Evaluation of Design Criteria for Construction Sediment Control Ponds

Markham, Ontario

Excess discharge of sediment from construction sites can cause significant damage to streams, lakes and reservoirs. To mitigate adverse impacts, building contractors are required to implement detailed erosion and sediment control plans. These plans typically stipulate that areas of exposed soil be reduced to a minimum and structural measures be put in place to reduce overland transport of sediment.

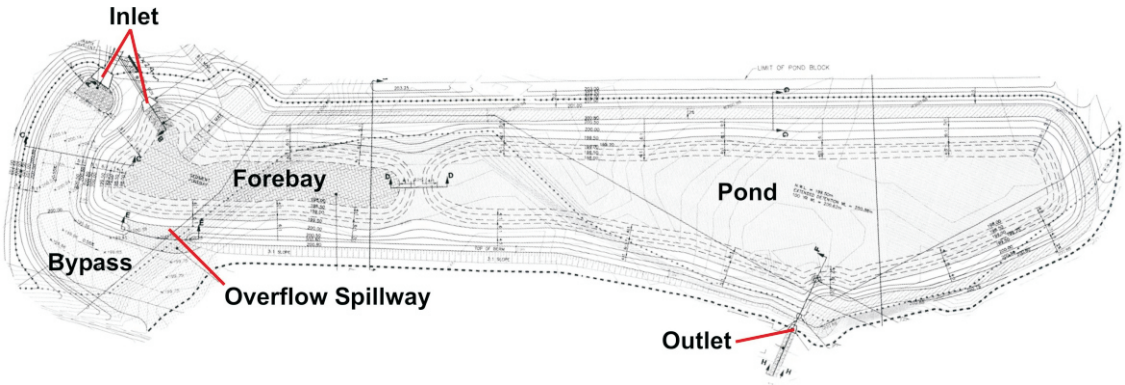
Construction sediment control ponds are a key feature of these plans because they provide the last and critical line of defense before runoff is discharged to receiving waters. Unfortunately, as currently designed, these ponds do not provide adequate control. Earlier monitoring studies of sediment control ponds, designed to current Ontario guidelines, reported effluent sediment concentrations well in exceedance of receiving water standards.

Project Objectives

This two year study monitored a temporary sediment control pond in Markham as a basis for evaluating current guidelines for construction sediment ponds. Monitoring was undertaken over the full construction cycle from the stripping phase through to final construction and stabilization of the site. Various pond design scenarios were simulated using a finite element hydrodynamic and sediment transport model to help determine how the existing guideline (1994) should be modified to provide improved performance.

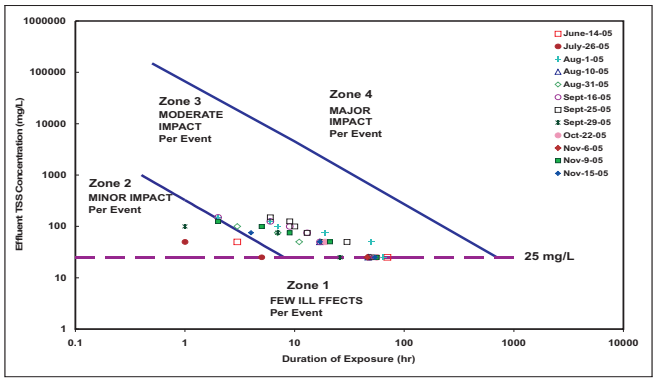
Site Description

The 89 hectare drainage area for the temporary construction sediment pond is located on predominately Peel clay soil in the Town of Markham. The pond design exceeds OMOE 'enhanced' level guidelines for post-construction stormwater management ponds. It has a permanent pool volume of 127 m^3/ha, a large extended detention volume of 144 m^3/ha, a forebay, a length-to-width ratio of 8:1 and drawdown over a minimum of 48 hours. The inlet is located at one end of the pond and the outlet downstream on the opposite bank of the pond (see below).



Key Findings

- Pond bathymetric surveys conducted four times over the course of the study indicated that sediment was trapped mostly within the forebay and middle portion of the pond. Sediment accumulation in the downstream third of the pond was negligible.
- The pond's sediment trapping efficiency was high, with 99% of incoming suspended solids trapped inside the pond (on a load basis). Despite this high efficiency, sediment concentrations in wet weather effluent typically remained above the target of 25 mg/L for the protection of downstream aquatic ecosystems. The average volume weighted event mean effluent TSS concentration for 21 events was 55.1 mg/L, ranging during individual events from 13 to 93 mg/L.
- A receiving water impact analysis of effluent concentrations and durations showed that, assuming no dilution in the stream, most events would have a moderate impact on downstream aquatic biota.



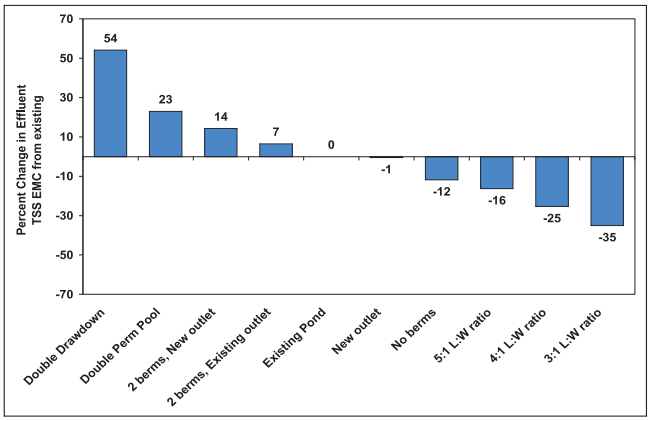
The potential impact of total suspended solids (TSS) based on the concentration and duration of effluent TSS for monitored events. Values represent the number of hours that specified concentrations were exceeded during an event. Impacts do not account for dilution of effluent in receiving waters. The fisheries impact framework is from Newcombe (1986; as cited in Ward, 1992).

Modelling:

Nine scenarios were developed to examine the influence of various design parameters on pond performance. The following design parameters were selected for evaluation:

- Length-to-width ratio (3:1; 4:1; 5:1)
- Presence or absence of 1 or 2 submerged berms
- Drawdown time (2 times existing)
- Relocation of the outlet to the end end of the pond
- Permanent Pool Volume (2 times existing)

These scenarios were simulated using a two dimensional finite element hydrodynamic (RMA2)and sediment transport model (SED2D), calibrated to monitored data. As shown in the figure below, scenario simulations revealed that all pond design parameters selected for analysis had some impact on pond performance, with the magnitude dependent on the degree of variation.



Percent change in effluent event mean concentrations (EMC) of total suspended solids (TSS) associated with various pond design parameters. Changes are relative to the 'existing Greensborough pond, described on the reverse side of this fact sheet (8:1 length-to-width ratio, one forebay berm, etc.)

Recommendations:

Based on monitoring and modeling results, the following changes to the existing (1994) pond guideline were recommended:

Design or Maintenance Feature	Current Guideline (TRCA, 1994)	Recommended Guideline
Permanent Pool Volume (m^3/ha)	125	50% increase in perm. pool if either drawdown or length to width criteria cannot be achieved
Extended Detention Volume (m^3/ha)	125	125
Drawdown Time (hrs) (25 mm, 4 hr storm)	min 24	min 48 (72 preferred)
Length-to-Width Ratio	at least 3:1 (4:1 or 5:1 preferred)	at least 4:1 (5:1 or greater preferred)
Forebay/berm	none specified	two submerged berms or a forebay and a permeable curtain
Clean out frequency	when accumulated sediment reaches 50% of *pond* design capacity	when accumulated sediment reaches 50% of *forebay* design capacity

For more information on this project or the Sustainable Technologies Evaluation Program, contact

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The final report for this study is available for download from the STEP website at www.sustainabletechnologies.ca.

Project Funding Partners

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