# VERIFICATION STATEMENT

## GLOBE Performance Solutions

Verifies the performance of

## RWM-DM-1200 & DM-1200-OS Stormwater Systems

Developed by Rainwater Management Ltd.
Port Coquitlam, BC, Canada

**Registration: GPS-ETV_V2022-09-15**

In accordance with

## ISO 14034:2016

**Environmental Management —
Environmental Technology Verification (ETV)**

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Executive Chairman
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September 15, 2022
Vancouver, BC, Canada

Verification Body
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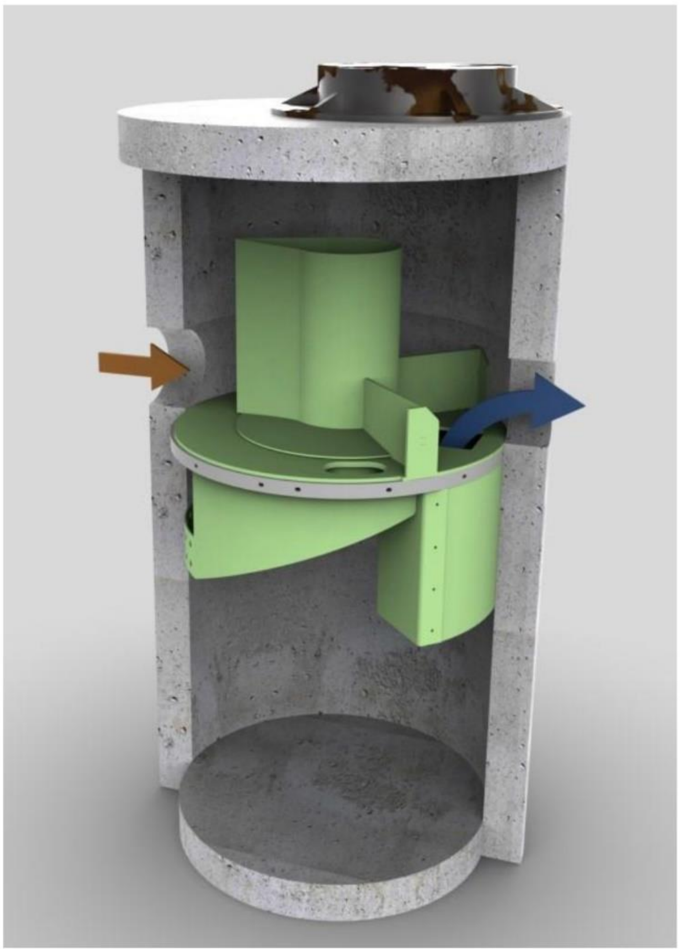
# Technology description and application

The RWM-DM-1200 and RWM-DM-1200-OS test unit is a full scale 1.22 m (4 foot) diameter by approximately 2.44 m (8 foot) high stormwater treatment device that facilitates the capture of oil (OS only) and sediment. The test tank was fabricated from plastic and included 305 mm (12 inch) diameter inlet and outlet pipes, oriented along the centerline of the tank. The pipe inverts were located 1.52 m (60 in.) above the sump floor with 1.5% slopes. The effective sedimentation area was 1.17 $m^2$ (12.57 $ft^2$)



The test units consist of a treatment disk containing a 406 mm (16 inch) diameter flow splitter and cleanout tube, two oval inlet openings, followed by two angled bypass weirs. The weir height of the RWM-DM-1200 was 229 mm (9 inches) and the RWM-DM-1200-OS was 152 mm (6 inches). A 254mm x 254mm (10" x 10") outlet opening was located downstream of the bypass weirs. Flow entering the unit was split to either side of center and directed to the oval inlets. The flow is conveyed into the collection sump volume by means of two sloped channels that curved along the tank wall and converged at the upstream side. An enclosed outlet baffle conveys the flow upward to the square outlet hole and into the outlet pipe.

**Figure 1: Graphic of a typical inline RWM-DM-1200 unit and core components**

# Performance conditions

The data and results published in this Verification Statement were obtained from the testing program conducted on the Rainwater Management Ltd.'s DM-1200 and DM-1200-OS OGS devices, in accordance with the Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014) and associated bulletins, including *CETV 2021-04-0001* which requires more stringent test conditions that limit the potential for sediment to accumulate in the inlet pipe and *CETV 2018-09-0001* which changes how the light liquid simulation test is undertaken. The Procedure was prepared by the Toronto and Region Conservation Authority (TRCA) for Environment Canada's Environmental Technology Verification (ETV) Program. A copy of the Procedure may be accessed on the Canadian ETV website at www.etvcanada.ca.

# Performance claim(s)

Capture test[1]:

During the capture test, the RWM-DM-1200, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L, removes 67.7, 63.3, 54.9, 45.4, 42.1, 35.5, and 33.6 percent of influent sediment by mass at surface loading rates (SLR) of 40, 80, 200, 400, 600, 1000, and 1400 L/min/$m^2$, respectively.

During the capture test, the RWM-DM-1200-OS, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L, removes 67.7, 63.3, 54.9, 45.4, 42.1, 35.0, and 28.7 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/$m^2$, respectively.

Scour test[1]:

During the scour test, the RWM-DM-1200, with 15.2 cm (6 inches) of test sediment pre-loaded onto a false floor reaching 50% of the manufacturer's recommended maximum sediment sump storage depth, generate corrected effluent concentrations of 0.4, 3.4, 2.0, 0.0, and 0.4 mg/L at 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/$m^2$, respectively.

Scour testing was not performed on the DM-1200-OS unit because the unit is identical to the DM-1200 model with the exception of the bypass weir, which is set at a lower elevation (i.e. the unit bypasses at lower flow rates). Tests at SLRs up to the lower weir height would experience the same scour as the DM-1200 unit. Test SLRs that overtop the bypass weir would have lower scour rates than the DM-1200 because there would be lower velocity and turbulence within the collection sump.

Light liquid retention test[1]:

DM-1200-OS, with the lower chamber oil collection zone pre-loaded with floatable low density polyethylene beads as an oil surrogate, and representing oil volume equal to a depth of 5 cm over the sedimentation area, retains 99.9% of the bead mass and volume loaded into the unit both initially during the preloading process and at 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/$m^2$.

# Performance results

The test sediment consisted of ground silica (1 – 1000 micron) with a specific gravity of 2.65, uniformly mixed to meet the particle size distribution specified in the testing procedure. The *Procedure for Laboratory Testing of Oil Grit Separators* requires that the average of the test sediment particle size distribution (PSD) meet the specified PSD percent less than values within a boundary threshold of 6%. The comparison of the average test sediment PSD (n=7) to the CETV specified

[1] The claim can be applied to other units smaller or larger than the tested unit as long as the untested units meet the scaling rule specified in the Procedure for Laboratory of Testing of Oil Grit Separators (Version 3.0, June 2014)

PSD in Figure 2 indicates that the test sediment used for the capture and scour tests met this condition.

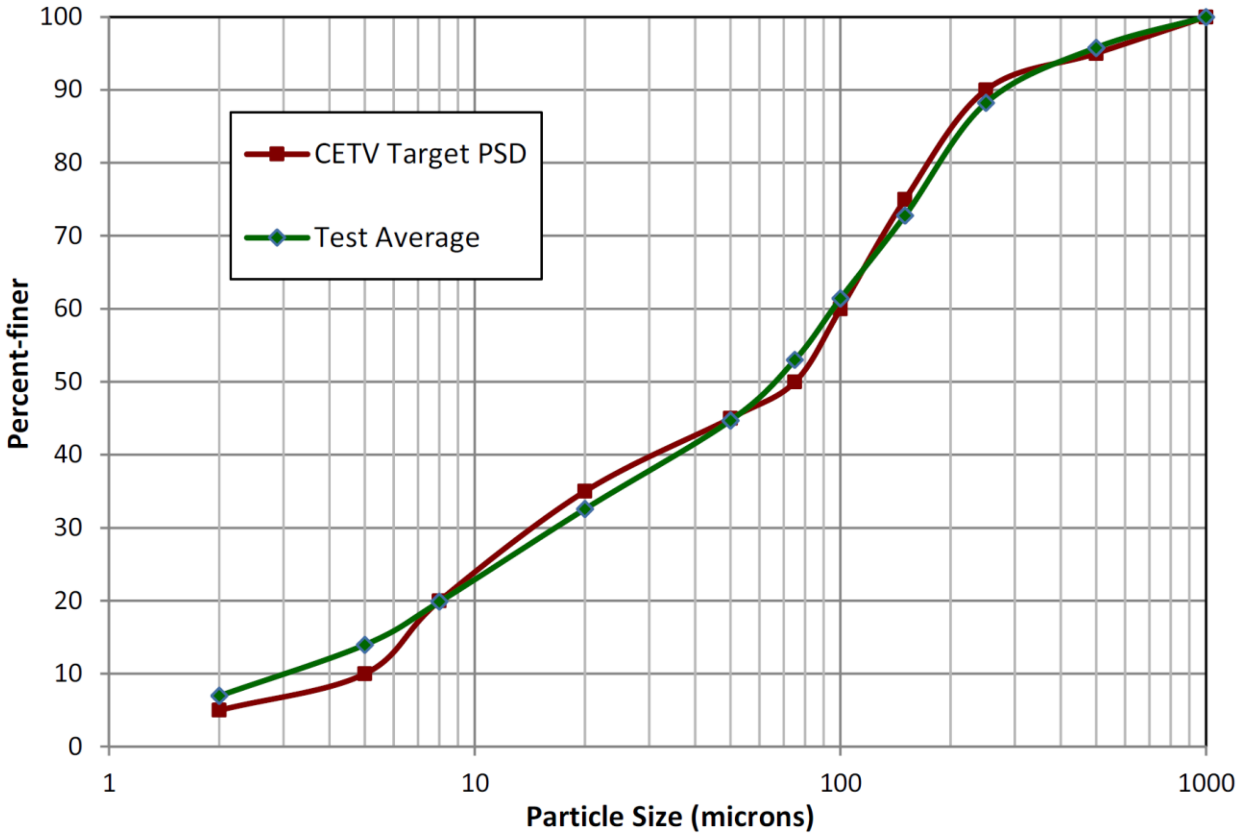



**Figure 2. Particle size distribution of test sediment compared with the CETV Target PSD.**

The capacity of the device to retain sediment was determined at seven surface loading rates using the modified mass balance method. This method involves measuring the mass and particle size distribution of the injected and retained sediment for each test run as the basis for calculating removal efficiencies. Performance was evaluated with a false floor simulating the technology filled to 50% of the manufacturer's recommended maximum sediment storage depth. The test was carried out with clean water that maintained a sediment concentration below 20 mg/L. Based on these conditions, removal efficiencies for individual particle size classes and for the test sediment were determined for each of the tested surface loading rates (Table 1). Since the DM-1200 and DM-1200-OS models are identical except for the weir height, which was shortened from 9" to 6" for the DM-1200-OS unit, sediment capture tests at surface loading rates from 40 to 1400 L/min/$m^2$ were only performed on the DM-1200 unit. Two additional tests were conducted on the DM-1200-OS unit at the bypass SLRs of 1000 and 1400 L/min/$m^2$.

**Table 1. Removal efficiencies (%) of the DM-1200 and DM-1200-OS units at specified surface loading rates**

| *Particle size fraction (µm)* | Surface loading rate (L/min/m$^2$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 40 | 80 | 200 | 400 | 600 | 1000 | 1400 | OS-1000 | OS-1400 |
| >500 | 100* | 100* | 93 | 89 | 100* | 57 | 93 | 100* | 86 |
| 250 - 500 | 97 | 88 | 86 | 92 | 95 | 92 | 89 | 100* | 72 |
| 150 - 250 | 97 | 100* | 91 | 100* | 100* | 70 | 58 | 66 | 65 |
| 105 - 150 | 100* | 100 | 100* | 81 | 58 | 44 | 44 | 40 | 47 |
| 75 - 105 | 100* | 100* | 85 | 64 | 46 | 29 | 22 | 31 | 23 |
| 53 - 75 | 87 | 78 | 67 | 37 | 30 | 18 | 19 | 17 | 11 |
| 20 - 53 | 68 | 38 | 26 | 13 | 6 | 3 | 5 | 6 | 4 |
| 8 - 20 | 24 | 17 | 0 | 0 | 0 | 0 | 1 | 3 | 2 |
| 5 – 8 | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| <5 | 14 | 14 | 8 | 7 | 6 | 7 | 6 | 0 | 0 |
| **All particle sizes by mass balance including SS in the inlet pipe** | **67.7** | **63.3** | **54.9** | **45.4** | **42.1** | **35.5** | **33.6** | **35.0** | **28.7** |
| All particle sizes by mass balance not including SS in the inlet pipe | 67.7 | 63.3 | 54.9 | 45.4 | 42.0 | 30.2 | 29.7 | 35.0 | 28.7 |

* Removal efficiencies were calculated to be above 100%. Calculated values ranged between 101 and 133% (average 110%). See text and Bulletin # CETV 2016-11-0001 for more information.

In some instances, the removal efficiencies were above 100% for certain particle size fractions (Table 1). These discrepancies are not unique to any one test laboratory and may be attributed to errors relating to the blending of sediment, collection of representative samples for laboratory submission, and laboratory analysis of PSD. Due to these errors, caution should be exercised in applying the removal efficiencies by particle size fraction for the purposes of sizing the tested device (see Bulletin # *CETV 2016-11-0001*). The results for "all particle sizes by mass balance" shown in Table 1 are based on measurements of the total injected and retained sediment mass, and are therefore not subject to blending, sampling or PSD analysis errors.

Mass balance sediment removal efficiencies are provided for sediment capture in the unit and inlet pipe as well as for the sediment settling only in the unit. These values show that sediment accumulated in the inlet pipe primarily during the 1000 and 1400 SLR tests on the DM-1200 model (5.3% and 4.0% of the injected mass, respectively). Sediment deposition in the inlet pipe consisted of coarse sediment > 100 µm. The *Procedure* allows for the mass of sediment accumulated in the inlet pipe to be claimed as captured mass. Measures were implemented in 2021 through *Bulletin CETV 2021-04-0001* to limit the potential for fine sediment accumulation in the inlet during lab tests.

Figure 3 compares the PSD average of the of the test sediment to the PSD of the sediment retained by the DM-1200 at each of the tested surface loading rates. As expected, the capture efficiency for fine particles in both units was generally found to decrease as surface loading rates increased.

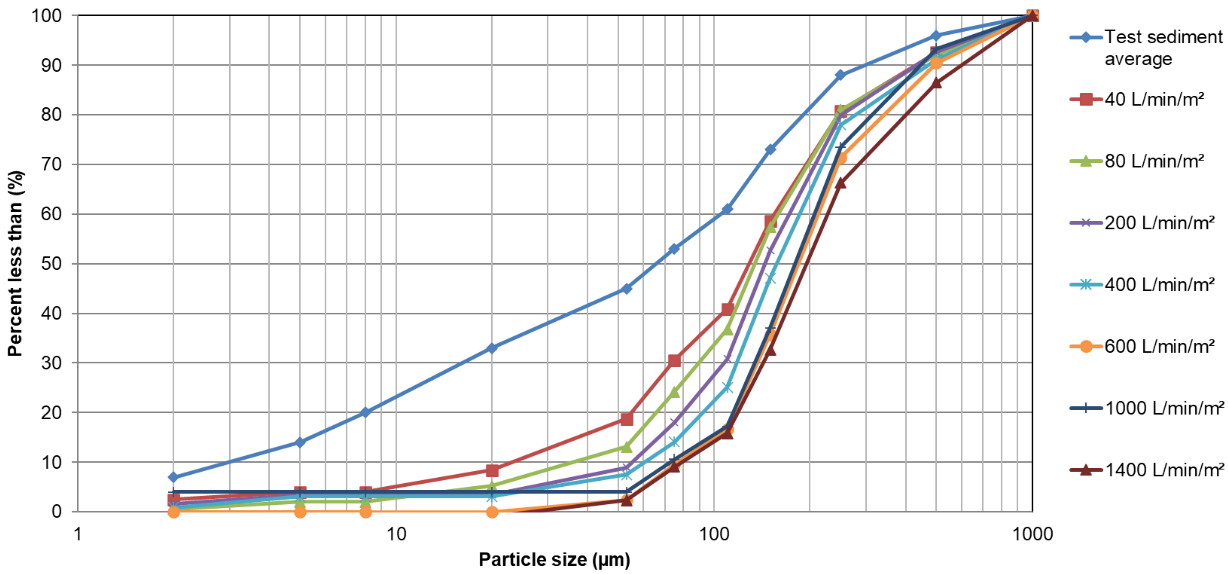



**Figure 3. PSD average of the of the test sediment to the PSD of the sediment retained by the DM-1200 at each of the tested surface loading rates**

Table 2 shows the results of the sediment scour test for the DM-1200 unit. The scour test involved preloading 10.2 cm of fresh test sediment into the sedimentation sump of the device. The sediment was placed on a false floor to mimic a device filled to 50% of the maximum recommended sediment storage depth. Clean water was run through the device at five surface loading rates over a 30-minute period. Each flow rate was maintained for 5 minutes with a one-minute transition time between flow rates. The test was stopped and started after the 800 L/min/$m^2$ test to change flow meters. Effluent samples were collected at one minute sampling intervals and analyzed for Suspended Sediment Concentration (SSC) and PSD by approved methods. The effluent samples were adjusted based on the background concentration of the influent water. Typically, the smallest 5% of particles captured during the 40 L/min/$m^2$ sediment capture test is also used to adjust the concentration, as per the method described in *Bulletin # CETV 2016-09-0001*. However, the low flow rate particle size adjustment was not made because the concentrations were very low even without adjustment. Results showed average effluent sediment concentrations below 4 mg/L at all tested surface loading rates.

**Table 2. Measured scour effluent concentration (mg/L)**

| Measured concentration at each surface loading rate | | | | | |
|---|---|---|---|---|---|
| Effluent Sample No. | 200 L/min/$m^2$ | 800 L/min/$m^2$ | 1400 L/min/$m^2$ | 2000 L/min/$m^2$ | 2600 L/min/$m^2$ |
| 1 | 1.5 | 0.0 | 1.7 | 0.0 | 0.0 |
| 2 | 0.1 | 0.0 | 4.5 | 0.0 | 0.7 |
| 3 | 0.0 | 2.0 | 2.8 | 0.0 | 1.2 |
| 4 | 0.0 | 8.2 | 0.7 | 0.0 | 0.2 |
| 5 | 0.5 | 6.6 | 0.0 | 0.0 | 0.0 |
| **Average** | **0.4** | **3.4** | **2.0** | **0.0** | **0.4** |

The results of the light liquid retention test used to evaluate the unit's capacity to capture and prevent re-entrainment of light liquids are reported in Table 3. The test involved preloading

33.4 kg (corresponding to a 5 cm depth over the collection sump area of 1.17m$^2$) of surrogate low-density polyethylene beads (Dowlex™ 2517) within the oil collection skirt and running clean water through the device continuously at five surface loading rates (200, 800, 1400, 2000, and 2600 L/min/m$^2$). Each flow rate was maintained for 5 minutes with approximately 1 minute transition time between flow rates. The effluent flow was screened to capture all the pellets that were lost during the preloading process (i.e. that did not enter the collection skirt) and all re-entrained pellets throughout the test. Results showed that 99.9% of the bead mass injected into the unit were retained.

**Table 3. Light-liquid retention test results**

| Surface loading rate | Collected mass (grams) | Remaining Mass (grams) | Retained Mass (%) |
|---|---|---|---|
| Not captured during preloading | 20.5 | 33,380 | 99.9 |
| 200 L/min/m$^2$ | 0.0 | 33,380 | 99.9 |
| 800 L/min/m$^2$ | 4.6 | 33,375 | 99.9 |
| 1400 L/min/m$^2$ | 2.1 | 33,373 | 99.9 |
| 2000 L/min/m$^2$ | 0.9 | 33,372 | 99.9 |
| 2600 L/min/m$^2$ | 0.5 | 33,371 | 99.9 |

The DM-1200 and DM-1200-OS were tested with clean water to establish head loss through the units. Flow and water level measurements were recorded at steady-state flow conditions. Flows were set and measured using calibrated differential-pressure flow meters and control valves. Each test flow was set and operated at steady state for approximately 5 minutes, after which time a minimum of 60 seconds of flow and pressure data were averaged and recorded for each pressure tap location. Water elevations were measured one pipe-diameter upstream and downstream of the unit, as well as upstream and downstream of the bypass weir. The measured bypass rate for the DM-1200 and DM-1200-OS was 21 and 11.7 L/s (1,077 and 600 L/min/m$^2$), respectively. Results of the measurements, corrected for velocity head, are provided in Table 4.

**Table 4. Head loss measurements by flow rate for the DM-1200 and DM-1200-OS**

| Water Elevations (adjusted to outlet invert) | | | Losses (DM-1200) | | |
|---|---|---|---|---|---|
| Measured Flow | Inlet Pipe | Outlet Pipe | **Inlet El. (A')** | **Outlet El. (D')** | **System Energy Loss** |
| | A | D | **Corrected for Energy** | **Corrected for Energy** | **A'-D'** |
| L/sec | m | m | m | m | m |
| 1.6 | 0.045 | 0.025 | 0.050 | 0.041 | 0.009 |
| 3.2 | 0.062 | 0.036 | 0.069 | 0.058 | 0.011 |
| 6.3 | 0.093 | 0.054 | 0.100 | 0.081 | 0.020 |
| 11.7 | 0.140 | 0.074 | 0.147 | 0.111 | 0.036 |
| 21.2 | 0.220 | 0.102 | 0.228 | 0.152 | 0.076 |
| 25.3 | 0.237 | 0.114 | 0.247 | 0.166 | 0.080 |
| 30.0 | 0.252 | 0.125 | 0.264 | 0.183 | 0.081 |
| 38.0 | 0.287 | 0.159 | 0.302 | 0.209 | 0.093 |
| 44.6 | 0.302 | 0.169 | 0.322 | 0.228 | 0.094 |
| 50.9 | 0.318 | 0.177 | 0.343 | 0.245 | 0.097 |
| 60.2 | 0.341 | 0.188 | 0.375 | 0.271 | 0.105 |

| Water Elevations (adjusted to outlet invert) | | | Losses (DM-1200-OS | | |
|---|---|---|---|---|---|
| Measured Flow | Inlet Pipe | Outlet Pipe | **Inlet El. (A')** | **Outlet El. (D')** | **System Energy Loss** |
| | A | D | **Corrected for** | **Corrected for Energy** | **A'-D'** |
| L/sec | m | m | m | m | m |
| 1.6 | 0.045 | 0.025 | 0.050 | 0.041 | 0.009 |
| 3.2 | 0.062 | 0.036 | 0.069 | 0.058 | 0.011 |
| 6.3 | 0.093 | 0.054 | 0.100 | 0.081 | 0.020 |
| 11.7 | 0.141 | 0.075 | 0.148 | 0.111 | 0.037 |
| 15.8 | 0.161 | 0.085 | 0.171 | 0.131 | 0.040 |
| 25.3 | 0.197 | 0.109 | 0.211 | 0.169 | 0.043 |
| 30.0 | 0.212 | 0.117 | 0.229 | 0.186 | 0.043 |
| 37.8 | 0.250 | 0.146 | 0.269 | 0.207 | 0.062 |
| 47.3 | 0.280 | 0.163 | 0.304 | 0.235 | 0.069 |
| 57.2 | 0.310 | 0.180 | 0.341 | 0.263 | 0.078 |
| 63.6 | 0.328 | 0.190 | 0.367 | 0.280 | 0.087 |
| 72.7 | 0.360 | 0.196 | 0.411 | 0.306 | 0.105 |

# Variations from the Procedure

Minor variances from the *Procedure for Laboratory Testing of Oil-Grit Separators* used as the basis of testing for this verification were as follows:

1. The *Procedure* states that the tested device "must be a full scale commercially available device with the same configuration and components as would be typical for an actual installation." The unit tested for this verification had the same internal components as would be typical for a commercial installation, but the internal components were placed inside a structure constructed of plastic, rather than a manhole made of concrete, the latter of which is typical for most installations. The dimensions of the structure were the same as would have been the case had the manhole been concrete. The use of alternate materials for the structure was not believed to significantly affect system performance and the variance was approved by the verifier prior to testing

2. As part of the capture test, evaluation of the 40 and 80 L/min/$m^2$ surface loading rate was split into 3 and 2 parts, respectively. The test was conducted in parts because of the long duration (i.e. over 10 hours) needed to feed the required minimum of 11.3 kg of test sediment into the unit. At the end of the first and second parts of the test, the flow rates were gradually shutdown to prevent capture of particles that would have been washed out under normal circumstances. The requirement to split the test into parts was not anticipated during the writing of the *Procedure* but has been a common feature of testing at the lower surface loading rate. The breaks were not likely to have significantly impacted results and the variance was approved prior to testing.

3. It was necessary to change flow meters during the sediment scour and light liquid re-entrainment test, as the required flows exceeded the minimum and/or maximum range of any single meter. When the flow capacity of the selected meter was reached, the flow was shut down over a period of approximately 10 seconds and all flow data saved. The next data acquisition file was executed, and flow increased at a rate that corresponded to reaching each previous target flow after a period of 1-minute. This procedure was approved by the verifier prior to testing, in recognition that most particles susceptible to scour at low flows would not be in the sump at higher flows. Similarly, re-entrainment of the oil beads was not expected to be significantly affected by the flow meter change.

# Verification

This verification was completed by the Verification Experts, at the Toronto and Region Conservation Authority (TRCA), contracted by GLOBE Performance Solutions, using the International Standard ***ISO 14034:2016 Environmental management -- Environmental technology verification (ETV)***. Data and information provided by Rainwater Management Ltd. to support the performance claim included the Technical Evaluation Report No. 1292RWM-R0 prepared by Alden Research Laboratory of Holden, Massachusetts, dated May 2022. This report is based on testing completed in accordance with the *Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014)* and associated Bulletins.

# What is ISO14034:2016 Environmental management – Environmental technology verification (ETV)?

ISO 14034:2016 specifies principles, procedures and requirements for environmental technology verification (ETV) and was developed and published by the *International Organization for Standardization (ISO)*. The objective of ETV is to provide credible, reliable and independent verification of the performance of environmental technologies. An environmental technology is a technology that either results in an environmental added value or measures parameters that indicate an environmental impact. Such technologies have an increasingly important role in addressing environmental challenges and achieving sustainable development.

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