Weathering the Storms:

Municipalities Plead for Stormwater Infrastructure Funding

ONTARIO SOCIETY OF PROFESSIONAL ENGINEERS
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Residential & Civil Construction Alliance of Ontario
RCCAO
Constructing Ontario's Future

OSWCA
Ontario Sewer & Watermain Construction Association

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TABLE OF CONTENTS

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ABOUT

OSPE

The Ontario Society of Professional Engineers (OSPE) is the voice of the engineering profession in Ontario. We represent the entire engineering community, including engineers, engineering professionals, graduates, and students who work or will work in several of the most strategic sectors of Ontario's economy.

OSPE elevates the profile of the profession by advocating with governments, offering valued member services and providing opportunities for ongoing learning, networking and community building.

OSPE was formed in 2000 after members of Professional Engineers Ontario (PEO) voted to separate regulatory and advocacy functions into two distinct organizations.

RCCAO

The Residential and Civil Construction Alliance of Ontario (RCCAO) is an alliance composed of management and labour groups that represents a wide spectrum of the province's construction industry. RCCAO's goal is to work in cooperation with governments and related stakeholders to offer realistic solutions to a variety of challenges facing the construction industry, and which also have wider societal benefits.

Our motto is "Constructing Ontario's Future," because together we build the homes, roads, watermains and much more. This infrastructure is of critical importance to the residents and businesses of Ontario. We have always taken pride in the quality of work that goes into building our communities and aim to collectively accomplish even greater things to meet the demands of a growing population.

OSWCA

The Ontario Sewer and Watermain Construction Association (OSWCA) is a champion of environmental protection and best practices in safety and water system management. We have represented the sewer and watermain construction industry in Ontario since 1971. We represent over 750 companies across Ontario including contractors, manufacturers, distributors and consulting engineers. Collectively, we perform over $1 billion a year in capital projects to ensure clean safe drinking water and environmentally responsible wastewater and stormwater treatment and disposal.

The OSWCA is the voice of the sewer and watermain industry and continually promotes the delivery of clean water, safe wastewater and stormwater management through advocacy, education and environmentally sustainable practices to enhance the quality of life for all Ontarians. The OSWCA motto is "Clean Water is Everybody's Business.

EXECUTIVE SUMMARY

In order to assess Ontario's ability to cope with the impending impacts of climate change and severe weather patterns, The Ontario Society of Professional Engineers (OSPE), Residential and Civil Construction Alliance of Ontario (RCCAO), and Ontario Sewer and Watermain Construction Association (OSWCA) have partnered to conduct a study of the condition of stormwater infrastructure and the type of asset management planning that is done in municipalities across Ontario.

A survey was sent to one representative in a pertinent department at all 444 Ontario municipalities in February 2017. A total of 55 surveys were completed. Recipients were asked to complete the survey anonymously so that aggregated data from local experiences could be collected to generate evidence and recommendations for policy and decision makers.

In looking at survey responses, especially those from open-ended questions, several key messages can be identified.

- Significant investments will be required to maintain or bring municipal stormwater infrastructure up to a good or better condition rating.
- Most municipalities do not have adequate Stormwater Infrastructure Asset Management Plans (SIAMP); adequate funding resources to meet the changing demands and regulatory requirements for these assets; and/or, the human resources to appropriately track and monitor these assets and their metrics.
- Stormwater infrastructure assets are a major part of municipal infrastructure and need to be appropriately accounted for in municipal asset management plans.
- Climate change and its effects on stormwater infrastructure is recognized by municipalities and a palpable apprehension for what this means in future.

Key statistics garnered from survey results include:

- Most respondents represent towns with a population of less than 50,000. However, cities of all population sizes are represented and come from all regions of Ontario.
- 58% have limited to no engineered stormwater management infrastructure.
- 35% have a separate SIAMP from their water/wastewater plan.
- Only 15% have a Stormwater Monitoring Plan – a plan that collects data on the performance of the existing systems (i.e. are stormwater ponds meeting environmental compliance?).
- Only 11% reported that their SIAMP accounted for climate change.
- The cost to replace stormwater infrastructure in six focus municipalities ranging in population from less than 50,000 to more than 500,000 is estimated at $1.2 billion, or on average, over $200 million.
- In 2016, 16 municipalities had emergencies that required repairing damaged stormwater infrastructure at an overall cost of $2.1 million – 88% in towns of fewer than 50,000 people.
- 25% have implemented Low Impact Development (LID) practices, such as rain gardens, permeable pavement, etc., although several are concerned about the costs that could be incurred as a result of the proposed Ministry of Environment and Climate Change (MOECC) LID standards, with one respondent reporting that their municipality estimates costs to implement and maintain LID could require hundreds of millions of dollars.

Overall, recommendations centre on the absolute importance of municipalities developing SIAMPs. Through incentives, guidelines and regulations, the Ontario Government must ensure all Ontario municipalities have the means to develop SIAMPs.

In summary:

- SIAMPs should be a required component of municipal asset management plans to ensure that all municipalities are working towards the provincial Climate Adaptation Goals.
- Stormwater management assistance needs to be considered a funding priority in the next provincial Long-Term Infrastructure Plan, especially for municipalities with populations under 50,000, as many do not have the necessary resources to develop a SIAMP. It should be noted that the Ontario Community Infrastructure Fund (OCIF) at the Ministry of Infrastructure provides steady, long-term funding for small, rural and northern communities to develop their infrastructure.
- Ontario needs to develop standardized measurement criteria for municipalities to properly monitor stormwater infrastructure. There are differences between municipalities, their assets and geographies – what is needed is a standardized approach to what and how stormwater infrastructure is inventoried.

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BACKGROUND

Section 1: Municipal Characteristics

S1Q1: What is the population of your municipality?

A breakdown of population ranges of respondent municipalities, along with a comparison of their range of population as a proportion of the actual 444 municipalities is summarized in Table 1.

Table 1: Population of Respondent Municipalities

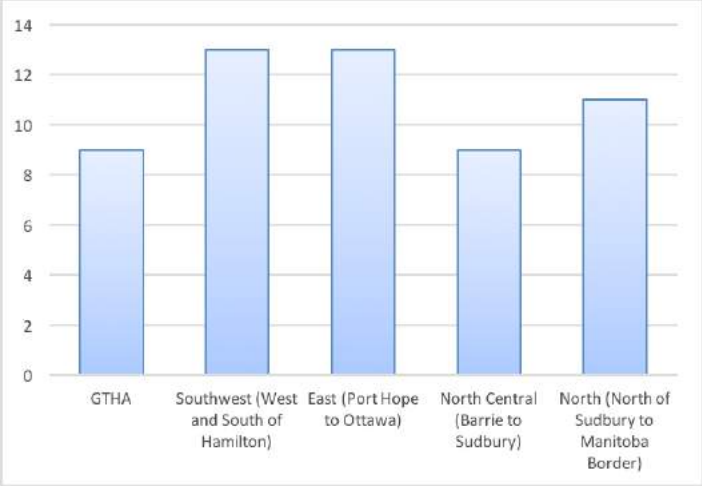
	Number of Survey Respondents	% of Survey Respondents	Number of Ontario Municipalities	% of Ontario Municipalities
<50,000	42	76%	376	85%
50,000-100,000	5	9%	31	7%
100,000-250,000	4	7%	21	5%
250,000-500,000	2	4%	6	1%
>500,000	2	4%	10	2%
Total	55	100%	444	100%

Although fewer municipalities under 50,000 submitted surveys than actual percentages in the province, they nonetheless comprise a large majority of completions. The other population ranges comprised higher percentages of completed surveys than they represent among all 444 municipalities.

S1Q2: What part of Ontario is your municipality located in?

Respondents represented municipalities from throughout the province as shown in Figure 1.

Figure 1: Location of Respondent Municipalities



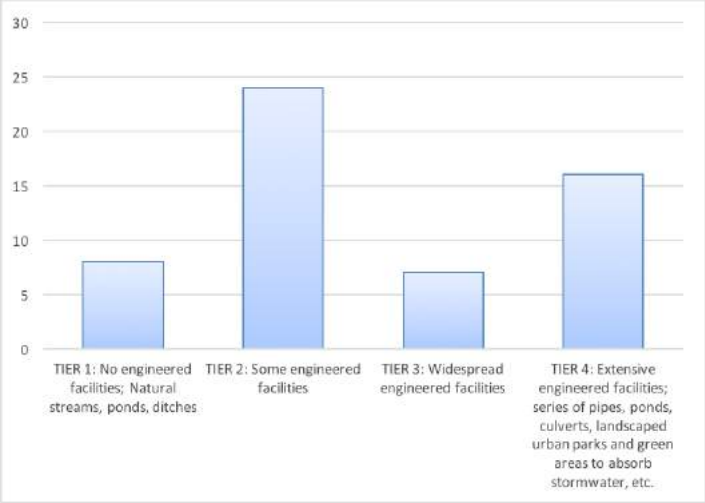
Municipalities in eastern and southwestern Ontario represent most of the completed surveys at 13 each (26 or 47% total). Although unexpected as overall population is sparse in the north, the second highest individual category of respondents are from north of Sudbury over to the Manitoba border (11 or 20%). The Greater Toronto Hamilton Area (GTHA) and North Central regions both had the same number of respondents at nine each, representing 33% of the municipalities completing the survey.

S1Q3: In terms of stormwater infrastructure existing in your municipality is your municipality considered Tier 1, Tier 2, Tier 3, Tier 4?

Survey recipients were asked to self-identify the extent of stormwater infrastructure existing in their municipality. Tier 1 was no engineered facilities up to Tier 4 with extensive engineered facilities. These conditions are summarized in Figure 2.

With the majority of respondents representing municipalities under 50,000 population, it is not surprising that most of their stormwater infrastructure is relatively minimal. Tier 1 and Tier 2 represent 32 (58%) municipalities and Tier 3 and Tier 4, 23 (42%).

Figure 2: Extent of Stormwater Infrastructure in Respondent Municipalities

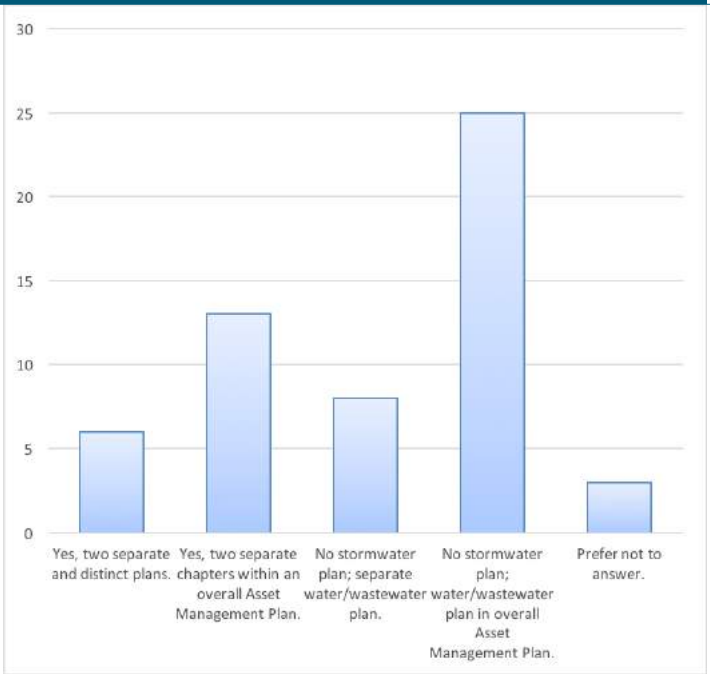


Section 2: Asset Management Planning

S2Q1: Does your municipality have a separate and distinct Stormwater Infrastructure Asset Management Plan (SIAMP) from your Water and Wastewater Asset Management Plan?

Survey recipients were given several choices concerning their stormwater and water/wastewater asset management plans. These are summarized in Figure 3.

Figure 3: State of Stormwater and Water/Wastewater Plans



Most municipalities (33 or 60%) do not have a SIAMP. However, a significant number of municipalities (19 or 35%) have separate stormwater and water/wastewater plans, whether separate and distinct or separate chapters within an overall asset management plan. Either way, having a separate SIAMP demonstrates that these municipalities have a more detailed inventory of stormwater infrastructure than of those who do not have a SIAMP. Table 2 provides characteristics of these 19 municipalities.

Table 2: Population and Location of Municipalities with a Separate SIAMP

Population		Location	
<50,000	11	GTHA	5
50,000-100,000	1	Southwest	9
100,000-250,000	3	East	1
250,000-500,000	2	North Central	0
>500,000	2	North	4

Except for the North Central region, municipalities are relatively proportional to the distribution of all completed surveys. It is interesting that 11 (26%) of the municipalities <50,000 have the resources to develop a SIAMP.

S2Q2: Was your SIAMP developed using internal resources (staff), outsourced to a third party or conducted by the Region?

Answers were straightforward with 15 (27%) municipalities using internal staff resources to develop their SIAMP and 21 (38%) outsourced to a third party. Ten municipalities preferred not to answer, two stating they are in the process of deciding or that a SIAMP is upcoming. The remainder did not have a SIAMP or ignored the question. As there are more municipalities specifying whether plans were developed internally or by third party than those that stated they had a SIAMP in the prior question, it is assumed they responded to this question referring to their water/wastewater or overall asset management plan. In retrospect, the question should have had conditional wording such as, ”If you have a SIAMP, was it developed …”

Of the 19 municipalities that have a SIAMP, internal staff developed the SIAMP for four municipalities with <50,000, one from a population between 50,000 and 100,000, and two municipalities each in the 100,000 – 250,000 and 250,000 – 500,000 population categories. Third parties prepared the SIAMP in seven municipalities with <50,000, one in 100,000-250,000 and >500,000 population categories. One municipality of >500,000 stated they are deciding whether their SIAMP should be developed internally or by a third party. The trend, unsurprisingly, is that the larger the municipality, the more internal staff resources are used, although one municipality >500,000 used a third party.

S2Q3: Does your municipality have a Stormwater Management Plan – a plan that sets the framework for what the municipality does to manage stormwater?

Quite a few municipalities have a Stormwater Management Plan at 17 (31%) with a majority not having such a plan at 37 (67%). As the relevance and applicability of having an overall asset management plan (AMP) becomes common among municipalities, it is anticipated that more details such as stormwater planning will be included in plans. The 17 municipalities already having a Stormwater Management Plan are well on their way to having a comprehensive and detailed overall AMP. MOECC should act now to ensure all municipalities have the resources to develop comprehensive and holistic AMPs.

S2Q4: Does your municipality have a Stormwater Monitoring Plan – a plan that collects data on the performance of the existing systems (i.e., are stormwater ponds meeting environmental compliance?).

Fewer municipalities have a Stormwater Monitoring Plan at 8 (15%) with a large majority not having such a plan at 46 (84%).

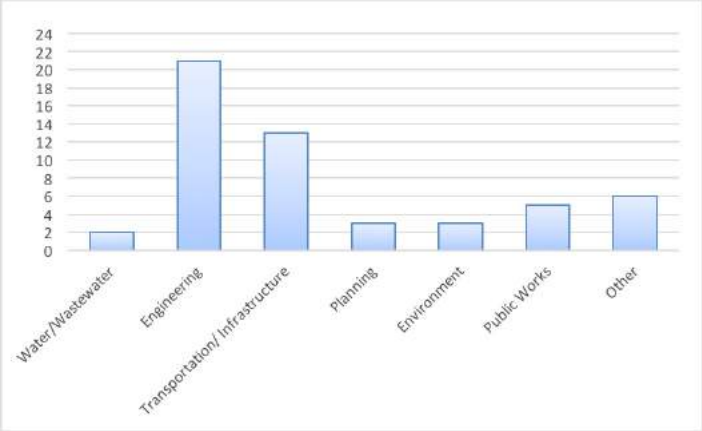
S2Q5: Does your municipality track stormwater assets that have been built by developers but have yet to be assumed by the municipality?

Quite a few municipalities track such assets at 23 (42%) with 29 (53%) not conducting such tracking.

S2Q6: In which department/area or region are decisions made towards stormwater infrastructure asset management planning?

As demonstrated in Figure 4, by far decisions about stormwater management reside in Engineering and Transportation/Infrastructure departments at a combined number of 34 (62%). Other departments where decision-makers reside include water/wastewater, planning, environment and public works.

Figure 4: Municipal Departments Where Stormwater Management Decisions Are Made



S2Q7: Does your municipality employ a Hierarchical Approach to stormwater management solutions – starting with "at source," then "at conveyance," and finally "at end-of-pipe"?

Answers to this question were relatively evenly spread with 22 (40%) municipalities stating that, yes, they employ a Hierarchical Approach, and 28 (51%) indicating, no, they do not employ this approach to stormwater management solutions. The 40% of municipalities that use a Hierarchical Approach may indicate a greater understanding of the complicated nature that differentiates components of stormwater management from water/wastewater management.

S2Q8: If so, what structures do you use at the “at source” point?

A wide range of answers was provided to this question. A complete list is in the Appendix.
Several examples are offered below.

> “Rural municipality ... culverts under rural roads is major infrastructure. Local area municipalities will ask developers for ponds/oil-grit items. County comments on impact to ditches and culverts.”
>
> “Road surfaces, swm ponds, oil grit separators, low impact development, drainage galleries, infiltration pits.”
>
> “Currently implementing Low Impact Development strategies such as: rain gardens, rain barrels, tree box filters etc.”
>
> “The specific LID "At Source" structures (management features) used to achieve the targets are at the discretion of the designer. The city prescribes whether recharge-focused LIDs are required to meet downstream erosion mitigation as opposed to other methods like end of pipe pond extended detention. We are reviewing the types of LIDs that the city will accept and view road surfaces (permeable surfaces) unfavourably due to O&M burden. Common LIDs in existing subdivisions include recharge galleries, sometimes "At Source" individual lots or sometimes more centralized.”
>
> “We have bioswales in City parks, and roof top gardens on City buildings.
> - We encourage residents and developers to adopt rain gardens, permeable parking lots, permeable pavers, and rain barrels.”

S2Q9: If so, what structures do you use at the At Conveyance point?

The range of answers was not as broad as the previous question. However, several informative answers were provided, with most respondents stating that pipes are the key structures involved at this stage. The complete list is in the Appendix.

> “Pipes, swm ponds, drainage channels, drainage galleries, infiltration pits”
>
> “Grassed ditches sometimes with higher culvert elevations to encourage soaking in rather than flowing away. Some detention areas. Rock check dams.”
>
> “Urban area is a combination of ditches and traditional storm sewer, manhole/catch basins with sumps.”

S2Q10: If so, what structures do you use at the At End-of-Pipe point?

Ponds were mentioned in most comments from respondents answering this question. All answers are in the Appendix, with several samples below.

> “Erosion control is a concern, once volume is determined to be acceptable.”
>
> “Ponds for new subdivisions, or outfalls to receiving water body or drain.”
>
> “SWM ponds. Multiple bays to encourage sedimentation. Rock check dams. Diffusers to reduce erosion.”

> “Wet ponds and wetlands, centralized recharge galleries, centralized end of pipe storage/treatment tanks (e.g., concrete Storm Traps, or HDPE arch/gravel systems), oil and grit separators (pretreatment to tanks or for retrofits in untreated sewer service areas). Previously dry ponds.”

S2Q11: What technologies does your municipality use to inventory stormwater infrastructure and what are their names/types?

A total of 41 (75%) municipalities responded to this question. Geographic Information Systems (GIS) only was mentioned by 15 (27% of 55) and Geographic Positioning Systems (GPS), along with GIS and other technologies mentioned by 14 (25%) municipalities. A further 12 (22%) respondents mentioned either no technologies were used or they used manual approaches. The most detailed answer was, “GPS (Trimble handheld device), Total Station survey where required to get elevations, GIS (digitization from engineering plans), geotagged photos (inspections / inventory).”

S2Q12: Does your municipality record details (metadata) for each asset or just its location and size?

Most municipalities in the survey record metadata for each asset at 32 (58%), with 21 (38%) not recording this data and two preferring not to answer.

S2Q13: Does your municipality track energy usage of stormwater management systems?

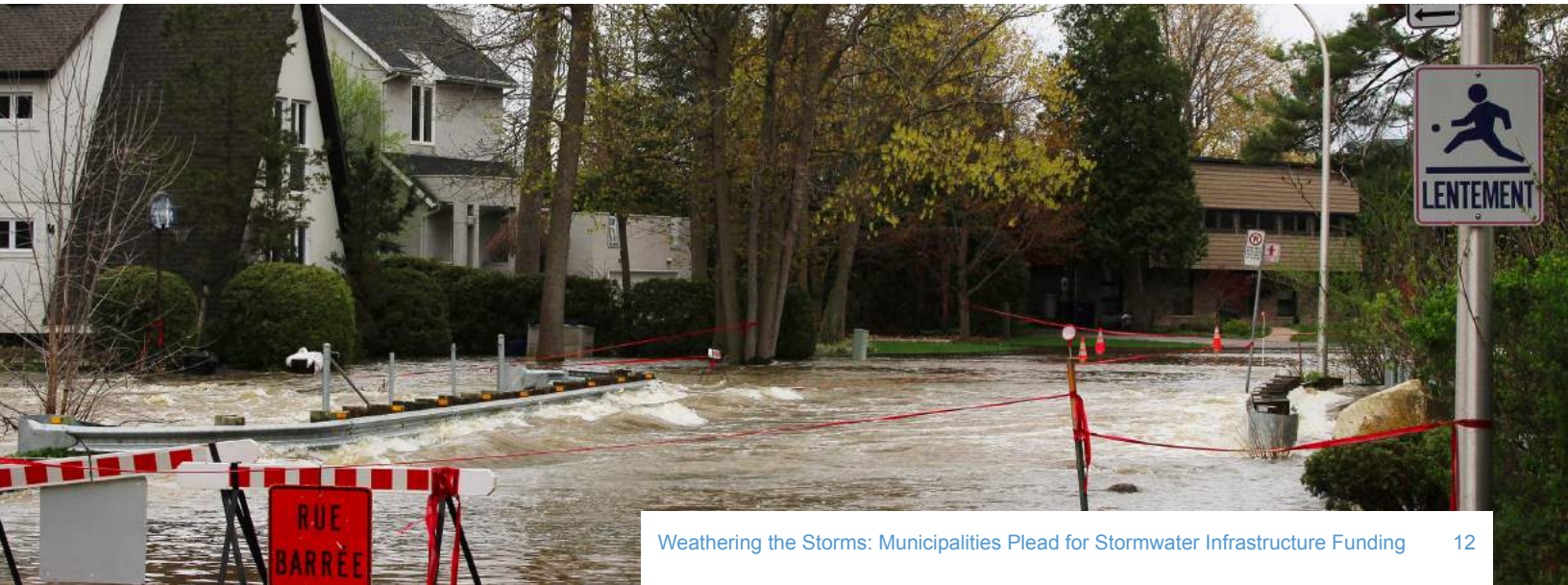
Only one (2%) municipality responded affirmatively that they track energy usage. This municipality is <50,000, in the North, and has a SIAMP which was outsourced to a third party.

S2Q14: Does your municipality measure leakages/cross connections in stormwater management systems?

Slightly more municipalities answered affirmatively to this question at five (9%).

S2Q15: Has your municipality incorporated adaptation plans in a Stormwater Infrastructure Asset Management Plan that accounts for climate change and future adaptations and mitigation of climate change?

Only six (11%) municipalities reported their SIAMP accounted for climate change in their plan.



S2Q16: What specific resources does your municipality need to fully develop a Stormwater Infrastructure Asset Management Plan?

Most municipalities mentioned finances and internal resources (staff), and the mechanisms to gather data as needed to fully develop a SIAMP. Several detailed answers are below and all are in the Appendix.

> "Require staff specifically for asset management and COUNCIL BUY IN...!!! better yet, regulation that Council cannot work around!"
>
> "Need more data - condition assessments, sediment surveys - and staff resources."
>
> "Financial implications are a key component. We have a real issue with stormwater here due to our extremely flat topography and silty clay soil conditions. A municipal wide storm water management plan would provide recommendations to alleviate some of these issues."
>
> "Developer's design and convey to municipality. In part, little if any thought given in a rural municipality as to how any SWM features would be maintained. Engineer or Planner did not necessarily convey any info to Public Works. Unlikely to have as-builts. All of which makes an inventory challenging in order to get started in asset management. It will be easier on a go-forward basis as new assets are assumed given that SWM is now part of every development design. There is no technical expertise on staff so even this will require external resources."
>
> "We have recently completed a list of potential climate change impacts (including those impacts that may impact storm water management); and have completed a vulnerability assessment with the intent to complete a risk assessment shortly."
>
> "Technology – beyond conventional none-link models for pipes and manholes, there are no accepted GIS/ database data models for stormwater assets, so we are developing /adapting our own."
>
> "More data on water quality: We are currently only collecting Total Suspended Solids. If we had more resources (staff & funds) we would also collect levels of other pollutants (e.g., nitrates and nitrites). Erosion studies: If we had more resources (staff and funds), we would conduct erosion studies. Work orders with asset life cycle activity and cost details."

Section 3: Stormwater Infrastructure Assets

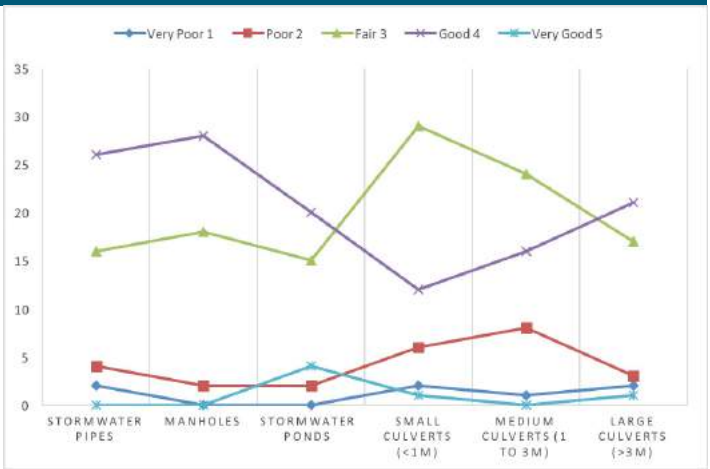
S3Q1: What is the condition of stormwater infrastructure of the following assets: Stormwater Pipes; Manholes; Stormwater Ponds; Small Culverts (<1m); Medium Culverts (1 to 3m); Large Culverts (>3m).

As listed in Table 3 and illustrated in Figure 5, there is a range of conditions of the state of stormwater infrastructure assets.

Table 3: Number of Municipalities Rating Conditions of Stormwater Infrastructure

Stormwater Asset	Assets Very Poor (1)	Assets Poor (2)	Assets Fair (3)	Assets Good (4)	Assets Very Good (5)
Stormwater Pipes	2	4	16	26	0
Manholes	0	2	18	28	0
Stormwater Ponds	0	2	15	20	4
Small Culverts (<1m)	2	6	29	12	1
Medium Culverts (1 to 3m)	1	8	24	16	0
Large Culverts (>3 m)	2	3	17	21	1

Figure 5: Number of Municipalities Rating Conditions of Stormwater Infrastructure



The above table and figure indicate that most stormwater infrastructure assets are rated as Fair or Good. A total of 32 assets, however, were rated as Poor or Very Poor, with only six as Very Good. Manholes have the highest number of Good ratings (28), with stormwater pipes a close second (26). Stormwater ponds are rated quite highly with 24 as Good and Very Good. Small and Medium Culverts have the most ratings of Poor and Very Poor, with eight and nine, respectively. Overall, slightly more assets (seven) are rated Very Poor than assets rated Very Good (six).

S3Q2: What is the approximate replacement value and the cost, if known, to separate assets from wastewater assets (CSO) for Stormwater Pipes?

Note: Sec. 3 Questions 2-7 was complicated and most municipalities did not respond or wrote “non-applicable”. Nonetheless, monetary values were obtained from six municipalities.

For replacement value for Stormwater Pipes, values ranged in the tens to hundreds of millions of dollars, with reported values of $5 million, $10 million, $162 million, $300 million and $500 million.

S3Q3: What is the approximate replacement value and the cost, if known, to separate assets from wastewater assets (CSO) for Manholes?

Of those responding, replacement costs are lower than for stormwater pipes with values stated as $108,000, $585,000, $42 million and $100 million.

S3Q4: What is the approximate replacement value and the cost, if known, to separate assets from wastewater assets (CSO) for Stormwater Ponds (including other facilities such as Oil-Grit Separators)?

Three municipalities answered this question with stated replacement values of $600,000, $7 million and $26 million.

S3Q5: What is the approximate replacement value and the cost, if known, to separate assets from wastewater assets (CSO) for Small Culverts (<1m)?

The three stated values to this question are $250,000, $2 million and $5 million.

S3Q6: What is the approximate replacement value and the cost, if known, to separate assets from wastewater assets (CSO) for Medium Culverts (1 to 3m)?

Stated values are $431,337, $500,000, $1 million and $4.5 million.

S3Q7: What is the approximate replacement value and the cost, if known, to separate assets from wastewater assets (CSO) for Large Culverts (>3m)?

Stated values are $500,000, $700,000, $1.5 million and $21,125,501.

Overall Characteristics of Municipality Stormwater Infrastructure

In reference to S2Q4, municipalities were clearly asked whether they have a Stormwater Monitoring Plan -- a plan that collects data on the performance of the existing systems (i.e., are stormwater ponds meeting environmental compliance?). Only eight (15%) municipalities reported that they monitor stormwater infrastructure.

Most, at five (63%) of the eight municipalities that monitor their infrastructure are <50,000 in population, two between 100,000-250,000 and one between 250,000-500,000 in size. Four (50%) have separate SIAMPs from water/wastewater asset management plans. As the sample size is so small, generalized conclusions cannot be made. If they are viewed as case studies, and because they monitor their infrastructure, their ratings of stormwater infrastructure conditions are deemed accurate and realistic.

Seven of these municipalities reported on the condition of their stormwater infrastructure and by a wide margin, reported conditions as Good or Very Good.

As indicated in Table 3, all municipalities rated many of their stormwater infrastructure as Fair and Good, whether they have a stormwater monitoring plan or not. Thus, there seems to be a disconnect – if municipalities indicate they know the condition of stormwater facilities, yet state they do not monitor them, how are they sure about their conditions? Municipalities would benefit from having more resources to accurately monitor their facilities to gain knowledge of the actual condition of their stormwater infrastructure.

Given that MOECC needs evidence-based information to determine the overall provincial state of stormwater facilities, it also needs to encourage and/or provide resources to ensure standardization of how and what municipalities need to develop SIAMPs and to develop a Monitoring Plan so they can accurately report their infrastructure in a SIAMP.

Concerning replacement value of stormwater infrastructure, as mentioned above, only six municipalities provided detailed information about the replacement value of stormwater infrastructure that they rated. These values are summarized in Table 4.

Table 4: Replacement Value of All Stormwater Infrastructure in Six Municipalities

Municipality Population	Number	Total Replacement Value - All Stormwater Infrastructure	Average Value
<50,000	3	$60,943,000	$20,314,333
50,000-100,000			
100,000-250,000	1	$256,556,838	$256,556,838
250,000-500,000	1	$411,500,000	$411,500,000
>500,000	1	$500,000,000	$500,000,000
Total	6	$1,228,999,838	$204,833,306

With the small sample size of six municipalities that provided data on replacement values of stormwater infrastructure, we cannot accurately extrapolate to all 55 municipalities, but we can look at them as case studies. As such, each of the three smallest municipalities (<50,000) would spend an average of more than $20 million to replace their stormwater infrastructure. For the larger reporting municipalities, the three in this category would need on average more than $380 million each to replace their stormwater infrastructure.

Particularly for the smaller municipalities, these are significant costs. As borne out in responses to open-ended questions, there is a palpable concern and recognition that, with aging infrastructure and the effects of climate change, in the near to medium future this infrastructure will need replacing. Many, if not most, municipalities will not have the funds to do this or will need to redirect funds from other needed expenditures.

As case studies, Table 5 summarizes the six municipalities with detailed values of stormwater infrastructure replacement and their comments about the critical issues facing them in the next five years.

Table 5: Comparisons of Municipalities with Detailed Assessments of Value of Stormwater Infrastructure Replacement						
Municipality	Location	Facilities	SIAMP?	Monitoring Plan?	Condition	Critical Issues Next 5 Years
<50,000	North Central	TIER 2	No	Yes	All Good	Maintenance
<50,000	North	TIER 2	No	Unknown	Poor/ Very Poor Exc. Manholes Good	Replacement of storm sewer pipes due to its ages, about 85% of storm water pipes has gone beyond its life expectancy.
<50,000	Southwest	TIER 3	Yes	No	All Good Exc. Culverts all Fair	Trying to handle the intensities of the storms now. The quantity of rainfall over the event has not changed but the durations are shorter (more intense).
100,000 - 250,000	GTHA	TIER 4	Yes	No	All Good Exc. Ponds Fair	Inadequate funding, increasing maintenance costs to deal with calcification, upsizing of pipes, pond cleanouts/ rehabilitation
250,000 - 500,000	GTHA	TIER 4	Yes	No	All Good Exc. Ponds Fair	Flood control is the largest stormwater program and mitigation of existing flood risks is part of a long-term strategy. This includes sewer systems and some open channel systems.
>500,000	GTHA	TIER 3	Yes	No	All Fair	Improved financing for the infrastructure and finalizing the asset management plan which is currently underway.

As expected, most of the six municipalities have separate SIAMPs from water/ wastewater asset management plans. Surprisingly, only one reported monitoring stormwater infrastructure and yet, the five who did not seem to have a firm account of the value of their infrastructure. The most useful insight is derived from their comments about critical issues they face in the next five years. Flood risk and funding are key themes.

S3Q8: Approximately how much money was spent in 2016 on fixing stormwater infrastructure after an emergency (e.g., broken sewer main, flooding from major storm)?

Almost 30% (16) of municipalities reported they had to spend money specifically to fix stormwater infrastructure after emergencies. Of these, most were less than $100,000, with one reporting $500,000 and one, of <50,000 population, with $1,000,000, commenting, "500 m of a street was rebuilt at a total cost of $1 million including storm sewers, manholes, catch basins, installation of some concrete curb & gutter, new watermain and road reconstruction with asphalt gutters." The total amount spent by the 16 municipalities was $2,181,708, with an average of $136,357.

S3Q9: Which statement best describes whether the fees you collect for stormwater management are enough to cover costs?

Very few municipalities collect fees specifically to cover stormwater management. Results are as follows:

- We do not collect fees specifically for stormwater management: 44 (80%)
- Fees collected are insufficient to cover normal costs now and in future: three (5%)
- Funds are sufficient to cover normal costs now; they will not be sufficient to cover future costs: three (5%)
- Funds are sufficient to cover normal costs now; there is a long-term plan to generate sufficient funds to cover future costs: four (7%)

S3Q10: How would you rate/rank the importance of key Stormwater Management Targets to your municipality?

Results show a range of the level of importance municipalities place on stormwater targets as demonstrated in Table 6. Targets included:

- Water Balance (or annual runoff volume for erosion control, groundwater recharge and downstream habitat protection);
- Water Quality (for protection of downstream water resources); and
- Water Quantity (peak flow control for flood management, and both peak flow and runoff volume control to mitigate erosion impacts).

Table 6: Number of Municipalities Rating/Ranking the Importance of Key Stormwater Management Targets

	Important	More Important	Most Important	Equally Important
Water Balance	23	12	4	12
Water Quality	12	9	20	12
Water Quantity	12	8	17	14

Water Quality is rated as most important 20 times and, while important, Water Balance is rated less important than both Water Quality and Water Quantity. The three targets are rated as equally important 12 to 14 times.

S3Q11: Why?

Numerous and wide-ranging answers were provided to this question about stormwater management targets. All are listed in the Appendix with a few highlighted below.

> "As an upper-tier municipality in a rural area, most concerns relate to flooding. Most of our drainage is by open-ditch and cross-culverts."
>
> "Protection from erosion and washouts, sedimentation, environmental balance is important and should be considered at time of development and when new capital works are completed."
>
> "Stormwater management techniques mainly focus on water balance in terms of hydro logic cycle which is really important due to rapid development/urbanization impacting hydro logic cycle. Increased runoff causes decreased infiltration which directly affect natural hydro logic cycle which required alternate solution. Water quality is most important factors for the aquatic habitats which can lead to reduced diversity of aquatic life which is basically a main focus of stormwater management. Last but not least, water quantity also an important factor which prevents increased flooding and erosion which can cause damage to property and human life."
>
> "The hydrological cycle is intimately intertwined and addressing all three of these items will better ensure the end goal of overall environmental/hydrological protection/maintenance."
>
> "Our town is constructed on a major river with a dam separating the east from west halves. A tremendous amount of water passes through the town, the amount collected from our storm infrastructure will have effects all the way through Manitoba. Given the flat nature of our town the biggest issues we have is getting the water to move to the outfalls to mitigate flooding through the municipality."

S3Q12: Does your municipality measure Water Quality as part of its Stormwater Management objectives?

Most municipalities do not measure Water Quality in this regard, with only 12 (22%) reporting that they do.

S3Q13: In the next five years, what are the most critical issues facing stormwater infrastructure in your municipality?

Numerous and wide-ranging answers were provided by respondents to this question. A few highlights are quoted below and all answers are listed in the Appendix.

> "Aging infrastructure is most critical, then the increase in storm severity, and lastly population growth/development."
>
> "Once Storm Water infrastructure is included in AMP financial commitment will be required to bring infrastructure to a condition rating which meets a reasonable level of service."
>
> "We are moving towards OGS installations with new development rather than ponds and ensuring regular maintenance is completed yearly in accordance with manufacturer specifications to ensure that the units are meeting water quality performance objectives. Too often, municipalities pay little to no attention to their ponds which may or may not be meeting the quality objectives that they were originally constructed for."

> "New MOECC LID standards -- will be very expensive to implement and maintain. Cleaning out stormwater management ponds (high costs)."
>
> "Trying to handle the intensities of the storms now. The quantity of rainfall over the event has not changed but the durations are shorter (more intense)."
>
> "Sink holes started appearing at the stormwater locations following a major flood in the area in 2013. A camera inspection revealed that the entire system is decaying. The Municipality had no reserves in place for the storm sewers. It is now budgeting annually but, cannot budget enough in one year to complete any one section. The Municipality requires Provincial or Federal assistance."
>
> "Climate change -- Increasing intensity and frequency of storms, resulting in more flooding issues. Regulatory requirements – We are expecting environmental regulations to become more stringent. Aging infrastructure -- It is not urgent right now, but we know it's an issue, and we need to prepare for the future."

S3Q14: Has your municipality implemented green infrastructure solutions (e.g., urban forests, bio retention cells, constructed wetlands, reuse of excavated soil, etc.)?

Twenty-three (42%) municipalities answered no to this question. Two stated not yet but they intend to. Twelve municipalities mentioned examples where they have implemented green infrastructure. A few examples are included below with all responses in the Appendix.

> "Yes, we use infiltration galleries and are looking into constructing some new wetlands."
>
> "We have used our excavated soil if suitable material for coverage on our rehabilitated dump sites and aggregate pit sites. Also, have supplied residents with fill for their properties for landscaping etc."
>
> "Bioswales – implemented. Roof gardens – implemented. Rain gardens – implemented. Tree trenches – implemented."

S3Q15: Has your municipality implemented Low Impact Development practices (e.g., rain gardens, rain barrels, permeable pavement, etc.)?

Similar to green infrastructure, 19 (35%) respondents stated no, they have not implemented LID and five (9%) stating not yet but intend to. There were 14 (25%) municipalities stating, yes, they have implemented LID practices and gave a range of answers. All answers are provided in the Appendix, with a few notable examples listed below.

> "Yes, infiltration basin style storm water management in small urban developments, and hybrid wet swales."
>
> "All new development within the Town is required to provide on-site stormwater retention facilities to help alleviate the demands on the system."
>
> "Markham has supported the use of LID technologies to meet water management goals for many years. For example, the 2007 Kylemore Homes Subdivision stormwater management plan incorporated features such as biofilters/infiltration trenches, passive infiltration basins, and a cooling trench to maintain and enhance quarter quality and to sustain Bruce Creek habitat in the Rouge River Watershed -- those features were constructed in 2010 and assumed by the City in 2016. Recently, enhance stormwater management functions and enhance local biodiversity in the Don River Watershed, Markham retrofitted an older development area, constructing the

Glencrest Park Raingarden in 2016. To effectively preserve and enhance hydrologic functions in future large future developments, the 1,000-hectare North Markham area, the City is completing comprehensive subwatershed studies to identify LID targets that satisfy local groundwater recharge goals and to minimize downstream erosion risks. Markham is also implementing and testing LID technologies, such as on the Markham's "Green Road," a half-kilometre long demonstration project that incorporates innovative, award-winning runoff pre-treatment devices, bioswales and recharge gallery features. Permeable pavements are used at one facility. Rain barrels are promoted for water conservation as opposed to stormwater management benefits -- we have evaluated internet/real-time control rain barrel technology but it does not appear to be cost-effective."

Section 4: Stormwater Infrastructure Issues

S4Q1: What stormwater infrastructure issue is most important to understand or to gain a better awareness of – for municipal councillors and decision-makers?

Most respondents commented on this question, many of which provided a fulsome and detailed answer. All responses are listed in the Appendix with a select few below.

"Climate change and aging infrastructure will require additional funding in the near future to replace and upgrade the systems installed in the '50s and '60s."

"That it is a major part of Municipal infrastructure that needs to be captured in an AMP and managed."

"There are multiple issues which can be eliminated with the effective stormwater management but basically most important issues for municipal councillors and decision-makers to understand is the economic and health and safety to the local residents. There are multiple layers of economic costs related to flooding. There are also long-term socio-economic damage and costs related to flooding that can be substantial. There are tangible and intangible losses associated with floods as well. When homes are damaged, more than foundations and structures are affected. Personal belongings are also damaged: their emotional significance cannot be calculated, nor is it possible to place a financial value on them. There are also psychological stresses on residents and on institutions involved in flood management."

"How grading and drainage work – i.e., you just can't place a bigger pipe in the ground to take the increase in water. Also the need to fund the infrastructure as a user fee much like water and wastewater."

"SWM has been largely the domain of the engineers and those obtaining MOECC (in the past) or Conservation Authority clearance. Council did not really think about these facilities as municipal assets. Members are now coming back from conferences asking questions, which in turn operational staff and managers realize that there aren't many answers ..."

"1. Funding and resources needing to sustain a good state of repair of existing stormwater infrastructure network and management of system performance 2. Stormwater needs to be viewed as a resource vs. nuisance."

"That LID implementation as proposed by the MOECC will increase lifecycle costs by 400-600% over conventional wet pond servicing. LID retrofit implementation under proposed policies will increase road maintenance costs by 300% and add over 30% to road reconstruction costs. LID cost savings are relevant to rural estate residential subdivisions where sewer pipes can be avoided, but not relevant to dense/sustainable communities being built in Ontario with densities prescribed by Places to Grow legislation."

S4Q2: What stormwater infrastructure issue is most important to understand or to gain a better awareness of – for provincial politicians and decision makers?

Many detailed comments were provided as answers to this question. A common theme was that municipalities need more funding from the provincial government to maintain and sustain their stormwater infrastructure. All answers are provided in the Appendix with several examples below.

> "Funding – municipalities who've been fiscally responsible at the cost of their level of service/state of infrastructure are still in need of funding."
>
> "Limited resources of small municipalities to maintain assets downloaded from provincial and upper-tier municipalities."
>
> "Grant funding opportunities need to be available for condition assessment and capital upgrade to accommodate climate change in stormwater systems."
>
> "That smaller municipalities need some financial assistance in upgrading or in some cases maintaining SWMP, especially if Ministry inspection are going to being (sic) as they have for us."
>
> "How climate change impacts stormwater infrastructure."
>
> "The need for more grant funding for stormwater infrastructure because of climate change."
>
> "The funding implications for operation and maintenance of stormwater infrastructure as a result of increasingly stringent legislations by the province. Limited provincial grants are available to the municipalities on competitive basis for retrofit projects but no grants for operation and maintenance."
>
> "1. Funding and resources needing to sustain a good state of repair of existing stormwater infrastructure network and management of its performance 2. Must provide clear and consistent decisions, directions and regulations to municipalities for planning, management and repair of stormwater infrastructure 3. Must understand that a "blanket" approach cannot be used province-wide -- e.g., what works for the GTA may not work for other areas within the province."
>
> "ECAs at ponds do not seem to be monitored or enforced. Province does not promote rain water as a resource. We need policies that encourage people to treat rain water and gray water as a resource. We need policies that promote innovation in rain water and stormwater capture."

S4Q3: What stormwater infrastructure issue is most important to understand or to gain a better awareness of – for developers and large property owners?

Answers to this question presented clearly defined view-points for developers and large property owners to carefully plan the future development of their properties. All answers are in the Appendix with samples below.

> "Climate change, and potential need to adhere to higher occurrences of one- to100-year storm events."
>
> "That pre must equal post conditions and low impact and water balancing applications need to be considered at the expense of the developer not the taxpayer."
>
> "The protection of not only onsite properties with respect to water quality, water quantity and erosion control but also offsite properties (downstream properties) that are affected as a result of development."
>
> "Ecological Impact Impervious surfaces result in greater volume of runoff at a higher rate of flow that can cause channel modification and increased sediment loading there by affecting aquatic habitats. In addition, the surface runoff carrying debris, oil, grease, nutrients, and combined sewer overflows that, when discharged to the natural water body, can further deteriorate the flora and fauna. Depending upon the time factor and concentration of the contamination, acute and chronic impacts can occur. This pollution can travel a significant distance and remain in the environment for a long period of time. More energy is required to prevent and control pollution from the water stream, and more greenhouse gases are released in the atmosphere."

> "Need to have holistic vision of the entire system – not just worrying about their development."
>
> "Runoff control and mitigation to control the impacts on the existing systems and downstream ecosystems."
>
> "1. Funding and resources needing to sustain a good state of repair of existing stormwater infrastructure network and management of its performance 2. Access needed to municipal crews for maintenance of stormwater infrastructure 3. Stormwater flows to/collects at the lowest points, takes path of least resistance 4. Developing within a floodplain or along a riverbank is never a good idea 5. The province does not always provide the most clear, direct and/or consistent approach(es) for permitting and planning approvals 6. Must provide clear and consistent decisions and directions to municipalities for planning, management and repair of stormwater infrastructure."
>
> "Ensure design/construction will operate as intended and be conducive to long-term performance. Regards for future maintenance."

S4Q4: What stormwater infrastructure issue is most important to understand or to gain a better awareness of – among the general public?

Not surprisingly, respondents offered many suggestions about what they thought the public needs to know about stormwater infrastructure. Typical were comments about the need to understand the technical dynamics of stormwater management vis-à-vis what contributes to stormwater causing damages to property and municipal infrastructure. All comments are in the Appendix and several key quotes are stated below.

> "Why stormwater management (SWM) strategies are important, and how they directly impact capital planning."
>
> "That stormwater must not instantly disappear after a storm, it takes time to percolate, infiltrate and evaporate as part of the stormwater system for environmental balance. Contaminants need to be keep out of that process. Recharge is required in the city and the country."
>
> "Impervious surfaces result in greater volume of runoff at a higher rate of flow that can cause channel modification and increased sediment loading there by affecting aquatic habitats. In addition, the surface runoff carrying debris, oil, grease, nutrients, and combined sewer overflows that, when discharged to the natural water body, can further deteriorate the flora and fauna. Depending upon the time factor and concentration of the contamination, acute and chronic impacts can occur. This pollution can travel a significant distance and remain in the environment for a long period of time. More energy is required to prevent and control pollution from the water stream, and more greenhouse gases are released in the atmosphere."
>
> "Need to understand the full effects of their actions – for example, dumping engine oil down a catch basin has horrific effects on the downstream environment. Need to be educated on the works of SWM ponds."
>
> "SWM is an important part of the engineered landscape and these areas need to be protected and respected. I like to say that Mother Nature always wins, so you alter a drainage feature at your peril."
>
> "The public needs to be aware that rainwater is a valuable resource. Effect of expanding driveways (legally or illegally) and other impermeable surfaces on our stormwater infrastructure."

Respondent Characteristics Based on Municipality Population

It is important for governments and other municipalities to ascertain if differences exist in responses to stormwater infrastructure questions based on population size. If there are trends or conditions more common in certain population categories, approaches to asset management planning can be tailored to these characteristics. This section outlines trends and conditions of survey respondents based on the population size of their municipalities. Only responses that demonstrate trends or characteristics specific or of interest to the variable being described are summarized.

Municipalities <50,000:

With 42 municipalities represented, this category at 76% makes up the majority of survey respondents. As summarized in Figure 6, municipalities <50,000 in population are located throughout the province, with the most from the North (26%).

Figure 6: Locations of Municipalities <50,000 in Population

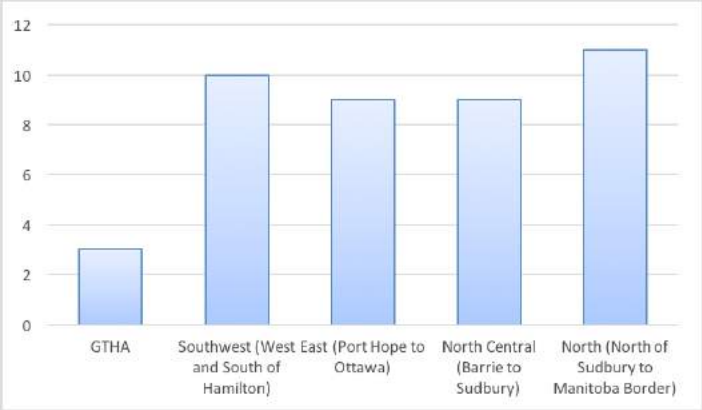
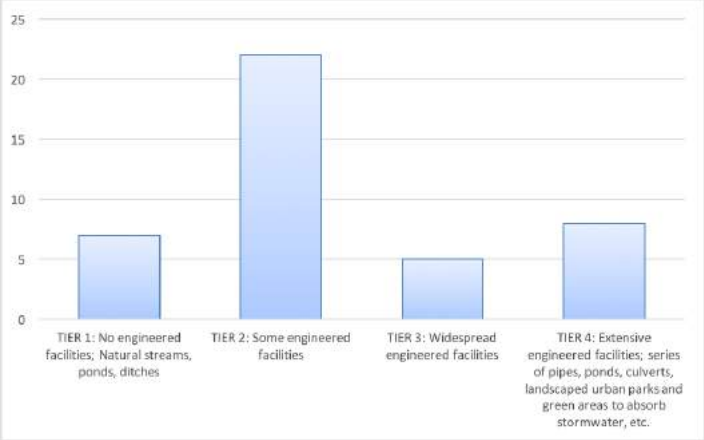


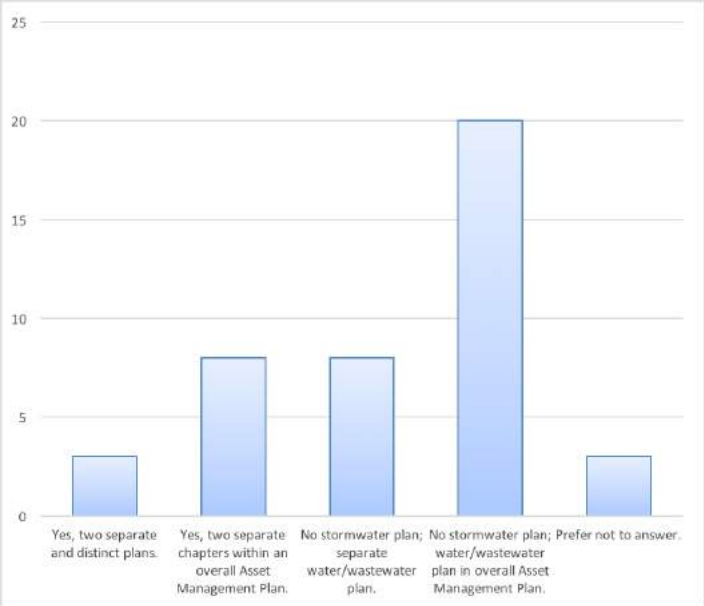
Figure 7: Extent of Stormwater Infrastructure in Respondent Municipalities <50,000



As expected, the majority of municipalities <50,000 in population have no or some engineered stormwater infrastructure facilities, at 29 (69%). However, eight (19%) of these smaller centres report extensive engineered facilities (Figure 7).

Of the eight (19%) municipalities <50,000 in population reporting extensive engineered infrastructure (Tier 4), three (7%) are in Southwest Ontario, two (5%) each from the GTHA and the North, and one (2%) from North Central Ontario. None were from Eastern Ontario.

Figure 8: State of Stormwater and Water/Wastewater Plans in Municipalities <50,000



It is expected that most smaller municipalities do not have stormwater infrastructure asset management plans (SIAMP) with 28 (67%) municipalities <50,000 in population reporting as such. It is interesting to note that all 11 (26%) municipalities <50,000 in population that have separate stormwater and water/wastewater plans are from Southwest or North Ontario, with seven (17%) and four (10%) respectively.

Although 11 municipalities <50,000 in population reported having a SIAMP, 26 reported that either internal staff (eight) produced one or that it was outsourced (18). It is speculated that they were referring to a water/wastewater plan or overall asset management plan.

Among municipalities <50,000 in population, 15 (36%) report that they employ a Hierarchical Approach to stormwater management solutions, with structures within this approach similar to those mentioned by all respondents.

The only municipality of all the respondents to report tracking energy usage of stormwater management systems is from a municipality of <50,000 population and located in the North. They have some engineered stormwater facilities and do not have a SIAMP. However, in addition to tracking energy usage, they seem proactive on mitigating the effects of climate change, stating, “We have recently completed a list of potential climate change impacts (including those impacts that may impact stormwater management); and, have completed a vulnerability assessment with the intent to complete a risk assessment shortly.”

Municipalities <50,000 demonstrate a dichotomy in terms of rating the conditions of stormwater assets. Among all respondents, these were the only municipalities to rate assets Very Good and Very Poor. There ratings are summarized Table 7.

Table 7: Rating of Conditions of Stormwater Assets in Municipalities <50,000 Population					
Stormwater Asset	Assets Very Poor (1)	Assets Poor (2)	Assets Fair (3)	Assets Good (4)	Assets Very Good (5)
Stormwater Pipes	2	3	13	18	0
Manholes	0	2	14	20	0
Stormwater Ponds	0	2	8	17	4
Small Culverts (<1m)	2	2	22	9	1
Medium Culverts (1 to 3m)	1	6	19	11	0
Large Culverts (>3 m)	2	2	15	13	1

Other than the Very Poor and Very Good ratings, municipalities with <50,000 population are relatively consistent with ratings from all respondents.

However, while these observations are useful on an individual, case study-type basis, there is little confidence of the accuracy of data. Without assurances that infrastructure was measured in a consistent, standardized methodology, ratings of conditions is likely subjective. If conditions as rated are accurate, then emphasis is on funding needed to maintain infrastructure.

Of 16 municipalities overall reporting spending funds on fixing stormwater infrastructure in an emergency, 14 were from municipalities <50,000 in population. Expenditures ranged from $2,000 to $1,000,000.

Municipalities 50,000 – 100,000:

The five municipalities with a population of between 50,000-100,000 are from Southwest and East Ontario. Engineered stormwater facilities in these communities are all represented with one each for Tiers 1-3 and two with Tier 4 infrastructure. The municipality claiming no engineered facilities is located in East Ontario. One of the municipalities has separate stormwater and water/wastewater asset management plans as chapters in an overall asset management plan. Four do not have SIAMPs, including the municipality with no engineered stormwater facilities (Tier 1).

There are no discernable unique answers to any other survey questions concerning municipalities with 50,000-100,000 in population compared with all respondent answers.

Municipalities 100,000-250,000:

Three of the four municipalities with a population of between 100,000-250,000 are from the GTHA and one from Southwest Ontario. All four consist of extensive engineered stormwater facilities (Tier 4). Three of the municipalities have separate stormwater and water/wastewater asset management plans as chapters in an overall asset management plan, two of which were developed by internal staff and one was outsourced. One of these municipalities does not have a SIAMP. All four municipalities rated the conditions of stormwater assets as Fair or Good.

There are no discernable unique answers to any other survey questions concerning municipalities with 100,000-250,000 in population compared with all respondent answers.

Municipalities 250,000-500,000:

The two municipalities with a population of between 250,000-500,000 are located in the GTHA and have extensive Tier 4 stormwater facilities. Both have separate SIAMP and water/wastewater plans either distinct or separate chapters in an overall asset management plan, and all developed internally by staff. Both rate the conditions of all types of their stormwater infrastructure as Good, except stormwater ponds rated as Fair. The two municipalities consider Water Quantity as the most important key Stormwater Management Target, with one placing equal importance to Water Quality. Both consider Water Balance as important although not as important as the other targets.

For reasons why Stormwater Management Targets are important, one of the municipalities stated:

> "Water balance in existing development areas is not a concern as baseflows in the Rouge and Don Watersheds have increased over past decades despite conventional stormwater servicing (see Toronto Assessment Report or statistical analysis by TMIG for BILD). Erosion issues are a result of poor infrastructure placement (in valleys, too close to meandering creeks) and not due to water balance issues. In new development areas, water balance is analyzed to set mitigation targets to meet erosion and habitat protection (baseflow maintenance) and to meet Clean Water Act policies for municipal water supply quantity maintenance. Quantity ranks highest due to resident and business priorities to address existing flood risks / limitations in level of service with older design standards (pre-1980s)."

There are no discernable unique answers to any other survey questions concerning municipalities with 250,000-500,000 in population compared with all respondent answers.

Municipalities >500,000:

The two municipalities with >500,000 population are located in the GTHA and in East Ontario. Unexpectedly, one states that they have only some engineered stormwater facilities (Tier 2) and the other having widespread (not extensive) Tier 3 engineered facilities. While clearly a subjective question, those answers do not make sense, although all other answers made sense in terms of municipality population size.

Nonetheless, the largest municipalities could have misunderstood the question. Another possible explanation is that stormwater facilities are a regional issue and not that of the municipality (although regions are defined as municipalities).

Both of these large municipalities have separate and distinct SIAMPs and water/ wastewater asset management plans, with one outsourcing its development and another in the process of decided whether to keep the SIAMP in-house or to outsource it to a consultant. Both rate the condition of their entire stormwater infrastructure as Fair. Neither reported spending any money on fixing stormwater infrastructure damaged from emergencies.

One municipality >500,000 rated Water Quality as Most Important of the key Stormwater Management Targets and both rated Water Balance as less important, with one of the municipalities rating Water Quality as equally less important. Both rated Water Quantity as More Important. Neither offered a reason why they chose the ratings for these targets. Both municipalities also have not implemented LID although one is planning on it.

Comparisons of Characteristics Based on Population:

Differences between municipalities based on their population size are apparent in answers to several questions.

Table 8 breaks down geographic locations of responding municipalities by their population size. As the largest category of respondents, those municipalities <50,000 represent all regions of the province and it is especially interesting that so many of them are located in the North.

Table 8: Locations of Municipalities Based on Population

Population of Respondent Municipalities	Number of Municipalities	GTHA	Southwest (West and South of Hamilton)	East (Port Hope to Ottawa)	North Central (Barrie to Sudbury)	North (North of Sudbury to Manitoba Border)
<50,000	42	7%	24%	21%	21%	26%
50,000-100,000	5	0%	40%	60%	0%	0%
100,000-250,000	4	75%	25%	0%	0%	0%
250,000-500,000	2	100%	0%	0%	0%	0%
>500,000	2	50%	0%	50%	0%	0%

In looking at whether municipalities have SIAMPs, Table 9 demonstrates a trend that the larger the municipality, the greater the likelihood of a SIAMP. Nonetheless, quite a few smaller municipalities do indeed have one.

Table 9: State of Stormwater and Water/Wastewater Plans Based on Population

Population of Respondent Municipalities	Number of Municipalities	Yes, two separate and distinct plans	Yes, two separate chapters within an overall asset management plan	No stormwater plan; separate water/ wastewater plan	No stormwater plan; water/ wastewater plan in overall asset management plan	Prefer not to answer
<50,000	42	7%	19%	19%	48%	7%
50,000-100,000	5	0%	20%	0%	80%	0%
100,000-250,000	4	0%	75%	0%	25%	0%
250,000-500,000	2	50%	50%	0%	0%	0%
>500,000	2	100%	0%	0%	0%	0%

CONCLUSION

Many studies have provided detailed descriptions of stormwater infrastructure asset management. Recently, the Environmental Commissioner of Ontario (2016) in *Urban Stormwater Fees: How to Pay for What We Need* looked at whether municipalities collected or plan to collect stormwater fees to cover costs of stormwater infrastructure. By far, most municipalities do not have the funds to cover those costs.

The Interdisciplinary Centre on Climate Change based at the University of Waterloo released a report in 2017, *CANADIAN VOICES ON CHANGING FLOOD RISK: Findings from a National Survey*, found that while most Canadians are willing to take action to reduce the risk of flooding, very few have implemented measures to do so or even realize they live in flood-prone areas.

In 2014, the Ontario Coalition of Sustainable Infrastructure (OCSI) issued a report, *When the Bough Breaks: Helping municipalities prioritize infrastructure investment to build resilient wastewater and stormwater systems*. A key finding of the study was that "Municipalities identified their number one priority for short-term and long-term challenges related to sustainable wastewater and stormwater as funding for rehabilitation and preventative maintenance, with adequate funding for capital works a close second."

The study upon which this report is based also demonstrates similar findings from the grass-roots perspectives of municipal workers. The survey indicates most municipalities do not have separate stormwater fees, have concerns regarding climate change and resulting severe weather events, and are extremely concerned about how to fund stormwater infrastructure.

In looking at survey responses and especially those from open-ended questions, several key messages are identified.

- Significant investments will be required to maintain or bring municipal stormwater infrastructure up to a good or better condition rating.
- Most municipalities do not have adequate Stormwater Infrastructure Asset Management Plans (SIAMP); adequate funding resources to meet the changing demands and regulatory requirements for these assets; and/or, the human resources to appropriately track and monitor these assets and their metrics.
- Stormwater infrastructure assets are a major part of municipal infrastructure and need to be appropriately accounted for in municipal asset management plans.
- Climate Change and its effects on stormwater infrastructure is recognized by municipalities and a palpable apprehension for what this means in future.

Key statistics garnered from survey results include:

- Most respondents represent towns with a population of less than 50,000. However, cities of all population sizes are represented and come from all regions of Ontario.
- 58% have limited to no engineered stormwater management infrastructure.
- 35% have a separate Stormwater Infrastructure Asset Management Plan (SIAMP) from their Water/ Wastewater plan.
- Only 15% have a Stormwater Monitoring Plan – a plan that collects data on the performance of the existing systems (i.e., are stormwater ponds meeting environmental compliance).
- Only 11% reported that their SIAMP accounted for climate change.
- The cost to replace stormwater infrastructure in six focus municipalities ranging in population from less than 50,000 to more than 500,000 is estimated at $1.2 billion, or on average, over $200 million.
- In 2016, 16 municipalities had emergencies that required repairing damaged stormwater infrastructure at an overall cost of $2.1 million – 88% in towns of fewer than 50,000 people.
- 25% have implemented Low Impact Development (LID) practices, such as rain gardens, permeable pavement, etc., although several are concerned about the costs that could be incurred as a result of the proposed MOECC LID standards, with one respondent reporting that their municipality estimates costs to implement and maintain LID could require hundreds of millions of dollars.

Overall recommendations centre on the absolute importance of municipalities to develop SIAMPs. Through incentives, guidelines and regulations, the Ontario Government must ensure all Ontario municipalities have the means to develop SIAMPs. In summary,

- SIAMPs should be a required component of municipal asset management plans to ensure that all municipalities are working towards the provincial Climate Adaptation Goals.
- Stormwater management assistance needs to be considered as a funding priority in the next provincial Long-term Infrastructure Plan, especially for municipalities with populations under 50,000, as many do not have the necessary resources to develop a SIAMP; it should be noted that the Ontario Community Infrastructure Fund (OCIF) at the Ministry of Infrastructure provides steady, long-term funding for small, rural and northern communities to develop their infrastructure.
- Ontario needs to develop standardized measurement criteria for municipalities to properly monitor stormwater infrastructure; this recognized there are differences between municipalities, their assets and geographies – what is needed is a standardized approach to what and how stormwater infrastructure is inventoried.

REFERENCES

Interdisciplinary Centre on Climate Change based at the University of Waterloo, April 2017, *CANADIAN VOICES ON CHANGING FLOOD RISK: Findings from a National Survey.* https://uwaterloo.ca/climate-centre/

Environmental Commissioner of Ontario, November 2016, *Urban Stormwater Fees: How to Pay for What We Need.* https://eco.on.ca/our-reports/other-publications/

Ontario Coalition of Sustainable Infrastructure (OCSI), November 2014, *When the Bough Breaks: Helping municipalities prioritize infrastructure investment to build resilient wastewater and stormwater systems.* http://www.on-csi.ca/index.php

APPENDIX: Verbatum Answers to Open Ended Questions

S2Q8: If you use a hierarchical approach to stormwater management solutions, what structures do you use at the At Source point?

- Bioswales, parking lots, roofs, OGS, reduced lot grading, goss traps, MH sumps
- Storm ponds/tanks, oil-grit separators
- Rural municipality ... culverts under rural roads is major infrastructure. Local area municipalities will ask developers for ponds/oil-grit items. County comments on impact to ditches and culverts.
- Parking lots and road surfaces
- Road surface, ponds / tanks, oil grit separators
- Grassed swales, SWM ponds, OGS. Incorporating LID for 2017 capital projects.
- Road surfaces, parking lots
- OGS, ponds, LID, grasses swales
- OGS, inlet control devices for roads and parking lots, dry ponds
- Parking lots, roadways, storm ponds, OGS
- Parking lots, rooftops, ponds, oil-grit separators
- LIDs and sometimes for the use of parking lots
- Follow published MOE BMPs. Pre- and Post-year matched for five-year and 100-year return storm.
- Retention ponds, catch basin sumps
- Road surfaces, swm ponds, oil grit separators, low impact development, drainage galleries, infiltration pits
- Parking lots, OGS, Ponds
- Parking lots, road surfaces, stormwater ponds, oil-grit separators, Low Impact Development
- French drains or soak away pits or grassed swales on lots Grit and oil separators in parking lots
- Parking Lots, road surfaces and curbs
- Currently implementing Low Impact Development strategies such as: rain gardens, rain barrels, tree box filters etc.
- Orifice plates (surface ponding), oil-grit separators, rain gardens
- Subwatershed study planning in concert with land use planning prescribes targets for at source stormwater management based on local conditions in each subwatershed - the subwatershed plan prescribes end of pipe and at source control performance targets (we note that storm ponds / tanks are typically not examples of "At Source" structures but rather "End of Pipe"). The specific LID "At Source" structures (management features) used to achieve the targets are at the discretion of the designer. The city prescribes whether recharge-focused LIDs are required to meet downstream erosion mitigation as opposed to other methods like end of pipe pond extended detention. We are reviewing the types of LIDs that the city will accept and view road surfaces (permeable surfaces) unfavourably due to O&M burden. Common LIDs in existing subdivisions include recharge galleries, sometimes "At Source" individual lots or sometimes more centralized.
- We have bioswales in City parks, and rooftop gardens on City buildings. - We encourage residents and developers to adopt rain gardens, permeable parking lots, permeable pavers, and rain barrels.

S2Q9: If you use a hierarchical approach to stormwater management solutions, what structures do you use at the At Conveyance point?

- Pipes
- Pipes, Storm Ponds/Tanks, Culverts, Channels
- Local Area issue
- Catch basins, pipes and culverts
- As situation requires
- Pipes, culverts, channels
- Pipes
- Pipes, channels, culverts
- Pipes, grassed swales, culverts
- Pipes and ditches
- Pipes, ponds, ogs, channels and ditches
- Pipes, channels, culverts, ponds
- Various - refer to MOE BMP's
- Include municipal drains
- Pipes, swm ponds, drainage channels, drainage galleries, infiltration pits
- Culverts, pipes, LID's
- Grassed ditches sometimes with higher culvert elevations to encourage soaking in rather than flowing away. Some detention areas. Rock check dams.
- Catch Basins, Culverts and ditches
- Urban area is a combination of ditches and traditional storm sewer, manhole/catch basins with sumps.
- Pipes, ditches, open drains
- Bioswales have been used in the past - these are common parks. Markham's recently tendered Green Street uses infiltration galleries in parallel to the conventional conveyance system and also uses bioswales in the ROW.
- We have bioswales in City parks, and roof top gardens on City buildings. - We encourage residents and developers to adopt rain gardens, permeable parking lots, permeable pavers, and rain barrels

S2Q10: If you use a hierarchical approach to stormwater management solutions, what structures do you use at the At End-of-Pipe point?

- Ponds
- Storm Ponds/Tanks, Out Fall from Pipe Discharge
- Erosion control is a concern, once volume is determined to be acceptable
- Discharge streams
- As situation requires
- Ponds for new subdivisions, or outfalls to receiving water body or drain
- Outfall from Pipe Discharge
- Pond, watercourses
- Outfalls from pipe discharge
- SWM ponds
- OGS, ponds
- Oil-grit separators, ponds
- Mostly ponds
- Rap channels, storm interceptor/settling tank with baffles
- Oil Grit Separators and Ponds
- Outfall from pipe discharge, storm pond, drainage ditches
- Outfalls, ponds
- LID's, Storm Ponds, pipe discharge
- SWM ponds. Multiple bays to encourage sedimentation. Rock check dams. Diffusers to reduce erosion.
- River, ponds and natural infiltration
- Outfall
- Outfalls, ponds (wet and dry), open drains
- Wet ponds and wetlands, centralized recharge galleries, centralized end of pipe storage/treatment tanks (e.g., concrete StormTraps, or HDPE arch/gravel systems), oil and grit separators (pretreatment to tanks or for retrofits in untreated sewer service areas). Previously dry ponds.
- We use outfall from pipes, and storm ponds, culverts. We currently do not use tanks.

S2Q16: What specific resources does your municipality need to fully develop a Stormwater Infrastructure Asset Management Plan?

- Finance and staff
- Internal resources
- Finances
- Require staff specifically for asset management and COUNCIL BUY IN...!!! better yet regulation that Council cannot work around!
- Internal staff expertise / templates
- Finances, consultant services, staff expertise, technology
- More staff & funding
- Need more data - condition assessments, sediment surveys - and staff resources
- Finances and staff
- Financing, staff expertise and more staff
- Condition assessment, funding, internal staff
- Finances
- Improved finances and internal staff expertise
- Finances and consultant assistance
- Dedicated staff and the associated funds to maintain the structures
- More Staff
- Internal staff
- Finance, and political will
- We rely on the local CA, residents and staff
- Finances, staff expertise, staff resources
- More staff resources
- Time, resources and money
- Finances, staffing and some better way to camera and inventory the current infrastructure
- Finances, External Expertise
- Time and finances. We have quality staff that could do the work just not enough available time to complete it.
- Staff, increased finances, technology
- Finances and engineering
- Finances and technology
- Human resources and time
- Financial implications are a key component. We have a real issue with stormwater here due to our extremely flat topography and silty clay soil conditions. A municipal wide storm water management plan would provide recommendations to alleviate some of these issues.
- Developer's design and convey to municipality. In part, little if any thought given in a rural municipality as to how any SWM features would be maintained. Engineer or Planner did not necessarily convey any info to Public Works. Unlikely to have as-builts. All of which makes an inventory challenging in order to get started in asset management. It will be easier on a go forward basis as new assets are assumed given that SWM is now part of every development design. There is no technical expertise on staff so even this will require external resources.
- Funds, Internal Staff Expertise, More Staff
- We have recently completed a list of potential climate change impacts (including those impacts that may impact storm water management); and, have completed a vulnerability assessment with the intent to complete a risk assessment shortly.
- Finances to hire the expertise and technology
- Finances, internal staff expertise and more technical staffing, overall leadership, Council/public education, awareness and understanding (e.g., stormwater is a resource and not nuisance)
- Technology - beyond conventional none-link models for pipes and manholes, there are no accepted GIS/ database data models for stormwater assets, so we are developing /adapting our own.
- More data on water quality: We are currently only collecting Total Suspended Solids. If we had more resources (staff & funds) we would also collect levels of other pollutants (e.g., nitrates and nitrites). Erosion studies: If we had more resources (staff and funds), we would conduct erosion studies. Work orders with asset life cycle activity and cost details.
- Not sure.

S3Q11: Why would you rate/rank the importance of key Stormwater Management Targets to your municipality (Water Balance, Water Quality, Water Quantity)?

- We are fortunate not to be regularly affected (our roads) by larger events. Mostly rural with very small % impervious areas.
- As an upper-tier municipality in a rural area, most concerns relate to flooding. Most of our drainage is by open-ditch and cross-culverts.
- Flooding occurring, water runoff directly into Lake and River - quality good
- Protection from erosion and washouts, sedimentation, environmental balance is important and should be considered at time of development and when new capital works are completed.
- Protection from flooding and protection of fish habitat.
- Master plans dictate as does legislation and best practices.
- Stormwater management techniques mainly focus on water balance in terms of hydro logic cycle which is really important due to rapid development/ urbanization impacting hydro logic cycle. Increased runoff causes decrease infiltration which directly affect natural hydro logic cycle which required alternate solution. Water quality is most important factors for the aquatic habitats which can lead to reduced diversity of aquatic life which is basically a main focus of storm water management. Last but not least water quantity also an important factor which prevent increased flooding and erosion which can cause damage to property and human life.
- These issues are driven by the local conservation authority
- Rising water levels affect erosion, can contaminate surface and groundwater.
- City is located on water body that is designated as a Remedial Action Plan Area
- Surface water drinking water system on Federal Waterway (Rideau River)
- In effort to be good environmental stewards it is important to maintain our natural stormwater facilities
- Our groundwater flows into the Thames River upstream of London. We are working with the municipalities of the Upper Thames River Conservation Authority on a Water Management Plan for the watershed that is looking at Water Quality and Water Quantity.
- Lake and bay water quality at outlets.
- Proper ditching and culvert sizing and replacement helps prevent erosion and road base stability.
- The hydrological cycle is intimately intertwined and addressing all three of these items will better ensure the end goal of overall environmental/ hydrological protection/maintenance
- Our town is constructed on a major river with a dam separating the east from west halves. a tremendous amount of water passes through the town, the amount collected from our storm infrastructure will have effects all the way through Manitoba. Given the flat nature of our town the biggest issues we have is getting the water to move to the outfalls to mitigate flooding through the municipality.
- Conservation Authority is lead agency on SWM. Emphasis is on quality, quantity as well as recharge.
- Most of the local rivers have some designation regarding sensitive fish habitat; and, some houses on steep holes are lower than the centre line elevation of the road making them subject to flooding.
- Don't believe this municipality has sufficient volume to make any of these more important than the other.
- Flood protection is critical to prevent damage and destruction to municipal infrastructure and property located within floodplains. 2. Lots of industry located within municipality, thus importance with respect to water quality.

- Water balance in existing development areas is not a concern as baseflows in the Rouge and Don Watersheds have increased over past decades despite conventional stormwater servicing (see Toronto Assessment Report or statistical analysis by TMIG for BILD). Erosion issues are a result of poor infrastructure placement (in valleys, too close to meandering creeks) and not due to water balance issues. In new development areas, water balance is analyzed to set mitigation targets to meet erosion and habitat protection (baseflow maintenance) and to meet Clean Water Act policies for municipal water supply quantity maintenance. Quantity ranks highest due to resident and business priorities to address existing flood risks / limitations in level of service with older design standards (pre-1980s).
- Water quality and quantity (flooding) have a bigger impact on our residents than erosion does.
- Protection of water quality is a high priority in this cottage area. Flooding is an issue and has caused major damages in the past.

S3Q13: In the next five years, what are the most critical issues facing stormwater infrastructure in your municipality?

- Climate change, increase storm frequency/duration/ intensity, adequate outlet issues
- Lack of funding
- For staff at County - culvert sizing. The Trent Severn waterway runs through the municipality and is of huge concern (volume), but we don't think this is what you are asking since this is not our infrastructure.
- Aging infrastructure is most critical, then the increase in storm severity, and lastly population growth/development.
- Major storms and if the system can handle it.
- Lack of funding for stormwater management system maintenance and replacement.
- Unknown until the assets are inventoried
- Sizing of Pipes due to Climate Change, Deterioration increased due to heavy storms
- Once Storm Water infrastructure is included in AMP financial commitment will be required to bring infrastructure to a condition rating which meets a reasonable level of service.
- Climate change versus old infrastructure, get complete asset condition assessment picture and plan for replacements with end of pipe treatment versus direct run off into watercourses. Lack of funding to complete this.
- Deteriorating infrastructure
- We are moving towards OGS installations with new development rather than ponds and ensuring regular maintenance is completed yearly in accordance with manufacturer specifications to ensure that the units are meeting water quality performance objectives. Too often, municipalities pay little to no attention to their ponds which may or may not be meeting the quality objectives that they were originally constructed for.
- Maintenance costs
- Maintenance
- Replacement of storm sewer pipes due to its ages, about 85% of stormwater pipes has gone beyond its life expectancy.
- Improved financing for the infrastructure and finalizing the asset management plan which is currently underway.
- Funding
- Ongoing maintenance of swm ponds that have been assumed from growth.
- New MOECC LID standards - will be very expensive to implement and maintain. Cleaning out stormwater management ponds (high costs)
- Replacement of existing CSP Pipes
- Financing
- Changing climate, bigger and more frequent storms.
- Climate change and cost of maintenance and repair.
- Maintaining existing ponds and developing additional end of pipe treatment facilities.
- Finding money to maintain them.
- Upgrading old infrastructure and trying to maintain existing, failing infrastructure
- Bridges, and new infrastructure that will have to be assumed by municipality.
- Refine Condition Ratings
- Trying to handle the intensities of the storms now. The quantity of rainfall over the event has not changed but the durations are shorter (more intense).

- Inadequate funding, increasing maintenance costs to deal with calcification, upsizing of pipes, pond cleanouts/rehabilitation
- Having suitable stormwater management infrastructure to handle climate change (flooding) in the municipality and the finances to be able to do the work needed.
- Replacement
- Corrosion of CSP
- Replacement of some failing culverts and ditching along roads. Also failing County Bridge Structures in our township which is their responsibility which are becoming unsafe for public travel. And these structures are on some main stormwater runoff stream and creek areas.
- Assessing the asset worth and establishing appropriate reserves
- The deterioration of corrugated steel pipe and the abilities of the system to handle larger events seen through climate change.
- Understanding what we have. The costs are hidden as we do not track or think of these assets (beyond the typical roadside culvert)
- Expansion
- Funding for replacement of existing infrastructure with an emphasis on low impact developments.
- Sink holes started appearing at the stormwater locations following a major flood in the area in 2013. A camera inspection revealed that the entire system is decaying. The Municipality had no reserves in place for the storm sewers. It is now budgeting annually but cannot budget enough in one year to complete any one section. The Municipality requires Provincial or Federal assistance.
- Lack of funding to address backlog of repair and replacement needs. 2. Increased urban expansion and development pressures.
- Flood control is the largest stormwater program and mitigation of existing flood risks is part of a long-term strategy. This includes sewer systems and some open channel systems.
- Age and deterioration of infrastructure
- Climate change - Increasing intensity and frequency of storms, resulting in more flooding issues. Regulatory requirements - We are expecting environmental regulations to become more stringent. Aging infrastructure - It is not urgent right now, but we know it's an issue, and we need to prepare for the future.
- Maintenance and rehab of existing facilities.

S3Q14: Has your municipality implemented green infrastructure solutions (e.g., urban forests, bio retention cells, constructed wetlands, reuse of excavated soil, etc.)?

- Local area municipal initiatives
- Soil reuse
- LIDs just starting, some bio retention swales
- Urban forests, include soil trenches.
- LIDs
- Yes, we use infiltration galleries and are looking into constructing some new wetlands.
- Rural area that considers all natural methods of management.
- We have used our excavated soil if suitable material for coverage on our rehabilitated dump sites and aggregate pit sites. Also, have supplied residents with fill for their properties for landscaping etc.
- Not yet but strongly encouraged in the Planning/ Development processes
- We have implemented rain barrels; and, have a design for a rain garden which we intend to build in 2017.
- No. The Municipality is largely rural in nature.
- Bioretention is an LID that is used. Constructed wetlands have been used since the early 1990s, sometimes combined with wetpond features.
- Working on bioswales for stormwater runoff
- Bioswales – implemented; roof gardens – implemented; rain gardens – implemented; tree trenches - implemented

S3Q15: Has your municipality implemented Low Impact Development practices (e.g., rain gardens, rain barrels, permeable pavement, etc.)?

- Yes, rain gardens, rain barrels, permeable pavers, vegetative cover.
- Local area municipal initiatives
- Past rain barrels - some rain gardens
- Starting in 2017.
- Yes, on a few occasions
- Yes, infiltration basin style stormwater management in small urban developments, and hybrid wet swales.
- Yes, for new development.
- Not yet, but now being included in future projects.
- None implemented still in the development stage in consultation with the local conservation authority
- A subdivision has been built using LID, a major building being considered.
- We only advertise for rain barrels and promote the natural use of the water and not to send it to the storm sewer unless no other option.
- Encouraged with new development only.
- Yes, some rain gardens and rain barrels.
- We have one development with LIDs with another bigger development being planned for 2017.
- Not yet but strongly encouraged in Planning/ Development processes
- All new development within the Town is required to provide on-site stormwater retention facilities to help alleviate the demands on the system.
- We have implemented rain barrels; and, have a design for a rain garden which we intend to build in 2017.
- Rain barrels will be considered at its community gardens
- Yes. Residential rain garden and rain barrel programs.
- Markham has supported the use of LID technologies to meet water management goals for many years. For example, the 2007 Kylemore Homes Subdivision stormwater management plan incorporated features such as biofilters/ infiltration trenches, passive infiltration basins, and a cooling trench to maintain and enhance quarter quality and to sustain Bruce Creek habitat in the Rouge River Watershed those features were constructed in 2010 and assumed by the City in 2016. Recently, enhance stormwater management functions and enhance local biodiversity in the Don River Watershed, Markham retrofitted an older development area, constructing the Glencrest Park Raingarden in 2016. To effectively preserve and enhance hydrologic functions in future large future developments, the 1,000-hectare North Markham area, the City is completing comprehensive subwatershed studies to identify LID targets that satisfy local groundwater recharge goals and to minimize downstream erosion risks. Markham is also implementing and testing LID technologies, such as on the Markham's Green Road, a half-kilometre long demonstration project that incorporates innovative, award-winning runoff pre-treatment devices, bioswales and recharge gallery features. Permeable pavements are used at one facility. Rain barrels are promoted for water conservation as opposed to stormwater management benefits - we have evaluated internet/ real-time control rain barrel technology but it does not appear to be cost-effective.
- Rain barrels
- Bioswales – implemented; roof gardens – implemented; rain gardens – implemented; tree trenches - implemented
- Not implemented; however, they are encouraged.

S4Q1: What stormwater infrastructure issue is most important to understand or to gain a better awareness of -- for municipal councillors and decision-makers?

- Cost, affects, and positive results from properly implemented systems. everyone knows the negative results from improper systems.
- Lifecycle costs associated with storm sewer infrastructure is nonexistent.
- Funding
- Changes in storm event volume/peak.
- Aging infrastructure and the "infrastructure gap."
- Updating the infrastructure
- How climate change will impact municipal stormwater conveyance systems.
- Unclear
- Age and Deterioration of underground pipes. Pipes deteriorate faster than water and wastewater
- Asset listing and condition surveys will bring quantitative value to the assets which have been ignored previously
- Climate change and aging infrastructure will require additional funding in the near future to replace and upgrade the systems installed in the ’50s and ’60s.
- Fish Habitat Protection Legislation.
- SWM pond maintenance and costs.
- That it is a major part of Municipal infrastructure that needs to be captured in an AMP and managed.
- There are multiple issues which can be eliminated with the effective stormwater management but basically most important issues for municipal councillors and decision-makers to understand is the economic and health and safety to the local residents. There are multiple layers of economic costs related to flooding. There are also long-term socio-economic damage and costs related to flooding that can be substantial. There are tangible and intangible losses associated with floods as well. When homes are damaged more than foundations and structures are affected. Personal belongings are also damaged: their emotional significance cannot be calculated, nor is it possible to place a financial value on them. There are also psychological stresses on residents and on institutions involved in flood management.
- The need to asset management plans and how they relate to financing needs.
- Cost of maintenance.
- Cost to maintain the structure into the future
- Feasibility of LID. Maintenance costs are not fully understood.
- Condition of existing underground infrastructure especially CSP pipes, cleanup of existing SWM ponds
- Planning and asset lifecycle
- General effects of stormwater control, quantity and quality.
- Ongoing maintenance costs.
- Long-term maintenance requirements (including costs) of swm facilities.
- There is a cost associated with every stormwater infrastructure.
- The condition of infrastructure and the new ponds and systems that are to be taken over by the municipality will have maintenance that will need to be completed.
- Cost to treat stormwater when segregating combined sewer systems.
- How all the infrastructure works together and their costs.
- Regulatory requirements, lifecycle activities for the proper function of the pipes (Flushing/reaming), effects of climate change.
- How grading and drainage work ie you just can't place a bigger pipe in the ground to take the increase in water. Also, the need to fund the infrastructure as a user fee much like water and wastewater.
- Infrastructural cost to the AM plan.
- Proper control of storm water runoff to prevent township assets and to do so in an environmentally friendly way.
- Overall system integrations and interdependencies
- The state and condition of the infrastructure
- SWM has been largely the domain of the engineers and those obtaining MOECC (in the past) or Conservation Authority clearance. Council did not really think about these facilities as municipal assets. Members are now coming back from conferences asking questions, which in turn operational staff and managers realize that there aren't many answers ...
- The size of the catchment area and the cost for the required infrastructure.
- The cost to replace the system.
- Funding and resources needing to sustain a good state of repair of existing stormwater infrastructure network and management of system performance

2. Stormwater needs to be viewed as a resource vs nuisance
- That LID implementation as proposed by the MOECC will increase lifecycle costs by 400 - 600% over conventional wet pond servicing. LID retrofit implementation under proposed policies will increase road maintenance costs by 300% and add over 30% to road reconstruction costs. LID cost savings are relevant to rural estate residential subdivisions where sewer pipes can be avoided, but not relevant to dense/sustainable communities being built in Ontario with densities prescribed by Places to Grow legislation.
- Floods are a risk to residents' property. When residents' property is damaged, insurance claims against the City go increase. Flood mitigation reduces the risk to residents' property, and to our insurance costs.
- Ensure budgets are sufficient for maintenance and rehabilitation of existing infrastructure.

S4Q2: What stormwater infrastructure issue is most important to understand or to gain a better awareness of – for provincial politicians and decision-makers?

- Cost, effects and positive results from properly implemented systems. Everyone knows the negative results from improper systems.
- Infrastructure deficit as a whole.
- Funding
- Changes in legislation
- Funding - municipalities who've been fiscally responsible at the cost of their level of service/state of infrastructure are still in need of funding.
- Climate change
- Provincial Design Guidance on the implementation of LID/green infrastructure.
- Ensuring when roads are done underground infrastructure is definitely looked at before job commences. Stop spending surface only money.
- Limited resources of small municipalities to maintain assets downloaded from provincial and upper tier municipalities
- Grant funding opportunities need to be available for condition assessment and capital upgrade to accommodate climate change in stormwater systems.
- That smaller Municipalities need some financial assistance in upgrading or in some cases maintaining SWMP, especially if Ministry inspection are going to being as they have for us.
- Economic
- How climate change impacts stormwater infrastructure.
- Cost of maintenance
- Cost
- Feasibility of LID. Maintenance costs are not fully understood. - cost of maintaining existing SWM ponds
- Financial restrictions of small municipalities
- The cost to construct and maintain these systems.
- Maintenance costs and control of costs.
- Monitoring should not be required as a condition of ECA for new SWM facilities. Studies have shown that ponds built to design will meet quality requirements.
- Huge financial burden to all the municipalities
- Storm Water Management Plans
- Cost to treat stormwater when segregating combined sewer systems.
- Municipalities don't have endless resources to fund projects just because there was a problem at one location.
- Need to have the tools and funds to comply to the regulatory requirements.
- The need for more grant funding for storm water infrastructure because of climate change.
- Infrastructural cost to the AM plan.
- Smaller Municipalities face limited financial capabilities to deal with issues such as storm water infrastructure. Which many are overlooked due to not financially being able to address such issues.
- Same as above but with a profound understanding of the related cost challenges
- Impacts on existing infrastructure imposed by climate change.
- The cost to maintain.
- The importance of the systems to our infrastructure and the need to assist with funding to replace to them.
- Funding and resources needing to sustain a good state of repair of existing stormwater infrastructure network and management of its performance
  2. Must provide clear and consistent decisions, directions and regulations to municipalities for planning, management and repair of stormwater infrastructure 3. Must understand that a "blanket"

approach cannot be used province-wide - e.g., what works for the GTA may not work for other areas within the province
- GTA watersheds like Markham's do not have a baseflow crisis requiring expensive LID retrofit intervention - the conceptual impacts to baseflows predicted by “model concepts” is not supported by actual data on baseflow trends over the past 50 years. Also, LID implementation will adversely affect wastewater systems (infiltration causing high extraneous flows) causing sewer backup, and recharge of salt laden road runoff with LIDs will corrode cast iron watermains and metal fitting to new plaster watermains.
- ECAs at ponds do not seem to be monitored or enforced. Province does not promote rain water as a resource. We need policies that encourage people to treat rain water and gray water as a resource. We need policies that promote innovation in rain water and stormwater capture.
- Not sure.

S4Q3: What stormwater infrastructure issue is most important to understand or to gain a better awareness of -- for developers and large property owners?

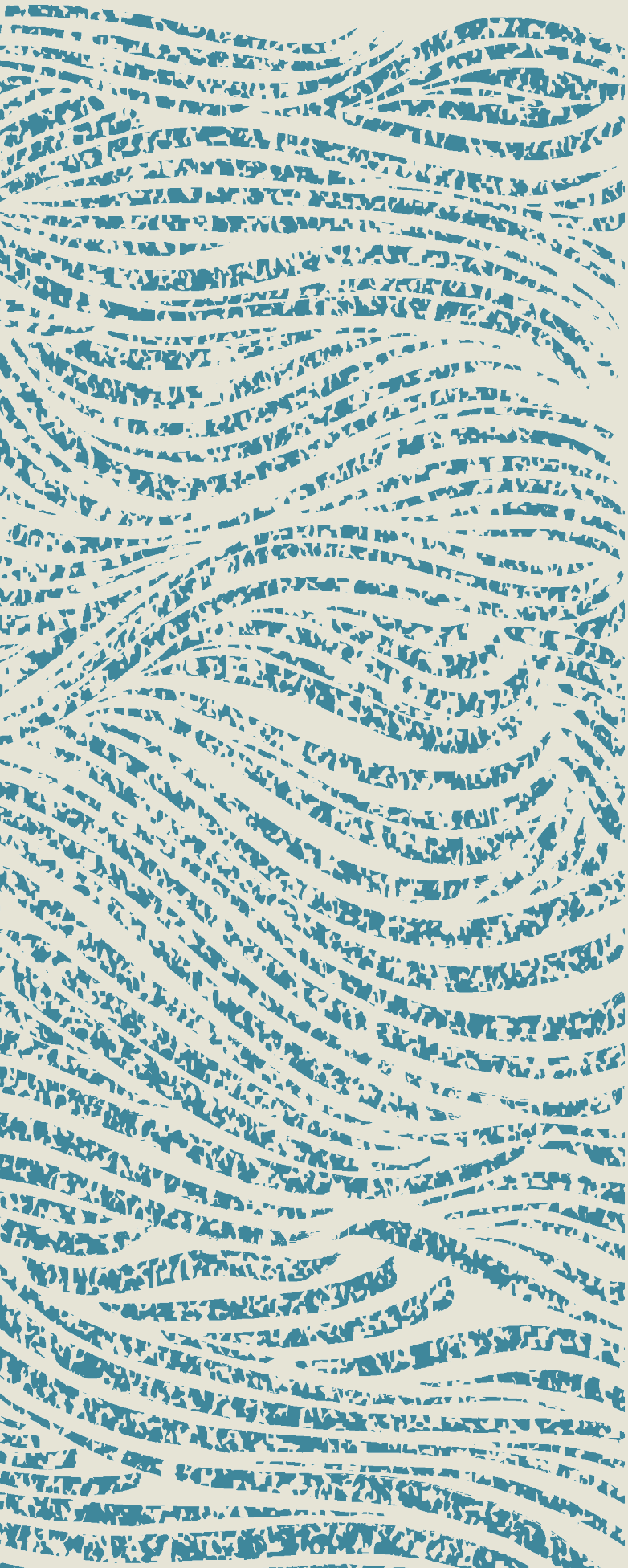
- Cost, effects and positive results from properly implemented systems. Everyone knows the negative results from improper systems.
- Climate change, and potential need to adhere to higher occurrences of one- to -100-year storm events.
- Changes in legislation and cost-effective options.
- Neutral contribution to the existing stormwater system and planning for future growth, especially for staged developments.
- Proper runoff
- Quality / Quantity Controls
- In ground infrastructure
- Impact it has downstream and what impact it has to those purchasing the property
- Maintenance of infrastructure to meet CofA and ECA requirements.
- That pre must equal post conditions and low impact and water balancing applications need to be considered at the expense of the developer not the taxpayer.
- At source treatment options.
- That when constructing them that they need to be accessible and easily maintainable if Municipalities are eventually going to take ownership.
- Ecological Impact Impervious surfaces result in greater volume of runoff at a higher rate of flow that can cause channel modification and increased sediment loading there by affecting aquatic habitats. In addition, the surface runoff carrying debris, oil, grease, nutrients and combined sewer overflows that, when discharged to the natural water body, can further deteriorate the flora and fauna. Depending upon the time factor and concentration of the contamination, acute and chronic impacts can occur. This pollution can travel a significant distance and remain in the environment for a long period of time. More energy is required to prevent and control pollution from the water stream, and more greenhouse gases are released in the atmosphere.
- Proper techniques for installing LID solutions and why LIDs are important.
- LID
- Design and construction to minimize long term costs for the municipality
- Benefit of SWM to the development, vs. minimizing costs.
- Life cycle and growth planning
- Stormwater quality and quality.
- Outlet control to better protect downstream owners.
- That if done right SWM facilities can be an asset to the development.
- They have to be part of the solution.
- If they do it right off the start then maintenance and repairs are minimal.
- Source controls - post to pre.
- That it is not about capital costs to build facilities but that it should be about life cycle costs. What costs the least over time.
- Need to have holistic vision of the entire system - not just worrying about their development.
- The need to design for the 250-year storm.
- Ability to have a zero impact on surrounding areas through engineered solutions of management.
- The geographical layout of the land and the natural run off either spring water runoff and storm water runoff.
- The need to properly manage stormwater on site to protect Source Water and regeneration

requirements
- Runoff control and mitigation to control the impacts on the existing systems and downstream ecosystems.
- That these features are a part of a system. As development beyond more dense, the system relies on property owners to understand what a swale is and why they cannot build or fill in this "wet area."
- No significant development is planned for the immediate future.
- The need for proper installation and easements.
- Funding and resources needing to sustain a good state of repair of existing stormwater infrastructure network and management of its performance 2. Access needed to municipal crews for maintenance of stormwater infrastructure 3. Stormwater flows to/collects at the lowest points, takes path of least resistance 4. Developing within a floodplain or along a riverbank is never a good idea 5. The province does not always provide the most clear, direct and/or consistent approach(es) for permitting and planning approvals 6. Must provide clear and consistent decisions and directions to municipalities for planning, management and repair of stormwater infrastructure
- On-site stormwater controls must be maintained (e.g., regularly clean oil and grit separators).
- Developers should be encouraged to implement at-source solutions, such as permeable pavers, and gray water systems.
- Ensure design/construction will operate as intended and be conducive to long term performance. Regards for future maintenance.

S4Q4: What stormwater infrastructure issue is most important to understand or to gain a better awareness of – among the general public?

- Cost, effects and positive results from properly implemented systems. Everyone knows the negative results from improper systems.
- Why Storm Water Management (SWM) strategies are important, and how they directly impact capital planning.
- Importance of having infrastructure and need to fund
- Costs associated with infrastructure ... who pays.
- The general public should be educated on the impact of their changes to the stormwater system (i.e., filling in ditches and swales, tiling farm land lower than downstream water levels, etc.)
- Knowledge
- Pipe sizing and the deterioration of pipe
- Function of stormwater infrastructure, fountains and wildlife are not components of the ECA
- That stormwater must not instantly disappear after a storm, it takes time to percolate, infiltrate and evaporate as part of the stormwater system for environmental balance. Contaminants need to be keep out of that process. Recharge is required in the city and the country.
- The impact of contamination of drainage into catch basins that discharge into our rivers and creeks.
- That they are dump sites or compost areas. This reduces the effectiveness of the systems.
- Impervious surfaces result in greater volume of runoff at a higher rate of flow that can cause channel modification and increased sediment loading there by affecting aquatic habitats. In addition, the surface runoff carrying debris, oil, grease, nutrients, and combined sewer overflows that, when discharged to the natural water body, can further deteriorate the flora and fauna. Depending upon the time factor and concentration of the contamination, acute and chronic impacts can occur. This pollution can travel a significant distance and remain in the environment for a long period of time. More energy is required to prevent and control pollution from the water stream, and more greenhouse gases are released in the atmosphere.
- The proper use of stormwater infrastructure, including making environmentally conscious decisions.
- Their need
- General understanding of SWM
- Patience
- Stormwater quality and quantity.
- Education.
- Why it is required.
- The traditional way of managing stormwater is no longer meeting today's standards
- Pollution prevention.
- That all stormwater needs an outlet. Doesn't have to be large but there still needs to be an outlet.
- Need to understand the full effects of their actions

for example dumping engine oil down a catch basin has horrific effects on the downstream environment. Need to be educated on the works of SWM Ponds.
- The same as for municipal councillors, you can't just place a bigger pipe to handle the increase in water.
- Cost.
- Awareness of low lying road ways which could possibly flood over during a heavy rain storm or during spring thaw. Which could cause dangerous driving or access conditions.
- Limitations of the current systems and changes to the demands through climate change.
- SWM is an important part of the engineered landscape and these areas need to be protected and respected. I like to say that Mother Nature always wins, so you alter a drainage feature at your peril.
- Cost
- The importance of storm water management.
- Funding and resources needing to sustain a good state of repair of existing stormwater infrastructure network and management of its performance 2. Access needed to municipal crews for maintenance of stormwater infrastructure 3. Stormwater flows to/collects at the lowest points, takes path of least resistance 4. Building a home within a floodplain or along a riverbank is never a good idea 5. The province does not always provide the most clear, direct and/or consistent approach(es) for permitting and planning approvals 6. Must provide clear and consistent decisions and directions to municipalities for planning, management and repair of stormwater infrastructure
- That contrary to insurance industry and generalist statements, storms are not more severe today than before. Flood risks have increased due to other factors (hydrology, pavement and runoff) and sometimes due to operational decisions. A breakdown of the extreme weather trends that are not reflected in any Ontario government policies or in general public / media material can be found here: https://www.slideshare.net/RobertMuir3/storm-intensity-not-increasing-factual-review-of-engineering-datasets Unfortunately, there is a pervasive “availability bias” at play in the general public and media that is skewing the issue of extreme weather, and that can divert attention from key drivers for flood risk. Canada's Engineering Climate Datasets (version 2.3) clearly show no detectable trend in extreme rainfall, as published in Atmosphere Ocean in 2014. But the facts are not being communicated to the public. Unfortunately, the insurance industry has been promoting incorrect trends and this is counterproductive to finding effective solutions.
- Provide knowledge and awareness of stormwater impact to lakes and streams.
- The public needs to be aware that rain water is a valuable resource. Effect of expanding driveways (legally or illegally) and other impermeable surfaces on our stormwater infrastructure.
- Not sure.



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