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Economic Instruments to Motivate Stormwater Management on Private Lands

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PREFACE

The Economic Discussion Paper grew out of substantial research, in-field studies and demonstration projects, and the work of the Sustainable Technologies Evaluation Program (STEP)[1]. These efforts collectively identified key impediments to sustainable stormwater management (SWM) in Canada, including the following:

1. Private sector participation in the provision of stormwater services is imperative to deal effectively with a growing stormwater infrastructure deficit in the face of a changing climate (more frequent and intensive storm events) and continued population growth.
2. Private property owners will not participate in on-site SWM solutions unless appropriate incentives exist.

The paper explores the mechanisms available to incent installation of Low Impact Development (LID) technologies, with particular focus on private commercial properties. It is a companion document to the *White Paper on the Drainage Act*, which describes how an existing legal framework can be applied to facilitate installation and maintenance of stormwater infrastructure on private property.

The White Paper also provides background for a pilot study to be undertaken in the Southdown area of Mississauga. This study will examine the potential of aggregating private commercial property under the Drainage Act to secure installation of communal LID technologies and realize cost-efficiencies. The Economic Discussion Paper in turn provides the context for developing economic incentives and policy instruments that would incent private landowners to install LID.

The next phase of the study involves developing cost-optimized designs for communal LID technologies for fourteen commercial properties in the Southdown area. Subsequently, the value of co-benefits for LID technologies will be quantified and the cost of these designs will be compared with conventional stormwater infrastructure that would deliver the same level of service. A range of economic incentive values will be generated from this process, enabling a detailed cost-benefit analysis.

Based on the outcome of the pilot study, the approach could scale up to the entire Southdown drainage area and apply to the development of the master drainage plan. It is understood that the magnitude of the benefits and savings associated with LID technologies will be area dependent. Priorities are thus best determined by CVC's Risk and Return on Investment Tool (RROIT), currently under development. However, Southdown is an immediate priority for the City and is, therefore, targeted for initial scale up.

STEP is a multi-agency initiative developed to support broader implementation of sustainable technologies and practices within a Canadian context. STEP works to achieve this objective by: carrying out research, monitoring and evaluation of clean water and low carbon technologies; assessing technology implementation barriers and opportunities; developing supporting tools, guidelines and policies; delivering education and training programs; advocating for effective sustainable technologies; and collaborating with academic and industry partners through our Living City Labs and other initiatives.

EXECUTIVE SUMMARY

The discussion paper provides the qualitative framework for a business case that:

- Demonstrates the potential viability of incorporating green infrastructure on private property into municipal stormwater management systems
- Demonstrates the financial potential viability of green infrastructure for private landowners
- Ultimately paves the way for wide-scale adoption of green infrastructure by private landowners

Problem Statement

Municipalities face several stormwater-related infrastructure problems as outlined below.

Performance

- The inability of existing infrastructure to meet water quality targets due to inadequate maintenance
- The inability of existing infrastructure to cope with increased runoff due to urbanization and resulting increases in impervious cover
- The high likelihood that existing capacity will be inadequate to cope with increased runoff associated with the population growth and intensification of development as delineated in the Growth Plan for the Greater Toronto Area (GTA)
- The fact that climate change is likely to lead to more frequent extreme weather events resulting in higher flow intensities and velocities within the stormwater system and increased flooding
- The increased risk of flood damage to infrastructure resulting from expanded urban areas, intensification of urban corridor development, and increasing frequency and intensity of storm events due to climate change

Planning and management

- Local/fragmented approach to planning stormwater management systems lead to inefficiencies
- Stormwater planning and management is not integrated with water and wastewater systems in Peel, Halton and Durham regions
- Asset management and master planning approaches may not use lifecycle costing as the financial basis for evaluation of options
- Private lands, which comprise the majority of lands within a municipality, are excluded from proposed solutions
- Centralized, standardized administration processes make it difficult to implement innovative solutions

Financial

- The high costs of increasing conveyance capacity (storm sewers)
- The high cost of end-of-pipe solutions (detention ponds)

- The high cost/lack of land available to construct detention ponds
- Rising costs of flood related property damage and commensurate price tag to the insurance industry
- Inadequate provision for stormwater asset maintenance and replacement.
- User fees that do not reflect the full cost of the service provided and benefit received
- Lack of adequate economic incentives for private landowners to implement stormwater solutions on their properties
- Public stormwater infrastructure is funded by property taxes and is drawn from the general revenue pool where it has to compete with all municipal services for budget allocation

Insurance and Liability

- Higher insurance premiums
- Decreased insurability
- Increased liability exposure due to greater risk of flooding and associated private property damage and losses

Landowners are unwilling to retrofit their properties with stormwater infrastructure given:

- High upfront costs
- Uncertain maintenance requirements
- Low or no return on investment
- Landowners bear the cost while the benefits accrue to downstream properties and the general public
- Relatively high transaction costs (expenses incurred in the process of installation – these include costs associated with receiving planning approval, etc.)

Proposed Solutions

A paradigm shift in how municipalities approach stormwater management is required to address the above issues. Such an approach would:

- Consider storm water management from a watershed perspective
- Consider the full life cycle cost of stormwater infrastructure
- Consider the costs of inadequate stormwater management to municipalities and property owners and the
- Incorporate private property in the treatment train
- Consider the entire water cycle and integrate storm water, water and waste water management
- Optimize cost and benefits
- Incentivize private landowners to retrofit their properties by sharing municipal cost savings with property owners
- Ensure equitable responsibility across different levels of government and cost sharing among municipalities in a watershed
- Allow for flexible administration process that facilitates decentralized administration

Outcome

The ideal outcome of the approach advocated above would be a cost effective, affordable watershed scale, linked and integrated water/stormwater management system that combines green infrastructure on private property with public facilities. Such a system will have greater capacity to reduce the risk of flooding due to climate change events and increased urbanization, while achieving water quality targets.

Summary

This discussion paper provides context for the current state of stormwater infrastructure in Ontario and discusses:

- The barriers to private sector uptake of green infrastructure
- The financial measures used to evaluate private sector projects (NPV, IRR, payback period)
- Policy, economic, and cost control measures that can be applied to overcome constraints to green infrastructure implementation
- Project implementation mechanisms

The paper concludes with an evaluation of the instruments that can be used to facilitate green infrastructure implementation and recommends offsets, grants and subsidies and financing assistance as the preferred measures based on public acceptance, equity, ease of implementation and availability of funding.

Next Steps – Quantification

- Complete a pilot project comprising the aggregation of 14 properties in the Southdown area of Mississauga to install communal green infrastructure
- Finalize the design based on a life cycle cost optimization exercise
- Quantify incentive values based on cost savings when compared to end of pipe solutions as well as benefits provided by green infrastructure
- Conduct a landowner survey
- Develop a business case for nature-based infrastructure on private lands by proposing incentives that overcome cost, administrative, and financial return barriers
- Scale the project up to the Sheridan Creek subwatershed, Southdown area
- Incorporate recommendations in Southdown Master Drainage Plan
- Develop guidance documents that delineate the processes, costs, benefits, monitoring requirements and metrics that can be deployed to implement cost effective green stormwater management infrastructure solutions on individual and aggregated private properties

1. INTRODUCTION

1.1 Purpose of this Document

Flooding and water quality impairment are two of the top concerns in urbanized areas of Ontario due to aging stormwater management (SWM) infrastructure that is unable to cope with runoff resulting from high density developments and more frequent storm events (due to climate change). As a result, Ontario's municipalities are experiencing increased flood-related damages and this trend is set to continue. The dearth of public land on which to locate stormwater detention ponds in urban areas, specifically in the southern parts of the Credit River Watershed, renders it challenging to address the problem with conventional stormwater infrastructure.

The only way to provide adequate stormwater services that meet current SWM objectives,[2] as established by the Ministry of Environment and Climate Change, is by retrofitting existing private property to deal with runoff closer to the source.

Green infrastructure (GI) options for SWM, and, more specifically, Low Impact Development (LID) technologies which manage stormwater (SW) on-site, have been successfully implemented in pilot scale projects across Southern Ontario[3] and elsewhere in North America, Europe and Asia. Despite their proven performance, the uptake of LID in Ontario, particularly on private non-residential property, is negligible.

Barriers to LID Implementation on Private Property

Barriers to the installation of LID technologies include:

1. High up-front costs
2. Uncertain ongoing maintenance requirements
3. Low return on investment
4. Limited benefits accrue directly to property owners, yet they incur the costs
5. High transaction costs

There are also several factors that prevent municipalities from actively pursuing the installation of green infrastructure on private property.

2 See Appendix A for details of SWM objectives

3 See Sustainable Technology Evaluation Program website for details.

Institutional Barriers to Implementation of LID by Municipalities

1. Funding mechanisms that create economic barriers to implementation of GI measures on private lands
2. Provincial and federal funding programs that favor grey infrastructure because they are focused on larger shovel-ready capital projects
3. Lack of legislative mandate
4. Approaches to planning and approval that do not require an integrated resource management framework that encompasses multiple quality and quantity objectives while factoring in flood risk, adaptation to climate change, and land use intensification
5. Fragmented governmental responsibilities
6. Limited institutional capacity

From the above it is clear that a paradigm shift is required to ensure that stormwater management systems can handle the challenges of increasing urbanization, climate change, intensification and infill.

Paradigm Shift

The shift involves a combination of innovative ways to:

1. Apply policies, legislation, regulation, and bylaws
2. Lower the cost of installing and maintaining LID
3. Develop economic and marketplace incentives that will foster the uptake of GI technologies on private commercial property
4. Frame municipal and private property LID and GI adoption responsibilities

Objective

This discussion paper focuses on points 2 and 3 above - the evaluation of alternative ways to overcome the financial barriers to LID adoption on private commercial land. The approaches considered address:

1. The economics of project design and delivery
2. The prospects for cost recovery by the private sector
3. Financing to overcome funding constraints

1.2 Current Situation

While SWM has a long history in Ontario, approaches to SWM have not kept pace with evolving objectives and changing urban conditions, such as:

- Intensification of urban centres
- Impacts of an expanding urban footprint on watersheds
- Changing weather patterns
- Need to preserve natural hydrology[4]

Today's SWM is constrained by existing grey infrastructure designed to quickly convey stormwater away from older urban areas without regard for water quality and quantity impacts. Stormwater related water quality problems are made worse where combined sewers allow discharge of untreated and partially treated sanitary effluent into surface waters during storm events.

Beginning in the 1970's, efforts to control urban stormwater in development areas focussed on end-of-pipe control using detention ponds. Dry ponds were initially used to restrict runoff volumes. Wet ponds were subsequently introduced to provide quantity and quality control.

1.3 Stormwater Detention Ponds

Building new detention ponds is not generally feasible in established areas where land use densities and high land values make them cost prohibitive. Consequently, the urban areas where this type of control is feasible are limited.

Table 1: Use of Stormwater Controls in Urban Areas

Watershed	Area with SWM controls*	Including quality controls*	Reference
TRCA – total area	35%	n.a.	TRCA (2013d)
Don River	20%	13%	TRCA (2009)
Highland Creek	9%	n.a.	TRCA (2013d)
Humber River	38%	15%	TRCA (2008)
Mimico Creek	31%	8%	TRCA (2010), TRCA (2013c)
Rouge River	77%	n.a.	TRCA (2013d)
City of Mississauga	Na	20%#	Region of Peel (2017)
City of Brampton	Na	58%#	Region of Peel (2017)
Town of Caledon	Na	54%#	Region of Peel (2017)
Region of Peel	Na	25%#	Region of Peel (2017)
Lake Simcoe	38%	21%	LSRCA (2007)

* Controls are primarily dry and wet detention ponds. Use of enhanced controls is negligible.

\# % of urbanized area with stormwater management quantity and quality controls

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[4] This is reflected in the following statement by the Ontario Ministry of Environment and Climate Change (MOECC, 2015): "Currently, preservation of the natural hydrology is not sufficiently reflected in the Environmental Compliance Approval (ECA) applications submitted to the ministry for stormwater management systems."

Where detention ponds have been used, investigations reveal that they frequently fail to achieve quality and quantity control objectives due to inadequate maintenance (Lake Simcoe Region Conservation Authority, 2011).

1.4 Water Quality and Quantity

Limited control of stormwater runoff in urban areas has contributed to the degradation of water quality in our urban streams. The Credit River is now the largest source for total suspended sediment on Lake Ontario's north shore. Evaluation of several watersheds reveals evidence of contamination with bacteria, nutrients, heavy metals, organic compounds, and chlorides; deteriorated fish habitat and communities (often due to increases in water temperature); and minimal wetland protection. Peak flows are also increasing in many watersheds. As of 2013, surface water quality in CVC's largely rural **Upper** and **Middle** Watersheds received grades between **Fair** and **Good**; however, nearly one-third of CVC's sub-watersheds – all located in the heavily urbanized **Lower** Watershed – received grades between **Poor** and **Very Poor**. Water quality is influenced by a number of factors, but land use change is the most important influencing factor in the Credit River Watershed (CVC, 2013)

1.5 Stormwater Infrastructure Deficit

Existing SWM grey infrastructure is not being adequately maintained. While 23% of municipal SW assets (total replacement value of $31 billion), were estimated to be in fair, poor or very poor condition in 2016, SW asset reinvestment rates are only about 24% of the rate required to maintain these assets (Federation of Canadian Municipalities, 2016). This has led to Ontario's current municipal infrastructure deficit. The scope of the deficit is daunting. Municipalities in Ontario are now required to develop infrastructure asset management plans in order to help redress infrastructure deficits. Unfortunately, these plans often involve desk top exercises that fail to establish the actual condition of assets or their performance levels. In the case of detention ponds, condition assessments, if made at all, do not consider asset performance since routine monitoring of pond performance is not required.

Moreover, Public Sector Accounting Board (PSAB) reporting is not based on replacement cost[5] and municipal records of SWM assets installed in earlier decades are limited and in some cases, do not exist.

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[5] Watson & Associates presentation to CVC Nov 27, 2014. Reporting under PSAB requires depreciation of fixed asset investments over time by dividing the original acquisition cost by the estimated number of useful years for the asset and assigning those depreciation costs to future years. In some jurisdictions, for example New Zealand, depreciation is estimated using replacement cost rather than original acquisition cost. However, this approach falls short of life cycle costing which is used in 'best-practice' infrastructure asset management planning. A life cycle approach considers future costs for operation, maintenance and replacement, compares these costs across available options including green and grey options, and identifies how these costs are to be covered using current revenues, debt and reserves.

1.6 Climate Change

Climate change will exacerbate the short comings of current SWM infrastructure, especially with respect to flood resiliency. From 2000 to 2008 Ontario experienced nine flood events caused by storms exceeding the 100-year storm, three of which exceeded the regulatory storms used in flood management planning. This history suggests that storms are getting bigger—a 50-year storm today will likely be a 20-year storm by the 2050s (Conservation Ontario 2009).

1.7 Paradigm Shift

A new direction for SWM based on LID has been identified in recent policy documents (MOE 2010). LID features the use of GI on public or private lands in order to "manage runoff as close to the source as possible" (MOECC 2017). Rather than conveying stormwater away from where it falls as rain, LID aims to filter, infiltrate, use and store that water as close to where it falls as possible. In so doing, LID practices mimic the natural hydrological cycle as closely as possible. The intent of this policy is not to replace grey infrastructure with GI, but rather to combine grey and green infrastructure in ways that address local conditions and achieve optimal long-term performance in a cost-effective manner.

These directives set the stage for a paradigm shift to watershed-scale, linked and integrated use of green infrastructure that includes public and private lands and is underpinned by sound economic principles and analysis

A multi-pronged approach, consisting of the elements listed below, is necessary to achieve the proposed change to optimized, long term, cost effective SWM.

1. An integrated approach to SWM planning that embodies treatment train concepts common in water and sewage treatment design
2. Applying systems modelling to evaluate the expected performance of strategic combinations of green and grey infrastructure measures against watershed objectives
3. Modelling future scenarios to test for resiliency in the face of climate change, on-going land development and intensification
4. Incorporating stormwater infrastructure on private property in the treatment train
5. Use of life cycle analysis when planning stormwater infrastructure
6. Identification and calculation of green infrastructure benefits
7. Cost sharing among municipalities to facilitate equitable allocation of costs and benefits
8. Incentivizing private landowners to retrofit their properties by sharing municipal cost savings with property owners
9. Administrative ease and flexibility

While the above changes have to be considered collectively as part of an all-inclusive shift in the approach to SWM, the present paper focuses on engaging the private sector in SWM and the economic incentives required to render this a feasible undertaking.

2 ENGAGING THE PRIVATE SECTOR IN SWM: PROBLEM STATEMENT

2.1 Institutional constraints to promoting GI on private property for SWM

As mentioned in the introduction, several factors prevent municipalities from actively pursuing the installation of green infrastructure on private property. These range from funding mechanisms that create economic barriers to lack of legislative mandate, including an integrated resource management framework, and limited institutional capacity (Roy et al., 2008).

2.2 Constraints to Private Sector Investment in Green Infrastructure

SWM measures on private lands are presently limited to controlling on-site drainage by means of pre-treatment mechanism such as oil-grit separators and limited detention controls. Developments in older urban areas, built before SWM standards were established, lack even these basic provisions. SWM infrastructure optimization calls for the use of LID on private lands especially in developed urban areas, but constraints exist to the implementation of LID on private lands. Financial constraints include the following:

- The high cost to build and maintain assets
- Limited benefits accruing directly to property owners who incur those costs (Vander Linden and Patterson, 2017)
- Long payback periods

Non-financial constraints compound the difficulties with implementation, especially for small and medium size enterprises (SMEs). These include (Brammer, Hoejmose and Marchant, 2012):

- Owners and managers who believe they have little environmental impact or are ill-informed about the benefits of environmental management
- Inability to benefit from publicity for good deeds, especially for SMEs due to their low visibility
- Lack of the necessary resources and skills to implement environmental practices
- Owners who have little, if any, knowledge or understanding of SWM and associated issues
- Limited or no concerns over potential flooding, property damage, lost time, or liability
- Competing priorities, with significant focus on day-to-day operation of the business
- Perceptions that limited benefits to the public image and/or profile of the business will be realized through environmental actions or investments

Financial constraints exist because public and private benefits and costs are not balanced. The majority of direct benefits from LID implementation tend to accrue to downstream properties while the costs are incurred by the property owner.

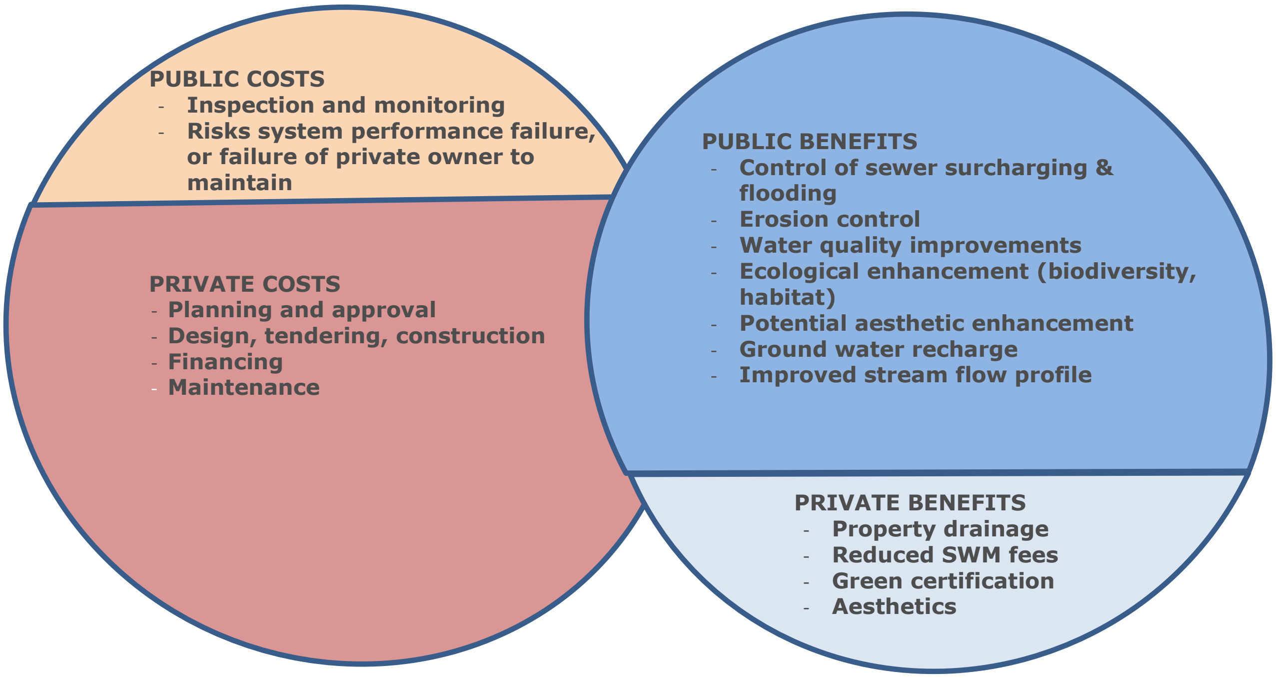


Figure 1: Current Benefits and Costs are Not Balanced

2.3 Measuring Up - Private Sector Valuation of GI investment

Expenditures on LID are investments that will be evaluated in the private sector like any other investment that a business owner can make. The evaluation is based on a direct comparison with alternative investments. Given that funds available for investments are always limited, new investments must be justified in terms of cost savings or increases in revenues. Investments in GI are often relatively small and are included in an annual capital budget, where they will compete for funds with items such as replacement vehicles, new production equipment, building repairs or energy saving investments with shorter payback periods.

A number of standard measures are used to evaluate investments for capital budgeting purposes. The majority of large firms use discounted cash flow analysis (Bennouna, Meredith and Marchant, 2010), while small firms are more likely to use a payback period approach (Block 1997).

In discounted cash flow analysis, annual costs and benefits, including cost savings, are forecast over the life span of an investment and converted into their equivalent current period values based on the 'time value of money'—the discount rate. The discount rate is an interest rate that reflects expected rates of return on investments in the private sector and incorporates allowances for taxes on profits and for risk. It reflects the fact that money earned today is more valuable than the equivalent sum earned next year, given the uncertainty that the income or cost saving will actually materialize in the future. The further out the anticipated cash flow, the more uncertain its occurrence and hence the smaller its present value and impact on the overall viability of the project.

Uncertainty is one component of risk and is incorporated in the discount rate used to evaluate the project. Higher risk generally necessitates using a higher discount rate, meaning that returns diminish in value at a faster rate than a comparable project with a lower risk. This method enables companies to compare projects across the risk spectrum. The elevated discount rate also reflects the fact that investors generally will not invest in risky projects unless the potential payoff is large. For this reason, the discount rate can also be considered the required rate of return or hurdle rate. Once costs and benefits are discounted, then either the net present value (NPV) or the internal rate of return (IRR) for the investment can be computed.

- NPV is estimated by summing the discounted cash value of costs and benefits. A positive NPV, where the total present value of benefits exceeds the total present value of costs, indicates that an investment is viable.
- IRR is the interest rate at which the NPV is zero. If IRR equals or exceeds the discount rate, then the investment is financially viable. If it is less, then the investment is not financially viable.
- Payback period is the period of time, measured in months or years, over which the cost of the initial investment is recovered through cost savings or new revenues. It is estimated as the initial investment divided by the average monthly or annual net revenue or cost savings. A longer payback period indicates a lower return and greater risk and uncertainty associated with an investment.

See Appendix C for sample calculations.

Investment criteria, i.e. the threshold values for the discount rate or the payback period used in investment decisions, varies from one company to another. These thresholds can be high. A 1998 investigation by the US General Accounting Office indicated that four years was the maximum payback period acceptable for energy conservation investments. Many companies demanded a payback period of 3 years or less. A survey of small US firms revealed that they required an average payback period of 2.8 years or about 34 months. These time periods are far shorter than the useful life of typical assets and imply high discount rates. (If a business can get a higher IRR by investing in other projects, it will).

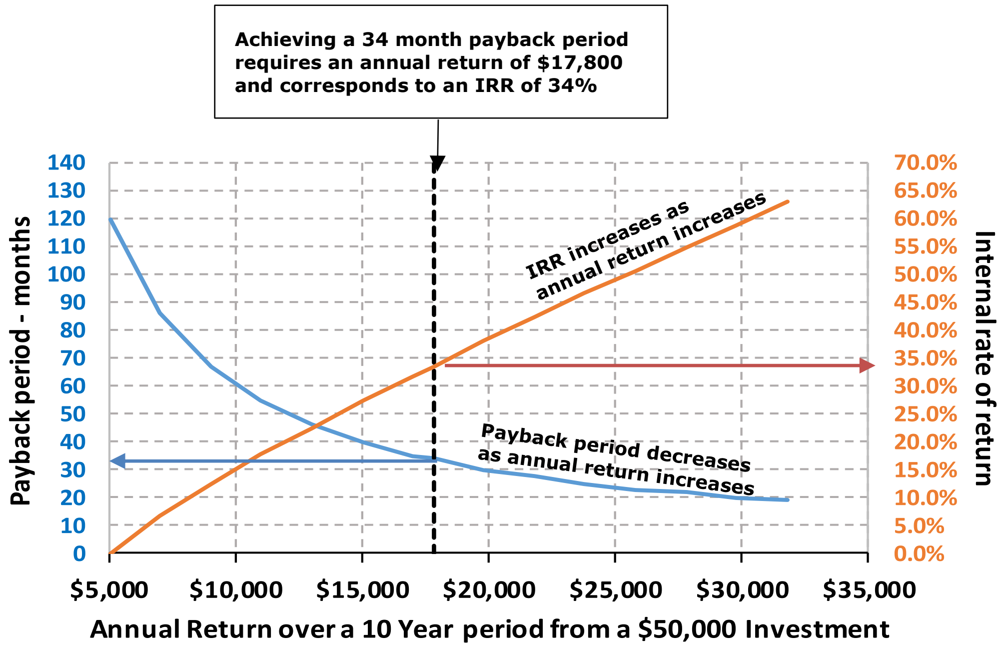


Figure 2: Payback Period and Internal Rate of Return

Not all investments by the private sector are driven by profit expectations. Many businesses invest in projects that are not financially viable but that align with their strategic goals. They are motivated by "potential cost savings, new customers, higher staff retention and good publicity …" (Revell, Stokes, Chen 2010). Responding to public concern also drives green investments among medium and small businesses. Larger corporations, however, reap greater benefits from such practices. They are more visible which allows them to "market" their green efforts to stakeholders. Business owners can do this, for example, by securing sustainability certifications (e.g. ISO 14000, LEED certification, BOMA Best). The non-financial motivations for GI should, however, not be overlooked in considering incentives for installing LID on private property.

Armstrong Manufacturing Inc. Case Study

Water saving opportunities were assessed for this company's Mississauga facility. Low cost water efficiency measures with payback periods of 1.2 to 4.6 years were identified and recommended. However, a rooftop rainwater collection system to supply cooling water was not found to be financially viable based on the avoided cost of municipal water alone. Armstrong's stormwater charge at $1,610 / year could potentially be reduced by 10% to 20% with the rainwater harvesting but this additional savings was not sufficient to justify rainwater harvesting. "*However, if Armstrong determines that there is a marketing advantage to incorporate rainwater into some of its 'green' cleaners, determination of potential stormwater credits can be revisited*".

Enviro-Stewards Inc. June 13, 2016. *Region of Peel Indoor Water Assessment for Armstrong Manufacturing Inc.*

3 OVERCOMING CONSTRAINTS TO INSTALLATION OF LID BY PRIVATE COMMERCIAL PROPERTY OWNERS

While there are multiple challenges to commercial property owners installing LID on their properties, several measures can potentially be applied to overcome these challenges. This section describes and analyzes some potential solutions, which may be broadly divided into command and control and economic incentive policy instruments as well as cost control measures.

3.1 Command and Control Policy Instruments

Command and control policy instruments are requirements imposed by regulation. These tools were the first type of policy instrument used to address pollution problems in jurisdictions across North America. As private citizens we will all be familiar with highway speed limits, which are a command and control instrument. A long standing example to manage pollution is the imposition of limits on pollutant concentrations or loadings in wastewater effluent discharged to open waters by municipalities. Existing SWM regulations are primarily concerned with local flooding and impose controls on SW, via infrastructure design standards, to manage SW runoff generated by storms that represent extreme flood events. Options exist for command and control instruments that address pollutant loads and instream flows generated by SW. Those directed to private property owners are listed in Table 1 below.

Table 2: Command and Control Policy Instruments

Appropriation of land for easements	Easements can be registered on land required to install LID technologies such as bioswales along roadways.
Design standards for property development	Design standards require a higher level of SW control on private lands based on downstream objectives. Draft LID guidelines for Ontario are moving in this direction by proposing a runoff volume control target for new development, redevelopment, infill, intensification, linear infrastructure, and retrofits of municipal SW infrastructure. (MOECC 2017).
Municipal development and approvals by-laws/ordinances	Requirements for on-site SWM for new development, redevelopment or major renovations. Jurisdictions where SWM is a significant consideration have implemented regulations for lot-level run-off control.

One widely recognized weakness of command and control instruments is that they are usually inflexible and focus on remedial actions such as best management practices as opposed to outcomes. In doing this they do not allow regulated parties to seek the most cost-effective management strategies for achieving the targeted outcomes. The following section addresses the issue of cost control, identifying measures that move us in the direction of efficient and cost-effective SWM strategies. Following this, we introduce and discuss economic incentive policy instruments that further promote the use of cost-effective strategies by giving regulated parties more leeway in deciding how they pursue the targeted outcomes of our SW policies.

3.2 Lowering LID Costs

The private sector incurs a variety of both direct and indirect costs when installing LID technologies. Reducing these expenses can help facilitate LID implementation in conjunction with command and control as well as economic policy instruments. The types of expenditures associated with LID installations and suggestions for how to minimize these outlays are presented in table 2 below.

Table 3: Controlling LID Implementation Costs

TYPE OF COST	OPTIONS TO CONTROL PRIVATE SECTOR COSTS
Initial learning curve - Time and effort to learn about and understand LID options and the programs that support LID implementation.	Responsible agencies provide well designed, concise material to educate the public about and promote LID technologies. Purpose made resources that speak to commercial interests should target the ICI sector. It should be made easy for prospective proponents of LID to: (a) identify feasible best management practices for their properties, (b) understand the impact of these measures on their properties and downstream, and (c) determine approximate costs of implementation and the available financial support for these measures. [6] Information resources should be supplemented by proactive face-to-face promotion by knowledgeable staff.
Design - Costs associated with design from concept through to detailed design and tender drawings.	Provide technical guidelines to support selection of LID technologies based on site conditions and objectives. Guidelines should help the user identify appropriate technologies and appropriate scales in terms of facility size, drainage area size, etc. to design cost effective systems that are efficient and make use of economies of scale.
Planning and approval - Costs associated with securing approvals and permits. These include the expenses associated with preparation and filing of applications, reporting, monitoring and inspections. These outlays consist of: direct	Planning and approval costs can be minimized by an efficient streamlined approval mechanism involving, for example, 'one stop' procedures, reliance on web-based procedures, and use of an approval team coordinator within the responsible agency. Application forms should be as simple and self-explanatory as possible and reporting requirements should be minimized. Since LID is largely installed for

[6] CVC's *Grey to Green Business & Multi-Residential Retrofits: Optimizing your Bottom Line through Low Impact Development* and STEP's *Treatment Train and Life Cycle Cost Tools* provide a business case for LID and tools to plan, design and cost LID technologies based on site specific parameters.

TYPE OF COST	OPTIONS TO CONTROL PRIVATE SECTOR COSTS
costs for professional services, any fees for permits or inspections and the indirect costs associated with time spent in the planning and approval process. The latter includes time spent in meetings, on the phone, etc. as well as time lost due to delays in the approval process.	public benefit, there should be no agency fees for services such as filing applications, issuing permits, and completing inspections.
Tendering and construction - Costs associated with tendering, awarding contracts, and project construction.	The tendering process might be more efficient if the responsible agency maintains a list of certified contractors who have demonstrated their ability to install LID technologies. Selection from this list should not, however, be mandatory since this might reduce competition and lead to higher bids. While the list of certified contractors provides some protection against shoddy work, the best line of defense in this case is robust project inspection by the responsible agency.
Aggregation – Several property owners, typically of abutting properties, cooperate to implement larger scale LID measures that service all properties, thereby gaining improving efficacy and cost effectiveness.	Aggregating private property into grid blocks could reduce individual property owner costs by sharing design, planning and approval, construction, and maintenance costs among several properties. Where aggregation is feasible the responsible agency should provide the institutional framework to encourage and facilitate aggregation (see section 5.1 for more details). This could entail mechanisms such as private sector 'aggregators' who contract with property owners to implement LID measures in grid blocks, or the direct involvement of government in developing LID in grid blocks through public-private partnerships.
Operations and Asset management - Operating costs include materials and supplies, routine maintenance, monitoring, reporting, insurance, etc. Asset management costs include costs incurred to periodically refurbish or replace assets. The latter includes costs associated with the tendering process, development of designs and obtaining the necessary permits, etc.	The principal means of assuring cost-effective operations is to address these costs during the planning and design process by selecting and designing LID technologies based on a life cycle cost evaluation approach. The responsible agency can support this type of analysis by maintaining a database of capital and operating costs from past projects as well as information on expected asset lifespans. The monitoring and reporting requirements for LID installations should be kept to a minimum and the responsible agency should consider assuming responsibility for monitoring activities.

3.3 Economic Incentive Policy Instruments

While there is scope for controlling and reducing the private sector costs of LID implementation, costs, once controlled, are still likely to exceed benefits to the individual property owners (proponents) by a margin that will dissuade them from installing LID. For this reason, it is important to consider options for compensating proponents for the cost of LID implementation. Table 3 below delineates some of the economic incentives that could be employed to facilitate LID uptake on private commercial property.

Table 4: Economic Incentive Policy Instruments

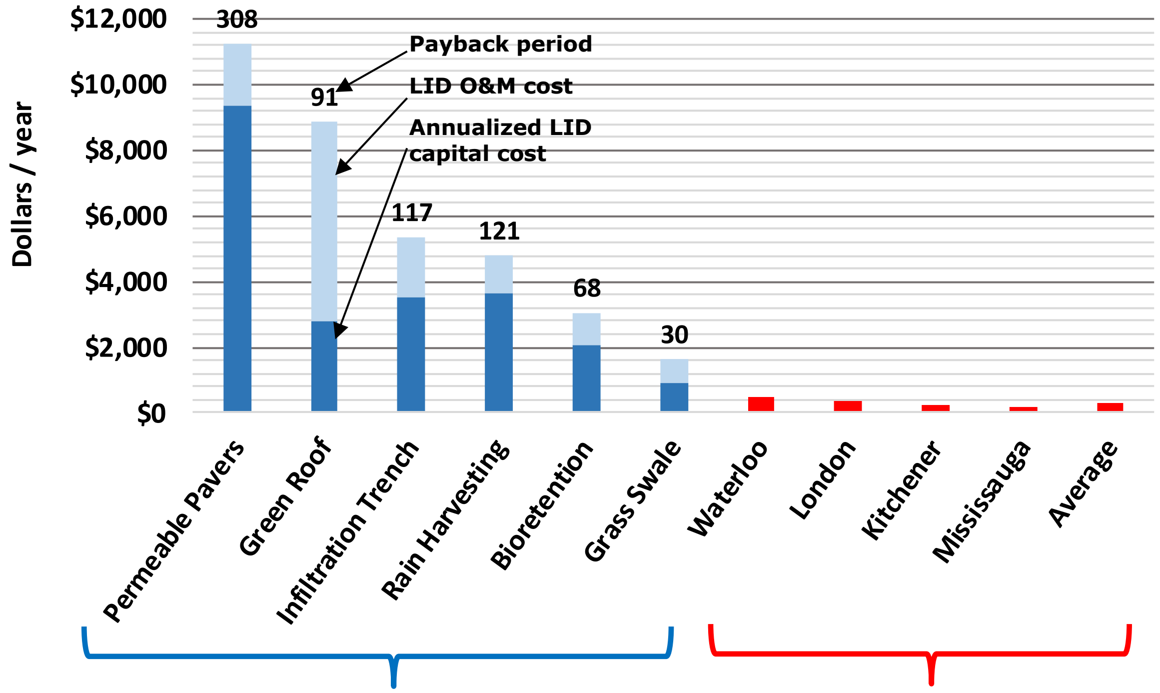
SWM user fees and credits	User fees are based on quantity of SWM leaving a property. Fees usually take the form of area based charges. (See Appendix E for alternative ways of calculating the area). When the chargeable area correlates with potential runoff from a property, LID technologies can lower the total charge to the property owner as long as the user fee includes provision for a credit for installing LID. A 2013 survey of 16 Canadian municipalities with SWM user fees revealed that six had area based charges and credit programs. These included Mississauga, London, Kitchener, and Waterloo (Fortin 2013). Credits were capped at a maximum percentage—typically about 50%—of project costs.
Offsets	An offset program compensates a property owner for installing LID based on cost savings realized by a municipality from reducing or eliminating the need to implement a control measure or measures elsewhere in the catchment. The offset may be measured in terms of estimated units of runoff quantity or quality. Offset programs can take different forms: - A property owner implements LID and the reduction in runoff volumes or pollutant loads exceeds regulatory requirements. The excess control creates the offset that a second party buys in order to comply with a regulatory target. The offset allows the second party to comply with the target without implementing controls on their own property. - The regulated party implements an LID measure at one facility, then uses the resulting offset to comply with a regulatory target at another facility they also own. For example, compliance with a maximum runoff target on a new development is attained by achieving an equivalent level of runoff at an existing development in the same catchment (Cappiella, Hirschman, Stack, 2013). - Offset payments are offered by a municipality as compensation for implementation of LID technologies on private property that contribute to the municipality's storm water management

	objectives. The LID measures allow the municipality to save money by avoiding investment in grey SW infrastructure while still achieving its objectives. Offset savings may also arise from avoided compensation to flood victims and reduced insurance costs.
Payments for ecological services	This type of program resembles an offset program in structure but payments are predicated on the value of ecological services created by LID technologies rather than cost savings. Ecological services include non-monetary benefits such as habitat enhancements, recreational and aesthetic values, and impacts on wellbeing.
Grants and subsidies	Provision of lump sum grants or reductions in development charges, or property taxes, payments in lieu of obligations in return for the voluntary implementation of LID technologies that achieve SW control levels exceeding regulatory requirements. The grant program may be funded from the proceeds of payments for offsets by regulated parties in the catchment.
Assistance with finance	Financing assistance can take the form of loans at a low or zero interest rate or measures to facilitate private sector financing. In the USA, financial support for qualifying green investments is provided at the Federal level in the form of a tax exemption on the dividends paid out on 'Green Bonds'. The tax exemption makes these bonds, which are issued by project participants, attractive to investors. The tax-free status lowers the yield on the bond that the financial markets require thus lowering the cost of funding for the proponent. The Government of Ontario started a Green Bond program in 2014; however, the issued bonds are not tax exempt like those in the US and only Province of Ontario approved government projects are eligible for bond funding. These bonds are, however, backed by the province and consequently benefit from the latter's strong credit rating which, in turn, lowers the yield required by the market (Ontario Financing Authority, 2014).

3.4 Economic Incentive Policy Instruments Used in Ontario

3.4.1 SW Fees

Several municipalities have implemented SW fees in recent years, but these tend to be quite low when compared to the costs of implementing LID technologies, as can be seen below. Consequently, the impact of SW fee credits is small. For example, a 2014 market research study found that uptake of SW credits by commercial property owners in Kitchener was below 5%. Furthermore, many of the commercial property owners who applied for the SW credits did not actually implement new LID measures but rather, requested reassessments based on existing on-site measures such as oil grit separators.



THE ANNUAL COST OF LID MEASURES
Assumptions:
Lot size = 5,000 m^2; Impermeable area treated with LID measure = 1,000 m^2
Costing with STEP-LID-Tool Version 1.1.xlsm
Annualised capital cost estimated using an 8% discount rate over 25 years (equivalent to a mortgage payment)
Payback period = total capital cost ÷ average SW fee credit (capital cost shown in the figure is annualized not total)

ANNUAL CREDIT ON THE SW CHARGE FOR LID IMPLEMENTATION
Assumptions:
Lot size = 5,000 m^2; Impermeable area treated with LID measure = 1,000 m^2
SW charges for 2017 and a credit of 45% to 50% on the SW charge (credit varies by municipality)

Figure 3: Comparing Annual LID Costs to SW Fee Credits

SW credits are low because they are tied to SW fees based on the historical cost of constructing the infrastructure. The latter does not consider replacement cost or the cost of upgrading or enhancing the system to address the pressures created by climate change, increasing urbanization and intensification. Where field assessments are not regularly undertaken, fees might also not reflect actual maintenance costs. From a municipal perspective, it makes sense for SW fees to be based on full cost accounting that includes all SW operating, maintenance, and capital costs. Even when SW fees do reflect the full costs of existing SW infrastructure, they may still be relatively low compared to the cost of LID technologies as illustrated in Figure 3. One reason for this unfavourable comparison is that existing costs, especially in older developed areas with outdated SWM systems, do not reflect the full cost of creating a SWM system that can effectively prevent sewer surcharging and flooding, and accommodate the flow regimes expected with climate change, continued high rates of urban growth, and the increased imperviousness associated with intensification.

3.4.2 Offsets and Grants

These take various forms. Ontario's Conservation Authorities (CAs) offer cost-offsetting grants to landowners who voluntarily undertake environmental projects such as cropland erosion control, habitat restoration, or improved manure management which create benefits well beyond their property boundaries. In urban areas, landowners who take down mature trees must often pay a fee to the municipality which uses the resulting funds to finance compensatory plantings that offset the loss of urban tree canopy. In the current case, we are dealing with offset payments to private landowners who implement LID technologies that benefit downstream property owners.

Offsets and grants are better suited to the task of compensating the private sector for LID implementation because they can be based on a municipality's avoided costs, such as: construction of a SW detention pond on expensive urban land and/or benefits associated with levels of flood control that cannot be achieved by existing SWM systems alone. Offsets are well suited to situations where one party bears the costs of an intervention while others reap the benefits. The following section explores offsets in more detail.

The Lake Simcoe Phosphorus Offset Program (LSPOP) is a good example of an offset program. The Program is designed to reduce phosphorous loadings at present levels while facilitating greenfield development in the Lake Simcoe area. In this scheme developers unable to meet the no net gain targets will pay the Lake Simcoe Region Conservation Authority (LSRCA) an agreed upon rate to clean up pollution and retrofit older urban areas. The intent is that the retrofits will facilitate sufficient reduction in phosphorous loads in these areas to ensure that there is no net gain for the watershed as a whole. More details are available on the LSRCA website at http://www.lsrca.on.ca/watershed-health/phosphorus-offsetting-program (Appendix F contains an example of the offset calculation).

4 DESIGNING EFFECTIVE OFFSETS

4.1 Offset Basics

Offsets are payments offered to proponents of LID infrastructure in compensation for costs incurred when significant benefits accrue to other parties. A principle of equity or fairness underlies this type of compensation based on the argument that costs should be borne proportionately by those who benefit from the green investment.

Public sector contributions in the form of offsets are justified to achieve a balanced approach to cost sharing that reflects how all costs and benefits are incurred. Doing this requires identification and quantification of benefits, namely:

- The reduction in damages caused by contaminated SW and uncontrolled SW runoff that can cause sewer backups
- Overland flooding
- Combined sewer overflows

- Sewage treatment plant bypassing caused by SW inflow and infiltration into sanitary sewers. These benefits can be both monetary and non-monetary, as indicated below

Primarily direct monetary:

- Avoiding additional capital expenditure to construct new SW detention ponds and other grey infrastructure in older, underserviced urban areas
- Reducing the investment required to increase the capacity of SW infrastructure in response to increasing frequency and severity of storm events due to climate change
- Reducing the damage to private property and public infrastructure from sewer surcharging and overland flooding
- Reducing municipal liability for damages caused by flooding associated with sewer backups
- Avoiding the insurance premium and deductible increases associated with high risk properties (Sandink, Kovacs, Oulahen, McGillivray 2010)

Primarily non-monetary and indirect monetary:

- Lower risk of contamination of sources of drinking water
- Reduced impairment of aquatic ecosystems (biodiversity, fish habitat, fish populations, etc.)
- Reduced incidence of beach closures and aesthetic impairment of water bodies
- Reduced or avoided damage to cold water fisheries
- Enhanced aesthetic value of the urban landscape
- Energy conservation and greenhouse gas reduction
- Decreased heat island effect from expanded vegetation and tree canopy and use of natural heritage areas as part of SWM infrastructure

These non-monetary and indirect monetary benefits can be quantified to help inform decisions about the magnitude of offset payments available to facilitate LID implementation.

Ecological Enhancements Create Market Value

Green infrastructure can improve the aesthetic value of homes. Stormwater treatment using measures such as plantings in bio-retention gardens and swales is creating a street aesthetic that sells property (Zagoudis 2015).

"[A]partment rents in buildings with green roofs in the Battery Park City area of New York were about 16% higher on average than in buildings without green roofs" (Ichihara, Cohen 2011).

4.2 Calculating Offset Values

Offset values are determined by adding together the potential cost savings associated with implementing LID technologies and the value of the accompanying non-monetary and indirect monetary benefits. A variety of methods can be used to assign value to the benefits of installing LID technologies for SWM. The choice of method depends on the nature of the benefit and the resources available to complete the analysis. Table 4 describes the primary valuation methods for GI benefits:

Table 5: Valuation of Off-Site Benefits for GI

BENEFIT	VALUATION METHOD*
Infrastructure cost savings	The total benefit is the change in total cost (capital and operating costs), where the change is the difference in costs with and without implementing the project. Costs are evaluated over a long time period corresponding to the life of affected assets. Capital costs include refurbishments and replacements during this time. These costs can be inferred from sources such as municipal SWM master plans, asset management plans, and annual capital plans. Care must be taken to ensure costs reported in available documents account for the increased capacity required to accommodate changing climate patterns, increased urban footprint and intensification as well as other existing shortcomings in older SW systems.
Flood damage cost reductions	Apply standard MNR methodologies for estimation of flood damages (Water's Edge Environmental Solutions Team Ltd et.al. 2007, McBean et.al. 1988). Insurance claims for flood damages also provide data that can be used to calculate potential flood damage costs. The Insurance Bureau of Canada reports annual insurance claims for catastrophic events in Canada. For example, flood and wind losses totalled $1.0 billion for the July 8–9, 2013 storm in Toronto (IBC 2017). To use insurance data for flood damage cost estimates, reported losses must be expressed as a damage function. Where loss data for a single area is available for two or more floods it may be possible to develop a stage-damage curve relating flood stage or level to total damages. At a minimum, reported damages can be converted into unit losses—by area or structure—and then applied to the study area after modelling the likely extent of flooding.
Reduced municipal exposure to liability resulting in lower insurance premiums	Reducing the risk of flooding directly benefits property owners exposed to overland flooding and sewer surcharging and backup. It may also provide an indirect benefit to municipalities responsible for SW infrastructure to the extent that their liability insurance premiums may decrease in response to implementation of flood control measures. A review of insurance premiums and discussions with insurance providers are required to quantify this benefit.
Recreation	Recreation benefits linked to water quality improvements are often estimated by analysing travel costs incurred to access outdoor amenities with unimpaired water quality. The value of the water quality improvement, say at a beach, is determined by analyzing the additional travel costs incurred to access the facility, because people travel farther to get to a clean beach. The increase in travel cost is a proxy for the value of the water quality to beach users. The travel cost method has been used to value a wide range of recreational benefits including swimming, boating, fishing, hunting, camping, and general park use.

Ecological enhancements	Willingness to Pay Surveys (WTP) – also known as contingent value surveys – are used to determine the value individuals place on new amenities. Statements about value are elicited from survey respondents by asking questions that reveal their WTP for the amenity in question. Contingent value surveys have been used to place a value on a wide variety of ecological organisms, their interrelationships and functions such as endangered species, wetlands, and pollution control.[7]
Enhanced landscape aesthetics	Landscape enhancements increase the livability of communities and affect real estate values in those communities. Property value models—also called hedonic models—use statistical techniques to examine price differentials between properties where the differentials are correlated with the presence of valued amenities that can be significant price determinants. The price differentials provide a basis for valuing improvements to landscape aesthetics.
Energy conservation and greenhouse gas (GHG) reduction	A wide range of benefits are associated with GHG controls, including infrastructure cost savings, flood damage reduction, and the prevention of economic losses in sectors such as agriculture. Various methods, some of which are discussed in this table, are used to place a value on efforts to control GHG. Summary measures of benefit reflecting damage averted per tonne of carbon emitted are typically used to assign value: "The most sophisticated of the published studies reviewed here produces an estimate of marginal damage figure of approximately £70/tC (2000 prices) for carbon emissions in 2000." (Clarkson, Deyes 2002). The equivalent Canadian value is $226/tC at 2017 prices.
Improved wellbeing	A variety of methods have been used to determine values associated with changes in morbidity and mortality. They do not assign an absolute value to life, but rather determine the individual WTP to avoid episodes of ill health and to reduce the risk of death from contaminated drinking water, for example. The WTP to reduce the risk of morbidity or mortality is inferred from voluntary expenditures such as purchases of UV sun screens or water filters to prevent illness (called an averting behaviour or defensive expenditures approach to valuation). The value of life is inferred from wage premiums paid to workers in dangerous jobs. This analysis assumes that workers are informed about job risk and are able to negotiate wage differentials based on this risk. The wage premium is a measure of the compensation required to accept a higher risk of morbidity or mortality.

* Unless otherwise noted, based on Fortin, Dofonsu, Strategic Alternatives, 2002 and ESSA Technologies, Fortin, 1994

The valuation methods introduced above are challenging and costly to apply rigorously. An alternative approach to valuation used often in planning and policy work is called 'Benefits Transfer'. This is a method for estimating benefits using

[7] This is one method only (it is not often used today as critics point out that the correlation between survey results and demonstrated "actual willingness to pay" has not been proven. In addition, valuations based on qualitative data (which may be considered speculative) are used to assign a monetary value to ecological systems where no market price exists. Ecological service valuation, natural capital valuation, and ecological economics (which bases value primarily on sustainability) are other valuation methods used today. These methods also have limitations.

measures derived from the published results of primary research based on travel cost, contingent value and other methods. Estimated benefits are 'transferred' to the area of interest by making adjustments to reflect local conditions such as physical scale or demography. The benefit transfer approach renders effective benefit assessment possible without the added cost and time requirements of carrying out primary research. Software packages such as AutoCase (Impact Infrastructure 2015) that develop values for ecological goods and services rely on benefits transfer methods.

Value of Ecological services

The value of water infiltrated as a result of LID implementation was estimated for Los Angeles. The analysis considered Los Angeles Department of Water and Power water production costs under normal and drought scenarios. At low groundwater capture levels and high water values infiltration benefits were estimated to represent 38.5% of LID implementation costs. (Cutter et.al. 2008)

4.3 Using offsets when off-site benefits cross jurisdictional boundaries

SW planning and management should exhibit a strong focus on the watershed since this is the natural hydrologic unit of response. This does not necessarily imply program delivery at a watershed scale, but, rather, strategic planning at a watershed scale with more detailed planning at the level of the sub-watershed and sewershed. The watershed SW plan should establish a framework for the more detailed design and implementation plans by establishing priority areas for action and a broad outline of optimal control measures.

Planning at a watershed scale creates the opportunity to address SWM issues that cross jurisdictional boundaries, such as downstream urban flooding caused by poor SWM in upstream jurisdictions. However, an issue of equity arises when the most cost effective means of remediating SW problems in a downstream municipality is investment in SWM infrastructure by an upstream municipality. All benefiting municipalities should contribute to the cost of this investment even though funding is normally the sole responsibility of the upstream municipality.

Where the regionally beneficial investment involves installing LID technologies on private commercial property, offset programs should value benefits across all benefiting jurisdictions and develop a mechanism for allocating the cost of those measures equitably.

There is precedent for municipal infrastructure investments that serve multiple jurisdictions. Existing institutional structures that facilitate joint programs between municipalities include:

- Conservation Authorities (CAs) that are jointly funded by member municipalities to achieve objectives that benefit all members

- Offset programs that compensate farm operators for implementation of various measures to control soil erosion and pollution from manure runoff and milk house wastewater are delivered by many CAs
- Inter-municipal contractual arrangements for water supply, wastewater and solid waste management, for example, the York Durham Sewage System and the Peel Region water system, which serves parts of York Region. Financing agreements between these Regions enable investment in systems that serve both partners

The approach to cost allocation for an LID offset program will depend on the participating partners and the objectives of the funding arrangements. Cost allocation principles that might apply include:

- Allocation in proportion to benefit received
- Allocation based on ability to pay, which, in the case of municipal jurisdictions, may correlate with population or tax assessment
- Allocation based on relative SW contributions to impaired systems (analogous to a ‘polluter pays’ principle)

Funding for CAs provides a template that can inform future negotiations regarding cost sharing for an interjurisdictional SW offset program. CA funding is derived from municipal levies (average 48% in 2013), own-source revenues (40%); provincial contributions (10%) and federal contributions (2%) (Conservation Ontario). Municipal levies are based on both tax assessment and benefit received (Government of Ontario 1990). Funding for an offset program may also come from the purchase of offsets by private sector developers who find it more cost effective to purchase offsets than implement remedial actions to meet regulatory design standards on their properties (XCG 2014).

5 MECHANISMS TO IMPLEMENT GREEN INFRASTRUCTURE

Policy instruments that can be used to promote installation of LID technologies are described in section 3. This Section looks more closely at some of these instruments and related institutional arrangements to evaluate their applicability in Ontario. The instruments are classified in terms of their contribution to project delivery, cost recovery, and project finance.

5.1 Instruments for Project Delivery

Project delivery concerns the institutional arrangements that facilitate project design, approval, tendering, and contracting. In Section 3.1, policy instruments were identified that could be used during the approval process to promote LID installation. These included: provision of information, promotional efforts, standardized project documentation, simple and clear design guidelines, accelerated approvals, and relaxed planning restrictions that might, for example, allow higher development densities where LID technologies are applied. While these are important, this section is more concerned with institutional arrangements that can support a sustainable LID market by developing an adequate supply of skilled LID contractors and providing the legal framework within which contracts can be delivered.

A regional market for LID contracts will be sustainable and effective when it is large enough to incentivize contractors to make the investments in training and equipment required to do the work and ensure competitive bids for available contracts. MOECC's proposed SW runoff control standards (MOECC 2017) will help create this market, just as the USEPA's National Pollutant Discharge Elimination System program has done in the USA. Economic incentives such as offset programs and SW user fee credits will also support the development of a viable market for LID contractors in Ontario.

The municipalities, perhaps in cooperation with CAs, could develop mechanisms that facilitate project implementation by issuing LID contracts that cover multiple projects and make use of public-private-partnership (P3) funding structures to increase contract size, thereby attracting larger contractors (see text box below).

Benefits of Project Aggregation

"**Philadelphia** found a 67% reduction in cost per greened acre by allowing private firms to 'bundle' green infrastructure across multiple private properties and Prince George's County is experiencing early successes through their P3 agreement." (O'Neill, Cairns 2016)

The benefits of project aggregation increase if property owners can be persuaded to cooperate in the implementation of LID technologies that serve multiple properties, referred to as a 'grid block'. This improves efficiency and lowers costs for the reasons cited in the preceding paragraph and because of the economies of scale associated with larger works and optimized performance. Grid block projects require a legal framework to define property rights and responsibility for maintaining the LID project assets. This framework establishes arrangements for cost sharing, asset operation, maintenance, and eventual replacement. The legal mechanisms described in table 5 can conceivably be used to create this framework:

Table 6: Legal Mechanisms for Aggregating Properties

Drainage Act	The Drainage Act provides a process for construction and maintenance of communal drainage works—including open ditches, underground pipes, culverts, catch basins, buffer strips, berms, riffles, grassed waterways, wetlands, ponds, pumping stations, and existing constructed infrastructure—on private lands and public roads. Work under the Act is highly proscribed, covering public engagement, design, reporting, costing and cost allocation among land owners, construction, and maintenance. Such work can be initiated by a petition from local landowners. A municipal bylaw accepting the final engineer's report for a project provides authorisation for undertaking the works. While the Drainage Act is most frequently used to implement rural drainage works, it has been applied on projects in urban areas. (Credit Valley Conservation 2017).

Common Elements Condominium	A Common Elements Condominium consists of the common elements jointly held by owners of benefiting properties. The owners' properties are 'tied' to the common element but are not part of the condominium. Under provisions of a condominium corporation, the owners of tied properties bear obligations toward the common element just as owners of units in a conventional condominium, and they pay common expenses. A Common Elements Condominium allows owners of existing properties to create a shared facility such as a parking facility. (Clifton 2007)
Joint venture	In a joint venture (JV), two or more entities cooperate under legal agreement to undertake a common purpose, in our case LID implementation. JVs can operate on the basis of a contract between partners, but for purposes of an ongoing LID project, the JV partners should form a corporation. The latter limits each partner's liability and creates a legal entity capable of applying for permits and licences, securing banking and insurance services, and entering into contracts with suppliers. JV corporations may receive tax-exempt or non-profit status if it is operated for an exempt purpose. JV agreements should clearly define relationships between corporate partners such as responsibility for: contributing resources, operations management, reporting and record keeping, dispute resolution, as well as risk allocation, etc. (Pasquino 2011)
Contracts with property owners	Legal agreements negotiated with property owners (as applicants) and deeded to properties. This approach is typically used in municipal offset and "payment for ecological services" programs. Such arrangements avoid imposed investments or incorporation obligations.

It is beyond the scope of this report to evaluate the relative merits of these three legal structures. It is, however evident that the preferred option should:

- Clearly define the LID undertaking
- Be easy to administer and not add burdens to landowners or tenants
- Identify the rights and responsibilities of involved parties
- Provide an operational and financial framework that can assure project sustainability

5.2 Economic Incentive Policy Instruments

Policy instruments can be used to recompense project costs or to help with project finance to provide economic incentives that foster the implementation of LID projects. Compensation for project costs reduces the proponent's direct cash outlay while assistance with financing lowers the cost of debt or eases constraints on securing debt financing (see section 3 for details).

Property taxes have traditionally been used to finance grey infrastructure for SWM, but problems with equity and reliability have motivated ever greater numbers of municipalities to adopt SW user fees as the primary funding source for grey infrastructure (Aquije 2016). The development of self-financing SW operations has coincided with our increasing understanding of the deleterious impacts of SW on the hydrologic function of our watersheds and the underperformance of grey infrastructure SW measures that were supposed to address this concern. Attention has therefore turned to LID technologies as an alternative way to manage SW that can facilitate restoration of the hydrological function of watersheds.

Mirroring earlier efforts to control rural non-point source pollution starting in the 1960s and controlling excessive water consumption and implementing waste using water conservation measures starting in the 1980s, we are now developing economic incentive programs to promote the implementation of LID technologies. It is important to ensure that the incentives are:

- Well targeted
- Priced to encourage participation (not too low)
- Not compensating for activities that would have been undertaken anyway
- Structured to facilitate long-term environmental improvements (Lockie 2013)

Many features increase the likelihood that an economic instrument will be successfully adopted (Feitelson, Lindsey, 2001):

- Simplicity
- Adequate local agency capacity based on its experience with similar instruments
- Development pressure and the structure of the development industry—adoption of financial instruments is more likely where growth, and thus demand, for LID technologies is greater
- Capacity of the development industry to take advantage of the instruments
- Instruments reward rather than discourage or punish
- Attitudes toward specific instruments prevalent in the local political culture and among special interest groups such as local environmental and development interests—for example, are offsets conceived as buying the right to pollute
- Framing of financial instruments in political and public discourse—e.g. tradeable permits are more likely to be accepted if described as compensation mechanisms
- Packaging financial instruments as components of a comprehensive policy package rather than as stand-alone measures

The issue of agency capacity has many dimensions:

- Staff must understand and be able to communicate the benefits of SWM to individual property owners and the wider community
- The agency should be able to estimate the ecological and social impacts of LID technologies in order to evaluate the efficacy of incentive programs
- Procedures must be in place to evaluate applications from participants and assess competing bids - these protocols should be based on an understanding of how actions impact SWM objectives
- Once program applications have been approved, the agency must have the capacity to monitor compliance and performance on an ongoing basis - the

terms and conditions of the monitoring program should be agreed upon by all participants

It is clear from the above that the role of the agency in delivering an incentive program is demanding and it is not the case that economic incentives are an alternative to good planning and governance (Lockie 2013).

6 INSTRUMENTS FOR ONTARIO

6.1 Evaluation of Instruments

The foregoing discussion provides a framework for a qualitative evaluation of instruments that can be used to promote implementation of LID technologies. The following evaluation criteria are distilled from this discussion as well as the primary author's experience in similar exercises.

Table 7: Evaluation Criteria for Policy Instruments

Equity	In the context of economic incentive instruments, equity concerns the perceived fairness of the allocation of costs and rewards among the general public, incentive payment recipients, beneficiaries of LID measures and others.
Public acceptance	This will be a function of the attitudes of various sectors of the public towards environmental agendas, government 'interference' in the private sector, and the perceived nature of incentives (e.g. do they reward the 'bad guys').
Proponent acceptance	Program uptake will depend on how prospective LID proponents view the incentive mechanisms: Is it too time and resource consuming to apply? Is the compensation sufficient? Are inspection and reporting requirements reasonable? etc.
Simplicity	The simplicity of the incentive mechanism and the capacity of the agency are closely related factors affecting successful implementation. Agency capacity is not identified as separate criteria, since it is a common thread across all instruments and does not therefore help discriminate among them.
Funding source	Funding source is an important determinant of the political acceptability of any new program. Programs that draw on general revenues and apply upward pressure on taxes are more likely to meet with political opposition.
Administrative costs	Agency costs to develop and administer new incentive programs will be higher for programs that entail new skill sets, additional staffing, and new facilities. Programs that extend existing programs will be less costly to introduce.

6.2 CONCLUSION

Based on the foregoing research, the criteria delineated above, and given the focus of the study on demonstrating the potential viability of installing LID technologies on private commercial property, CVC and its consultants have selected the following economic incentive policy instruments for further testing:

- Offsets
- Grants and subsidies
- Finance

6.3 Variations on the Financial Instruments

Variations on these instruments that might be considered for testing include:

6.3.1 Credit trading

This is a form of offsetting that formalizes the process using a market structure. Offsets created by LID proponents are quantified in the form of standardized tradeable credits measured in terms of water volumes or mass of pollutants (not to be confused with credits in SW user fee programs). Certified credits are documented in a government-created market registry and they can then be sold to regulated parties as a means of compliance with caps on their discharges.

Establishing the cap and trade regime requires a watershed target, allocation of that target to regulated sources, and a trading ratio to account for heterogeneous sources and uncertainty. The market or trading mechanism can involve a free-exchange, a clearinghouse, or even bilateral negotiations. (Parikh et.al. 2005). Agents in the market may act as 'aggregators' by creating offsets on numerous properties under contract to landowners. (Cappiella, Hirschman, Stack 2013).

Credit trading program should include:

- Minimum baseline reduction requirements for each polluter before credits are created
- Timeline of credits, i.e. temporary, permanent, or a mixture of the two
- Agreed upon procedures to verify credits
- Possibility that trades could generate greater load reductions than achieved through conventional compliance due to the trading ratios applied
- Potential for credits to reflect multiple benefits, e.g. quantity and quality (Cappiella, Hirschman, Stack 2013)

Formal credit trading programs are complex and administratively burdensome. They are likely to be beyond the capacity of most municipalities to implement and would be a challenge even for the larger CAs.

6.3.2 Grants and reverse auctions:

Incentive programs using offsets and grants may be managed on a first come first served basis but even where there is screening of applications to select those that yield the greatest benefit, the compensation levels are prescribed by program policy. A reverse auction modifies the application and approval process by soliciting offers from proponents. The latter enters a bid that describes the LID technology that they wish to implement as well as the amount of financial compensation required. The administering agency selects approved projects based on both the efficacy of measures proposed and the extent of financial assistance requested. This system could achieve greater SW control for the same budget if requests come in below what would be administered under prescribed compensation programs. A few examples of such reverse auctions are documented for the US:

> ***Shephards Creek,*** *Ohio – An auction, which was conducted in 2007 and in installation of 81 gardens and 165 rain barrels on 30% of 350 eligible properties. Approximately 55% of the bids were for $0. The auction promoted more participation than education alone and at a lower unit control cost than a SW control payment plan. The study indicates that small financial incentives can incentivize homeowners and provide ready access to private property for retrofitting watersheds with LID measures. (Thurston et. Al. 2010; Roy, Thurston, Taylor no date)*
>
> ***Philadelphia*** *– The Philadelphia Water Department launched a competitive grant program to promote LID on private property. The Greened Acre Retrofit Program encourages contractors or design/build firms to bundle GI projects and compete for limited public funding for providing low cost retrofit opportunities on private land. The program creates a competitive GI market that allows the utility to obtain installed LID infrastructure at a fraction of the cost of public right-of-way projects while ensuring similar environmental impact. Local GI contractors benefit from project aggregation and secure long-term contracts for GI maintenance. Property owners benefit from reduced stormwater fees and increased property value. (Valderrama, Davis 2015).*
>
> ***Alberta's Living Laboratory Project –*** *The city of Calgary has been collecting money from developers for dissembling wetlands around the city. Part of these funds were used to test the effectiveness of using market-based instruments (reverse auctions) as a method for determining wetland restoration priorities in the Nose Creek watershed area. The project also tested whether private landowners are willing to accept a payment to restore wetlands on their properties (2015/16). For more information visit:* http://restoreourwetlands.ca/#about

Reverse auctions are complex compared to existing grant programs. However, they are a tested mechanism that promises improved outcomes when compared to simple grant programs and should be piloted by municipalities in cooperation with CAs.

7 MOVING FORWARD, NEXT STEPS

The next phase will consist of quantifying the benefits and cost savings of installing communal LID technologies on 14 aggregated properties in the Southdown area of Mississauga and calculating potential offset values based on the avoided costs and co-benefits associated with green infrastructure. Results will be scaled up in order to develop guidance materials that can be used to implement cost effective green stormwater management infrastructure solutions on a nationwide basis. The process will involve:

- Completing a pilot project comprising the aggregation of 14 properties in the Southdown area of Mississauga to install communal green infrastructure
- Finalizing the design based on a life cycle cost optimization exercise
- Quantifying incentive values based on cost savings when compared to end of pipe solutions as well as benefits provided by green infrastructure
- Conducting a landowner survey
- Developing a business case for nature-based infrastructure on private lands by proposing incentives that overcome cost, administrative and financial return barriers
- Publishing results in appropriate peer reviewed academic journals
- Scaling the project up to the Sheridan Creek subwatershed, Southdown area
- Incorporating recommendations in Southdown Master Drainage Plan
- Developing guidance documents that delineates the process, costs, benefits, monitoring requirements, and metrics that can be deployed to implement cost effective green stormwater management infrastructure solutions on aggregated private properties

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Appendix A – SWM Standards

SWM standards as delineated by Ministry of Environment, 2003:

- Preservation of groundwater and base flow characteristics
- Protection of water quality
- Prevention of undesirable and costly geomorphic changes within the watercourse
- No increase in flood damage potential
- Maintenance of an appropriate diversity of aquatic and terrestrial life as well as opportunities for human uses

Appendix B – Sample Calculations for Payback Period, Net Present Value and Internal Rate of Return

Assumptions: Values used for sample calculations in this table:

(1) Investment cost in the first year: $50,000;
(2) Savings to the company: $9,000 / year or $750 / month;
(3) Period of analysis: 10 years following completion of the investment;
(4) Discount rate (expected return given the risk of the project): 10%

Payback Period (years) = Initial investment/ savings per annum

= $ 50,000/($750 x 12)

= 5.6 years

Comment: a payback period of 5.6 years is generally too long for the private sector. Businesses want to recoup their investments much faster, preferably in less than 3 years.

Net Present Value = - Initial Investment

+ savings in year 1 x $(1/(1 + \text{discount rate}))^{1}$

+ savings in year 2 x $(1/(1 + \text{discount rate}))^{2}$

+ …. savings in year 10 x $(1/(1 + \text{discount rate}))^{10}$

+ disposal value in year 10 x $(1/(1 + \text{discount rate}))^{10}$

= - $ 50,000 + $9,000 x $(1/1.10)^{1}$ + $9,000 x $(1/1.10)^{2}$

+ ….$9,000 x $(1/1.10)^{10}$ + 0

= $4,818

Comment: A positive NPV indicates that the cost savings from the investment is likely to exceed the initial investment even given the fact that the savings accrue over time and the level of associated risk (uncertainty that the savings will actually materialize). The business owner will compare this value ($4,818) with the NPV of other proposed projects to determine which to undertake with his/her limited capital. The project with the largest NPV will generally be favoured.

Internal Rate of Return = expected rate of return

= the rate at which the NPV of a project equals 0, for example, in the following equation:

NPV = -$50,000 + $9,000 x $(1/(1+x))^{1}$ + $9,000 x $(1/(1+x))^{2}$

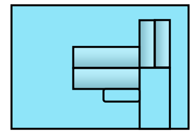
+ ….$9,000 x $(1/(1+x))^{10}$ = 0

Solve for x by inserting different values into the equation until the NPV =0

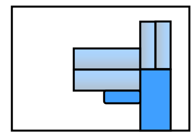
Comment: If the x, the IRR > 10% (the discount rate or required return) then the project is worth undertaking.

Appendix C – Alternative Measures for calculating Contributing Area for SW User Fees

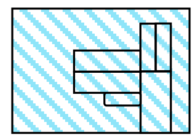
Gross area – The total area of a property. Directly related to the total incident rainfall onto a property without consideration of impervious area. Not necessarily correlated to runoff volumes due to the influence of impervious area, slopes etc. If soils are saturated or rainfall is extreme gross area will correlate with runoff.



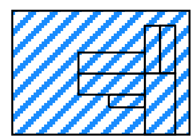
Impervious area – The area of hardened surface on a property (roof tops, pavement, sidewalks) that prevents infiltration and causes rainfall to runoff as soon as it falls. Impervious area “exerts the greatest influence on the peak rate, volume and quality of runoff.” (Water Environment Federation 2013).



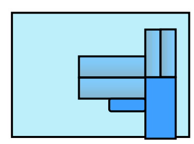
Gross Area Factored by a Runoff Coefficient – The gross area of a property multiplied by an assumed average runoff coefficient (RC) for that type or class of property. RC for a surface is a value representing the percentage of rainfall that is turned into stormwater runoff and it captures the combined effect of various characteristics of the surface and the rainfall. RC of an impervious area is close to 1.0 while it might be near zero for a highly permeable area.



Gross Area Classified by Intensity of Development – Properties are classified by the intensity of development. The percentage of impervious area is assumed to lie within a range for each category, for example, ‘undeveloped land’ rated at 0% to 3% impervious, ‘very heavy development’ rated at 71% to 100%. Gross area plus an intensity-of-development rating factor provides the basis for the SW charge.



Equivalent Hydraulic Area – Impervious and pervious areas are multiplied by hydrologic response factors to estimate the overall relative impact of a property on stormwater runoff. This is a data intensive approach that captures the impact on runoff of undeveloped properties that have no impervious areas.



(Fortin 2013)

Appendix D - Lake Simcoe Phosphorus Offset Program – Offset Value Calculation

Assumptions:

- The proposed development will build homes and roads for 176 lots on a 9.2 ha site
- The percentage of impervious cover will increase to 45%
- Estimated annual P load from the new development is 13.8 kg/year.
- The developer must maintain the water balance and reduce the phosphorus load to zero (0).
- Through low impact development and stormwater best practices, the proponent can control 75% of the total phosphorus from the development, or 10.3 kg/yr.

Offset Value Calculation

Given that the post condition total load off the site is 13.8 kg/yr., the phosphorus reduction needed to achieve net zero is:**13.8 – 10.3 = 3.5 kg/yr**

Based on the stormwater offset ratio (2.5:1), the total amount of phosphorus to be offset is: **3.5 kg/year X 2.5 (offset ratio) = 8.8 kg/year**

Proposed Offset Cost: **8.8 x $35,000 kg/y = $ 308,000**

Equates to **$1,750 per lot**

Glossary of terms and acronyms: Economic Instruments to Motivate Stormwater Management on Private Lands

Terms

Base flow: the volume of water flowing through a watercourse under low flow conditions, without the input of direct surface runoff.

Bioswale: a vegetated channel that retains water, filters and slowly releases it. Can be designed for infiltration as well.

Brownfields: brownfield sites are areas of land that are underutilized, have abandoned buildings or are underdeveloped, often containing low levels of industrial pollution.

Capital costs: fixed, one-time expenses incurred to purchase land, buildings, construction, and equipment used in the production of goods or in the rendering of services.

Combined sewers: sewers which receive both raw sewage and stormwater flows. When heavy rainfall occurs in an area with combined sewers, sewage treatment plants cannot contain the full flow and are forced to release untreated sewage, along with stormwater, into their receiving bodies of water (**sewage treatment plant bypassing**). Sewage can back-up into people's houses under these circumstances as well. This is called combined sewer overflow (CSO).

Co benefits: the added benefits we get when we LID technologies, above and beyond the direct benefits of stormwater infiltration, conveyance and storage.

Detention ponds: an excavated area installed on, or adjacent to, tributaries of rivers, streams, lakes or bays to protect against flooding and, in some cases, downstream erosion by storing water for a limited period of time. Detention ponds are typically dry ponds.

Discount rate: the interest rate used to determine the present value of future cash flows. Just as credit card companies charge an interest rate for allowing a debtor to make payments in the future, businesses require a return for investing money now and receiving repayments at a future date/s. The discount rate is an interest rate that reflects this required rate which incorporates allowances for taxes on profits and for risk. It reflects the fact that money earned today is more valuable than the equivalent sum earned next year, given the uncertainty that the income or cost saving will actually materialize in the future. Uncertainty is one component of risk and it is incorporated in the discount rate used to evaluate the project. Higher risk generally necessitates using a higher discount rate.

Discounted cash-flow analysis: annual costs and benefits, including cost savings, are forecast over the life span of an investment and converted into their equivalent current period values based on the 'time value of money'—the discount rate. The future stream of costs or benefits that go into calculation of the corresponding discounted cash flow is equivalent to the stream of mortgage payments that we make on debt to buy a house. In this case the discounted cash flow of our mortgage payments is the initial debt incurred.

Dry pond: temporarily store excess stormwater and allow some pollutants and sediment to settle to the bottom of the basin. These ponds are not meant to store stormwater for long periods of time. The water from dry ponds will slowly drain back onto adjacent land features including wetlands and streams, replicating the conditions of naturally vegetated areas. These types of ponds are normally dry and may have natural old field or even woody vegetation.

Easement: in Ontario, an easement is defined as a right or interest annexed to land, which permits the owner of the dominant land to impose restrictions on the owner of the servient land as to its use. Certain prerequisites are required. From https://www.ontario.ca/land-registration/2005-02-easements-and-release-easements

Ecological services: services provided by ecosystems and natural processes (e.g. natural hydrology). An approach to valuing these services estimates how much it would cost to provide a service if it weren't already being supplied for "free" by an ecosystem or natural process.

Equivalent hydraulic area: impervious and pervious areas are multiplied by hydrologic response factors to estimate the overall relative impact of a given property on stormwater runoff. This is a data intensive approach that captures the impact on runoff of undeveloped properties that have no impervious areas.

Green bonds: tax exempt bonds issued to encourage development of brownfields (in the US). The tax exempt status means that investors are willing to accept lower rates of return when compared to taxable bonds. This decreases the cost of attracting funds in a competitive market (where investors will lend money to the 'highest bidder' given the same level of risk.

Greenfields: an undeveloped or agricultural tract of land that is a potential site for industrial or urban development.

Green infrastructure: the natural vegetative systems and green technologies including: urban forests and woodlots, permeable pavements, bioswales, wetlands, ravines, waterways and riparian zones, engineered wetlands and stormwater ponds, meadows and agricultural lands; green roofs and green walls, urban agriculture, parks, gardens, turf, and landscaped areas. It also includes soil in volumes and qualities adequate to sustain green infrastructure and absorb water, as well as technologies like porous pavements, rain barrels and cisterns, which are typically part of green infrastructure support systems. The green technologies in this definition replicate the functions of ecosystems, such as stormwater storage and filtration.

Grey infrastructure: engineering projects that typically use concrete and steel and that are considered 'conventional' since they involve the first technologies used to control storm water flows and contaminants. Grey water control of flows usually involves quickly conveying it away from affected areas by pipes and open channels. Grey water control of contaminants includes treatment processes to remove contaminants such as grease and sediment interceptors.

Grid blocks: multiple properties can be 'bundled' or aggregated to form a 'grid block'. Aggregation improves efficiencies and lowers project costs due to: improved access to private capital due to larger project size; reduced costs (per property) for project preparation, design, permitting, approvals, etc.; reduced financial and technical risk as a result of risk pooling; and economies of scale associated with larger civil works. Grid block projects require a legal framework to define property rights and responsibility for maintaining the LID project assets. This framework establishes cost sharing arrangements and mechanisms to facilitate asset operation, maintenance and eventual replacement.

Heat island effect: urban areas are composed of surface features which trap, retain and slowly release heat. This creates higher temperatures in urban areas than in rural or natural areas.

Hydrology: the scientific study of the movement, distribution, and quality of water on earth and other planets, including the water cycle, water resources, and environmental watershed sustainability.

Impervious area: hard surfaces which are impermeable to water. Most urban areas have a high ratio of impervious surface to pervious surface. This generates high amounts of stormwater runoff.

Infiltration: occurs when water enters the soil. Urbanization has a large negative impact on the infiltration capacity of a watershed.

Infrastructure deficit: when a governmental organization does not build new or maintain old infrastructure, it accrues a deficit, since this infrastructure will have to be built or maintained in the future.

Internal rate of return: an investment where the returns are generated by future savings on maintenance or replacement costs, i.e. the ROI for investments into a business's operations.

Linear infrastructure: infrastructure such as roads, power lines, railways, canals, etc. This type of infrastructure is particularly problematic in terms of causing ecological damage, e.g. habitat fragmentation.

Low impact development (LID): an approach to stormwater management that aims to preserve and restore natural hydrological cycles by storing, filtering and infiltrating water where it falls as rain, managing runoff as close to its source as possible.

Morbidity: incidence of ill health in a given population.

Mortality: number of deaths in a given population.

Net present value: present value of a future income stream. Equivalent to the discounted cash flow (see above).

Offset program: offsets are payments offered to compensate for costs incurred to implement environmental investments such as LID when significant benefits accrue to parties other than the entity/person incurring the costs. Offset values are generally based on the cost savings/benefits accrued to third parties.

Payback period: payback period is the period of time, measured in months or years, over which the cost of the initial investment is recovered through cost savings or new revenues. It is estimated as the initial investment divided by the average monthly or annual net revenue or cost savings. A longer payback period indicates a lower return and greater risk and uncertainty associated with an investment.

Peak flow: the point at which a watercourse has the highest rate of flow as a result of a runoff generating event.

Pollutant load: the amount (mass) of a pollutant that is discharged into a water body or carried by flowing water during a period of time (i.e. tons of sediment per year).

Probability (from a financial perspective): probability is used to quantify uncertainty. It indicates the likelihood that a possible outcome will be realized in the future; for example, the probability of occurrence of a storm of a given intensity in a year or a month.

Proponent: a person who puts forward a proposition or proposal to implement an action.

Rate of flow: the volume of water passing through a watercourse during a defined period of time; expressed in various ways: litres per second, cubic meters per day.

Regulatory storm: an extreme storm event expected in an area and used as the basis for design of infrastructure. This storm can be either a large historical storm or a theoretical storm generated from local rain data to estimate the worst storm that could occur in say 100 years.

Return on investment: a measure of the 'effectiveness' of an investment, calculated by expressing the excess (profit) generated by an investment as a percentage of the cost of the investment. The higher the return, the more lucrative the investment rendering it more likely that the project will be undertaken.

Risk: Probability x consequences.

Sewage treatment plant bypassing: the release of untreated or partially treated wastewater by a sewage treatment plant. This can be caused by: heavy flows entering the plant during rainfall and snowmelt events due to the existence of combined sewers in the collection network, the connection of roof and footing drains to the sewers, and leaky sanitary sewers that allow water moving through the soil to enter the sewer through cracks. Bypassing may also occur due to system failure in the sewage treatment plant.

Surcharging: an overload or excessive flow within a sewage system which causes stormwater to overflow the storm water system through storm drains on the street.

Stormwater: rainfall and snowmelt that seeps into the ground or runs off the land into storm sewers, streams, and lakes. Water entering storm sewers also includes runoff from activities such as watering lawns, washing cars, and draining pools.

Stormwater utility fees: service fees charged by municipalities for providing stormwater services. There are different ways to calculate these fees. The most accurate way to determine these fees consists of allocating storm water system costs to properties based on each property's size and its pervious and impervious surface areas, since these characteristics determine a property's contribution to water entering the storm sewers. Municipalities usually employ simpler approaches to setting these fees including flat fees for classes of properties and simple area based fees.

Systems modelling: systems modeling is the process of developing abstract models, usually mathematical, to describe and simulate the behaviour of a system. Alternative models emphasize different aspects of a system and different levels of detail in describing system attributes and processes.

Time value of money: reflects the fact that money earned today is more valuable than the equivalent sum earned next year, given the uncertainty that the income or cost saving will actually materialize in the future. The further out the anticipated cash flow, the more uncertain its occurrence and hence the smaller its present value. See discount rate for more details.

Watershed: an area of land where surface water collects into a channel (river) where it flows into a receiving body of water or watercourse. Also known as a drainage basin or catchment area.

Willingness-to-pay: the maximum amount an individual is willing to pay for a good or service or to avoid/achieve an outcome. This value is estimated by surveying persons who may value the good or service (contingent value surveys) or by observing actions and decisions that are affected in some way by the good or service (e.g. paying more for a house located near a clean river or park). Estimates of willing-to-pay are used to value ecological amenities, e.g. parks, wetlands, and endangered species. A typical contingent value survey question would ask respondents to consider two or more options, each offering different levels of a valued amenity at different costs, and would ask the respondents to select their preferred option (there are many other formats for this type of question).

Wet pond: a wet pond is a stormwater facility constructed through filling and/or excavation that provides both permanent and temporary storage of stormwater runoff. It has an outlet structure that creates a permanent pool and detains and attenuates runoff inflows and promotes the settlement of pollutants. To remain effective, wet ponds require periodic maintenance including dredging.

Acronyms

BMP: best management practices

CAs: Conservation Authorities

CVC: Credit Valley Conservation

ECA: environmental compliance approval (United States of America)

GHG: greenhouse gas

GI: green infrastructure

ICI: industrial/commercial/institutional

IRR: internal rate of return

LID: low impact development

MNR: Ministry of Natural Resources (Ontario)

MOECC: Ministry of the Environment and Climate Change

NPV: net present value

P3: Public private partnerships

PSAB: Public Sector Accounting Board

ROI: return on investment

SME: small to medium sized enterprise

STEP: Sustainable Technologies Evaluation Program

SW: stormwater

SWM: stormwater management

tC: Tons Carbon (measurement)

TRIECA: Toronto Region International Erosion Control Association

USEPA: United States Environmental Protection Agency

WTP: willingness to pay