- Strategies and protocols that are adaptive to climate change scenarios, such as increased intensity and frequency of extreme storm events should be developed. Although the trend analyses presented in this study do not show definitive evidence that the accelerated increases in mean annual peak flows are a result of climate change, this trend should continue to be monitored and other potential metrics should be considered.
- Ensure that Master Environmental Servicing Plan (MESP) studies address quality, erosion, quantity and water balance aspects of stormwater management, for all new development blocks. Infill development should be subjected to the current stormwater

management criteria and site level retrofits (such as greenroofs or bioswales) should be required.
- Recognize the need to integrate floodline management with development review in high risk areas (such as Special Policy Areas). This is even more prevalent today given the current planning approach of intensification around urban centres. Maintaining or reducing peak flow rates is critical to maintaining the existing extent of the floodplain.

Monitoring and Further Study:
- Maintain TRCA's Regional Monitoring Network sites within the watershed to measure quality, erosion at sensitive locations. The current coverage of stream gauging is not adequate to allow for effective calibration of hydrology models. Therefore, the identification of appropriate gauging sites and installation should be undertaken by TRCA's hydrometrics group, as funding permits.
- A few discrepancies in the data were identified during this study that did not affect the general results of the analysis, but should be resolved in the near future. In particular, the cross-boundary issues (delineation of external watershed boundaries) should be corrected to more accurately reflect existing conditions and to allow for more accurate modelling and watershed management. This is a mapping exercise to be lead by TRCA's GIS department, with support from technical staff and watershed specialists.
- Further monitoring and analysis of the Brampton Esker system (particularly the outlet of the Major Oaks stormwater pond) is recommended to assess potential changes to the hydrology and hydraulics as a result of the backfilling of Esker Lake North. Mitigation options should be determined based on a variety of scenarios so that action can proceed in a timely manner.

Continuous Improvements to SWM Practice:
- The flood protection and remedial capital works strategy should be completed and projects that will mitigate flooding should be undertaken as funding permits. TRCA will encourage partnerships between our member municipalities and the province to expedite these works. These works are an important step toward achieving the goal of reducing the number of flood vulnerable areas and roads within the watersheds to protect existing and future properties.
- Opportunities to implement the findings of the retrofit studies and the Catchment 219 study should be pursued.
- TRCA and the municipalities should continue to work together in the development of their stormwater management strategies. Partnerships should be strengthened to expedite improvements to the watersheds and continually advance the science and practice. The Regional Stormwater Management Strategy to be led by the Region of Peel, in partnership with area Municipalities and Conservation Authorities represents an opportunity to define mandates, roles, a collaborative work program of priority initiatives and sustainable funding sources and/or arrangements, which would significantly benefit these watersheds.

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5.7 APPENDIX 5-A: DETAILED LAND USE BREAKDOWN

	Etobicoke Creek																										Mimico Creek
	Etobicoke Headwaters			Etobicoke Main Branch			Etobicoke West Branch			Little Etobicoke Creek			Lower Etobicoke			Spring Creek			Tributary 3			Tributary 4			Total		
Land Use (2002)	Area (ha)	% Sbwtrshd	% Wtrshd	Area (ha)	% Sbwtrshd	% Wtrshd	Area (ha)	% Sbwtrshd	% Wtrshd	Area (ha)	% Sbwtrshd	% Wtrshd	Area (ha)	% Sbwtrshd	% Wtrshd	Area (ha)	% Sbwtrshd	% Wtrshd	Area (ha)	% Sbwtrshd	% Wtrshd	Area (ha)	% Sbwtrshd	% Wtrshd	Area (ha)	%	%
Agricultural	4194.0	70.3	19.3													563.4	12.1	2.6							4757.3	21.9	
Vacant																											0.2
Total, Undeveloped Land	**4194.0**	**70.3**	**19.3**													**563.4**	**12.1**	**2.6**							**4757.3**	**21.9**	**0.2**
Beach/Bluff													0.8	0.0	0.0										0.8	0.0	
Forest	441.3	7.4	2.0	93.3	3.9	0.4	98.8	3.0	0.5	68.1	3.0	0.3	94.7	5.5	0.4	216.5	4.6	1.0	5.1	0.5	0.0	25.5	5.0	0.1	1043.2	4.8	1.9
Meadow	315.4	5.3	1.5	181.2	7.7	0.8	351.8	10.8	1.6	341.7	15.3	1.6	89.9	5.2	0.4	282.1	6.0	1.3	149.4	14.8	0.7	18.3	3.6	0.1	1729.7	8.0	7.4
Parkway Belt				5.0	0.2	0.0	95.3	2.9	0.4	37.2	1.7	0.2				64.3	1.4	0.3	74.8	7.4	0.3				276.5	1.3	1.5
Successional	20.1	0.3	0.1	7.6	0.3	0.0	1.3	0.0	0.0	12.8	0.6	0.1	6.7	0.4	0.0	16.9	0.4	0.1	3.5	0.3	0.0	2.5	0.5	0.0	71.2	0.3	0.5
Wetland	62.7	1.1	0.3	2.1	0.1	0.0	4.1	0.1	0.0	5.1	0.2	0.0	0.2	0.0	0.0	49.7	1.1	0.2	2.9	0.3	0.0	2.5	0.5	0.0	129.5	0.6	0.2
Total, Natural	**839.5**	**14.1**	**3.9**	**289.1**	**12.2**	**1.3**	**551.3**	**17.0**	**2.5**	**464.9**	**20.8**	**2.1**	**192.2**	**11.1**	**0.9**	**629.4**	**13.5**	**2.9**	**235.7**	**23.3**	**1.1**	**48.8**	**9.6**	**0.2**	**3250.9**	**15.0**	**11.5**
Cemetery	0.2	0.0	0.0				10.2	0.3	0.0							0.3	0.0	0.0	25.9	2.6	0.1	0.4	0.1	0.0	37.1	0.2	0.0
Urban Open Space	187.4	3.1	0.9	63.5	2.7	0.3	194.5	6.0	0.9	68.7	3.1	0.3	60.9	3.5	0.3	307.4	6.6	1.4	18.1	1.8	0.1	121.5	24.0	0.6	1022.1	4.7	3.5
Open Water	2.3	0.0	0.0																						2.3	0.0	0.3
Recreational							36.2	1.1	0.2	6.5	0.3	0.0	21.1	1.2	0.1				2.9	0.3	0.0				66.6	0.3	1.3
Golf Course				50.6	2.1	0.2	35.9	1.1	0.2				47.9	2.8	0.2	45.1	1.0	0.2	44.8	4.4	0.2	43.9	8.7	0.2	268.1	1.2	1.3
Utility				6.0	0.3	0.0				8.2	0.4	0.0	13.7	0.8	0.1				3.5	0.3	0.0	8.8	1.7	0.0	40.2	0.2	0.5
Total, Other	**190.0**	**3.2**	**0.9**	**120.0**	**5.1**	**0.6**	**276.8**	**8.5**	**1.3**	**83.3**	**3.7**	**0.4**	**143.6**	**8.3**	**0.7**	**352.8**	**7.6**	**1.6**	**95.2**	**9.4**	**0.4**	**174.7**	**34.5**	**0.8**	**1436.4**	**6.6**	**7.0**
Commercial	48.1	0.8	0.2	28.0	1.2	0.1	185.3	5.7	0.9	78.4	3.5	0.4	198.5	11.5	0.9	186.0	4.0	0.9	31.7	3.1	0.1	7.9	1.6	0.0	764.1	3.5	4.2
Industrial	83.3	1.4	0.4	846.9	35.8	3.9	863.2	26.6	4.0	928.9	41.5	4.3	406.8	23.6	1.9	757.5	16.2	3.5	561.7	55.5	2.6	22.2	4.4	0.1	4470.5	20.6	31.8
Institutional	37.3	0.6	0.2	43.0	1.8	0.2	110.2	3.4	0.5	42.8	1.9	0.2	57.7	3.3	0.3	152.3	3.3	0.7	1.5	0.1	0.0	10.7	2.1	0.0	455.5	2.1	3.0
Total, IC&I	**168.8**	**2.8**	**0.8**	**917.9**	**38.8**	**4.2**	**1158.7**	**35.7**	**5.3**	**1050.1**	**46.9**	**4.8**	**663.0**	**38.4**	**3.1**	**1095.8**	**23.5**	**5.0**	**594.9**	**58.8**	**2.7**	**40.8**	**8.1**	**0.2**	**5690.1**	**26.2**	**39.0**
High Density Residential	3.8	0.1	0.0	88.3	3.7	0.4	46.9	1.4	0.2	65.8	2.9	0.3	59.7	3.5	0.3	114.4	2.5	0.5	2.1	0.2	0.0	0.9	0.2	0.0	381.9	1.8	0.7
Medium Density Residential	14.2	0.2	0.1	80.8	3.4	0.4	98.0	3.0	0.5	139.9	6.3	0.6	219.8	12.7	1.0	215.3	4.6	1.0	1.7	0.2	0.0	17.2	3.4	0.1	786.8	3.6	10.3
Low/Medium Density Residential	492.4	8.2	2.3	254.4	10.8	1.2	987.5	30.5	4.5	343.2	15.3	1.6	334.8	19.4	1.5	1034.3	22.2	4.8	36.3	3.6	0.2	224.0	44.2	1.0	3706.8	17.1	20.8
Total, Residential	**510.3**	**8.5**	**2.3**	**423.4**	**17.9**	**1.9**	**1132.3**	**34.9**	**5.2**	**549.0**	**24.5**	**2.5**	**614.3**	**35.6**	**2.8**	**1364.0**	**29.2**	**6.3**	**40.0**	**4.0**	**0.2**	**242.1**	**47.8**	**1.1**	**4875.5**	**22.4**	**31.8**
Airport	67.5	1.1	0.3	557.0	23.6	2.6	33.1	1.0	0.2							537.0	11.5	2.5							1194.6	5.5	5.7
Highway				57.2	2.4	0.3	71.5	2.2	0.3	88.6	4.0	0.4	94.8	5.5	0.4	112.0	2.4	0.5	46.6	4.6	0.2				470.7	2.2	3.2
Railway							18.7	0.6	0.1	1.6	0.1	0.0	17.9	1.0	0.1	9.2	0.2	0.0							47.4	0.2	1.6
Total, Transportation	**67.5**	**1.1**	**0.3**	**614.2**	**26.0**	**2.8**	**123.4**	**3.8**	**0.6**	**90.1**	**4.0**	**0.4**	**112.7**	**6.5**	**0.5**	**658.1**	**14.1**	**3.0**	**46.6**	**4.6**	**0.2**				**1712.7**	**7.9**	**10.6**
Total	**5970.0**	**100.0**	**27.5**	**2364.7**	**100.0**	**10.9**	**3242.4**	**100.0**	**14.9**	**2237.4**	**100.0**	**10.3**	**1725.9**	**100.0**	**7.9**	**4663.5**	**100.0**	**21.5**	**1012.4**	**100.0**	**4.7**	**506.4**	**100.0**	**2.3**	**21722.9**	**100.0**	**100.0**

Land Use (2002)	Etobicoke Creek																										Mimico Creek
	Etobicoke Headwaters			Etobicoke Main Branch			Etobicoke West Branch			Little Etobicoke Creek			Lower Etobicoke			Spring Creek			Tributary 3			Tributary 4			Total		
	Area (ha)	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha)	Percent	Percent
Open Water	2.3	0.0	0.0																						2.3	0.0	0.3
Rural	4194.0	70.3	19.3													563.4	12.1	2.6							4757.3	21.9	
Natural	839.5	14.1	3.9	289.1	12.2	1.3	551.3	17.0	2.5	464.9	20.8	2.1	192.2	11.1	0.9	629.4	13.5	2.9	235.7	23.3	1.1	48.8	9.6	0.2	3250.9	15.0	11.5
Urban	934.2	15.6	4.3	2075.6	87.8	9.6	2691.2	83.0	12.4	1772.5	79.2	8.2	1533.7	88.9	7.1	3470.7	74.4	16.0	776.8	76.7	3.6	457.6	90.4	2.1	13712.3	63.1	88.2
Total	**5970.0**	**100.0**	**27.5**	**2364.7**	**100.0**	**10.9**	**3242.4**	**100.0**	**14.9**	**2237.4**	**100.0**	**10.3**	**1725.9**	**100.0**	**7.9**	**4663.5**	**100.0**	**21.5**	**1012.4**	**100.0**	**4.7**	**506.4**	**100.0**	**2.3**	**21722.9**	**100.0**	**100.0**

Land Use (2002)	Etobicoke Creek																										Mimico Creek
	Etobicoke Headwaters			Etobicoke Main Branch			Etobicoke West Branch			Little Etobicoke Creek			Lower Etobicoke			Spring Creek			Tributary 3			Tributary 4			Total		
	Area (ha)	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha	ent (Subwater	ent (Water	Area (ha)	ent (Subwater	ent (Water	Area (ha)	Percent	Percent
Undeveloped Land	**4194.0**	**70.3**	**19.3**													**563.4**	**12.1**	**2.6**							**4757.3**	**21.9**	**0.2**
Natural	**839.5**	**14.1**	**3.9**	**289.1**	**12.2**	**1.3**	**551.3**	**17.0**	**2.5**	**464.9**	**20.8**	**2.1**	**192.2**	**11.1**	**0.9**	**629.4**	**13.5**	**2.9**	**235.7**	**23.3**	**1.1**	**48.8**	**9.6**	**0.2**	**3250.9**	**15.0**	**11.5**
Other	**190.0**	**3.2**	**0.9**	**120.0**	**5.1**	**0.6**	**276.8**	**8.5**	**1.3**	**83.3**	**3.7**	**0.4**	**143.6**	**8.3**	**0.7**	**352.8**	**7.6**	**1.6**	**95.2**	**9.4**	**0.4**	**174.7**	**34.5**	**0.8**	**1436.4**	**6.6**	**7.0**
IC&I	**168.8**	**2.8**	**0.8**	**917.9**	**38.8**	**4.2**	**1158.7**	**35.7**	**5.3**	**1050.1**	**46.9**	**4.8**	**663.0**	**38.4**	**3.1**	**1095.8**	**23.5**	**5.0**	**594.9**	**58.8**	**2.7**	**40.8**	**8.1**	**0.2**	**5690.1**	**26.2**	**39.0**
Residential	**510.3**	**8.5**	**2.3**	**423.4**	**17.9**	**1.9**	**1132.3**	**34.9**	**5.2**	**549.0**	**24.5**	**2.5**	**614.3**	**35.6**	**2.8**	**1364.0**	**29.2**	**6.3**	**40.0**	**4.0**	**0.2**	**242.1**	**47.8**	**1.1**	**4875.5**	**22.4**	**31.8**
Transportation	**67.5**	**1.1**	**0.3**	**614.2**	**26.0**	**2.8**	**123.4**	**3.8**	**0.6**	**90.1**	**4.0**	**0.4**	**112.7**	**6.5**	**0.5**	**658.1**	**14.1**	**3.0**	**46.6**	**4.6**	**0.2**				**1712.7**	**7.9**	**10.6**
Total	**5970.0**	**100.0**	**27.5**	**2364.7**	**100.0**	**10.9**	**3242.4**	**100.0**	**14.9**	**2237.4**	**100.0**	**10.3**	**1725.9**	**100.0**	**7.9**	**4663.5**	**100.0**	**21.5**	**1012.4**	**100.0**	**4.7**	**506.4**	**100.0**	**2.3**	**21722.9**	**100.0**	**100.0**