Retrofitting of Urban Stormwater Management Facilities in the Lake Simcoe Watershed Using Innovative Technologies:

Comparison of Three Innovative Solutions

Post Construction of Stormwater Management Pond Retrofit at Colony Trail, East Gwillimbury

High Level Results

- Anticipated total phosphorus reduction of 64kg/year (three projects combined)
- Water quality improved as a result of retrofitting the traditional stormwater ponds with innovative technologies and approaches
- Educational signage increased public awareness and understanding of why the projects were completed and the environmental benefits
- Great project sites to demonstrate the potential for future stormwater management retrofit opportunities

“The Ontario Ministry of Environment’s Showcasing Water Innovation program gave the Lake Simcoe Region Conservation Authority an opportunity to create a partnership with our community, municipal and other government partners and implement stormwater management retrofit opportunities recognized in our watershed management plans.

Having a great team of project partners with the same mindset was the key to having a successful project like this. We all have the same goal in protecting the health and beauty of Lake Simcoe and its watershed.”

Brook Piotrowski, Environmental Project Coordinator
Lake Simcoe Region Conservation Authority

Project Context

Stormwater management ponds are widely used in Ontario to provide quantity and quality control of runoff prior to entering watercourses. Over time, however, excessive deposition of silt, sand and other materials in the ponds can compromise their performance. Previous research conducted by the Lake Simcoe Region Conservation Authority (LSRCA) staff has shown that traditional stormwater management ponds accumulating particulate phosphorus in the anoxic zone may become a source of soluble phosphorus, which contributes to excess weed growth, eutrophication, and loss of cold water fish habitat downstream. As a result, there is a need to retrofit stormwater management ponds in a cost-effective manner that address performance concerns (e.g. water quality) and account for existing site-constraints.

Under the Lake Simcoe Protection Act, 2008, the Lake Simcoe Protection Plan became effective June 2, 2009 and sets out the following objectives:

- protect, improve or restore the elements that contribute to the ecological health of the *Lake Simcoe watershed*, including, water quality, hydrology, key natural heritage features and their functions, and key hydrologic features and their functions;
- restore a self-sustaining coldwater fish community in Lake Simcoe;
- reduce loadings of phosphorus and other nutrients of concern to Lake Simcoe and its tributaries;
- reduce the discharge of pollutants to Lake Simcoe and its tributaries.

LSRCA’s mandate and mission also revolve around the health and protection of Lake Simcoe and its watershed.

Challenge

LSRCA identified three facilities to be retrofitted in this project. These ponds were all originally constructed to meet local water quantity management objectives as part of urban development in their respective communities. Additionally, these ponds no longer meet the minimum stormwater quality performance standards, as they provide little if any water quality improvement benefits. The retrofit approaches undertaken employed technologies designed to remove soluble phosphorus on the downstream side of the treatment train, before the water is discharged into the receiving surface watercourse.

With all three projects being retrofit opportunities, careful consideration had to be put into the design to deal with existing conditions such as re-grading with the regional storm flood plain, protection of fisheries habitat and migration, and incorporating a treatment train system within already confined property boundaries. Monitoring the sites for water quality was also a challenge as some sites had multiple inlets and large catchment areas with a flashy urban system.

Construction timing was also crucial with permit approval restricted during fishery spawning timing windows as well as working around planned activities on surrounding parkland areas.

Project Goals

The objective of this project was to compare and contrast the efficiency and efficacy of three innovative technology approaches to retrofitting stormwater management ponds, each designed to decrease the level of phosphorous and other pollutants discharged to the receiving water body. The implementation of three different technologies will not only assess the technologies individually, but also comparatively in order to demonstrate how each approach may be best-suited to similar catchment areas province-wide.

In addition, the project will address issues such as economic long-term maintenance plans for the stormwater facilities and the limited amount of physical space that is available for both the retrofit construction process and ongoing maintenance through time. The approaches to be implemented here will increase the level of water quality improvements in a smaller working envelope, allow for easier periodic maintenance, and facilitate regular monitoring of the effectiveness and efficiency of the treatment system.

Monitoring data collected pre and post construction will be shared with other communities across the province.

Solution

Some of the key factors that led to the success of these projects were having frequent on-site meetings with all project partners and having a focus on achieving the same goals and objectives.

Different innovative technology approaches were taken to retrofit each of the three ponds. Listed below are the three designs incorporating a treatment train approach.

<u>Retrofit 1:</u> The design for the George Richardson stormwater management retrofit project in Newmarket included a typical forebay and main cell with the installation of an oil/grit separator and a red sand filter media chamber. The treatment train approach is intended to first capture the larger sediment particles and then the suspended particles and soluble material as the water travels through the system. The red sand filter media chamber is designed to capture the soluble phosphorus that generally passes through a typical stormwater management pond. Considerably level existing grades were one of the issues at this site. The original concept design looked at installing a pumping system to assist in conveying flows through the treatment train. Due to the potential costs and maintenance issues, the solution was to extend the outfall pipe to create enough elevation for the system to function on gravity alone.

<u>Retrofit 2:</u> The design for the Colony Trail stormwater management retrofit project in East Gwillimbury included a typical forebay with the installation of several wetland cells and a “sorbtive” media chamber. The treatment train approach is similar to the above noted project with the “sorbtive” media chamber being the last stop to capture the soluble phosphorus prior to entering the receiving waters. This project included a mixture of using natural plant life in the wetland cells and innovative media materials to improve water quality.

<u>Retrofit 3:</u> The Lincoln pond stormwater management retrofit project in Uxbridge included an engineered wetland component in the design. Similar to the above noted projects, the Lincoln pond included a forebay and main cell with a clear aggregate added in part of the treatment train. The clear aggregate provides an area of voids that allows for vegetation root systems and micro-bacteria to grow and capture additional soluble material.

Dewatering and Excavation of Forebay at George Richardson site

Results

The total cost of all three projects including design, consulting and construction fees was $2.2 million dollars.

The majority of our pre and post construction water quality monitoring results are very positive, with all sites having a reduction in phosphorus after travelling through the treatment train.

The treatment train approach appears to be an effective way of improving the water quality. With monitoring stations located at strategic locations at the project sites, the results show the water quality improving as the water passes through the various components of the treatment train system. As these projects are innovative and fairly new, additional time will be required prior to determining if they are more cost-effective than traditional ponds.

The George Richardson stormwater management retrofit project has a catchment area of 155.0 hectares with an anticipated phosphorus reduction of 23 kg/year.

The Lincoln pond stormwater management retrofit project has a catchment area of 18.5 hectares with an anticipated phosphorus reduction of 16 kg/year.

The Colony Trail stormwater management retrofit project has a catchment area of 19.3 hectares with an anticipated phosphorus reduction of 25 kg/year.

As mentioned above, several of the sites had infrastructure in-place with some having elevations that caused backflows during certain rain events. This made it challenging to obtain accurate water quality sampling results during these backflow events.

The water quality results for one of the project sites have been attached below.

Table 1 – Colony Trail Facility Monitored Performance 2013

		Inlet (kg)					Outlet (kg)					Reduction (%)				
Date	Rainfall (mm)	Total Phosphorus	Ortho phosphorus	Total Suspended Solids	Chloride	Volume (L)	Total Phosphorus	Ortho phosphorus	Total Suspended Solids	Chloride	Volume (L)	Total Phosphorus	Ortho phosphorus	Total Suspended Solids	Chloride	Water Balance (%)
Sept 21	40.6	0.1788	0.1295	15.77	78.86	1,816,200	0.1217	0.0633	18.22	58.33	1,643,400	31.9	51.1	-13.4	26.0	**-9.5**
Oct 16/17	19.6	0.1116	0.0611	4.11	15.64	506,700	0.0331	0.0142	4.13	60.97	556,200	70.3	76.8	-0.5	-74.4	**8.9**
Oct 26	8.5	0.0460	0.0335	0.87	8.32	124,200	0.0018	0.0017	0.53	17.08	131,400	96.0	94.9	39.5	-51.3	**5.5**
Oct 31 - Nov 2	19.6	0.1782	0.0955	10.57	78.72	860,400	0.0840	0.0391	3.52	100.45	915,300	52.9	59.0	66.7	-21.6	**6.0**

Additional results are available through LSRCA's SWI monitoring report at http://www.lsrca.on.ca/.

Several cost-saving approaches were used in the projects, including the incorporation of excess clean fill material to be re-graded on site, adjacent to the retrofitted pond. This reduced off-site haulage costs. Additional cost savings included the promotion of community planting events. This reduced contract costs and provided an educational component to the project with the community getting involved.

Physical on site-monitoring of all three sites will continue in 2014, observing how the projects are functioning during and after rain events (i.e. spring freshet). This is especially critical as the vegetation on all three sites continues to mature and stabilize.

Autosampler at George Richardson site

Next Steps

The next steps will be to continue on promoting the completed SWI projects as well as working with future project partners on the implementation of additional innovative project sites. Subject to funding availability, the LSRCA monitoring staff have allocated additional staff time to continue water quality monitoring of some of the key stormwater management retrofit projects.

Application for Ontario communities

Hundreds of stormwater ponds exist across Ontario. These SWI projects can be used to demonstrate the opportunities available to retrofit existing stormwater facilities and provide environmental improvements in your community.

With all the various communication methods implemented on these projects, there is increased public awareness and understanding of why these projects were completed and their importance to Lake Simcoe and its watershed.

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