CREDIT VALLEY CONSERVATION

Elm Drive

Low Impact Development Infrastructure Performance and Risk Assessment

May 2016

Monitoring Plan

Road Right-of-Way Retrofit

Credit Valley Conservation Proposal: Monitoring of a Low Impact Green Road Retrofit Project

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BACKGROUND

Municipalities across Canada are struggling to address a number of issues, from aging infrastructure to insufficient stormwater management, to prevent the degradation of receiving streams and the Great Lakes, and damage to property and infrastructure from erosion and flooding.

The purpose of the study is to evaluate the effectiveness of bioretention trenches, with respect to: catchment hydrology, surface water quality, and hydrogeology. This project will help educate urban municipalities on how to balance growth, redevelopment, stormwater infrastructure, and the environment in light of climate change; providing a template that municipalities can employ to cost-effectively address environmental and development issues.

PROJECT DELIVERABLES

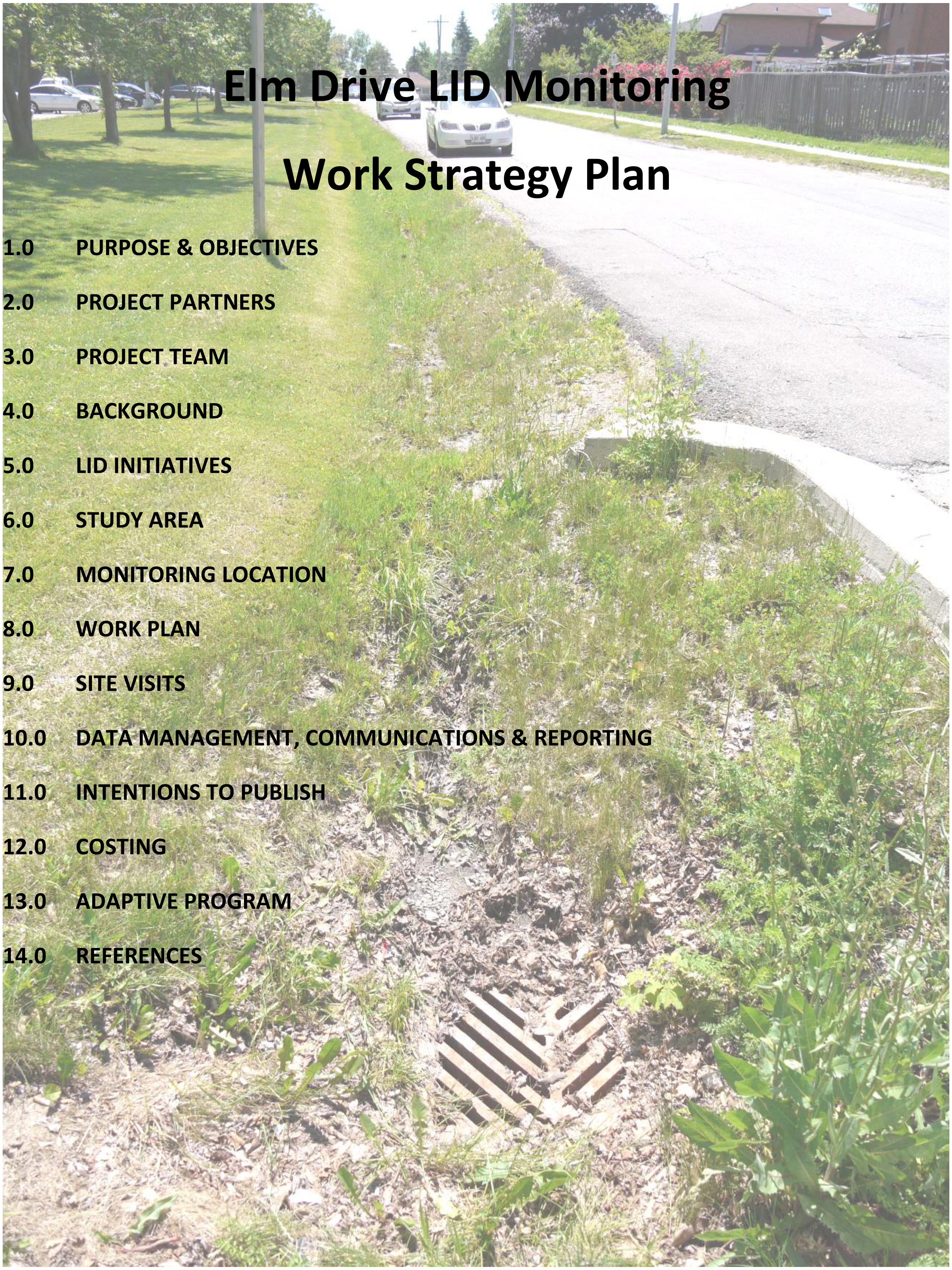
1. To support initiatives such as source protection and municipal stormwater management in light of climate change.

2. "Innovative" stormwater management demonstration site
   This stormwater treatment approach is "above and beyond" the standard practices in place pertaining to stormwater management in Ontario, using bioretention trenches as source control for innovative stormwater treatment and management. There is also little performance data currently available to support design initiatives of such practices.

3. Template for Municipalities Across Ontario
   Comprehensive effectiveness monitoring of performance data will be conducted to provide municipalities across Ontario with a template for LID implementation.

PROJECT SCHEDULE

1. Initiation of Environmental Monitoring – Spring 2011
2. End of Project – Late Fall 2016



Elm Drive LID Monitoring

Work Strategy Plan

1. Monitoring Purpose and Objectives

The purpose of the study is to evaluate the effectiveness of bioretention trenches as alternatives to roadside catch basins in dealing with storm water runoff in urban areas, with respect to catchment hydrology, water quality, and hydrogeology.

Objectives/Targets:

<u>Water Quantity</u>

- Monitoring data will be used to calibrate the models used for designing the LID applications. The models will then be rerun to determine how realistic they were in estimating the runoff volumes for the various design storms.
    - Post 2 yr = 87m^3, Post 5 yr = 143m^3, Post 10yr =195m^3, Post 25yr = 235m^3, Post 50yr =275m^3 and Post 100 yr=316m^3
- Determine the groundwater infiltration rate from the Bioswales.

<u>Water Quality</u>

- The bioretention gardens have been designed to provide Enhanced treatment per MOE guidelines.
    - Monitoring to confirm that 80% of TSS is removed from the stormwater produced from the LID Measures on an average annual basis.

This monitoring plan is based on the protocols and practices being used in other CVC monitoring programs.

2. Project Partners

1. City of Mississauga
2. Peel Board of Education
3. The Ministry of the Environment
4. Credit Valley Conservation Authority (CVC)

3. Project Team

- City of Mississauga Staff, Transportation & Works, City of Mississauga

- Christine Zimmer, Senior Water Resources Engineer, CVC
- Jennifer Dougherty, Water Quality Engineer, CVC
- Amanjot Singh, Water Quality Engineer, CVC
- Phil James, Water Resources Engineer, CVC
- Neelam Gupta, Water Resources Engineer - Hydrology, CVC
- Robb Lukes, Water Resources Specialist, CVC
- Andrew O'Rourke, Water Resources Specialist, CVC

4. Background

Our communities are supported by functions provided by our environment such as abundant, safe drinking water, and clean air. Studies conducted on the Credit River Watershed have found that we need to integrate how we build our communities with how we manage our stormwater to support a sustainable environment. This is known as Low Impact Development (LID). The planned design for the Elm Street West retrofit includes LID measures such as, biofilters, rain gardens and permeable paving stones, which will help to reduce environmental impact.

Since LID attempts to mimic natural processes, its performance depends on local conditions including, climate, soils, and drainage. Individual LID measures should be examined with respect to basic hydrological cycle components: evapotranspiration, infiltration, and runoff. Stormwater infiltration occurs on natural soils with pervious cover and at special facilities (bioretention and swales) located throughout the catchment area. At the Elm Street site, it is expected that infiltration will occur in the bioretention areas (bioswales and rain gardens). Long-term sustainable infiltration depends on soil cover, soils, hydrology, risk of clogging of infiltration sites, and infiltration facility maintenance. The process of maintaining a water balance as close to the natural state as possible also supports the enhancement of runoff quality and ecological integrity in receiving streams (J. Marsalek and Q. Rochfort 2008). CVC will be working with Mississauga Staff to assess if the LID practices put in place do indeed lead to a more natural site hydrology and water quality than in conventional stormwater management practices.

This monitoring project can act as a model to other sites contemplating bio-retention systems and a point of comparison to other locations with similar systems already in place.

This partnership research project would support the vision, goals, and objectives of Mississauga's Strategic Plan "Our Future Mississauga" by ensuring the health and attractiveness of Mississauga's communities, natural environments, and drinking water supply would be improved by encouraging and supporting alternative stormwater drainage strategies. This is also consistent with the vision of "Our Future Mississauga" - "As an environmentally responsible community, the City of Mississauga is committed to environmental protection, conducting its corporate operations in an environmentally responsible manner and promoting awareness of environmental policies, issues, and initiatives." This project sets an excellent example for the residents and businesses of Mississauga that everyone has a role to play in helping to protect and enhance the land, air, water that is enjoyed by all in Mississauga.

5. LID Initiatives

The most commonly used method of stormwater drainage in urban areas is curb and gutter. It is a very effective method for draining stormwater from neighbourhoods; however, it may be too effective. With curb and gutter drainage, storm water is quickly brought to receiving watercourses in impervious pipes. Very little of the water therefore soaks into the ground to be naturally filtered before it reaches these watercourses. This can lead to a number of problems in local streams including flash flooding, a decline water quality, and a reduction of stream baseflow and groundwater levels. Through a combination of swale drainage, biofilters, rain gardens and permeable paving stones, the hydrology and water quality leaving the Elm Street site will be improved over conventional stormwater practices.

- **Swale drainage** can reduce pollutant and sediment concentrations, and can have significant reduction time of flow to local creeks and storm drain systems. Open drainage also has the ability to reduce mosquito breeding areas through the reduction of areas with standing water (catchbasins).
- **Biofilters** or **bioretention cells** are a stormwater management technique that uses the chemical, biological, and physical properties of plants and soils to treat stormwater runoff. They are designed to mimic natural conditions promoting infiltration, retention, and the slow release of stormwater runoff.
- **Permeable Paving Stones** are an alternative to traditional impervious pavement, allow stormwater to drain through them and into a stone reservoir where it is infiltrated into the underlying native soil or temporarily detained.

6. Study Area

The subject site for the study is located in the City of Mississauga, within the Cooksville Creek watershed, and drain directly to Cooksville Creek (Figure 1). It includes Elm Street West between Joan Drive and Karlya Drive (Figure 2).

Preconstruction stormwater drainage for this roadway was served by a combination of grass swales and catchbasins with internal storm sewers, which drain directly to Cooksville Creek. A manhole was installed during construction at the end of the treatment train for monitoring purposes (Figure 2). Since the manhole will drain a specific area, it will be possible to equip it with monitoring equipment to measure flow and take water samples during rainfall or snowmelt events. A rain gauge will be installed at the site to provide precipitation data.

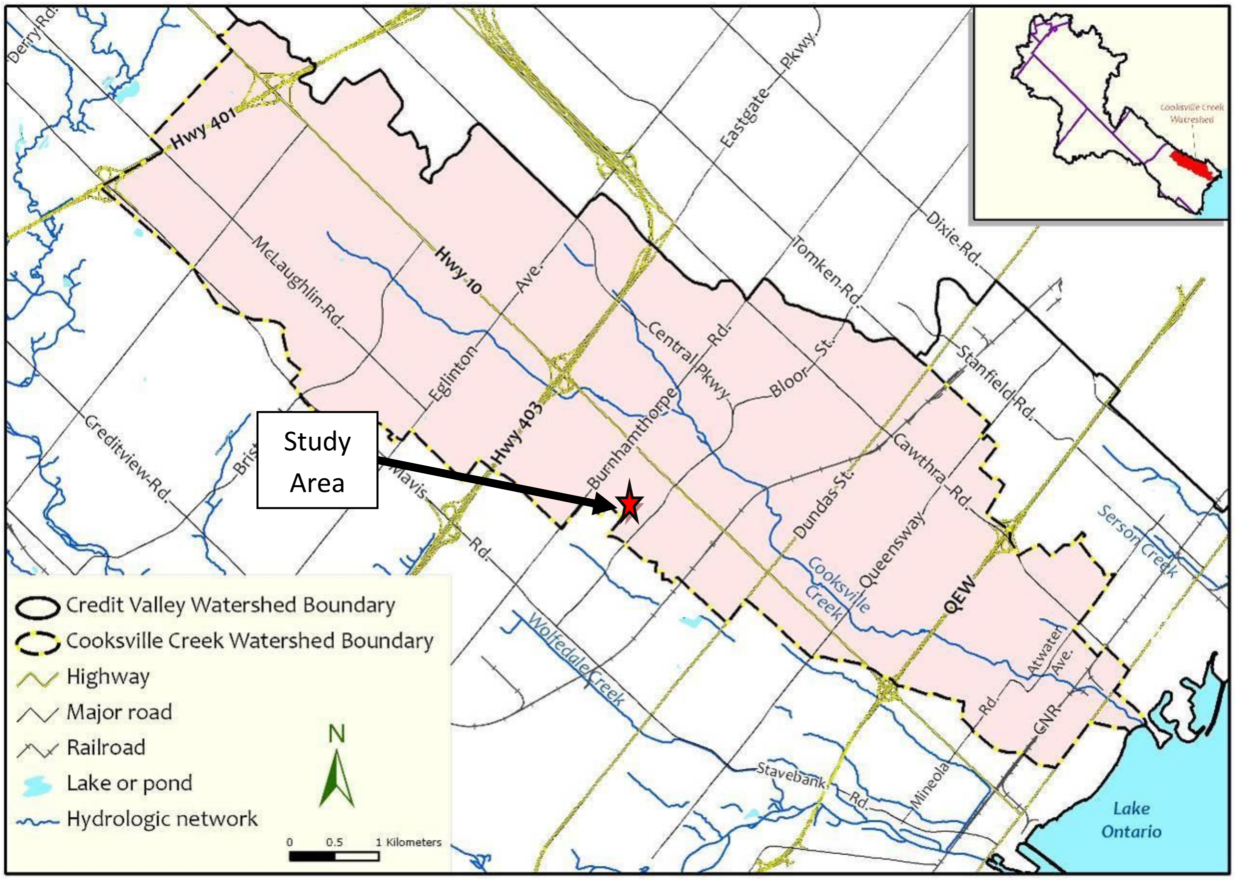


Figure 1: Study area located in the Cooksville Creek Watershed

Figure 2: Areal View of Project Area

7. Monitoring Location

Existing site plans were reviewed followed by a site walk to gain an understanding of the existing drainage system for the study area. One monitoring station is proposed for this project. During construction, a manhole was installed at the end of the treatment train for monitoring purposes. An automatic water sampler and water level logger will be installed in the manhole. Figure 3 shows an external and internal view of the manhole.

Figure 3. Monitoring station.

8. Work Plan

8.1 Hydrology

A flume or weir will be installed in the manhole located at the end of the treatment train. An ISCO 4150 or equivalent flow meter will be installed in the manhole with the probe secured to the weir to ensure accurate water level measurements. The flow meter will be set to record water levels at 10-minute intervals. In addition, a heated rain gauge will be installed close to the site to record precipitation and will be set to record at 10-minute intervals.

8.2 Surface Water Quality

A minimum of ten (10) precipitation events will be sampled per year from the monitoring location with an ISCO 6712 Automatic sampler or equivalent. The sampler will be connected to the water flow logger and triggered when a predetermined water level is recorded by the flow logger. A wet event will be defined as any rainfall event greater than 10 mm or snowfall event greater than 5 cm. The monitoring program will continue until thirty (30) precipitation events have been collected.

The sampler holds twenty-four (24) one (1) litre bottles. Samples will be analysed for:

- Chloride
- Turbidity
- Conductivity
- pH
- Total Suspended Solids (TSS)

- Total Dissolved Solids (TDS)
- Nutrients:
  - Total Phosphorus
  - Orthophosphate
  - Total Kjehldahl Nitrogen (TKN)
  - Total Ammonia
  - Nitrate & Nitrite
- Total Metals
- PAH (only 5 events, June-July)
- E.Coli Bacteria (only 5 events, June-July)
- Oil & Grease (only 5 events, June-July)

Event sampling will be conducted as follows:

- Two (2) samples will be submitted per surface water quality monitoring station per event.
- 1 initial first flush grab sample will be collected in the samplers first 6 bottles and submitted for analysis.
- The remaining 18 bottles will be used to collect a flow weighted composite sample. The length of time between bottle fills may be lengthened or reduced depending on the event forecasted. This will either shorten or lengthen the sampling to program in order to get a sample that best represents the event. An example program is given below.
  - The remaining 18 bottles will be filled 500 mL every 10 minutes. Therefore, 1 bottle will be filled every 20 minutes and the program will last for 6 hours.
- The 18 bottles will then be mixed into 1 flow weighted composite sample and submitted for analysis.
- Water quality samples will be brought to an accredited Canadian Laboratory for laboratory analysis.

8.3 Surface Water Infiltration

Three piezometers were installed in the bioretention cells during construction. Continuous water level loggers will be placed in the piezometers to measure water level. Level readings will then be compared to rainfall amounts to calculate surface water infiltration in the cells.

A HOBO U20 or equivalent continuous water level logger will be placed in each of the piezometers to measure water level. An additional logger will be placed at one of the locations, at the top of the piezometer above the water level, to record barometric pressure. Barometric measurements will be used to correct the water level measurements for barometric pressure. All loggers will be set to record at 10 minute intervals. Water Level readings will then be compared to rainfall amounts to calculate surface water infiltration in the bioretention cells. In addition, it will be possible to determine the drawdown time for stormwater to fully infiltrate into the rain gardens and the cells.

9. Site Visits

The site will be visited at a minimum of every two weeks to check battery power, inspect equipment, and make sure everything is operational. Data will downloaded either remotely or in person from each piece of equipment biweekly as a minimum using ISCO Flowlink 5 or Hoboware software (or equivalent). The software will automatically summarize and plot the data graphically, which can then easily be exported to a program like Microsoft Excel.

10. Data Management, Communication Strategy, & Reporting

CVC will manage water flow, water level and water quality data sets, and provide data analysis for the study. Regular updates of data can be provided to Peel Board of Education staff in Excel format for use in The Board's educational programming. CVC will coordinate with the City of Mississauga to develop a public information strategy and identify information to communicate to the public. CVC will also coordinate with Mississauga and the Peel Board in the development of interpretive signage and its erection at the study site. CVC will develop a draft report outline, author a draft report for review by the City of Mississauga, and submit a final report detailing the entire study and results.

11. Intentions to Publish

CVC and Mississauga will discuss the results and their implications. While the study is underway, information collected is confidential and not to be shared with personnel outside the study team. Once the monitoring data has undergone a thorough internal review, the intention is for the information to enter into the public domain.

12. Costing

A table outlining monitoring costs for the research project is summarized in appendix 1.

The cost estimate provides the following breakdown:

- Cost to purchase equipment;
- Cost of Equipment installation;
- Cost to Trigger samplers and collect samples;
- Cost of monthly data acquisition, equipment maintenance and calibration;
- Cost of Laboratory Analysis.

These costs are based on hiring a consultant to install the equipment. Since the equipment will be installed within the manholes, personnel certified in confined space entry will be required. In addition, staff may need to trigger and collect samples outside of typical business hours as precipitation events may occur during evenings and weekends.

13. Adaptive Program

The program is intended to be adaptive in nature, implying that the program will be continually reviewed and changes may be made to the sampling protocols, methods, and locations as needed.

14. References

CVC (Credit Valley Conservation Authority). (2008). Cooksville Creek Watershed Study and Impact Monitoring: Background Report Draft. Not Published.

CVC (Credit Valley Conservation Authority). (2009). Cooksville Creek Watershed Study and Impact Monitoring: Characterization Report. Not Published.

J. Marsalek and Q. Rochfort. 2008. Observations on Monitoring the LID Project “Meadows in the Glen”. Memo to Credit Valley Conservation & Intercorp.