Elm Drive: Low Impact Development Demonstration Site Case Study

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Context

Almost every year since 1995, Ontario has had a state of emergency linked to severe weather[1]. Climate change is predicted to exacerbate the risks and challenges municipalities face today with aging infrastructure and growth pressures[2]. The serious impact of storm events, such as the one that took place on July 8, 2013 in the Greater Toronto Area, calls attention to the need to build additional stormwater capacity within our urban areas to handle these large, intense rainfall events. High intensity storms produce heavy rainfall in very short time periods. Large volumes of stormwater runoff overstress conventional stormwater systems leading to flooding, erosion, habitat destruction, degraded water quality, damage to infrastructure systems and post-flooding health-related concerns including mould growth and contaminated water.

Our approach needs to change in order to stay ahead of stormwater challenges. We need to think of stormwater management not just in terms of dealing with storms, but as managing our water cycle during dry periods to optimize integrated water management (water, wastewater and stormwater). We need to be able to manage extreme rainfall events like July 8, 2013, combination events like the excessive rain and snow runoff causing the Bow River flood in Calgary in 2013, and extended periods of drought as occurred in southern Ontario in 2007 and 2016. These types of events are increasing in frequency and have costly consequences including power outages and costly property damage.

Green infrastructure, including low impact development (LID), is gaining traction as an approach to enhance stormwater management within existing urban areas to reduce stress on aging infrastructure. LID has been found to build resiliency, optimize water and wastewater treatment costs, improve watershed health and the local economy. LID can also contribute to cost savings; a recent report generated estimates of the monetary value of flood loss avoidance that could be achieved by green infrastructure implemented watershed-wide, in new development and redevelopment, in the United States[3].

LID technologies are designed to mimic the natural movement of water in the environment. They are engineered landscape features that infiltrate, filter and store stormwater runoff. They also provide surfaces for evaporation to occur. By emulating natural or pre-development conditions at a site, LID technologies help reduce the volume of runoff, removing nutrients, pathogens and metals. LID technologies can also restore groundwater and stream flows, support wastewater dilution, protect our fisheries and enhance human well-being.

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Project Description

LID projects are easy to incorporate into new developments, urban retrofits or redevelopments. An example is CVC's right-of-way demonstration site at Elm Drive in Mississauga. The City of Mississauga the Peel District School Board and Credit Valley Conservation collaborated to develop this green-street project, located approximately two blocks south of the Square One mall. The project is located on a mixed-use street with residential homes and an education centre. Features onsite include a permeable pavement sidewalk and laybys, and a series of six bioretention cells connected with an underdrain. CVC monitors the quantity and quality of runoff leaving the site. The site provides stormwater treatment, improving the quality of stormwater discharged to Cooksville Creek including thermal mitigation, and reduces the runoff volume to municipal storm sewers.

Elm Drive is just one of the many projects implemented and monitored by CVC as part of the Infrastructure Performance and Risk Assessment (IPRA) program. IPRA is a multi-year stormwater monitoring program focused on gathering detailed information to evaluate stormwater facility performance in various land use types, climate conditions and development stages. The IPRA program also evaluates the effectiveness of stormwater facilities in flood control, erosion protection, nutrient removal, cold climate performance and the maintenance of pre-development water balance.

The monitoring program is based around a set of objectives that have been developed with an advisory committee consisting of municipalities, provincial and federal environmental agencies, academia, and engineering professionals. Several of these objectives have scoped the monitoring program at Elm Drive, such as evaluate how a site with multiple LID practices treats and manages stormwater runoff; evaluate the long-term maintenance needs and impact of maintenance on performance; and, assess the quality and quantity performance of LID designs in clay or low infiltration soils.

Project Outcomes

LID offers a quick win solution to build capacity into existing stormwater management infrastructure while conventional practices are upgraded. In existing urban areas built prior to flood control requirements, there is little available land for conventional practices such as berms or stormwater management ponds, which require a large amount of available land. LID projects can get into the ground quickly and can make use of space in public areas such as schools, parks and road right-of-way. Municipalities like Mississauga are finding that LID may be able to provide opportunities to build flood control capacity and reduce stress on existing infrastructure, particularly in the Cooksville Creek subwatershed. When incorporated into multiple locations and different land use types across a watershed, LID is an effective tool for managing the impacts of stormwater such as erosion, degrading water quality and associated costs. In doing so, LID also helps to protect natural features and biodiversity.

Project Lessons Learned

Performance monitoring at Elm Drive has provided valuable data to address many of the gaps and barriers associated with wide LID implementation. This data has shown that the site is able to achieve substantial volume reductions for events of all sizes and provide a thermal benefit to receiving watercourses. Volume reduction is achieved by retaining water (through infiltration or evapotranspiration) such that it does not contribute to outflow from the site. It is important for groundwater recharge and water balance objectives as well as water quality objectives. Monitoring has indicated that 80% of all precipitation events at Elm Drive produce no outflow. Events up to 25 mm account for 90% of storm events in this area and contribute to a large proportion of the average annual precipitation in southern Ontario. Due to their frequency, events in this size range are also responsible for transporting a large proportion of the annual contaminant load delivered to receiving waters. For events less than 25 mm, a volume reduction of 93% was achieved, significantly reducing the amount of stormwater runoff entering Cooksville Creek.

In addition to providing volume reduction for frequent events, Elm Drive was able to manage runoff from the large 105 mm event on July 8, 2013. Elm Drive was designed to reduce the peak flows from a 100-year storm by 13%; but monitoring results from this large event found that the LID features were able to reduce the peak flow by approximately 60%, dramatically outperforming design criteria. These features also reduced runoff volume by approximately 30% (which translates to almost a 1/3 of the rainfall being diverted from the municipal system). In addition, a lag time of 20 minutes delayed flow to the storm sewers reducing stress on the already burdened municipal system.

The treatment train at Elm Drive has also proved very effective in reducing the thermal load to downstream watercourses. Data from monitoring the inflow and outflow water temperatures on site suggest that the LID features significantly improve the thermal loading impacts across all event sizes. The decrease in outflow volume through runoff storage within the LID facility is the leading factor in producing high thermal and temperature reductions at Elm Drive. Additionally, any outflow produced must pass through cooler, permeable soil where thermal energy is transferred. The treatment train provides high thermal reduction in all events ranges and nearly 100% reduction during smaller, more frequent events. The LID provides consistent event mean temperature (EMT) reductions each year, demonstrating the need to implement LID designs upstream of known sensitive streams habitats. These results suggest similar LID technologies can be used to meet Ministry of Natural Resources and Forestry requirements for protecting Redside Dace habitats.

More information on the performance of the LID features at Elm Drive and other projects can be found on our website at www.creditvalleyca.ca/low-impact-development/.

Next Steps

In 2017 and beyond, CVC is working to continue to share and communicate key outcomes of the LID performance Monitoring program including training and webinar development. We are continuing to monitoring specific sites for longer terms to quantify maintenance requirements, costs and benefits. We are also reviewing the key monitoring objectives to refine the program objectives to include new investigations including seasonal water balance, effects on adjacent infrastructure and defining evapotranspiration contributions to LID site scale water balance.

[1] Sandink, D., Kovacs, P., Oulahen,G., & McGillivray, G. 2010. Making Flood Insurable for Canadian Homeowners: A Discussion Paper. Toronto: Institute for Catastrophic Loss Reduction & Swiss Reinsurance Company Ltd. Available at URL: http://www.iclr.org/images/Making_Flood_Insurable_for_Canada.pdf.

[2] Zimmerman, R. and Faris, C. 2010. Chapter 4: Infrastructure impacts and adaptation challenges. Annals of the New York Academy of Sciences, 1196(1), 63-86

[3] Atkins. 2015. Flood Loss Avoidance Benefits of Green Infrastructure for Stormwater Management. Prepared for United States Environmental Protection Agency, December 2015. Available at URL: https://www.epa.gov/sites/production/files/2016-05/documents/flood-avoidance-green-infrastructure-12-14-2015.pdf.