Central Parkway

Location: Mississauga
Constructed: Fall 2014

Case Study

Road Right-of-Way Retrofit

Project Objectives, Design and Performance

- Road retrofit comprised of Silva Cell technology that treats and infiltrates road runoff from the four-lane roadway.
- Retrofit aimed at improving stormwater management within the Cooksville Creek watershed by providing water quality and thermal benefits.
- Conduct infrastructure performance assessment to address knowledge gaps impeding the wide-scale adoption of LID technologies in Ontario.

Overcoming Barriers and Lessons Learned

- It is important to provide instruction and detailed plans to ensure that the project is completed with little disruption to traffic and in a timely manner.
- Monitoring through performance assessment should be planned in the design. Modifications may need to be made to the design to accommodate monitoring infrastructure and equipment.

Practices Implemented

Bioretention

Innovative SWM

Barriers & Issues Encountered

Design

Construction & Comissioning

Overview

The Central Parkway low impact development (LID) road retrofit is located on Central Parkway East, just south of Burnhamthorpe Road in Mississauga, Ontario.

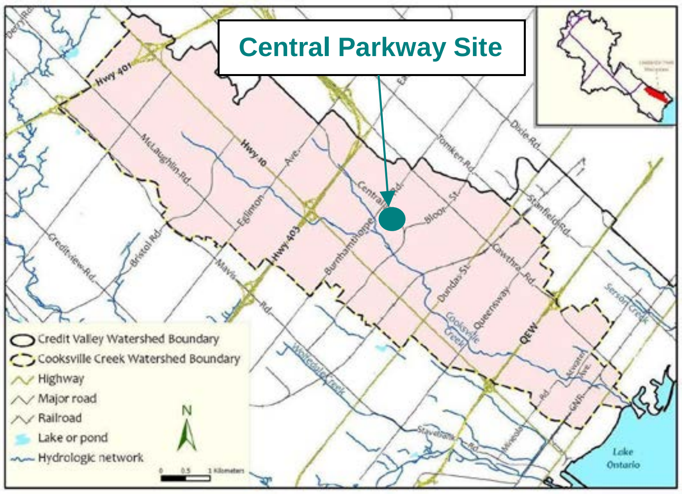

Figure 1: The road retrofit is located on Central Parkway East in Mississauga, ON, within the Cooksville Creek watershed

The Central Parkway project incorporates Silva Cell technology within the existing road median of the four-lane road. Runoff from the road flows to catch basins, and is then directed to the Silva Cell system for water quality treatment.

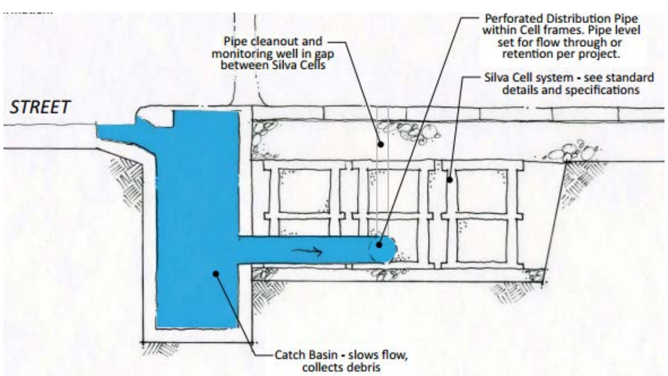

Figure 2: Non-site specific Silva Cell schematic depicting stormwater entering a catch basin and a Silva Cell feature (Source: DeepRoot)

Goals and Drivers

There are several goals and drivers that prompted the LID retrofit of the median on Central Parkway East:

- Upgrading the existing roadway and stormwater management infrastructure with modern LID techniques, as part of the City of Mississauga's re-surfacing program.
- Establishing a LID road retrofit demonstration site that can be used to showcase the effectiveness of LID practices to various Ontario stakeholders.
- Providing a site where the stormwater quality control, quantity control and water balance benefits as well as long-term life cycle activities could be assessed under real-world conditions.
- Providing stormwater treatment, thereby improving the quality of stormwater discharged to Cooksville Creek.
- Ease the burden (runoff volume) on existing municipal storm sewers within the Cooksville Creek watershed.

Successes

The successes achieved with this project include:

Innovative project – The Central Parkway project is the first green road retrofit to take place in Mississauga where the Silva Cell system has been specifically used for stormwater treatment in addition to encouraging tree growth and aesthetic design.

Joint partnership – A partnership was formed between the City of Mississauga and Credit Valley Conservation (CVC). CVC provided design and construction assistance, and is conducting performance monitoring and maintenance inspections.

Demonstration showcase – The LID feature at Central Parkway has been showcased through presentations, events and site tours. These efforts have helped educate numerous stakeholders on the benefits of LID.

Performance – Preliminary monitoring indicates that the LID feature is performing well, and that for the majority of rainfall events little to no stormwater runoff leaves the site.

Overcoming Barriers and Lessons Learned

As with any project, there will be challenges faced by the parties involved. The barriers, issues and solutions encountered with this project include:

- To minimize the negative impacts of topsoil mixing with bioretention soil, the contractor ensured that dump truck would be washed or used exclusively for bioretention soil.
- Keeping monitoring in mind, the design called for the concrete chambers to be located side by side within the road median. Due to the width of the road and available excavation space, this was not possible. The chambers were realigned within the existing road median and fitted with pipes to allow the monitoring equipment to be installed and function as intended.
- Through monitoring and a water test it was determine that the catch basins were experieicing a

lead. To mitigate the leak, the sumps were raised and sealed with an impermeable liner.

- Through monitoring and water testing, it was also determined that the overflow pipe in one catch basin was installed at a lower elevation than the system inlet pipe. To mitigate this issue, the overflow pipes were raised and fitted with elbows to ensure runoff enters and is treated by the LID feature.

Lessons Learned:

- Field investigation prior to design is critical. Observing how the site and adjacent areas are used daily will provide critical insight into how the LID feature should be designed.
- Design drawings should be as detailed as possible, including dimensioning of all components and location of all existing utilities and constraints.
- When constructing LID facilities, ensure that an appropriate benchmark is used for surveying to ensure proper and accurate layout.
- Sediment and erosion control guidelines should provide clear guidance for protection of infiltration areas in LID practices and inspectors should ensure that these requirements are being met.
- As LID is a new stormwater management approach for many contractors, it is recommended that municipalities budget for increased site inspection and supervision and construction meetings to address any issues as they arise.

Planning and Regulations

Coordination with project partners and stakeholders is important with LID adoption. The City of Mississauga was looking for an urban road retrofit site for LID. As part of their road re-surfacing program, the City had originally inspected Central Parkway north of Burnhamthorpe Road, but when looking south of Burnhamthorpe Road, the opportunity to maintain the existing drainage towards the under-utilized wide median and retrofit existing storm infrastructure was chosen as the best option.
The fact that the site would benefit the Cooksville watershed to improve water quality, and that the City received a grant from TD Green Streets were additional catalysts.

Design

Prior to implementing the retrofit project, Central Parkway East consisted of a four-lane roadway with a median. The stormwater management retrofit was designed to capture stormwater runoff and convey it through the DeepRoot Silva Cell system before discharging any remaining runoff to the existing storm sewer system.

Figure 3: Central Parkway East pre-retrofit

Drainage Area

Stormwater catchment areas were analyzed and drainage areas were calculated accordingly. Two select catchment areas provide stormwater runoff for the project. The east catchment area is 501 m^2 and the west catchment area is 545 m^2. The combined total catchment area is 1,046 m^2. The catchment areas are 100% impervious pavement with slopes ranging from 0.5% to 2.0%. Based on the design, the site is expected to provide filtration up to the 27 mm precipitation event.

Pre-treatment

Stormwater will initially be captured and pre-treated in existing catch basins, located adjacent to the median. The catch basins are retrofitted with internal pipe extensions to create a sump area and provide surface water screening. The sump area and surface water screening result in pre-treatment of larger sediments as well as floatable debris prior to conveyance to the system.

Silva Cells

The Silva Cell system is a modular suspended-pavement soil cell system which is designed to provide filtration of runoff from the contributing drainage area. The Silva Cells are fiberglass-reinforced polypropylene structures including frames and decks that are designed to support sidewalk loads. The frames are 400 mm x 600 mm x 1200 mm each, and the decks are 50 mm x 600 mm x 1200 mm.

Figure 4: Silva Cells

The excavated median trench is lined with non-woven geotextile over the compacted subgrade, followed by a 100mm aggregate sub-base. Two layers of Silva Cells were installed around the perimeter of the feature, and one layer of Silva Cell frames was installed under the tree root balls. Each tree provides 17.5 m^3 soil volume.

The project is designed to achieve the maximum stormwater treatment benefit by taking full advantage of the available void space volume provided by the Silva Cells and bioretention soil media. The Silva Cells and planter area for the project provide a soil media volume of 105 m^3. An industry standard conservative value of 20% void space is assumed to be provided within the soil media macropores. The resulting void space volume for the project is 21 m^3. This volume is utilized for water storage capacity. The bioretention soil median is outlined in the following table. Backfill, consisting of clean, compactable, coarse grained material was used to fill the space between the Silva Cells and the trench sides.

Table 1: Bioretention soil media

Bioretention Soil Media	
Component	**Percentage by Weight**
Coarse to medium sand (2.0 to 0.05 mmØ)	71 – 92%
Fine sand (0.25 to 0.05 mmØ)	0 – 17%
Silt and clay (<0.25-0.05 mmØ)	8 –12% (5% clay max)
Organic matter	3-5%

Distribution pipes were installed in the existing catch basins to route water to the bioretention/filtration system. The water is then distributed through 150 mm perforated pipes (wrapped in 100 mm pea gravel and geotextile) into bioretention soil media where it will percolate through the soil column, providing water to the trees and filtering out excess nutrients. Rigid 150 mm non-perforated PVC pipes were installed, connecting to the distribution pipes, to act as cleanouts.

Figure 5: Distribution pipe installation and bioretention media inspection

Once percolated through the soil column, water ultimately discharges at the base of the system through a 150 mm perforated underdrain that is connected to an existing storm sewer manhole structure. This is connected to the City of Mississauga's storm sewer system.

Bioretention Planter

The planter is surrounded by a concrete curb which is lined with a DeepRoot root barrier. The 75 m^2 planter houses Chanticleer Pear trees and Fragrant Sumac shrubs. The trees have been placed at an elevated level with bioretention soil crowned at the trees to accommodate for future settling. A 75 mm layer of shredded hardwood mulch is spread across the surface of the planter.

Figure 6: Completed planter with trees and shrubs

Infrastructure for Performance Monitoring

An important consideration in the design of this site was the inclusion of performance monitoring. To better understand and correlate the results of the bioretention system on overall water quality, as well as volume and rate reduction, monitoring activities and the required infrastructure were included in the design stage. Necessary modifications were also made throughout the construction process to allow for monitoring.

Recording and analyzing data can provide a baseline assessment of how these systems perform now, as well as provide data on performance as they age. The bioretention system design includes sub-surface vaults or chambers for housing and protecting stormwater monitoring equipment at the inlet and outlet of the system. See the Performance Monitoring section for additional details.

Figure 7: Installation of monitoring chambers and pipe connection

Design Issues

An important component in ensuring the feature at Central Parkway is functioning and performing as intended involved going on-site shortly after the feature was constructed and conducting visual inspections, photo logs and videos during rain events. Staff videotaped the site during precipitation events with various intensities. Prior to these observations, monitoring equipment had been installed and indicated that monitored flows at the inlet were low compared to expected flows based on a model.

By videoing the site during a particular event, staff observed runoff bypassing the system by entering the overflow pipe in the west catch basin and not entering the inlet pipe to the Silva Cell system. This suggested that the inlet pipe had been inadvertently installed at a higher elevation than the overflow pipe.

Based on this observation, a water test was conducted by pouring water directly into the two catch basins that receive runoff before entering the LID feature. The water test confirmed that the invert of the overflow pipe was at a lower elevation than the invert of the inlet pipe in the west catch basin. Water did not enter the inlet pipe at any point during the test, indicating that the drainage area of the west sub-catchment was bypassing the feature entirely.

Figure 8: Water test in the east catch basin

In addition, an obvious drawdown of water was observed in the west catch basin, indicating that a significant leak was also occurring. Observations indicated that surface flows from the east sub-catchment area directly entered the open overflow pipe as a result of its location close to the curb-side of the catch basin. A slight drawdown was observed in the east catch basin.

As a result of these observations, several repairs were performed. The overflow pipe in the west catch basin was raised several inches and fitted with an elbow to prevent bypass, and the overflow pipe in the east catch basin was fitted with an elbow to prevent direct surface flows. The sumps for both catch basins were filled, with the new bottoms raised to approximately the obvert of the existing overflow pipes.

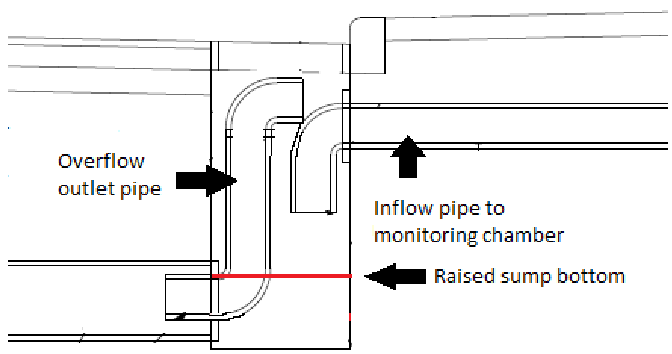

Figure 9: Example catch basin with a raised sump bottom

For further guidance and LID design best practices, refer to the **LID Design Guide**.

Construction and Commissioning

Construction took place over a period of approximately two months, during which time several issues were encountered by the contractor.

Construction Drawings

The construction drawings were quite detailed and left few assumptions for the contractor. The main oversight on the drawings was the scale of the monitoring and inlet chambers.

These chambers appeared in-line and directly adjacent to each other on the drawings. However, in the field the chambers that were specified were significantly larger in diameter. As a result, the contractor had to offset the chambers in order to fit them within the median which also changed some of the inlet piping.

Construction Inspection and Supervision

Overall, construction went smoothly and efficiently with inspectors from DeepRoot on site during key moments in order to help the contractor install the system as it was the first one installed by the contractor and the City of Mississauga.

A minor soil mixing issue occurred when a dump truck installed one batch of bioretention soil into the Silva Cells. It was identified by a CVC construction inspector that there appeared to be some clay-based topsoil within the batch.

This was verified quickly on site by a ribbon test. The CVC inspector notified all involved parties and it was determined that the dump truck had previously dumped a load of topsoil at another site. Some of the remaining topsoil came in contact and mixed with the bioretention soil. This can negatively impact the biomedia composition.

Figure 10: Ribbon test by CVC staff

It was determined that the extent of mixing was minor. The contractor removed the visible topsoil to the best of their ability and to the satisfaction of the site inspector. The contractor then ensured that no dump trucks would be used for topsoil prior to bioretention media.

From this and other experiences, LID projects would benefit from weekly on-site meetings to review the design and direct the contractor on any issues they have. Engineers and contractors are also encouraged to read CVC's **LID Construction Guide** for further guidance with LID best practices

Site Layout and Surveying

To minimize errors and keep construction on track, a survey crew should be on site to assist in establishing and confirming elevations. At Central Parkway, surveyors verified the elevations and placement of the monitoring, inlet and outlet chambers. They also confirmed the height at which to cut the chambers to ensure they were flush with the concrete and did not impede the monitoring equipment.

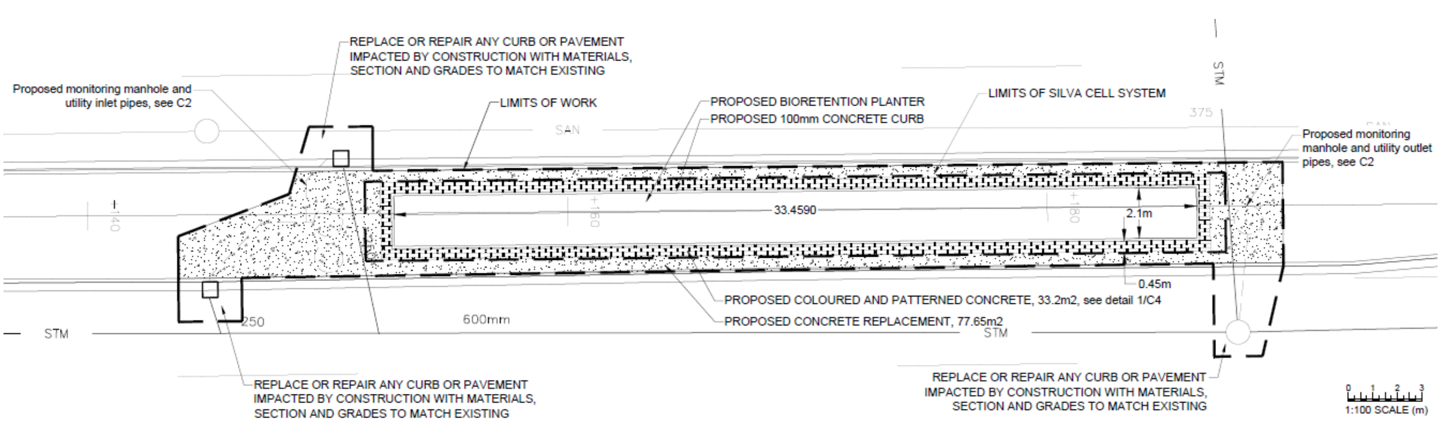

Figure 11: Proposed site plan

Figure 12: Survey staff on site

Erosion and Sediment Control

Erosion and sediment control ensured that the system was kept offline until completion and any deficiencies were addressed. During the construction process, the bioretention soil was wrapped using sacrificial pieces of geotextile to ensure debris could not enter the system. Bioretention soil was not stockpiled on site at any time and was installed as delivered from the dump trucks directly by the excavator.

Figure 13: Catch basin protected with erosion and sediment control

Operations and 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 larger ones and improves 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 general, it is recommended that the contractor 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.
- Apply pesticides in accordance with Federal, Provincial and Municipal regulations and when required by the City to control insects, fungus and disease. Product approval must be maintained from the City prior to application.
- Keep trunk protection and guy wires in proper repair and adjustment.
- Remove and replace dead plants and plants not in healthy growing conditions. Make replacements in the same manner as specified for original plants.

The City of Mississauga's Forestry Department has been performing maintenance activities, including removing accumulated trash, weeding and mulching. The City will also perform an annual inspection of the two catch basins. Since May 2015, CVC monitoring staff have been collecting data on maintenance activities performed and inspecting the conditions of the Silva Cell feature at Central Parkway on a monthly basis. A standard site inspection checklist has been created and is used by staff during each site visit.

To ensure that the infrastructure assessment provides comprehensive data regarding the long-term operation, maintenance and life cycle activities for LID practices, monitoring at the site will continue for an extended time period.

Performance Monitoring

Demonstrating that LID works in the real world and provides quantifiable stormwater management quantity and quality control benefits is critical to overcoming barriers and concerns among municipalities, regulatory agencies, developers, businesses and other stakeholders. To help address the concerns and barriers expressed by our stakeholders, CVC is currently undertaking a comprehensive infrastructure assessment at Central Parkway to monitor its performance in managing stormwater runoff at the site. This infrastructure assessment is being overseen by an expert advisory committee consisting of municipalities, regional government, the MOECC, consultants and universities.

In December 2012, the advisory committee prioritized study objectives for LID infrastructure assessments. Understanding maintenance and operation requirements and life cycle costs are the top priorities of the stakeholders. These study objectives are directly relevant to effective asset management. Other objectives include assessing the water quality and quantity performance of LID technologies, and the degree to which LID mitigates urban thermal impacts on receiving waters. The infrastructure assessment underway at Central Parkway is well suited to answering the questions of CVC's advisory committee and our broader stakeholders.

The infrastructure assessment began in 2015 shortly after the completion of construction in late 2014. Due to site design, monitoring does not take place in winter months. The assessment involves continuously monitoring runoff from the road and outflow from the LID feature. Unlike many LID sites, Central Parkway is unique in that we are able to monitor the volume and rate of runoff entering the system from the road. It is often difficult to monitor inflow data due to site constraints such as placement or multiple points of entry, as with permeable pavement.

Monitoring staff have equipped chambers at both the inlet and outlet of the facility with specialized equipment to measure the flow, volume and quality of stormwater leaving the site. Water quality sampling has not yet commenced, however flow-weighted water quality samples will be analyzed for total suspended solids, and a broad spectrum of nutrients and metals for all events producing discharge. Temperature loggers have also been installed at both the inlet and outlet monitoring chambers to determine how LID mitigates urban thermal impacts on receiving waters. Due to the limited dataset, analysis has not been conducted yet.

Figure 14: Outlet monitoring chamber and equipment

Observations

Monitoring staff have been able to observe the site "in-action" by capturing videos of runoff entering the catch basins during rainfall events of varying precipitation depths and intensities. Combined with data from the monitoring equipment, CVC staff determined that measured flows at the inlet were low compared to expected flows, as generated by a model; see the Design Issues section for more information. Several repairs were performed to minimize the bypass, with the final repair in November 2015. As a result, the 2015 dataset is small, and includes some degree of bypass.


Figure 15: Monitoring staff conducting a water level measuring at the inlet monitoring chamber

Water Quantity Analysis

Preliminary data analysis from August-September 2015 suggests that the LID practice at Central Parkway is performing well. It is important to note that this analysis is based on the monitored runoff that actually entered the system and the outflow. The average volume reduction for all events is 97%, and the average peak flow reduction is 96%.

Table 2 presents the volume reduction for events of varying magnitude. While the dataset is preliminary, the site retains approximately 98% of runoff for all events less than 25 mm, which make up the greatest proportion of storm events in southern Ontario.

Table 2: Monitored volume reduction

Event size	Influent volume (L)	Effluent volume (L)	Volume reduction
2 - 5 mm	2619	0	100%
5 - 10 mm	6930	0	100%
10 - 15 mm	5981	247	96%
15 - 20 mm	0	0	n/a
20 - 25 mm	0	0	n/a
>25 mm	40472	3452	91%
<25 mm	15530	247	98%

Figure 16 demonstrates an event from August 10, 2015. This storm event had a 22 hour duration and a precipitation depth of 28.8 mm, with a peak rainfall intensity of 40.8 mm/hr. Volume reduction for this event was estimated to be about 83% and peak flow reduction was estimated to be about 75%. These estimates are affected by many variables including normal variability in measurements and rainfall-runoff assumptions. A lag time of approximately 35 minutes was observed between the inflow runoff peak and the outflow peak for this large event.

For further information on the ongoing infrastructure assessment work being undertaken at Central Parkway and CVC's suite of LID guidance materials, visit **BeALeader.ca**

Acknowledgements

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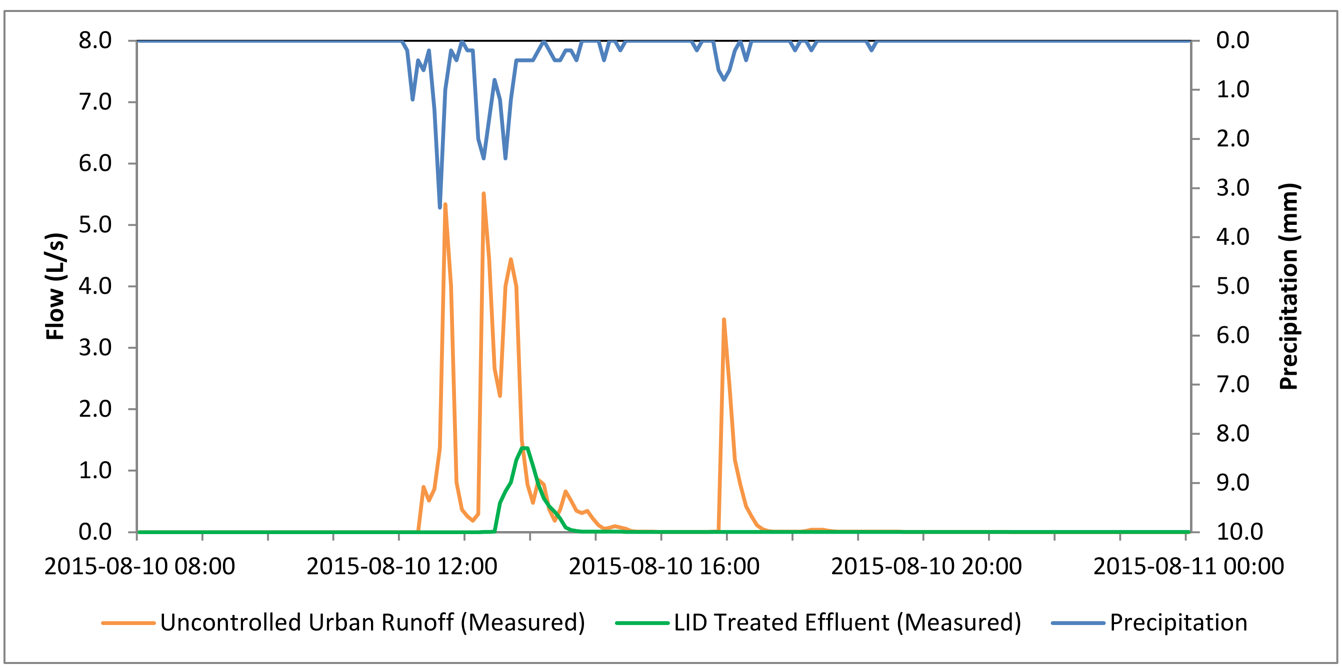

Figure 16: Response to the August 10, 2015 event at Central Parkway