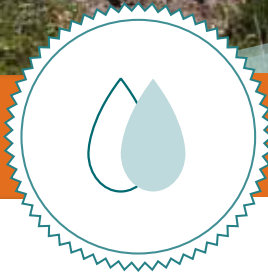




Lakeside Park

Location: Mississauga
Constructed: 2012



Public Lands

Project Objectives, Design and Performance

- City of Mississauga sought to create a green infrastructure demonstration site consistent with 2008 Mississauga Waterfront Parks Strategy.
- The 25-acre park includes several low impact development (LID) features as well as recreational amenities such as a splash pad, play structure, and leash free park.
- LID at the park includes a bioswale, green roof, pervious concrete overflow parking area, and repurposed water irrigation system.
- CVC staff are currently monitoring the water levels, landscape health and maintenance needs of the bioswale in order to understand the life cycle performance of LID practices.

Overcoming Barriers and Lessons Learned

- Implementation of LID helped preserve the natural environment while also adding aesthetic value to the park.
- As the park included numerous innovative features, the City partnered closely with CVC and industry experts to ensure the features were designed and constructed correctly.
- Parking lot runoff flows over sidewalks to enter the bioswale which has resulted in some icy sidewalks in winter requiring the use of de-icers. When designing LID practices, pedestrian and flow path conflicts should be considered.
- Invasive species have been spotted within the bioswale and are suspected to be blowing in from neighbouring properties. Training maintenance staff to identify invasive species can help to prevent the spread of invasive plants.

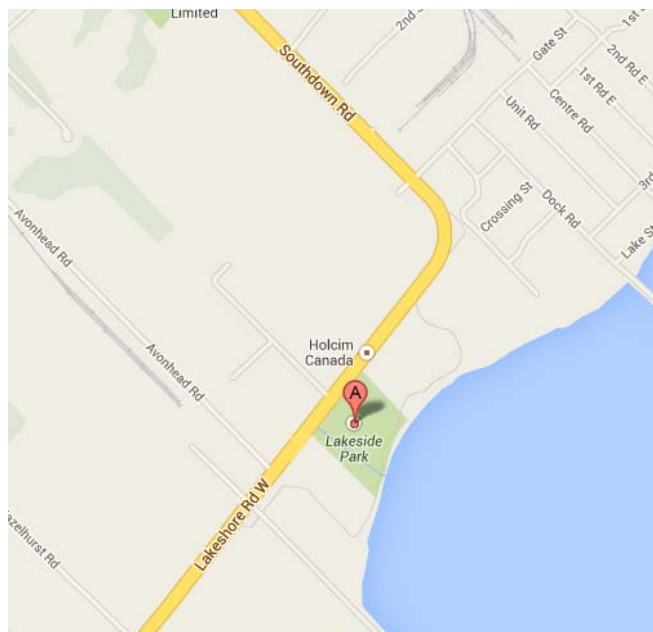
Practices Implemented



Barriers and Issues Encountered

Overview

Lakeside Park is one of the City of Mississauga's newest parks located on Lakeshore Road West, east of Winston Churchill Blvd in Mississauga, ON. The 25-acre park was redeveloped in 2010 and officially opened in June 2012. It is a destination park for the greater community, as it features several recreational amenities including a leash-free dog walking area, spray pad, waterfront and park trails, and a play structure.



Location of Lakeside Park

The goal in the design and development of Lakeside Park was to balance natural features with an active recreational program. In addition to the recreational features, the site also incorporates several low impact development (LID) practices in order to achieve this balance. Green infrastructure at Lakeside Park includes a pervious concrete overflow parking area, bioswale, green roof, and a reclaimed water irrigation system that uses recycled water from the site runoff and spray pad. These LID features not only provide stormwater management functions, but also add to the overall functionality and aesthetic of the park.

Goals & Drivers

In 2008, the City of Mississauga developed the Waterfront Parks Strategy, guided by the principal of putting the environment first. Lakeside Park was one of five priority parks chosen for redevelopment with a focus on green infrastructure. As the park is located in a highly industrial area in Mississauga, the city opted to incorporate this into the design. Several park features were designed to display the contrast between

industrial and waterfront landscapes. This was done through the use of industrial colours and materials.

The goals and drivers for this project included:

- Construct a park consistent with the City of Mississauga's Waterfront Parks Strategy.
- Develop green infrastructure demonstration site.
- Design a complementary landscape focusing on the contrast between industrial and waterfront landscapes.



Lakeside Park balances natural features with recreational programming through the low impact development.

Successes

Innovative Project – Lakeside Park uses innovative green infrastructure to reduce its environmental impact while increasing the aesthetic of the park. For instance, the reclaimed water irrigation system is used to irrigate the park grounds, while also providing a pond, which is a visual attraction for park users.

Water Quality and Quantity – The LID retrofit improves water quality and quantity by filtering, infiltrating and reusing stormwater. This improves water quality in Lake Ontario, Mississauga's drinking water source, and reduces demand on the municipal water system.

Showcase Site – Lakeside Park is regularly showcased to municipal staff, consultants and developers as a demonstration site for green infrastructure through site tours and case studies. The park also includes interpretive signage to help showcase green features to park users.

Award Winning Project – Lakeside Park was the recipient of the following awards:

- 2010 Brenda Sakauye Environment
- 2012 Ontario Builder Awards Category 3 from the Ontario General Contractors Association
- 2013 Mississauga Urban Design Award for Excellence

Overcoming Barriers & Lessons Learned

As with any project, there will be challenges faced during the design, construction, and commissioning phases. The barriers and issues encountered with this project include:

- The park retrofit had to balance the natural environment with the need for more public recreational space.
- Bioretention soil media originally installed in the bioswale did not meet CVC specifications as per CVC/TRCA Low Impact Development Planning and Design Guide.
- During the plant establishment period, several invasive species have appeared in the bioswale.
- The sidewalk beside the bioswale has experienced some ice build-up during winter months.

The following approaches were used to address these barriers:

- The design incorporated several LID features, which offered both water quality functions as well as aesthetic appeal.
- CVC notified the City of Mississauga that the bioretention soil media did not meet specifications. It was immediately replaced. CVC and City staff inspected the soil media prior to placement.
- To expand the objectives for a green sustainable landscape, City of Mississauga partnered with Holcim Canada to construct the permeable concrete parking lot.
- CVC and City of Mississauga routinely monitors the bioswale for invasive species and removes them as part of regular maintenance.
- City of Mississauga regularly checks areas where ice build up occurs during winter months and applies de-icing salt when necessary.

Lessons learned through this project include:

- It is important to stress to the contractor the importance of testing and approval of bioretention soil media prior to delivery on site.

This can save on the cost of replacement should the soil not meet specification once delivered.

- Partnerships can be an added benefit to the success of demonstration projects. Working with CVC and Holcim Canada gave the city access to additional resources to support the LID goals of the project.
- When designing bioswales in cold climates, it is important to ensure that drainage patterns do not encourage water to flow over pedestrian areas. Ice problems may occur in winter months.



Parking lot is graded to allow water to flow over the sidewalk and into the bioswale. This creates icing issues in winter months.

Planning & Regulations

As Lakeside Park was a public lands project initiated by the City of Mississauga, the concept and design was heavily influenced by the strategic directions of the City. The redesign of Lakeside Park worked towards reflecting the City of Mississauga's five Strategic Pillars for Change: Move, Belong, Connect, Prosper and Green. This meant creating a park that would be accessible and usable by everyone, would connect people and neighborhoods, and would promote healthy, green living.

The redevelopment of Lakeside Park was completed as part of the Mississauga Waterfront Parks Strategy. As such, the design of the park had to be consistent with the purpose, vision, principles and key strategies set forth by that document.

In order to meet the requirements of Waterfront Parks Strategy and the five Strategic Pillars, Lakeside Park had to carefully balance the natural environment with public recreational opportunities. This was accomplished by including green infrastructure into the design. This created environmental, functional, and

aesthetic benefits for the park. For instance, the bioswales provide a stormwater catchment and filtration function, while also creating a lush garden enjoyed by the public.

Design

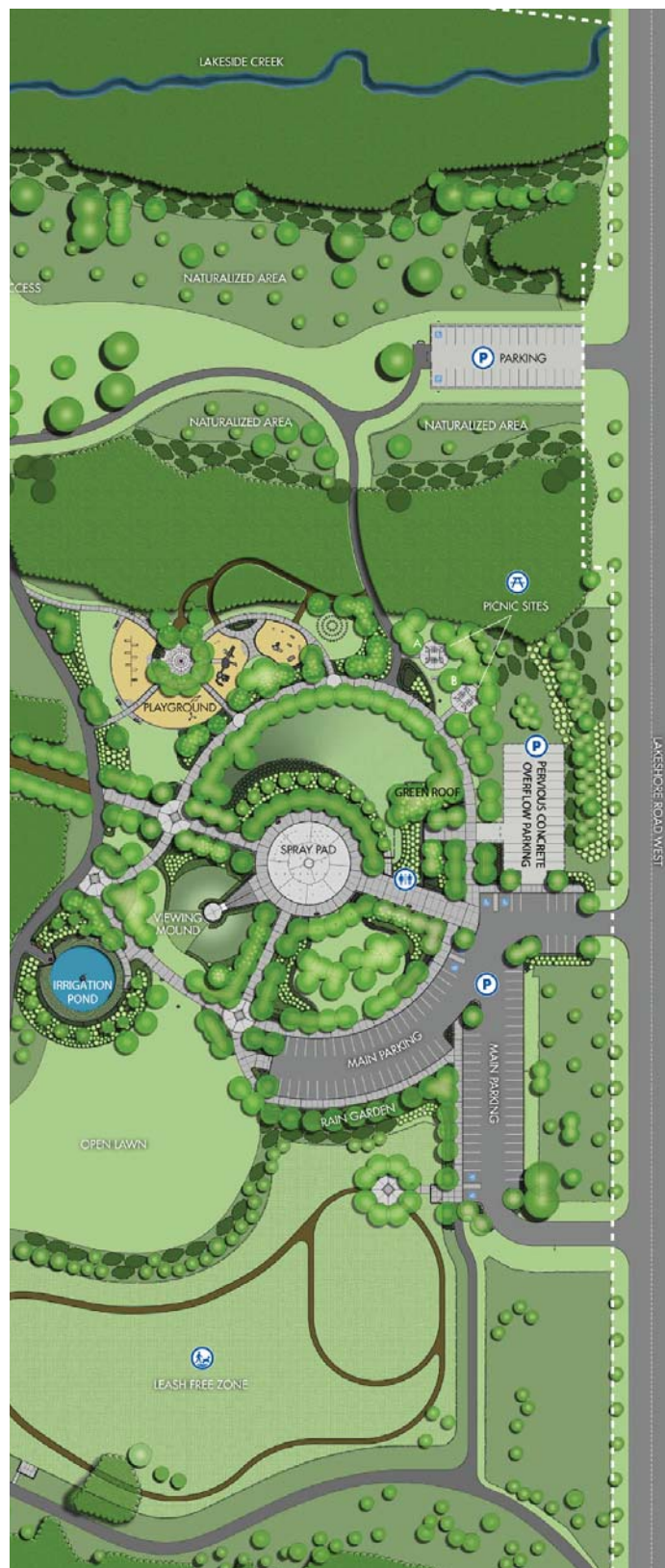
The innovative design of Lakeside Park seamlessly incorporates recreational opportunities with LID infrastructure. Park features include a leash free dog area, open spaces, viewing platforms, spray pad, playground, picnic sites, naturalized areas, waterfront and park trails, and ample parking. The design of Lakeside Park allows stormwater runoff to be captured through five primary measures: bioswale, green roof, pervious concrete parking area, green space infiltration and the reclaimed water irrigation system.

Many of the park features were designed to connect to one another and provide dual functions: stormwater management and park operations. For instance, the pervious concrete parking lot provides a practical function for park visitors, but it also captures rainfall, filters it, and then stores it until it can infiltrate into the soils below. The bioswale captures and treats runoff from the other parking lots with conventional asphalt, while its lush vegetation enhances the visual appeal of the park. Stormwater collected from the park and water from the spray pad is directed into the reclaimed water pond and irrigation system. This system is used to irrigate recreational lawn and planting beds of the park, while the pond with an incorporated fountain further enhances the aesthetic appeal of the park.

The design of Lakeside Park was also constructively influenced by the cultural heritage of the site. Prior to the development of the park, the site was home to a clay pipe manufacturer. Clay pipes left behind from this time were eroded by waves, forming a shale beach with unique copper colored cobblestones. The cobblestones were left in place to retain the natural beauty of the shoreline. The industrial heritage of the site as well as the natural beauty of the copper cobblestones inspired the aesthetic design of the park. Copper colours and industrial materials such as steel and stone were incorporated into the design of park structures, including the playground and the picnic sites.



Copper colored cobblestones on Lakeside Park beach



Layout of Lakeside Park (Drawing provided by the City of Mississauga)

Bioswale

The bioswale is located on the east end of the park and accepts runoff from the southern portion of the parking lot and side walk, as well as from the surrounding landscape. The bioretention swale is approximately 60m long, 0.25m deep and up to 10m wide, with an additional 70m of grassed swale contributing to the storage areas of the swale. Total volume of the swale is approximately 80m³



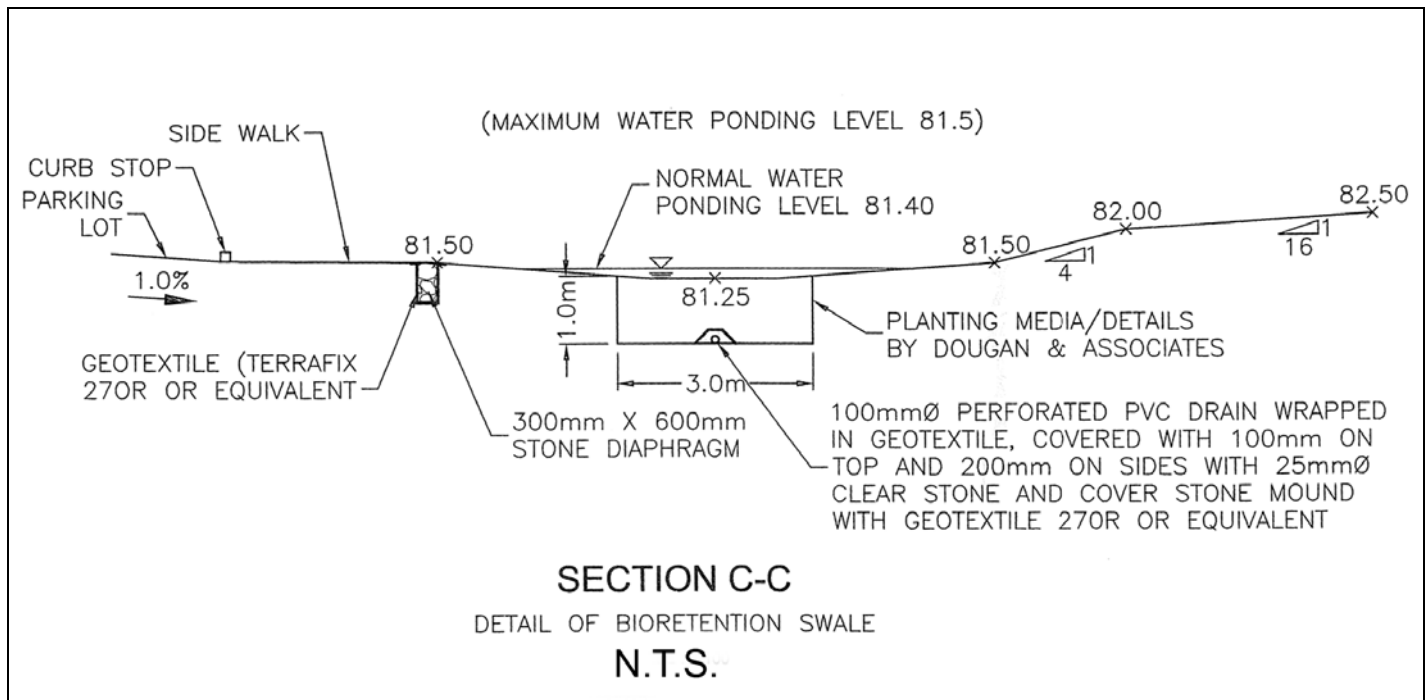
Bioswale with adjacent sidewalk and parking lot

The swale was designed with a slope towards the existing low point at the southern edge. The total area draining to the bioretention swale is approximately 0.85ha, with 0.11ha of impervious area.

Site plans were designed and reviewed prior to finalizing the CVC/TRCA Low Impact Development Planning and Design Guide but were based on the draft guidelines. Through coordination with CVC and the City of Mississauga, the consultant's design met the draft guideline recommendations. Among those recommendations was the soil mix:

2010 CVC/TRCA Low Impact Development Stormwater Management Planning and Design Guide soil specifications

Component	Percent by Weight
Sand	85-88%
Fines	8-12%
Organic matter	3-5%



Cross section of the bioretention swale. Stone diaphragm was removed from design
(Drawing prepared by AMEC Engineering and John George Associates for the City of Mississauga)

Landscaping

The overall design consisted of a mix of freeform and radial lines, groupings and tiers with topographic function. The vegetation included a colourful mix of native and ornamental trees, shrubs and perennials, such as:

- 'Gold Flame' Spirea
- Red Osier Dogwood
- Switch Grass
- Dwarf Fountain Grass
- 'Stella D'Oro' Daylilies

Some species are flood tolerant and were placed at the centre of the swale and others prefer drier conditions and were placed higher up in the swale.



A small, but diverse, number of plant species were used in the bioswale at Lakeside Park

Pervious Concrete

The pervious concrete parking area is approximately 700 m², located at the north west end of the park. Pervious concrete has a void ratio range of 0.15-0.25. The mixture consists of mainly coarse aggregate, cement materials, and water. The reduced sand content results in the high void content. Although exact specifications for the concrete mix were not available for this project, typical pervious concrete parking lot design will have 150-300 mm sub-base of 19 mm diameter clear stone on a geotextile fabric, with 120-200 mm of pervious concrete on top of the clear stone.



Pervious concrete overflow parking lot at Lakeside Park

Reclaimed water irrigation system

The main outlet for the site is directed to the irrigation pond, which includes captured runoff from the bioretention swale, pervious concrete overflow parking lot, and spray pad. The system was conservatively designed to convey the 100 year peak flow of 0.377 m³/s, plus an additional 0.05 m³/s to the irrigation pond.



Reclaimed water from the bioswale and spray pad is stored within this pond, which adds to the aesthetic value of the park.

The reclaimed water irrigation system provides a dual purpose. The irrigation pond itself provides an aesthetic feature for visitors to enjoy, while the stored water is used to irrigate landscaped features throughout the park. The re-use of this water reduces the demand on municipal water supply, as municipally treated water is not required for irrigation within the park.



The reclaimed water irrigation system is identified by purple sprayheads throughout the park

Green Roof

The intensive green roof is located over the park's public washrooms and maintenance depot facilities. Intensive green roofs have deeper soils, can sustain large plants like shrubs and trees and are accessible recreational spaces while extensive green roofs have shallow soils, low growing vegetation and are not meant for regular foot traffic.

The green roof structure consists of:

- A roof structure capable of supporting the weight of a green roof system;
- A waterproofing membrane designed to protect the building and roof structure;
- A drainage layer that consists of a porous medium capable of water storage for plant uptake;
- A geosynthetic layer to prevent fine soil media from clogging the porous media;
- Soil with appropriate characteristics to support the selected green roof plants; and
- Plants with appropriate tolerance for harsh rooftop conditions and limited root planting depths.



Intensive green roof adjacent to walkway

The green roof at Lakeside Park is accessible via a berm on one side of the roof. The sod landscaping for the grounds continues up the berm to the top of the roof. Additional low maintenance shrubs are planted on the roof. Visitors can walk up the berm and enjoy the view of the park from the roof.



Incline view of the intensive green roof at Lakeside Park.

Construction & Commissioning

Major construction of the park started and was completed in 2010. Landscape establishment took two years with the official park opening occurring in the summer of 2012.

Bioswale Soils and Mulch

As previously discussed in the design section, soils were specified based on the draft 2010 CVC/TRCA Low Impact Development Stormwater Management Planning and Design Guide. CVC staff visited the park after construction was complete to verify the LID features met the design specifications. CVC staff found that the bioretention soil media did not fully meet specifications. Site instructions were issued to the contractor to correct the problems. The contractor immediately replaced the soil media under their warranty obligations.



A simple ribbon test was conducted on site as a visual tool to gauge clay content. If the soil clumps into the length of a ribbon rather than crumbling, there is high clay content.

The mulch was predominantly shredded as specified, but a portion of the mulch consisted of large unshredded pieces, longer than the maximum recommended length of 100 mm. These larger pieces of mulch can dislodge and float during heavy downpours. This resulted in the minor problem of channeling and deposition of mulch near the overflow during heavy downpours.



Channeling of unshredded mulch towards overflow catch basin



Bioretention soil media has been scrapped out of the cell after discovering it didn't meet specifications.

Bioretention soil media is a new material to many contractors. Getting the soil media right is a common issue with many bioretention projects. CVC has developed a LID Construction guide to assist engineers and contractors. For further information, refer to this guidance document at www.bealeader.ca.

Pervious Concrete

The pervious concrete parking lot was made possible through a donation from Holcim (Canada) Inc. and is an example of an innovative partnership to fund the cost of this leading edge green technology in a Municipal project. Working drawings and construction administration were undertaken by the City's consulting team. The City through their General Contractor was responsible for the excavation, weeper drains, pre-cast curbs, gates, and restoration. Holcim Canada Inc. provided a subcontractor to the City's General Contractor who was responsible for installation of the granular material and pervious concrete.



Pouring pervious concrete directly on to base

A typical 150-300mm clear stone bed sits below the 100-200mm of pervious concrete material. Since pervious concrete has the most specific installation

requirements of all types of permeable pavements, CVC recommends that the following precautions should always be taken during installation:

- Dampening of the sub-base prior to installation to ensure the sub-base does not suck moisture out of the pervious concrete impacting curing times.
- Ready-mix concrete should be received on the dry side, as water can always be added on site rather than removed. Adding water is best accomplished by spraying a hose directly into the truck while mixing on site. An expert should always certify moisture content through appropriate testing. However a simple test is forming a ball in their hand. It should hold together but not bring paste to the surface.
- Screening should take place immediately, as any delay could cause improper consolidation.
- The hose from the truck should never be sprayed directly on the surface of the concrete, as it could result in excessive surface ravelling.
- Within 15 minutes of placement, pervious concrete should be covered with a plastic sheet to prevent moisture loss for a period of seven days with no load on the surface.



Non-vibratory screening of the fresh surface

Sediment and Erosion Control

During construction, it was critical to exercise extreme precautions to minimize sediment entering Lake Ontario. In addition to silt fences and sediment traps, construction was sequenced to minimize re-working of completed areas. Furthermore, storage of granular materials was not placed where they were susceptible to erosion.

Certification of the LID Practices

A basic inspection of the site was conducted to verify that the LID practices were constructed according to the design plans before the City assumed ownership. The Lakeside Park bioswale was part of a Showcasing Water Innovation project to test various methods and

tools for assuming bioretention. See the *Performance Monitoring* for more information.

Key Facts

Issues

- Original soil in bioretention swale did not meet specifications in the design, in accordance with CVC/TRCA Low Impact Development Stormwater Management Planning and Design Guide.

Solutions & Lessons Learned

- Bioretention soil media should be tested and approved by an engineer prior to delivery at a construction site.

Economics (Capital & O&M Costs)

The costs for the park redevelopment are provided in the table below.

Capital Costs	
Item	Cost
Bioretention Swale	\$14,000
Pervious concrete parking lot	\$156,000
Re-purposed irrigation system	\$210,000
Main parking lot	\$226,000
TOTAL	\$606,000

The cost of the material, the installation of the pervious concrete and the educational signage was provided by Holcim Canada, an integrated building material and construction company. Their donation was in line with their corporate social responsibility policies to contribute to their communities and promote sustainable technologies.

Operations & Maintenance

Maintenance of Bioswale

Maintenance is important, particularly during the initial establishment phase, because it enhances the performance, aesthetics, and longevity of the LID practice. In the long run, maintenance will prevent small problems from becoming large ones and improve the overall public acceptance of the practice. It may be necessary to follow-up with the contractor throughout the warranty period to ensure that activities specified within the maintenance agreement are taking place.

In the case of the Lakeside Park bioswale, maintenance includes removing accumulated trash and sediments, weeding, mulching and watering. During the establishment period for Lakeside Park, maintenance was carried out by the contractor, the City of Mississauga and CVC.

As per the tender of Lakeside Park, the contractor was required to perform the following maintenance operations from time of planting to substantial completion:

- Cultivating and weeding of planting beds and tree pits.
- Watering when required to maintain plant health and in sufficient quantities to saturate the root system.
- Pruning, including the removal of dead or broken branches.
- Keep all accessories in good condition and properly adjusted. Repair or replace accessories when required at no extra cost.
- At the time of acceptance, all material must be in a healthy, vigorous growing condition. Beds and tree pits must be freshly cultivated and free of weeds, rubbish, and debris.

The City of Mississauga and CVC have been performing maintenance tasks including litter pickup, weeding, mulching and some irrigation (see table below). The surrounding areas that are upstream of the bioswale are irrigated. The bioswale has received the same level of maintenance as other City properties. No maintenance occurs within the bioswale during the winter except for deicing of surrounding sidewalks. Maintenance performed to date has been to ensure establishment and is not typical of long term maintenance.



CVC monitoring crew after a day of weeding

Lakeside Park Bioswale Establishment Maintenance Activities (2011-2013)

Task	Frequency
Litter removal	biweekly
Removal of weeds/invasive species	2-3 times each summer
Watering through irrigation system	As needed
Replacement of dead species by contractor	Fall 2012
Supplemental planting by CVC	Fall 2013

Since June 2012, CVC monitoring staff have been collecting data on maintenance activities performed and inspecting conditions of the bioswale at Lakeside Park on a biweekly basis. A standard site inspection checklist has been created and is used by staff during each site visit. Review of the preliminary data shows that recurring maintenance issues include invasive species removal.

One issue that has been noted at Lakeside Park is the presence of two invasive species, European Reed Grass and Canada Thistle, within the bioswale. They are likely blowing in from the adjoining industrial sites. These invasive species pose a great risk to the establishment of native vegetation in the swale. CVC has assisted the City of Mississauga in identifying and removing these invasive species and replanting native species. Once the native plants in the bioswale are established, they should outcompete invasive species. Until then, CVC and the City of Mississauga must routinely monitor the bioswale for invasive species.



Invasive species European Reed Grass and willow colonizing the bioswale

The plants are doing very well as they are now fully established. The plants have had two years to establish and are thriving. Most of the bioswale has filled in. The plants have no sign of salt damage despite the parking lot and sidewalks being heavily salted throughout the winter. Some adaptive landscaping is necessary. The upstream portion of the swale where most of the flow enters is often saturated. Several Hackberry trees are dying or stressed and scheduled to be replaced with more flood tolerant trees such as Red Maple. One planted species, Sandbar Willow, is a native species that is growing vigorously and is starting to take over the front of the bed and must be cut back periodically. As mentioned earlier, invasive species were taking over the landscape but about 95% of the European Reed Grass and Canada Thistle has been removed and their growth is being monitored. Overall, the bioswale

landscaping has been well received by the general public.



Bioswale in September 2013

Pervious Concrete Maintenance

The pervious concrete parking lot has been designated as overflow parking and is not in use during the winter. The lot is closed off by a gate and is not ploughed or deiced in the winter. Deicing salts can cause pervious concrete to degrade faster. The City's management approach of this lot should help to extend the life of the pavement.

The cement paste is air-entrained (intentional creation of air bubbles in concrete) and the pervious concrete is placed on 150-300 mm of clear stone which minimizes impacts from freeze-thaw. Clogging will also be minimized as the site will not receive any winter maintenance in the form of granular materials for snow removal. As a result of these considerations, the pervious concrete lot should not require more maintenance than a typical asphalt or concrete parking lot.

Performance Monitoring

Since construction of Lakeside Park was just recently completed in 2012, long-term performance data is currently unavailable. Monitoring of water level and the maintenance of the LID feature is currently ongoing at the site. However, water level data collected in 2012 and 2013 has indicated that the bioretention planter is successful at managing stormwater runoff from the adjacent parking lot.

Monitoring results from 2013 indicated that a large majority of rainfall events had little to no discharge to the local storm sewer, demonstrating that the runoff was either infiltrated through the bioretention cell or lost through evapotranspiration. When ponding occurs during larger events, infiltration through the surface is observed to take place within 24 hours, which meets design standards. Ongoing collection of water level data and the completion of inspection checklists will help to determine long-term trends in performance and to determine if there is a relationship between

maintenance and infiltration rates. This will be important to determine the life-cycle cost of the bioswale and to establish if design has an influence on maintenance and performance.

LID Inspection Checklist

CVC monitoring staff has developed an inspection checklist to document obvious visual maintenance needs during routine site visits. Although this information has been collected since mid-2012, meaningful interpretation can only be made with additional years of monitoring, especially if life-cycle costs are to be calculated.

A checklist format was chosen in order to record site conditions and maintenance needs as accurately as possible. The goal of the checklist is to make inspections simple and straightforward for anyone to complete. There is a corresponding legend to accompany the checklist to give guidance to someone who may not be familiar with LID. Information on maintenance and LID condition is collected each time in the same format, ensuring proper documentation and making it easier to track changes over time which gives consistency to the monitoring results. The checklist data can provide the frequency of maintenance needed for each site and insight into future designs and planning of LID features. Using these checklists, the user can gather data at the site and establish maintenance schedules and costs. This data is important to the functionality and life cycle of LID features.



This photo was taken as one of the LID Checklist Inspection photos for the photo log in order to track site progress and maintenance needs over time. Plants are established and doing well but a bit of weeding is required at this time as a part of the routine maintenance plan

A photo log is kept from all of the site visits. This is a very important and useful tool as this provides documentation of the visual progression of the site over time. Many members of the public see the LID feature and want it to look aesthetically pleasing and are not interested in what is going on below ground. Keeping the sites looking beautiful for the public to enjoy is very important.

2013 Certification Protocols Summary

Municipalities and businesses (property owners and managers) have protocols in place to thoroughly inspect work done on their property to ensure that the work was carried out in accordance with the design and was properly constructed. A thorough certification protocol reduces the risk to the owner and ensures that they are assuming a facility that is functioning properly and will not require costly, short or long term repairs.

LID is a new stormwater management practice for Ontario municipalities. To assist municipalities, CVC has developed certification protocols for infiltration and filtration practices. Lakeside Park is one of the seven bioretention sites where the protocols were piloted. At Lakeside Park, the following protocols were performed:

- Visual inspection
- Vegetation survey
- As-constructed survey
- Infiltration testing
- Water level monitoring

The protocol results are presented in the sections below, which outline whether the facility passed or failed the various protocols and recommendations to address identified deficiencies.

Visual Inspection Findings

A standard visual inspection of the drainage area, inlets, outlets and bioretention bed was performed on October 29th, 2013. Overall, the facility **passes** the visual inspection protocol. The inlets were mostly free of obstruction with no visible erosion. The bioretention bed showed minimal side slope erosion which was mainly due to foot traffic with no settlement or sediment build-up or caking. The bioretention facility was very well maintained as there was minimal trash or debris present.

Vegetation Survey Findings

The vegetation protocol evaluates the overall condition of the vegetation in a practice. When carrying out the vegetation protocol, the property owner records the percentage of covered ground and invasive, dead, struggling or unattractive plants, the symptoms of the dead and struggling plants and the reason for their decline. The site must pass each of those assessment items in order for the property owner to shift to a post establishment maintenance program. The property owner then records plant health and makeup. Then the property owner determines if the aesthetic goals of the original site design are being met, which can include but are not limited to colour, year round interest, clean formal appearance and planter visibility. The property owner can then determine which site management changes can be made and which plant species need to be replaced.

Assessment Item	Metric / Passing Threshold	Result	Pass / Fail
1. What percentage of the ground is covered?	80%	85%	Pass
2. What percentage of plants is invasive/undesirable?	5%	2%	Pass
3. What percentage of planted species has died?	5%	3%	Pass
4. What percentage of the species is thriving?	80%	92%	Pass
5. Does the site meet aesthetic goals?	Yes	Yes	Pass

The landscaping assessments were conducted in September 2013 and overall, the site **passes** the vegetation survey protocol. The plants are thriving and are meeting the aesthetic goals as shown in the picture below



Bioswale showing good fall colour

As-constructed Survey Findings

The as-constructed survey was compared with the design plan for consistency. Specifically, the area of the drainage and the practice were confirmed. The drainage patterns were evaluated to ensure no bypass if occurring. Results are summarized in the following table.

Assessment Item	Metric/ Passing Threshold (Design)	Result (As-built)	Pass / Fail
1. Contributing drainage area:	3,600 m ²	3,670 m ²	Pass
2. Bioretention area	165 m ²	165 m ²	Pass
3. Surface storage volume	-	1.9 m ³	-
6. Total storage capacity	115.5 m ³	95.1 m ³	Pass

The bioretention facility and the drainage area sizes match the design and there is no bypass. The storage capacity is slightly smaller than the design but the facility still meets the MOE's required minimum sizing for Level 1 Enhanced Protection.

Like with the soil media mix, small variations from the specified design elevation can have a significant impact on the performance of bioretention practice. Contractors may overfill soil assuming that it will settle. However, experience with other bioretention installations in Ontario has found very little settlement of bioretention media. It is important for the project consulting team to follow through and verify detailed execution of the drawings during construction, especially aspects relating to grading as it has such a large impact on LID performance. It is recommended that inspectors be present to ensure that LID practices are installed correctly, including finished grading and elevations of inlets and outlets to the cells. For further details refer to the LID Construction Guide (available at bealeader.ca).

The facility could be upgraded in the future by regrading the surface to increase surface ponding capacity.

Infiltration Test Findings

The Guelph Permeameter method was used at the site on November 4th, 2013. The Guelph Permeameter is one of several methods to measure the saturated hydraulic conductivity of soils which can then be translated into an infiltration rate. The bioretention facility passes the infiltration capacity protocol threshold of 25 mm/hr.

There were some challenges with regards to performing the infiltration tests at this site given frequent wet weather events. At least a 24 hours dry period is required to perform these tests accurately. The depth of bioretention soil media was also a challenge in performing the infiltration test because the ideal well depth should be between 20-30 cm, which was hard to achieve in this case due to a gravelly/rocky layer just 30-50 cm beneath the bioretention soil media. However, to overcome this barrier, shallower wells were

dug between 14-17 cm to avoid the rocky layer and test only the media layer.

The tests were performed at three locations near the downstream end immediately next to the catch basin overflow. The three tests yielded infiltration rates of 7mm/hr, 12 mm/hr and 70 mm/hr with an average of 30 mm/hr.

Infiltration testing will not provide the same level of accuracy as the real world monitoring that occurs in level 3 and 4.

Assessment Item	Metric / Passing Threshold	Result	Pass / Fail
1. Surface Drawdown Time (hrs)	24 hrs	The bioretention cell was designed with little to no surface ponding depth	N/A
2. Subsurface Drawdown Time (hrs)	48 hrs	Ranges from 2.4 hrs to 8.2 hr with an average of 4.8 hrs	Pass

Continuous Water Level Monitoring

The collection of water level data over time within the practice can provide drawdown times for ponding and infiltration rates over a variety of antecedent conditions and storm types. This type of monitoring is cost effective and interpreting the results is straightforward. To collect water level data, observation wells and inexpensive water level loggers need to be installed.

The as-constructed bioretention facility passed the drawdown criteria for surface ponding and sub surface ponding. The site is located adjacent to Lake Ontario and generally has a high water table. Despite saturation throughout the year, the practice still satisfied the water balance requirements on a yearly basis. As shown in the design, the facility was not designed to provide surface ponding capacity and if that becomes a concern, the surface can be regraded to provide additional ponding storage.

Summary

The Lakeside Park bioretention facility functions within the design parameters and the facility drains down much quicker than 48 hrs. The vegetation is in good health and provides a great aesthetic appeal.

The Certification Protocols for Filtration and Infiltration Practices and a more detailed report on the Lakeside

Park performance under these protocols can be found on CVC's website at www.bealeader.ca

Acknowledgements

Credit Valley Conservation would like to sincerely thank the following companies, organizations and individuals for the support in the development of this case study:

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- Region of Peel
- Ministry of the Environment

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