Laboratory Testing Guidelines for Certification of Manufactured Stormwater BMPs

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Abstract

For the past decade, manufactured stormwater best management practices (BMPs) have been widely used in urban areas to remove suspended solids from stormwater runoff to meet the local and federal government agencies' standards. The ASCE/EWRI Task Committee on Guidelines for Certification of Manufactured Stormwater BMPs formed a subcommittee to develop the laboratory testing guidelines. The focus of this subcommittee has been on developing laboratory testing guidelines to assess the efficiency of the devices used for physical separation of the full spectrum of stormwater-borne non-dissolved solids. In general, these devices include hydrodynamic separators and filters.

After reviewing the protocols developed by organizations, but not limited to, the state of Washington Technology Assessment Protocol-Ecology (TAPE), the state of Wisconsin Method for Predicting the Efficiency of Proprietary Storm Water Sedimentation Devices, the TARP Protocol for Stormwater Best Management Practice Demonstrations, the subcommittee utilized the experience obtained from the laboratory tests conducted on these devices and employed the material in the existing protocols to develop the testing guidelines. These guidelines are designed to conduct robust laboratory testing with stated repeatability. The guidelines encompass three separate series of tests for addressing three different processes: (1) Testing to determine the efficiency of hydrodynamic separators in removing suspended sediments, (2) testing to quantify sediment retention of hydrodynamic separators, and (3) testing to determine the efficiency of filters in removing suspended solids.

Introduction

For the past decade, manufactured stormwater treatment devices, also known as manufactured best management practices (BMPs), have been widely used in urban areas with the goal of removing pollutants from stormwater runoff. The main advantage of these devices is their small foot print where space is limited. These devices can be divided into two main categories: (1) settling devices, and (2) filters. The settling devices, primarily hydrodynamic separators, remove pollutants by settling the particles, while filters remove pollutants through the attachment of particles to the media filter. Hydrodynamic separators are often designed to remove floatables, e.g. oils from stormwater runoff.

These devices have been monitored in the field and tested by either the manufacturers' laboratories or other independent laboratories under a set of specific conditions. There are few protocols or guidelines for the performance assessment of these devices. Therefore, in 2007, the Stormwater Infrastructure Committee of EWRI's Water, Wastewater, and Stormwater Council (WWSC) in collaboration with the Wet Weather Flow Technology Committee of the Urban Water Resources Research Council (UWRRC) formed a committee to develop guidelines for certification of manufactured BMPs. In May 2007, six subcommittees were formed to develop the guidelines. This paper is a summary of the work done by the members of the Laboratory Testing Subcommittee.

Development of the Laboratory Testing Guidelines

The goal of the subcommittee has been to develop laboratory testing guidelines to assess the efficiency of the devices, i.e. hydrodynamic separators and filters, used for physical separation of particles (the full spectrum of stormwater-borne non-dissolved solids) from stormwater runoff. The guidelines are intended to include scouring of the removed particles under high flow conditions. The guidelines do not include removal of trash, leaves and hydrocarbon products.

The first task of the subcommittee members was to review and assess the existing protocols. Some of the protocols reviewed have not been finalized, however, the subcommittee decided to review all the existing knowledge in the community before attempting to draft new guidelines. Therefore, several protocols were reviewed and their pros and cons were summarized. Among them were (1) Technology Assessment Protocol-Ecology (TAPE 2002) papered by the Washington Department of Ecology as part of their Stormwater Management Manual (SWMM) that includes stormwater treatment facility design criteria, performance goals, and a process evaluating the performance of stormwater treatment facilities, (2) the New Jersey Department of Environmental Protection (NJDEP 2003) for evaluating hydrodynamic separators, (3) the protocol developed by the Wisconsin Department of Commerce and the Wisconsin Department of Natural Resources (WDC & WDNR 2007) for evaluating hydrodynamic separators, (4) the draft standard for Measurement of Suspended Sediment Removal Efficiency of Hydrodynamic Stormwater Separators and Underground Settling Devices prepared by the ASTM, (5) the Laboratory Testing Specifications for Manufactured Water Quality Structure prepared by the Ohio DOT, (6) the Laboratory Testing Protocol for Manufactured Stormwater Treatment Systems prepared by the City of Indianapolis, (7) the Procedure for Lab-based Testing of a Hydrodynamic Separator by the Direct Method prepared by Hydro International, and (8) Procedure for Lab-based Testing of a Hydrodynamic Separator by the Indirect Method prepared by Hydro International.

In addition to summarizing the pros and cons of all these protocols, the main features of the first three protocols were compared and summarized in a single table (Figure 1). The main three protocols specified target removal efficiencies and designed the procedure to meet the targets.

Table 1. Summary of the parameters used in the NJDEP, WDNR and TAPE protocols.

FEATURE	NJCAT/NJDEP	WA DOE	WI DNR
Specified Test Material	5% - 500-1000 µm 5% - 250-500 µm 30% - 100-250 µm 15% - 50-100 µm 25% 8-50 µm 15% 2-8 µm 5% 1-2 µm (d50 ~67 µm)	OK-110 (d50 ~110 µm)	0.90 lb US F-95 1.2 lb OK-110 0.25 lb Sil-Co-Sil 250 4.0 lb Sil-Co-Sil 106 1.0 lb Sil-Co-Sil 52 2.0 lb Min-U-Sil 40 1.0 lb Min-U-Sil 30 1.0 lb Min-U-Sil 15 4.0 Min-U-Sil 10 (d50 ~8 µm)
Target Influent Concentration	100, 200, 300 mg/l	100, 200 mg/l max.	150-250 mg/l
Flow Increments	25%, 50%, 75%, 100% and 125% of unit's rated treatment capacity	50%, 75%, 100% and 150% of unit's rated treatment capacity	5%, 20%, 50% and 100% of unit's rated treatment capacity
# of Tests	3 for each flow rate and concentration (15 total)	2 for each flow rate and concentration (8 total)	1 for each flow rate and concentration for 2 models min. (8 total)
Preloaded Sediment for Resuspension Test	Specified test material at 50% and 100% of unit's rated sump capacity	Specified test material at 100% of unit's rated sump capacity	15% ASTM C33 Conc. Sand 10% NJ 0 Sand 20% NJ 4 Sand 15% Flint #12 Sand 10% Flint #15 Sand 15% F60 Grade Sand 10% 20/40 Oil Frac 5% HI-50
Resuspension Test	2 tests at maximum hydraulic operating rate w/preloaded sediment & clean water	Maximum flow without negative removal efficiency w/preloaded sediment	30 min or 5t_r 5 paired grab samples Max. +25 mg/l effluent w/clean water
Min. Performance	70% as SSC/50% as TSS at rated treatment capacity	80% removal as TSS at rated treatment capacity	Flow limited to 83% of allowable based on resuspension test
Sampling Method	Not specified	Not specified (grab samples or compositing inferred)	Total mass fed & collected in separator + 5 grab samples for influent/effluent SSC & TSS + PSD from all
# of Models	One	One	Two minimum (Ratio between surface areas of primary settling chambers of at least 2.5)
PSD Analysis	None specified	Optional laser diffraction	Feed per ASTM C117, C136 and D422 Influent/Effluent residuals per same methods for >63 µm, Coulter counter for <63 µm
Temperature	73-79 °F max.	None specified	50-80 °F

FEATURE	NJCAT / NJDEP	WA DOE	WI DNR
Other Aspects			False floor allowed to simulate 50% sediment load – system run clean Recommended 5 lbs of accumulated sediment in unit
Pros	1. Flow increments cover wide range of operation	1. Single, commercially available feed material in range of expected removal capability 2. Simple, conservative resuspension test	1. Direct sediment collection w/sampling backup 2. Resuspension test using material representative of captured sediment 3. Testing more than one model allows more direct scaling method
Cons	1. Preloaded sediment conflicts with direct collection to determine removal efficiency 2. Complex feed and resuspension test material mixture 3. Sampling methods not clarified	1. Sampling methods not clarified 2. Resuspension test method needs clarification	1. Fine feed material largely not captured at typical flow rates 2. Complex feed and resuspension test material mixtures 3. Mandatory PSD analysis expensive

The subcommittee decided to prepare the guidelines using the existing protocols. However, instead of specifying the flow rates, the particle size distributions, influent concentrations, etc., the committee has organized the guidelines with the goal of developing performance functions for the tested devices. A performance function for a tested device allows the cities, counties, and other local government agencies and end users to evaluate the performance of a tested device under a variety of climatic and environmental conditions without the requirement of further testing of that device. In order to develop the performance function of a device, only the range of tested flow rates, particle size distributions, and influent concentrations would be determined in the guidelines.

Subsequently, the Laboratory Testing Subcommittee formed three task groups to prepare the first drafts for (1) removal efficiency testing of hydrodynamic separators, (2) sediment retention testing of hydrodynamic separators, and (3) removal efficiency testing of filters.

Since hydrodynamic separators are primarily cost effective for removing sand and very coarse silt particles, and sampling these particles could cause large errors in the results, especially in the effluent pipe, the subcommittee agreed to recommend a semi-mass balance method for testing hydrodynamic separators. In a semi-mass balance method, it is required to weigh the amount of sediment to be fed into a hydrodynamic separator prior to each test, and at the end of each test to collect, dry and weigh all the sediments removed by the device. For testing filters, however, sampling of influent and effluent is allowed if the non-organic particles fed into the device during the test are fine silt or smaller.

The Laboratory Testing Certification Guidelines is comprised of four main sections. The first section is on the terminology used in the guidelines. The other three sections are the documents prepared by the task groups on testing the removal efficiency of hydrodynamic separators, sediment retention testing of hydrodynamic separators and filter testing. Each section includes the general features of the laboratory test stand, characteristics of the materials fed into the system or used to preload the system, measurement of the hydraulic characteristics of the device during a test, measurement of the materials removed by each device, and measurement of the materials washed out of a preloaded device. Testing filters includes (a) removal efficiency test, sediment retention test and clogging test which is to measure the changes in head and discharge over time.

Summary

The ASCE/EWRI Task Committee on Guidelines for Certification of Manufactured Stormwater BMPs formed a subcommittee to develop the laboratory testing guidelines. The objective of this subcommittee was to develop guidelines for laboratory testing to assess the efficiency of manufactured devices for physical separation of the full spectrum of stormwater-borne non-dissolved solids.

The laboratory testing guidelines includes a terminology section, and three sections on testing the removal efficiency of hydrodynamic separators, sediment retention testing of hydrodynamic separators and filter testing. The foundation of these laboratory testing guidelines are based on the existing protocols, however, the main difference is in developing performance functions for the tested devices which can be used under a variety of climatic and environmental conditions.

References

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