Making Green Infrastructure Mainstream: Exploring the Use of the Drainage Act for Decentralized Stormwater Management on Private Property

Sustainable Technologies
EVALUATION PROGRAM

MAKING GREEN INFRASTRUCTURE MAINSTREAM: EXPLORING THE USE OF THE DRAINAGE ACT FOR DECENTRALIZED STORMWATER MANAGEMENT ON PRIVATE PROPERTY

Discussion Paper

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1.0 PURPOSE OF THIS DOCUMENT

Recent years have seen the implementation and successful operation of a number of pilot scale Low Impact Development (LID) projects across Southern Ontario and, more generally, throughout Canada. Despite their demonstrable success and proclivity to outperform design expectations, adoption of LID practices – particularly on private property - has not occurred. This is true despite the ongoing issues of urban flooding, water quality impairment and continued pressure on overtaxed and aging infrastructure. While several factors have been implicated as barriers hindering broad scale LID implementation, market research conducted in the Greater Toronto Area (GTA) indicates that the high up-front costs and long or non-existent payback period are the largest barriers inhibiting LID adoption. Innovative tools and approaches are needed to overcome these barriers.

This discussion paper will assess and evaluate the Drainage Act as a tool for property aggregation to support wide scale adoption of LID on private property in urban areas. The Drainage Act is a pre-existing Ontario Statute that provides a process for the construction and maintenance of communal drainage works on both private and public lands, including roads. By extension, communal drainage works include LID and related forms of Green Infrastructure (GI) amongst the suite of drainage tools. LID is an approach to stormwater management that uses a combination of improved urban design, landscape features and other techniques to filter, store, infiltrate and use rainfall where it falls. GI is similar to LID in that it seeks to maintain and restore essential environmental processes – including the hydrologic cycle – through the protection and rehabilitation of living systems. The main difference is that GI consider benefits which extend beyond the domain of stormwater management, and hence it is typically broader in scope. It may consider the urban heat island and aesthetic benefits of streets trees, for example, in addition to their stormwater benefit. Stormwater management is the primary purpose of LID, while the concept of GI is much more multi-faceted in nature.

This discussion paper is the first in a series of papers and technical reports that will evaluate different novel stormwater management approaches. To improve the state of stormwater management, new and innovative ways of considering relevant policies, legislation, regulation, and bylaws, economic and marketplace incentives, and municipal and private property adoption requirements insofar as they relate to LID and GI adoption are needed. The series of reports and discussion papers generated through this evaluation are nested within a larger micro-economic project that seeks to develop a viable economic model that will quantify the extent and value of privately held lands through the lens of stormwater management. This is in addition to an evaluation and quantification of the economies of scale achieved via the aggregation and linking of GI and LID measures, and the financial benefits associated with the uptake of GI and LID practices by private landowners as part of a broader stormwater infrastructure optimization process. Ultimately, aggregation will help to facilitate wide scale implementation, reduce

infrastructure deficits and provide for an adaptive, resilient and integrated water management system.

2.0 BACKGROUND

Urban expansion throughout the Province of Ontario is leading to the rapid loss of agricultural land. This is evident in the Census of Agriculture results, which show that 1.46 million ha (nearly 25%) of productive farmland lost in the Province between 1971 and 2016 activities (Statistics Canada, 1971-2016). A 2002 study by the Ontario Federation of Nature and the Ministry of Natural Resources found that 80% of forest patches (contiguous forests) in Southern Ontario were less than three hectares in size (Federation of Ontario Naturalists, 2002) and did not constitute viable forest habitat for most species. By 2014, Southern Ontario had lost over 75% of its original wetlands (MNRF, 2015). Despite such statistics, Ontario is projected to add an additional 4.2 million residents by 2041 – an increase of more than 30% from today (Ontario Ministry of Finance, 2017). The collective loss of agricultural land and natural habitat to urbanization has changed the hydrology of the Great Lakes region and led to continued degradation of surface and groundwater resources, increased erosion and flooding, increased vulnerability to the effects of more frequent extreme weather and an overall decline in the health of the Great Lakes themselves.

In addition to the pressures arising from continued population growth and increasing urbanization, water quality and urban flooding issues are being exacerbated by problems arising due to aging infrastructure. Drinking water, wastewater, stormwater and road infrastructure are in an overall state of disrepair, and are in need of rehabilitation and replacement. The total national cost associated with the repair of these systems is estimated to be upwards of $123 billion, and growing at a rate of approximately $2 billion annually (Mirza, 2007). Approximately 25% of Canada's infrastructure deficit pertains to wastewater and stormwater systems (Mirza, 2007). In Ontario there is a $60 billion investment gap regarding the building and replacement of municipal infrastructure (AMO, 2015), with a $6.8 billion infrastructure deficit for stormwater alone (ECO, 2016). Unfortunately, these estimates fail to take into consideration the need for upgrades to pre-existing infrastructure in urban areas that are not receiving an adequate level of stormwater management service as per current flood control and water quality standards. It is estimated that only 35% of the greater Toronto area (GTA) has stormwater quality treatment, leaving 65% of our urban areas underserviced (TRCA, 2013). Innovative approaches to managing stormwater – including those which use LID and other forms of GI – are needed to address the aforementioned infrastructure gap, extend the useful service life of existing infrastructure, and to slow the growth rate of mounting infrastructure deficits.

Municipalities have identified and recognized the urgency of such needs, and as such have worked to develop innovative instruments intended to address budgetary constraints surrounding stormwater infrastructure. Many cities throughout North America have adopted stormwater utility programs, and these frequently include some type of credit component. The United States alone boasts more than 1,400 such programs, 86% of which structure user fees according to their amount of impervious area contributing flow to the stormwater system (Kea,

2015). Unfortunately, these programs have so far failed to demonstrate an effective ability to drive wide-scale LID adoption or to suitably address the most egregious environmental impacts of stormwater. To identify specific barriers inhibiting wide scale adoption of LID, market research studies undertaken by the Cities of Mississauga (Freeman & Associates, 2008) and Kitchener (Aquafor Beech Ltd. and Freeman & Associates, 2015) identified the primary barriers to the wide-scale, linked and integrated use of GI and LID to be as follows:

Private Sector

- Poor Return on Investment (ROI) for commercial and industrial property owners. Payback periods in excess of seven years or more were not uncommon for most types of LID practices. For rainwater capture and reuse payback periods typically extended beyond 20 years.
- Stormwater credits – or "feebates" – had little impact on reducing the simple payback period, hence uptake rates across the US and Canada in jurisdictions providing incentives for GI/LID are typically below 5% for all types of private property owners. It is worth noting that the 5% figure includes the engaged segment of the population whose interests in green infrastructure extend beyond simple financial incentives.
- Overall, private property owners felt that there were no effective financial drivers in place to encourage GI/LID investments by commercial and/or industrial land owners. It is worth noting that, in urban municipalities, private holdings of land typically account for more than 70% of the total urban land area.

Public (Municipal) Sector

- Water infrastructure deficits continue to mount despite new fee systems and full-cost accounting requirements.
- Municipalities continue to operate on a linear, command and control approach to owning and operating infrastructure. Generally, water infrastructure planning is focused almost exclusively on public systems on public lands – a model with origins dating back to the late 19th Century.
- Capital investments by municipalities in GI/LID remain narrowly-scoped and project-based. Therefore, opportunities for integrated water infrastructure planning and management (i.e. the 'One Water' approach) are not being realized. Ongoing funding for infrastructure operation and management suffers from the same challenges in that it too tends to be project-based.
- Municipal water master planning tends to be done in silos wherein water supply and waste water treatment are addressed separately from stormwater management and source water protection. In other words, the One Water integrated approach to water infrastructure planning and management remains a novel concept that is not yet being put into practice.
- With limited exceptions, total impervious cover continues to increase in the most threatened and heavily-impacted watersheds.

To overcome these barriers, some municipalities in the US which have implemented stormwater utilities have begun moving towards a model that supports property aggregation for the purposes of comprehensive stormwater management conducted at a neighbourhood-scale. The City of Philadelphia, for example, has recently implemented the Green Acres Retrofit Program (GARP), which provides grants of up to $90,000 USD per acre ($221,400 USD per ha) for project aggregators who manage stormwater onsite from multiple properties having an aggregated drainage area of 10 acres (4.06 ha) or greater (City of Philadelphia, 2016). The benefits of having municipalities encourage aggregation at the neighbourhood scale cannot be understated; reductions in costs related to design, construction, operation and maintenance (O&M) can be realized for all parties involved – municipalities and private property owners alike. Restated, this translates into a decrease in the payback period, which makes the ROI more lucrative and broad-scale LID/GI implementation – even under retrofit conditions – more attainable. If aggregation is considered within the context of a stormwater utility fee and credit program, it opens the door to credit trading opportunities amongst property owners who provide over control (enhanced stormwater management that goes beyond a predefined minimum in terms of runoff volume and/or quality). Excess credits can be sold to property owners who are unable to meet minimum on site requirements. Such an approach provides an added financial incentive for all property owners residing within a utility's jurisdiction.

On July 13, 2017 CVC hosted a workshop to discuss the application of the Drainage Act to implement and promote decentralized stormwater management in urban environments. Drawing nearly 100 stormwater management professionals, participants were asked focused market research questions in order to identify key drivers and preferences with respect to the state of stormwater management and the application of the Drainage Act on private and public property in urban environs within Ontario. Contributors were from a variety of sectors including Municipal, Provincial, Federal, Conservation Authorities, Academia, Private Businesses and Consulting, and Environmental NGOs. Results by sector for 25 market research questions are included herein under Appendix B.

As property owners work together to manage stormwater it generates new opportunities to explore approaches to infrastructure optimization at the catchment scale, and this is true not only for stormwater, but for potable water and wastewater as well. For example; when considering stormwater aggregation approaches in areas of high potable water use - such as industrial, institutional or commercial lands – potential exists to harvest stormwater to meet some of the water resource needs of the facilities in question, particularly in instances for which water need not be potable (e.g. toilet flushing, lawn watering, vehicle and floor washing, equipment cooling, fire suppression, etc.). Opportunities are further enhanced by the relative proximity and physical characteristics of large catchment areas (e.g. rooftops and parking lots),

and the flexibility in water quality needs which exist when a large number of diverse water users are considered. To illustrate this point, consider the common engineering approach of pinch analysis, wherein the water required for an industrial process or use is satisfied by water treated to the minimum required standard. For example; harvested rooftop runoff can be used for many non-potable indoor uses, such as toilet flushing or industrial floor washing. With a minimum level of filtration such water may then be suitable for the primary washing of industrial products; automotive parts and so on. Conversely, such water is typically of a much higher quality than what is needed for outdoor lawn irrigation. To meet non-potable outdoor water needs, filtered surface runoff from commercial parking lot areas may be acceptable. This concept is illustrated in Figure 1. Note that in this simple example, the volume and quality of water from the two reclamation sources are such that all listed needs can be met without the need for treatment, and that the supply is equal to demand.

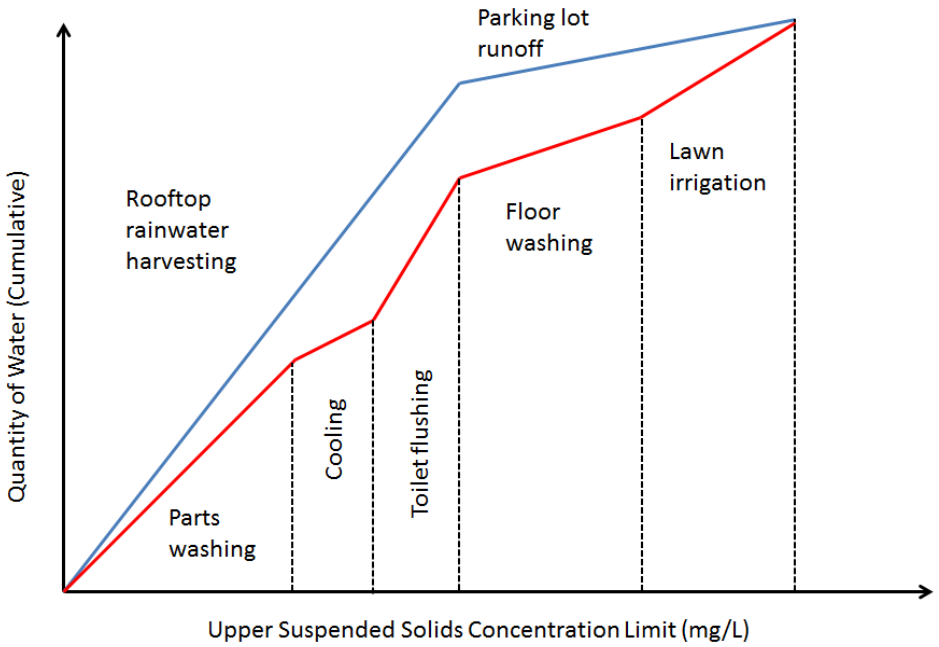

Figure 1 Conceptual Pinch Analysis for an Industrial/Commercial Water Reclamation and Reuse Scenario

In the context of stormwater aggregation it is critical to note that commercial property owners may be a source of relatively clean parking lot runoff, compared to an industrial counterpart. As such, there may be a business opportunity for the commercial property owner to provide rooftop and parking lot runoff to a high-volume industrial user. Such water may also be cheaper than the conventional municipal supply; thus such an arrangement would be economically beneficial to both parties. Extrapolating further, a sufficient number of such arrangements may allow for the deferment of water treatment infrastructure upgrades, or the realization of additional 'hidden capacity' from within the urban supply.

Despite its brevity, the above summary underscores both the most pressing challenges inhibiting broad-scale LID implementation, as well as some of the most innovative market-based

instruments and approaches that can be employed to overcome such barriers. Regionally, there are also a number of mechanisms that can be used to facilitate the advancement of LID implementation across Ontario, and these include elements of aggregation, market incentives and access to capital. These may include – but are not limited to – the following:

- The Drainage Act
- Local Improvement Charge (O. Reg. 586/06, amended in 2012 to support water retrofits),
- Credit trading,
- Property tax rebates
- Other rebates/subsidies

Although such mechanisms may provide an effective means of driving enhanced stormwater management, they have not been properly evaluated in the context of Ontario's unique physiographic, legislative and political climate. No steps have been taken to apply such mechanisms for aggregation or LID/GI adoption purposes from either a public or private property perspective. The remainder of this paper will be limited to an evaluation of the tools and approaches which exist within the Drainage Act - a specific legislative vehicle unique to the Province of Ontario – for their potential to drive widespread LID implementation in underserviced areas. Evaluation of other legislation and policies – including those noted above – will be the subject of future discussion papers. The Drainage Act's pre-existing mechanisms for aggregating properties to manage drainage waters and apportion both the associated costs and benefits related to such activities warrants serious consideration as a means of enhancing urban stormwater management in communities where controls are lacking or inadequate.

3.0 SCOPE OF DOCUMENT

Given the myriad and complex challenges identified previously, it is necessary to clearly identify what is inside – and what is outside – the scope of this paper. This discussion paper explores and evaluates how the Drainage Act can be used to aggregate and retrofit industrial/commercial neighbourhoods comprised predominantly of small and medium-sized enterprises (SMEs). SMEs are of particular interest as they account for approximately 99.7% of all businesses nationwide, and it is SMEs that typically cannot tolerate simple payback periods that extend beyond a two to three-year time horizon (Government of Canada, 2016). As such, analysis of the Drainage Act's utility to drive enhanced stormwater management will be achieved via the completion of the following:

- Describe the precedent set by the Drainage Act in terms of aggregating properties insofar as shared drainage may be concerned
- Explore the possibility of using processes available within the Drainage Act to incorporate source and conveyance controls for the purpose of stormwater management on private properties

Given the overarching complexities surrounding this this issue, and in recognition of the myriad social, economic, political and legislative dimensions contained therein, it is important to identify what is outside the scope of this paper. Items that will not be addressed in the current work include:

- Full cost accounting of the services provided by LID/GI
- A complete package of policy and legislative mechanisms to facilitate or augment GI implementation
- Identification or explication of the appropriate offset value or benchmark level for a structured credit trading scheme

4.0 WHY EXPLORE THE DRAINAGE ACT FOR DECENTRALIZED STORMWATER MANAGEMENT?

Extensive market research was conducted that explored randomized representative sample group's attitudes, opinions and perceptions with respect to LID implementation. Through this, research barriers and impediments to implementation were identified. The top barriers were determined to be the high upfront costs, the long payback period, and the lack of priority placed on stormwater management by private property owners. The results of the market research led inextricably to the conclusion that even when a stormwater utility fee and credit program exists, adoption of LID by private landowners is hindered by the low ROI. Table 1 summarizes the specific barriers identified by the market research study, as well as the relevant mechanism within the Drainage Act and the associated section where it is discussed within the current work. Pursuant to this, critical evaluation of the Drainage Act may provide insight into processes and approaches which speak to:

- Much needed strategies for demonstrating the deferral or avoided capital expenditures of taking a green infrastructure approach over a grey infrastructure approach;
- A framework which highlights how innovative water management approaches could be implemented to extend the lifespan of existing conventional infrastructure;
- A transparent methodological framework which helps municipalities justify budgetary expenses and investments while also allowing them to better focus on priorities.
- A fulsome understanding of both the risks and consequences of alternative investment decisions.

A CVC led market research study polled participants from an assortment of organizations and identified that the greatest challenge for effective stormwater management was thought to be insufficient funding and revenue for stormwater infrastructure. The best methods to fund stormwater infrastructure were perceived to be:

- Dedicated revenue source through stormwater utility
- Provincial/federal funding of municipal stormwater management/GI projects
- Development charges

Table 1 Market research barriers and recourse within the Drainage Act.

Problem / Barrier	Relevant Mechanism Within the Drainage Act	Report Section Where Discussed
Financial Costs		
Cost to municipalities/private land owners. Includes long (or non-existent) payback.	The Drainage Act allows for aggregation (within a catchment or drainage shed) to achieve economies of scale. Complete assessment of costs allows for expenses to be shared equitably amongst the public and private sector, as well as utility companies.	8.2 and 8.3
Policy Barrier		
Drainage across multiple properties.	The Drainage Act is inherently communal; it is built around the idea of shared drainage (multiple properties).	11.0
Conflict with zoning bylaws, municipal plans, property setbacks, etc.	The Drainage Act allows drainage works to cross multiple property lines. While not exempt from other policy/regulations or guidelines, the Drainage Act can be applied so long as in doing so it does not create or exacerbate the problem(s) that the aforementioned policies were intended to solve.	11.0
The administrative burden associated with ECAs and other permits on an individual basis makes the wide scale implementation of LID unduly cumbersome.	The Drainage Act process would allow for a single permit for aggregated works which span more than one property. The aggregated works cover an area equivalent to the area requiring drainage downstream to the sufficient outlet described in the report of the engineer.	5.0 and 8.2.4
There is uncertainty with respect to the means by which pre-existing stormwater works could be incorporated or otherwise considered as part of a broader SWM infrastructure strategy.	The Drainage Act has mechanisms to adopt existing infrastructure within larger drainage works projects (S.31).	8.2.1
Legal		
Municipalities wishing to construct, operate or otherwise own works on private lands do not have a legal means of entering on to said lands unless permission is explicitly given.	The Drainage Act allows municipal infrastructure to be constructed and maintained on private properties. Access for the purposes of inspecting and maintaining all drainage works is expressly protected under the statute.	8.4, 8.7 and 9.0
Easements can be created as redress to the above, but this can be cumbersome, expensive and potentially litigious (i.e.	The Drainage Act process provides an easement and compensation to the land owner where the easement is located. The Drainage Act does not require registration on title.	8.2.1

expropriation).		
Subdivisions of land creates uncertainty with respect to the rights and responsibilities of affected landowners.	The Drainage Act contains provisions which allow for the reassessment of costs to landowners following the subdivision of land or any material change affecting the parcel(s) in question.	9.0
Operation and Maintenance		
Operation and maintenance of infrastructure on private property by private owners is difficult or impossible to ensure. It is legally challenging for municipalities to perform inspections and to verify or enforce maintenance.	The Drainage Act allows municipalities to enter on to private properties in order to construct, inspect and maintain drainage infrastructure located on such properties. Topographic surveying and related engineering work is also legally sanctioned.	8.4, 9.0, and 10
Questions abound as to how costs would be recouped if private land owners – or a third party – damages LID (drainage works) features situated on private property.	The Drainage Act allows a municipality to order a landowner to correct damages to a drainage works. In cases of noncompliance, the Act allows municipalities to correct damages at the landowner's expense. The municipality can also make claim for damages and/or press charges in Provincial offences court (S.80-82).	9.0 and 10.0
Process		
There is no process for landowners(s) or municipalities to initiate development of communal drainage works (LID).	The Drainage Act has a petitioning process that allows either of the parties noted to initiate an engineer's investigation into the feasibility of constructing such drainage works.	7.4
A transparent way to apportion capital costs is required.	The Drainage Act contains a mechanism to assess and apportion all design, construction and associated capital costs to affected lands and roads.	8.3
A transparent way to apportion O&M costs is required.	The Drainage Act contains mechanisms for specifying and scheduling future maintenance activities and for assessing the full cost of future maintenance activities to landowners in a manner proportional to the benefit derived from the maintenance works.	8.3
Lack of Incentives		
There is no impetus or incentive for private landowners to implement LID practices, even in municipalities that have a stormwater utility fee and credit system.	The Drainage Act does not directly address this. However, the Drainage Act does codify the potential provision of grants and related incentives for agricultural lands (S.85). A parallel program for urban areas could be modelled after this.	N/A
Conflict Resolution		
Shared drainage works may lead to disputes between co-owners and numerous questions remain with respect to how such issues could be resolved.	The Drainage Act has a multi-tiered dispute resolution and appeal process (Court of Revision, Appeal Tribunal, and Drainage Referee). The Drainage Act distinguishes between appeals made on design (technical) and assessment	8.6

	(financial) grounds.	
Performance Monitoring		
The utility of LID practices hinges on their proper performance. As such, a way to pay for monitoring costs is needed so that LID functionality can be verified on a periodic basis.	The Drainage Act maintenance process requires inspection (monitoring).	10.0
Feasibility		
Canadian municipalities continue to grapple with a substantial infrastructure deficit, and this poses a major financial challenge to the wide scale implementation of LID.	The Drainage Act contains a mechanism to assess shared costs to both public and private lands which benefit from the construction of drainage works.	8.3
There are not enough general tax dollars available to implement decentralized SWM systems on all roads and exercise proper control over stormwater on private property.	The Drainage Act allows for the creation of drainage works on both public and private lands, and this allows stormwater to be managed using the optimal combination of public and private spaces.	7.1 and 11.1
Publically-owned lands typically account for less than 20% of the total urban fabric, and the right-of-way (ROW) is host to a broad array of infrastructure and utility types. As such, managing stormwater solely within this space may be difficult or impossible.	The Drainage Act allows for shared drainage solutions on both public and private properties. The proportion of public and private property usage for drainage scheme implementation is achieved using a suite of criteria which balances cost, performance, capacity and appeals considerations.	7.1 and 11.1
Secondary Barrier: once infrastructure is in place, it may be difficult to upgrade or improve, or make infrastructure adaptable if it is located on private lands.	The Drainage Act contains specific narrative (S.78) which allows for existing drains to be upgraded to suit the evolving needs of the area being served.	9.0
Utilities located in the ROW make LID implementation in the public domain too expensive. It is infeasible to use the ROW as a location for SWM	The Drainage Act allows engineers to assess the increased cost of construction due to the occurrence of a utility/utilities to be assessed to the utility company (S.26).	8.3.1
Opportunity		
How can the useful life of publically-owned infrastructure be extended by leveraging the stormwater management potential of private lands?	The Drainage Act allows engineers to assess allowances to landowners as a form of compensation for restriction on land use within a drainage scheme.	8.2.1

Municipalities today are looking at the ROI in terms that extend well beyond mere dollars. There is a growing recognition that in addition to economic benefits, LID and related GI practices also improve public physical and psychological health, build climate resiliency, reduce urban heat island impacts, enhance urban micro habitats and improve the overall quality of the built environment when appropriately incorporated within the broader urban fabric (Tzoulas et al., 2007; Lee and Maheswaran, 2011; Vandermeulen et al., 2011). As such, it is critical that mechanisms which may encourage broad scale implementation of these practices be explored.

5.0 SOLUTIONS – AGGREGATION

As both properties and stormwater are pooled, the flexibility which arises within the optimization process allows for greater cost efficiencies and optimal decisions to be made. As such, the aggregation of properties is one of several tools that – working in tandem with complimentary measures - can help break the pay back challenge currently faced by proponents of GI, particularly when incentive mechanisms exist to augment LID/GI uptake.

Currently however, there does not appear to be a strong business case which adequately incentivizes individual landowners to retrofit their properties on a lot-by-lot basis. The payback period – regardless of the means used to compute it – which is arrived at through the adoption of LID projects in such contexts is simply too long (in the order of years to decades), or simply non-existent. Furthermore, utilizing an approach which relies on individual actors is certain to result in missed opportunities. For example, if a given landowner does not have the space to retrofit their site and obtain the full credit but a second landowner within the same drainage area does, the means afforded to them via aggregation would allow them to increase the size of their jointly-owned facility so that it may accommodate not only their full required stormwater treatment volume, but that of their neighbours as well. This would allow the two aforementioned property owners to share in the capital, operation and maintenance costs of their facility, while also realizing the financial value of credits for the provision of volume capture for their neighbours as well. Both properties would then benefit from a full rebate on their stormwater utility fee, in addition to the ancillary credit associated with the management of their neighbour's stormwater.

If landowners collaborate at the catchment level economies of scale will begin to emerge via the efficiencies gained through the sharing of the planning, design, construction and on-going O&M costs for the associated LID works. In much the same way that the Drainage Act utilizes a single engineer's report for a given drainage system, aggregated LID adopters would benefit by virtue of the fact that they could jointly pay for one geotechnical engineering report, a single design consultant's work and so on. The actor initiating the property aggregation process for the purposes of shared stormwater works (the 'aggregator') can reasonably expect additional savings to be accrued as a result of streamlined data collection, infiltration testing, modeling, ancillary consulting fees, utility daylighting work, and permitting. Simply put, concurrent construction lowers costs. Furthermore, we posit that long-term monitoring and/or maintenance are best performed across multiple, aggregated sites by a trained and efficient team – the existence of which is made viable at such a scale (Valderrama and Davis, 2015). Such a scenario underscores the fact that economies of scale would not only be achieved in terms of the sizing and performance optimization of the works themselves, but in terms of the design-related costs as well.

By using an aggregation approach scenarios are likely to arise wherein the optimal neighbourhood-scale implementation entails that some proportion of private properties' stormwater management be executed on public lands (i.e. LID retrofits within a road allowance, park land, etc.). In such instances it is entirely feasible for upstream landowners to earn credits and the municipality to share in the cost. Construction costs could be shared between the municipality and the landowner(s) in proportion to the amount of stormwater being handled by the LID feature(s) within the public allowance for each party in question. If space permits, municipalities would be remiss to forego such an arrangement as it would undoubtedly lead to additional volumetric stormwater capture and improved water quality – both of which are universal management priorities for municipalities across the country.

Figure 2 illustrates what a shared public-private stormwater management arrangement could look like under an aggregation regime. Note that in the figure below source controls are depicted on private lands (orange permeable landscaped and hardscaped surfaces), while conveyance controls are depicted within the ROW envelope (green ovals). In practice, both control types may be found within either land use type, or ROW-based features could impinge upon adjacent private parcels with appropriate financial allowances and/or credits being granted.

Figure 2 Example of what source and conveyance SWM controls could look like when aggregated properties at the neighbourhood scale

5.1 POTENTIAL CHALLENGES TO AGGREGATING PROPERTIES

Decentralized, communally-owned water management systems by their very nature will require drainage across multiple property lines, and it is recognized that under current municipal bylaw frameworks this could pose a challenge. Furthermore, a number of outstanding questions requiring redress remain, such as:

- What mechanisms exist – or can be promulgated – that will encourage private landowners to work communally for the purpose of achieving shared drainage?
- With respect to the former, should priority be placed on regulations, market-based incentives or some combination thereof?
- What legal liabilities need to be addressed with respect to drainage crossing multiple property lines and/or connecting new private drainage works to municipal drainage infrastructure?
- With respect to the former, how would the aggregation of properties impact Official Plans, zoning bylaws and other municipal policies?
- In Ontario, Environmental Compliance Approvals (ECAs) are issued as part of the permitting process associated with operating stormwater works and it is yet to be determined if the ECA process has the flexibility to comfortably allow for aggregation.

6.0 AGGREGATING PROPERTIES USING GRID BLOCKS

The current approach to modelling uptake of LID is by looking at the percent uptake on an individual lot basis. Modelling work typically specifies a set volume of capture within the LID features for each site, usually prorated according to a parcel's total percent imperviousness. While practical at the conceptual design stage, such an approach is problematic as designers move through to the detailed design phase as this approach sets a trajectory predicated on the idea that each property (and hence each property owner) will be wholly responsible for managing their stormwater on their own property.

The Grid Block approach provides both a SWM efficiency as well as a cost efficiency compared to stacking an equivalent suite of individually-retrofitted properties because it provides opportunities to optimize infrastructure. For example; if the boundary between two parcels is an open, grassed area suitable for LID implementation, aggregation affords the opportunity to excavate a single soak away area which straddles both properties. Such a shared feature would only require one contractor, one set of design drawings, one geotechnical report, etc. By its very nature it would also forego the blanket application of property setback requirements, which would consequently lead to it making better use of the available space.

To aggregate Grid Blocks, a suite of criteria – including property selection criteria – are required. Prima facie, we posit that criteria for the formulation of a Grid Block be predicated on the need for properties to form contiguous parcels as this is how water flows. Therefore, by definition, a Grid Block requires a minimum of two (2) parcels, each having suitable land ownership. Furthermore, aggregation for the purposes of LID implementation cannot proceed unless the use of LID is feasible. Feasibility includes both technical and practical considerations, as landowners will dictate some of the key details of the aggregation process, including which neighbours they prefer to work with. We also recommend that contiguous parcels be within same storm sewershed, as this will allow existing drainage systems to be leveraged for conveyance purposes, and will allow for Grid retrofit installations to be translated into a 'percent uptake' value.

6.1 TYPES OF GRID BLOCKS

As alluded to in Section 4.0 , there are many possible combinations and variations of Grid Block aggregations. The size of parcels; whether they are privately or publically held; the number of LID features and the types of practices utilized all work to create variability. Far from being problematic, such variability is exactly what gives the Grid block approach its inherent robustness and flexibility: design engineers can mix and match a myriad of different tools and approaches to devise workable solutions for virtually any scenario. The following sections illustrate some of the key configurations which are apt to characterize Grid Block assemblages.

6.1.1 Grid Block Type 1 – 100% Private lands

Figure 3 Grid Block Type 1 (100% private lands)

6.1.2 Grid Block Type 2 – Private and public lands

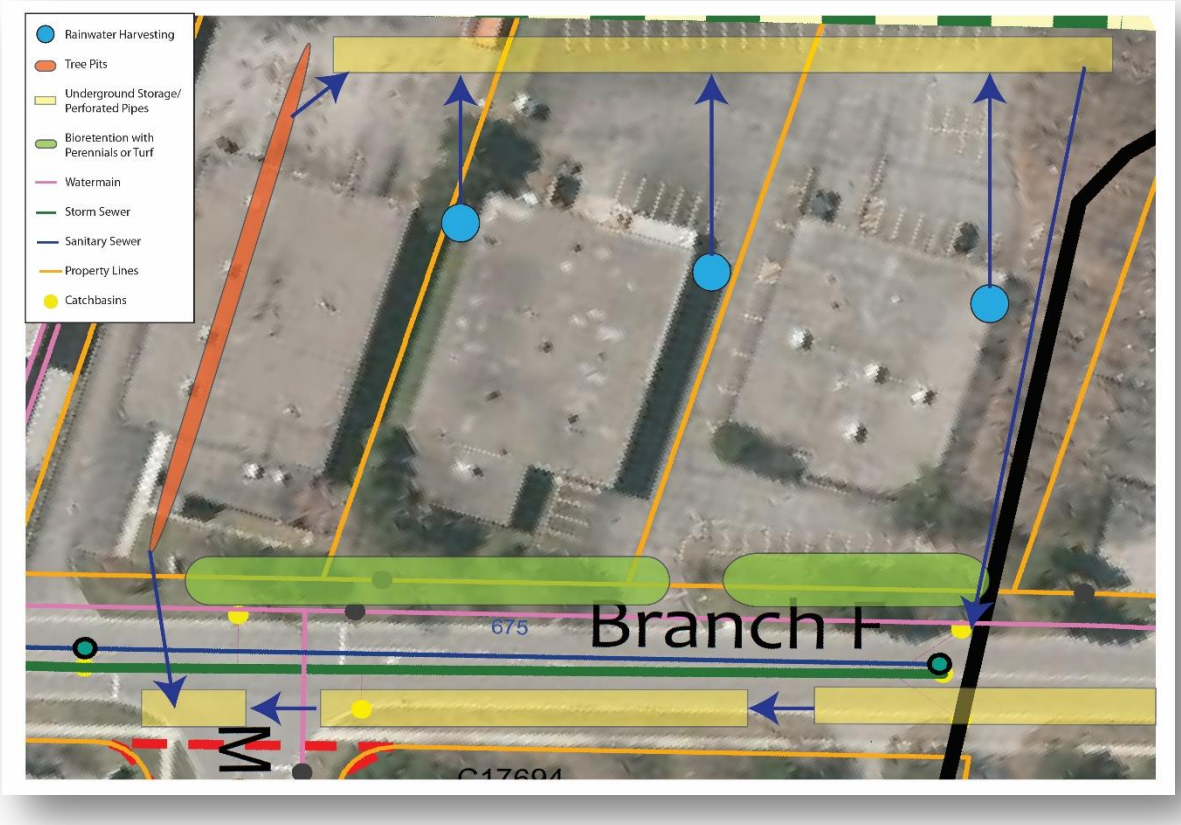

Figure 4 Grid Block Type 2 (Private and Public lands)

Because of spatial constraints and the presence of pre-existing utilities – including stormwater infrastructure – there will undoubtedly be instances where it is not feasible to manage stormwater within the ROW. This is underscored by the point noted earlier; namely that public spaces typically account for approximately 20% of the total urban fabric, while private and institutional lands account for the remainder. More specifically, the land uses in the urban area depicted in Sections 6.1.1 and 6.1.2 are approximately 18% municipal ROW and 82% private lands. With recognition for the fact that public lands alone cannot reasonably be expected to provide enough suitable area to provide complete SWM in all instances, as noted in Table 1, it is necessary to look to private spaces for their ability to provide SWM. As such, Sections 6.1.1 and 6.1.2 depict the two most general scenarios which are likely to arise through aggregation. Figure 3 illustrates what complete stormwater management on exclusively private property could look like. In this example, a combination of rainwater harvesting, subsurface exfiltration trenches and enhanced tree pits work in tandem to manage stormwater via a treatment train approach. Figure 4 depicts what a shared public-private solution could look like. In this example, a treatment train approach is still employed across an aggregated block of private parcels, and excess water not treated onsite is routed to a subsequent set of LID features located within the ROW. The LID features located in the ROW would be designed such that surface overflows would enter the minor system as it currently exists. Note that in either example (Figure 3and/or Figure 4), stormwater from the road is managed within the ROW.

6.1.3 Grid Block Type 3 – Private parcels exercising over control

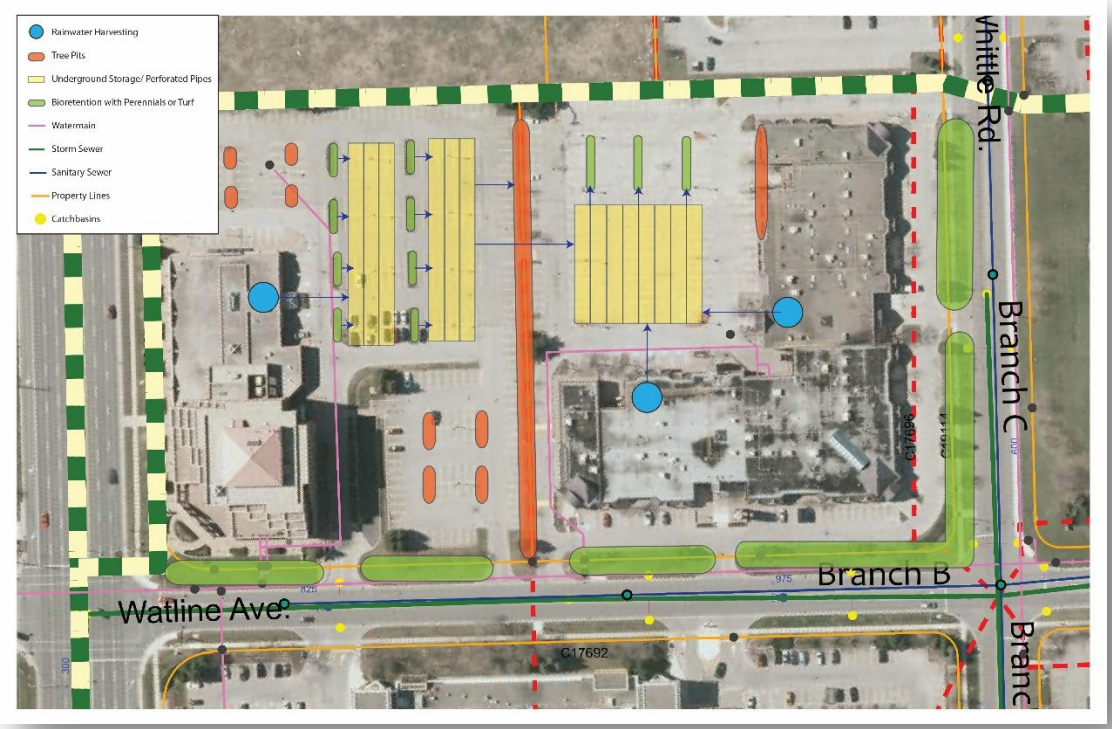

Figure 5 Grid Block Type 3

The Grid Block configuration depicted in Figure 5 illustrates a scenario in which private property owners have implemented a suite of LID practices which provide over control for their aggregated parcels. Such a scenario may arise under a credit trading scheme. That is, over control of stormwater on some Grid Block properties may offset the lack of control on adjacent properties within the same sewer shed. Likewise, there may be some instances where the presence of utilities or related infrastructure within the ROW makes SWM within the road allowance impractical or impossible (Similar to the situation arising in Figure 6). In such instances over control within a Grid Block would provide benefits to downstream areas.

Grid Block Type 4 – Private parcels treating drainage from public lands

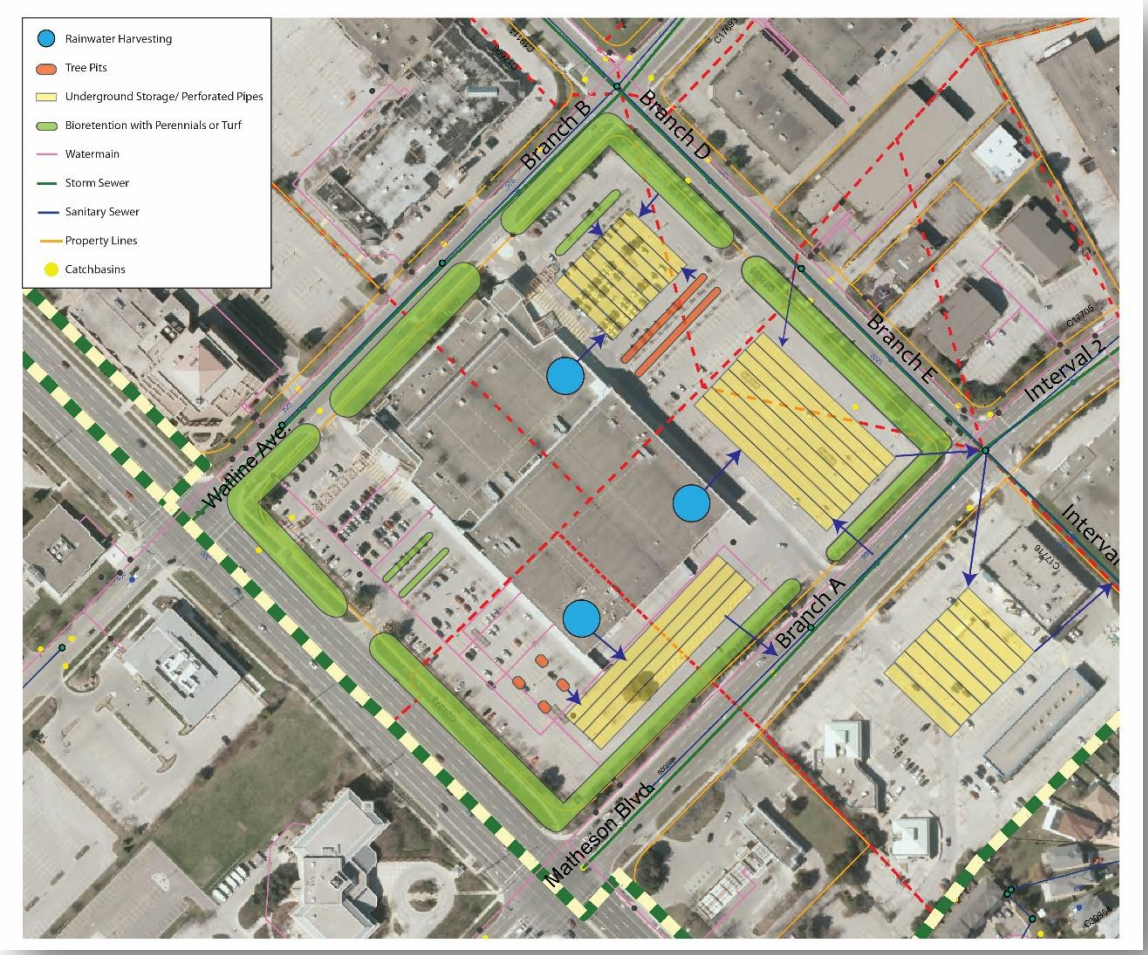

Figure 6 Grid Block Type 4 (Single Parcel treating external drainage)

As noted in 6.1.3 , situations are likely to arise where stormwater management within the road allowance is either too expensive, too difficult or some combination therein. In such situations it may be in the best interest of both the private property owner and the municipality to treat stormwater from the public domain on private property. Such arrangements would almost certainly be mutually beneficial; the municipality's SWM goals would be realized and the private property owner may be eligible to obtain credits for the service rendered by their lands. This speaks to the need for a comprehensive stormwater utility fee and credit system capable of accounting for and incentivising such services. Note that a third party – all downstream landowners in this instance – would also benefit from the management of stormwater on the private property depicted in Figure 6.

In order for the parcel depicted in Figure 6 to meet both its own utility and credit-driven stormwater management objectives in addition to providing for the treatment of offsite drainage,

the LID SWM works would need to be suitably oversized to meet the aggregated block's overarching performance criteria. This underscores the need to take a holistic, unified approach when designing the stormwater works. Without a multi-parcel, catchment-scale perspective design engineers would be far more likely to struggle in their efforts to optimize the sizing of source and conveyance controls, and this would be true with respect to both the water quantity and quality management aspects of their design work. However, if an aggregation approach is applied during the neighbourhood screening phase, opportunities to optimize configurations of drainage works are more likely to emerge...

7.0 THE DRAINAGE ACT AS AN AGGREGATION TOOL

While the above examples highlight some of the key benefits associated with aggregating parcels to facilitate cost-effective stormwater management, a means to facilitate such an approach is required. It is here that the Drainage Act may serve as a useful tool which can be examined for its unique mechanisms, rules and approaches for facilitating multi-property, communally owned drainage infrastructure. The following sections describe both the history and nature of the Act as well as the redress it may offer to urban environs seeking to improve the state of stormwater management.

> Opinion research gathered from stormwater professionals by CVC showed that 74% of the individuals polled strongly agree or agree that the mechanisms within the Drainage Act can be used to promote green infrastructure uptake.

7.1 WHAT IS THE DRAINAGE ACT, AND WHAT IS A MUNICIPAL DRAIN?

As alluded to in Section 4.0 , and Table 1 in particular, The Drainage Act provides many useful examples as to how urban SWM can be enhanced through the encouragement of shared drainage solutions. In light of this, it is important to first derive an understanding of what the Drainage Act is, its history, how it functions and common ways in which it has been applied to manage stormwater in Ontario.

The Drainage Act is an Ontario Statute that provides a process for the construction and maintenance of communal drainage works on private lands and public roads. The definition given in Section 1 of the Act states that drainage works "…includes a drain constructed by any means, including the improving of a natural watercourse, and includes works necessary to regulate the water table or water level within or on any lands or to regulate the level of the waters of a drain, reservoir, lake or pond, and includes a dam, embankment, wall, protective works or any combination thereof…"

Drainage works constructed by a municipal bylaw using the Drainage Act process are commonly referred to as Municipal Drains. This includes open ditches, underground pipes, culverts, catch basins, buffer strips, berms, riffles, grassed waterways, wetlands, ponds, pumping stations, incorporated existing constructed infrastructure, and so on. In summary, Municipal Drains include not only the linear drainage feature, but all related components, appurtenances and associated infrastructure as well.

The Drainage Act process is used primarily in rural (agricultural) watersheds. However, despite this fact and the observation that linear conveyance features are the most common outcome of the use of the Act, the Drainage Act is by no means limited to application in agricultural or rural

areas. On the contrary, the Drainage Act has been successfully used many times in urban watershed areas to facilitate the construction of storm drains, drainage swales and storm water management ponds. It has been applied in urban areas where it has led to the incorporation of existing storm drainage infrastructure as part of the drainage works constructed or created through the Act. In the Act, the word "agriculture" only appears in specific sections which pertain directly to a grant by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) to the owners of agricultural lands assessed a portion of the cost of the drainage works.
There are many elements of the Drainage Act process that can be drawn upon in order to advance decentralized and distributed stormwater projects on public and private lands. However, there is a dearth of water resources and civil engineers working in the land drainage discipline which are familiar with the Drainage Act process and the ways in which it could be applied in an urban context.

The Drainage Act provides guidance to engineers on how the costs of drainage infrastructure projects can be allocated. This process can be drawn upon in order to implement water conservation and stormwater management projects in urban areas. Industry professionals have a great deal of knowledge on how to apportion drainage project costs in a fair and equitable manner. The Drainage Act has provisions for assessments for “benefit, outlet liability, special benefit and increased cost”. The increased cost assessment in Section 26 allows for the increased cost to a drainage works caused by the existence of a road or public utility to be assessed to the road authority or public utility. The Drainage Act also allows for other grant contributions to be accounted for during the cost apportionment process.

Stormwater Management as an Issue of Liability

Scarborough Golf Country Club Ltd. v. City of Scarborough (1989)

A golf course operated within the municipal limits of the City of Scarborough since 1912 periodically experienced occasional flooding during larger storm events. This was due to the presence of a creek which drained upstream agricultural lands that passed through the golf course. However, after 1955 the area upstream of the golf course was rapidly urbanized, and the City drained the developed lands to the creek. This led to significant instream erosion and caused the channel to become both twice as wide and deep as it was previously. While the City added gabions and concrete lining to some sections of the channel, the golf course experienced significant erosion and increasingly frequent flooding to the point where some holes needed to be shortened and sections of the course became generally unplayable.

While the trial judge found that, as the upper riparian owner, the City had the right to natural drainage into the creek and that the club was obliged to accept that drainage, it was also noted that the club – as the lower riparian owner – had the right to the natural flow, quantity and quality of the water in the creek. The trial judge found that the drainage was not reasonable based upon the evidence, since it was obvious that the capacity of the creek was exceeded by the city's actions. Ultimately, the City was found liable for the damages caused by their approach to managing urban stormwater and they were forced to provide compensation to the golf club to help cover the costs of stabilizing sections of the channel passing through the golf course property.

7.2 HISTORY OF THE DRAINAGE ACT

While the overview provided in 7.1 is critical to understanding key aspects of this important legislative vehicle, a summary of the key drivers of this legislation is also important. Issues related to the drainage of land and the movement of waters which transcend property lines were a concern for settlers in what would become the Province of Ontario as early on as 1835. The Drainage Act traces its roots to an Act put in place in 1835 in Upper Canada to regulate Line Fences and Watercourses. Today these same issues still cause problems between neighbours. In such instances the Drainage Act can be a useful tool to manage surface water drainage issues while the Line Fences Act is useful for managing property line issues.

7.3 DRAINAGE ACT PROCESS

The Drainage Act process is an extensive, rigorous and comprehensive process for resolving drainage issues. The following is an outline of the processes and duties of the stakeholders. See Figure 7 for a Drainage Act process flow diagram (applicable in instances where the process is initiated via petition, which is a formal request in pursuit of drainage).

The Drainage Act is a Provincial Statute that is administrated by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). The Act gives authority to lower tier and single tier municipalities to administer the process, with the municipal council, clerk and drainage superintendent fulfilling many important functions under the Act. Disputes are resolved through an appeals process outlined in the Drainage Act involving a provincially appointed Tribunal and Referee.

Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) Drainage Resources

OMAFRA provides a number of resources to educate landowners and help them understand and navigate the Drainage Act process. A series of Drainage Factsheets can be found through the Ministry's website, including a plain English "Drainage Legislation Factsheet", amongst many others (http://www.omafra.gov.on.ca/english/landuse/drain-pub.htm). This factsheet highlights the key steps involved in the Drainage Act process and, while specific sections of the Act are referenced as appropriate, this particular document lays out the timing of key events in chronological order.

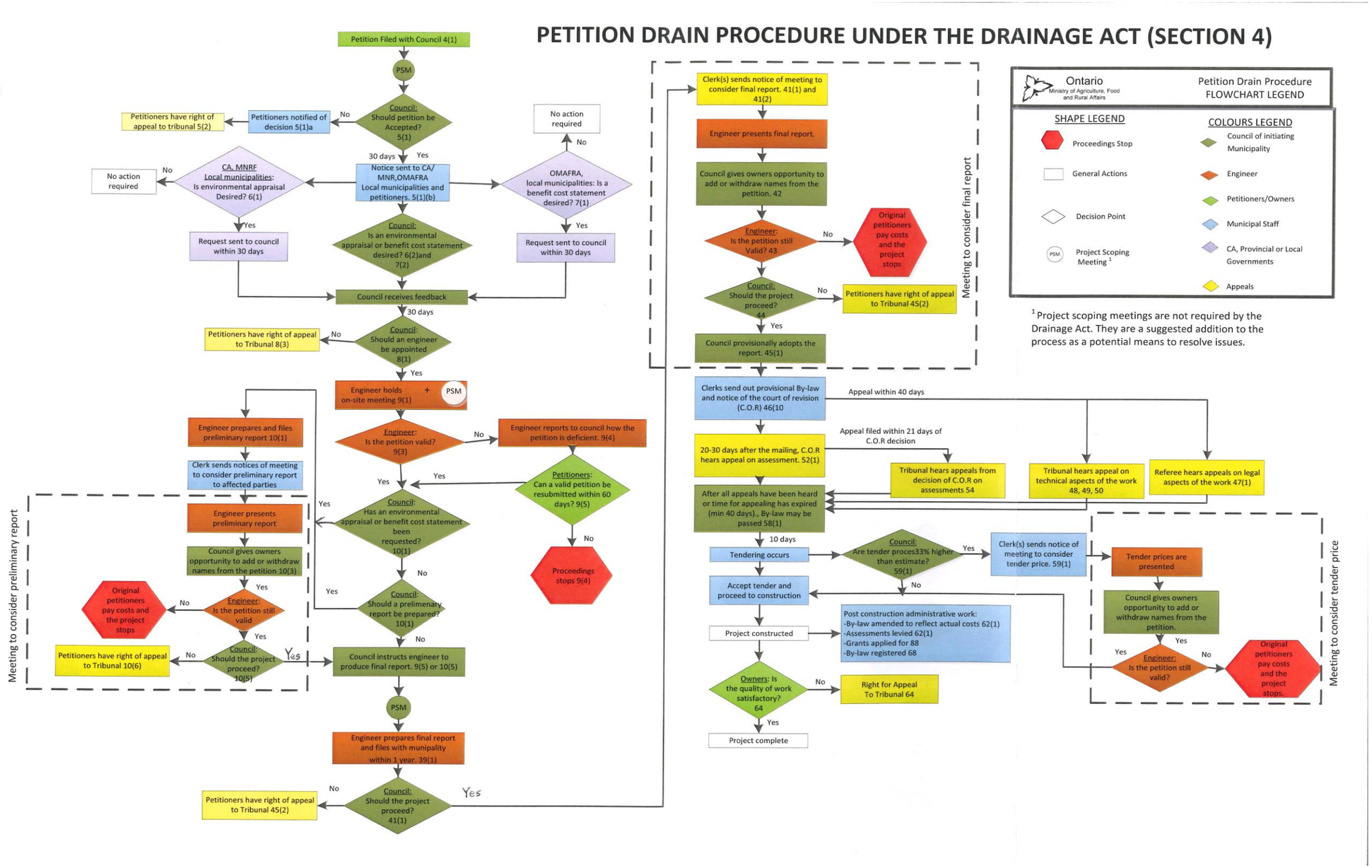

Figure 7 Petition Drain Procedure under Section 4 of the Drainage Act (courtesy of OMARFA, 2017)

7.4 INITIATING A PROJECT

Under the Drainage Act, a drainage works project is initiated by a petition from a landowner or group of landowners or the road authority, and OMAFRA has made these forms conveniently available to anyone online (http://www.omafra.gov.on.ca/english/landuse/drain-form.htm).
Any landowner or road authority can sign a petition for drainage works. Sections 4(1)(a) and (b) outline the criteria required to be met in order for a petition by landowner(s) to be valid. These sections clearly state that signatories to a petition must account for 50% plus one of all landowners in the area requiring drainage (ARD), or account for 60% of the total lands in the ARD. If either criterion is met the petition passes muster and is considered valid. Furthermore, Section 4(1)(c) notes that where drainage works are required for a road or part thereof, a petition may be submitted by the engineer, road superintendent or person having jurisdiction over such road or part thereof. Originally intended to ensure that the drainage needs of critical municipal infrastructure were met and to prevent damage to it, Section 4(c) has important implications with respect to the weight ascribed to municipally-initiated petitions.

Upon submission of a petition for drainage works under Section 4, the council of the municipality to which the petition was submitted must consider the petition. Council can decide to not proceed with the petition. A decision to not proceed can be appealed to the Tribunal by the petitioner and the Tribunal can order the municipality to proceed with the petition. If council decides to proceed with the petition they then appoint, by resolution or bylaw, an engineer to prepare a report on the petition for improved drainage. This appointment gives the engineer the authority to carry out the Drainage Act process, as denoted in Section 8(1) of the Act. The appointed engineer must hold an on-site meeting in the area where the drainage works have been proposed. Proper notice must be served to all landowners in the area requiring drainage so that they may attend and ask questions and provide input to the engineer. A site examination and survey must also be completed to determine the work required to provide the improved drainage requested by the petitioners. The engineer determines the ARD and whether the petition is valid for preparation of a drainage report. Consequently, landowners in the affected area delineated by the engineer are given the opportunity to add their names to the petition. Aside from the fact that onsite meetings may need to be conducted as several smaller meetings, and potentially set within a community hall or similarly appropriate venue, there is no reason why an engineer could not follow a similar process for the aggregation of urban properties requiring stormwater management.

In urban areas, the ARD would perhaps be defined as the area requiring stormwater management, or ARSWM. The engineer would meet with the landowners in a manner similar to that noted above, perform a site examination, and complete the design work required to provide improved stormwater management. Figure 8 depicts a hypothetical ARD (dashed line) within a larger subwatershed. The delineated ARD in this instance would be within a Grid Block if the delineated properties are aggregated for the purposes of shared SWM.

Figure 8 Example of small scale decentralized infrastructures at the site level scale. Private (L) and public (R) ARSWM are depicted.

7.5 MEETINGS

As noted in 7.4, the Drainage Act requires that a first meeting be held on-site within the ARD. The Clerk of the municipality sends notices directly to affected landowners, utilities, municipal staff and agencies. This meeting is used to determine what the petitioner is requesting, the physical extent of the ARD, agencies' concerns and the location of utilities which must be factored into the design process.

Though the Drainage Act does not require the engineer to conduct additional meetings beyond the on-site meeting prior to filing their report with the municipality, most drainage engineers do hold additional meetings with affected landowners. These meetings are used to present design options, cost estimates and estimated cost sharing schedules. This highlights the engineer's unofficial role as negotiator and arbiter, since such meetings help to secure broad-based support for the project.

8.0 REPORTS UNDER THE DRAINAGE ACT

By virtue of the fact that it brings together a diverse group of landowners – each having slightly different project goals, financial resources and attitudes about their private property rights and uses – the aggregation approach must clearly outline what the improved SWM design will look like, who will pay for shared SWM works, and how much each party can be expected to benefit. Here too the Drainage Act can be examined as it contains specific wording related to these project elements. Specifically, Section 8 of the Drainage Act requires that engineers complete a detailed technical report related to the works arising as a result of a Section 4 petition. Section 8(1) of the Act states that the Engineer's report shall include:

1. A watershed plan, profiles and specifications for the proposed drainage works;
2. Allowances to owners affected by the construction of the drainage works;
3. Total estimated cost of the work;
4. Schedule of assessment to levy the total estimated cost to all affected lands and roads using benefit assessment and outlet liability assessment and other provisions for assessment as outlined in Sections 21 to 28;
5. Provisions for future maintenance of the drain once constructed.

As an addendum, Section 10(1) clarifies that, where council deems it expedient or where an environmental appraisal is required, the engineer may be appointed to produce a preliminary report which would include a basic outline of the works, their associated cost and a benefit-cost statement, if applicable. Interpretation of Section 10(1) suggests that effort undertaken under this section is akin to a feasibility or similar screening study.

For urban property owners interested in using LID, the engineer’s report would be completed for a stormwater retrofit plan that aggregates multiple properties (both private and public) using the same basic principles which already exist in the Drainage Act as described above. The Drainage Act has long-established processes for assessing allowances and compensation, direct and indirect benefits, and special assessments for projects. For example, a neighbourhood could be retrofitted within a catchment area and both the costs and benefits could be apportioned to both the landowners and the municipality.

Pre-Project Scoping Meetings

Aligning Interests in the Beaver Creek Municipal Drain

Compared to the Drainage Act, the Species at Risk Act, Endangered Species Act, and Conservation Authorities Act are relatively new. Given the different priorities of these various pieces of legislation, the challenge to landowners, municipalities and regulatory agencies is to meet the intent and responsibilities of the various programs. To help with the process and to ensure that all parties found success, a pre-project scoping meeting was held prior to the maintenance of the Beaver Creek Municipal Drain, located in the Town of Fort Erie and the City of Port Colborne. A steering committee was formed comprised of representatives from the following groups:

- Town of Fort Erie
- Fisheries and Oceans Canada
- Ministry of Natural Resources
- Ministry of Agriculture, Food and Rural Affairs
- Niagara Peninsula Conservation Authority
- Friends of Fort Erie Creeks
- Bert Millar Nature Club
- University of Guelph
- Niagara College
- Several private corporations which provided technical expertise

All members of the steering committee worked together to define what collective success on this project would look like, and project goals included enhanced species protection, habitat improvement, reduce difficulty in acquiring permits and improved drainage of agricultural lands.

While a process involving such a diverse group of partners can sometimes be difficult, the Beaver Creek Municipal Drain maintenance effort resulted in an enhanced drainage feature with self-sustaining flows, improved flood storage, enhanced farming opportunities, better water quality and naturalized fish habitat.

8.1 DRAWINGS AND SPECIFICATIONS

The Drainage Act requires the engineer to have “plans, profiles and specifications of the drainage works”, in their report (Section 8(1)(a)). The final design drawings and specifications – including things like benchmark elevations - form part of the by-law once the engineer’s report has been officially adopted by the municipality. The information contained within the report is used to guide the future operation, repair and maintenance of the drainage works. The drawings and specifications are similar to municipal design standards. The specifications should have some inherent flexibility in order to allow the works to be maintained with newer

technologies, methods and techniques as they become available. This forward-thinking consideration is supported in Section 78(1) of the Act, which states that work may be undertaken at any time after the features have been established to, amongst other things, facilitate "…better use, maintenance or repair of the drainage works…". The municipality can appoint an Engineer to prepare a report under Section 78 for an existing drain without a petition being required. Such clauses make the Drainage Act incredibly adaptable in an evolving stormwater management environment.

At present, green infrastructure implementation suffers from a deficiency in that municipalities do not have standard specifications regarding the design of GI (e.g. Ontario Provincial Specifications Drawings [OPSDs] or equivalent). However, the flexibility associated with green infrastructure design and adaptability – one of its greatest strengths – makes the development of standard specifications a distinct challenge. There needs to be flexibility for engineers in terms of the design of green infrastructure approaches for the benefit of the landowners as they will be the ones paying for the installation, operation and maintenance of such infrastructure.

8.2 PROJECT COSTS

The engineer's report provides a detailed and transparent accounting of the costs associated with the project. These costs include:

- Allowances (for land dedicated to the works, the disposal of spoil, loss of property access, etc.)
- Construction costs (labour, equipment and materials)
- Engineering costs (topographic surveys, public meetings, professional design services, assessments schedules, prepare report, attend report meetings)
- Administrative costs (non-clerical costs incurred by the municipality)

8.2.1 Allowances/Compensation

Since the Act allows for work to be done on private land, allowances and compensation must be given to private lands on which drainage works occur. Section 8 of the Drainage Act specifies the requirement that the engineer's report provide allowances where appropriate. Under an aggregated approach to managing stormwater, allowances would be valuable financial tools to incentivize the implementation of surface treatment shared stormwater works on private lands. For example; if a small section of a landowner's parking lot is decommissioned and the corresponding land allocated to the construction of a bioswale or similar surface feature, the landowner would be compensated for the area dedicated to the construction of the stormwater works.

The amount of any one-time compensation is be determined by the design engineer and would be funded through the assessments made against the upstream properties draining to the proposed works. Historically, allowances have been granted to landowners to account for the

disposal of spoil on their property and the corresponding impacts this may have on land production, aesthetics, and so on, and there is no reason why this could not also be done in an urban SWM improvement scenario. Allowances are also given in order to purchase easements that provide access to the drainage works and the area in which the works are situated (Section 29 of the Act).

Any damages to private lands, gardens, crops, etc. which are the result of construction activities are also eligible to receive allowances in accordance with Section 30. Section 31 provides allowances to landowners who had previously paid to construct their own drainage infrastructure (e.g. swales, ditches, etc.) when such features are incorporated within a municipal drainage scheme. Allowances are also provided for less common occurrences, such as property damages resulting from an insufficient outlet (Section 32 of the Act), as well as for the loss of property access (Section 33 of the Act). Table 2 below depicts a typical allowance table in a drainage report.

Table 2 Typical allowance table in a drainage report

Con	Lot	Roll No.	Owner	Right-of-Way (Section 29)		Damages (Section 30)		Existing Drain (Section 31)		Total
				Cost ($)	Width (m)	Cost ($)	Width (m)	Cost ($)	Item	
5	Pts 12&13	08-1250	B. Trenouth	26,000	10*	2,000	20*	1,000	600mm Culvert	29,000
5	Pt 13	08-1190	K. Vander Linden	900	2	100	4	2,000	900mm Culvert	3,000
TOTAL ALLOWANCES ($)				**26,900**		**2,100**		**3,000**		**32,000**

*right-of-way for construction of stormwater management plan.

The allowances granted for easements give authority to the municipality to enter on to private lands for the purposes of inspection, monitoring and future maintenance of the drainage works. The Engineer's report creates an easement or ROW through a property but the easement is not registered on title. The ROW does have status under the drainage report by-law and provides the municipality with the right to enter the property, but is not a public right of way. The right of way is similar to a zoning by-law which has restrictions but these restrictions are not registered on the title of the property.

8.2.2 Construction

The costs incurred through the construction of the drainage works must be presented as specific items listed in table form within the engineer's report. Table 3 below provides an

example of what typical construction cost summaries include, and how this information is presented within the engineer's report.

Table 3 Typical construction cost summaries itemized in an engineer's report (rural example)

Line Item	Station No.	Description of Works Associated with Cost	Unit	Amount	Unit price ($)	Cost ($)
33	0+960 to 0+971	Relocate existing 11 m of 525 mm dia. plastic pipe across new location including road restoration (Town to replace asphalt)	L.S.	1	3,500	3,500
34	0+970 to 0+987	17 m of 250 mm dia. plastic tubing	m	17	30	500
35	0+987	Construct 150 mm dia. Hickenbottom complete with 75 mm orifice plate	L.S.	1	400	400
36	0+970 to 0+980	Place 30 m² of riprap on filter underlay at outlet spillway including construction of 10m of overflow swale	m²	30	45	1,350
37	0+980 to 1+079±	Excavate storm surge area complete with sediment forebay and low flow channel, fill in 65 m of existing ditch, and construct a 0.5 m high x 3.6 m, wide top x 65 m long earth berm including inlet and outlet spillways	m³	800	5	4,000
38	0+980 to 1+079	Topsoil stripping and saving in working area for storm surge area	m³	552	5	2,800
39	0+980 to 1+079	Topsoil and seed storm surge area and berm	m²	3680	1	3,700
40	1+055	13 m² of riprap on filter underlay	m²	13	45	600
41	1+075 to 1+088	Place 70 m² of riprap at major storm inlet	m²	70	45	3,150
42	1+075 to 1+088	13 m of 600 mm dia. HDPE plastic pipe at storm surge area inlet	m	13	250	3,250
43	1+088	Place 10 m² riprap on filter underlay at storm surge area inlet	m²	10	45	450
44	1+100 to 1+130	Remove approximately five trees for berm construction	L.S.	1	400	400
					Total	**$124,435**

The detailed list of items and costs summarized in the engineer's report gives the landowner a clear picture of what the project's construction costs will be. If landowners find a cheaper price for materials that meet an equivalent standard of quality and performance, they can be used in lieu of what was specified in the report. The landowner may be willing to accept a cheaper product on their property once specific cost items are disclosed. This practice becomes more

complicated under an aggregated stormwater management arrangement as there are larger risks associated with the failure of stormwater works and the liability therein. Instead of flooding a field or similar rural parcel, shops, warehouses and other businesses could be flooded and much more significant damages to property could be incurred. Furthermore, the population densities of urbanized areas predisposes them to an elevated level of risk. Therefore, municipalities would have to be clear in terms of what materials, safety factors and redundancies are required for LID/GI-based construction projects, and this needs to be balanced against what costs and level of risk landowners would be willing to accept.

8.2.3 Engineering

Typical engineering costs for a report include work associated with gathering background information, attending meetings, conducting field surveys, defining drainage areas, preparing drawings (cross sections, profiles and details), detailed design of the stormwater works, the preparation of design alternatives, the preparation of cost estimates and assessment schedules. Maintenance schedules, design specifications, report writing and final design drawings are also eligible engineering costs. Engineering services during construction may involve the preparation of tender documents, review and award of contracts, attendance at pre-construction meetings, periodic construction inspections, payment processing, final inspections, post construction follow-ups and assistance for final cost levy. Table 4 provides a typical breakdown of costs listed in the Engineer's Report.

Table 4 Typical Breakdown of Costs (Engineer's Report)

Item	Cost
Report Preparation	$5,000
Consideration of Report (attend 1 meeting)	$200
Court of Revision (Attend meeting)	$200
Services during construction	$1,000

Since the costs are transparent, there is implicit pressure on the engineer from landowners and ratepayers to keep project costs at a minimum. However, this is tempered by consideration of the fact that land owners are typically more concerned about minimizing their individual costs, as opposed to minimizing project costs as a whole (i.e. over the entire Grid Block area). This requires that the engineer exercise sound judgement when developing and promulgating a design and also that municipalities incentivize green infrastructure so that project costs are harmonized and that such problems are precluded to the greatest extent possible. By properly incentivizing green infrastructure/LID implementation and through the exercise of grouping properties into Grid Blocks, performance and cost efficiencies can be realized (due in part to the reasons noted in Section 5.0).

8.2.4 Administration

Under the Drainage Act, many administrative costs can be included as eligible costs within the engineer's report and assessed out to private and public landowners in accordance with the assessment schedule. These include permit applications, printing of reports, taxes, tender documents, postage costs, interest, legal fees, hall and meeting room rental space, unforeseen costs, etc. Municipal staff costs and council costs for the drainage act process cannot be included as an administrative cost. Below is a typical breakdown of costs listed in an Engineer's Report.

Table 5 Typical Itemized Costs (Engineer's Report)

Item	Cost
Agencies submissions for approvals, if required	$500
Printing of reports	$400
Printing of tender documents	$150
Interest Estimate	$3,000
Permits and Applications Fees Allowance	$150
Unforeseen costs	$2,400
Net HST (1.76%)	$4,715

If the municipality has to borrow money in the interim, the interest on the loan also becomes an eligible project cost. Since the costs are initially borne by the municipality and the municipality receives a tax rebate, there is only 1.76% HST added to the project costs – a significant savings to private landowners.

8.2.5 Other Costs

Other costs that can be included are:

- Test pits
- Environmental studies
- Geotechnical surveys
- Archeological work

While the report can only address costs incurred at the time of the report's writing and during construction, any future maintenance/operation costs can be assessed to the landowners using the maintenance schedules contained within the report.

8.3 ASSESSMENT OF PROJECT COST

The "assessment schedules" provide a transparent framework for the fair apportionment of the project cost and future maintenance costs. All costs are to be divided between all lands, roads and utilities in the watershed. Two schedules are created within the report, one for the new construction works and the other for Future Maintenance costs. Engineers use established approaches for apportioning costs on a prorated basis while considering both the amount of

land being served by a drainage works as well as a parcel's runoff intensity and the potential benefit to the lands and buildings or structures contained thereon.

8.3.1 Assessment Schedules for new Works

For instances where all costs are eligible to be divided between municipal and private lands and utilities, the costs are broken up into different elements and apportioned in a manner similar to that presented in Table 6. Note that engineers must adhere to the basic tenets of this method in order to remain in compliance with Section 22 (Benefit), Section 23 (Outlet Liability), Section 24 (Special Benefit), and Section 26 (Utilities) of the Act. A brief description of the key considerations contained within each of these Sections is provided below.

i. A *Benefit* is an increase in value or ease of maintenance as a result of the drainage works. Benefit assessments are most commonly used for property directly touching the drainage works.
ii. *Outlet Liability* is based on the volume and rate of flow of the water artificially caused to flow. This is typically a factored area that is dependent on land use, soil type and slope. Since LID features would reduce the flow and volume the concept of outlet liability may be used to credit the lands containing the LID features.
iii. *Special Benefits* are made to landowners requesting features that don't affect the functionality of the drainage system (fences, hedges, gardens, patio stones, etc.). Such requests can be accommodated within the engineer's report at the full expense of the requesting party.
iv. If there is an increase in costs due to the presence of a road or utility that must be accommodated through design modifications, the corresponding road or utility shall pay the entirety of the increased cost to the construction of the drainage works beyond what the expense would have been should the road or utility not have been present.

Table 6 Assessment Schedule for Project Cost

ASSESSMENT SCHEDULE						
Roll No.	**Owner**	**Approx. Ha. Affected**	**Approx. Ha. Adjusted**	**Benefit ($)**	**Outlet ($)**	**Total ($)**
001-18500	Souchez	13.40	13.00	0	664	664
001-18800	Thelus	28.70	23.55	0	1,203	1,203
001-18850	Merite	4.10	3.75	0	192	192
001-18900	Nivelle	10.90	8.10	2,200	414	2,614
Special Benefit (Fence)		0	0	4,000	0	4,000
001-27500	ONL	1.30	1.95	2,700	100	2,800
Utility Assessment to ONL (001-27500)		0.00	0.00	6,665	0	6,665
TOTAL ON LANDS		**58.40**	**50.35**	**15,565**	**2,573**	**18,138**
Vimy Ridge Road	Twp of Black River-Matheson	1.70	2.55	2,000	130	2,130
Utility Assessment to Vimy Ridge Road				8,040	0	8,040
Balsam Drive	Twp of Black River-Matheson	1.00	1.50	0	77	77
TOTAL ON ROADS		**2.70**	**4.05**	**10,040**	**207**	**10,247**
TOTAL VIMY RIDGE DRAIN		**61.10**	**54.40**	**25,605**	**2,780**	**28,385**

8.3.2 Assessment Schedule for Maintenance and Operation Cost

Once the drainage works come into legal existence through the adoption of the engineer's report as a municipal bylaw, it is the municipality's responsibility to maintain the drainage works as described in the bylaw. The Act requires a means for assessing the full cost of future maintenance activities, and this can include assessment of costs to both privately-held lands and public roads throughout the entire drainage area as provided for in the Engineer's report.

8.4 PROVISIONS FOR FUTURE MAINTENANCE

The engineer's report is to include future maintenance provisions indicating how the drain is to be maintained. The report provides the details about the operation and maintenance needs of the infrastructure and the fact that it has become bylaw provides a legal mechanism of enforcement. This would include operational plans and maintenance requirements (planting

native plants, future development restrictions, future connections, culvert replacement on private lands and landowner operation recommendations). The report is where the authority/responsibility to enter on to private property arises. The report could also outline monitoring requirements to ensure environmental compliance.

8.5 BY-LAW

The Engineer's Report, when filed with the municipality, follows the process outlined in the Act ending with the municipal council passing a by-law to adopt the Engineer's Report. The by-law cannot be adopted until all appeals are resolved and/or timelines for the appeal process have expired.

8.6 APPEAL PROCESS

In the by-law adoption process there are a number of opportunities for an appeal by the affected and assessed lands and roads. The following are the key junctures during which appeals can be made:

- Consideration of report before council. A council meeting to consider the Engineer's report must be held not less than ten days after the last notice has been sent to landowners under subsections (1) and (2) of Section 41 of the Act. At the meeting to consider the report a landowner can express concerns related to the design of the drainage works if they own lands situated within the ARD, as stated in Section 42. If, based on comments from landowners - or any for any other reason - council feels the report should be reconsidered, council can refer the report back to the engineer for further consideration if required (Section 57).
- The Court of Revision, which is set up by the municipality, addresses appeals against the assessment schedule of costs in the report. This body is made up of 3 or 5 people appointed by council. Note that According to Section 46 of the Act, the Court of Revision is always required.
- The Tribunal (an independent panel appointed by the Ministry of Agriculture, Food and Rural Affairs) deals with appeals related to the design of the recommended drainage works and appeals on assessment where the appellant was not satisfied with the decision of the Court of Revision.
- If an affected owner is not satisfied that the municipality and/or the engineer have properly followed the legal requirements of the Act then an appeal can be launched to the Drainage Referee for resolution.

8.7 CONSTRUCTION AFTER BY-LAW IS ADOPTED

After the engineer's report has been adopted by a municipal bylaw, a contractor – appointed by council through a tendering process – then has the right to engage in the construction of the drainage works within the designated working area. The Drainage Act allows council to require work on private land without express permission of the landowner. After a drain is constructed the municipality levies the final cost of the project in accordance with the schedule of assessment contained within the report.

9.0 FUTURE OPERATION & MAINTENANCE

Section 74 of the Act requires municipalities to maintain the drainage works as established in the Report and to the specifications outlined in the Report. This is to ensure that the drainage works will function as designed.

Maintenance can be requested by a landowner but only initiated by the Drainage Superintendent. Cost of the Drainage Superintendent is to be paid from the general funds of the municipality. The Drainage Superintendent can have an assistant or commissioner to monitor specific works on a routine basis but their costs would be to the drainage works. Cost of maintenance is levied to the affected lands and roads as outlined in the Schedule of Assessment for future maintenance in the Report.

If major changes occur (i.e. the site is redeveloped or the landowner wants to upgrade the LID features), a report could be prepared in accordance with Section 78 in order to improve or modify existing drainage works. This report would follow the same process as the initial report. If parcels are sub-divided or the land use is changed a Section 65 re-apportionment could be done to update the maintenance schedule. The engineer's report, once adopted would serve as an asset management plan for the communal drainage works on both public and private properties.

A Bylaw for a drainage works remains in effect until a new report is prepared, thus ensuring support for on-going operation and maintenance of the infrastructure. In municipalities that have stormwater utility fee and credit systems, landowners may need to prove that their facilities have been inspected and maintained on a recurring basis in order to continue to receive their credit rebate. In some cities, for example, if landowners receive a partial credit on their stormwater utility fee they are required to renew their SWM facility permit every five years and provide proof that their infrastructure has been properly operated and maintained. This in turn allows them to secure their rebate for the next five year cycle.

Ensuring Success through Long-Term Maintenance

STEP Stormwater Management Practice Inspection and Maintenance Guide

The Toronto and Region Conservation authority (TRCA) has released a free document to help LID facility owners, operators and maintenance service providers understand the long-term maintenance needs of LID facilities. The *Stormwater Management Practice Inspection and Maintenance Guide* provides information on everything from typical maintenance activities, recommended minimum maintenance frequencies, photographic examples of facilities in need of maintenance, and inspection checklists to help inspectors understand the critical components of various LID features which require inspection. The guide can be accessed online at http://www.sustainabletechnologies.ca.

10.0 PROTECTION AND CONTINUITY OF FEATURES

Municipal drainage infrastructure is granted legal status and is protected under the Drainage Act through the adoption of the Engineer's report by bylaw. The advantage of such legal status is difficult to ignore; many surficial urban drainage features without the same kinds of legal protection as features created under the Act are commonly subject to infill, encroachment or neglect (e.g. case study examples in section 12.2).

If design deficiencies lead to chronic maintenance issues, municipalities maintaining infrastructure under the Act have the ability to make any modifications considered necessary to improve the works; this is noted under Section 78(1.1)(4). The flexibility afforded to municipalities in this regard warrants consideration. Operational staff dealing with clogged inlets, inlet scour/erosion issues, or other deficiencies that are the indirect result of design shortcomings have the ability to translate this information back to the capital works group, who can then remedy the cause of the problem instead of dealing only with the symptoms of a more systemic issue. There is also no reason why landowners – or their maintenance subcontractors – could not work with the municipality's Drainage Superintendent to propose practical design modifications to existing low impact drainage systems that would lead to streamlined maintenance procedures and/or reduced costs. In such ways the continuous improvement and continuity of the features can be guaranteed.

Given the scale of investment in infrastructure assets, municipalities are concerned about the long-term protection and integrity of drainage features – low impact or otherwise – situated on private property. In light of the mixed success surrounding the implementation of infrastructure on private property, such concerns are justified. In order to protect infrastructure located on private land which serves a larger collective good, the Drainage Act contains provisions intended to deter harmful alterations to drainage features and also to provide a means of recourse in those instances where the works are damaged or otherwise harmed. Section 80(1) of the Act states that anyone who obstructs the drainage works is responsible for removal of the obstruction upon notice. While 'obstruction' is characterized in terms of anything which alters "…the free flow of water…" it is reasonable to suggest that this is defined in accordance with the intent of the Engineer's report. In other words, an obstruction can be anything which alters or otherwise modifies the function of the drainage works in a manner that is not aligned with what was intended through the Engineer's design.

Subsequent to the aforementioned, Section 80(1) of the Act also notes that if a landowner fails to remove an obstruction the municipality may choose to do so at the cost of landowner. Section 80(2) clarifies that, if the landowner fails to pay the cost associated with the work, the municipality can choose to pay for the cost of the work and the municipal clerk can place the amount of the cost on the collector's role, and the amount shall be collected in the same manner

as real property taxes. Such means of recourse act as a strong deterrent to those who would otherwise interfere with municipal assets.

Section 12 of the Act guarantees the Engineer's right to enter on to private property in fulfillment of their duties, while Section 12(2) states that anyone who willfully obstructs an Engineer or any of their assistants are guilty of an offense and liable to a fine up to $1,000. Similarly, Section 63(1) guarantees the rights of contractors and their assistants to enter on to any private lands necessary in order to complete the work summarized in the Engineer's report, while Section 63(2) contains provisions for a similar $1,000 fine. Finally, the Drainage Superintendent is granted the same powers to enter on to private property as the Engineer, as per Sections 95 and 96. This provides the municipality with the legal means to enter on to private lands for the purposes of inspection, maintenance and reporting on the drainage works. Note that municipalities are legally required to engage in such activities under the Act, thereby ensuring that stormwater infrastructure is regularly inspected and maintained.

If municipalities are concerned about their ability to enforce protection of communal infrastructure, additional recourse can be found in Section 82(1). This section gives municipalities the authority to bring an action for damages against any person who destroys or injures any drainage works, including - but not limited to - things like bench marks. Awarded damages are to be used for the construction, improvement, maintenance and repair of the drainage works. Finally, with respect to pollution prevention and the protection of receiving water quality, Section 82(2) states:

"Every person who obstructs, fills up or injures or destroys by any means a drainage works is guilty of an offence and on conviction, in addition to liability in damages, is liable to a fine of not more than $1,000 or to imprisonment for a term of not more than thirty days, or to both".

The phrase 'fills up' refers to sediment or spoil. This helps to ensure that only unpolluted waters are discharged to the drainage features. Furthermore, other articles of water quality legislation – including the *Canada Water Act* and *Environmental Protection Act* – are also applicable. While punitive measures such as those noted above are certainly undesirable, it is reassuring to know that mechanisms exist which help to ensure that the central tenets of the Drainage Act statute are abided by for the benefit of all parties.

11.0 URBAN APPLICATIONS OF THE DRAINAGE ACT

While the Drainage Act has been widely applied to solve drainage issues on rural lands under agricultural production, the Act is by no means limited in application to rural or agricultural lands. Indeed, no mention is made within the Act of the types of lands to which this process may be applied beyond the fact that such lands must require drainage (Section 4). Furthermore, these are some excellent examples across the Province of Ontario where the Drainage Act process has been successfully applied to remedy drainage problems in urban environs. Below are some examples which speak to various aspects of this topic.

> Prior to CVC's Urban Drainage workshop which convened stormwater experts to discuss applying the Drainage Act process for the implementation of LID/GI using aggregated properties, 40% of attendees indicated that they were not aware that the Drainage Act is used to remedy drainage issues and is not limited in application in rural areas.

11.1 NEW STORM DRAINS IN URBAN AREAS

Historically, street drainage in the village of Mindemoya on Manitoulin Island had discharged to a surface watercourse that crossed private property. The municipality wished to improve several streets and required a proper outlet for new storm drains. The Road Superintendent submitted a petition for improved drainage outlet for the streets to be reconstructed. A 2013 report was prepared for the Mindemoya Drain which provided for new storm drains on the streets to be improved and an outlet drain across private property to an outlet into a watercourse. The project cost was assessed to all lands and roads within the drain watershed which was primarily in the village of Mindemoya.

Lower tier Townships in Oxford County have a number of village areas within the Townships. In most of these village areas the storm drain systems are under the Drainage Act primarily through a Road Superintendent petition. For example, the Township of Blandford-Blenheim has storm drainage systems under the Drainage for the villages of Bright, Drumbo, Princeton and Plattsville. In new residential development areas the developer designs and builds the storm drain system. The development agreement then requires the developer to submit a petition to have the storm drain system incorporated under the Drainage Act.

The Townships in Oxford County are primarily rural agricultural land where any improved drainage is under the Drainage Act. The advantage to having the storm drains under the Drainage Act in the village areas is that construction cost and the maintenance cost of the storm drain system can be levied to the watershed area in the built up area instead of using general tax dollars. This would be similar to having a storm water utility in large urban municipalities with the Drainage Act being used to create the storm water utility.

11.2 EXISTING URBAN DRAINAGE ISSUES

The Balsam Street Drain in the City of Welland and the Woodridge Drain in Mannheim in the Township of Wilmot addressed issues where the lot grading established for the residential area failed. The municipalities were unable to carry out work on private property to remedy the lot grading issues since no easements had been established for the lot grading set in the subdivision planning.

For the Balsam Street Drain an existing rear yard swale which had been impacted by the construction of rear yard fencing and other post-development activities was incorporated and improved upon through an Engineer's report under the Drainage Act.

For the Woodridge Drain a new rear swale was created across the agricultural land that fronted on the rear yards of ten separate residential properties. A new pipe drain carried the swale drainage across a residential property to an outlet into an on street storm drain.

Both of the above drains were initiated by a petition by landowners. The Drainage Act process allowed the municipality to construct improvements on private property and to maintain the improvements in the future.

11.3 OUTLET FOR LOW IMPACT DRAINAGE

The Gravel Ridge Drain in the City of Kitchener addressed the issue of a legal outlet for the discharge from the storm water management facility for a new residential development. A legal outlet was a condition set by the City of Kitchener in the approval of the proposed subdivision since the outlet was onto private property. No outlet to existing municipal storm drain infrastructure was available. The developer was not able to negotiate an agreement for a drainage easement with the downstream owners so the developer submitted a petition under the Drainage Act to obtain a legal outlet for the storm water management facility. The report for the Gravel Ridge Drain incorporated an existing surface drainage water course across the downstream lands to an outlet into a protected wetland area. The report provided for some minor improvement to the watercourse. The report for the Gravel Ridge Drain created an easement along the watercourse that allows the City of Kitchener to control and maintain this watercourse on private property in the future.

The following section will explore some of the ways in which the roles of the various actors operating under the Drainage Act can be expected to be reshaped in an urbanized, 21st century context.

Room for Innovation - Turning Sewage Lagoons into Functional Wetlands using the Drainage Act

Port Rowan Wetland Restoration Project

In 2012 the town of Port Rowan commissioned a new mechanical sewage treatment facility, leading to the mothballing of a 24.4 ha (60 ac.) sewage lagoon. Rather than fill the retired sewage lagoons, an exciting partnership between Bird Studies Canada, the Backus Conservation Area and Norfolk County was formed to provide a naturalized wetland habitat for a variety of bird species along the Lake Erie shoreline. Norfolk County's then-current Senior Drainage Superintendent Peter Bryan-Pulham noted that the site is intended to serve as an environmental education opportunity and bird observation point, replete with an elevated observation platform compliant with Ontario's Accessibility (AODA) standards. Peter Bryan-Pulham notes that his three keys to success on this innovative project – like all projects he has worked on under the Act – are "co-operate, compromise and communicate". Clearly, a spirit of fellowship and an attitude of cooperation can yield innovative, exciting outcomes when applying the Drainage Act to 21st century water resource management challenges.

Image courtesy of Norfolk Trails (www.norfolktrails.ca)

12.0 CREATING DECENTRALIZED STORM WATER MANAGEMENT FEATURES UNDER THE DRAINAGE ACT

There are many examples of Municipal Drains in urban areas. In some examples newer municipal drains have been constructed which incorporate low impact drainage. The creation of urban LID/GI under the Drainage Act is merely a matter of combining two pre-existing engineering design approaches: the design of urban drainage systems and green infrastructure for source and conveyance control. The following sections will explore the roles of the actors involved in the synthesis of the Drainage Act and LID/GI.

12.1 LANDOWNER (PRIVATE MARKET)

A landowner's primary role is to initiate the process by signing a petition and through the provision of information to the engineer on the drainage improvements required. If an urban landowner is encouraged by financial incentives such as capital grants and/or a stormwater utility and credit program which incentivizes the use of low impact drainage that owner may choose to submit a petition under the Drainage Act to have the Low Impact Drainage constructed on private property and connected to the municipal storm drain.

After the final cost bylaw has been passed the landowners must pay their portion of the assessed cost. If a landowner refuses to pay their assessment the amount owing becomes a part of the property tax and would be collected in the same manner as any property that is in default of property tax payment. All landowners have the right to appeal the engineer's or municipality's decisions if they feel it is in contravention of the Act or the spirit of the decision is somehow unfair.

The landowner is responsible for informing the engineer with respect to existing site conditions, and what their optimal criteria are from an infrastructure design perspective. This has a direct bearing on both the design of the project and the overall project costs, which in turn is influenced by the structure of any corresponding utility and credit problem. It is here that the importance of the business case is manifest, as most landowners could reasonably be expected to note that favourable ROI's or minimum payback periods are the desired outcome, which would in turn influence project design objectives.

12.2 ENGINEER (AGGREGATOR)

The role of the Engineer (Aggregator) is to find a solution to the drainage problem and ensure the solution is constructed as designed, and that such a design will remedy the problem in question. The engineer needs to be able to internalize landowner concerns within the design, determine a fair division of costs, obtain any needed permits, provide defensible cost estimates, and defend both cost apportionments and the specified design while following all applicable laws and legislation over the course of their work. The Engineer is typically not a municipal

employee. The Engineer is required to prepare a report that is fair and impartial as per Section 11 of the Drainage Act.

Part of the engineer's duties is to hear landowner concerns and help the landowner navigate the Drainage Act process. As it is the Drainage Superintendent's role to oversee and ensure the completion of maintenance work once the systems is constructed, the engineer should seek their input during the design stage and coordinate their work with them. Since the engineer must look at many solutions, assistance may be required for new LID features or speciality designs. The Drainage Act process would not exempt LID features from a required ECA, so engineers should be prepared to defend their design calculations, complete the requisite hydraulic design sheets and so on.

The engineer could also be responsible for creating tender documents, construction supervision and inspection and computing the final cost division to the landowners. The municipality would therefore only be responsible for mailing bills, the report and notices to the landowners, and such work is done by the municipal clerk.

The Drainage Act is not exempt from other existing legislation, policies, bylaws etc. It is the duty of the Engineer to ensure that a successful design is developed and implemented as part of the drainage project without creating problems that other legislations, plans and policies were put in place to prevent. For example, the project may be in contravention with some aspects of zoning bylaw policy but so long as the project does not create the problem that the zoning bylaw was intended to prevent, the project can move forward. This is an incredibly powerful advantage of the Drainage Act as it would not require amendments to existing legislation, plans or policies, but rather ensures that the Act's application fits comfortably amongst pre-existing legislative, policy and planning frameworks. Recourse and resolution of conflicts is still afforded by the Act as any decision the engineer makes can be appealed.

12.3 MUNICIPALITY (VENUE)

The municipality's role in the Drainage Act is as a place for the community to come together, and it gives legal authority to do the work. The municipality commissions the design engineer, hosts the Court of Revision, and ensures that drainage infrastructure is maintained, typically through the hiring of a drainage superintendent.

Council is to appoint an engineer and drainage superintendent, but council does not have the authority to mandate such people to take a specific action as outlined within the Drainage Act. In other words, the municipality plays a pivotal role in the application of the Drainage Act process but they do not control it. It is the petitioner who starts or stops the process. If the petition is stopped then engineering fees are submitted to the municipality for remuneration but are assessed to the original petitioners.

12.4 MUNICIPAL CLERK (LID ANALYST)

The municipal Clerk is tasked with mailing notices, reports and invoices to landowners. All petitions, landowner concerns and appeals are first received by the Clerk before they are directed to the Council, the Engineer or the appropriate appeal body. Through an aggregation approach the Clerk's role would be one of an LID Analyst. The Clerk would be the first point of landowner contact for information about grants and procedures, as well as a resource to provide petition forms and related forms.

12.5 DRAINAGE SUPERINTENDENT (GREEN INFRASTRUCTURE ASSET MANAGER)

Under the Drainage Act, the Drainage Superintendent's role is to inspect and coordinate maintenance activities in accordance with the bylaw pertaining to the drainage project – in other words they must execute the instructions summarized in the maintenance provisions of the report. The skills of the Drainage Superintendent or equivalent would be needed to ensure that LID/GI features are maintained in such a way that they provide the stormwater benefit (quantity and/or quality) intended. Under an aggregation scheme, this role could perhaps be more appropriately referred to as the "Green Infrastructure Manager". The Green Infrastructure Manager would need to possess a strong working knowledge of green infrastructure and water conservation design (and possibly energy). Although an engineer would be retained to lead and design the project, the Drainage Superintendent – or Green Infrastructure Manager - would still need to review the engineer's reports, drawings and assessment schedules.

12.6 CONSERVATION AUTHORITY (INTEGRATED WATER SPECIALIST)

Conservation Authorities (CA's) play a crucial role in the Drainage Act process. Under Section 5(1)(b), municipalities deciding to proceed with the construction of drainage works are required to serve notice to CA's having jurisdiction over any lands in the affected area, or the Ministry of Natural Resources and Forestry if no CA exists. Subsequently, Section 6(1) grants CA's a maximum of thirty days to send the municipality a notice that an environmental appraisal of the works is required, with the costs of the appraisal to be paid by the CA. CA's have the right to appeal any appraisals deemed to be unsatisfactory to the Tribunal.

CA's having jurisdiction over urban watersheds could expect to have the same roles and responsibilities as those identified in the Act currently. However, with a focus on integrated water management, natural resource conservation and watershed protection and restoration, CA's are well-positioned to help project proponents and aggregators by bringing their expertise to the pre-project scoping meeting as well.

13.0 IDENTIFYING OUTSTANDING GAPS & ROOM FOR FUTURE WORK

While the intent of this document has been to analyze an assess the potential of the Drainage Act to meet the evolving flooding, drainage and surface water management needs of Ontario in the 21st century, the review and discussion provided is by no means exhaustive. As noted in Section 3.0 , many important policies, bylaws and pieces of legislation that interact with – and impinge upon – the Drainage Act were necessarily left beyond the scope of this document. Furthermore, such a novel application of the Drainage Act leads to exciting new questions that warrant further investigation. As such, it is hoped that this document will also be seen as the beginning of an important discussion, and not the ultimate thought on the issue. Summarized below are some key questions raised by the authors over the course of this document's production. Such questions may need to be the subject of future discussion papers when this process is explored further.

Table 7 Key questions for future work

Outstanding Gaps	Redress / Plan to Address
Lack of experience in dealing with the Drainage Act process	Many actors – particularly in urbanized areas – may require some training as part of a capacity building process to ensure that they are familiar with the Act and its application.
Lack of experienced drainage engineers, municipal learning curve.	Given the improved drainage needs which exist in many urban areas, a capacity gap likely exists in the drainage engineering community. While OMAFRA offers regular courses to train engineers on matters surrounding the Act and its application, upscaling of these activities may be required.
Business case and incentives need to be formulated	Collectively, action is needed regarding the exploration of different forms of SWM business models, and works to identify acceptable market offset values which will drive uptake. This in turn is contingent on the various utility and credit/rebate schemes which may exist. This will be the subject of a future discussion paper.
Need for technical guidance on how to aggregate properties using a transparent methodology	Guidance surrounding a transparent, repeatable aggregation methodology (or methodologies) is required. This will be the subject of a future discussion paper.
Conflicts and synergies with other existing policies, regulations and legislative pieces	Local improvement charges, municipal standards, etc. can help or hinder application of the Drainage Act process. This will be the subject of a future discussion paper.
Municipal adoption requirements / private landowner adoption requirements.	The rate at which properties are aggregated for the purposes of stormwater management will impact the overall water quality benefit realized by the municipality. Adoption requirements, offset values and realized outcomes can help municipalities understand the business case underpinning improved stormwater management

Currently there are typically two scenarios that describe most uses of the Drainage Act.

1. When a downstream landowner refuses a reasonable amount of flow through their property.
2. When a farmer can make a strong business case for the project after analyzing the crop yield increase and land value increase, OMAFRA grants and communal sharing of costs. A business owner or landowner would need similar incentives and financial support. At this time this does not exist.

Since the Drainage Act has not been used for installing LID features a guide may be needed to help people who wish to become aggregators. Without proper guidance and training, the complexities surrounding the implementation of communally-owned stormwater infrastructure may pose an insurmountable challenge.

Since drainage works exist as quasi-municipal infrastructure, they typically come with a greater number of attendant requirements compared to private works (e.g. tender documents, bid bond insurance, adherence to municipal construction standards, etc.). As such, senior municipal staff must understand that since urban applications of the Drainage Act would almost certainly be a landowner driven process and that landowners would be paying a sizable portion of the project costs, then adhere to such standards may need to be carefully re-evaluated.

14.0 CONCLUSIONS AND NEXT STEPS

The Drainage Act has seen more than 150 years of successful application throughout the Province of Ontario. The processes afforded within this unique and powerful piece of legislation have helped to alleviate flooding and related drainage issues across countless properties, and this has led to the creation of thousands of kilometers of municipal drainage infrastructure, all of which is fully funded through provisions within the Act.

Conversely, many of our older urban areas and watercourses they drain to suffer from the effects of inadequate or improper drainage and degraded or impaired water quality. These problems are exacerbated by the growing effects of climate change and urban intensification. At the same time, an ever-growing amount of our urban drainage infrastructure is as at or beyond the end of its useful life. With a nationwide, multi-billion dollar infrastructure deficit, the replacement of this aging infrastructure is a tremendous challenge. However, this situation presents a marked opportunity for the Drainage Act and the practitioners working under its banner. Furthermore, we believe that the application of the Act and its well-documented processes in a 21st century context warrants further consideration. As such, the next steps in this work are as follows:

1) Apply the Drainage Act and its processes to a well-defined study area. This work – which constitutes Phase II of the overall project – is intended to help identify in what circumstances, if any, the existing Drainage Act framework is imperfectly suited for the process of decentralized stormwater management implementation.

2) Related to the above, Phase II will also evaluate how the application of the Drainage Act impinges upon other policies, ordinances or bylaws. While the application of the Act is intended to work harmoniously amongst other policies, legislation and bylaws, such processes are not always perfectly aligned with the aforementioned. As such, the use of the Drainage Act process may be better served if such policies and bylaws are amended.

3) Develop a transparent aggregation methodology to assist drainage Engineer's in the development of low impact drainage reports. Approaches to aggregation are bound to be both numerous and complex. Successful aggregation approaches must balance a range of financial and performance considerations, as well as the appropriate offset value that aggregated stormwater management works will provide to municipalities and downstream areas.

4) Upon application of the aggregation methodology to the study area, develop assessment schedules for private and public property owners which equitably consider the capital, operation and maintenance costs of the proposed stormwater works, and the stormwater management and water quality benefits such works provide to municipalities and downstream landowners. As with the current process, there are different apportionment techniques which can be applied, and it has yet to be determined what criteria (allowances for additional volume capture, special benefit assessments for extraneous landscaping of LID practices, etc.) are most critical to consider within the schedules.

5) The outputs from the above task will help to identify many of the minimum costs associated with a communal, aggregated approach to urban green infrastructure. This information will inform the value of offsets required to provide an acceptable payback period to businesses considering such an approach.

6) Review market research results (Appendix B) obtained from a workshop CVC hosted on applying the Drainage Act to implement decentralized stormwater management in urban areas using aggregated properties. Results will be reviewed with the purpose of setting priorities to scope work related to applying and evaluating the Drainage Act and its processes with respect to the context of this discussion paper. The results will provide insight into the level of understanding amongst stormwater experts from a variety of organizations with respect to the Drainage Act.

7) Taking advantage of the operation, maintenance and monitoring data currently being collected by the STEP Water partners, subsequent work will also strive to provide refined estimates of the long-term life cycle costs of low impact drainage works. This information will be useful in refining the assessment schedules for the stormwater works in the study area.

8) The microscale (neighbourhood level) analysis to be carried out in fulfillment of the current phase of this work will be used to inform a larger, macroscale optimization analysis, which is also being carried out by the STEP Water partners. The macroscale analysis will focus on the equitable sharing of costs across property and municipal boundaries, and will evaluate a subwatershed-based cost sharing model.

The preceding analysis is intended to catalyze ongoing discussion surrounding this issue. The success of broad scale low impact development implementation, as well as any associated economic model, hinges upon adequate and sincere public and private consultation throughout the policy development process. Only by such means is it possible to take a truly integrated approach to managing water resources and improving the state of stormwater management within the Province.

15.0 GLOSSARY OF TERMS

Stormwater Related Terms

Area Requiring Stormwater Management (ARSWM)	Similar to the area requiring drainage (below), the area requiring stormwater management is a real basin area - constituting all or part of a larger watershed - requiring enhanced stormwater management for the purposes of improved water balance, water quality or some combination thereof.
Green Infrastructure (GI)	The planned and managed network of natural resources (forests, open space, waterways, etc.) in a community or watershed with the intention of maximizing the environmental benefits these areas provide to communities. Benefits include - but are not limited to - improved water quality treatment and stormwater management.
Grid Block	A cluster of two or more properties which pool their stormwater resources and share a communal low impact drainage infrastructure system to manage the resource.
Low Impact Development (LID)	LID is a comprehensive stormwater management strategy that seeks to mitigate the impacts of increased runoff and stormwater pollution by managing runoff as close to its source as possible. This approach to stormwater management includes both source and conveyance controls.
Pinch Analysis	A methodology used to minimize municipal water consumption by analyzing the minimum water quality requirements associated with specific industrial, commercial and related processes, and by matching process needs with one or more corresponding streams of reclaimed water which satisfy both the quality and quantity needs of the process streams in question.

Drainage Act Related Terms

Area Requiring Drainage	Usually defined by legal property description, a properly-identified area requiring drainage represents a real drainage basin which may constitute all or part of a watershed, subwatershed or similar catchment area.

Assessment	The provisioning of costs within the Engineers Report in accordance with the principles of benefit, outlet liability and injuring liability. This information is summarized in an assessment schedule within the Engineers Report, and the sums assessed are listed for each parcel of land and road.
Benefit	Describes any advantage to any lands, roads, buildings or other structures from the construction, improvement, repair or maintenance of drainage works. Benefits can include - but are not limited to - higher market value, increased crop production, improved appearance of the aforementioned, as well as better control of surface or subsurface waters.
Court of Revision	A court of revision constituted under the Drainage Act.
Injuring Liability	The part of the cost of the construction, improvement, maintenance or repair of a drainage works required to relieve the owners of any land or road from liability for injury caused by water artificially made to flow from such land or road upon any other land or road.
Outlet Liability	The part of the cost of the construction, improvement or maintenance of a drainage works that is required to provide an outlet or an improved outlet.
Petition	A petition for drainage through the construction of drainage works which serve an area requiring drainage that is filed with the clerk of the local municipality, in accordance with Section 4.
Preliminary Report	An engineer's report containing the information specified in section 10.
Referee	The referee appointed under the Drainage Act. The referee or an acting referee must a judge of the Superior Court of Justice or a barrister of at least ten years standing at the bar of Ontario.
Report	An engineer's report containing the information specified in Section 8 of the Drainage Act.
Special Benefit	Any additional work or feature included in the construction, repair or improvement of a drainage works that has no effect on the functioning of the drainage works.
Sufficient Outlet	A point at which water can be discharged safely so that it will do no damage to lands or roads.
Tribunal	The Agriculture, Food and Rural Affairs Appeal Tribunal (AFRAAT) continued under the Ministry of Agriculture, Food and Rural Affairs Act.

Utility	A legal entity having jurisdiction over any water works, gas works, electric heat, light and power works, telegraph and telephone lines, railways, street railways, works for the transmission of gas, oil, water or electrical power or energy, or any similar works supplying the general public with necessaries or conveniences.

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APPENDIX A

1.0 THE STUDY AREA

A study area was selected for testing the feasibility of a collaborative approach to distributed and decentralized stormwater management systems within an existing industrial/commercial neighbourhood. Small and medium sized enterprises (SME's) make up the vast majority of landowners within the study area, and this is important given that small and medium sized enterprises (SME's) make up the vast majority of businesses in Ontario. Canada wide, small businesses make up 98.2 percent of employer businesses, medium-sized businesses make up 1.6 percent of employer businesses and large businesses make up 0.2 percent of employer businesses (Statistics Canada, 2012).

The Gateway district in Northeastern Mississauga encompasses the headwaters of the Cooksville Creek watershed and consists of two planning districts, Gateway-North and Gateway-South. Only a small portion of the Gateway-North district is in the Cooksville watershed. See Figure A 3 for a map of the study area.

The district has 1,225 business sites, with 1,105 businesses. About 25% of the businesses have less than four employees, and about 20% of the businesses have between five and nine employees. About 33,145 people are employed in the district, which includes offices, retail trade businesses, wholesale trade businesses, manufacturing, and transportation and warehousing businesses. Supporting businesses, such as restaurants and hotels, are also found in the district.

Many of the properties have large buildings, large parking lots for employees and customers, and large turf areas. Parking lots generally have curb and gutter drainage systems, and most of the properties drain to private storm systems that outlet into the municipal storm sewer system. With few exceptions, turf areas appear to undergo high maintenance regimes.

As noted in Figure A 1, the majority of the land use in the Gateway district is:

- Commercial/Office/Mixed Use;
- Transportation right-of-way; and
- Industrial

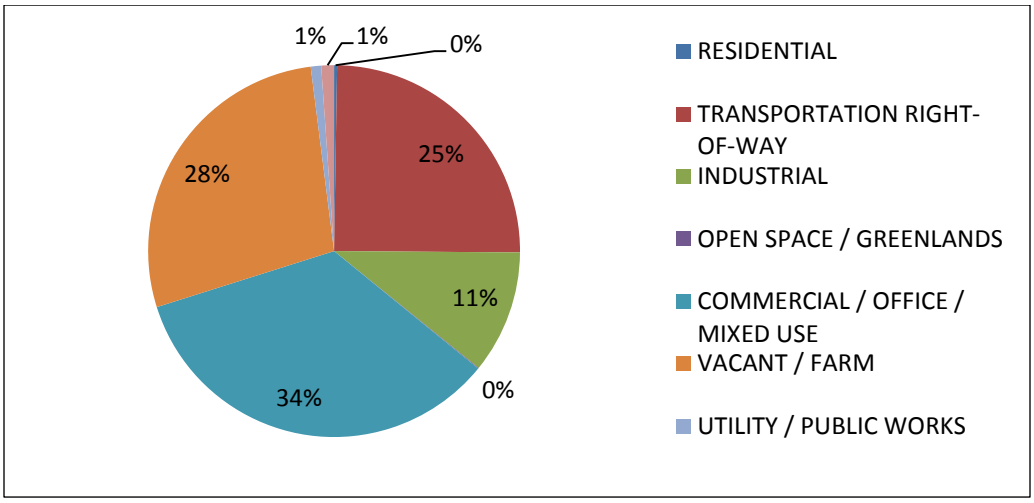


Figure A 1 Breakdown of properties in the study area

As noted in Figure A 2, the majority of properties are:

- Office
- General retail
- General industrial

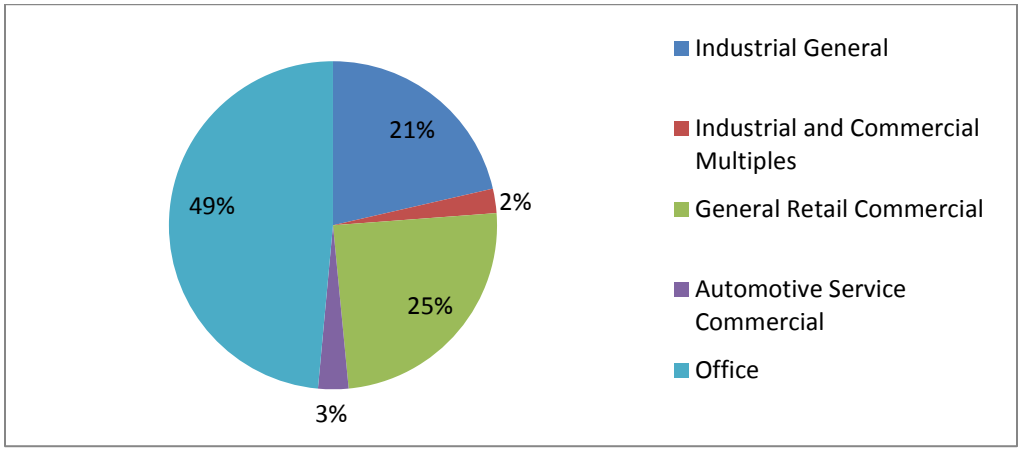


Figure A 2 Breakdown of types of businesses

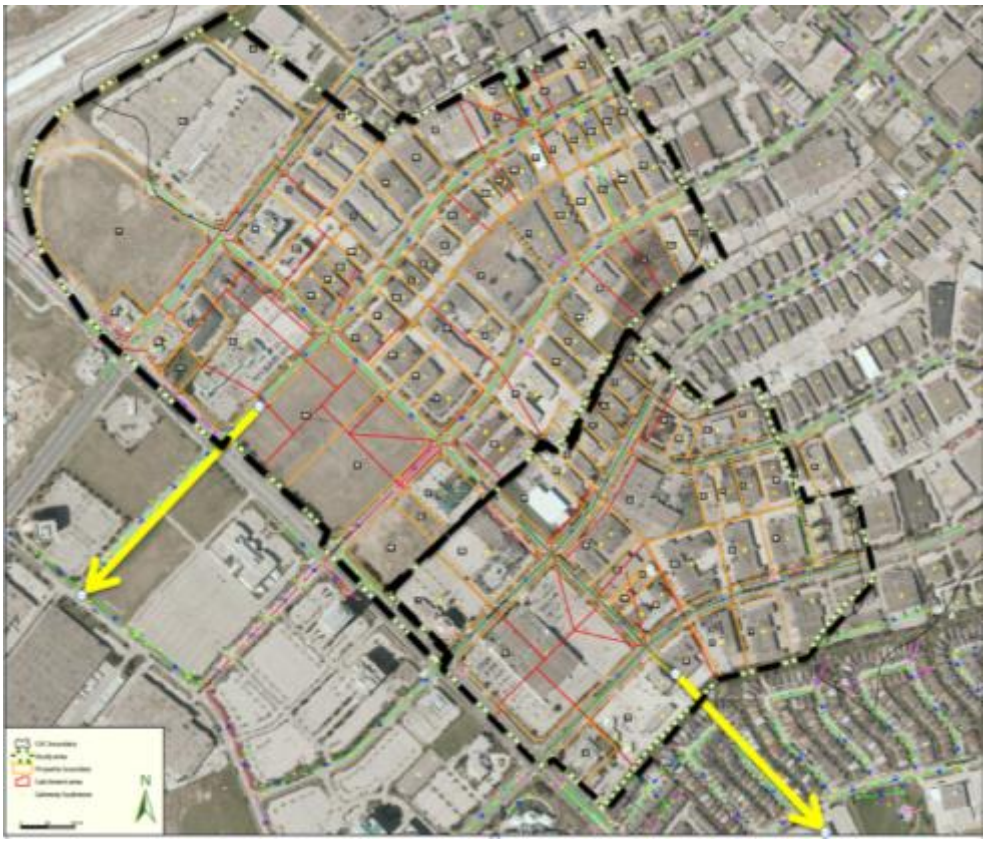


Figure A 3 Study area and storm sewer subcatchment boundaries.

The upper portion of the study area drains west across Hurontario Road and then into the newly constructed Matheson pond at the top of the main branch of Cooksville Creek. The lower portion of the study area drains south to the east branch of Cooksville Creek, and there are currently no stormwater management controls in place.

1.1 EXISTING STORMWATER MANAGEMENT CONTROLS

Given the age of the development, only minimal stormwater controls are in place. It has been estimated that the stormwater controls within this area are sufficient only for the 2yr to 5yr, pre-to-post control scenario; however there are no records available to confirm this.

The City of Mississauga's Water Quality Control Strategy Update Study (Aquafor, 2011) noted that only 15 percent of the city has stormwater management facilities in place. This is typical of other urban areas around the Greater Golden Horseshoe Area (GGHA) as stormwater management has evolved significantly since the 1970's.

2.0 THE ROAD ALLOWANCE & LID RETROFIT POTENTIAL

There are a variety of different types of road allowances within the study area, each having their own characteristics. Understanding these characteristics helps in understanding the different types of LID options that can be used in order to meet the required performance criteria.

CVC's Grey to Green Road Right of Way Retrofit Guide

Provides guidance on the types of LID opportunities and the constraints for each of the ROW types described below. The guidance will give the designer a sense of the LID opportunities unique to that specific road type. The guide also notes that there are other considerations such as adjacent land uses, traffic demands, utility locations, budget constraints and geological conditions that will determine the most appropriate LID solution.
The guide provides an overview of the LID options that are best suited for a particular type of road ROW. To help identify the best option(s) for a particular road retrofit project, the guide provides descriptions, photos and illustrated renderings of the different types of LID practices.http://www.creditvalleyca.ca/wp-content/uploads/2014/08/Grey-to-Green-Road-ROW-Retrofits-Complete_1.pdf

2.1 LOCAL INDUSTRIAL ROAD

The local industrial roads are used for access to commercial or industrial businesses. This road type typically has a ROW up to 24 meters wide, with the paved road surface being 12.5 meters wide, and a design speed of up to 50 km/h. The following local industrial roads are within the study area Brunel Road, Watline Road and McAdam Road. The ROW width on the roads ranges from 20 to 24m.

2.2 MINOR COLLECTOR (INDUSTRIAL)

A minor collector road typically serves local businesses and residences while also being a road which connects traffic to and from local roads or to other neighbourhoods or arterial roads. Minor collector roads generally have a ROW up to 22 meters with a paved road area of 10 meters, and are wide enough for two lanes and parking on one or both sides. Minor collector roads have a design speed up to 60 km/h. The only road within the study area designated as a minor collector is Traders Blvd East, with a ROW width ranging from 24-26m

Central Parkway (During Construction)

Central Parkway (Post Construction)

Figure A 4 Road right-of-way (ROW) retrofit example using a pre-cast silva cell system

2.3 MAJOR COLLECTOR (RESIDENTIAL AND INDUSTRIAL)

A major collector is a collector road with at least two lanes with room for parking on both sides, but may be up to five lanes wide. The typical ROW of major collector roads is up to 30 meters wide with a paved road surface of 14 to 17 meters wide and a design speed of up to 70 km/h. The following roads are designated as major collectors in the study area Britannia Road East (26m), Matheson Blvd East (30m) and Whittle Road (26m)

Elm Drive – Planters

Figure A 5 A ROW LID feature using bioretention planters

2.4 ARTERIAL

Arterial roads typically serve as connector roads for traffic between neighbourhoods and to and from highways. Arterial roads have limits to the number and distance between driveways. Arterial roads can be two, four, or six lanes and may have medians. Their design speed can be up to 90 km/h, and they require large minimum curve radii, stopping sight distance, and intersection tangent length.

BEFORE	AFTER

Figure A 6 Artistic rendering of a large ROW bioswale feature located along an arterial roadway

3.0 INDUSTRIAL AND COMMERCIAL LANDS RETROFIT POTENTIAL

The industrial and commercial properties located within the study area are typical of what can be found across most of Ontario. Understanding the characteristics of the individual lots helps in understanding the different types of LID options that can be used to meet the required performance criteria.

CVC's Grey to Green Business & Multi-residential Retrofit Guide

Provides guidance on the types of LID opportunities and constraints for each of the property types described below. The guidance will give the designer a sense of the LID opportunities unique to a specific property type. The guide also notes that there are other considerations (i.e. pollution hotspots) that need to be considered when selecting an appropriate LID solution. To help identify the best option(s) for a particular property type, the guide provides descriptions, photos and illustrated renderings of the different types of LID practices. http://www.creditvalleyca.ca/wp-content/uploads/2015/01/Grey-to-Green-Business-and-Multiresidential-Guide1.pdf

3.1 INDUSTRIAL LANDS

The industrial properties within the study area have a base zoning of E1 or E2. E1 and E2 employment zones allow for a variety of business operations, including various industrial operations. Unless otherwise permitted, all uses in an E1 or an E2 zone shall be located wholly

within a building, structure or part thereof. An exception zone is a base zone that has been modified by adding or deleting one or more permitted uses and/or regulations. The uses and/or regulations stipulated in an exception zone take precedence.

Figure A 7 below is a series of images taken within the study area and the different types of site characteristics such as parking areas and landscape features.

	
Landscaped areas	**Parking Lots**
	
Large expanses of parking	**Raised turf islands**

	
Tree planter without trees	**Raised landscape islands**
	
Large expanses of parking	**Raised landscape islands**
	
Raised landscape islands	**Raised landscape islands**

	
Raised landscape islands	**Raised landscape islands**
	
Paved parking lot islands	**Raised landscape islands**
	
Access roads for transport truck deliveries	**Thin linear landscape strips**

Wide Streets

Wide Streets

Figure A 7 Gateway District

3.2 COMMERCIAL ZONES

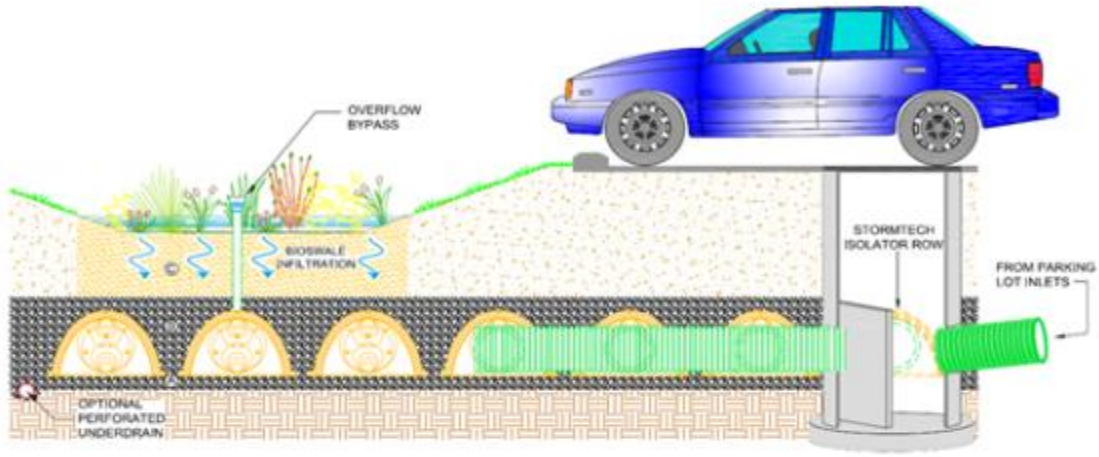


Figure A 8 Examples of large subsurface stormwater storage chambers, which can be incorporated within many pre-existing land use fabrics (Source: ADS Canada).

APPENDIX B

1.0 MARKET RESEARCH RESULTS

1) Which response best describes the sector you represent?

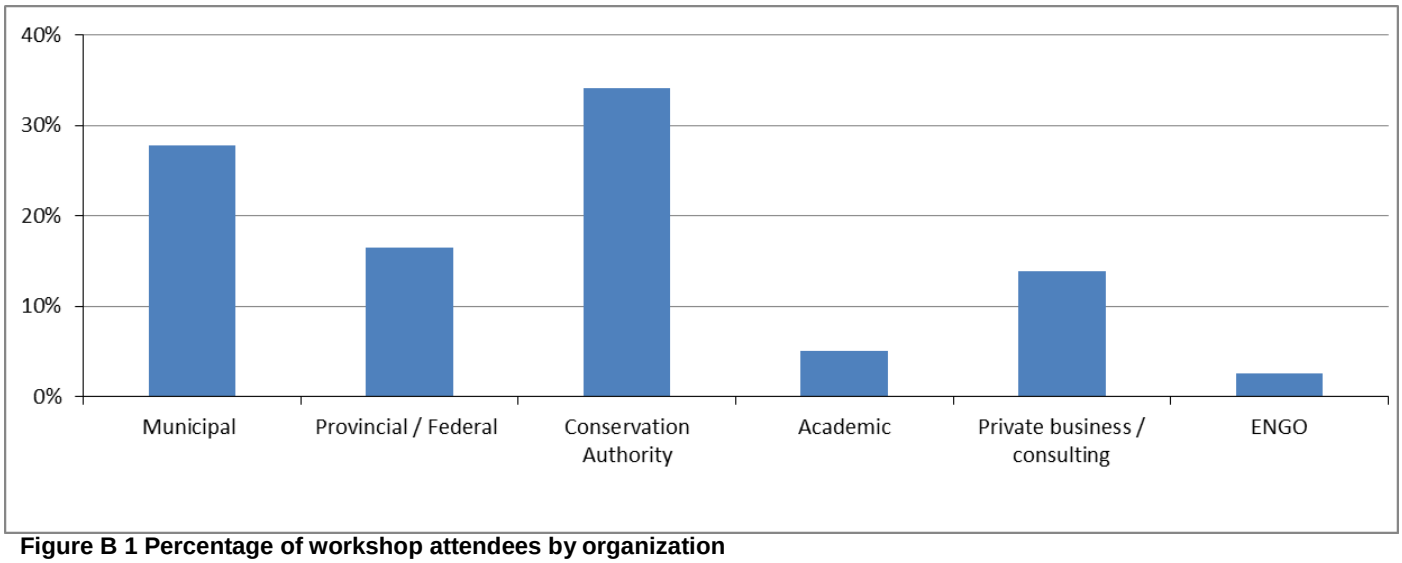


Figure B 1 Percentage of workshop attendees by organization

2) If you answered 'municipal' to the previous question, please indicate whether or not you hold the title of 'Drainage Superintendent' or similar

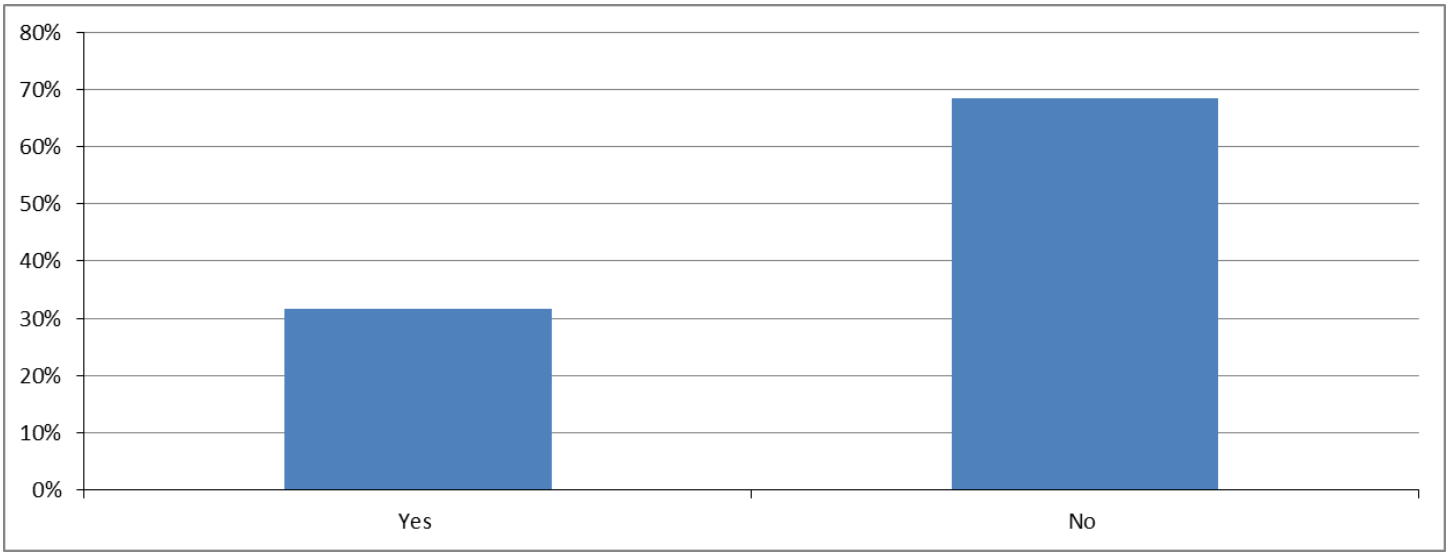
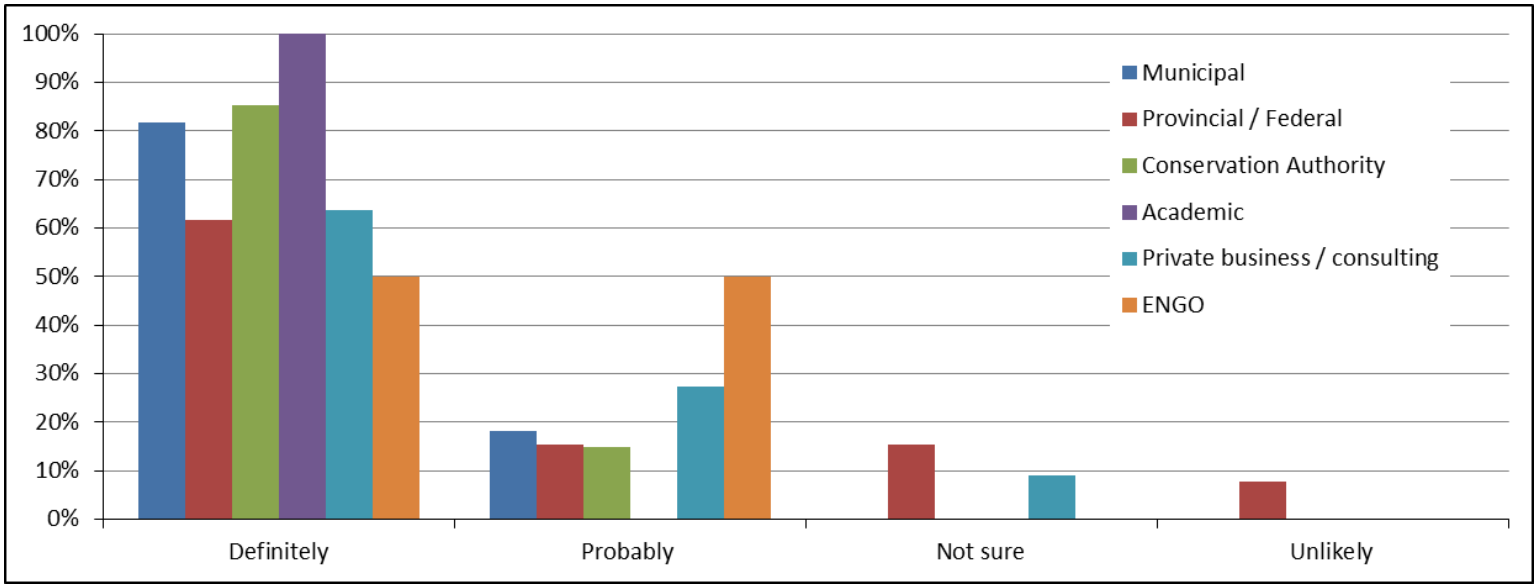


Figure B 2 Municipal staff at the workshop who identify as a Drainage Superintendent

3) Do you think there is a need for improved stormwater management in your municipality/jurisdiction?

Figure B 3 Perceived need for improved stormwater management by organization



4) Please select the top three (3) stormwater issues of greatest interest to your organization

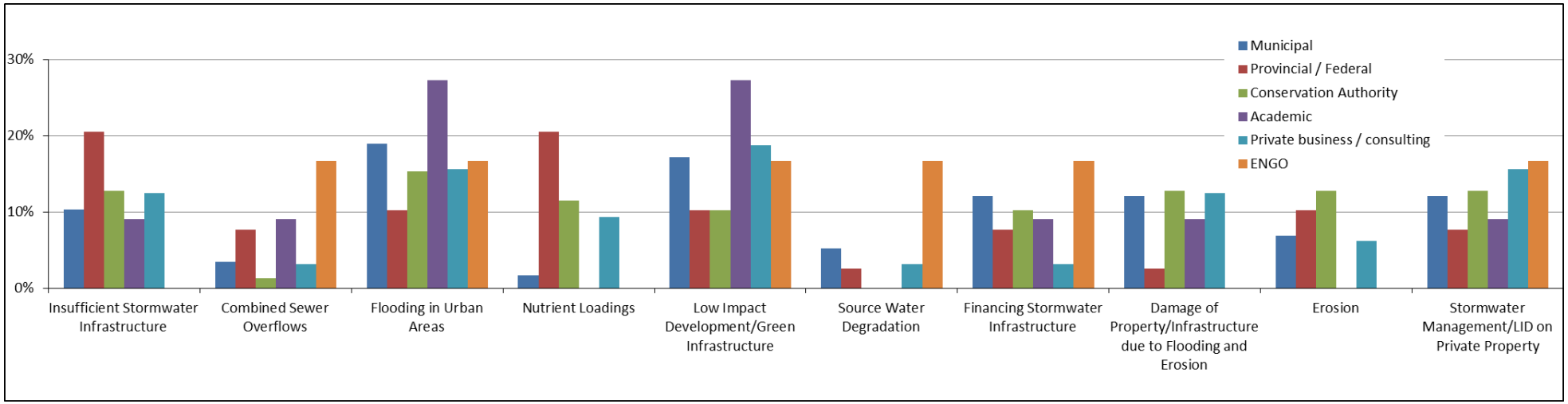
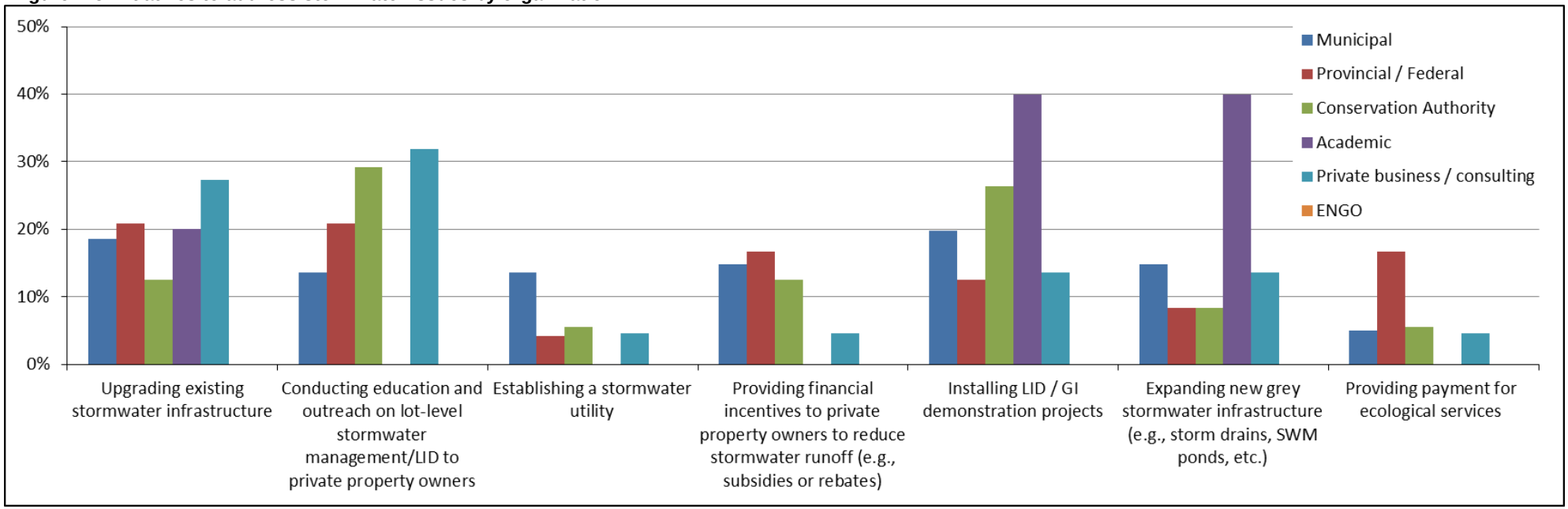


Figure B 4 Interests in stormwater issues by organization

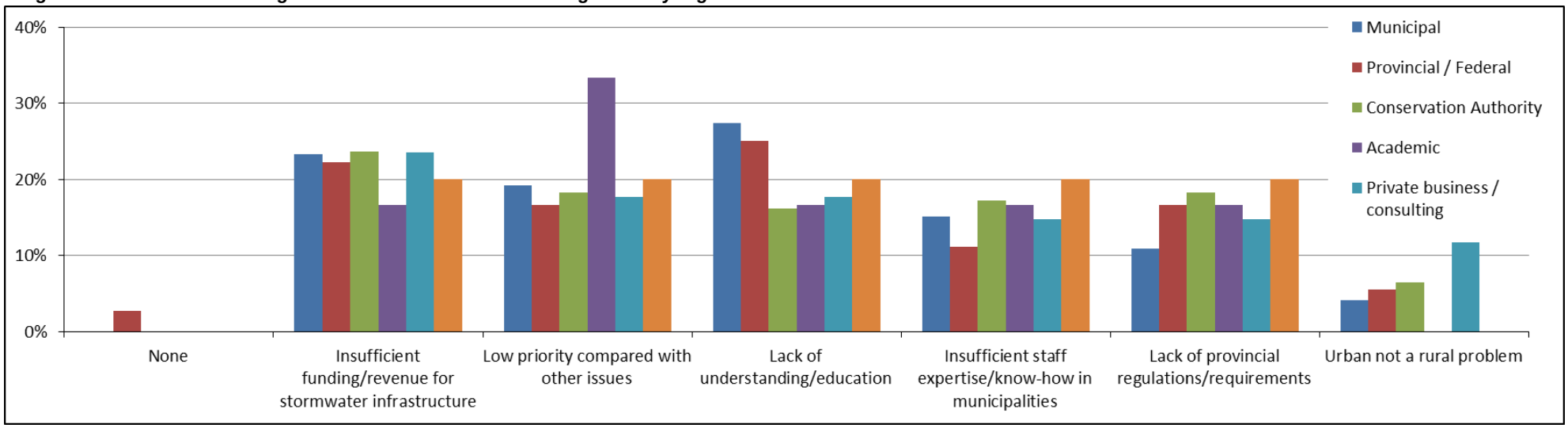
5) Please indicate what your organization has done/is planning on doing to address the stormwater issues you identified (select all responses that apply)

Figure B 5 Initiatives to address stormwater issues by organization



6) Please indicate what you think are the most significant challenges to effective stormwater management (select all responses that apply)

Figure B 6 Perceived challenges to effective stormwater management by organization



7) Please indicate what you think are the best methods to fund/finance stormwater infrastructure, including conventional and GI/LID (select all response that apply)

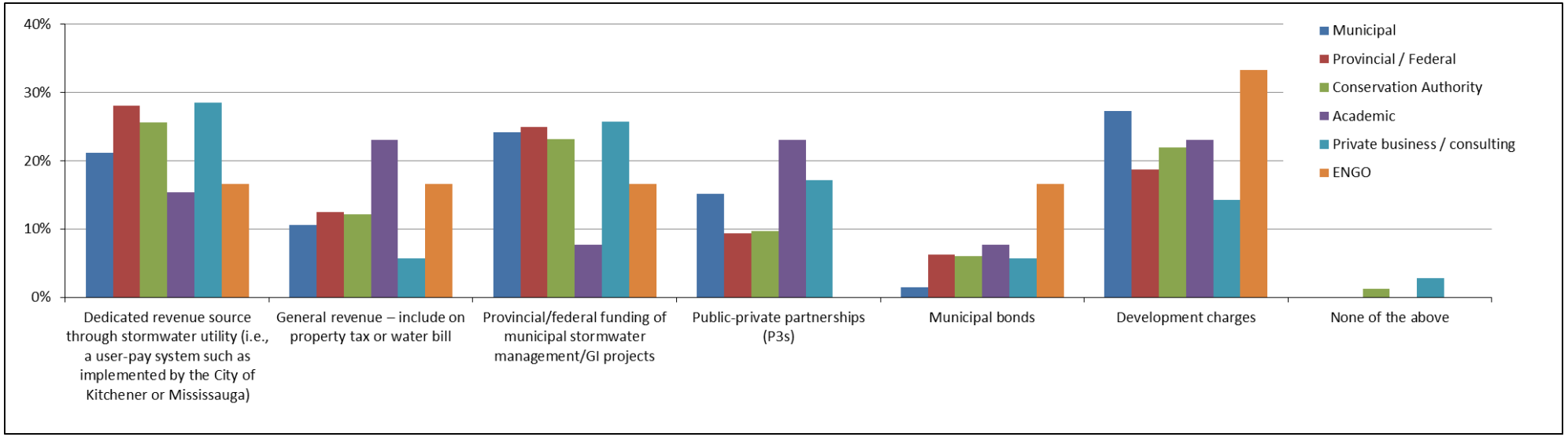


Figure B 7 Perceived best methods to fund/finance stormwater infrastructure by organization

8) If you work for a municipality, is it urban or rural?

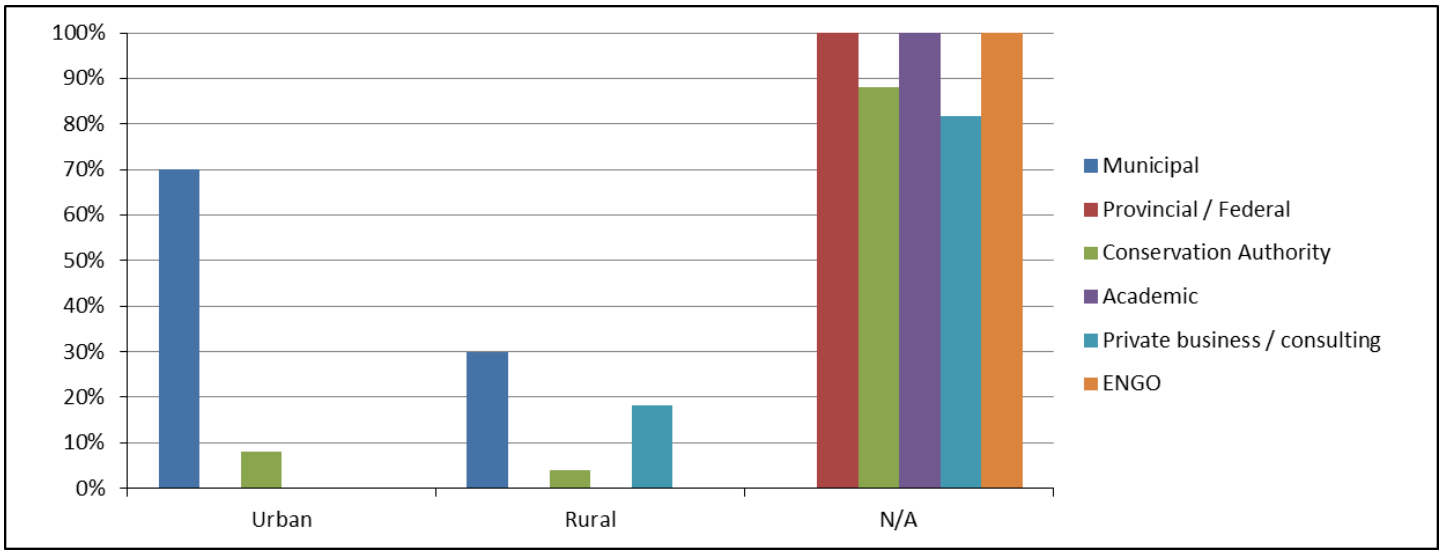


Figure B 8 Urban and rural municipalities represented at the workshop by municipal sector attendees

9) If you work for a municipality, please select the size which best describes it

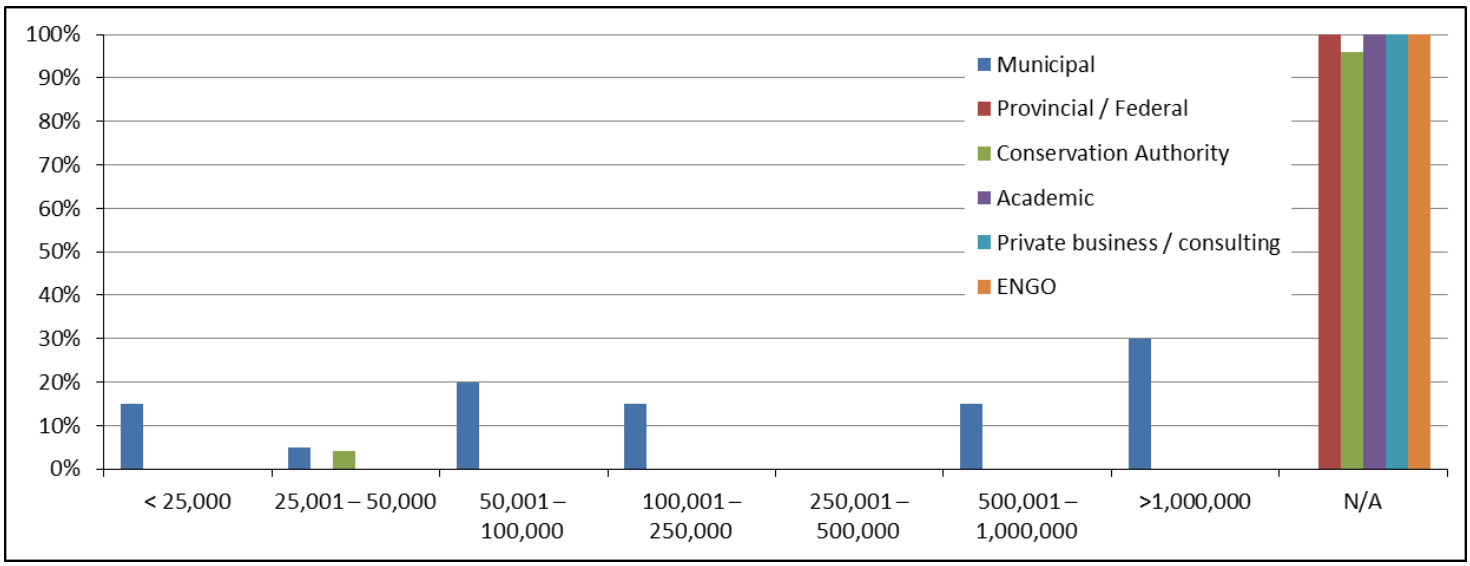


Figure B 9 Size of municipalities represented at the workshop by municipal sector attendees

10) Is the municipality where you live urban or rural

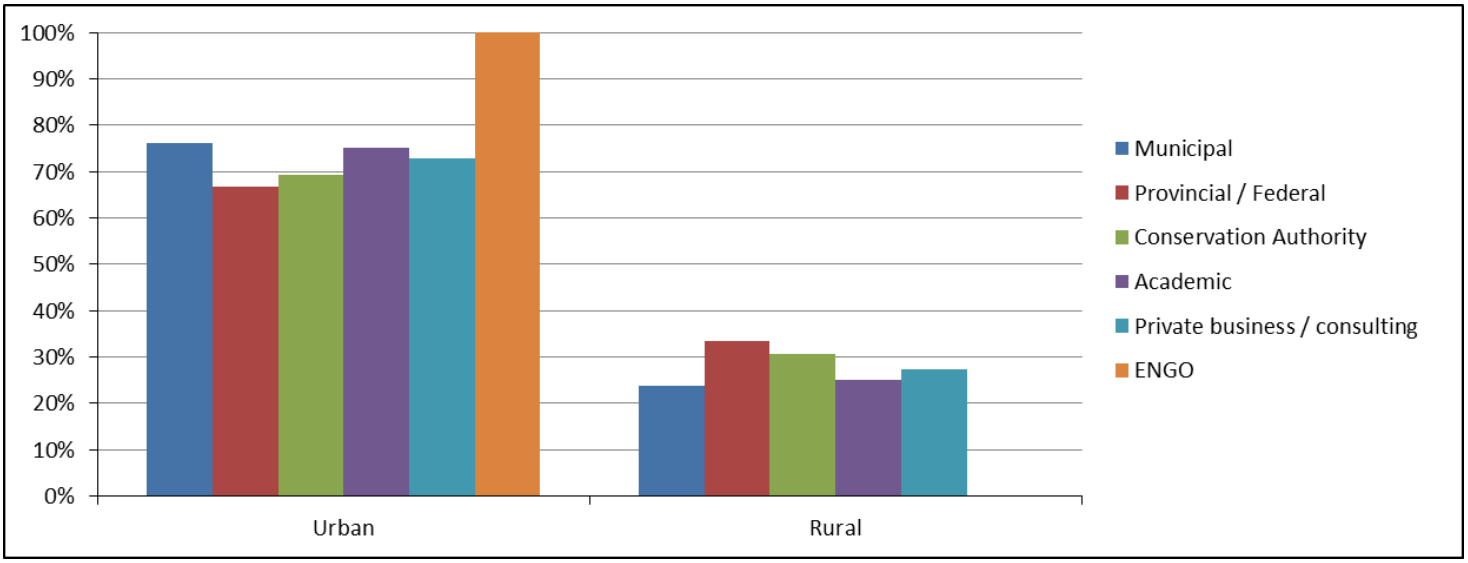


Figure B 10 Workshop participants that live in urban and rural environments

11) With respect to the municipality where you live, please select the size which best describes it.

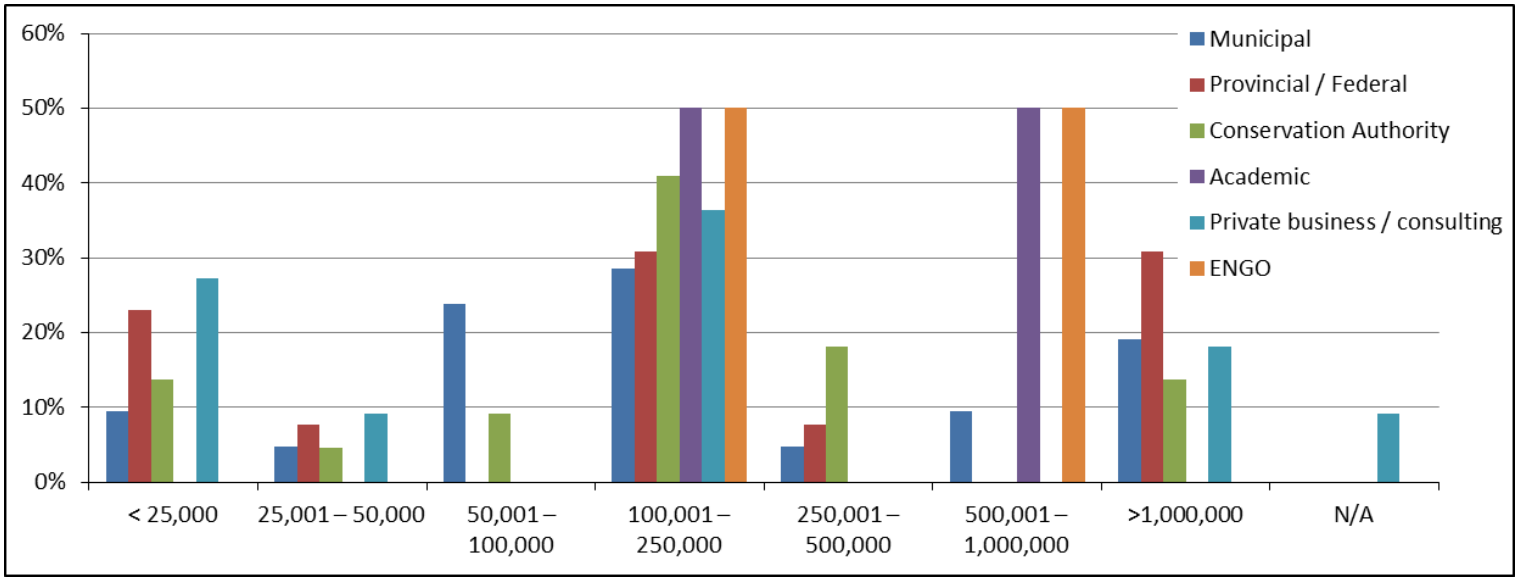


Figure B 11 Size of municipalities that workshop attendees live in

12) Does your organization or municipality regularly receive inquiries or complaints regarding flooding/drainage from private property owners?

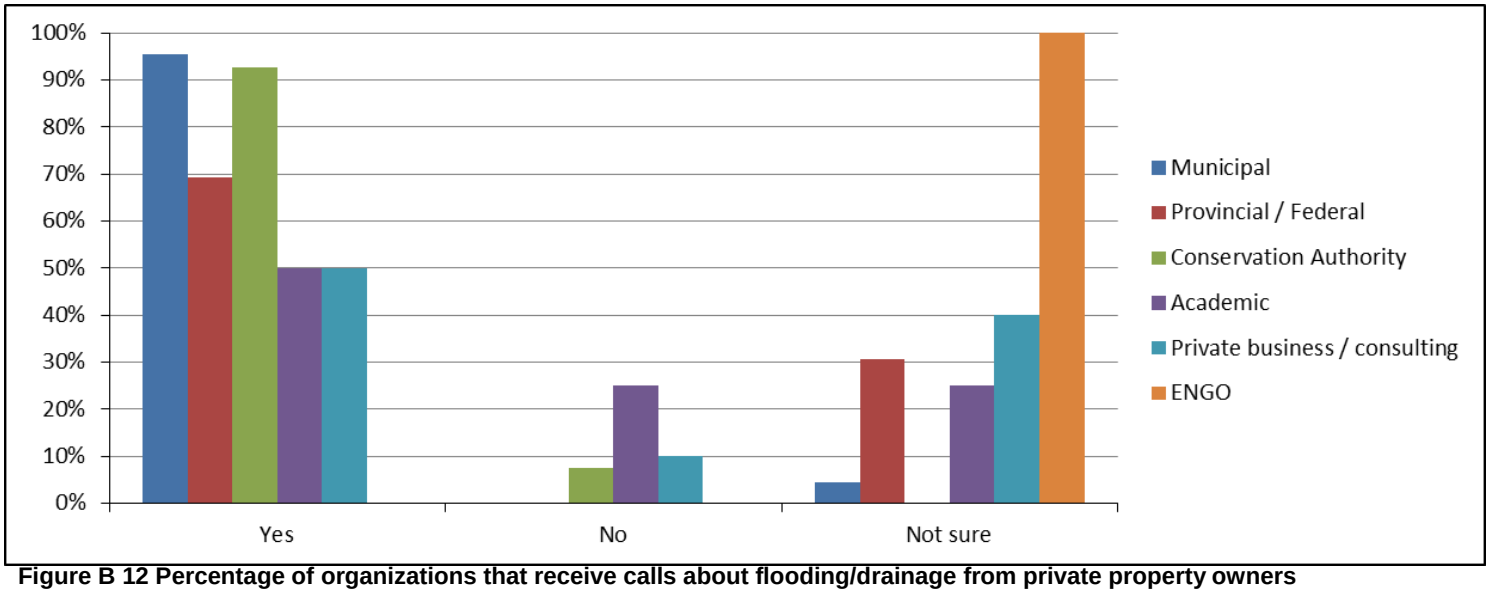
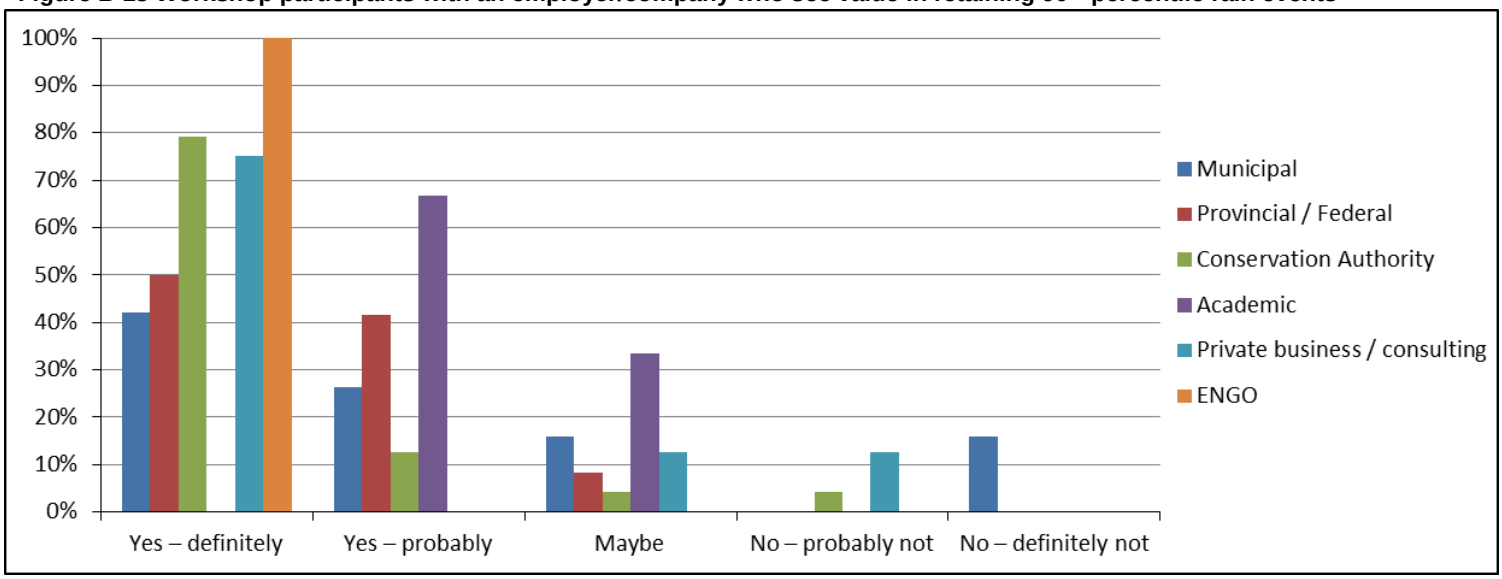


Figure B 12 Percentage of organizations that receive calls about flooding/drainage from private property owners

13) Do you agree or disagree that your employer/company sees value in retaining or otherwise treating the 90th percentile event (25 – 32 mm for Southern Ontario)?

Figure B 13 Workshop participants with an employer/company who see value in retaining 90th percentile rain events



14) Does your organization or municipality track incoming drainage complaints and/or their nature?

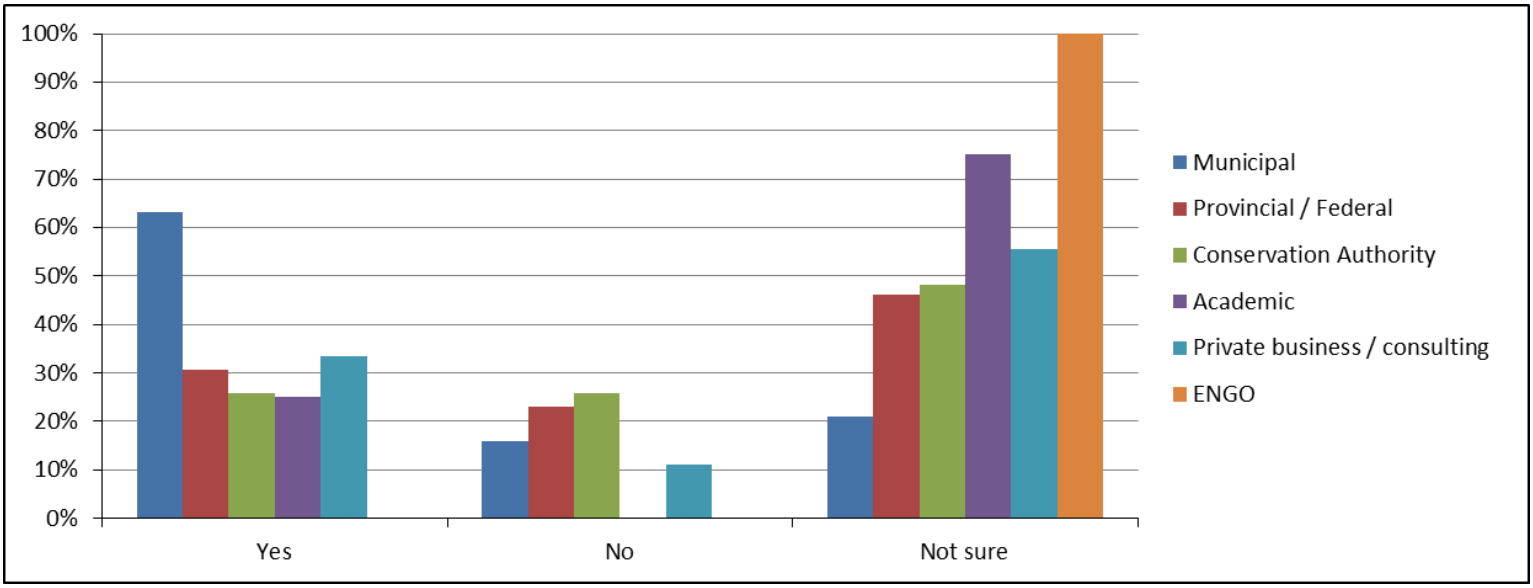


Figure B 14 Percentage of organizations that track incoming drainage complaints

15) Does your organization or municipality intervene or otherwise become involved in drainage disputes amongst private property owners, or is it up to the private property owners to resolve drainage problems amongst themselves?

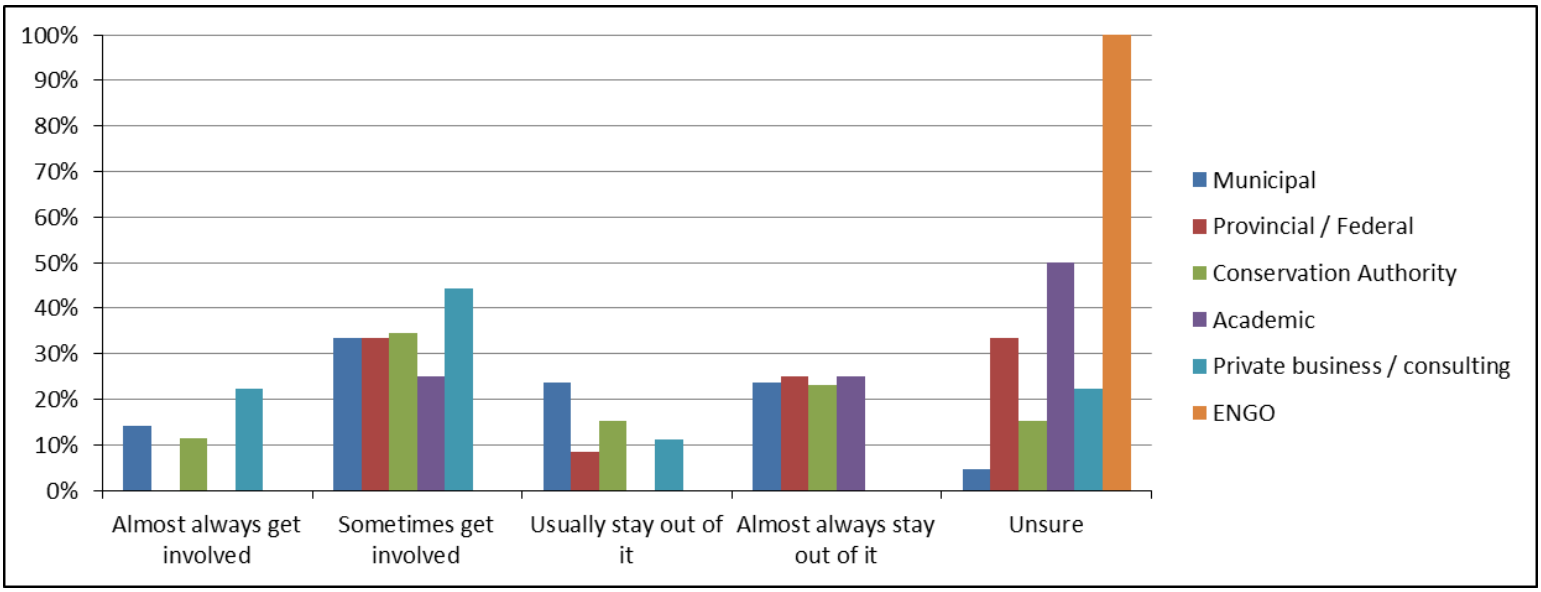


Figure B 15 Workshop participants who are involved in drainage disputes amongst private property owners

16) If someone asked you 'Are you familiar with the Drainage Act?' how would you respond?

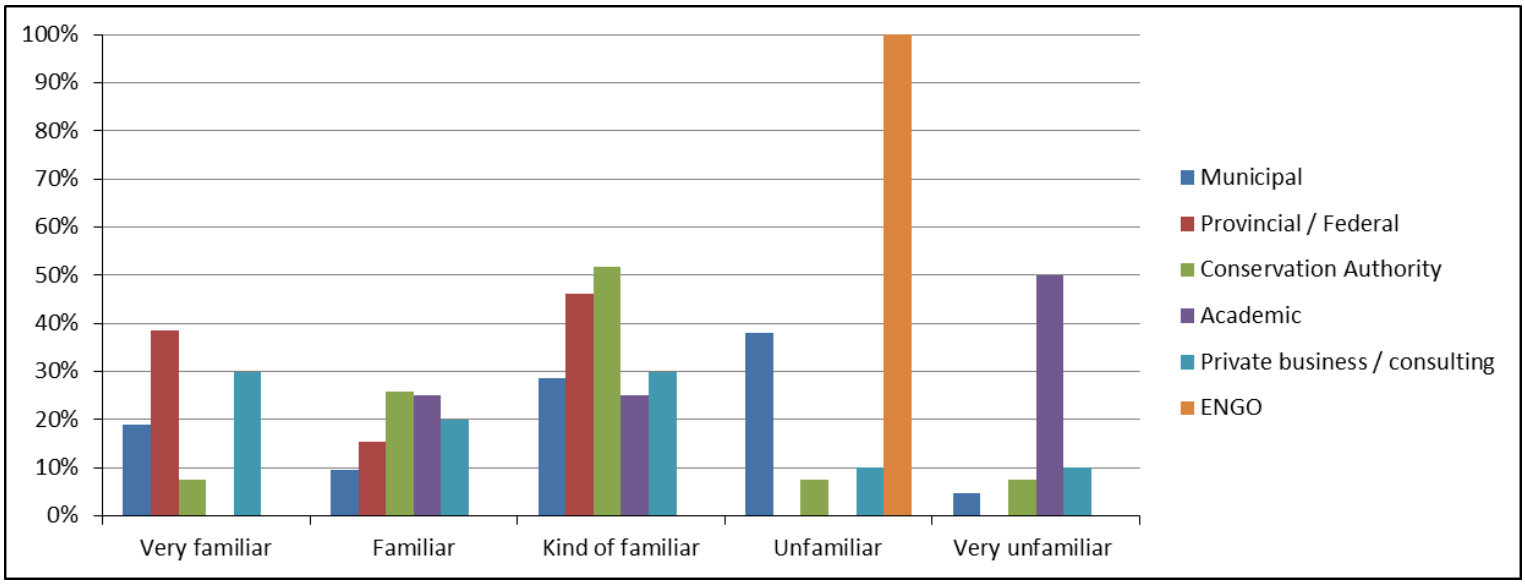


Figure B 16 Workshop participants familiar with the Drainage Act

17) The Drainage Act defines drainage works as "a drain constructed by any means, including … work necessary to regulate the water table or water level within or on any lands …" Do you think that LID features installed on public and/or private lands fit this definition?

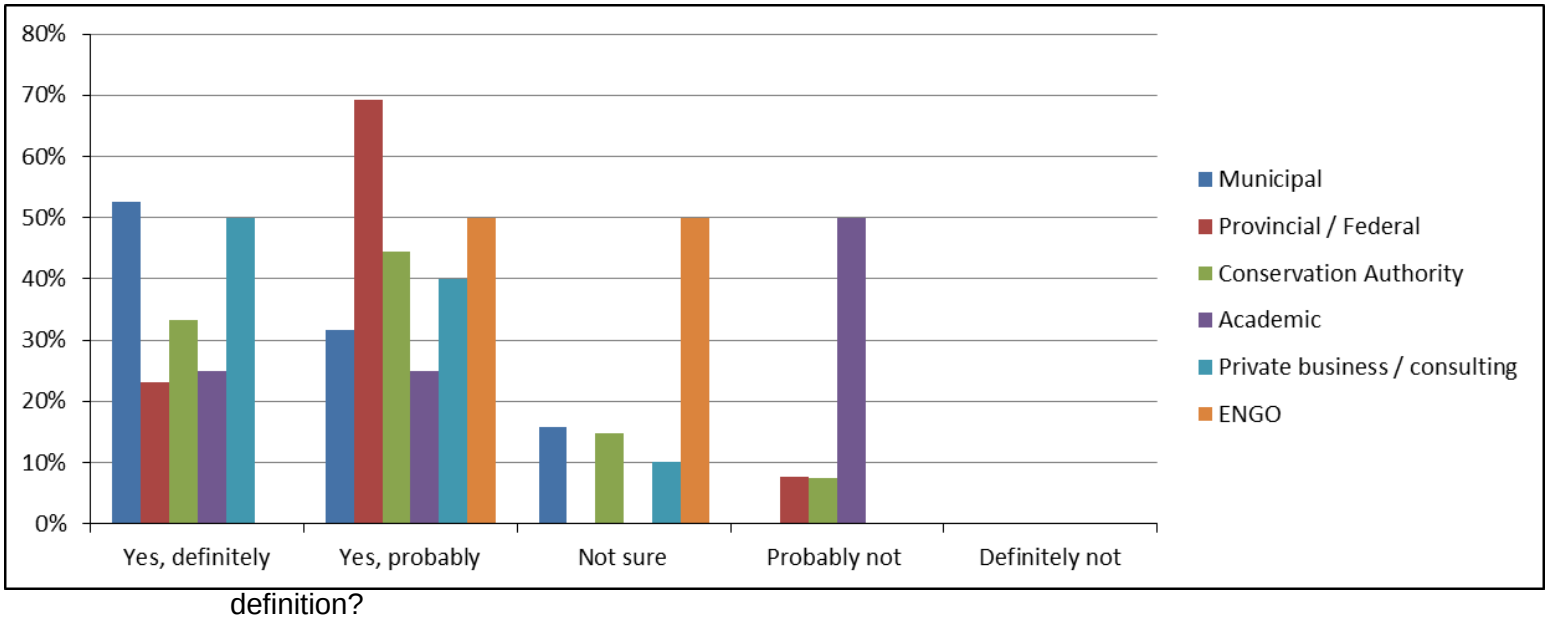


Figure B 17 Workshop participants who think LID is considered "drainage works" as defined in the Drainage Act

18) Improvement is defined in Section 1 of the Act as "…any modification of or additions to a drainage works intended to increase the effectiveness of the system". Do you think that LID features could be considered 'improvements' under the current definition?

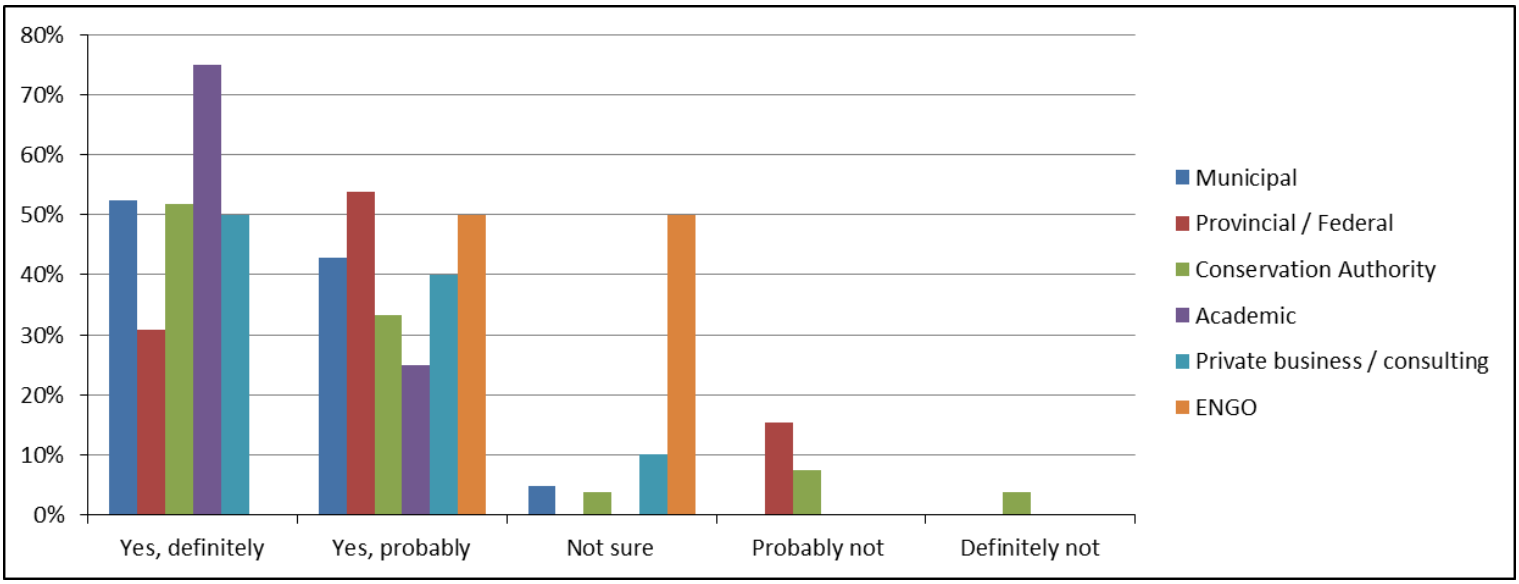


Figure B 18 Workshop participants who think LID is considered an "improvement" as defined in the Drainage Act

19) The concept of sufficient outlet is defined in Section 1 of the Act as the "... point at which water can be discharged safely so that it will do no damage to lands or roads". In urban areas subject to overland flooding, could LID works established on private lands for quantity control purposes help engineers satisfy the sufficient outlet requirement listed under Section 15?

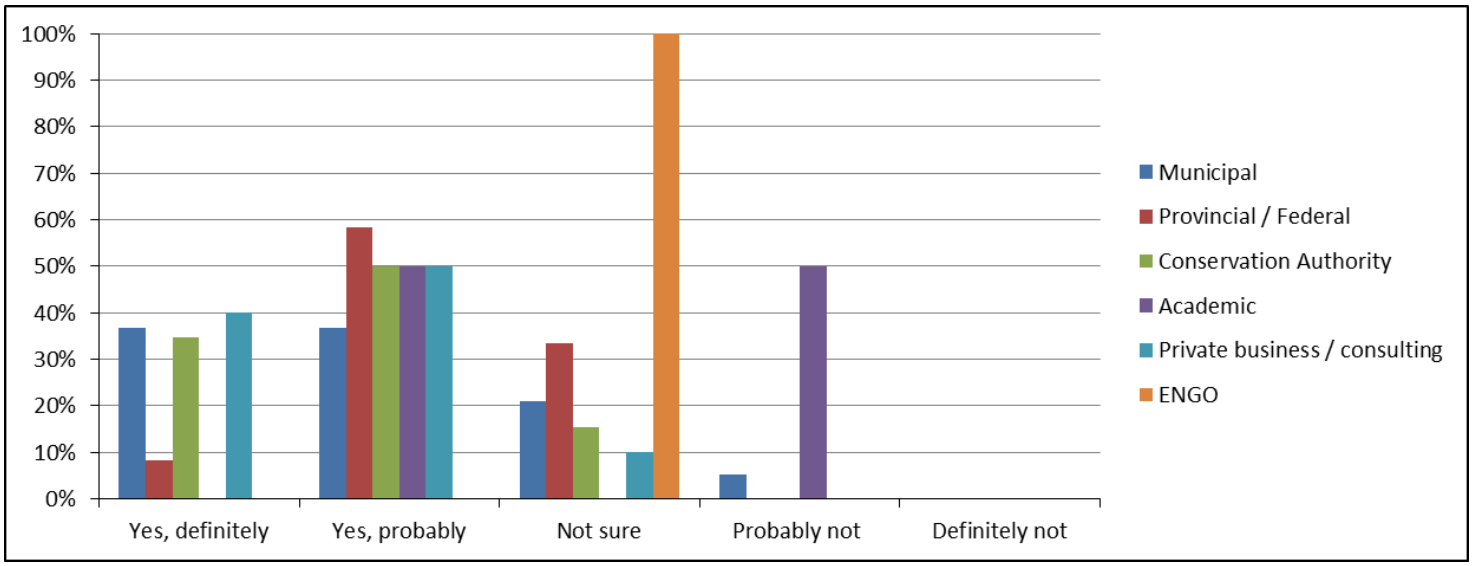


Figure B 19 Workshop participants who think LID works is considered a "sufficient outlet" as defined in the Drainage Act

20) Before this workshop, were you aware that the Drainage Act is used to remedy drainage issues, and that it is not limited in application in rural areas?

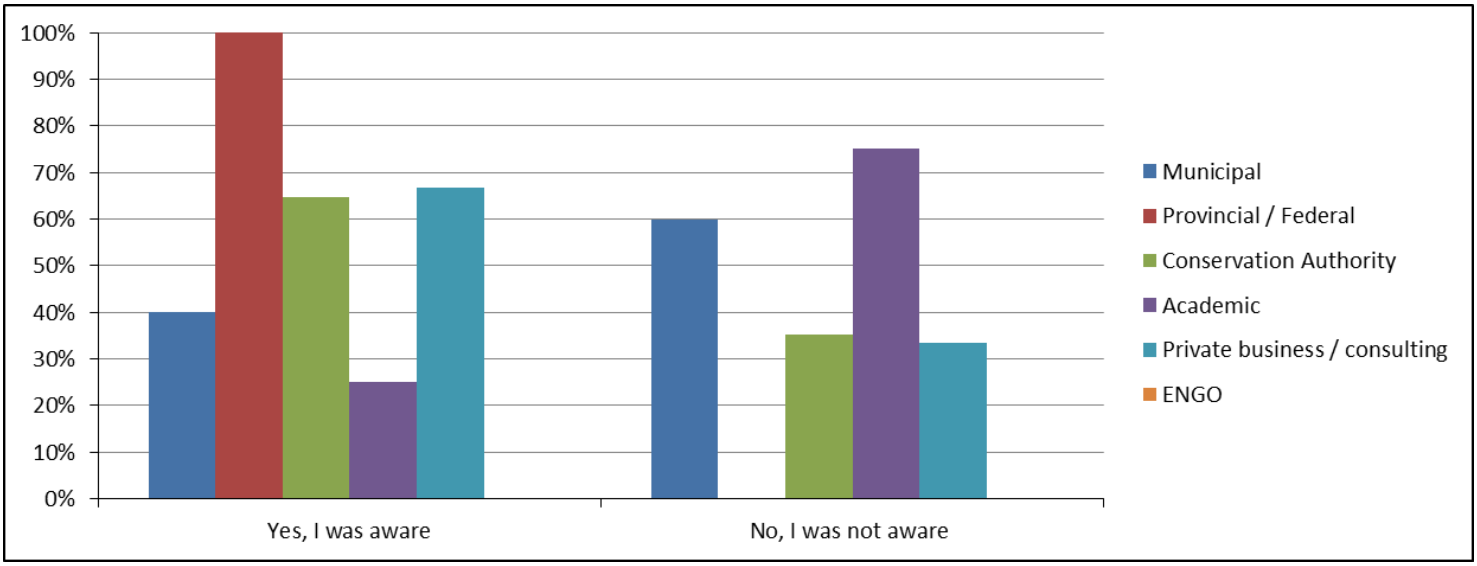


Figure B 20 Workshop participants who were aware that application of the Drainage Act is not limited to rural areas

21) After reviewing the Drainage Discussion Paper and attending this workshop, would you feel comfortable using this information as a resource to address drainage issues by implementing green infrastructure or LID projects in your municipality?

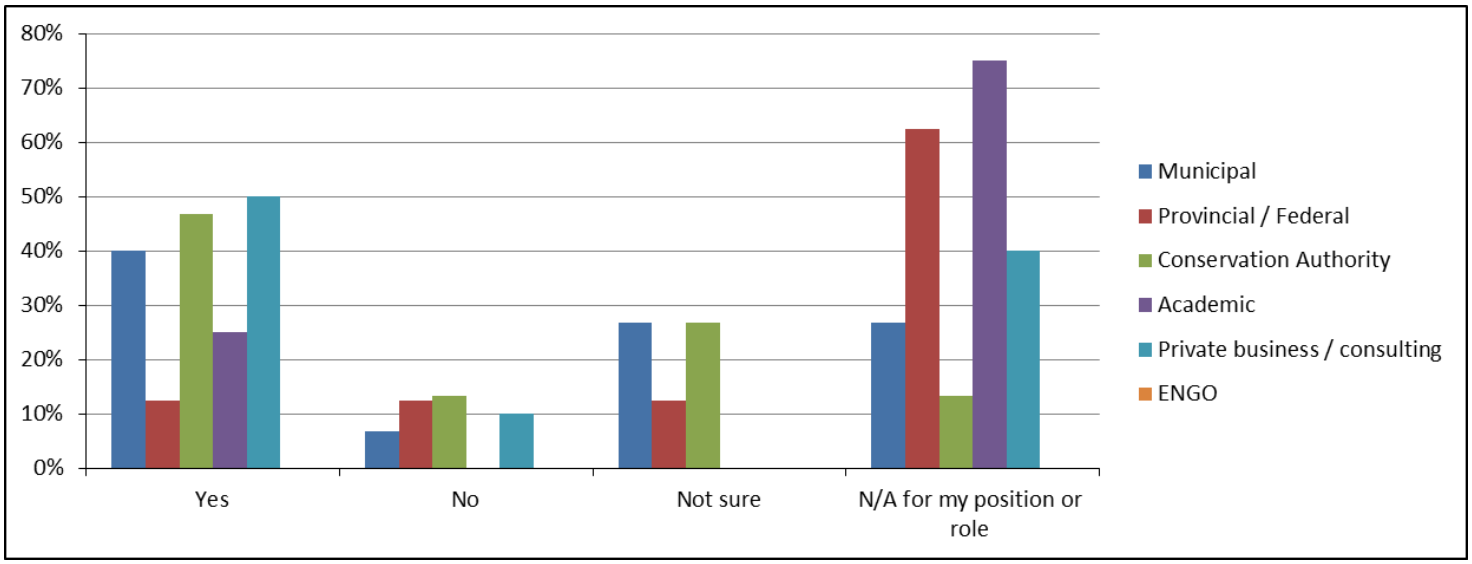


Figure B 21 Workshop participants who feel comfortable addressing drainage issues by implementing GI and LID after reviewing the Drainage Discussion Paper and attending the workshop

22) Today's workshop has improved my knowledge of the Drainage Act.

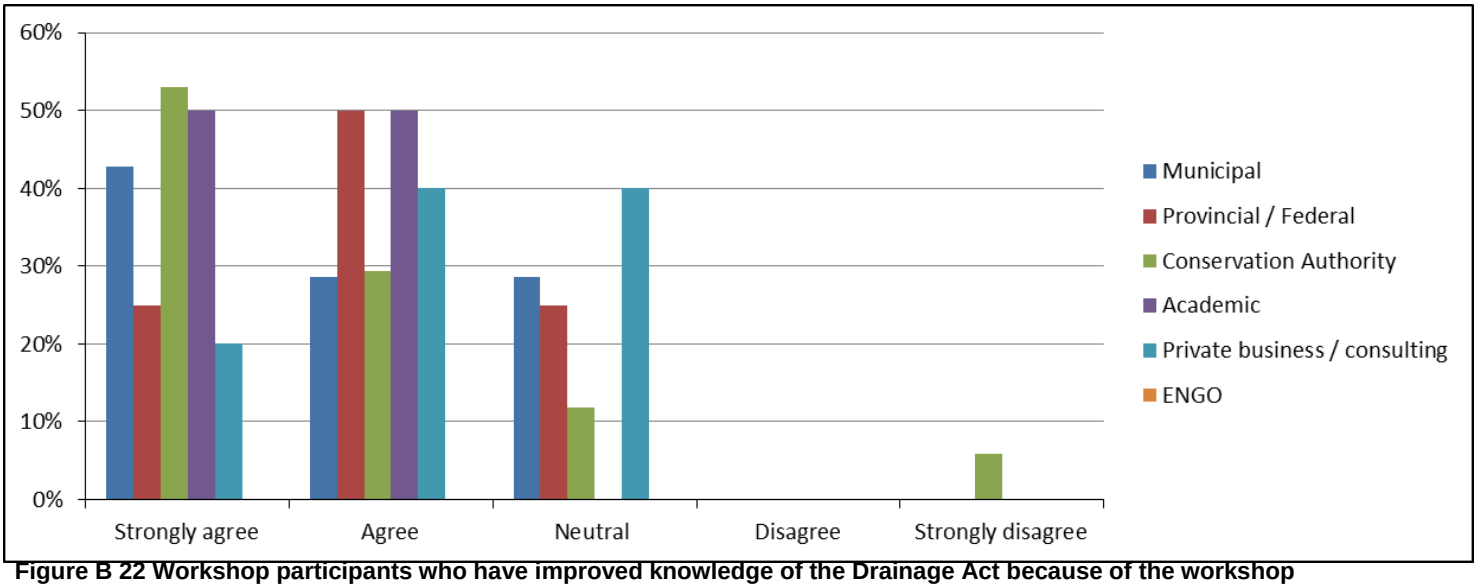


Figure B 22 Workshop participants who have improved knowledge of the Drainage Act because of the workshop

23) Today's workshop has introduced to me the possibility of using the Drainage Act in a new way.

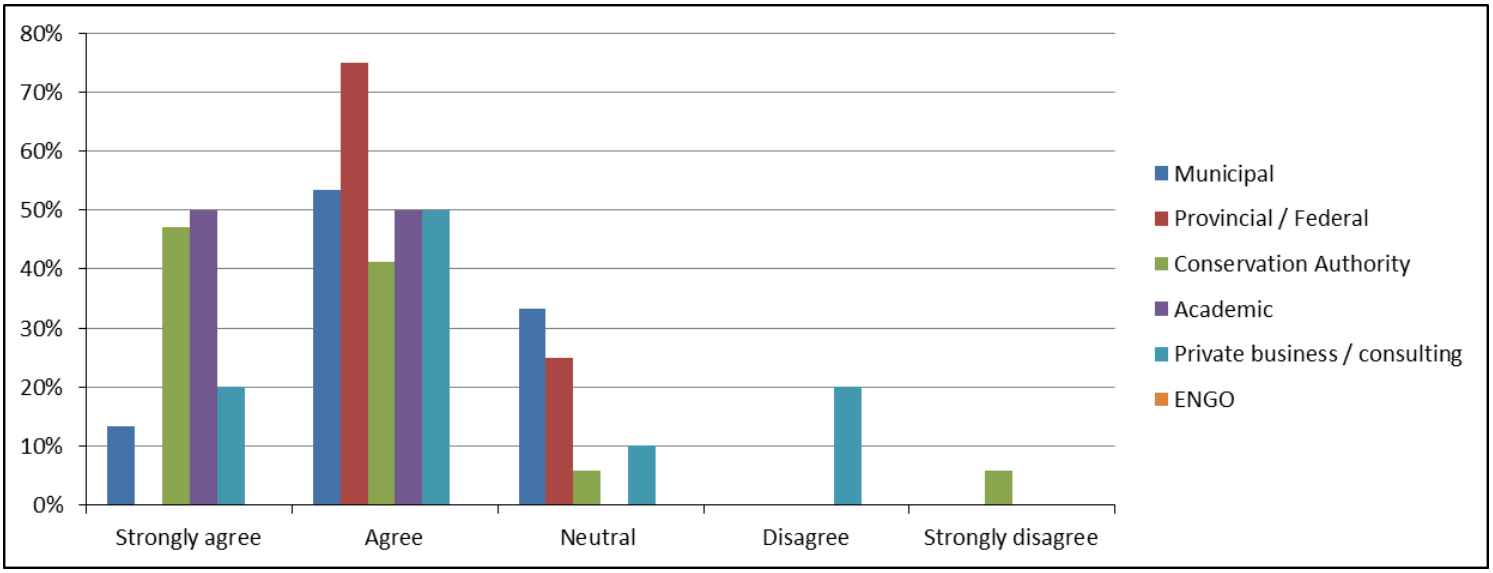


Figure B 23 Workshop participants who were introduced to new applications of the Drainage Act at the workshop

24) Today's workshop has increased my understanding of low impact development, or LID.

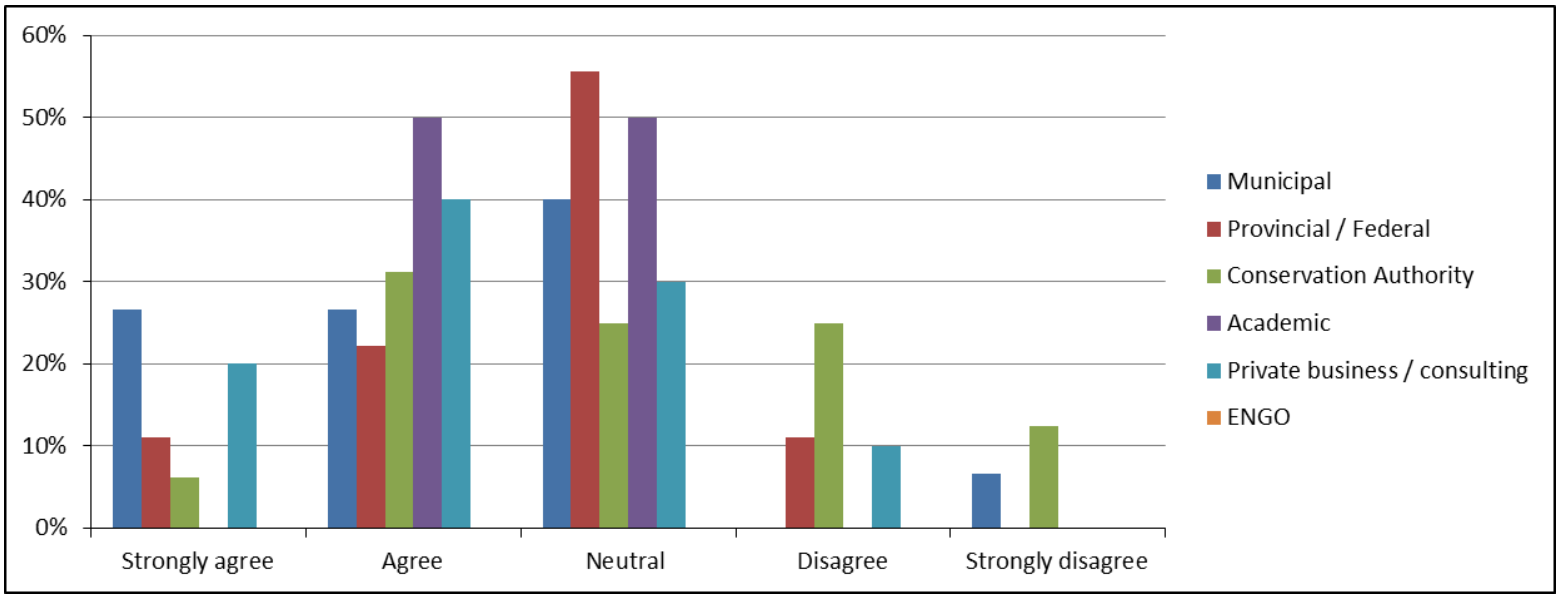


Figure B 24 Workshop participants who have an increased understanding of LID because of the workshop

25) I think that mechanisms within the Drainage Act can be used to promote green infrastructure uptake, and that this would be a net benefit to society.

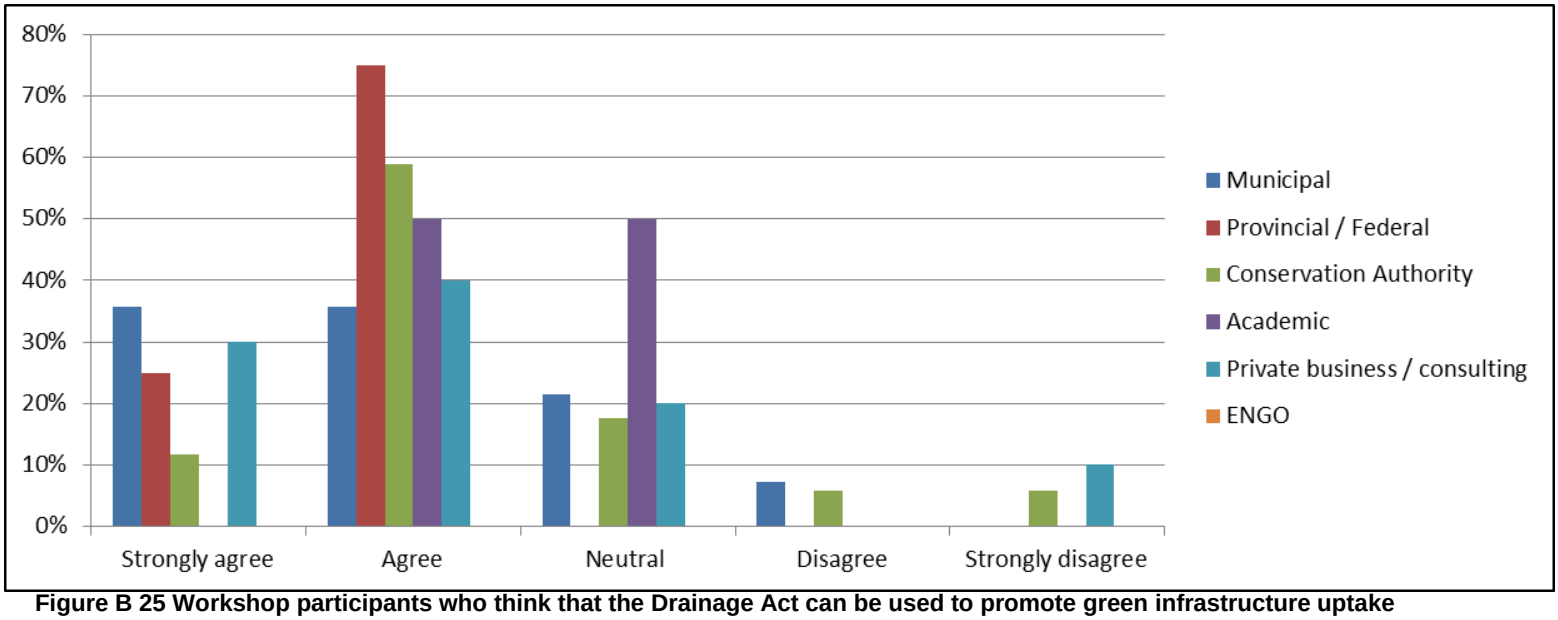


Figure B 25 Workshop participants who think that the Drainage Act can be used to promote green infrastructure uptake