University of Minnesota

ST. ANTHONY FALLS LABORATORY
Engineering, Environmental and Geophysical Fluid Dynamics

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Capture of Gross Solids and Sediment by Pretreatment Practices for Bioretention

Final Report for the Project:
Field performance assessment of sediment and gross solids removal from surface inlet pretreatment practices for bioretention

by

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- South Washington Watershed District
- Valley Branch Watershed District, and
- City of Edina

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EXECUTIVE SUMMARY

The purpose of this project was to measure the performance of several pretreatment practices for bioretention, both proprietary and non-proprietary, commonly used in Minnesota using field-based performance testing. Five pretreatment practices for bioretention were assessed for capturing sediment and gross solids with field testing.

Most bioretention practices in Minnesota are designed to store the volume of runoff from a 1-inch rainfall event. Design volume tests involved measuring performance at the design storage volume (full storage volume before bypass) of the bioretention practice and were completed for four pretreatment practices. For this testing, the full design storage volume was added from a fire hydrant to the pretreatment and bioretention within 40 minutes (low intensity) or within 20 minutes (high intensity). The pretreatment and bioretention practices were not allowed to overflow or bypass during the design volume tests. Four pretreatment practices were tested, including:

- grass lined inlet (i.e., grassed buffer strip),
- Rain Guardian Bunker proprietary device,
- Rain Guardian Turret proprietary device,
- rock lined inlet (i.e., riprap).

A fifth pretreatment practice, an in-line shallow sump grit chamber, was tested for performance when the design storage volume was added in 30 minutes (low intensity) and 15 minutes (high intensity). The shallow sump grit chamber was also with bypass conditions, which involved adding approximately two and a half times the design volume to the pretreatment and bioretention practice, causing the system to overflow and bypass some water and solids to the downstream conveyance system. The goal of this testing was to determine the performance of an in-line shallow sump grit chamber under bypass conditions.

Prior to testing each pretreatment practice was thoroughly cleaned. Three sediment sizes including a coarse sediment (D_{50} = 1.17mm), a medium sediment (D_{50} = 0.41mm), and a fine sediment (D_{50} = 0.12mm) and three types of gross solids (plastic forks, synthetic leaves, and wood dowels) were added to water from a fire hydrant throughout the duration of each test. After testing was complete, sediment and gross solids were collected and then analyzed at St. Anthony Falls Laboratory to determine capture performance.

Summary of Results

All five pretreatment practices captured greater than 88% of the total sediment and greater than 65% of the fine sediment fraction (D_{50} = 0.12mm) in the low intensity tests, from an initially clean condition. During the high intensity tests, all practices captured greater than 70% of the total sediment mass and greater than 30% of the fine sediment fraction, similarly from an initially clean condition. Four of the five pretreatment practices captured 75% of the gross solids during low intensity tests and more than 55% of the gross solids during high intensity tests. The grass lined inlet captured the least gross solids; 20% during low intensity and 30% during high intensity. The performance for several sequential tests and maintenance needed for long-term operation of these pretreatment practices was not measured in this project.

Bypass tests were conducted to determine the performance of an in-line shallow sump grit chamber under bypass conditions. During these tests, overall sediment captured decreased from 95% during low intensity design volume tests down to 80% capture during high intensity bypass tests. Gross solids capture decreased from greater than 80% to below 40%. Thus, bypass at these

flow rates had minimal effect on the sediment, but measurable effect on the gross solids performance.

Though at least four of the five pretreatment practices performed similarly in terms of sediment and gross solids capture, only three out of the five appear to be simple to inspect and maintain. When maintenance is required, the grass lined inlet and rock lined inlet likely require the same amount of effort and cost to maintain them as would be needed to install them. In addition, the grass lined inlet and rock lined inlet would likely become filled with sediment within a few storm events. Of the pretreatment practices tested in this study, the grass lined inlet and rock lined inlet are among the most difficult and costly to maintain.

To maintain the Rain Guardian Bunker, Rain Guardian Turret, and shallow sump, one would need to remove the top grate and either shovel or hydro-vac the collected sediment and gross solids from within the collection chamber. The Bunker and Turret are both easily visible from the street so visual inspections of accumulated sediment depth are simple. The shallow sump is hidden underground, which makes assessing sediment accumulation depth more challenging. The Bunker, Turret, and shallow sump appear to have ample storage volume for collection and retaining sediment and gross solids. Of the pretreatment practices tested in this study, the Bunker and Turret are among the easiest to maintain, and the shallow sump is moderately easy to maintain.

Partnerships

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