Stormwater Equipment Manufacturers Association (SWEMA) Laboratory Protocol to Assess Gross Pollutant Removal by Manufactured Treatment Devices

January 3, 2018

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1. Overview

This document describes a laboratory testing protocol for verifying the gross pollutant removal performance of a stormwater best management practice (BMP). It can be applied to devices designed specifically for gross pollutant removal as well as devices with a primary sediment removal function and a secondary gross pollutant removal function. The goal of the protocol is to provide end users with data that can be used to compare the relative performance of units under controlled conditions while limiting the cost and complexity of testing so as to encourage manufacturers to conduct the testing.

It is based primarily on work reported in the Caltrans document Laboratory Testing Of Gross Solids Removal Devices - CTSW-RT-05-73-18.1. (http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-05-073-18-1.pdf). It has been heavily modified to accommodate oil grit separators and filters, taking elements from the New Jersey Department of Environmental Protection (NJDEP) protocols for testing those types of devices. (http://www.njstormwater.org/mtd_guidance.htm)

The output of the testing is intended to meet or exceed the data quality and quantity requirements of ISO 14034 and existing stormwater device testing protocols such as those published by the New Jersey Department of Environmental Protection. This protocol does not establish pass/fail criteria, that decision is up to an appropriate regulatory or approvals agency or other authority having jurisdiction (AHJ). What it does is provide a standardized basis for comparison of the performance of different technologies.

2. Definitions

Authority Having Jurisdiction (AHJ)

An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

Geometrically Proportional

For the purposes of scaling, a GPRD is considered geometrically proportional to a reference GPRD when:

a. the design of the different model of GPRD is such that the flow pattern in the treatment area is the same as in the reference GPRD
b. ratios of the dimensions of GP capture device are the same as the ratios of the GP capture device of the reference GPRD. It is noted that the GP capture device is often some kind of screen or net that can be varied independent of the geometry of the overall GPRD. In this case the screen must be scaled to maintain the same flux rate as the reference unit.

Gross Pollutant

For the purposes of this protocol, gross pollutants are objects greater than 5 mm at their minimum dimension that are described in Table 1. The gross pollutants used to simulate trash in this test are based on the recipe presented in CTSW-RT-05-73-18.1 and related reports.

Gross Pollutant Removal Device

For the purpose of this protocol, a GPRD is a stormwater BMP that has the capacity to capture and retain gross pollutants. This may be the primary objective of the device or it may be a secondary feature of a device designed primarily as a hydrodynamic separator (HDS) or a filter for capturing sediment particles. This protocol does not address the sediment removal of such devices.

Maximum Hydraulic Flow Rate (MHFR)

The maximum hydraulic flow rate (MHFR) of a GPRD is the highest flow rate that can be conveyed through the GPRD with specified head loss. This value is primarily designed to provide maximum flows that can be safely conveyed through the unit to protect against backup during extreme events where overland flooding is a concern. The MHFR is determined or estimated by the

manufacturer/specifier based on hydraulic characterization tests that are not described in these protocols.

Maximum Treatment Flow Rate (MTFR)
The maximum treatment flow rate (MTFR) is defined as the highest flow rate that can be conveyed through the MTD while still achieving the performance claim based on the testing procedures described later in this protocol.

Mesh
In this document mesh refers to a screen, net or filter that consists of openings of a defined size. The mesh can be rigid or flexible but in any case must be strong enough to withstand the flows it is designed to handle. The size of the mesh is determined by the size of the largest opening.

3. Laboratory Testing Criteria

A. Testing Laboratory

Ideally the testing laboratory is accredited under ISO17025 to run this test, since this will allow the testing to meet the requirements of ISO 14034 Environmental Technology Verification. Given the very specialized nature of the test there may not be any ISO17025 accredited testing labs, in which case a lab with a quality system and ISO accreditation to some other standard is the next best option. The third option is testing at an in-house lab using an ISO 17020 accredited or SWEMA approved verifier to assess the lab and witness the testing. In any case, the desired AHJ i.e. NJDEP, CalTrans, etc. should be consulted in advance to determine if they will accept the results.

B. Analysis of GP Samples

Analysis of all gross pollutant samples shall be done on a dry mass basis by a competent ANSI or ISO accredited lab. Again ISO 17025 is preferred for compliance with ISO 14034.

C. Temperature

The temperature of the water for all testing shall not exceed 80 degrees Fahrenheit
(26.7 degrees Celsius).

D. Background water

The water used shall be clean municipal water without any surfactants, flocculants or other added chemicals.

E. GPRD Size and Availability

Where practical a full scale, commercially available GPRD must be tested in the laboratory in the same configuration and with the same components as typically used in actual installations. In cases where a commercial unit is designed for very large flows and it relies on a mesh a smaller section of mesh may be tested in order to keep the testing manageable. See the scaling section for criteria. In any case an exception is the materials of construction of the outer structure. If these are normally concrete a lighter structural material may be used.

4. Scour Testing

For GPRDs intended to be installed off-line, the scour testing shall be conducted at a minimum 125% of the maximum treatment flow rate (MTFR). Testing performed at this flow rate or higher is necessary to ensure that the washout of previously captured gross pollutants is not excessive. To determine if a MTD can be located on-line, scour testing shall be conducted at a minimum 200% of the MTFR. The flow rate used for scour testing must include only flows that passed through the MTD and may not include any externally bypassed flow.

The total amount scoured must be less than <5% of the captured GP. If this benchmark is achieved during scour testing at a minimum 200% MTFR, separate scour testing at a minimum 125% of the MTFR is not required.

If a system is designed such that all flow must go through a sub 5 mm mesh at all flow rate then a scour test is not required.

A. Scour Testing Procedure

The capture device shall be pre-loaded to 100% of the manufacturer's recommended maximum GP storage volume, or the equivalent if a scaled system is used. The pre-load shall be consistent with the GP recipe given in Table 1. The pre-loaded material can be wet or dry, allowing the scour test to be run before or after a performance loading test.

Following pre-loading and the addition of clear water, the test shall commence by conveying clear water through the MTD at increasing flow rates up to either the minimum 125% or 200% MTFR scour tests. Effluent samples shall be collected in a screen, net or filter continuously throughout the test. The flow rate shall be recorded continuously, once per minute. The flow rate shall be increased to the target flow rate within five minutes of commencement of the test. The flow rate shall then remain constant at the target maximum flow rate for the remainder of the test duration. Samples shall only be taken from the effluent of the MTD and shall not include any externally bypassed flow.

If the minimum 200% MTFR scour testing is conducted subsequent to the minimum 125% MTFR scour testing, any scoured GP must be replaced to restore the 100% GP load.

B. Sampling Procedures

Effluent samples shall be collected by using a <5 mm mesh at the opening of the effluent pipe. All particles are large enough to be visible so 100% recovery is required.

C. Scour Testing Results

Scour testing results shall be reported as % of previously captured mass found in the effluent at the end of the test.

5. Solids Removal Efficiency

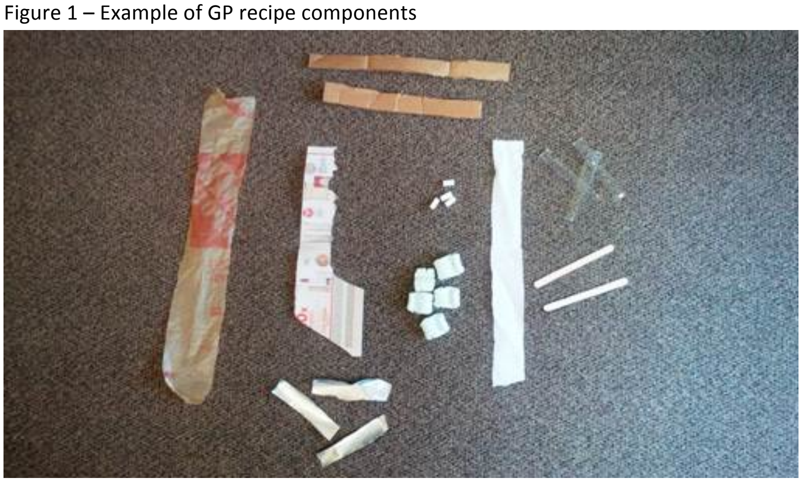
A. Test Trash Mix Composition

The recipe proposed here is based on work done by the California Department of Transportation in the early 2000s and published in a number of reports. The % volume values were converted to % mass for ease of reproducing the recipe. The conversion is based on data in

Gregory Williams 2018-1-3 7:05 PM
Comment [1]: Which report

Component	Description	Dimensions	% by Mass
Cigarette Filter	OCB regular cigarette filters 9.15 g/100 filters Bulk density = 900 filters/1L	7 mm diameter x 15 mm	14
Newspaper	Standard news print sheet cut in strips	28 cm x 5 cm	17
Wood	Popsicle sticks	11 cm x 0.95 cm x 0.2 cm	11
Plastic-Moldable	10 oz. PETE plastic cup cut in strips	9 cm x 2.5 cm	23
Plastic-Film	Plastic shopping bag split in half and cut in strips	40 cm x 8 cm	8
Cardboard/Chipboard	Cardboard box cut in strips	23 cm x 2.5 cm	10
Cloth	Cotton linen fabric cut in strips	35 cm x 5 cm	6
Metal – Foil, Molded	Aluminum drink can cut in strips	10 cm x 2.5 cm	7
Styrofoam	Standard “S”-shaped peanut packing material	3 mm x 3.5 mm x 1.5 mm	4

Figure 1 – Example of GP recipe components



The same batch of GP shall be used for all testing, to allow for “weathering”.

B. GP Removal Efficiency Testing

Gross Pollutant Removal Efficiency must be calculated as the mass of GP in the effluent as a percentage of the influent mass. GP Removal Efficiency testing shall be performed at a constant flow rate = 100%, of the GPRD's MTFR. The test shall be repeated at least 5 times, re-using the GP, in order to generate statistically meaningful results.

Test set up

a. The test shall consist of two tanks, an insertion tank and an outlet tank, with the GPDR to be tested piped between them. The length of pipe between units shall be 7-15 pipe diameters (PD) at a slope ≥ 1%. The diameter of the pipe between units shall be at least 24".
b. Both tanks shall have openings large enough to allow for loading and recovery of trash and visual confirmation that all trash has been removed. If the tanks have a top there must be enough head space to accommodate the entire volume of trash above the surface at all times.
c. The outlet tank must be able to accommodate a net at the end of the outlet pipe to allow for capture of any trash in the effluent flow.
d. A flow measurement device must be located either upstream or downstream of the MTD, in a location where trash will not interfere with the readings and where the flow is equal to the flow through the test unit. All flow meters used in this protocol must be calibrated as required by the instrument manufacturer. Copies of flow meter calibrations shall be included in the final report.
e. A temperature measurement device must be located in one of the tanks or in the GPRD. The temperature measurement device must be calibrated as required by the instrument manufacturer.

Test procedure:

a. Prior to the commencement of each test, all gross solids accumulated within the GPRD shall be removed, and the screens shall be cleared of all debris.
b. Adjust system until the required flow rate is attained.
c. Shut down system and add GP in the insertion tank upstream of the device.
d. Start system and run for 20 minutes, or until the system reaches an equilibrium state. Specifically, the water depths attain steady-state levels and all the gross solids that were introduced are transported into the GPRD.
e. Record flow rate every minute and report the average. During all test runs, the allowable variation from the target flow rate shall be ±10%. The COV shall be within 0.03.
f. Record temperature every minute and report the maximum. The maximum acceptable value is 80 ^{o}F (26.7 ^{o}C).
g. Water depths shall be measured every 5 minutes. The measurement points are: within 1 PD of the inlet to the GPRD, (y_i), within 1 PD of the end of the outlet pipe from the device (y_e) and inside the litter storage area, upstream of the screen or litter capture area, if this elevation is not the same as y_i. y_i and y_e are measured from the pipes' inverts.

C. Effluent Sampling Test Method

Effluent sampling shall be performed using a mesh with openings smaller than 5 mm yet large enough to allow all flow through the openings. All particles are large enough to be visible, and most will float, so 100% recovery is required.

Removal efficiency shall be calculated as follows:

$$Removal\ Efficiency\ (\%) = \frac{Dry\ mass\ added - Dry\ mass\ in\ effluent}{Dry\ mass\ added} \times 100$$

6. Success Criteria

Ultimately the success criteria are determined by the AHJ. In general it is expected that the following three conditions will be met:

a. Removal efficiency is ≥95%
b. GP retention at 200% MTFR is ≥95%
c. The recommended headloss at the inlet to the GPRD at 100% MTFR is not exceeded at 100% MTFR during any run.

7. Scaling of GPRDS

The scaling criteria are a function of the mode of operation of the system. For systems that do not use a mesh, units of a different capacity from the tested (reference) unit may be sized by scaling from the reference unit if the two units are geometrically proportional, as defined in section 2. If the units are not proportional a scaling model must be developed by testing 2 units at least 250% apart in capacity.

For units that do rely a mesh, it is only necessary to scale the mesh portion and test at the same flux rate as the full scale system. System capacity can be determine by simple scaling the volume of the test system to the volume of the full scale system. Headloss can be scaled with velocity squared.

8. Units of Measure

Where Imperial dimensions are reported, the metric equivalent should be included.