CVC
CREDIT VALLEY CONSERVATION

O'Connor Park

Location: Mississauga
Constructed: 2011

Case Study

Public Lands

Project Objectives, Design and Performance

- Introduce green space into a residential neighbourhood, for both recreation and species protection.
- Protect the existing wetland area and preserve the runoff and groundwater water volumes needed to keep it healthy.
- Contain all storm water runoff produced on site by using LID features including bioretention cell, permeable pavement, and infiltration trenches.
- CVC staff are monitoring water levels, landscape health and maintenance needs of the bioretention cell in order to understand the lifecycle performance of LID practices in Ontario.

Overcoming Barriers and Lessons Learned

- Identification of existing wetlands required that the initial parks plan be modified to not only accommodate the valuable natural heritage features but also design a stormwater management system to keep it healthy.
- As the park included several innovative features, the City worked closely with CVC to ensure they were designed with the best guidance available.
- Several post-construction issues were identified, including a section of bioretention soil did not meet the recommended specification and an overflow catch basin at a lower level than in the design drawings. These construction issues could result in more frequent bypassing and reduced overall infiltration performance.

Practices Implemented


Bioretention


Soakaways & Infiltration Gallery


Permeable Pavement

Barriers and Issues Encountered


Construction & Comissioning

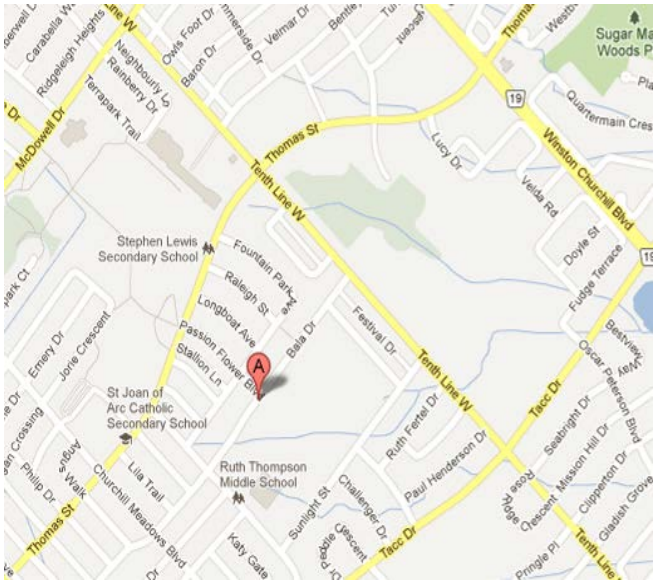

Operation & Maintenance


Design


Planning & Regulations

Overview

O'Connor Park is located on Bala Drive in the west end of Mississauga, Ontario in the Sawmill Creek sub-watershed. The water that infiltrates at O'Connor Park contributes to the base flow of Sawmill Creek, which ultimately contributes to the Credit River and Lake Ontario – the drinking water source for much of the Greater Golden Horseshoe.



Location of O'Connor Park, Bala Dr. in Mississauga, ON

Prior to its development into a park, the land was a remnant farm property with small natural wetlands and pond, surrounded by the Churchill Meadows Community residential neighbourhood. Identification of these natural heritage features on the property required the city and the local conservation authority (Credit Valley Conservation) to work together to balance the desire to provide residents with active recreation features with the need to protect and enhance the existing wetland features.

Goals & Drivers

When developing the remnant farm property, the City of Mississauga wanted to provide multiple active recreation features for residents. The City also wanted to protect the natural heritage features found on site. City of Mississauga and Credit Valley Conservation (CVC) collaborated to create goals for the project which would do both.

The early goals and drivers for the project included:

- Introducing green space into a residential neighbourhood, for both recreation and species protection.
- Protecting the existing wetland area and ensuring sustainability.
- Containing all storm water runoff produced on site by using LID features to further support wetland preservation.
- Providing habitat for various plant, bird, mammal, amphibian and reptile species, including the Midland Painted Turtle

Successes

The successes achieved with this project include:

Multi-functional park space – O'Connor Park has naturalized areas, maintained soccer fields, a play area, and multiple LID features.

Award winning project – the O'Connor Park Development Project Team received the *Brenda Sakauye Environment Award* in recognition of the park's advancement of the City of Mississauga's *Living Green Master Plan*, as well as the 2012 Mississauga Urban Design Award of Merit for Community Scale, Living Green, Innovation and Execution.

Protection of natural heritage features – an increased natural wetland and meadow area were all protected with the development of O'Connor Park

Effective partnership – the City of Mississauga and CVC worked in partnership to balance environmental conservation and recreation needs for residents.

Overcoming Barriers & Lessons Learned

The barriers encountered with this project include:

- Soils analysis indicates that one portion of the bioretention cell has bioretention soil media with a greater than recommended portion of fines, which can reduce infiltration rates
- The overflow catch basin within the bioretention is at a lower elevation than specified in the design drawings, which can result in more frequent bypassing and reduced overall infiltration performance

The following approaches were used to address these barriers:

- Infiltration rates within the bioretention cells are currently being monitored by CVC and the City to determine if there is a loss in function due to the area of finer soils and whether the bioretention soils need to be amended or replaced in the future.

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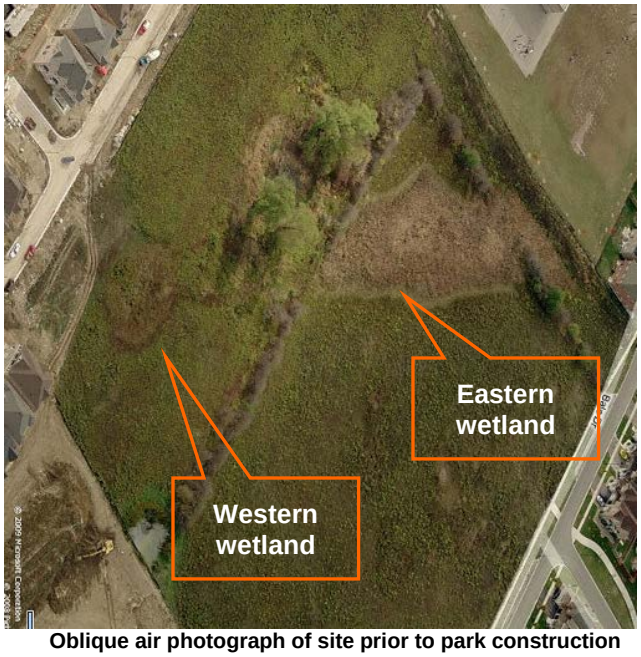
Lessons learned:

- Adequate protocols (such as soils testing and construction inspection) need to be in place to ensure that the proper bioretention soil media is installed and meets specifications.

Planning & Regulations

From the very beginning of the project, prior to the preparation of any preliminary designs, the City was committed to understanding the natural heritage features of the site. The City reached out to CVC and the two partners worked together to study the natural heritage features, identifying the presence of wetlands and wildlife habitat at the site. The City of Mississauga worked with CVC to create a park plan that could balance active recreation facilities with the protection of these existing natural heritage features.

Two cattail mineral shallow marshes were identified on the property, a large marsh approximately 0.45 ha on the western portion of the property, and a smaller 0.25 ha march on the eastern portion of the property. The location and size of the wetlands on the remnant property are shown in the following aerial photograph.



Oblique air photograph of site prior to park construction

Through the planning process it was determined that the eastern wetland would be filled to permit the construction of soccer fields and the west wetland would be expanded and improved to provide an ecological net gain. In the end, the total wetland area was increased by 3.5 times. Species from the eastern wetland were relocated to the enhanced western wetland.

During the planning stages, a variety of different park layouts were developed and refined by reviews of the stakeholders involved. The final layout generated through this process is provided in the following rendering.

Illustrated rendering of O'Connor Park (Drawing prepared by PMA Landscape Architects for the City of Mississauga)

The features of the park include: two soccer fields, wetland with a habitat island, naturalized areas, playground, walkway adjacent to the wetland and parking lot with innovative LID features.

The inclusion of LID features within the park was identified during this early planning process as an effective means of managing stormwater at the site. LID was proposed to help support the function of the natural heritage features, as part of a treatment train (where multiple features are used in series to treat stormwater to help meet stormwater management objectives). Rather than drain the stormwater runoff directly into the natural heritage features, the LID features would first treat the stormwater before entering the expanded wetland. This ensured that the wetland would be comprised of higher quality runoff, supporting plant and aquatic species within the wetland area.

Design

LID features are primarily located within the parking lot of the park, however additional infiltration practices were installed throughout the soccer fields.

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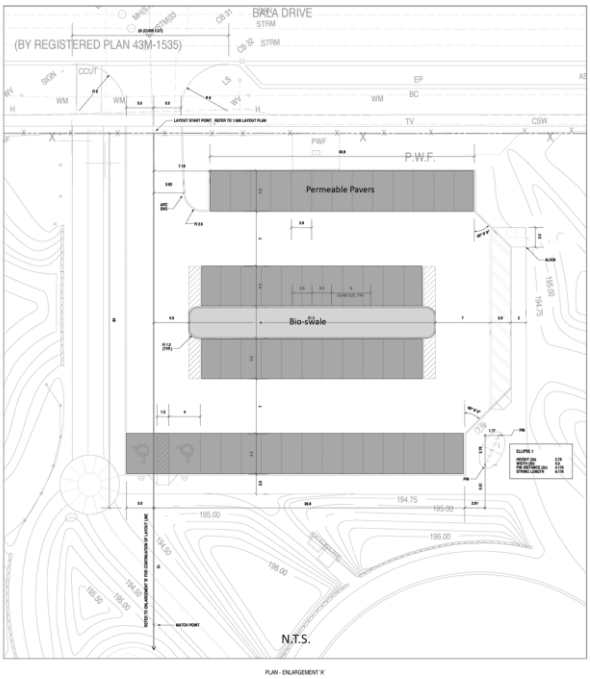


Parking Lot with permeable pavement and bioretention areas labeled (Drawing prepared by PMA Landscape Architects for the City of Mississauga)

Bioretention Cell

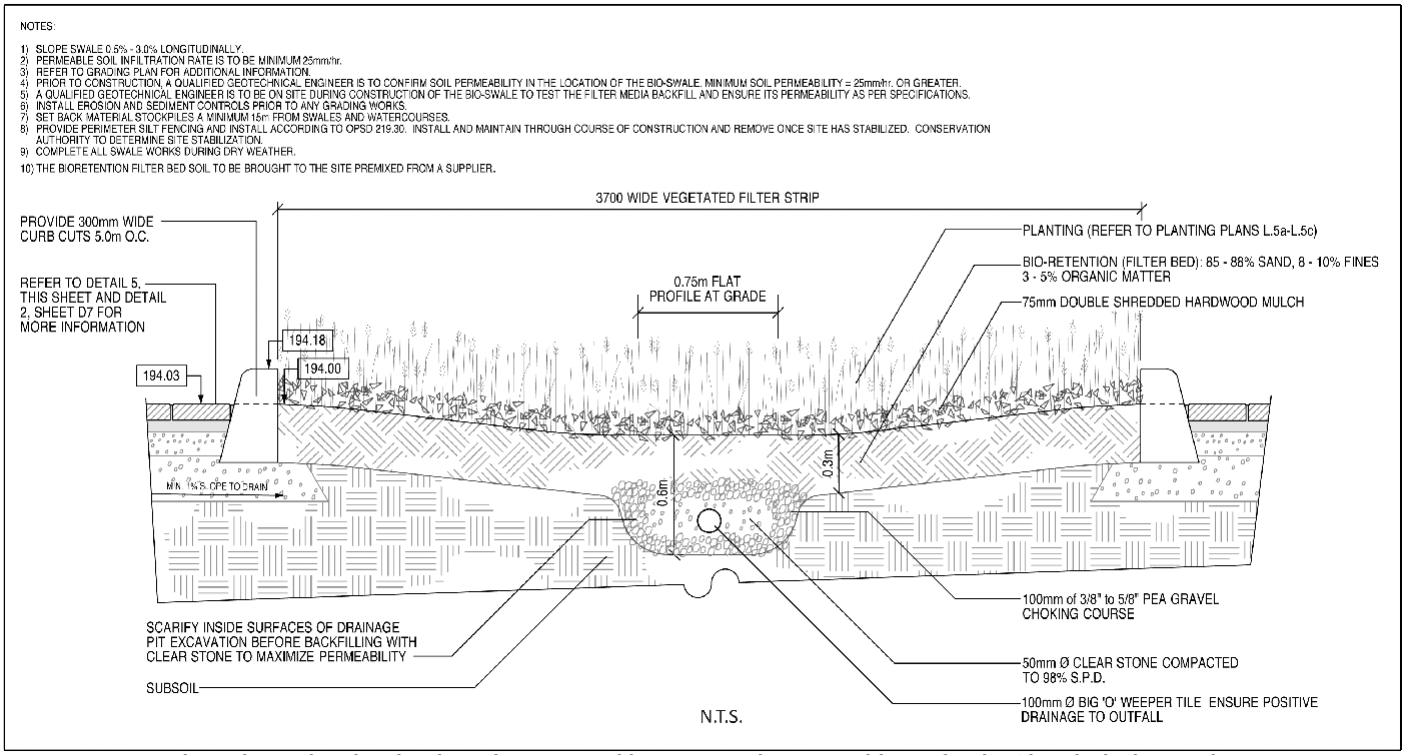
The bioretention cell is 24 m by 3.7 m and is located in the center of the parking lot. It is graded at 2% to allow the runoff to be directed towards it more effectively. Around the perimeter of the bioretention cell is a small retaining curb, with 30 cm cut-outs at 5 m intervals, to allow for the surface runoff to enter the cell. This curb design prevents cars from driving into or parking on the swale while allowing low concentrations of flow to enter at multiple locations. At the curb cut inlets are 100mm clear stone pads that help to slow and spread flow while providing erosion control. The base of the bioretention cell contains a subdrain, which is sloped towards the catch basin leading to the open lawn area at 0.4%. The subdrain is surrounded by 50 mm clear stone, which is then surrounded by 100 mm pea gravel. This was done to replace the need for geotextile fabric, which can become clogged.

A specific mix of soil was specified to allow for proper infiltration rates (detailed in the table). And a layer of 75 mm double shredded hardwood mulch was suggested to lie above the soil.

Bioretention Soil Media Mix

Component	Percentage by Weight
Sand (2.0 to 0.05mmØ)	85 – 88%
Fines (<0.05 mmØ)	8 – 10%
Organic Matter	3 – 5%

An engineering cross-section detail for the bioretention cell is reproduced below.



Bioswale section drawing (Drawing prepared by PMA Landscape Architects for the City of Mississauga)

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For ease of maintenance, landscaping was kept simple within the bioretention cell; only two plant varieties were used. The O'Connor Park bioswale has a decorative dwarf fountain grass border with rows of black-eyed Susan in the middle, creating a landscape with clean lines and colour. For more recommendations on LID planting plans see CVC's LID Landscape Design Guide (available for download at bealeader.ca).

Black Eyed Susan and Foxtail Grass planted in bioretention cell

Permeable Pavement

Surrounding the perimeter of the bioretention cell is a strip of permeable paving, which provides spaces for parking on both sides of the cell. The remaining parking area is comprised of asphalt, which is sloped towards the LID features located in the centre of the lot.

Typical rainfall events are managed through the permeable pavers, with larger rainfall events creating sheet flow directed to the bioretention cell through the curb cut-outs.

Permeable pavement surrounding the bioretention cell

Soccer Fields

The park also includes a series of infiltration trenches with underdrains that surround the perimeter and cross the soccer fields. These units promote infiltration of water while minimizing ponding and wet conditions on the fields. As with the parking lot LID features, the infiltration trenches also discharge into the wetland. A plan drawing showing the infiltration features of the soccer fields follows.

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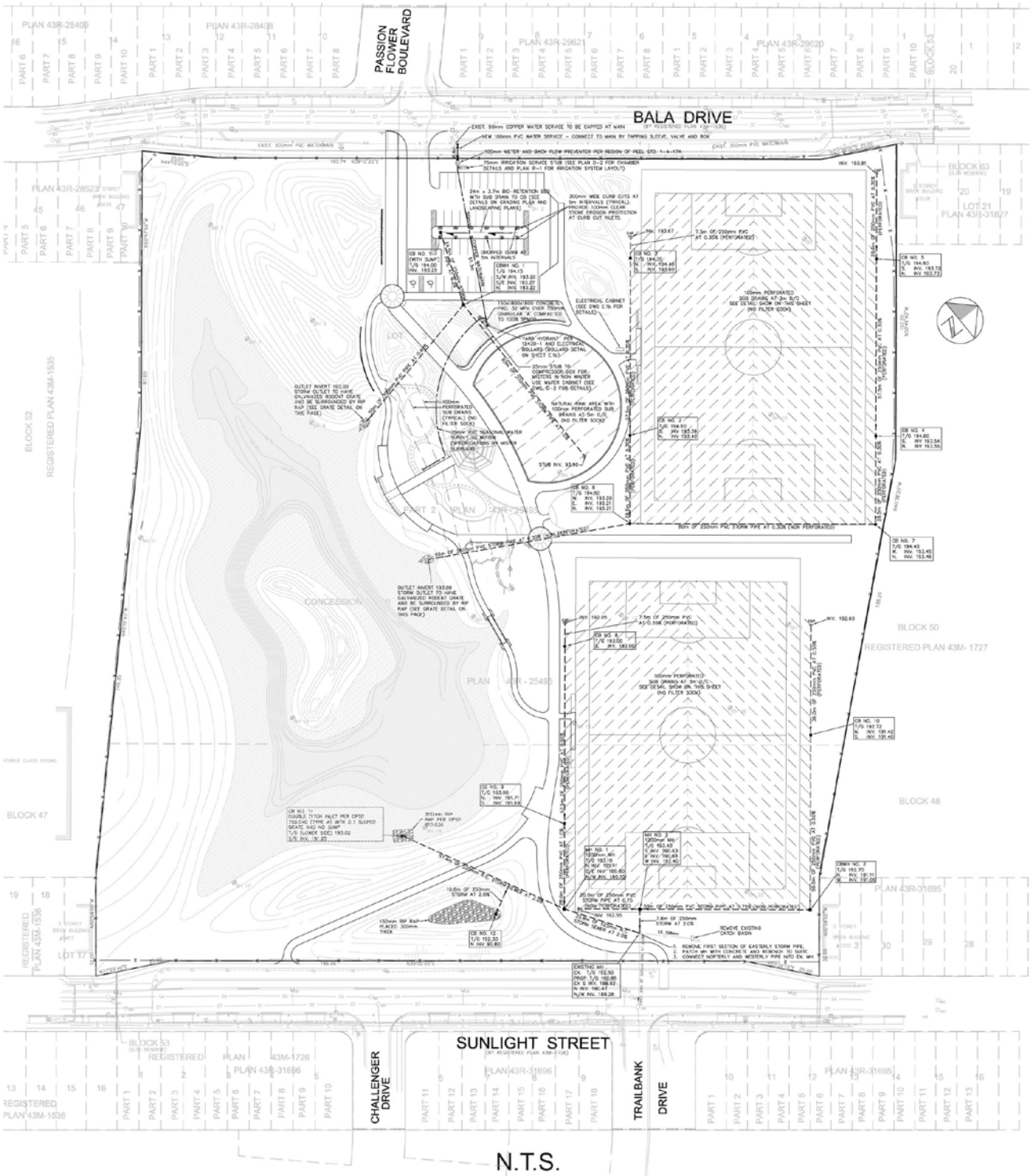

Plan drawing of O'Connor Park (Drawing prepared by AMEC Engineering and PMA Landscaping Architects for the City of Mississauga)

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Construction & Commissioning

Soil Mixture

In order to function properly bioretention soil media must contain a certain ratio of sand, fine and organic matter. Post-construction soils analysis performed by CVC found that the majority of the bioretention cell contains soil that meets the design specification, some of the media contained higher levels of fines, which can impair the performance of the LID practice.

Moist soil formed a solid cast, meaning a higher than desirable amount of fine particles like clays

The cause for the excess fines in the bioretention media could be from construction sediment or an improper mix brought to the site. Due to the sensitivity of bioretention performance associated with media mix, it is recommended that rigorous protocols be in place to ensure that the media being installed meets design specifications during construction. Recommendations for installation of bioretention soil media from the CVC LID Construction Guide include:

1. The soil media should be obtained premixed from a vendor.
2. Samples of the filter media should be tested for the appropriate specification (see *Bioretention Soil Media Mix* table above).
3. Three samples of the soil should be tested from every batch prepared by the supplier, a sample from the top of the pile, middle of the pile, and bottom of the pile.
4. No bioretention soil should be brought to the site until the soils and their test results have been approved by the site engineer.

In cases where the incorrect media has been delivered to the site and/or has been installed, it is recommended that the bioretention media immediately be replaced with soil containing the right mix of sand, fines and organics due to the critical nature of this component of the LID practice. In the case of O'Connor Park, CVC and the City of Mississauga are currently monitoring the performance of the bioretention cell for any issues associated with the bioretention media mix. At this time, the bioretention cell is performing well.

Photograph of the bioretention cell during construction

Catch Basin in the Bioretention Cell

Another issue identified post-construction is the elevation of the catch basin within the bioretention cell. As shown in the cross-section on the next page, the design indicates that the catch basin was to be located 50 mm [2 in] above the bioretention bed elevation.

However, visual inspections of the cell following construction found that the catch basin is level (or even slightly below) the mulch layer in the bioretention cell. A photograph of the catch basin is provided below.

Incorrect catch basin elevation within the constructed bioretention cell

The present elevation of the catch basin impairs the performance of the bioretention cell as it permits surface flows to directly enter the catch basin. Ideally, a raised catch basin forces stormwater to pond for short periods of time (typically 24 hours maximum), encouraging additional infiltration and reducing the

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amount of runoff that enters the storm sewer. The City of Mississauga is currently making adjustments to the existing catch basin to provide for short term ponding.

Parking lot during construction

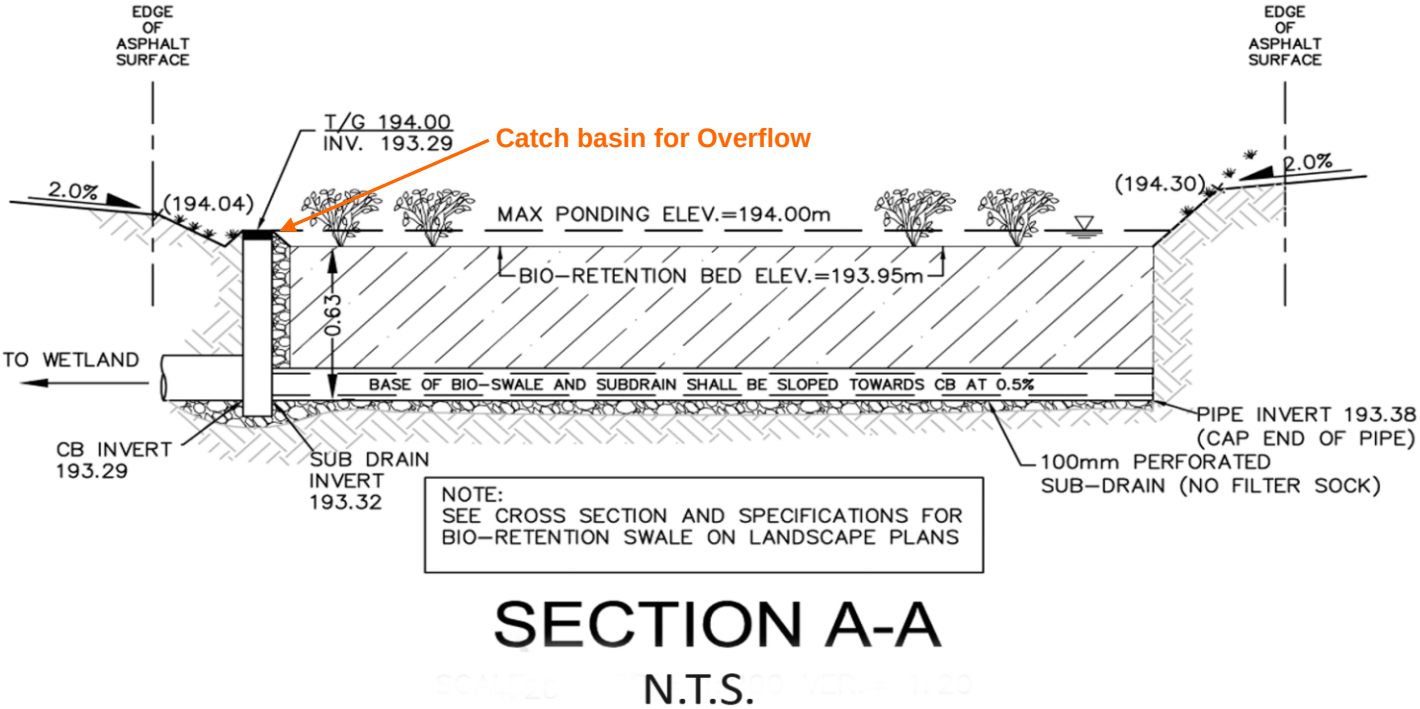
Like with the soil media mix, small variations from the specified design elevation can have a significant impact on the performance of bioretention practice. Contractors may overfill soil assuming that it will settle. However, experience with other bioretention installations in Ontario has found very 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).

Certification of the LID Pracitces

A basic inspection of the site was conducted by project consultants to verify that the LID practices were constructed according to the design plans before the City assumed ownership. These basic inspections ensure accountability of the consulting team in executing the design. The O'Connor Park bioswale was part of a Showcasing Water Innovation project to test various methods and tools for assuming bioretention. See the *Performance Monitoring* section for more information.

Wetland Protection

Prior to construction of the soccer fields, aquatic species residing within the smaller eastern marsh were relocated to the western wetland, which was significantly enhanced to compensate for the loss of habitat. .



Profile design drawing of bioretention cell, indicating elevation of catch basin and bioretention cell bed
(Drawing prepared by PMA Landscape Architects for the City of Mississauga)

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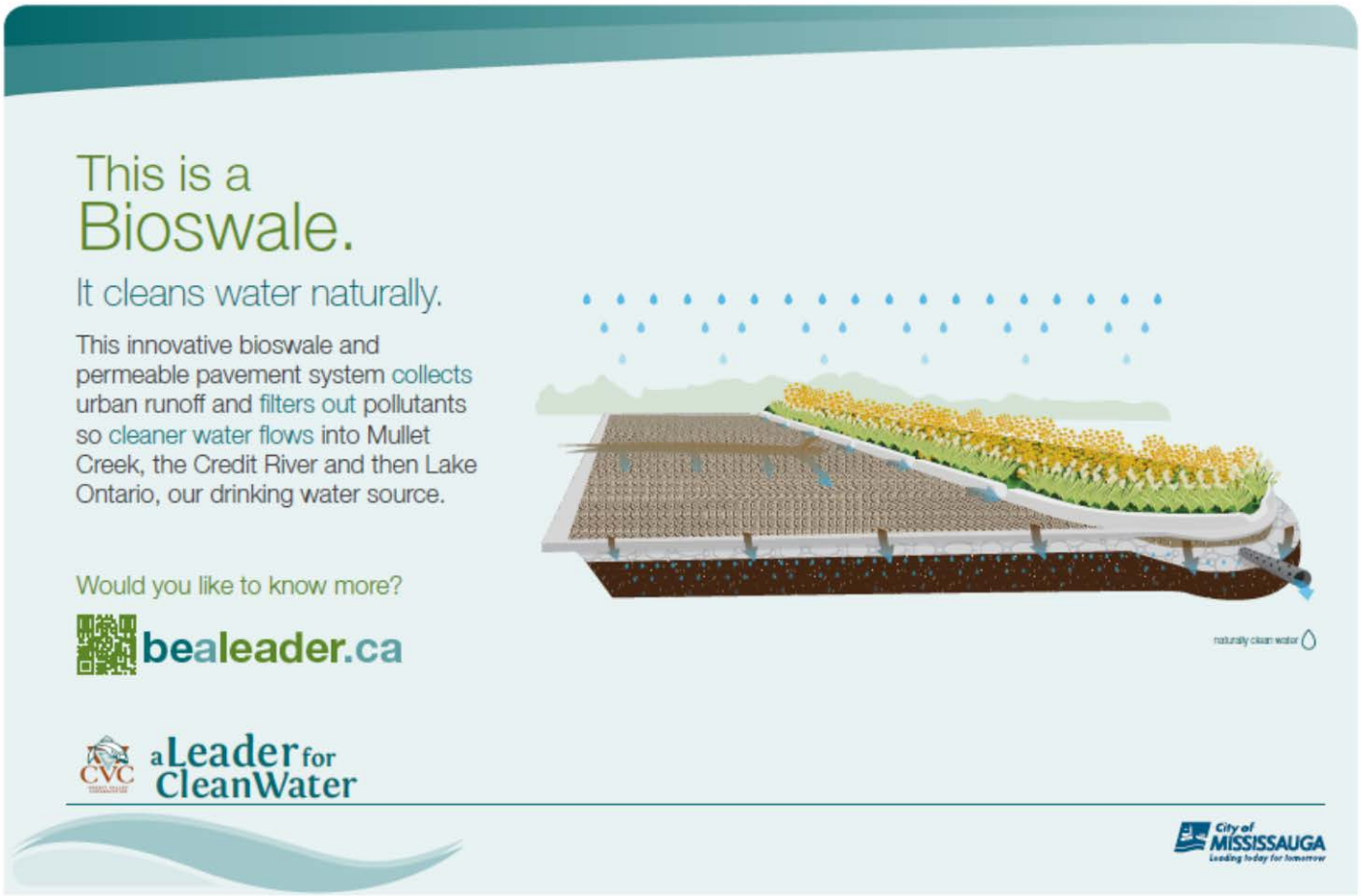
CVC staff assisting with species relocation prior to dewatering cattail mineral shallow marsh on eastern portion of property

In respect of the Natural Area enhancement and protection the NAS 2007 identified the natural area as 0.7 ha and the completed project was assessed at 2.7ha; a ratio increase of 3. 5:1. Construction could only take place after the breeding season was complete.

A complex five stage erosion control process was required to protect the wetland and infiltration areas from sediment, compaction, and contamination. Some details of this plan are provided on the erosion and sediment control plan drawing provided on the following page.

Signage Installation

Part of the outreach program to inform local residents and park visitors of the unique features of the park was signage. CVC worked with City of Mississauga to develop signage on both the natural heritage features and LID features.



Educational signage providing residents information on the LID features at O'Connor Park

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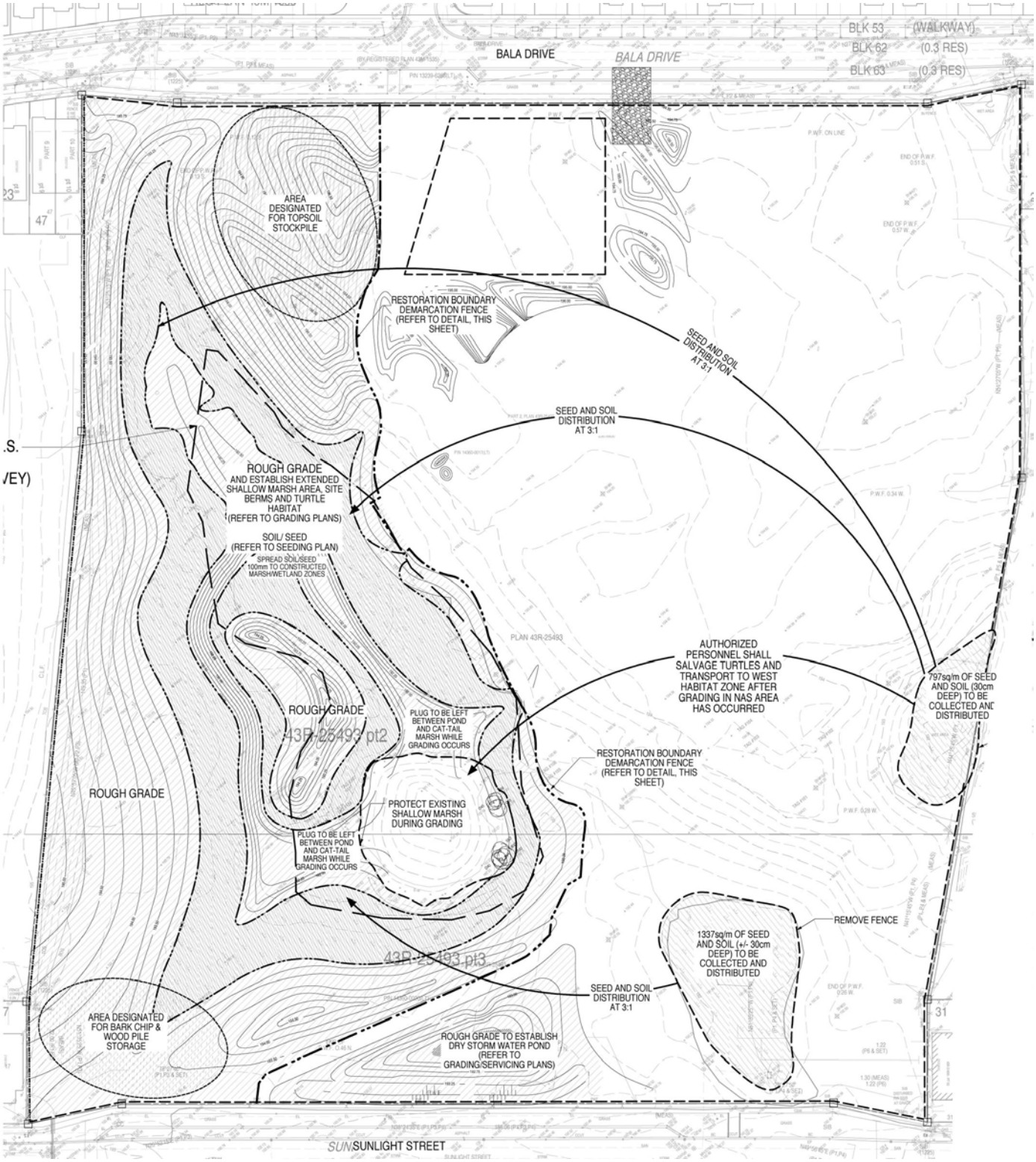

This erosion and sediment control plan indicates where species and wetland soils with native seed banks were to be relocated (Drawing prepared by PMA Landscape Architects for City of Mississauga)

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Economics (Capital & O&M Costs)

The table below compares the costs of constructing the parking lot with LID versus asphalt.

Items	Cost
Bioretention unit	$19,000
Permeable pavement	$93,000
Asphalt and curbing	$68,000
Total	**$180,000**
All Asphalt Lot (does not include downstream stormwater management costs)	$123,000

There was a $57,000 cost premium for the LID parking lot. However, conventional asphalt lot would not meet stormwater management requirements and would require treatment by downstream practices like a pond. The conventional asphalt cost does not account for the potential land and construction costs of downstream stormwater management which could range from $20,000 - $50,000. The LID saved land space and added aesthetic value through the pavers and functional landscaping. Also, it is important to keep in mind that there is a cost premium associated with constructing new and innovative practices.

Operations & Maintenance

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.
Maintenance of the permeable pavement and bioswale includes removing accumulated trash and sediments, weeding, mulching and watering. During the establishment period for O'Connor Park, the contractor and the City of Mississauga maintained the bioswale and permeable pavement.

The tender for O'Connor Park required the contractor to perform the following maintenance operations from time of planting to substantial completion:

- Water to maintain soil moisture conditions for optimum establishment, growth and health of plant material without causing erosion. For evergreen plant material, water thoroughly in late fall prior to freeze-up to saturate soil around root system.
- Remove weeds monthly.
- Replace or re-spread damaged, missing or disturbed mulch. For non-mulched areas, cultivate as required to keep top layer of soil friable.
- Remove dead or broken branches from plant material.
- Keep trunk protection and guy wires in proper repair and adjustment.
- Remove and replace dead plants and plants not in healthy growing condition. Make replacements in same manner as specified for original plantings.

The contractor and the City of Mississauga have been performing maintenance including litter pickup and weeding (see table below). The plants are now fully established and are doing very well. City staff also trim and remove the black-eyed Susan in preparation for winter weather since they die back in the winter. This LID site has been well maintained. To date only establishment maintenance is being completed and is not typical of long term maintenance.

O'Connor Park Bioswale and Permeable Pavement Maintenance Activities (2013)

Task	Frequency
Litter removal	biweekly
Removal of weeds/invasive species	2-3 times each summer
Mulch application by the City of Mississauga	June 2013
Additional permeable pavers were installed on the driveway of the parking lot by the City of Mississauga.	Fall 2013

Since June 2012, CVC monitoring staff have been collecting data on maintenance activities performed and inspecting conditions of the bioswale and permeable pavement at O'Connor Park on a monthly basis. A standard site inspection checklist has been created and is used by staff during each site visit.

Over the past four years some trends have been observed at this site and recorded. Trash is an issue at O'Connor Park as the bioswale is across the street from a residential area. On garbage day each week it was very common to see trash blow across the street from the homes and get trapped in the plants within the bioswale. It was common for homeowners to have open recycling boxes with trash blowing out very easily,

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but the Region of Peel has now provided new covered garbage and recycling bins to reduce this issue. A quarter of our inspections from the past three years show that garbage cover has been 15 per cent or higher, with the facility failing twice with over 20 per cent garbage cover. Garbage cover of 15 per cent or higher is considered severe and should immediately trigger maintenance activities to correct the issue.

Many of the maintenance concerns that are now recorded are due to construction issues. Over time the permeable pavers surrounding the bioretention swale have been settling, causing depressions where water has been collecting. These areas receive more concentrated runoff from the parking lot and sediment has been collecting between the paver joints, causing them to become plugged over time. The settling has also resulted in the inlets becoming a higher elevation than originally designed, preventing runoff from entering the system and allowing debris to gather in front of them, restricting flow from entering. Although water can still infiltrate most of the permeable paver area, the system is not functioning as well as it could be. The City is looking into these issues and is creating a plan for the permeable pavers to be repaired.

Settling pavers with sediment collecting between joins causing clogging

Long Term Performance

Midland Painted Turtle Monitoring

A three year monitoring plan was implemented by CVC to study the Midland Painted Turtle population after some were relocated during the construction process of O'Connor Park. There were two main goals that CVC wanted to accomplish with this monitoring program: to determine if the enhanced wetland was a suitable habitat for the turtles and if there were any negative effects on turtles from increasing the population. Since many turtles were relocated from the eastern wetland to the enhanced western wetland, the population increased from about 35 to over 60. A 'habitat island' was created in the middle of the wetland area so the turtles would have a secluded area to breed and hibernate during the winter. To keep track of the turtles some were tagged with a radio monitoring device, and others were notched in the shell to show they have been accounted for.

Midland painted turtle

Boreholes were drilled for this purpose of monitoring the wetland. Suggestions were also made to monitor the wetland boundary, the extent of the wetland, and to create vegetation maps. This is to see if there are any fluctuations in water height as it can change seasonally and with stormwater events, or lack there of. Vegetation maps are also helpful to track the status of specific species and to ensure the successful restoration of the natural area enhancements.

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 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. O' Connor Park is one of the seven bioretention sites where the protocols were piloted. At O'Connor Park, the following protocols were performed:

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- 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 passes 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 November 4th, 2013. Overall, the facility ***passes*** the visual inspection protocol. However, the mulch depth was less than 50-100 mm which requires topping up. Also, the overflow catch basin was flush with the ground which can cause runoff to bypass the facility and drain away. To address this, the ground surface around the catch basin should be lowered to allow water to flow around the catch basin and infiltrate into the ground.

Vegetation Survey Findings

The vegetation protocol is a tool that 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. Once plant health and species makeup are recorded, the property owner then determines if the aesthetic goals of the original site design are being met. At O' Connor Park, the goals were to provide 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%	80%	Pass
2. What percentage of plants is invasive/ undesirable?	5%	0%	Pass
3. What percentage of planted species has died?	5%	4%	Pass
4. What percentage of the species is thriving? Ex. ranked 3 or higher	80%	95%	Pass
5. Does the site meet aesthetic goals?	Yes	Yes	Pass

The landscaping assessments were conducted in September 2013 and overall, the sit passes the vegetation survey. The bioretention site exhibits excellent flower display and formal appearance.

As-constructed Survey Findings

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

Assessment Item	Metric / Passing Threshold (Design)	Result (As-built)	Pass / Fail
1. Contributing drainage area	1, 800 m^2	1, 877 m^2	Pass
2. Bioretention area	89 m^2	111 m^2	Pass
6. Total storage capacity	47.17 m^3	58.8 m^3	Pass

The bioretention facility and drainage area sizes match the design plans.

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 infiltration test results for this site are deemed inconclusive as discussed below.

The tests were performed within a 24 hours dry period to ensure accurate results as provided in literature. A total of three test wells were dug across the length of the bioretention facility. The infiltration rates were 3 mm/hr, 7 mm/hr and 9 mm/hr with an average of 6 mm/hr which is below the 25 mm/hr passing threshold.

When the infiltration tests were being performed, it was noted that the underdrain was still flowing indicating saturated subsoil. The subsoil was still draining down which can affect infiltration rates which seem low for such coarse sandy soils. Bioretention facilities are mainly designed for 48-72 hours of drain down time

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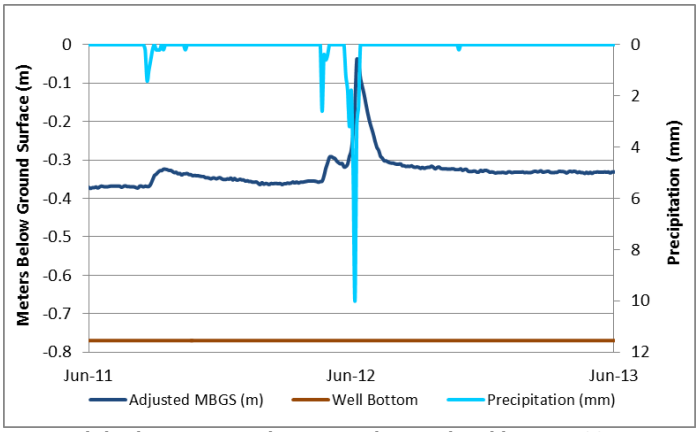
which need to be accounted for when performing these infiltration tests. The infiltration tests for this site should be performed again following at least a 72 hours dry period to ensure accurate results.

Level 3 – Continuous Water Level Monitoring

The collection of continuous water level data from 2013 to 2014 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.

Assessment Item	Metric / Passing Threshold	Result	Pass / Fail
Average Drawdown time to Underdrain	48 hr	393 hr	Fail
Estimated Average Loss Rate above Underdrain	25 mm/hr	4.2 mm/hr	Fail

The water level monitoring found that the as-constructed bioretention facility does not pond on the surface. There is evidence of the underdrain holding water and not completely draining it out of the system, this resulted in the calculated infiltration rates to be lower than the design criteria. The average drawdown time to the underdrain is also extremely slow in this analysis as water sometimes collects within it. The bioretention facility seems to function despite this issue as infiltration still occurs during precipitation events. If a larger irises then actions will be made to correct the problem.



Precipitation event and measured water level in June 2014

The graph above illustrates a large summer storm with the second peak of precipitation being intense as a large volume of rain fell quickly. This 37 mm precipitation event above was fully infiltrated into the bioretention cell without surface ponding. The bioretention cell was able to capture this storm and the sub-surface water level drawdown was able to receed back to the pre-storm level.

Summary

The O'Connor Park bioretention facility passed the original certification protocols and is functioning within the design parameters. If excessive ponding is observed in the future, then soil aeration, soil amendments or replacement might need to be considered.

The Certification Protocols for Bioretention Practices and a more detailed report on the O'Connor Park performance under the protocols can be found on CVC's website at www.bealeader.ca.

Acknowledgements

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- PMA Landscape Architects
- AMEC Engineering
- Region of Peel
- Ontario Ministry of the Environment

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