Assessment and Recommendations for the Operation of Standard Sump Manholes as a Best Management Practice for Stormwater Treatment

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Introduction

- Background
- Sump Manhole Assessment
- The SAFL Baffle Retrofit
Background

- Urban Lakes and Storm Sewer System
- Winter Maintenance (sand and salt → salt only)
- Sump Manholes (collect sand) older installations
- MnDOT Metro District MS4 Permit
  - Inventory BMPs
Sump Manhole Assessment Project

- Phase 1 – Sump manhole performance
  - Sediment retention vs. washout
  - Do we need to include in MS4?

- Phase 2 – SAFL Baffle
  - Retrofit to improve effectiveness of sump manhole

- Previously assessed other BMPs
  - $123,000 from Local Road Research Board
Sump Manhole Assessment Project

- Funded by MnDOT
  - Phase 1 $160,000
  - Phase 2 $97,000

- Project Advisory Panel
  - Cities, Watershed Districts, MnDOT

- Research by University of Minnesota
- St. Anthony Falls Laboratory (SAFL)
Previous Tests of Hydrodynamic Separators (proprietary devices tested at SAFL)

BaySaver

ecoStorm
Previous Lab Tests (cont.)
(proprietary devices)

Downstream Defender

Stormceptor

Envoronment21
Assessment of Standard Sumps for Stormwater Treatment

University of Minnesota, St. Anthony Falls Laboratory
St. Anthony Falls Laboratory (SAFL) at the University of Minnesota

• Designed and built on island in Mississippi River in the 1930s
• 45 feet of elevation head flows through research facilities through a side channel
St. Anthony Falls Laboratory (SAFL) at the University of Minnesota
Sump Manhole Testing

- 4-foot diameter manhole
  - 2-foot sump, 4-foot sump
- 6-foot diameter manhole
  - 3-foot sump, 6-foot sump
- Test sediment removal efficiency
- Test washout
6-foot Diameter Test Setup
6-foot Diameter Test Setup

- 6-foot diameter with 3-foot or 6-foot sump
- 24” inlet and outlet pipes
- 1-year storm flow (estimated) = 7 cfs
- 10-year storm flow (estimated) = 19 cfs
- Flowrate measured using two Pitot cylinders
- Free outfall
Test Procedure to Determine Removal Efficiency

• Initially Clean Sump

• Three Distinct Particle Size Ranges
  – 89-125\( \mu m \)
  – 251-420\( \mu m \)
  – 500-589\( \mu m \)
  – 100 and 200 mg/L Influent Concentration

• Multiple Flow Rates
  – 0.6, 1.2, 1.8, 2.4 cfs for the 4-ft sump
  – 1.8, 3.5, 5.3, 7 cfs for the 6-ft sump
Sump Removal Performance

MN/DOT 72" and 48" Sump Performance Function

η = \left(1 + \frac{1}{444*Pe^{0.066}}\right)^{-\frac{1}{2.066}}

R^2 = 0.995
RMSE = 3.90%

η = \left(1 + \frac{1}{255*Pe^{0.107}}\right)^{-\frac{1}{4.107}}

R^2 = 0.993
RMSE = 5.92%
Washout Testing

• Preload sediment about one ft of sump depth
• U.S. Silica F-110
  – Median particle diameter of 110um
• Multiple flow rates (1- and 10-year flow rates)
• One to Two hour duration
• Sediment determined using load cells and sediment depth measurement

• Significant Washout Occurs from Sump Manholes
Baffle Experimental Setup
SAFL Baffle Development
(measure flow patterns)
Baffle Improved the Performance Results

MN/DOT Deep Sump With Porous Baffle Performance Function

\[ \eta = \left( 1 + \frac{1}{(0.369 \times Pe)^{17.768}} \right) \left( \frac{1}{17.768} \right) \]

\[ R^2 = 0.985 \]

\[ RMSE = 6.73\% \]

Pe = Vs*h*d/Q (Peclet number)

St. Anthony Falls Laboratory
UNIVERSITY OF MINNESOTA
Testing the SAFL Baffle for clogging potential

For Minneapolis:
140 pounds per year of trash and vegetation
(estimate for typical storm drainage manhole)
Clogging / Washout Testing

Leaves
Plastic Bags
Plastic Bottles
Scale Model Testing
Scale Model Testing

0.25 inch Hole diameter  

0.75 inch Hole diameter
Scale Model Testing Conclusions

• **Deep sumps** (depth = 1 x diameter)
  • Not a lot of washout when clogged

• **Shallow sumps** (depth = ½ x diameter)
  • Washout highly dependent on clogging
  • Larger holes reduce clogging and washout
Implementation

MnDOT Negotiating whether sump manholes need to be included in MS4 Permit inventory
ASTM standard test method for hydrodynamic separators in ASTM review process (balloting)
U of M patent application for SAFL Baffle
Field trial installations of SAFL Baffle retrofit
U of M developing materials and installation methods for commercialization
Thank you...

Omid Mohseni (P.I.) SAFL and Barr Engineering
Prof. John Gulliver, University of Mn SAFL and Dept. of Civil Engineering
Adam Howard, Graduate Researcher Assistant
Kurt McIntyre, Graduate Research Assistant

Questions?
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