Sustainable Technologies
EVALUATION PROGRAM

TECHNICAL BRIEF

Performance Evaluation of Catch Basin (CB) Shields

This study evaluates a proprietary stormwater pre-treatment system (CB Shields) that acts to reduce the velocity of stormwater runoff into the storm drain system via curb and gutter conveyance. The reduction in velocity is aimed to capture more sediment while preventing scour and transport of accumulated sediment out of the catch basin sump.

Results from a three-year study show catch basins with CB Shields installed were found to have collected statistically significant more sediment than the corresponding controls without CB Shields, an average of 74.1 cm versus 53.9 cm, respectively. Despite a few large storm events having occurred during the study period there was no evidence of scour in catch basins with CB Shields, while three incidents of scour were recorded in the control catch basins. The CB Shields are easy to install and maintain, which would provide benefits to the lifespan of stormwater infrastructure such as ponds or LID features or extend the frequency of catch basin clean outs.

INTRODUCTION

The increase in impervious surfaces associated with urban areas, such as roads and parking lots, alter the natural hydrologic cycle by increasing the volume and rate of stormwater runoff. This increase in stormwater runoff serves to wash off and transport particulate matter along with pollutants such as nutrients or metals that may be associated with these particles. Ultimately this additional pollutant load leads to the degradation of receiving

Pre-treatment of stormwater runoff is an inexpensive way to reduce the amount of sediment and their associated pollutants from entering rivers and streams. Utilizing pre-treatment ahead of traditional stormwater management facilities (SWM ponds) can extend their clean out frequency, saving municipalities the high cost of the removal and proper disposal of these polluted sediments.

waters, impacting ecosystem health and recreational opportunities. Over the last three decades, greater attention and innovation has been directed to the interception and treatment of stormwater runoff prior to its release to receiving waters. Initially this effort focused on large scale, end of pipe treatments such as stormwater management (SWM) wet or hybrid ponds. However, due to the cost of maintenance and questions over their efficacy, the stormwater management industry is moving away from these end of pipe features towards distributed approaches to SWM control throughout an urban catchment. The shift in SWM practice is seeing more application of Low Impact Development (LID) practices, providing water quality treatment through retention and infiltration or filtration, working in concert with existing stormwater infrastructure including centralized features that provide more quantity (flood) control, including urban parks and sport fields. Whether conventional SWM pond end-of-pipe, or more contemporary LID practices with centralized features, conveyance systems that include ditches, pipes, inlets, catch basins, and roads or other major easement pathways for major flows all support the routing of the stormwater through the water quantity and quality features before discharging to the receiving water.

A catch basin is an inlet to the storm drain system on roads or parking lots. Along with a grate to prevent large debris from entering the storm drain system, the catch basin typically has a sump to capture coarse sediment and smaller debris. Due to intense storm events, it is possible to lose captured sediment due to scour in the sump.

Catch basin (CB) Shields are an example of how to enhance pre-treatment of stormwater in catch basins. Coupled with appropriate catch basin clean out frequency, the use of CB Shields could extend the life of downstream stormwater infrastructure and reduce maintenance costs. This study evaluates the performance of CB Shields installed along two residential streets in the Town of Newmarket. The duration of the study was for three years (August 2016 to May 2018), measuring the accumulation of sediment in catch basins with and without CB Shields to evaluate total sediment accumulation and any incidents of sediment scour in the catch basin sump.

CB SHIELD

A periodic cleaning of the catch basin sump is required to ensure continued performance; the frequency of cleaning is dependant on the depth of the sump and the pollutant load of the stormwater entering the system. The CB Shield (Figure 1) is a catch basin insert designed to prevent the scour of accumulated sediment in the catch basin sump. The CB Shield is also intended to enhance the capture of sediment in the sump area by reducing sediment resuspension under all storm runoff conditions. Enhancing the capture and retention of sediment in the catch basin sump prevents this material from being washed downstream into receiving water bodies or stormwater infrastructure and, at the same time, can improve (or extend) the maintenance interval between catch basin cleanings. CB Shields have undergone rigorous third-party testing using a modified version of the 'Procedure for Laboratory Testing of Oil Grit Separators developed by TRCA for the Canadian Environmental Technology Verification (ETV) Program (TRCA 2016).

Figure 1 – Example of a CB Shield installed in a typical catch basin

STUDY SITE

This study consisted of two residential streets constructed in the 1980s: John Bowser Crescent and Glenway Circle, in the Town of Newmarket. Stormwater conveyance is via curb and gutter with a network of ten paired catch basins on John Bowser Crescent and eight on Glenway Circle. The minor

west to east longitudinal road slope of Glenway Circle was ideal to test the function of the CB Shield, as the stormwater runoff to each catch basin will be less likely to bypass further down the road slope. John Bowser Crescent has a greater west to east longitudinal road slope, providing a better opportunity to compare how the CB Shields will respond to potentially higher energy flows. Seven CB Shields were installed, four on John Bowser Crescent and three on Glenway Circle (Figure 2 and 3) and were paired with the corresponding catch basin across the road as a control. The drainage area to each of the paired catch basins was typically less than 1 ha.

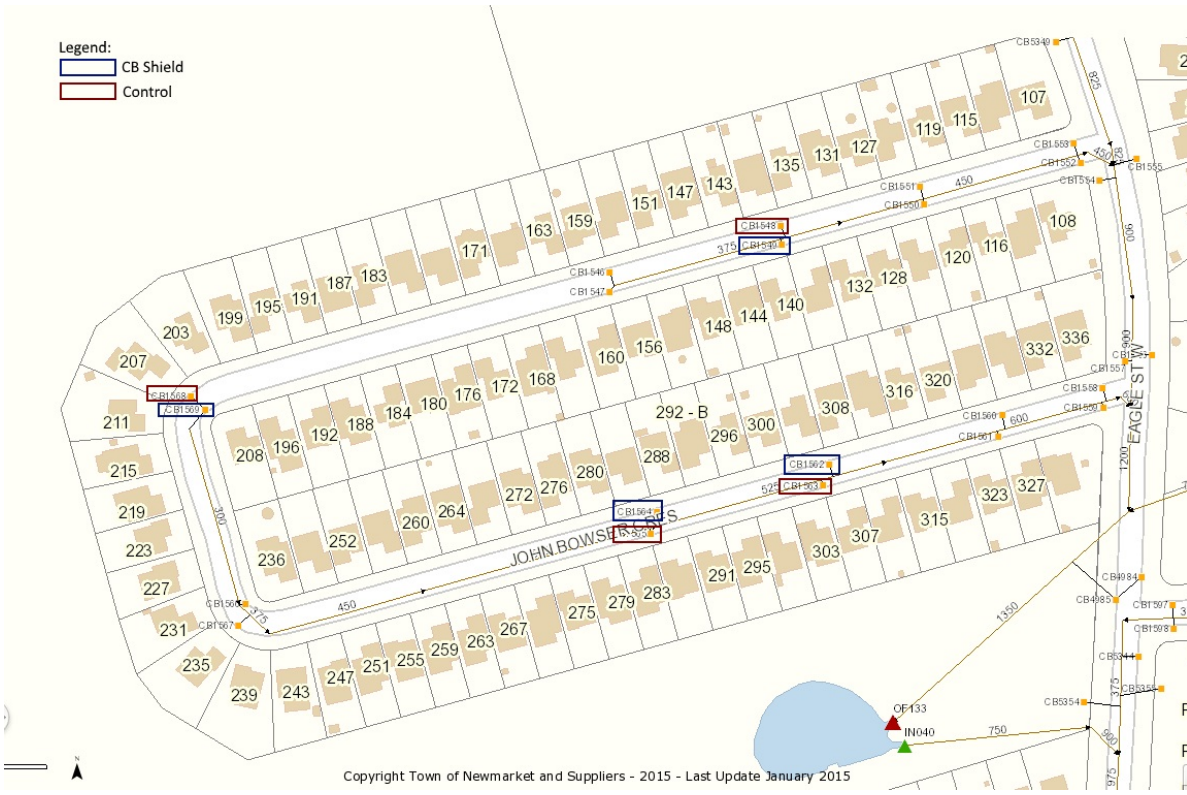

Figure 2 – John Bowser Crescent Site Map

Figure 3 – Glenway Circle Site Map

Town of Newmarket standards for catch basin design follows Ontario Provincial Standard 705.01 and consists of an 83 cm square grate cover aligned with the underlying catch basin with a sump of approximately 60 cm. A few catch basins were found to vary from this standard with grates offset from the underlying catch basin and differing sump depths. This made the installation and extraction of the CB Shield difficult and in some cases was not possible for some catch basins.

MONITORING STUDY DESIGN

The monitoring program consisted of collecting sediment depth measurements in the seven catch basins with CB Shields installed, as well as measurements in the paired control catch basin (with no CB Shield installed) across the road, both of which were assumed to receive similar drainage volumes. All catch basins on John Bower Crescent and Glenway Circle were cleaned out in 2015 as part of the regular catch basin maintenance schedule. Monitoring commenced in August of 2016 through to May 2019 with 10 sediment depth measurements collected. To collect a sediment depth measurement the CB Shield was first removed, and depth measured at three locations in the catch basin to yield an average depth of sediment for each visit. The amount of sediment accumulation was calculated for each visit analyzed for positive or negative (scour) accumulation. Total accumulation in control catch basins versus those with CB Shields installed were analyzed for a statistically significant difference.

During each visit, observations regarding condition of the CB Shield, general condition of the catch basin and types of material collecting in the catch basin were also documented. On a number of occasions CB Shields were found misaligned or sideways due either to installation challenges with misaligned catch basins or possibly due to tampering by residents. For CB1617 this was a chronic issue, and therefore this location was removed from the final analysis. On numerous occasions CB1569 was observed with a thick compressed mat of leaves covering the grate preventing stormwater from entering the catch basin. As a result, CB1569 was found to have accumulated considerably less material and was removed from the final analysis.

Precipitation normals for Newmarket are 857mm per year (Environment Canada). For the period of monitoring annual precipitation totalled 681 mm (2016), 958 mm (2017), and 896 mm (2018). There were no large precipitation events (>25mm) during the period of monitoring in 2016, six events in 2017, five in 2018 and one in 2019.

FINDINGS

Catch basins with CB Shields installed were found to have collected significantly more sediment after three years than the corresponding controls without CB Shields. Using a one-way ANOVA test on the total accumulation in the catch basins with CB Shields (average = 74.1 cm) versus those without (average = 53.9 cm) indicated that significantly ($p<0.05$) more sediment had accumulated in the CB Shield catch basins than the control. As shown in Table 1, the final measurement on May 19th, 2019 found all catch basins with CB Shields installed had accumulated more material than their corresponding control catch basin, with the exclusion of CB1549, which differed by only 1 cm, and those catch basins excluded from the analysis.

There were no incidents of scour recorded in any catch basins with a CB Shield installed while three incidents of scour were recorded in the control catch basins. Despite a number of large storm events having occurred during the period of monitoring there was no evidence of scour in catch basins with CB Shields suggesting they are indeed protecting the catch basin sump from scour or at least greatly minimizing the amount of scour. In contrast, considerable sediment was lost from control CB1611 between September and December of 2018, from CB1613 between April and September 2018, and from CB1563 between October 2017 and April 2018. The first instance of scour was observed in little more than a year into the study at CB1563 suggesting that the optimal catch basin clean out frequency would be annually. See Table 1 and Figures 4 and 5.

The rate of sediment accumulation was greatest during the winter of 2016/17 due to the application of road sand for winter road maintenance. Over the period of study, the average accumulation in the catch basins

Table 1 – Sediment accumulation (cm) in catch basin sumps for catch basins with CB Shields vs without (control) from August 2016 to May 2019

	Nov-16	May-17	Sep-17	Oct-17	Apr-18	Sep-18	Dec-18	Apr-19	May-19	Total
CB1610	-0.3	12.5	15.2	4.5	5.0	10.5	-0.2	4.5	1.5	53.2
CB1611 (control)	2.2	15.7	12.3	5.3	4.0	5.3	-21.0	2.7	7.7	34.2
CB1612	2.0	22.3	8.7	6.7	18.0	6.0	4.5	0.5	7.7	76.3
CB1613 (control)	3.5	19.7	11.0	3.3	22.5	-6.2	4.7	-0.7	5.7	63.5
CB1617*	0.8	15.7	9.0	4.7	2.7	4.0	2.0	1.8	7.3	48.0
CB1616 (control)	5.8	13.0	5.7	4.0	6.7	8.3	3.2	2.8	6.5	56.0
CB1562	7.5	54.0	1.0	8.0	14.7	4.3	1.3	1.7	1.5	94.0
CB1563 (control)	10.5	34.0	3.0	40.3	-24.7	11.0	-74.2	75.5	6.0	81.5
CB1564	7.3	35.0	16.8	5.2	5.5	7.5	1.3	1.8	5.8	86.3
CB1565 (control)	6.2	31.2	15.0	-3.0	6.3	0.5	0.2	3.7	1.2	61.2
CB1569*	0.7	8.0	1.0	3.3	0.7	4.0	2.3	1.8	0.0	21.8
CB1568 (control)	-0.7	16.7	9.7	0.7	6.3	2.3	4.2	1.0	2.0	42.2
CB1549	-3.7	34.7	11.2	7.8	8.7	5.7	1.7	1.7	5.7	73.3
CB1548 (control)	7.8	22.3	8.0	5.7	8.0	11.7	3.0	6.7	1.2	74.3
CB Shield Average	2.6	31.7	10.6	6.4	10.4	6.8	1.7	2.0	4.4	76.6
Control Average	5.0	21.8	9.2	8.0	4.2	4.7	-11.4	13.1	4.3	59.0

*Repeated issues with these catch basins resulted in their removal from analysis.

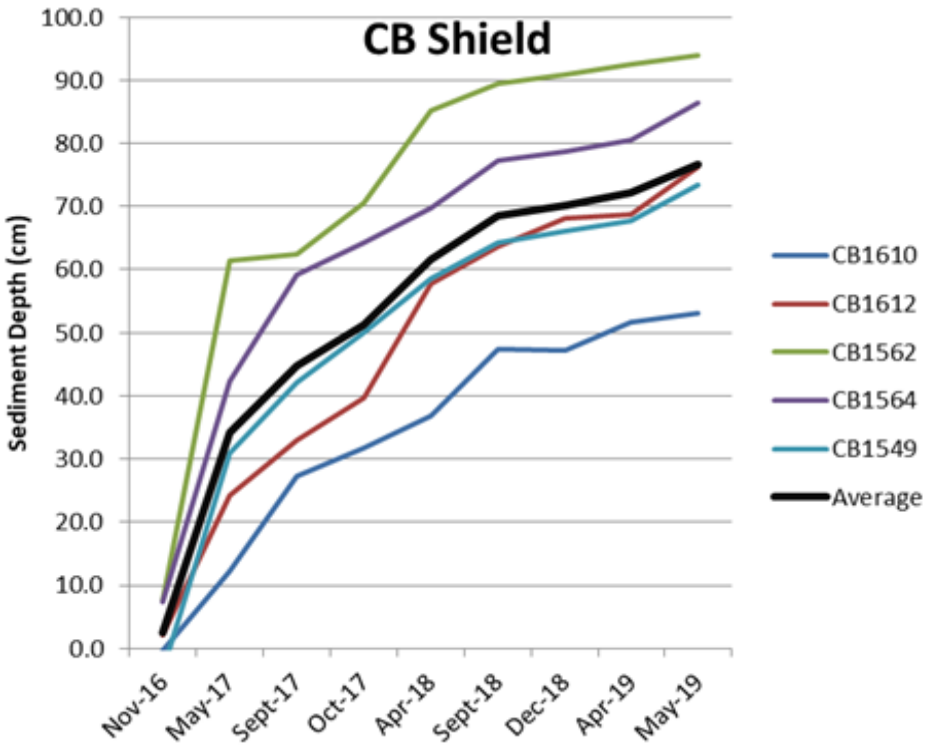

Figure 4- Sediment accumulation in catch basins with CB Shields installed. Significantly more sediment accumulated in catch basins with CB Shields installed and no instances of scour were observed.

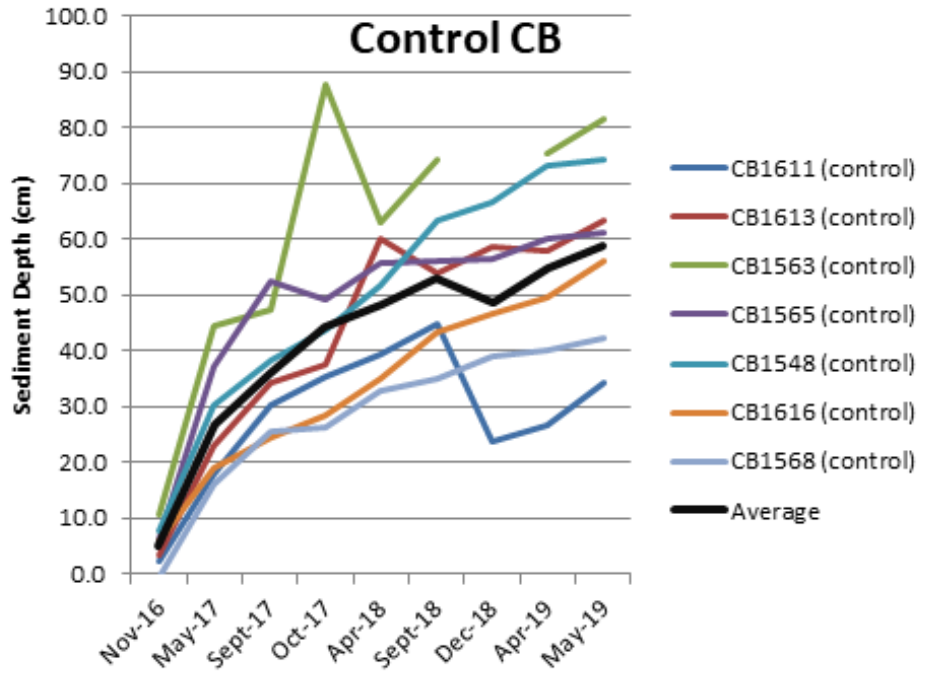

Figure 5- Sediment accumulation in control catch basins. Scour events were observed in three catch basins CB1611, CB1613 and CB1563

with CB Shields was greatest following the 2016/17 winter (31.7 cm) as compared to accumulation following the 2017/18 winter (~10.4 cm) and the 2018/19 winter (~2 cm). Winter maintenance practices by the Town in 2016/17 consisted of a 50/50 sand/salt mix being applied to their roads while only salt was being used for winter road maintenance in 2017/18. The changes in practice explains the sharp decrease in the sediment accumulation during the study period.

In areas where sand is applied to roads during winter the frequency of catch basin clean out could be up to 3 times greater than for those areas not using sand for winter maintenance. For the two complete calendar years captured, 2017 and 2018, the total annual accumulation in 2017 was influenced by winter sand application while 2018 was not. The typical application rate of sand/salt used by the Town for winter maintenance in 2016/17 was 210 kg/lane km, or 105 kg of sand/lane km. The total accumulation in 2017 was 48.7 cm and 18.9 cm in 2018. For a standard catch basin with a 60 cm sump this would suggest that when sand is used for winter maintenance, catch basins should be cleaned out annually while for areas not using sand or grit for winter maintenance, the clean out frequency would be approximately every 3 years. However, if opting for a 3 year clean out frequency a CB Shield would still be recommended to prevent scour.

Maintenance of the CB Shields is simple, requiring tools and skill sets that are readily available to any municipality. During routine catch basin clean outs, a CB Shield can be easily removed, and the catch basin sump cleaned out as per usual protocols. Any accumulated sediment or debris on the CB Shield can be washed into the catch basin prior to the clean out of the sump. Removing and replacing the CB Shield can be done in approximately 5 minutes and can be completed with com-

RECOMMENDATIONS

This study demonstrated the effectiveness of CB Shields as a tool to enhance stormwater pre-treatment by capturing and retaining more sediment than a regular catch basin. The following recommendations are based on the findings from this CB Shields application study along with suggestions on further in situ research.

1. The use of CB Shields in areas that apply winter sand or grit would see the greatest benefit as this would enhance the capture of sand and prevent scour prior to catch basin clean out.

2. Loss of sediment in catch basin sumps was found to occur after approximately one year. To prevent sediment loss due to scour, annual clean out of catch basins is required, or the installation of CB Shields, which would reduce clean out to approximately every three (3) years.

3. The use of CB Shields should be prioritized on catchments that do not have any downstream stormwater treatment such as ponds or LID features to prevent sediment loading to receiving water bodies. Additional priority should be placed on catchments that discharge to sensitive fish habitat to prevent smothering of critical habitat and spawning grounds by catch basin material.

4. CB Shields could also be considered to extend the maintenance frequency / lifespan of stormwater infrastructure such as ponds or LID features, particularly LID features that use catch basins as inlets (e.g., soil cells). This could be a broadly applied stormwater management tool to improve sediment capture at the source by installing CB Shields in all catch basins. As a more targeted approach, CB Shields could be installed upstream of a stormwater facility that is nearing its clean out threshold but is not scheduled for maintenance for several more years. CB Shields would enhance pre-treatment, thus lessening the burden on the facility until it can be properly serviced.

Figure 6- Removal of a CB Shield from a catch basin

5. Sediment accumulation rates in this study varied greatly from the initial year due to the change in the use of sand for winter maintenance. Further research into sediment accumulation in catch basin sumps for areas using winter sand verses no sand use would help in determining the ideal frequency of catch basin

cleanout for each. Monitoring for scour under both these conditions would improve the identification of accumulation thresholds and timing at which scour begins to occur.

6. On a number of occasions, the top grate of the catch basin was found to be completely blocked by accumulated leaves, grass clippings and sand, compacted by parked cars to the point at which stormwater was no longer entering the catch basin (Figure 7). Regular clean up of the debris via a combination of street sweeping and educating residents to not dispose of or blow leaves and grass onto the road would improve the function of the storm sewer system.

Figure 7- The top grate of a catch basin completely blocked by accumulated leaves, grass clippings and sand

REFERENCES

Environment Canada (https://climate.weather.gc.ca/climate_normals/)

TRCA. 2016. Performance Testing of Catch Basin Shield Technology (https://docs.wixstatic.com/ugd/515620_1142bc92259b4c07989faf7a89b492d0.pdf)

https://www.cbshield.com/

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