Verification Statement

Hydro International Downstream Defender® Oil Grit Separator
Registration number: (V-2019-09-01)
Date of re-issue: 2022-09-15

Technology type	Oil Grit Separator
Application	Technology to remove oil, sediment, trash and debris from stormwater and snowmelt runoff as well as other pollutants that attach to sediment particles, such as nutrients and metals
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Verified Performance Claims

The Hydro International Downstream Defender® Oil Grit Separator (OGS) was tested by Good Harbour Laboratories Inc. (GHL), Mississauga, Ontario, Canada in 2016 The performance test results were verified by Toronto and Region Conservation Authority (TRCA), Vaughan, Ontario, Canada following the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The following performance claims were verified:

Capture test[1]:
During the sediment capture test, the Downstream Defender® device, 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 72, 68, 58, 52, 43, 36, and 27 percent of influent sediment by mass at surface loading rates of 40 L/min/m^2, 80 L/min/m2, 200 L/min/m^2, 400 L/min/m^2, 600 L/min/m^2, 1000 L/min/m^2, and 1400 L/min/m^2, respectively.

Scour test[1]:
During the scour and resuspension test, with 10.2 cm (4 inches) of test sediment pre-loaded onto a false floor reaching 50% of the manufacturer's recommended maximum sediment storage depth, the Downstream Defender® device generates corrected effluent concentrations of less than 1 mg/L at 5 minute duration surface loading rates of 200 L/min/m^2, 800 L/min/m^2,1400 L/min/m^2, 2000 L/min/m^2, and 2600 L/min/m^2, respectively.

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[1] The claims 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)

Technology Application

The Downstream Defender® Oil Grit Separator can be used as a stand-alone stormwater treatment technology, depending on water quality objectives, or as a pretreatment component in a treatment train when higher TSS removals are required and polishing or volume reduction best management practices (BMPs), such as infiltration or bio-infiltration, are installed downstream. Downstream Defender® OGS applications include: stormwater treatment at the point of entry into the drainage line; sites constrained by space, topography or drainage profiles with limited slope and depth of cover; retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line; pretreatment for filters, infiltration, other sedimentation BMPs and storage.

Technology Description

The Downstream Defender® Oil-Grit Separator is an advanced vortex separator designed to utilize the principles of swirl-enhanced gravity separation to remove Total Suspended Solids (TSS), trash and hydrocarbons from stormwater runoff. The Downstream Defender® has a tangential inlet to introduce a rotary flow path to the precast treatment chamber while high density polyethylene (HDPE) flow-modifying internal components stabilize the swirling flow path to reduce turbulence. The swirling flow path of the Downstream Defender® augments gravitational (FG) forces with swirl-induced forces (FCF, FCT) to remove solids from stormwater runoff.

Stormwater enters the Downstream Defender® through a submerged tangential inlet. Hydrocarbons and other floatable solids rise to the surface where they are captured in the chamber as the stormwater spirals downward around the interior cylindrical baffle. When it reaches the center cone the flow changes direction from downward to upward, passing through a zero flow velocity “shear” zone where solids settle out of the flow scheme and into the pollutant storage sump. After flow is deflected upward by the center cone, it spirals upwards around the center shaft inside the cylindrical baffle and discharged via the effluent pipe. To prevent washout, a benching skirt protects settled particles in the pollutant storage sump from high scour velocities.

The Downstream Defender® is available in five model sizes. The 1.8, 2.4, 3.0 and 3.7 m diameter Downstream Defender® models are geometrically proportional to the 1.2m test model. All inside dimensions of length and width are geometrically scaled. Additionally, the aspect ratio of depth to diameter slightly increases with model size.

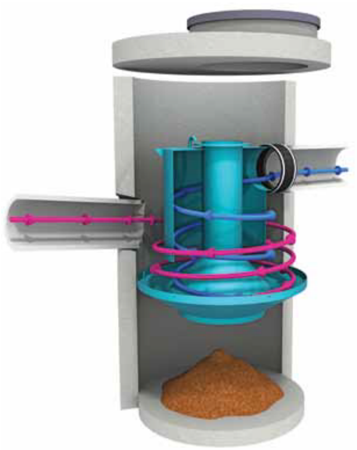

Figure 1 – Schematic of the Hydro International Downstream Defender® Oil Grit Separator

The test unit was 1.2 m (4 foot) in diameter with a 0.52 m sump depth measured from the outlet invert to the floor of the unit. The effective treatment area (also known as the effective sedimentation area) is 1.17 m^2. The maximum sediment storage depth is 0.46 m.

Description of Test Procedure

The test data and results for this verification were obtained from independent testing conducted on a 1.2 m (48 inch) diameter Hydro International Downstream Defender® OGS device, in accordance with the *Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014)*. The laboratory test procedure was originally prepared by the Toronto and Region Conservation Authority (TRCA) in association with a 31 member advisory committee from various stakeholder groups.

Verification Results

Toronto and Region Conservation Authority verified the performance test data and other information pertaining to the Downstream Defender® Oil Grit Separator. A Verification Plan was prepared to guide the verification process based on the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol.

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 three sample average of the test sediment particle size distribution (PSD) meet the specified PSD percent less than values within a boundary threshold of 6%, and a median particle size no greater than 75 µm. Comparison of the individual sample and average test sediment PSD to the specified PSD shown in Figure 2 indicates that the test sediment used for the capture and scour tests met this condition. The median particle size was 50 µm. Samples from test sediment batches used for each run also met the specified PSD within the required tolerance thresholds.

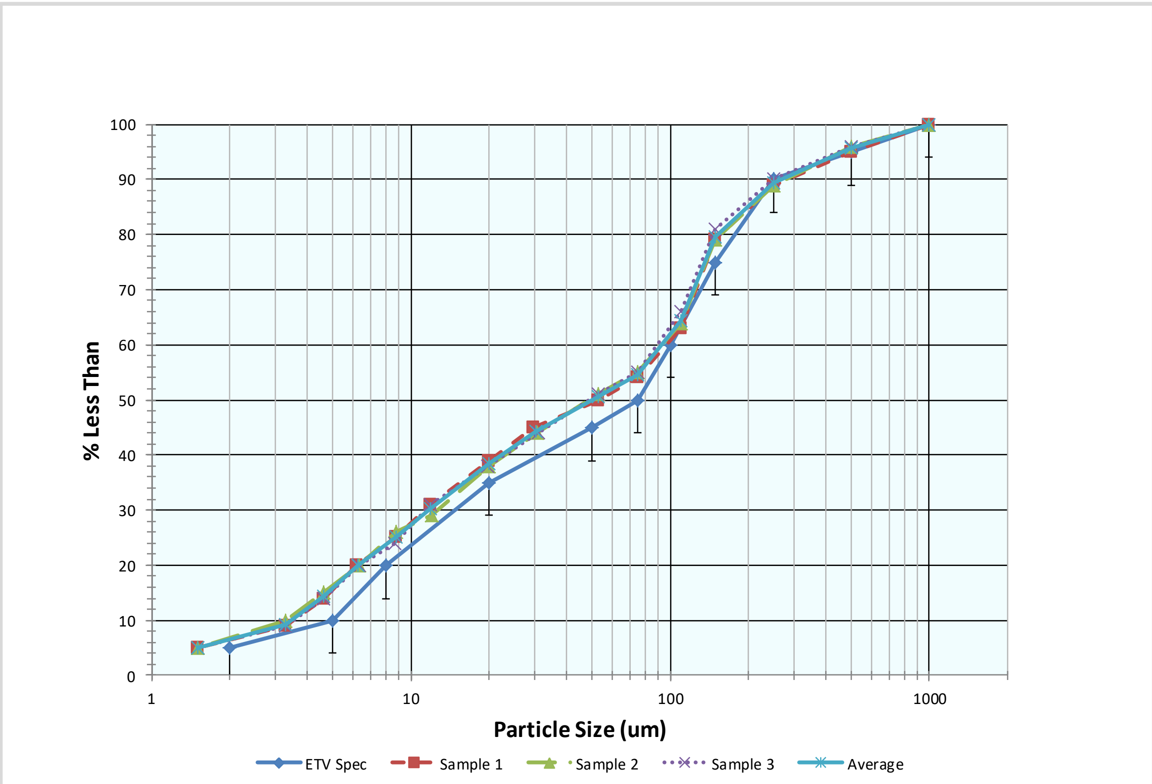

Figure 2 - The three sample average particle size distribution (PSD) of the test sediment used for the capture and scour test compared to the specified PSD

The capacity of the device to retain sediment was determined at seven surface loading rates using the modified mass balance method. This method involved measuring the mass and particle size distribution of the injected and retained sediment for each test run. 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 as a whole were determined for each of the tested surface loading rates (Table 1).

In some instances, the removal efficiencies were above 100% for certain particle size fractions. These discrepancies are not unique to any one test laboratory and are 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" (see 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.

Table 1 - Removal efficiencies (%) of the Downstream Defender® OGS at specified surface loading rates

Particle Size Fraction (µm)	Removal Efficiency (%)						
	40 L/min/m²	80 L/min/m²	200 L/min/m²	400 L/min/m²	600 L/min/m²	1000 L/min/m²	1600 L/min/m²
> 500	100*	100*	100*	91.6	100*	98.8	99.7
250 - 500	84.5	100*	100*	87.3	91.3	89.8	84.2
150 - 250	100*	100*	89.5	100*	89.9	79.9	62.0
100 - 150	95.8	100*	91.0	97.9	68.0	56.9	34.7
75 - 100	99.6	97.7	100*	57.6	47.3	49.4	29.5
50 - 75	84.2	75.0	89.7	44.5	29.2	31.2	20.7
20 - 50	74.0	45.4	39.1	21.8	18.2	10.7	12.3
8 - 20	48.0	44.5	17.1	12.6	8.9	9.8	2.6
5 - 8	22.6	23.3	12.5	22.3	14.5	3.8	0.0
< 5	21.9	10.7	0.0	0.0	0.3	0.0	0.0
Removal efficiency based on mass balance (%)	**72.43**	**67.66**	**57.91**	**52.36**	**42.59**	**35.94**	**26.58**

*Removal efficiencies were calculated to be above 100%. Calculated values ranged between 101 and 128% (average 113%). See text and Bulletin # CETV 2016-11-0001 for more information.

Figure 3 compares the particle size distribution (PSD) of the three sample average of the test sediment to the PSD of the sediment retained by the Downstream Defender® OGS device at each of the tested surface loading rates. As expected, the capture efficiency for fine particles was generally found to decrease as surface loading rates increased.

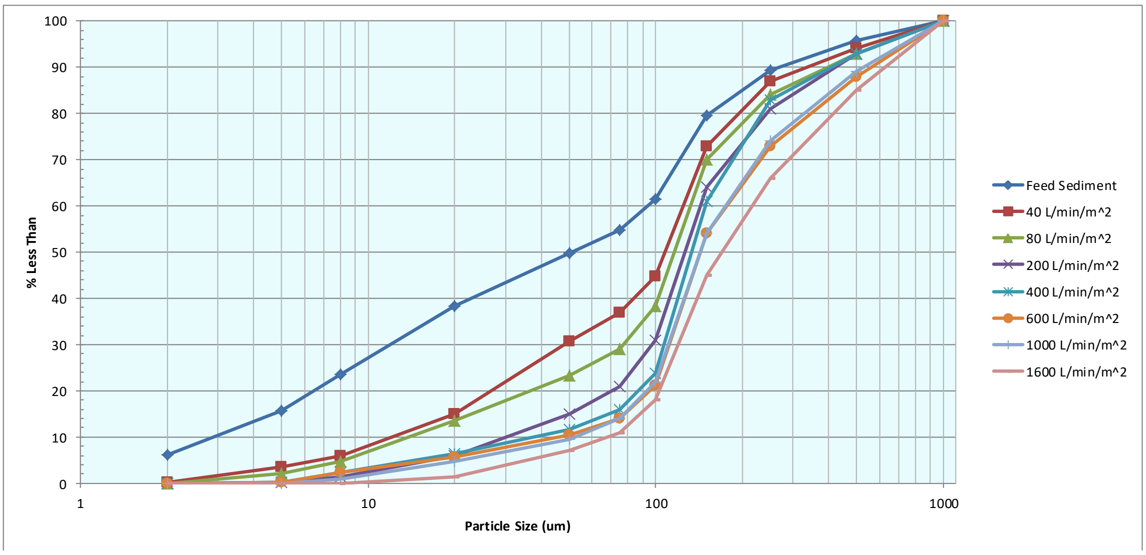

Figure 3 - Particle size distribution of sediment retained in the Downstream Defender® OGS in relation to the injected test sediment average

Table 2 shows the results of the sediment scour and re-suspension test for the Downstream Defender® Oil-Grit Separator unit. The scour test involved preloading 10 cm (4 inches) 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. Effluent samples were collected at one minute sampling intervals and analyzed for Suspended Sediment Concentration (SSC) and PSD by recognized methods. The effluent samples were subsequently adjusted based on the background concentration of the influent water. The smallest 5% of particles captured during the 40 L/min/m^2 sediment capture test (6.7 μm in this case) was used to further adjust the effluent sediment concentrations, as per the method described in Bulletin # CETV 2016-09-0001, in recognition that these fine particles would not likely be captured by the unit under field conditions. Results showed average adjusted effluent sediment concentrations below 1 mg/L at all surface loading rates.

Table 2 - Scour test effluent sediment concentration at each surface loading rate (SLR) (see text for notes on adjustments and corrections)

Run	SLR (L/min/m²)	Run Time	SSC Initial (mg/L)	SSC Adjusted (mg/L)	Average SSC Adjusted (mg/L)	SSC Adjusted D5 corrected (mg/L)
1	200	1:00	< MDL	< MDL	0.2	0
		2:00	1	0.2		
		3:00	< MDL	< MDL		
		4:00	1	0.2		
		5:00	< MDL	< MDL		
		6:00	1	0.2		
2	800	7:00	< MDL	< MDL	< MDL	0
		8:00	< MDL	< MDL		
		9:00	< MDL	< MDL		
		10:00	< MDL	< MDL		
		11:00	< MDL	< MDL		
		12:00	< MDL	< MDL		
3	1400	13:00	1	0.2	0.7	0
		14:00	2	1.2		
		15:00	2	1.2		
		16:00	2	1.2		
		17:00	1	0.2		
		18:00	1	0.2		
4	2000	19:00	2	1.2	2	0
		20:00	3	2.2		
		21:00	3	2.2		
		22:00	3	2.2		
		23:00	4	3.2		
		24:00	3	2.2		
5	2600	25:00	4	3.3	7	0.6
		26:00	7	6.2		
		27:00	9	8.2		
		28:00	9	8.2		
		29:00	9	8.2		
		29:50	10	9.2		

Variances 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 composite materials, 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.

2. As part of the capture test, evaluation of the 40 and 80 L/min/m² 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 become a common feature of testing at the lowest surface loading rates. The breaks were not likely to have significantly impacted results.

Quality assurance

Performance testing and verification of the Downstream Defender® Oil-Grit Separator were performed in accordance with the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The verifier, Toronto and Region Conservation Authority, has confirmed that quality assurance requirements were addressed throughout the performance testing process and in the generation of performance test results. This includes reviewing all data sheets and data downloads, as well as overall management of the test system, quality control and data integrity.

Verification Summary

In summary, the Downstream Defender® Oil-Grit Separator is designed to remove oil, sediment, trash and debris from stormwater and snowmelt runoff as well as other pollutants that attach to sediment particles, such as nutrients and metals. Verification of performance claims for the Hydro International Downstream Defender® Oil Grit Separator was conducted by Toronto and Region Conservation Authority based on independent third-party performance test results provided by Good Harbour Laboratories, as well as additional information provided by Hydro International. Table 3 summarizes the verification results in relation to the technology performance parameters that were identified to determine the efficacy of the Downstream Defender® Oil Grit Separator.

Table 3 - Summary of Verification Results Against Performance Parameters

Performance Parameter	Verified Performance
Sediment Removal Rate	The sediment removal rate of the Downstream Defender® is dependent upon flow rate, particle density and particle size. Removal efficiency decreased with increasing surface loading rate from 72% at 40 L/min/m² to 27% at 1400 L/min/m². The weighted average removal efficiency achieved by the unit will vary depending on the rainfall distribution of the jurisdiction in which it is installed, and site characteristics.
Sediment Scour	When pre-loaded with sediment with a particle size distribution matching that of the feed sediment used in the sediment capture test, the Downstream Defender® Oil-Grit Separator generated D5 corrected effluent suspended solids concentrations of less than 1 mg/L at surface loading rates ranging from 200 L/min/m² to 2600 L/min/m².
Bypass flow rate	The Downstream Defender® does not have an internal bypass.
Head loss	The loss of hydraulic head across the Downstream Defender® was determined by measuring the static water elevation upstream of the device just after the standpipe. Head loss may vary based on model size. For the tested unit the head loss ranged from 39 mm at 4 L/s to 255 mm at 50 L/s. Head loss increased consistently with flow rate.

What is ISO 14034?

The purpose of environmental technology verification is to provide a credible and impartial account of the performance of environmental technologies. Environmental technology verification is based on a number of principles to ensure that verifications are performed and reported accurately, clearly, unambiguously and objectively. The International Organization for Standardization (ISO) standard for environmental technology verification (ETV) is ISO 14034, which was published in November 2016.

Benefits of ETV

ETV contributes to protection and conservation of the environment by promoting and facilitating market uptake of innovative environmental technologies, especially those that perform better than relevant alternatives. ETV is particularly applicable to those environmental technologies whose innovative features or performance cannot be fully assessed using existing standards. Through the provision of objective evidence, ETV provides an independent and impartial confirmation of the performance of an environmental technology based on reliable test data. ETV aims to strengthen the credibility of new, innovative technologies by supporting informed decision-making among interested parties.

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Signed for Hydro International: *Original signed by:* *Phillip Taylor* Phillip Taylor Technical Product Manager	Signed for VerifiGlobal: *Original signed by:* *Thomas Bruun* Thomas Bruun, Managing Director *Original signed by:* *John Neate* John Neate, Managing Director

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