

# Executive Summary: Application of LID in a Residential Subdivision – Wychwood Technical Monitoring Report

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Credit Valley Conservation's (CVC) Infrastructure Performance and Risk Assessment (IPRA) program is a multi-year stormwater monitoring program designed to evaluate the performance of stormwater management infrastructure across various land uses, climate conditions, and real-world scenarios. The program monitors and evaluates low impact development (LID) features that CVC and partner municipalities have implemented on both public and private land.

For more than 10 years, the IPRA program has monitored LID's ability to provide flood control, erosion protection, nutrient removal, cold weather performance, and maintenance of pre-development water balance. This information helps municipalities:

- Identify opportunities to reduce stormwater risks, and plan for and justify future infrastructure investments.
- Develop measures to improve water runoff quality, protect receiving stream habitats, and support stormwater management in tablelands upstream of flood zones.
- Inform climate change strategies: the program can supply metrics to help measure the mitigation of stormwater runoff impacts over time. The performance monitoring includes maintenance inspection and tracking to record the frequency and extent of maintenance activities during a stormwater feature's life cycle.
- Guide development of municipal asset management programs in adherence to Ontario Regulation 588/17 by 2024. While typical asset management programs focus on asset condition and operational needs such as

Municipalities are aiming to achieve the water resource enhancement objectives for providing effective water quality and quantity improvements proposed within their official plans. CVC is working together with the municipalities to address knowledge gaps and make further improvements in new developments, as well as the areas that do not already meet stormwater control standards.



**Figure 1: Wychwood grass swale.**  
**Source: CVC (2017)**

inspections and maintenance, monitoring programs can also build an understanding of maintenance needs and conditions assessments of existing stormwater assets.

### **1.1.1 The Wychwood Subdivision Pilot**

Located in the City of Brampton, the Wychwood Subdivision has a unique design addressing all stormwater criteria through distributed low impact development features within municipal right of ways and residential lots. As a result, land that would otherwise have been reserved for a pond can be used to build additional homes.

The site manages stormwater runoff through a variety of low impact development features that provide enhanced water quality and quantity treatment. As part of the IPRA program, CVC is conducting comprehensive monitoring and site inspections at Wychwood to evaluate the combined performance of permeable paver driveways, rain gardens, infiltration trenches, oil and grit separators and a bioswale. From 2016 to 2020, monitoring is focused on the rate in which runoff volume and pollutant load reduction is achieved before discharging to the Credit River. This evaluation is achieved by:

- Collecting stormwater quantity and quality performance data from a range of precipitation event sizes.
- Conducting site inspections and maintenance activities to evaluate the condition of the feature throughout its life cycle, starting at construction.
- Tracking the frequency and cost of maintenance activities and the impact on feature performance; to inform asset management protocols and provide guidance to optimize assets in future development applications.

Given that streets are the largest urban contributor and are municipally owned land, they provide a great opportunity to control runoff. Implementing subsurface low impact development features as part of land development practices not only improves stormwater quality but can increase the number of available residential lots for sale. Additionally, property values typically increase with proximity to green space which can be incorporated into stormwater management designs. (USEPA, 2012)



**Figure 2: Wychwood bioswale.**  
Source: CVC (2015)



**Figure 3: Rehabilitation of bioswale.**  
Source: CVC (2015)

### **1.1.2 Construction Inspection**

The construction of the Wychwood Subdivision was completed in June 2015. CVC's monitoring staff began inspecting the feature conditions while the site was still under construction. As construction is a critical time in a feature's life cycle, any issues will have performance impacts as soon as the feature is online. During the construction period, CVC monitoring staff observed poor erosion and sediment control and storage of concrete material within the feature. The developer was immediately informed of these concerns and remediated the area of major concerns prior to placing the bioswale feature in service.

Low impact development features are relatively new to Ontario and many builders and sub-contractors have little to no background on how these features function and the importance of keeping them clean and clear of debris during construction. As an added level of protection, site inspection and post-construction performance monitoring should be included as part of the site assumption process to ensure the municipality is assuming a site performing to the approved design standard. To ensure features are constructed as designed, performance results to the satisfaction of municipal reviewers could be an added condition for the release of development securities.

### **1.1.3 Compliance and Performance Monitoring**

Due to the site's unique stormwater management design, the Ontario Ministry of the Environment, Conservation and Parks (MECP) included specific monitoring, inspection, and reporting criteria through the site's Environmental Compliance Approval (ECA). The Wychwood Subdivision Technical Monitoring Report summarizes the performance results of CVC's monitoring and inspections from January 2016 to December 2017. During this time, CVC:

- Analyzed 125 precipitation events,
- Collected 41 water quality composite samples,
- Collected 3 event grab samples within the event size and season criteria as required by the ECA.



**Figure 4: Performance monitoring data collection. Source: CVC (2016)**

Studies have shown that events up to 25 mm in magnitude make up 90 per cent of rainfall events in a given year (STEP, 2018). As these events occur most frequently, they are responsible for transporting a large proportion of the annual contaminant load delivered to receiving waters.

This report provides lab results for total suspended solids (TSS) for all grab and composite samples collected during the monitoring period.

Performance monitoring results from Wychwood found that:

- Low impact development features provide 77 per cent volume reductions for events up to 25 mm.
- There was 84 per cent load reduction of TSS, exceeding the site's specific stormwater management water quality criteria of 80 per cent TSS removal.
- For events greater than 30 mm, peak flows were reduced on average by 74 per cent, with a total volume reduction of 59 per cent

These findings show low impact development systems can provide resilience under large and intense rainfall events, to support meeting flood control targets and erosion control criteria. Furthermore, limiting peak flow at the source will reduce pressure on downstream infrastructure which is often damaged during larger events with high intensities.

Performance monitoring determined that the low impact development features are not able to collectively meet the site's erosion control design criteria of managing, detaining or reusing all rainfall events up to 15 mm. The results indicate that for most events of approximately 15 mm in size, a portion of the precipitation is released as outflow. Review of the post-development observed dataset, site conditions, design assumptions and pre-development site conditions, provided several explanations for observed outflows for these events. CVC determined that the contributing factors to the erosion control criteria performance included:

1. Antecedent conditions impacting available storage within the feature;
2. Limited infiltration rates and available runoff storage within the infiltration trench feature due to a high groundwater table; and
3. Increases in lot-level impervious area.

It is essential for municipal authorities to properly regulate impervious landscaping within stormwater features on municipal property and enforce by-laws to protect the feature from being included in lot-level landscaping. Figure 5 represents a case from Wychwood where a resident has extended a private walkway through the enhanced swale, potentially impacting the underlining infrastructure and the feature's infiltration and storage capacity.



**Figure 5: Resident walkway constructed through grass swale. Source: CVC (2016)**

#### **1.1.4 Maintenance Inspection**

Once Wychwood's low impact development features were receiving storm flow, CVC staff performed site inspections of the conditions of the bioretention features, oil and grit separator units, and permeable pavement and began to collect data on completed maintenance activities. During these site inspections, CVC documented significant landscape changes across the subdivision from the approved plan that may impact overall stormwater performance. Spaces within the residential lots originally allocated in design plans as permeable area for runoff storage were converted to impervious walkways, driveway extensions, and storage structures.

As more of the subdivision becomes impervious, runoff volumes will increase, leading to greater runoff directed to site low impact development features. Despite these lot-level changes, the enhanced swales and bioswale located on municipal property remain in great condition. There is no evidence of residual runoff ponding 24 hours after events, but as mentioned, these cumulative alterations offer a partial explanation for the site's under performance in meeting the 15 mm event erosion control criteria. Additionally, private site alterations described above are not unique to

Legal precedent has identified risk to municipalities surrounding operation and maintenance of stormwater networks. The Risk Management Framework has shown that tracking and documenting compliance of stormwater systems has led to a reduction of overall risk and ability to demonstrate duty of care for meeting stormwater ECAs and permitting requirements. (Peel Climate Change Partnership, 2018)



**Figure 6: Site Maintenance Inspections. Source: CVC (2016)**

Wychwood; residential developments over time tend to increase in impervious cover (Credit Valley Conservation and Zizzo Strategies, 2018).

An annual site inspection is an ECA requirement at Wychwood; tracking site conditions over time provides guidance on required frequency of inspection appropriate for each low impact development feature. During the study period, CVC performed seasonal inspections (10 in total) to track maintenance trends and the impacts on feature performance. The main findings included:

- CVC documented the frequency and type of maintenance completed by either the residents or maintenance contractors.
- Residents maintained the lawns within the bioswale and trimmed vegetation within the rain gardens. Municipal sub-contractors completed all other maintenance activities within the bioswale and oil and grit separator units.
- Low impact development features were used for landscape material storage and as a throughway for construction equipment traffic during property maintenance and initial construction.
- The curb cut inlet to the rain gardens is a 90° inlet perpendicular to the curb gutter with a narrow opening. The inlet's poor design allows untreated stormwater in the road to bypass the rain garden and enter directly into the nearest catch basin
- The majority of permeable driveways are in good shape and are maintained by residents. Site inspections documented three occurrences of pavers clogged by sediment and 11 cases of structural damage allocated to minor chips on the edges of the pavers.

Nearly half of the 70 lots at Wychwood have either added impervious landscape features to their property or have modified lot-level drainage, increasing runoff volumes directed towards the LID features. (CVC, 2020)



**Figure 7: Residential yard with added impervious cover. Source: CVC (2019)**

Observed and modelled results from the Wychwood features indicate low impact development can be successful in managing stormwater across a subdivision. The low impact development features are achieving the site's design criteria of maintaining pre-development infiltration rates and controlling the 2 to 50-year design storm peak flows. These results, in addition to 84 per cent TSS removal, show that distributed and maintained low impact development features can

meet regulatory approvals for stormwater management in newly built developments and reduce the footprint of traditional end-of-pipe management techniques.

### **1.1.5 Conclusion and Next Steps**

For future low impact development residential subdivision application, here are some key lessons from Wychwood:

- Site inspection during the construction phase is critical for ensuring the features are built according to design, and appropriate sediment barriers are in place to protect the features from contamination.
- The presence of high groundwater will limit a stormwater feature's ability to store runoff and increase the volume of outflow released during runoff events.
- If landscaping enhancements include impervious materials, there will be an increase in impervious cover within the subdivision. Development of stormwater management designs and performance standards should anticipate a loss in pervious cover and storage volume within residential lots.
- Selecting the appropriate low impact development inlet design and ideal location within the site is critical to ensure the desired volume of runoff is directed towards and into each feature. This consideration will improve overall performance and contribute to attaining approved design standards.

Tracking changes in site conditions over time will allow the City of Brampton to develop feature-specific inspection and maintenance schedules and inform compliance monitoring requirements for future low impact development projects required through the Province of Ontario's asset management legislation (Ontario Regulation 588/17). CVC in collaboration with STEP partners have developed an extensive training program on a range of stormwater management topics including how to complete routine maintenance inspections for municipally owned and operated low impact development features. Training services may also include the development of site-specific standard operating procedures. At the request of the City of Brampton, site specific training can be provided to municipal staff.

To further investigate the impact that high groundwater levels have on runoff infiltration rates and storage within the features, CVC recommends a focused groundwater monitoring program be implemented in 2020. This program will inform the extent to which high groundwater levels impact low impact development performance. Groundwater monitoring will also fill in knowledge gaps in site water balance currently estimated with only surface flow monitoring data.

In 2020, the City of Brampton will begin collecting a stormwater charge to provide dedicated funding for operation, maintenance, renewal, and rehabilitation of the City's stormwater infrastructure valued at \$1.12 billion (City of Brampton, 2019). With newly obtained funding for stormwater infrastructure, implementing low impact development generates a valuable return for taxpayers given the peak flow reduction performance, erosion protection, and runoff water quality improvements that these features can provide.

### **1.1.6 *References***

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