INTRODUCTION

Integration of Low Impact Development (LID) best management practices (BMPs) into stormwater management (SWM) systems is widely advocated to better address the potential stormwater-related impacts of urbanization on the health of receiving waters. A substantial amount of guidance is available on the planning and design of LID BMPs (CVC & TRCA, 2010) and their construction (CVC, 2012) and some municipalities and conservation authorities commonly require them to be a part of new SWM systems.

However, even with sound design, LID BMPs may not provide the intended level of treatment if they are not installed properly or protected from damage during construction. Experiences with early applications have shown that failures are often due to:

- Practices not being constructed as designed or with specified materials;
- Lack of erosion and sediment controls (ESCs) during construction; and/or
- Lack of rigorous inspection prior to assumption.

A 2009 survey of stormwater BMPs in the James River watershed (Virginia) by the Center for Watershed Protection found approximately half (47%) of the 72 BMPs deviated in one or more ways from the original design, or were receiving inadequate maintenance (CWP, 2009). Similar results have been revealed from surveys of stormwater detention ponds in Ontario (Drake et al., 2008; LSRCA, 2011), highlighting the need for thorough inspections of BMPs prior to assumption and a proactive approach to stormwater infrastructure operation and maintenance.

Therefore, it is important to conduct timely inspections during construction and detailed inspection and testing prior to assumption to ensure that LID BMPs are:

- Built according to approved plans and specifications;
- Installed at an appropriate time during overall site construction and with protective measures to minimize risk of siltation or damage; and
- Fully operational and not in need of maintenance or repair at the time of assumption by the property owner or manager.

Like all stormwater BMPs, LID practices are designed to retain pollutants carried by urban runoff and all have a finite capacity to perform this function in the absence of maintenance, until their treatment performance declines or they no longer function as intended. Their functional and treatment performance will only be sustained over the long term if they are adequately inspected and maintained. Under the Ontario Water Resources Act, provincial approvals for SWM facilities and BMPs (i.e., Ontario Ministry of the Environment and Climate Change's Environmental Compliance Approvals process) typically make the property owner responsible for all inspection and maintenance tasks and associated record keeping (Zizzo et al., 2014). A proactive, routine inspection and maintenance program will also:

- Identify maintenance issues before they significantly affect the function of the BMP;
- Help to optimize the use of program resources by providing the feedback needed to determine when structural repairs are needed and to adjust the frequency of routine inspection and maintenance tasks where it is warranted; and
- Help to improve BMP design guidance and develop standards.

Unlike conventional SWM systems that centralize treatment facilities in few locations on publicly owned land (e.g., detention ponds) an LID design approach involves smaller scale practices distributed throughout the drainage area, potentially on both public and private land. Implementing an LID approach to system design has major implications on municipalities and property managers with respect to operating the stormwater infrastructure they are responsible for, as it increases the number and types of BMPs to be tracked, inspected and maintained.

Municipalities already face significant challenges in tracking, inspecting and maintaining their own conventional stormwater infrastructure (i.e., catchbasins, storm sewers, oil and grit separators, ponds and detention facilities) and ensuring practices on private property are adequately maintained. Such challenges include:

- Establishing sustainable program funding mechanisms;
- Securing dedicated program staff;
- Tracking BMP locations and responsible parties;
- Dealing with designs that are not conducive to access or ease of maintenance;
- Private owners that are unaware of inspection and maintenance responsibilities;
- Administering compliance and enforcement procedures; and
- Implementing technologies or software to support field data collection, reporting and database management.

Integrating LID BMPs into infrastructure asset management programs represents a substantial challenge to implementing an LID approach to SWM in many municipalities and organizations (CVC, 2010). In addition to those noted above, implicit with such an approach are the following additional challenges:

- Lack of experience with inspection and maintenance of LID BMPs;
- Administering legal agreements to ensure inspection and maintenance on private property;
- Distributed, decentralized practices are more numerous so require more effort to track; and
- Lack of detailed guidance and templates for program design and implementation.

This guidance document is intended to assist municipalities and property managers with developing their capacity to integrate LID SWM BMPs into their infrastructure asset management programs. Part 1 of the document provides guidance on designing an effective LID BMP inspection and maintenance program, based on experiences and advice from jurisdictions in Canada and the United States, and

adapted to an Ontario context. Part 2 of the document provides recommended standard protocols for inspection, testing and maintenance of the following types of structural LID BMPs:

- Bioretention and dry swales;
- Enhanced swales;
- Vegetated filter strips and soil amendment areas;
- Permeable pavements;
- Underground infiltration systems;
- Green roofs; and
- Rainwater cisterns.

Guidance in Part 2 includes recommended inspection, testing and maintenance tasks specific to each BMP type, a summary of staff skills and equipment required to complete them, sampling and testing procedures and estimated costs over a 50 year BMP life cycle. Drawing upon the information provided in this document, municipalities and property managers will be better able to design or adapt their infrastructure asset management programs to include LID BMPs effectively, and understand the tasks, procedures and estimated costs involved in adequately inspecting and maintaining them.

PART 1 – DESIGNING AN EFFECTIVE LID INSPECTION AND MAINTENANCE PROGRAM

1.0 SETTING THE PROGRAM SCOPE

Whether the context is a municipality or another organization involved in the management of properties where stormwater BMPs are present, some important scoping decisions need to be made at the onset of developing an inspection and maintenance program. The following questions highlight preliminary work and key decisions that need to be made to establish the scope of an LID BMP inspection and maintenance program.

1.1 How Many BMPs are to be Included in the Program?

A critical first step in setting the program scope is conducting an inventory of all existing and anticipated future BMPs within the organization's jurisdiction. The inventory should include information on both the physical and regulatory condition of each BMP. The physical condition includes the type of BMP, design parameters, and associated conveyances. The regulatory condition addresses whether the BMP was part of a provincial approvals process (i.e., Ontario Ministry of the Environment and Climate Change's (OMOECC) Environmental Compliance Approval (ECA), formerly known as Certificate of Approval (CofA)) or is part of a maintenance agreements between the municipality and the property owner or located within an easement that is accessible for inspection and maintenance tasks.

Managers must also decide what elements of the overall drainage infrastructure system should be included in the program. For example, will the program be limited to the BMP itself or will it include the conveyance system (e.g., gutters, catchbasins, pipes, pretreatment devices) leading to and from it? It may be decided not to include some BMPs in the program, for example, if they treat a very small drainage area (e.g., residential rain gardens, soakaways, rain barrels, permeable driveways) or if they were not designed or installed to meet regulatory requirements/requirements or as part of a municipal program (e.g., stormwater utility fee credit program or combined sewer overflow abatement plan).

1.2 Who is Responsible?

Assigning responsibility for inspection and maintenance tasks is an important policy question for municipalities and one that may have multiple answers depending on the location and function of the BMP. For example, the local municipality may be responsible for BMPs on public land and within public rights-of-way, but maintenance of BMPs on private land may be a shared responsibility or left to the property owner, manager or home owners association. This decision may depend on the status of easements, maintenance agreements and whether maintenance tasks are routine and aesthetic in nature, or involve structural repairs or rehabilitation. Three general approaches to assigning responsibility for LID BMP inspection and maintenance tasks are described further in Section 2.0.

1.3 What is the Current Status of Legal Tools for Inspection and Maintenance?

When part of a SWM system approved under an OMOECC ECA process, stormwater utility fee credit program, or combined sewer overflow (CSO) abatement program, municipalities must have the legal authority to require inspection and maintenance of BMPs located on private property, or it is likely that these duties will be neglected. The proper legal authority includes assigning maintenance responsibility through a municipal stormwater infrastructure program policy, legally binding maintenance agreements between the municipality and property owner, easements that provide adequate access to BMPs, and enforcement mechanisms. Section 3.3 contains guidance on types of legal tools that could be applied and critical elements of each to enable them to be used to require inspection and maintenance of BMPs on private property.

1.4 What "Level of Service" is Desired for the BMP or Program?

The desired level of service for an individual BMP or an entire inspection and maintenance program encompasses the frequency and type of inspection and maintenance activities that will be undertaken. For example, will BMP inspections be done on an annual basis or more frequently for high priority/visibility ones? Will this vary based on the size and type of BMP, whether the practice is on public or private land, or other factors such as implications if treatment performance is not maintained (e.g., within drainage areas of sensitive receiving waters or species at risk habitat)? Will maintenance be performed in response to complaints or emergencies or will it be based on preset schedules and findings from routine inspections? Table 1.1 outlines several key level of service decisions that need to be made by a municipality prior to program design and is intended to help managers of stormwater infrastructure with planning for the future as their programs develop and evolve.

1.5 Who is Responsible for Routine Maintenance Versus Structural Repairs?

Types of maintenance activities range from routine maintenance tasks like removal of accumulated trash, debris, and small amounts of sediment, weeding and trimming vegetation to more costly and complex structural repairs and rehabilitation of clogged or damaged components. Table 1.2 provides more examples of the differences between routine and structural maintenance tasks. One option for municipalities is to assign responsibility for routine maintenance tasks that are largely aesthetic in nature to the property owner while retaining responsibility for structural repairs. As municipal programs become more sophisticated, some routine maintenance tasks like sediment removal may be taken over by the municipality to avoid or prolong the need for more costly structural repairs.

Table 1.1: *Municipal stormwater BMP Inspection and Maintenance Program level of service matrix (adapted from CWP, 2008).*

Level of Service	BMPs Included	Maintenance Tasks	Maintenance Frequency	Inspectors	Inspection Frequency	Feedback from Experience
LOWER	BMPs on public land and within rights-of-way	Repair immediate threats to public health and safety	React to complaints and emergencies	Rely on owners/ managers or their contractors to inspect, maintain and keep track of records.	Complaint driven	Anecdotal
	+	+	+			+
	High priority, high visibility, and/or large BMPs on private land within easements and covered by agreements	Repair structural items: clogged or broken parts, erosion problems	Establish preset schedule for routine inspection and maintenance tasks	Inspectors send reports to responsible party and municipality	Annual or semi-annual	Feedback used to modify list of acceptable BMPs based on maintenance or performance record
		+	+	Co-inspections with public inspector and responsible party or their consultants	More frequent for high priority BMPs	
	+	Routine mowing, weeding, remove trash and debris, replace vegetation	Conduct structural repairs in response to Routine Operation, Maintenance and Performance Verification inspections	Periodic Maintenance and Performance Verification inspections	Maintenance Verification inspections every 5 years	+
		+				Feedback used to modify municipal programs and BMP design guidance or standards
HIGHER	All or most BMPs on private land within easements and covered by agreements	Includes retrofitting or reconstructing BMPs		System of certified private inspectors	Performance Verification inspections every 15 years	

Notes: (+) means that services are cumulative (level of service includes all previous tasks too).

Table 1.2: *Examples of routine maintenance versus structural repair tasks (adapted from CWP, 2008).*

Routine Maintenance Tasks	Structural Repair Tasks
◖ Mowing, trimming, weeding vegetation ◖ Removal of trash and debris ◖ Replacing individual dead plants, seeding bare spots ◖ Core aeration ◖ Removal of sediment and debris accumulated in pretreatment practices, inlets or outlets ◖ Flushing pipes	◖ Unclogging inlets, pipes, catchbasin sumps, filter beds, outlets ◖ Repairing or replacing broken or missing parts (e.g., pipes, wells, grates, manholes, valves, seals, pavements, curbs) ◖ Regrading to remedy extreme soil erosion or sedimentation ◖ Replacing large quantities of failed plantings, filter media or topsoil

1.6 Should the Responsible Party Use In-House Resources, a Contractor or Both?

Large municipalities and property management organizations with numerous properties and BMPs to maintain may choose to use in-house staff to conduct BMP maintenance. However, for small to medium-sized organizations, employing private contractors is often more efficient than hiring new staff and purchasing equipment. Another option is entering into an agreement with neighboring local municipalities, the upper-tier municipality or other property managers with stormwater BMPs to maintain to share responsibilities and maximize economies of scale in the use of equipment and personnel.

1.7 How will Maintenance Requirements be Tracked, Verified and Enforced?

For municipalities, enabling policies and program tracking and evaluation systems are key components of an effective stormwater BMP inspection and maintenance program. Before a development proposal is approved, each BMP in the SWM plan that contributes to meeting regulatory requirements should at a minimum, have an inspection and maintenance plan prepared and included in submissions for plan review and approval. Ideally, each BMP that contributes to meeting regulatory requirements should be part of an ECA or maintenance agreement that includes inspection and maintenance plans specific to each type of BMP in the associated site or subdivision plan. Section 3.3.2 describes key elements of maintenance agreements. When up-to-date inspection and maintenance records are not on file with the municipality and cannot be produced by the property owner, or a BMP is found through inspection to be inadequately maintained, mechanisms to enforce compliance with the conditions of the ECA or maintenance agreement must be in place.

2.0 APPROACHES TO ASSIGNING RESPONSIBILITIES

A critical policy decision facing municipalities regarding inspection and maintenance of stormwater infrastructure is who will be responsible, and for what types of tasks because the decision affects how the program will be designed. In general, there are three approaches a community can use to implement a stormwater infrastructure inspection and maintenance program:

1. Property owner approach: Property owners are responsible for performing all inspection, maintenance and repair/rehabilitation for BMPs on their properties and associated record keeping. The municipality provides inspection and maintenance plan templates, property owner outreach education resources and inspects, maintains and repairs BMPs on their land and within infrastructure rights-of-way.
2. Public approach: Municipality is responsible for performing or tracking inspection, maintenance and repair/rehabilitation of all BMPs that qualify for inclusion in their stormwater infrastructure program, whether located on public or private land (e.g., could include those implemented as part of a stormwater utility fee credit program or CSO abatement plan).
3. Hybrid approach: A hybrid approach consisting of both public and private entities responsible for various inspection, maintenance and repair tasks.

Each of these approaches is described further in Table 2.1 and the following sections.

2.1 Property Owner Approach

In a community where the property owner approach is applied, which is the approach being implemented across Ontario through the OMOECC ECA process, the property owner is responsible for all BMP inspection and maintenance, structural repairs and record keeping associated with such tasks. In this approach, the municipality is responsible for all inspection and maintenance tasks associated with stormwater BMPs they own, including those located in infrastructure rights-of-way. A municipal policy is needed that establishes the legal basis for the stormwater infrastructure inspection and maintenance program and establishes criteria regarding what BMPs qualify for inclusion. Placing routine inspection and maintenance responsibilities in the hands of property owners significantly reduces the costs to the municipality, and may be the best option for small communities that cannot afford to allocate municipal staff to inspect and maintain BMPs on private property.

Yet the municipality still plays a significant role under this approach. As the approvers of stormwater plans, municipalities are responsible for developing and maintaining an inventory of BMPs required to meet regulatory requirements, and verifying that they continue to exist. Over the operating phase of the BMP life cycle municipalities may also conduct periodic inspections to verify that ECA, or maintenance agreement conditions are being satisfied (i.e., Maintenance Verification inspections) and that the functional performance of the BMP remains acceptable (i.e., Performance Verification inspections). In this approach they would also be responsible for making sure the property owner

Table 2.1: *Three general approaches to assigning responsibilities.*

Typical Program Characteristics	Strengths/Weaknesses
Property Owner Approach	
◖ Property owner responsible for all inspection and maintenance tasks ◖ Property owner responsible for maintaining an inventory of all BMPs they own and record keeping related to inspection, maintenance and repair, including results from periodic inspections to verify performance ◖ Municipality responsible for educating property owners about the BMP and inspection and maintenance needs ◖ Municipality responsible for legal tools to require/enforce maintenance for regulated BMPs on private property	**Strengths:** ◖ Least costly approach for municipalities **Weaknesses:** ◖ Highest potential for non-compliance
Public Approach	
◖ Municipality responsible for inspection and maintenance tasks for all regulated BMPs and any others that qualify for inclusion in their program (e.g., part of a stormwater utility fee credit program or CSO abatement plan) ◖ BMPs required to meet regulatory requirements should only be located on public property or in rights-of-way ◖ Municipality responsible for maintaining an inventory of all BMPs that qualify for inclusion in their program and record keeping related to inspection, maintenance and repair, including results from periodic inspections to verify maintenance and performance	**Strengths:** ◖ Municipality has the most control over maintenance practices and schedules ◖ Compliance enforcement issues are minimized **Weaknesses:** ◖ Most costly approach for municipalities
Hybrid Approach	
◖ Municipality inspects and maintains BMPs on public land, and within rights-of-way or easements on private property ◖ Property owner responsible for performing some inspection and maintenance tasks and record keeping ◖ Municipality responsible for an inventory of all BMPs that qualify for inclusion in their program, and periodic inspections to verify maintenance and performance ◖ Municipality responsible for educating property owner about the BMP and inspection and maintenance needs ◖ Municipality responsible for legal tools to require/enforce maintenance of regulated BMPs on private property	**Strengths:** ◖ Maximum flexibility ◖ Useful during transition from property owner to public approaches as programs mature **Weaknesses:** ◖ Potential for non-compliance if roles & responsibilities are not made clear to all parties

receives information about the BMP, how it works and its inspection and maintenance needs upon assumption. It is also the role of the municipality to keep track of inspection and maintenance activities for all BMPs they own. If the municipal program fails to fulfill these roles, an inadequate level of maintenance is inevitable.

2.2 Public Approach

In a community where a purely public approach to managing stormwater infrastructure is applied, the municipality is responsible for inspection and maintenance of all BMPs that qualify for inclusion in their program, as established by a municipal policy, which could include those on private property in some cases. In most cases, qualifying BMPs should be located on public land or within a right-of-way that allows the municipality periodic access to conduct inspection and maintenance tasks. For existing BMPs required to meet regulatory standards that are located on private property and not within a right-of-way, the municipality would need to establish an easement to allow periodic access by municipal staff or their contractors for inspection, testing and repair.

While this approach is not common due to high administrative costs and extensive staffing needs, it offers some advantages. The need for maintenance agreements, enforcement and the associated administrative burden is minimized, and the municipality has more control over when and how inspection and maintenance tasks take place. As a municipality grows and their stormwater infrastructure program matures, there may be opportunities to transition from a property owner approach to hybrid or public approaches.

In general, this approach requires the municipality to establish a reliable source of program funding to support collection and management of detailed information about each BMP, and to maintain a team of dedicated program staff. An important first step for municipalities considering a transition to this approach is to conduct an inventory of existing BMPs and associated conveyances to help set the program scope (i.e., what BMPs will qualify for inclusion) and determine immediate maintenance needs.

2.3 Hybrid Approach

A hybrid approach that divides responsibilities for stormwater BMP inspection and maintenance tasks between public and private entities is the most common because it provides the most flexibility for program design. Municipalities using this approach are typically shifting responsibility for some inspection and maintenance tasks from private property owners to the municipality because they are not being performed or reported on as specified in ECAs or maintenance plans/agreements (i.e., compliance issues).

As in the property owner and public approaches, the municipality inspects and maintains BMPs they own on public land, and within rights-of-way and easements. In a hybrid approach, not all BMPs required to meet regulatory standards would need to be located on public land or within rights-of-way. Those located on private property should be part of an ECA or maintenance agreement and consideration given to establishing an easement around the BMP for access. Routine inspection and maintenance of BMPs on private property and structural repairs could be the responsibility of either the municipality or property owner which would need to be specified in ECAs or maintenance agreements. As in a property owner approach, the municipality is responsible for educating private

property owners about the BMPs and their inspection and maintenance needs. The municipality is also responsible for the legal tools to require and enforce inspection and maintenance of BMPs on private property (i.e., stormwater infrastructure program policy, maintenance agreements, easements).

In a community that blends public and property owner approaches, BMP inspection and maintenance responsibilities must be clearly documented and communicated for program success. One pitfall in a hybrid approach is when responsibilities are not systematically assigned and communicated. Municipal program staff must understand the conditions of each ECA and maintenance agreement and ensure that private property owners understand their responsibilities. Some recommended methods to assign and communicate inspection and maintenance responsibilities include:

- Use ECA templates or maintenance agreements that clearly document responsibilities for inspection and maintenance tasks;
- Use inspection and maintenance plan templates specific to each type of BMP that clearly describe the required tasks, frequencies and reporting procedures;
- Use easements to clearly document property access rights and responsibilities of both parties See Section 3.3.4 for further guidance on easements;
- Develop and distribute outreach educational materials about what LID stormwater BMPs are, how they work, and their inspection and maintenance needs geared for private property owners and their contractors (i.e., landscaping, road, sewer and roof maintenance contractors);
- Conduct Maintenance Verification inspections of BMPs on private property with representatives of both the municipality and private property owner present, during which inspection and maintenance responsibilities are explained or reiterated; and
- Provide links to BMP specific inspection and maintenance guidance on the municipal stormwater infrastructure program web site.

3.0 STEPS IN PROGRAM DEVELOPMENT

The following sections outline a recommended process for establishing an LID stormwater BMP inspection and maintenance program. Figure 3.1 summarizes eight (8) process steps that are critical in developing municipal SWM BMP inspection and maintenance programs, regardless of the chosen approach to assigning responsibilities (i.e., applicable to any approach), some of which should occur concurrently.

3.1 Develop BMP Inventory

To decide what BMPs will be included in the program and the level of service that can be provided within the constraints of available resources (e.g., funding, staff, equipment), a good understanding is needed of the number of BMPs that already exist and those that are in the planning approvals stage. Combined with information on typical life cycle costs of inspection and maintenance (see Section 7.0 for BMP specific information), it is possible to estimate program budget needs or determine the level of service that can be met with available resources.

The inventory should include compiling information on the physical and regulatory condition of each BMP. The physical condition includes the type of BMP, design criteria and parameters, functional performance targets and associated conveyances. The regulatory condition addresses whether the BMPs were subject to a provincial approvals process (i.e., OMOECC ECA or CofA) or if they are covered by maintenance agreements between the municipality and the property owner and located within rights-of-way or easements that are accessible for inspection and maintenance tasks.

At a minimum, the inventory should capture all BMPs designed or installed to meet regulatory requirements/requirements through the planning approvals process. To the greatest extent possible, retrofitted BMPs subject to a stormwater utility fee credit or to meet combined sewer overflow (CSO) abatement plan or mandatory downspout disconnection program requirements should also be included in the inventory. The level of effort required to collect information about BMPs on private land may warrant excluding them from the inventory or municipal program, such as voluntary lot level BMPs on residential properties (e.g., rain barrels, rain gardens, soakaways, permeable driveways). Inventory work should include collecting information about the conveyances that deliver stormwater to the BMP in addition to the BMP itself. Table 3.1 lists types of information that should be included in a BMP inventory. To gain an understanding of the immediate maintenance needs of existing BMPs, it is recommended that the inventory include field inspections in addition to desktop work to compile available records.

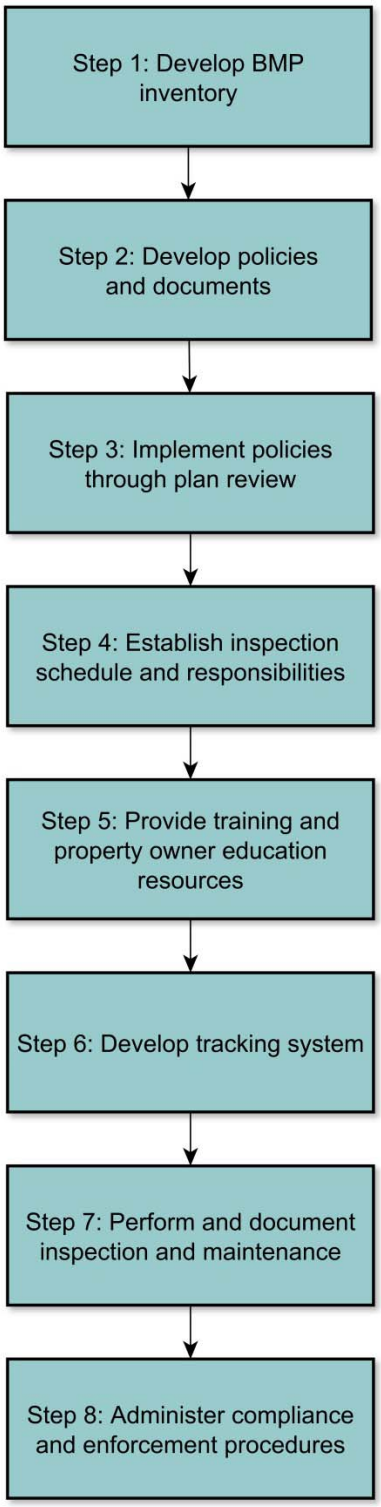

Figure 3.1: *Summary of recommended program development steps.*

Table 3.1: *BMP inventory checklist.*

Physical Condition	Regulatory Condition
◖ Location of BMP (watershed, subwatershed, property address, BMP geographic coordinates) ◖ Type of BMP ◖ Design criteria and functional performance targets ◖ BMP design features (e.g., Contrinbuting Drainage Area (CDA) size and imperviousness, BMP footprint area, water storage volume/design storm, pipe size, pretreatment devices, filter/growing media specifications, etc.) ◖ Conveyance design features (e.g., pipe size, pretreatment devices, etc.) ◖ Structural integrity (e.g., pavement, curbs, catchbasins, manholes, inlet/outlet, observation wells, etc.) ◖ Status of sediment/trash maintenance ◖ Measured sediment accumulation rate ◖ Inlet/outlet obstruction or erosion ◖ Evidence of standing water ◖ Status of vegetation	◖ Is BMP on public or private land? ◖ Is BMP within a right-of-way? ◖ Is BMP within an easement? ◖ Is the BMP adequately accessible for inspection and maintenance? ◖ Are there any utility easements that could complicate BMP maintenance/repair? ◖ Are copies of the final approved stormwater plan, design brief /drawings on file? ◖ Is there an OMOECC ECA (formerly CofA)? ◖ Is it part of an approved site plan or subdivision agreement? ◖ Is a maintenance plan or agreement in place? ◖ Are copies of as-built drawings on file? ◖ Are historical inspection and maintenance records available?

3.2 Develop Program Policies and Documents

This step requires critical policy-making decisions that will serve as the foundation for program budget and staffing and for determining the appropriate levels of service for the program. A typical first decision may be determining responsibility for routine inspection and maintenance versus structural repairs. In some communities, simple routine tasks such as inspection of inlets, outlets and vegetation and routine weeding, trimming, mowing and trash removal are performed by the property owner. Table 1.1 provides additional considerations for level of service policy decisions.

For a municipality, the program's legal and administrative foundation must be established in a municipal stormwater management policy (e.g., stormwater utility by-law, sewer use by-law), standard maintenance agreement templates and development permit application forms.

The overarching policy that establishes the municipal stormwater management program must include the following critical elements to be able to require inspection and maintenance of BMPs on private property and to authorize the municipality to enforce ECA and maintenance agreement conditions:

1. Legal authority for a municipality to manage stormwater and applicability provisions that dictate what BMPs will be included in the municipal program versus those that are exempt, and conditions for granting a variance;
2. Description of the permitting and stormwater plan review process including required plan review submission documents and conditions for approval;
3. Requirement that all permanent stormwater BMPs be routinely inspected and maintained by the responsible party, including those not subject to, or part of an OMOECC ECA;
4. Requirement for a maintenance agreement recorded with property title for BMPs on private property that specify right-of-entry for Maintenance and Performance Verification inspections by municipal staff or their contractors;
5. Requirement for BMP specific inspection and maintenance plans that are part of the maintenance agreement, set the schedule of inspection and maintenance tasks and describes reporting requirements and procedures;
6. Requirement for easements around BMPs and/or connections to municipal infrastructure on private property that provide access for Maintenance and Performance Verification inspections, and structural repairs;
7. Maintenance agreement compliance and enforcement provisions;
8. Requirement for a performance bond to cover the cost of rehabilitation or reconstruction needed to address any deficiencies revealed through inspection and testing; and
9. Requirement for as-built plans certified by a professional engineer and landscape architect (where applicable) and satisfactory Assumption inspection prior to release of the performance bond.

Other important program documents that form the administrative foundation of the municipal program include:

- SWM system design criteria that include requirements for features that help reduce the frequency of structural repairs (e.g., pretreatment devices upstream of BMPs) and that improve ease of inspection and maintenance tasks (e.g., features that allow the BMP to be taken off-line or drained by gravity). See Section 4.0 for tips on stormwater BMP design standards and plan review process that will improve inspection and maintenance program success;
- Standard maintenance agreement templates;
- Standard easement conditions and specifications (i.e., when required, width, rights of grantor and grantee);
- Standard inspection and maintenance plan templates for each type of BMP;
- Performance bond template;
- Notice of violation letter template;
- Schedule of penalties for non-compliance with maintenance agreement conditions;
- Educational materials on BMP function, key components, inspection and maintenance requirements and reporting procedures to educate property owners and inspectors (i.e.,

consultants, contractors and municipal staff). Guidance provided in Part 2 of this document can be used to develop BMP specific outreach education materials.

More detailed guidance on the legal and administrative foundation for a municipal stormwater program is provided in the Center for Watershed Protection guide, Managing Stormwater In Your Community: A Guide for Building and Effective Post-Construction Program (CWP, 2008), including a model municipal stormwater policy development tool and examples of maintenance agreements and maintenance easements.

In the context of a proposed new development or redevelopment of a property, the Province of Ontario provides a legislative framework that allows municipalities to place conditions on property titles regarding matters relating to sustainable development and environmental protection, including SWM. The Ontario Development Permit System (DPS) established by Ontario Regulation 608/06, came into effect January 1, 2007. Municipalities can use the DPS to apply conditions to a development permit related to periodic stormwater BMP inspection and maintenance tasks considered necessary for protection of the natural environment and public health and safety. Because the DPS conditions are registered to the property title, this makes them binding for all subsequent owners of the property. However, this only applies when a development permit is required. The DPS is not suitable for ensuring inspection and maintenance of voluntary stormwater BMPs retrofitted into existing developments. For more information about the Ontario Development Permit System see the Ontario Ministry of Municipal Affairs and Housing website (www.mmah.gov.on.ca).

An example of an Ontario municipality using the powers granted by the DPS is the City of Toronto, where green roofs are required for new residential, industrial, commercial and institutional developments with a certain size of roof area through the Green Roof By-law (City of Toronto, 2010). Green roof maintenance plans are required through site plan approvals and are attached to the property title so responsibilities are transferred when property ownership changes.

3.3 Implement Policies through Plan Review

3.3.1 Stormwater plan Review Submission Requirements

The plan review process should ensure that all the documents necessary for ensuring stormwater BMPs are inspected and maintained are in place when a development or redevelopment proposal is approved. These include:

- Maintenance agreement that is recorded with the property title that identifies the responsible party and the applicable lot(s) and specifies right-of-entry for Maintenance and Performance Verification inspections by municipal staff or their contractors;
- Inspection and maintenance plan specific to each type of BMP in the subdivision or site plan, which are part of the approved stormwater plan and maintenance agreements for BMPs located on private property. Guidance provided in Section 7.0 of this document can be used to develop BMP specific inspection and maintenance plan templates, which will need to be

prepared by the municipality to reflect how responsibilities for inspection, maintenance and record keeping tasks are assigned in that jurisdiction. Municipal templates should be provided to the design consultant who would prepare the BMP specific plans as part of document submissions for planning approval. The municipality should provide the BMP specific inspection and maintenance plan to the property owner or purchaser along with broadly accessible information about the BMP, its maintenance needs and sources for additional guidance;

- Maintenance easements around BMPs on private property that provide access to municipal staff or their contractors to perform Maintenance and Performance Verification inspections that are of adequate size to complete the maintenance tasks involved and recorded on the final property survey and title;
- Performance bonds, to provide a financial guarantee that the BMPs are installed correctly and maintained for a certain warranty period prior to assumption by the responsible party. Refer to Tool 7 in the Center for Watershed Protection guide, Managing Stormwater In Your Community: A Guide for Building and Effective Post-Construction Program (CWP, 2008) for more detailed guidance.
- Detailed design and landscaping plan drawings that include BMP features needed for inspection and maintenance. Such features should include monitoring wells in infiltration BMPs, standpipes or manholes connected to sub-drains for inspection and routine flushing, paths for accessing the BMP with equipment needed to perform routine maintenance task (e.g., jet-vac trucks and vacuum sweeping equipment), and pretreatment devices to extend the lifespan of BMPs and delay the need for structural repairs/rehabilitation (e.g., unclogging pipes and filter beds). See Section 4.0 for more detail on key considerations about BMP inspection and maintenance needs during final design and plan review stages.

Consideration of the inspection and maintenance needs of LID BMPs by plan reviewers (i.e., provincial, municipal and conservation authority staff) should occur early in the plan review and approvals process. Document submission requirements for subsequent stages should be clearly communicated to the applicant. Requirements for BMP features needed for inspection and maintenance and pretreatment devices should be communicated to the applicant to help ensure they are considered during detailed design of the BMPs and included on final design and construction drawings.

At an early stage in the design and planning approvals processes it is a good idea to include individuals that will be responsible for performing inspection and maintenance tasks (e.g., property manager or their contractors, municipal roads and parks operations departments) in the review of the proposal. This can help identify design features that will make performing the work easier, and avoid approving BMPs that the organization may not have the capacity to inspect and maintain. If there is a stormwater utility fee and credit program in place, this is the stage when decisions around fees and credits also need to be made.

Once the plan is approved, the project moves to the construction phase, during which inspections are performed to verify that BMPs on the plan are installed correctly. Accurate documentation should be

provided and centralized so that inspectors, and ultimately the parties responsible for maintenance, can locate the BMPs and understand their specifications. The types of documents needed from the plan review process to build an effective stormwater infrastructure asset management system and BMP tracking database are listed below. The use of georeferenced databases that can be linked to geographic information systems (GIS) and mobile devices for data collection is recommended to assist with locating BMPs in the field, keeping track of inspection results and maintenance records, scheduling Maintenance and Performance Verification inspections and determining when compliance enforcement actions are warranted.

- Project information: name of project, location, file or tracking number, file location;
- Plan reviewer contact information;
- Information from stormwater plan: number and type of BMPs, where they are located (address, lot number), design specifications, approved engineering and landscaping plan drawings and details;
- Copies of the property survey and title showing easements;
- Copies of ECAs or maintenance agreements;
- Inspection and maintenance plans specific to the BMP type;
- Performance bond form.

3.3.2 Maintenance Agreements

In Ontario, ECAs issued by OMOECC include conditions regarding BMP operation, maintenance, inspection and testing (i.e., monitoring), and associated record keeping and provide a potential mechanism for enforcing compliance with BMP inspection and maintenance plans. They include a Change of Owner section that requires notification of the OMOECC when property ownership changes. When a property is purchased, the new owner acquires the conditions of applicable ECAs.

For permanent BMPs that are not part of an OMOECC ECA, a maintenance agreement (i.e., contract) between the municipality and the property owner may be needed to guarantee that specific inspection and maintenance tasks are performed over its life cycle. It usually specifies enforcement actions that the municipality may take in cases of non-compliance. The maintenance agreement should be registered in the property title. When a property where a BMP subject to a maintenance agreement exists is sold, it is important that mechanisms are in place to update municipal stormwater infrastructure program databases, ideally in an automated manner (e.g., linked to a centralized property information system).

Critical elements to be included in a standard maintenance agreement template are as follows (Herrera Environmental Consultants and Washington Stormwater Center, 2013):

- Identifies the applicable lot;
- Links the agreement with the property title so the conditions transfer to the new owner when the property is sold;

- Identifies and characterizes the BMP(s) on site (e.g., as-built drawings, property survey showing rights-of-way or easements);
- Includes inspection and maintenance plans specific to BMP type;
- Assigns long-term responsibilities for routine inspection and maintenance tasks and non-routine, structural repairs;
- Describes compliance and enforcement procedures and timelines;
- Specifies right-of-entry by the municipality for periodic Maintenance and Performance Verification inspections and to perform necessary maintenance or structural repairs.

3.3.3 Inspection and Maintenance Plans

Inspection and maintenance tasks and their respective frequencies vary depending on the type of BMP and local contexts (i.e., some BMPs may warrant a greater level of service due to their location or characteristics of the receiving water). The inspection and maintenance plan sets the schedule for Assumption inspections, routine tasks and Maintenance and Performance Verification inspections and must be part of stormwater plans and maintenance agreements. It also describes record keeping and reporting procedures which will vary by municipality.

Standard templates for inspection and maintenance plans that are specific to the type of BMP need to be developed by the municipality to reflect how responsibilities for the various tasks and associated record keeping are assigned. Section 7.0 in Part 2 of this document provides information needed to prepare template inspection and maintenance plans for seven types of LID BMPs. Depending on level of service policy decisions, municipalities may choose to refine the frequencies of certain tasks for some types of BMPs or in certain local contexts. However, what is described in Section 7.0 should be considered to be recommended minimum standards.

Key elements to be included in BMP specific inspection and maintenance plan templates are:

- Brief overview of what the BMP is, how it works, what benefits it provides and its key components, including generic diagrams;
- Inspection tasks and frequencies (i.e., inspection schedule);
- Field inspection data form or checklist;
- Routine maintenance requirements (tasks and frequencies) and checklist;
- Include acceptance criteria with tolerance limits or ranges for visual and functional performance testing indicators that trigger when maintenance, repair, rehabilitation or further inspection is needed;
- Operating instructions for outlet component (if applicable);
- Structural repair procedural options;
- Record keeping requirements and reporting procedures.

3.3.4 Maintenance Easements

A maintenance easement is a legal instrument that grants the municipality right-of-entry to a private property for the purpose of inspecting and maintaining municipal or private infrastructure. Securing easements after a BMP has been built and after properties are occupied is time-consuming and has uncertain results. Therefore municipalities should strive to secure maintenance easements around regulated BMPs to be located on private property during the planning process through the review of stormwater plans. To be of legal standing, the easement must be shown on the property survey and recorded in the title. They should be included in the maintenance agreement but may be a separate document in instances when a maintenance agreement is not in place.

Maintenance easements should cover:

- The footprint of the BMP;
- Routes that facilitate access to the BMP by equipment needed for maintenance (e.g., irrigation equipment, hydro-vac trucks, vacuum sweepers) or repair (e.g., construction equipment) and a sufficient margin around all components to perform the work; and
- Conveyances and pretreatment devices associated with BMPs (if applicable under the level of service provided according to the stormwater infrastructure program criteria).

Access requirements for inspection, maintenance and structural repairs will vary depending on the type of BMP. Different standards may be needed than those typically used by municipalities for stormwater detention ponds. The municipality will need to develop standard easement templates for each type of BMP that specify when they are required, their width and rights of the grantor and grantee, along with procedures for recording easements. Access routes within easements, with suitable load-bearing capacity, should extend to all BMP components that will require access by heavy machinery for maintenance or repair, including conveyances and pretreatment devices, inlets and outlets.

3.4 Establish Inspection Responsibilities and Schedule

Over the various life cycle phases of a BMP there are four distinct categories of inspection activities, with different objectives and procedures associated with each category.

1. Construction: During construction inspections are needed to ensure that the BMP installation procedures are appropriate, that adequate ESCs are in place to prevent the BMP function from being compromised, and that materials meeting the specifications in the approved design drawings are used.
2. Assumption: When construction is completed, an as-built survey and thorough inspections are needed to confirm that the BMP was installed as designed with specified materials and is functioning properly.
3. Routine Operation: Over the operating phase routine inspections are needed to determine if the preset schedule of routine maintenance tasks specified in the inspection and maintenance

plan is sufficient and to identify when structural repairs are needed or further investigations into BMP function are warranted.

4. Maintenance and Performance Verification: Also over the operating phase, as the BMP ages, periodic inspections should be done to ensure compliance with the ECA or maintenance agreement conditions and BMP specific inspection and maintenance plan, and to evaluate functional performance and determine when repair, rehabilitation or replacement is warranted.

There are a variety of ways that inspection responsibilities could be assigned. The following subsections provide recommendations and describe some options for establishing inspection responsibilities and schedules. Detailed guidance on critical timing of inspections, the types of indicators that should be used, inspection and testing procedures and criteria for acceptance, and triggers for follow-up action specific to each LID BMP type, is provided in Part 2.

3.4.1 Construction Inspections

Construction inspections should be a shared responsibility between the property owner or their project manager, the designers (i.e., engineer and landscape designer) and the construction contractors.

Many municipalities already conduct some form of inspection of infrastructure they will eventually assume during its construction. Those that do not might choose to work with internal departments (e.g., road or building inspectors, parks/landscaping inspectors) or other agencies (e.g., conservation authorities) that routinely conduct inspections at active construction sites. With adequate training and staff resources, it might be possible to integrate stormwater BMP inspection duties during construction into existing programs. If the workload or skill set needed is beyond what existing programs can handle, or the timing of other types of inspections do not coincide with critical timing of BMP construction inspections, hiring of trained contractors or allocation of dedicated stormwater infrastructure program staff may be necessary.

There are a number of legitimate options to consider regarding who to involve in inspections during BMP construction:

- Consultants and contractors retained by the project proponent/developer or property owner;
- Consultants retained by the municipality (when they are not the proponent or property owner but still choose to be involved);
- Existing municipal inspection staff (e.g., inspectors of ESCs, roads, buildings);
- Dedicated stormwater infrastructure program staff.

Table 3.2 describes some pros and cons for each option.

When responsibility for conducting construction inspections is left entirely to the project proponent/developer or property owner (typically the case), individuals performing them should not be limited to employees of the construction contractor. In this scenario, the designers of the BMP (i.e., engineering and landscape design professionals) should be involved. It may be desirable to involve the project manager (where applicable), whether they are an employee of the proponent/developer or property owner or a consultant. The proponent/developer or property owner should ensure their construction contractors and inspectors are trained in, and experienced with installing and inspecting ESCs (e.g., Certified Professional in Erosion and Sediment Control – CPESC; Certified Inspector of Erosion and Sediment Controls - CIESC) and LID SWM BMPs (e.g., conservation authority training workshops).

Table 3.2: *Pros and cons of using different construction inspection options.*

	PROS	CONS
Using Consultants and Contractors Retained by the Developer or Property Owner		
	◖ Allows the designers (i.e., engineers and landscape architects), who are most familiar with the BMP, to be involved ◖ Cost is borne by the developer/owner ◖ Inspector observations are made independent of political pressures ◖ Municipality can concentrate on stormwater infrastructure program administration and outreach education	◖ Potential for conflict of interest issues if those involved are limited to employees of the construction contactor
Using Existing Municipal Inspection Staff		
	◖ Efficient use of staff ◖ Helps with integration of inspection of ESCs on municipal construction sites ◖ Allows inspectors to stay with the project through the entire construction period	◖ May stretch existing staff beyond their capabilities ◖ Stormwater BMP inspections might not get adequate attention ◖ Critical timing of BMP inspections may not coincide with other types of inspections
Using Dedicated Stormwater Infrastructure Program Staff		
	◖ Inspectors can concentrate on stormwater BMPs ◖ Inspector is specifically trained for their duties ◖ Follow-up and enforcement is easier	◖ In many municipalities and property management organizations, would require hiring additional staff ◖ Requires additional communication and coordination between inspectors with different responsibilities

The frequency of Construction inspections may be determined by the municipal stormwater infrastructure program policy or may be general program targets (e.g., weekly, after large storm events, as triggered by construction milestones and hand-off points between different contractors). At a minimum, inspections should occur just prior to the onset of BMP construction to ensure

compliance with erosion and sediment control plans and after any large storm event (e.g., 15 mm rainfall depth or greater) during the BMP construction period.

Sections 6.1 and 6.1.1 provide further guidance on Construction inspection objectives and tasks, skills required by inspectors, and a recommended stepwise process for conducting them. Section 7.0 provides detailed guidance regarding critical timing of Construction inspection tasks for each type of LID BMP. Further guidance on best practices to avoid common pitfalls during construction of LID BMPs is provided in Credit Valley Conservation's Low Impact Development Construction Guide (CVC, 2012).

Feedback from Construction inspections should be used to correct any issues associated with BMP installation or ESCs and to identify when changes to the installation procedures, ESCs or BMP design are needed due to site circumstances or complications encountered.

In cases where the project proponent or property owner uses a formal bidding process to select a construction contractor, opportunities exist to include special provisions in tender documents or contracts that will help ensure that LID BMPs receive adequate inspection and maintenance during construction. Special provisions are technical specifications for products, procedures and techniques to be used during construction. Construction supervisors use these technical specifications to ensure contractors comply with minimum standards and design details.

Special provisions in tender documents or construction contracts related to LID BMP installation that can be included to help ensure adequate inspection and maintenance during construction include the following (CVC, 2014a):

1. Clearly outline the work required to install each type of BMP and list the activities involved;
2. Detail the product and material specifications and whether approved equivalents are permissible;
3. Outline installation procedures for each type of BMP and critical points in the sequence of activities when Construction inspections are required before proceeding further (e.g., checking elevations and grades of excavations and pipes prior to backfilling);
4. State any testing requirements or quality assurance documentation for construction materials that must be received and accepted prior to delivering the material to the site (e.g., filter media, aggregate material);
5. Specify maintenance tasks the contractor is responsible for, including procedures and conditions for when or how frequently they need to be done (e.g., sediment removal from BMP pretreatment devices and conveyance structures, maintenance of plantings over the warranty/establishment period).

For more detail and examples of how special provisions relating to LID BMPs can be used in construction tender documents and contracts refer to Credit Valley Conservation's Grey to Green Retrofit Guides (e.g., CVC, 2014b).

3.4.2 Assumption Inspections

Assumption inspections should be a shared responsibility between the property owner or their project manager, the designers (engineering and landscape design professionals) and construction contractors involved in the project. When the municipality is not the property owner, they may choose to not be involved in performing or reviewing such inspection work but should still receive copies of Assumption inspection records so that an inventory database of permanent stormwater BMPs on private property that connect to municipal infrastructure can be developed and maintained. Other terms for such inspections include deficiency, project acceptance or certification inspections.

At a minimum, Assumption inspections should be performed:

1. Immediately after site construction (including landscaping) ends (i.e., the deficiency inspection) prior to substantial completion of construction, release of performance bonds (if applicable) and beginning of the warranty or establishment period, and;
2. Prior to termination of the warranty or establishment period (e.g., 2 years after substantial completion of construction), release of any maintenance holdbacks (if applicable) and assumption by the property owner.

Feedback from inspections should be used to correct any deviations from the approved design or material specifications not approved through change orders, deficiencies in BMP function due to how it was designed or installed and to initiate follow up to replace failed plantings that are under warranty. Once satisfactory results from Assumption inspections are achieved the performance bond(s) are released and the property owner assumes the BMP and becomes responsible for inspection and maintenance tasks. At this stage, documentation of results from Assumption inspections, and records describing the maintenance tasks performed over the establishment or warranty period should be provided by the consultant or municipality to the property owner. The municipality should also receive this information if they are not the inspector or owner and the BMP qualifies for inclusion in their program.

Sections 6.1 and 6.1.2 provide further guidance on Assumption inspection objectives and tasks, timing of inspections and skills required by inspectors. Section 7.0 provides detailed guidance specific to each type of LID BMP regarding key components to be inspected and what visual and testing indicators should be used. Appendix D provides template field data forms for recording inspection results.

There are a variety of approaches to ensuring thorough and satisfactory Assumption inspections of LID BMPs are completed prior to assumption by the property owner but the following contractual and administrative strategies should be considered.

Performance Bonds, Letters of Credit and Cash Sureties

A common method for ensuring BMPs are ready for acceptance/assumption at the end of construction and prior to termination of the construction contract is to require that a performance bond, letter of credit or cash surety be submitted by the contractor to the property owner as a condition of the contract, ideally in an amount equivalent to the full cost of the work. In such cases, construction contracts should specifically require that thorough inspection and testing of the BMPs be completed to the satisfaction of the property owner or their project manager and design consultants as a condition of Assumption, contract termination and release of the performance bond, letter of credit or cash surety.

Holdbacks in Construction Tenders or Contracts

The property owner can specify in construction tenders or contracts to retain a certain percentage of the total value of the work done for a period of 12 months from the date of final completion. In such cases, construction contracts should specifically require that thorough inspection and testing of the BMPs be completed to the satisfaction of the property owner or their project manager, design consultants and construction contractors as a condition of Assumption, contract termination and release of the holdback amount.

3.4.3 Routine Operation Inspections

Routine Operation inspections should be the responsibility of the property owner or their contractors. At a minimum, Routine Operation inspections should occur annually, but twice annually (in spring and fall seasons) is preferable for vegetated BMPs. More frequent inspections may be warranted for highly visible BMPs, those receiving drainage from high traffic areas (vehicle or pedestrian), or those designed with larger than recommended impervious drainage area to pervious BMP footprint area ratio (i.e., I:P ratio).

Feedback from inspections should be used to immediately address routine maintenance needs, schedule structural repairs or further investigations into potential problems with BMP function and to adjust the preset schedule of routine maintenance tasks to optimize the use of program resources.

Sections 6.1 and 6.1.3 provide further guidance on Routine Operation inspection objectives and tasks, timing of inspections and skills required by inspectors. Section 7.0 provides detailed guidance specific to each type of LID BMP regarding key components to be inspected and what visual and testing indicators should be used, routine maintenance tasks and recommended minimum frequencies. Appendix D provides template field data forms for recording inspection results.

3.4.4 Verification Inspections

Verification inspections should be the responsibility of the municipality or be a shared responsibility between the property owner (e.g., hires consultant to perform and document the inspections) and

municipality (e.g., approves and tracks documentation). A Verification inspection could replace one Routine Operation inspection that the property owner is responsible for that year.

For permanent BMPs designed and installed to meet regulatory or municipal program requirements, inspections to verify compliance with ECA or maintenance agreement conditions and associated BMP specific inspection and maintenance plans (i.e., Maintenance Verification inspections) should occur on five (5) year intervals beginning after the date of assumption. Maintenance Verification inspections should also be performed when property ownership changes to ensure the new owner is not assuming a BMP that has been neglected by the previous owner, and to help educate the owner about their inspection and maintenance and record keeping responsibilities. Inspection and testing to verify that functional performance remains acceptable (i.e., Performance Verification inspections) should at a minimum, occur on fifteen (15) year intervals beginning after the date of assumption. More frequent Performance Verification inspections may be warranted for BMPs draining to highly sensitive receiving waters or habitat of species at risk. Testing of functional performance (e.g., surface infiltration rate testing, natural or simulated storm event testing, continuous monitoring) is done in addition to Maintenance Verification inspection indicators (i.e., visual indicators and sediment accumulation testing).

Feedback from Maintenance and Performance Verification inspections should be used to initiate compliance enforcement actions if warranted and schedule structural repairs or further investigations into observed problems with BMP function.

Sections 6.1 and 6.1.4 provide further guidance on Verification inspection objectives and tasks, timing of inspections and skills required by inspectors. Section 7.0 provides detailed guidance specific to each type of LID BMP regarding key components to be inspected and what visual and testing indicators should be used, and structural repair options. Appendix D provides template field data forms for recording inspection results.

3.5 Provide Training and Property Owner Education Resources

Property owners are often unaware of what a LID BMP is, what benefits it provides, what they are responsible for, and what components need to be regularly inspected and maintained. Municipal and conservation authority staff, design professionals, construction contractors and project managers involved in projects that include LID BMPs need to be trained on their design, construction, inspection, maintenance and monitoring. Providing access to training programs and educational resources about LID BMPs, targeted to these audiences is essential for stormwater infrastructure program success.

3.5.1 Inspector Training

Since LID BMPs are an innovative approach to SWM and experience with their design, construction and operation is limited in most organizations, training programs for consultants or staff that will be

responsible for conducting LID BMP inspections will be needed. Inspectors of LID BMPs will need to be trained on:

- Installation and inspection of ESCs;
- Best practices to avoid common pitfalls during construction that can affect BMP function;
- Construction material specifications for LID BMPs;
- Inspection needs for each type of BMP (i.e., what to inspect and test as part of each type of inspection);
- Workplace health and safety procedures for conducting the work (e.g., confined space entry and rescue training for underground components);
- How to perform inspection tasks and testing (i.e., procedures, soil and water sampling and test methods);
- Minimum acceptable functional performance criteria and triggers for follow-up actions; and
- How to use inspection field data forms or other data management tools (e.g., mobile devices linked to a centralized BMP tracking database).

The inspectors should not only understand the above noted topics "on paper" but also understand how they translate in the field. Access to inspector training programs that feature hands-on, experiential learning opportunities with a full range of LID BMP types should be provided.
Consideration should be given to developing an accredited stormwater BMP inspector training program to promote consistency and quality control. Such a program could include training material catered to the specific needs of property owners, engineering and landscape design professionals, construction contractors, municipalities and conservation authorities.

3.5.2 Property Owner Education

Educational resources that inform property owners about LID BMPs, their inspection and maintenance needs and owner responsibilities are critical for successfully implementing an LID approach to SWM. Such resources could also support programs that promote environmental stewardship and adoption of sustainable practices at the watershed, municipal or neighbourhood scales.

Property owner education resources about LID BMPs should cover the following frequently asked questions, at a minimum (CWP, 2008; Herrera Environmental Consultants and Washington Stormwater Center, 2013):

- What is it? (i.e., describe the BMP and mention other commonly used terms);
- What does it do? (i.e., describe the functions and benefits it provides);
- What are my responsibilities as a BMP owner? (i.e., describe the property owners responsibilities regarding BMP inspection and maintenance, record keeping and reporting);
- What does routine inspection and maintenance involve? (i.e., describe the key components that need to be routinely inspected and recommended minimum frequencies of associated maintenance tasks);

- How do I know if it is functioning adequately? (i.e., describe minimum acceptable functional performance criteria in terms of conditions when further investigation or structural repair is needed to address issues with BMP function).
- How do I repair it (i.e., describe procedural options and equipment needed); and
- Where do I look for more information? (i.e., describe where additional resources can be accessed).

Information provided in Part 2 of this document can be used to develop property owner education resources for each type of LID BMP.

3.6 Develop Tracking System

Regardless of whether the municipality or property owner is performing BMP inspection and maintenance tasks, keeping track of these activities is essential. In large municipalities or property management organizations, advanced database systems with links to GIS and mobile devices for field data collection may be needed. An automated notification system could be added to send notices to property owners when inspection and maintenance records need to be submitted, or when an inspection identifies the need for maintenance, repair or further investigation. Table 3.3 describes types of information that should be included in the BMP database.

3.7 Perform and Document Inspection and Maintenance

Once policy decisions have been made regarding what BMPs qualify for inclusion in the municipal program and what inspection and maintenance tasks municipalities will be involved in for BMPs on private property, important questions may still remain about who will do the work to get it done most effectively. The assignment of specific duties will vary depending on whether it is an individual property owner, a property management organization or municipality, and the size of the organization. It is common for all but the largest municipalities or property management organizations to rely at least partially on contractors to conduct infrastructure inspection, maintenance and repair tasks because of equipment costs and the special skills and training needed by individuals performing the work. Table 3.4 describes some options for assigning specific inspection and maintenance duties in both municipal and property owner contexts.

Table 3.3: *Information to include in a BMP tracking database.*

Information Type	Description
BMP identifier	Unique identifier for the BMP
Lot description	Unique identifier for the lot where the BMP is located or legal description of the lot
Municipal permit number	Unique identifier for the development permit
ECA number	Reference to the ECA the BMP is part of
BMP location	Property address and geographic coordinates
Property owner	Address and contact information for the property owner

Date of assumption	Date the owner assumed responsibility for the BMP
Plans	Copies of the stormwater and landscaping plans and drawings
BMP design and performance criteria	BMP type, dimensions, treatment capacity and minimum functional performance criteria
As-built drawings	Copies of as-built drawings certified by design professionals
ECA/maintenance agreement and inspection and maintenance plan	Copy of the ECA or maintenance agreement and associated inspection and maintenance plan
Easement information	Copy of property survey showing easement and title of easement
Inspection records	Documentation from inspection and testing including test results and follow-up actions.
Maintenance records	Maintenance tasks completed
Structural repair records	Repair work orders, date completed, costs
Photographs	Photos of key components for inspection and maintenance and observed deficiencies that warrant maintenance, repair or further investigation.

Another option is forming partnerships between neighbouring local municipalities, local and upper-tier municipalities or other nearby property owners with stormwater BMPs to maintain to maximize economies of scale in hiring contractors/consultants, training and using staff, and obtaining and using necessary equipment.

Regardless of who performs the inspection and maintenance tasks, the following sections provide some tips for ensuring the work is done efficiently and produces the information and feedback needed for an effective program.

Table 3.4: *Options for assigning responsibilities for inspection and maintenance tasks.*

Program Task	Municipality	Contractor
Construction and Assumption inspections	Professional Engineer or Certified Engineering Technologist and Landscape Architect or Horticultural Professional	Professional Engineer or Certified Engineering Technologist and Landscape Architect or Horticultural Professional
Routine Operation inspections	Operations crew leaders or supervisors	Maintenance crew leader or supervisor
Routine maintenance – vegetated components	Parks operations staff	Landscape maintenance service contractor
Routine maintenance – non-vegetated components	Public works and transportation operations staff	Stormwater infrastructure maintenance service contractor
Structural repairs – vegetated components	Parks operations staff	Landscape maintenance service contractor
Structural repairs – non-vegetated components	Public works and transportation operations staff	Stormwater infrastructure maintenance service contractor

Maintenance and Performance Verification inspections	Professional Engineer or Certified Engineering Technologist and Landscape Architect or Horticultural Professional	Professional Engineer or Certified Engineering Technologist and Landscape Architect or Horticultural Professional

3.7.1 Require As-Built Drawings

Through the plan review process, property owners and municipalities should require that as-built drawings be provided that reflect any changes or material/plant substitutions from the approved engineering and landscaping design drawings, details and specifications that were necessary to overcome complications encountered during construction. Once construction of the BMP is completed, the construction contractor and/or engineering and landscape design professional should prepare as-built drawings, design professionals should certify (i.e., sign) them, and submit copies to the property owner (and municipality for regulated BMPs on private property). Standards for as-built drawings will vary by municipality but could be as simple as electronic copies of the approved design drawings (including BMP landscaping/planting plan), details and specifications marked up with changes or material/plant substitutions. The as-built drawings should be entered into the BMP inventory and tracking database(s) so they may be referred to during Acceptance and Verification inspections.

3.7.2 Use Standard Forms for Documentation of Field Activities

Standard inspection data forms for each type of LID BMP should be used to document observations and test results from site visits. BMP inventory and tracking database(s) should be designed to provide the means of uploading the information and associated photographs remotely from mobile devices. Section 7.0 provides standard inspection field data form templates for seven types of LID BMPs. Program managers can use these templates or customize them to best suit their needs.

3.7.3 Take Photographs

Inspectors should take photographs of key components of each type of BMP during Assumption inspections so they can be referred to during future inspections. Section 7.0 provides guidance on what the key components to be inspected and maintained are for each type of LID BMP. The visual records created can be used to train staff or contractors performing routine inspection and maintenance tasks to recognize the key components and what they looked like when the BMP was new.

When a maintenance or performance issue is encountered through visual inspection that warrants structural repair(s), the problem/deficiency and outcome(s) of repair/rehabilitation work should also be documented with photographs, where feasible. The visual records created can be used to train staff or contractors about minimum acceptable functional performance criteria and conditions that trigger the need for follow-up actions.

3.7.4 Document Structural Repair Items

Inspectors should clearly document items that require structural repairs on inspection field data forms and through photographs. The inspector may also mark up a copy of the as-built drawings to note problem areas and potential corrections. The inspection form should contain a field for recording information about any work orders for maintenance or repair issues as follow-up to the inspection. Such record keeping can be used during the next inspection to help confirm that the maintenance or repair was done correctly or if it was effective at addressing the cause of the problem.

3.8 Administer Compliance and Enforcement Procedures

The province or municipality is responsible for enforcement procedures when owners of regulated BMPs are found to not be in compliance with ECA or maintenance agreement conditions regarding inspection and maintenance. Provisions in the municipal stormwater policy must specifically define inspection and maintenance compliance methods, enforcement procedures and timeframes. Municipalities should be responsible for educating property owners about their responsibilities and applicable compliance methods and enforcement procedures.

A tiered enforcement procedure is often best. Initially the non-compliant property owner can be notified of inspection and maintenance task deficiencies. If tasks described in the ECA/maintenance agreement and BMP specific inspection and maintenance plan continue to not be performed or documented adequately, a more formal notice of violation that outlines specific tasks and a schedule for completing them can be issued. In cases of continued non-compliance or negligence, or where lack of maintenance poses a threat to public health and safety, penalties (e.g., fines) may be issued. Alternatively, if a property standards by-law allows, the municipality may choose to enter the property to inspect and undertake necessary maintenance or structural repairs and bill applicable costs to the property owner or apply them to property taxes.

Table 3.5 summarizes several compliance and enforcement methods that should be considered for ensuring regulated BMPs on private property are adequately inspected and maintained.

Table 3.5: *Review of available compliance methods.*

Method	Stage of Compliance	Description
ECA or maintenance agreement	Established during the planning approvals process. Used during the operating life cycle of the BMP as basis for enforcement	A contract between a municipality and a property owner designed to guarantee that specific inspection and maintenance tasks are performed and recorded.
Property Standards by-law	Used during the operating life cycle of the BMP as basis for enforcement	Municipal by-law that provides right-of-entry to a private property by the municipality or their contractors to perform necessary inspection, maintenance or repair work and specifies conditions for determining when property standards are being neglected and how associated costs are recovered (e.g., bill the property owner for associated costs or apply them to property taxes).
Notice of violation	First stage of enforcement after inspection and documentation of non-compliance/negligence	The property owner is sent a notice of violation letter outlining the nature of the violation, the specific actions needed to come into compliance, a schedule for completing the remedies and subsequent enforcement procedures that can be undertaken if the actions are not performed by the owner.
Stormwater utility fee credit revocation	Escalating level of enforcement if notice of violation does not lead to compliance	In cases where a stormwater utility fee and credit program exist, the municipality can revoke or reduce the credit provided to the property owner for having the BMP on their property if, through inspection, it is found to not be in compliance with ECA/maintenance agreement and inspection and maintenance plan provisions or functional performance is no longer acceptable.
Civil penalty	Escalating level of enforcement if notice of violation does not lead to compliance	As an incentive for compliance, the municipality can levy a monetary penalty for non-compliance. This penalty can be a fixed amount, or the amount could increase with the severity of the violation or frequency of reoccurrence.

4.0 KEY CONSIDERATIONS DURING BMP DESIGN AND PLAN REVIEW

Designing LID BMPs with ease of inspection and maintenance in mind is critical to the affordability of stormwater infrastructure asset management programs and must be considered during design and an early stage in the plan review and approval process. The following sections provide tips on tailoring the design of LID BMPs to help reduce the frequency of structural repairs and make inspection and maintenance tasks easier and cheaper to perform.

4.1 Provide Runoff Pretreatment

Pretreatment refers to techniques or devices used to retain coarse materials suspended in stormwater runoff, either through filtration or settling, before it enters the BMP. Proper pretreatment extends the operating phase of the BMP's life cycle by reducing the rate of accumulation of coarse sediment. Thereby, pretreatment helps delay the need for structural repairs like unclogging filter beds, pipes and orifices. Common pretreatment devices include vegetated filter strips, grass swales, geotextile-lined inlet filters, check dams, forebays, eavestrough screens or filters, oil and grit separators (i.e., hydrodynamic separators) and manholes containing baffles, filters and sumps. One important consideration for pretreatment is that these devices require frequent (i.e., annual) sediment and trash removal maintenance and should be easy to access.

4.2 Design Low Maintenance Conveyance Systems

The design of conveyance systems that carry stormwater into the BMP should anticipate potential maintenance issues and include features to minimize or avoid them. For example, during large storm events, rapidly flowing water into or out of the BMP often causes erosion in vegetated practices. Inlet and outlet designs should consider protective features that prevent erosion. The size of inlets to BMPs and their slope also needs careful consideration as small, gently sloping openings are easily clogged with coarse debris and sediment which could cause stormwater flows to by-pass or not enter the BMP, increasing maintenance needs. Curb cuts should curve into the BMP so that flowing stormwater does not have to turn sharply to enter and inlets should be sloped at between 5 and 10%. Inlets should also be easily accessible and unobstructed by permanent covers to make trash, sediment and debris removal maintenance easy to perform. When designing stormwater infiltration BMPs, consideration should be given to where the majority of trash, sediment and debris will accumulate in the BMP and where snow storage will occur (a significant source area for sediment and debris). Infiltration BMPs should include pretreatment devices, inlet designs or forebays that allow accumulation to occur without blocking inflow (e.g., 5 cm change in grade between pavement surface and BMP surface) and that isolate sedimentation areas from the main portions of the filter bed so that the area disturbed through routine sediment removal maintenance is minimized.

4.3 Include Inspection and Maintenance Features

Planning and design of LID BMPs should consider how they will be maintained (e.g., what equipment is needed?) and what features are needed to perform necessary inspection and maintenance tasks. For example, to understand whether or not a stormwater infiltration practice is draining at an adequate rate, features such as monitoring wells that extend to the bottom of the practice will be needed.

The following list provides some examples of inspection and maintenance features that should be considered in the BMP design process.

- For infiltration BMPs, monitoring wells that extend to the bottom and standpipes or manholes connected to sub-drains that allow access for drainage performance verification through water level measurements and routine flushing of sediment from pipes;
- For infiltration BMPs, sub-drain pipes should be 200 mm in diameter and be connected to manholes, maintenance hatches or standpipes (for standpipes, it is best to use two (2) 45 degree couplings) to allow for inspection by closed circuit camera (i.e., push camera) and sediment removal by jet-vac equipment;
- Lockable caps on monitoring wells and sub-drain clean-out standpipes to prevent unauthorized access, tampering, or vandalism;
- Features for taking the BMP off-line or draining stored water by gravity to improve ease of inspection and sediment removal maintenance tasks;
- Inlets should be readily accessible from surface conveyances, catchbasins, manholes or access hatches to avoid the need for specialized equipment for inspection (e.g., closed circuit or remote controlled cameras);
- For vegetated BMPs, consideration should be given to what source of water will be drawn upon for irrigation during the establishment/warranty period, how it will be delivered to the BMP (e.g., is equipment with sufficient volume and pressure available?), and in some cases an irrigation system should be part of the BMP design (e.g., green roofs);
- For vegetated BMPs in high pedestrian traffic areas, consider the need for walkways or stepping stones and barriers to help limit foot traffic to designated portions of the BMP, or discourage it altogether if it is causing vegetation maintenance issues;
- For underground pretreatment devices or BMPs, the associated manholes or maintenance hatches should be close to a drivable surface/path that can support the heavy vehicles needed for sediment removal maintenance (e.g., hydrovac trucks) and consider installing a staff gauge or graduated measuring tape to allow sediment depth to be assessed visually from the ground surface, without having to enter the confined space;
- Safe and efficient means of accessing and exiting a green roof site for installation, inspection and maintenance is a primary consideration as it will influence the time and effort required to transport tools, equipment and materials to and from the site; and

- For green roofs, tie-off points for ladders and personal fall protection safety equipment should be incorporated in the roof design for use by individuals performing inspection and maintenance work.

4.4 Include Planting Plans

All vegetated BMP designs should include planting plans that specify species that can tolerate both wet and dry conditions and, for BMPs that will receive de-icing salt laden runoff during winter, species that are salt tolerant. Where possible, planting should done during the wettest seasons/months of the year (e.g., early spring and mid-to-late fall) to help minimize the need for irrigation during the establishment/warranty period. Use of drought-tolerant and native species will help minimize or eliminate the need for irrigation during the operating phase of the BMP life cycle. Good vegetation cover on the surface and side slopes of BMPs helps to maintain infiltration function, contributes to runoff volume reduction function through evapotranspiration, and helps prevent erosion of soil or mulch by flowing water.

Both common and botanical (i.e., species) names should be used on planting plans so that inspectors and maintainers of the vegetation are better able to recognize or develop the means of recognizing the plants in the field and distinguishing them from weeds. Planting plans should also specify the planting method (e.g., seed vs. sod) and plant or container size (e.g., saplings vs. caliper tree; plugs vs. pots; bare root vs. root ball). Any deviations from the planting plan or species substitutions should be noted on as-built drawings/planting plans.

All construction contracts that include vegetation should specify a minimum two (2) year warranty period (i.e., establishment period) for the plants, which begins after planting is completed, and ends when the BMP is assumed by the owner. Over the warranty/establishment period the contractor is responsible for routine maintenance tasks (e.g., watering, weeding, and sediment and trash removal). Consideration should be given to specifying a phased approach to planting in construction contracts, in which planting occurs in two stages (e.g., fall and the following spring; spring and the following fall) to help ensure the full palette of plants specified in the plan are available. Thereby, any failed plantings from the first stage of planting are sure to be replaced in the second. If many or all plantings of a certain species do not survive the first phase, they can be substituted with another more tolerant or suitable species in the second.

4.5 Plan for Sediment Removal and Disposal

As mentioned previously, it is recommended that, where possible, pretreatment devices be included in BMP designs that help retain coarse sediment and debris in an easily accessible location before it enters the BMP itself. However even with pretreatment devices in place, fine sediment will inevitably reach the BMP and accumulate over time. LID BMP designs need to consider how sediment can be removed from associated manhole sumps, pretreatment devices, inlets and pipes, and include adequate features and routes for access by necessary equipment.

Examples of equipment that may be needed for sediment removal includes the following:

- For permeable pavements, regenerative air sweeper (for routine maintenance) or vacuum sweeper (for rehabilitation) equipment (e.g., street cleaner trucks or more compact units) will be needed, so designs should allow access to the majority of the surface by necessary equipment (e.g., minimize obstructions and sharp corners);
- For inlets, grass filter strips, gravel diaphragms, check dams and forebays of surface BMPs, use of a vacuum sweeper truck with hose attachment, soil blower truck (operated in reverse), sidewalk vacuum or hand tools (e.g., rakes and shovels) are options;
- For removing sediment from the filter beds of vegetated BMPs, use of a vacuum truck with hose attachment, soil blower truck (operated in reverse) or hand tools are options that can minimize the need to remove established vegetation, while use of a small excavator or backhoe can also be effective, but will require vegetation removal and transplanting (where feasible) or replacement after the work is completed;
- For underground BMPs (e.g., underground infiltration systems, soil cells) and associated pretreatment devices (e.g., manhole sumps, hydrodynamic/oil and grit separators, isolator rows, forebays), and in-line filters, hydro-vac trucks will likely be needed.

For underground conveyances (i.e., catchbasins, manholes, pipes), BMPs, pretreatment devices, and in-line filters, sediment removal often requires crews performing the work to enter confined spaces. Contractors or staff performing the work must have confined space entry training to satisfy occupational health and safety requirements (Ont. Reg. 632/05 – Confined Spaces Regulation).

How the material removed from conveyances, LID BMPs, pretreatment devices and in-line filters will be safely and sustainably managed also needs consideration. Due to the small drainage area of most LID BMPs, the rate at which they accumulate sediment and associated contaminants tends to be low in comparison to centralized stormwater treatment facilities like stormwater ponds or detention chambers/tanks that receive drainage from much larger areas. As a result, the potential for sediment accumulated in LID BMPs to qualify as contaminated according to Ontario Brownfields Regulation 153/04 standards for soil and sediment (OMOE, 2011) is low.

Most often, contractors or staff performing sediment removal maintenance procedures will be cleaning multiple BMPs and pretreatment devices at multiple sites on any given day. At the end of the day, the mixture of material collected either manually, or by vacuum equipment (e.g., regenerative air or vacuum sweeper, vacuum/soil blower truck, hydro-vac truck) will include a mixture of re-usable, recyclable and non-recyclable constituents. In order to recover reusable and recyclable materials and minimize the volume of material needing to be managed otherwise, the mixture should be screened to isolate trash (for recycling or disposal), natural debris and mulch (for composting), and gravel- to pebble-sized aggregates (for washing and re-use) from finer (i.e., sand- to clay-sized) material. The sand- to clay-sized material (i.e., material passing a 2 mm diameter (ASTM No. 10) sieve) should then be assessed and managed in accordance with provincial regulations (O.Reg. 347).

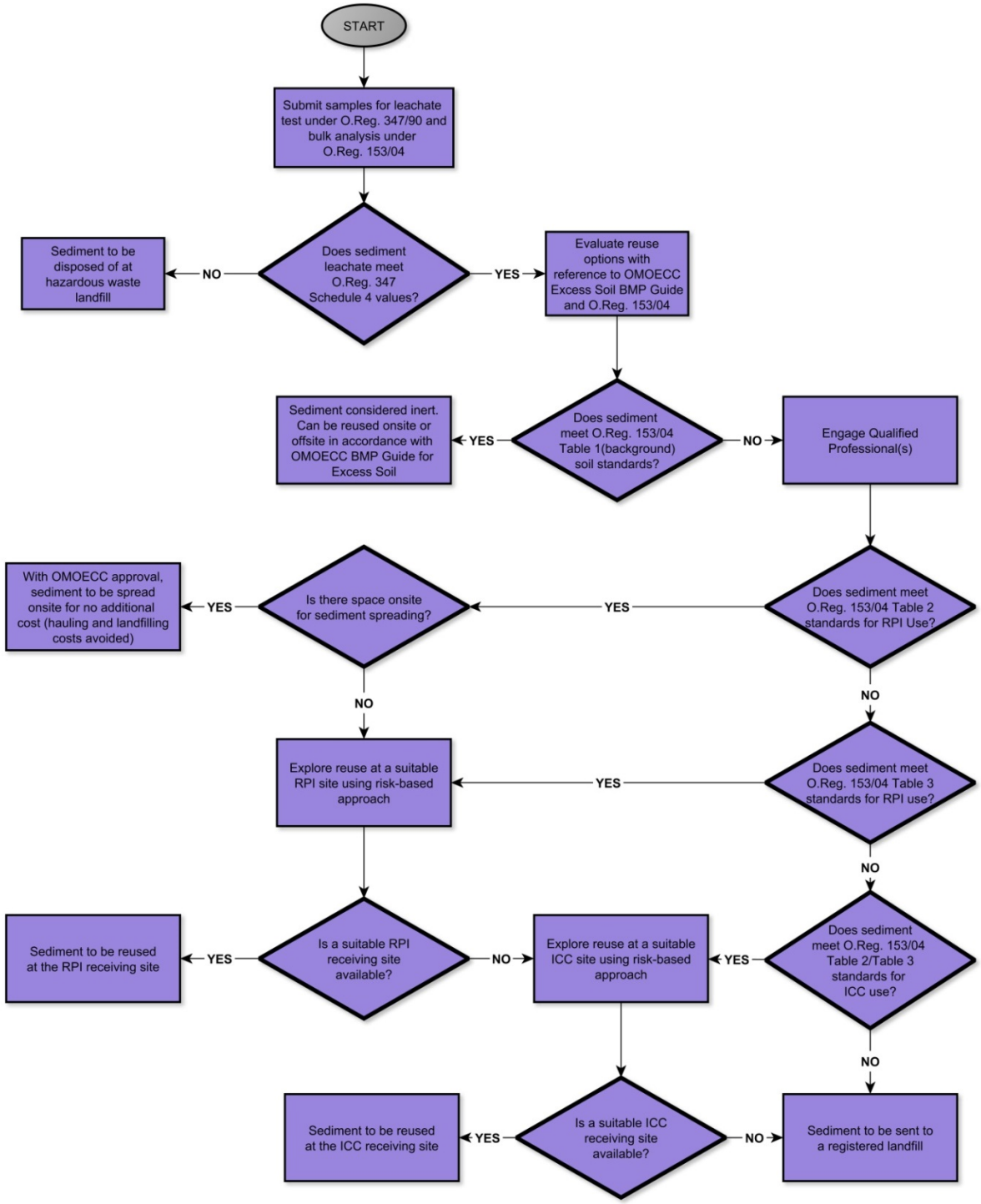

Figure 4.1: *Recommended process for determining reuse and disposal options for sediment from stormwater management BMPs (Source: Inspection and Maintenance Guide for Stormwater Management Ponds and Constructed Wetlands (TRCA and CH2M, 2016).*

Note: This flow chart does not depict OMOECC policy but rather a recommended approach based on TRCA's understanding of current OMOECC operational practices.

Laboratory testing to determine if beneficial reuse (e.g., spreading on landscaped areas or blending with other constituents for use as a soil conditioner) of the remaining sand- to clay-sized constituents is an option that should be considered. Determining beneficial reuse options for all constituents of the accumulated material could provide substantial savings in terms of costs associated with transporting and managing the material off-site. For more detailed guidance on what types of testing should be done on sediment accumulated in SWM BMPs and what standards to apply to determine when beneficial re-use is an option, refer to Chapter 9 of the Inspection and Maintenance Guide for Stormwater Management Ponds and Constructed Wetlands (TRCA and CH2M, 2016). The following flow chart (Figure 4.1) provides an overview of the process recommended in the aforementioned guide for determining sediment reuse and disposal options.

4.5.1 Recommended Laboratory Testing for Characterizing Sediment Quality

The selection of sediment quality analysis parameters should reflect the CDA's land use characteristics and reported spill history. The following are the suggested minimum lists of analytes that would be suitable for sites with no history of point source contamination. It is recommended that the OMOECC be contacted to determine if any spill events or other site specific circumstances would require additional analytes as well. The following step-by-step process would provide the data needed to evaluate the feasibility of beneficial use of the sediment or landfill disposal options.

Step 1A: O.Reg. 347 Leachate Test

As required by O.Reg. 347, testing of leachate toxicity by the Toxicity Characteristic Leaching Procedure (TCLP), establishes whether or not the sediment is hazardous waste, which would require disposal at a hazardous waste facility. This information is typically required by the OMOECC as a key first step in characterizing sediment. It may be advisable to conduct this analysis concurrently with Step 1B (O.Reg. 153/04 Bulk Soil Analysis) so that samples for both tests can be collected during the same visit.

A list of the 27 recommended analytes to be examined to assess leachate toxicity is provided below. This list is a subset of the analytes in O.Reg. 347 Schedule 4. Contaminants from Schedule 4 that are omitted from the list are those that are not found in sediment from BMPs draining residential, commercial and institutional sites.

- Arsenic
- Barium
- Boron
- Cadmium
- Chromium
- Fluoride
- Lead
- Mercury
- Selenium
- Silver
- Uranium
- 1,1-Dichloroethylene
- 1,2-Dichlorobenzene
- 1,2-Dichloroethane
- 1,4-Dichlorobenzene
- Benzene
- Carbon tetrachloride
- Chlorobenzene
- Chloroform
- Dichloromethane
- Methyl Ethyl Ketone
- Tetrachloroethylene
- Trichloroethylene
- Vinyl chloride
- Cyanide, weak acid dissociable
- Nitrate and Nitrite as N
- Total Polychlorinated Biphenyls (PCBs)

Step 1B: O.Reg. 153/04 Bulk Soil Analysis

Bulk soil analysis based on the O.Reg. 153/04 Standards is carried out to evaluate whether sediment is suitable for beneficial use or requires landfill disposal. The OMOECC has, on a case-by-case basis, accepted the contaminant thresholds in O.Reg. 153/04 Table 1 as a basis for classifying sediment as inert. Inert sediment can be used off-site without regulatory approval. Sediments that exceed Table 1 soil standards would require a risk evaluation to identify potential beneficial use options according to land use type (see Figure 4.1).

The following is a base list of bulk soil analytes to be tested. It may be necessary to include additional analytes if land use activities in the CDA or past spills are believed to have introduced contaminants that are listed in the Standards but not included in this list.

- Trace metal scan including hot water extractable boron
- Cyanide
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Petroleum Hydrocarbons (PHCs)
- Sodium Adsorption Ratio (SAR)
- Electrical Conductivity (EC)
- Particle Size Distribution (PSD)

Step 2: Topsoil Analysis and Certified Crop Advisor Report for Beneficial Use Evaluations

The topsoil analysis would only be conducted if the O.Reg. 153/04 bulk soil tests determine that the sediment does not require landfill disposal due to high contamination levels. Topsoil analysis would be necessary to demonstrate that amending the receiving site soils with the sediment would provide a benefit to the soils, as required by the Nutrient Management Act, without inhibiting plant growth. The list of analytes to be considered includes:

- Trace metal scan including hot water extractable boron
- SAR
- EC
- pH
- Soil Organic Matter (OM)
- Extractable (i.e., Available) Nutrients
- PSD

5.0 OPPORTUNITIES FOR PUBLIC INVOLVEMENT

Providing educational materials to property owners can improve compliance with ECAs and maintenance agreements. Stormwater BMP inspector training courses or workshops should be made available that teach participants about the various BMPs, what environmental protection benefits they provide and how to perform inspection and maintenance tasks. Table 5.1 provides a list of typical public stakeholders and strategies for involving them in BMP inspection and maintenance. The following sections describe the strategies further.

Table 5.1: *Key stakeholders in stormwater BMP maintenance and involvement strategies.*

Stakeholder Group	Involvement Strategies
Primary Stakeholders	
◖ Property owners ◖ Consultants and contractors ◖ Municipal inspectors ◖ Municipal operations staff	◖ Inspector training workshops or certification programs ◖ Educational brochures and mailings to property owners ◖ Co-inspections involving property owner or their consultants and municipal representatives
Other Stakeholders	
◖ Residents of neighbourhoods where LID BMPs are present ◖ Elected officials	◖ Volunteer/Adopt-a-BMP program with training and recognition/rewards ◖ Internet resources for basic information and answers to frequently asked questions about LID BMPs.

5.1 Co-Inspections

Municipal inspectors can accompany property owners or their consultants on inspections to help promote thoroughness and consistency. During these inspections, the municipal staff can immediately address any questions or concerns the property owner may have about the municipal program and explain available options for performing necessary maintenance or repair work.

5.2 Training for Inspectors

Training workshops can help ensure thoroughness and consistency in how BMP inspection tasks are conducted. In addition, the peer-to-peer interaction that occurs at such workshops and courses provides participants with opportunities to share field experiences, challenges and solutions. Tying training to an accreditation or certification program can also be a motivator to encourage participation.

5.3 Volunteer/Adopt-a-BMP Programs

To help ease the inspection and maintenance burden for LID BMPs located on public land or in right-of-way, municipalities might consider coordinating a volunteer program that recruits motivated individuals, service groups, neighbourhood associations, or school groups to help with some routine tasks like trash removal or weeding. This approach works for highly visible BMPs that have safe and easy access. Volunteers could also report potential problems or more labor-intensive maintenance needs to the municipality. Certificates of accomplishment, prizes, publicity or other incentives can be used to recruit volunteers and provide a rewarding experience.

5.4 Website Resources

Municipalities should provide access to resources on their website that provide basic information and answer frequently asked question about LID BMPs, written in broadly accessible, non-technical language. Consideration should be given to providing a means for residents to report specific BMP maintenance issues, request an inspection or ask technical questions on-line.