

**APPENDIX 9 – SuDS Treatment Train – Hydro International Up-Flo
Filter and Downstream Defender Data**



A Guide to The SuDS Manual (C753) Simple Index Approach

The SuDS Manual (C753) Simple Index Approach

Introduction

In Table 26.1 of The SuDS Manual (C753) four risk based approaches for water quality management are specified:

1. Simple Index Approach
2. Risk Screening (generally used to determine if Simple Index Approach is appropriate)
3. Detailed Risk Assessment
4. Process-Based Treatment Modelling

With the intention that the simpler approaches are applied in lower risk scenarios, with more sophisticated assessments only used when appropriate to the risk.

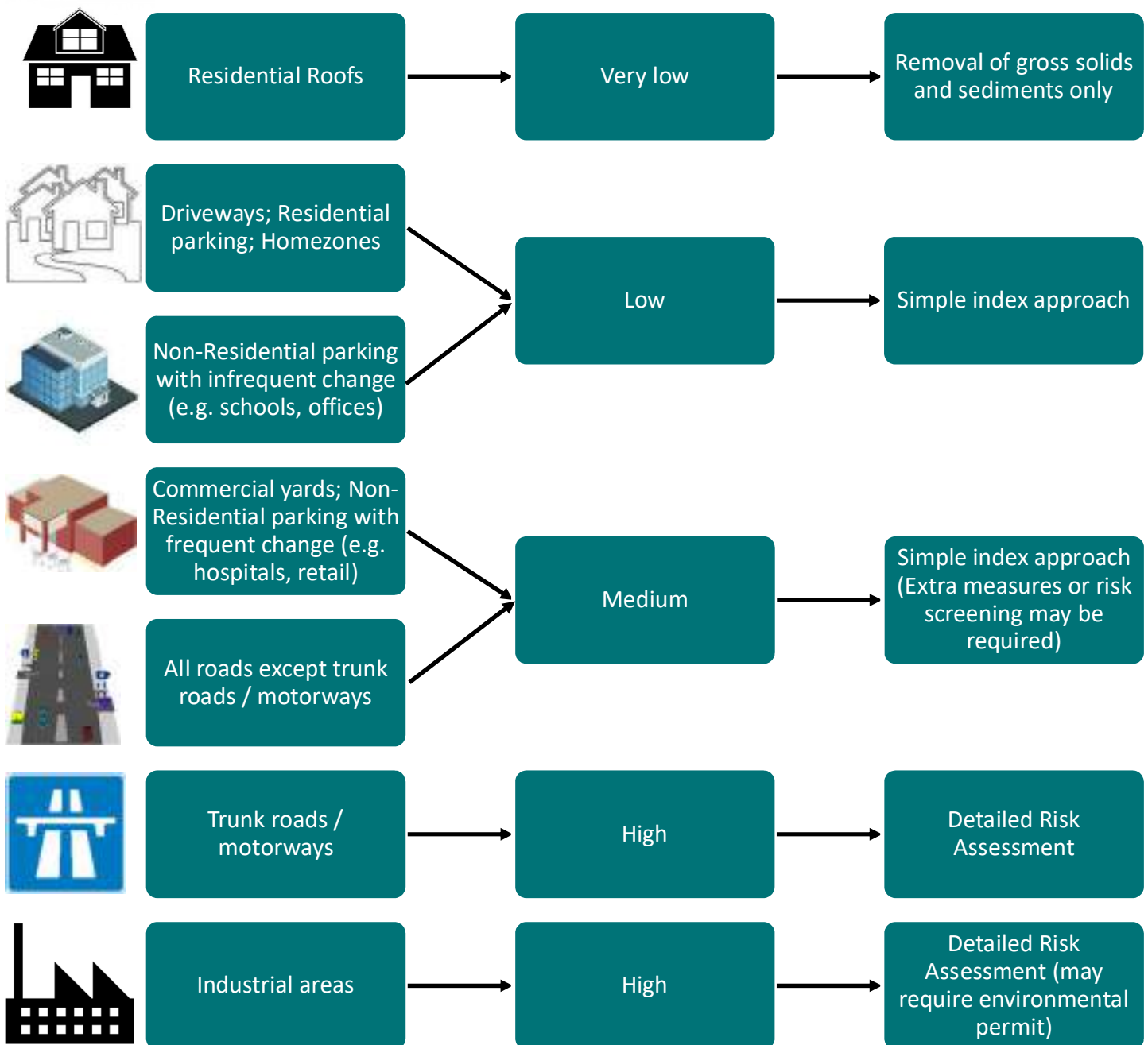


Figure 1: Applying the Risk Based Water Quality Management Approaches (Source: After Table 4.3 of the SuDS Manual)

Applying the Simple Index Approach (SIA)

The Simple Index Approach (SIA) recommended in Section 26.7.1 of The SuDS Manual (C753) was developed from that set out by Middlesex University (as outlined in Annex 5 of Chapter 26 of The SuDS Manual) and follows a three step approach:

Step 1 – Allocate suitable pollution hazard indices for the proposed land use categories

Step 2 – Select SuDS with a total pollution mitigation index that equals or exceeds the pollution hazard index

Step 3 – Where the discharge is to protected¹ surface waters or groundwater, consider the need for a more precautionary approach.

Note:

- 1 Designated as those protected for the supply of drinking water (see SuDS Manual Table 4.3).

Step 1: Define pollution hazard indices

Pollution hazard indices are presented in Table 26.2 of The SuDS Manual and reproduced here for simplicity. The indices range from 0 (no pollution of this type) to 1 (high pollution hazard for this contaminant type).

Table 1: Pollution hazard indices for different land use classes (Source: Reproduced from The SuDS Manual Table 26.2)

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Liquid Hydrocarbons (free floating oils)
Residential Roofs	Very low	0.2	0.2	0.05
Other Roofs (typically commercial / industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (e.g. cul de sacs, homezones and general access roads) and non-residential car parks with infrequent change (e.g. schools, offices) – i.e. <300 traffic movements / day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential parking with frequent change (e.g. hospitals, retail); all roads except low traffic roads and trunk roads / motorways¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites); sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways¹	High	0.8 ²	0.8 ²	0.9 ²
Notes: 1. Motorways and trunk roads should follow the guidance and risk assessment process set out in Highways Agency (2009) 2. These should only be used if considered appropriate as part of a detailed risk assessment – required for all these land use types (see also The SuDS Manual Table 4.3). When dealing with high hazard sites, the environmental regulator should first be consulted for pre-permitting advice. This will help to determine the most appropriate treatment approach to the development of a design solution. Also consider spill protection – contact Hydro International to find out more about our specialist treatment and containment options for high pollution hazard sites. Where a site land use falls outside of these categories, the indices should be adapted (and agreed with the drainage approving / adopting body) or else a more detailed risk assessment should be carried out. Equivalent indices should be developed for other contaminants of interest of any given site. For assistance with development of indices or detailed site analysis, contact Hydro International.				

Step 2: Determine SuDS Pollution Mitigation Indices

To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index (for that contaminant type):

$$\text{Total SuDS Mitigation Index (for each contaminant)} \geq \text{Pollution hazard index (for each contaminant)}$$

If the mitigation index of an individual component is insufficient, two components (or more) in series will be required, with a factor of 0.5 used to account for the reduced performance of secondary or tertiary components, in line with the following equation:

$$\text{Total SuDS Mitigation Index} = \text{Mitigation Index}_1 + 0.5 (\text{Mitigation Index}_2)$$

Where *Mitigation Index_n* = *Mitigation Index for Component n*.

If the only runoff destination is to surface water (i.e. there is no infiltration from the SuDS to groundwater), the surface water mitigation indices should be used.

Where the principal destination of the runoff is to groundwater, then the groundwater indices should be used. This will be the case, even for infiltration systems that are designed to discharge to surface waters once the infiltration capacity is exceeded – In this scenario, the overflow will often not need to be treated prior to discharge to surface waters as the risk will be low (highly contaminated flows will have been treated prior to infiltration) and dilution will be high.

In England and Wales, if the principal runoff destination is intended to be to surface water, but some infiltration (even in small amounts) may occur through unlined components, then the groundwater indices should be used for the proportion of runoff that discharges to groundwater and the surface water indices used for the proportion of runoff that discharges to surface waters. In Scotland & Northern Ireland, groundwater risk management is not a requirement for this scenario.

Table 2: SuDS mitigation indices for discharges to surface waters (Source: Extended and reproduced from The SuDS Manual Table 26.3)

Type of SuDS Component	Mitigation Indices ¹		
	TSS	Metals	Liquid Hydrocarbons
Filter Strip	0.4	0.4	0.5
Filter Drain	0.4 ²	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention System	0.8	0.8	0.8
Permeable Pavement	0.7	0.6	0.7
Detention Basin	0.5	0.5	0.6
Pond ^{3,4}	0.7 ³	0.7	0.5
Wetland ⁴	0.8 ³	0.8	0.8
First Defense® Vortex Separator	0.5 ^a	0.33 ^c	0.4 ^d
Downstream Defender® Advanced Vortex Separator	0.5 ^a	0.4 ^c	0.8 ^a
Up-Flo™ Filter	0.8 ^a	0.69 ^{c, e}	0.4 ^d
Hydro-Biofilter™ Bioretention System	0.8 ^b	0.8 ^b	0.8 ^d

Notes:

- 1) SuDS components only deliver these indices if they are designed and constructed for both hydraulics and treatment in accordance with the relevant technical chapters of the SuDS Manual (C753) and the Guidance on Construction of SuDS (C768). Designers and installers of SuDS components should be able to demonstrate competence in their respective areas.
- 2) Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.
- 3) Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment (TSS) should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.
- 4) Where a wetland is not specifically designed to provide significantly enhanced treatment performance, it should be considered as having the same mitigation indices as a pond.
- 5) Performance basis for Hydro StormTrain® Series of Proprietary Treatment Devices:
 - a) Derived from 3rd party testing and / or verification programmes. Test reports available on request.
 - b) Derived from testing and / or monitoring. Test reports available on request.
 - c) Derived from partitioning of sediment bound and dissolved contaminants and associated testing. Evidence available on request.
 - d) Based on typical values for components of this type.
 - e) Dependant on filter media used.
- 6) SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. SEPA's Regulatory Method 08 (WAT-RM-08) provides further information on the regulation of surface water discharges from built developments in Scotland.

Table 3: SuDS mitigation indices for discharges to groundwater (Source: Extended and reproduced from The SuDS Manual Table 26.4)

Characteristics of the material overlying the proposed infiltration surface, through which the runoff percolates ¹	Mitigation Indices		
	TSS	Metals	Liquid Hydrocarbons
A layer of dense vegetation underlain by soil with good contaminant attenuation potential ² of at least 300mm in depth ³	0.6 ⁴	0.5	0.6
A soil with good contaminant attenuation potential ² of at least 300mm in depth ³	0.4 ⁴	0.3	0.3
Infiltration trench (where a suitable depth of filtration material is included that provides treatment) underlain by soil with good contaminant attenuation potential ² of at least 300mm in depth ³	0.4 ⁴	0.4	0.4
Constructed permeable pavement (where a suitable filtration layer is included that provides treatment and including a geotextile at the base separating the foundation from the subgrade) underlain by soil with good contaminant attenuation potential ² of at least 300mm in depth ³	0.7 ⁴	0.6	0.7
Bioretention underlain by soil with good contaminant attenuation potential ² of at least 300mm in depth ³	0.8 ⁴	0.8	0.8
Flow through Proprietary Treatment System prior to infiltration SuDS	TSS	Metals	Liquid Hydrocarbons
First Defense® Vortex Separator	0.5 ^a	0.33 ^c	0.4 ^d
Downstream Defender® Advanced Vortex Separator	0.5 ^a	0.4 ^c	0.8 ^a
Up-Flo™ Filter	0.8 ^a	0.69 ^{c,e}	0.4 ^d
Hydro-Biofilter™ Bioretention System	0.8 ^b	0.8 ^b	0.8 ^d

Notes:

SuDS components only deliver these indices if they are designed and constructed in accordance with the relevant technical chapters of the SuDS Manual (C753) and the Guidance on Construction of SuDS (C768). Designers and installers of SuDS components should be able to demonstrate competence in their respective areas.

- 1) All designs must include a minimum of 1m unsaturated depth of aquifer material between the infiltration surface and the maximum likely groundwater level (as required by infiltration design – see The SuDS Manual Chapter 25).
- 2) For example as recommended in Sniffer (2008a and 2008b), Scott Wilson (2010) or other appropriate guidance.
- 3) Alternative depths may be considered where it can be demonstrated that the combination of the proposed depth and soil characteristics will provide equivalent protection to the underlying groundwater – see note 1.
- 4) If significant amounts of sediment are allowed to enter an infiltration system, there will be a high risk of rapid clogging and subsequent system failure. It is recommended to remove sediment prior to the infiltration system as far as reasonably practical.
- 5) Performance basis for the Hydro StormTrain® Series of Proprietary Treatment Devices:
 - a) Derived from 3rd party testing and / or verification programmes. Test reports available on request.
 - b) Derived from testing and / or monitoring. Test reports available on request.
 - c) Derived from partitioning of sediment bound and dissolved contaminants and associated testing. Evidence available on request.
 - d) Based on typical values for components of this type.
 - e) Dependant on filter media used.
- 6) SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. SEPA's Regulatory Method 08 (WAT-RM-08) provides further information on the regulation of surface water discharges from built developments in Scotland.

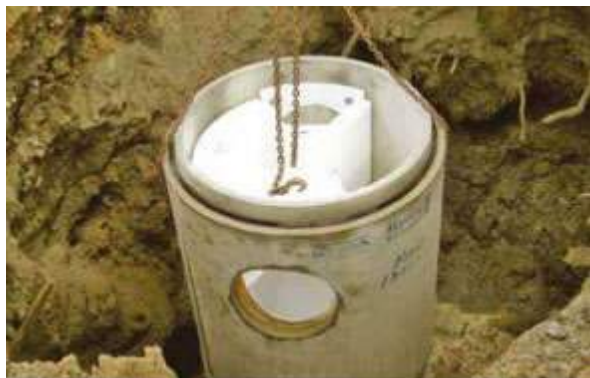
IMPORTANT NOTES:

- Where the indices are not considered representative by the designer, a more detailed risk assessment can be undertaken.
- Components should always be designed for treatment, as described in the relevant technical guidance set out in the individual component chapters of The SuDS Manual. **If they are incorrectly designed, constructed or inadequately maintained, their treatment performance could be significantly adversely affected.**
- Where the infiltration component itself does not provide sufficient pollution mitigation, the design should include upstream SuDS components that are lined to prevent infiltration from occurring until sufficient treatment has taken place.

Step 3: Consider the need for a precautionary approach where discharges are to protected waters

Reference should be made to local standards, planning requirements and guidance, particularly with reference to discharges to protected waters where more detailed risk assessments or enhanced treatment may be required.

Case Studies:



Small is Beautiful

A First Defense® provided a much-needed small footprint solution to meeting regulatory requirements on a confined site for a new commercial office development in Perkins Township, Ohio.

TSS was the main pollutant of concern and although the Simple Index Approach was not in use in Ohio at the time of installation, retrospectively considering this approach would give:

TSS Hazard Index (Office Development) = 0.5
First Defense® TSS Mitigation Index = 0.5

Mitigation Index $\geq$ Hazard Index



Pollution Protection in Whisky Country

Poor drainage, flooding and freezing weather led to a landslip and extreme surface degradation along a section of the narrow A95 near Elgin. Although it pre-dated the new SuDS Manual risk based approach, treatment was vital as the surface water runoff destination was to an area world-renowned for the production of single malt whiskey and an important salmon fishery.

A Downstream Defender® advanced hydrodynamic vortex separator minimises the risk of sediment and hydrocarbon pollution reaching the sensitive watercourse.

Downstream Defender® Mitigation Indices:
TSS = 0.5
Heavy Metals = 0.4
Liquid Hydrocarbons = 0.8



Fine Filtration enables Mixed-Use Development

Environment Agency planning conditions for a new commercial access road to retail and light commercial units as part of a mixed-use development in Faversham, Kent, required treatment prior to infiltration.

A bypass separator provides important spill protection for liquid hydrocarbons, prior to an Up-Flo™ Filter that ensures fine filtration of sediments and associated contaminants, such as Polycyclic Aromatic Hydrocarbons (PAHs). Although the installation pre-dates the Simple Index Approach, retrospective consideration of the approach gives:

Contaminant	TSS	Metals	PAHs
Hazard Indices	0.7	0.6	0.7
Up-Flo™ Filter Mitigation Indices	0.8	0.69	0.72



Stringent Quality Control, Naturally

Hydro Biofilter™ have brought attractive landscaping and stringent surface water quality control to a sensitive location in Barry, South Wales.

3 units were retrofitted to the Business Support Centre car park as part of a wide urban regeneration scheme, effectively removing pollutants prior to discharge into the adjacent, rejuvenated harbourside.

Contaminant	TSS	Metals	Hydro-carbons
Hazard Indices	0.7	0.6	0.7
Hydro Biofilter™ Mitigation Indices	0.8	0.8	0.8

Simple Index Approach (SIA) Tool

A SIA spreadsheet tool has been developed by HR Wallingford on behalf of the Scottish Environment Protection Agency (SEPA) to support the implementation of the Simple Index Approach. The tool is freely available to download at www.susdrain.org/resources/SuDS_Manual.html.

The spreadsheet tool works through the Simple Index Approach Design Steps:

Step 1: Define pollution hazard indices

		Pollution Hazard Indices			
Runoff Area Land Use Description		Hazard Level	Suspended Solids	Metals	Hydrocarbons
Select land use type from the drop down list (or 'Other' if none applicable): 	Non-residential car parking with frequent change (eg hospitals, retail)	Medium	0.7	0.6	0.7
If the generic land use types in the drop down list above are not applicable, select 'Other' and enter a description of the land use of the runoff area and agreed user defined indices in this row:					
Landuse Pollution Hazard Index		Medium	0.7	0.6	0.7

Step 2: Determine SuDS Pollution Mitigation Indices

				Pollution Mitigation Indices		
SuDS Component Description				Total Suspended Solids	Metals	Hydrocarbons
Select SuDS Component 2 (i.e. the second SuDS component in a series) from the drop down list: Select SuDS Component 3 (i.e. the third SuDS component in a series) from the drop down list:	Pond or wetland	0		0.7	0.7	0.5
	None	0		0	0	0
If the proposed SuDS components are bespoke/proprietary and/or the generic indices above are not considered appropriate, select 'Proprietary treatment system' or 'User defined indices' and enter component descriptions and agreed user defined indices in these rows:						
Downstream Defender		SuDS Component 1	SuDS Component 1	0.5	0.4	0.8
		SuDS Component 2				
		SuDS Component 3				
Aggregated Surface Water Pollution Mitigation Index				0.85	0.75	>0.95

Calculation of Total SuDS Mitigation Indices and Results

				Combined Pollution Mitigation Indices		
				Total Suspended	Metals	Hydrocarbons
Combined Pollution Mitigation Indices for the Runoff Area				0.85	0.75	>0.95
				Sufficiency of Pollution Mitigation Indices		
				Suspended Solids	Metals	Hydrocarbons
				Sufficient	Sufficient	Sufficient

The Hydro StormTrain® Series of Surface Water Treatment Devices

Each Hydro StormTrain® device delivers proven, measurable and repeatable surface water treatment performance. Each can be used independently to meet the specific treatment needs of a site; or can be combined with one another or in conjunction with other SuDS components to form a mangament train; or can be used to protect and enhance SuDS features less suited to providing the first stage of treatment or more prone to failure due to sedimentation or shock loads associated with spills.



First Defense®
Vortex Separator



Downstream Defender®
Advanced Hydrodynamic
Vortex Separator



Up-Flo™ Filter
Fluidised Bed Up Flow
Filtration System



Hydro Biofilter™
Bioretention System

Learn more...

Enquire about our SuDS Treatment Devices and Support Services

Hydro International's design, advisory, inspection & maintenance services can reduce the costs and risks associated with selecting, installing and maintaining SuDS.

Contact the team today:

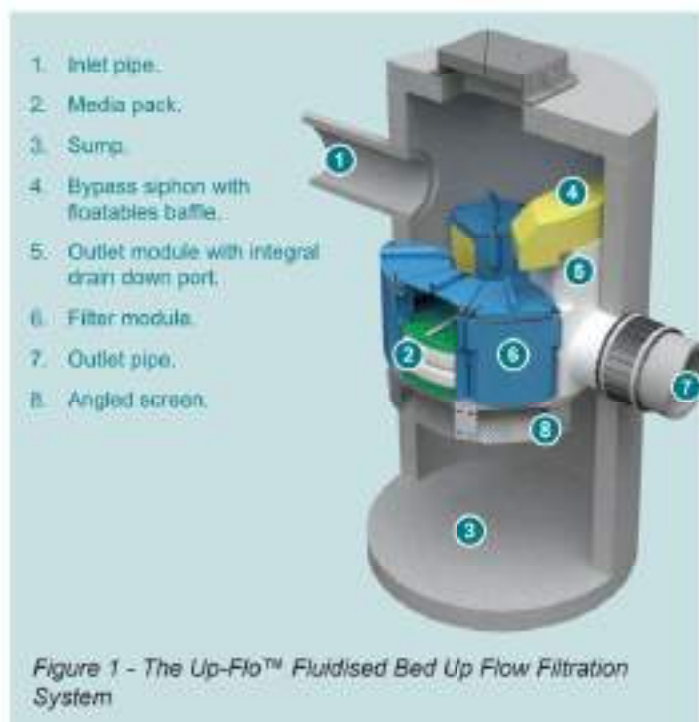
Call: 01275 337977

Email: sudsservices@hydro-int.com

Visit: www.hydro-int.com/sudsservices

Hydro International is a global leader in sustainable technologies for the control and treatment of stormwater and wastewater. For more than 30 years, Hydro has been at the forefront of water industry innovation and product development. From housing developments and municipal sewage works to paper mills and public highways, thousands of Hydro products are operating in countries all over the world. With strong bases in both the United States and the United Kingdom, and a network of partners and agents, Hydro is strategically placed to deliver winning technological solutions to customers wherever they are in the world.

The Up-Flo™ Filter is an innovative surface water filtration technology that delivers a high performance multi-stage treatment train within a single device. The Up-Flo™ Filter combines sedimentation and screening with fluidised bed filtration technology to deliver high levels of performance.



Components and Filter Media

The Up-Flo™ Filter packs a 4-5 stage treatment train into a single device that can be fitted into a standard manhole. Settleable solids are collected in the chamber sump, whilst floatable material gathers in the central chamber.

An angled 4 mm perforated screen prevents coarse material from reaching the filter media. The media itself can be tailored to target specific pollutant groups and, where required, promote reactive filtration. The fluidised bed technology prevents blinding, clogging and compaction of the media surface, whilst ensuring that no wormholes can form to short-circuit the treatment process.

Filter media options include:

Filter Sand:
A good all-round media to target sediment and sediment-bound pollutants.



CPZ™ Mix:
An engineered media to promote reactive filtration for enhanced treatment of metals, nutrients and organics.



Watch a short video showing the Up-Flo™ Filter operation at:

<http://www.hydro-int.com/uk/products/flo-filter>

Repeatable, Reliable Performance

The Up-Flo™ Filter combines multiple sequential treatment processes to deliver sedimentation, screening and filtration all in one compact unit to remove a wide variety of pollutants including:

Very Fine Particles



Greater than 80% removal of fine sand and silt particles to a mass-median particle size of 22 µm.

See Technical Abstract: Performance Verification of Sediment Removal with Sil-Co-Sil 106 for your media of choice.

Gross Pollutants



Inclusion of the angled screen and protected bypass syphon effectively removes gross pollutants, including litter and leaf debris.

Liquid and Sediment Bound Hydrocarbons



Removal of various forms of hydrocarbons, including polycyclic aromatic hydrocarbons (PAHs).

Heavy Metals



Greater than 70% removal of metals commonly found in surface water runoff.

See Technical Abstract: Field Evaluation of Metals Removal.

Nutrients



Greater than 70% removal of phosphorus and other nutrients.

See Technical Abstract: Field Evaluation of Phosphorus Removal.

Design Data

Up-Flo™ Filter

Fluidised Bed Up Flow Filtration System

Sizing

The modular design of the Up-Flo™ Filter ensures that project specific treatment goals are easily met. Intended for intercepting pollutants at or close to source, the modular components are standardised for installation into a standard 1.2 m diameter manhole. For larger catchment areas, custom built vaults can be created to accommodate additional filter modules.

For design purposes, the selected number of modules required should be such that the total Treatment Flow Rate is greater or equal to the site's Water Quality Flow Rate.

The hydraulic capacity of the system should be considered with respect to the peak discharge flow rate from the site or pipe full flow rate.

Model	Chamber Size (m)	Number of Filter Modules	Treatment Flow Rate (l/s) ^{a)}	Hydraulic Capacity (l/s) ^{b)}	Operating Head (mm) ^{c)}	Oil Storage Capacity (l)	Sediment Storage Capacity (m³)
Manhole	1.2 m diameter	1-6	1.3 - 7.8	170	750	190	0.7
Vault	Site specific	7-19	7.8 - 24.7	170	750	Site specific	Site specific

Notes:

- a) Treatment flow rates based on >80% removal of Sil-Co-Sil 106 fine sand and silt ($D_{50} = 22 \mu\text{m}$).
- b) Maximum flow rate that can pass through the chamber without surcharge to the upstream network.
- c) Driving head for filter media.

Table 1 - Up-Flo™ Filter design information.



Expert Design Service

Hydro's professional engineers are on hand to provide free support with the correct sizing and application of the Up-Flo™ Filter within in each drainage design.

We can also provide estimated maintenance intervals, whole life cost estimates and predicted pollutant removal performance.

Call the StormTrain® Hotline on: 01275 337955 or email stormtrain@hydro-int.com

Design Data

Up-Flo™ Filter

Fluidised Bed Up Flow Filtration System

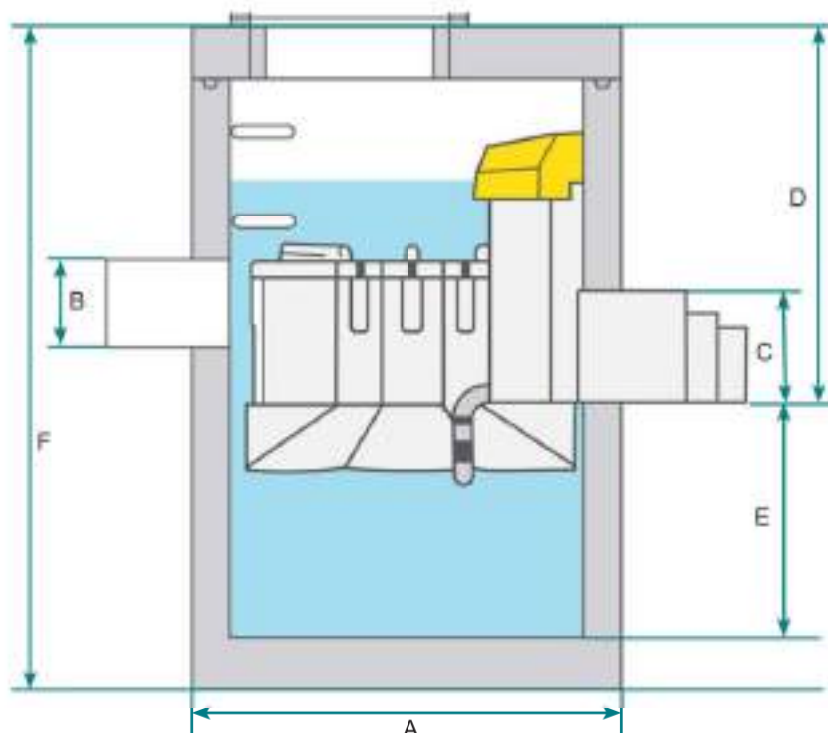
Easy Installation for Trouble-free Construction

The Up-Flo™ Filter is typically delivered to site as a pre-cast concrete manhole, complete with innovative manhole sealing system and internal components already installed. Installation is therefore similar to any other manhole installation on site.

The relative position of the filter modules and the inlet / outlet pipes can be adjusted to suit site conditions.

The outlet adapter allows a variety of different outlet pipe sizes to be easily connected (see Table 2).

Full installation guidelines are available.



Dimensions and Weights

The dimensions in Table 2 are given as a guide for standard manhole configurations. Vault configurations are site specific.

Detailed general arrangement drawings are available for download from <http://www.hydro-int.com/uk/products/flo-filter>

Unit	External Diameter of Unit (mm) (A)	Inlet Pipe Diameter (mm) ^{c)} (B)	Outlet Pipe Diameter (mm) ^{c)} (C)	Depth (m)			Lift Weight (t)
				Depth to Outlet Invert (m BGL) (D)	Sump Depth (m) (E)	Component Depth ^{a)} (m) (F)	
1.2 m Sealed Manhole System with HD Cover Slab	1460	300	225-375	1.150	1.100	2.560	n/a
HD Cover Slab ^{b)}						0.230	0.60
Base Section						1.145	1.85
Top Section						1.330	1.60

Notes:

- a) Base and Top Section component depths are shown as the total height during transportation / before assembly on site. The total depth is the depth of the assembled unit.
- b) Cover slabs are heavy duty, suited for highways loading and are supplied with one or two access openings for maintenance.
- c) Stub pipes are provided.

Table 2 - Up-Flo™ Filter dimensions and weights.

Design Data

Up-Flo™ Filter

Fluidised Bed Up Flow Filtration System

Simple and Cost-effective Maintenance

The gentle and effective action of the Up-Flo™ Filter ensures the filtration media have a much longer life than comparable media filters, so maintenance is infrequent, cost-effective and simple, with just three easy steps:

- 1) Floatable debris and litter is skimmed from the water surface.
- 2) Sediment collected in the sump is removed with a standard vacuum tanker.
- 3) Filter media packs are exchanged with no specialist lifting or handling equipment required.

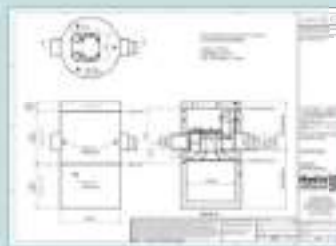
Up-Flo™ Filter Technical Guidance



Case Studies



Installation and
Maintenance Guidelines



General Arrangement Drawings

The Hydro StormTrain® Series of Surface Water Treatment Devices

The Up-Flo™ Filter is one of the Hydro StormTrain® Series of surface water treatment devices. Each device delivers proven, measureable and repeatable surface water treatment performance. Each can be used independently to meet the specific needs of a site or combined to form a management train. They can be used alongside natural SuDS features to protect, enable or enhance them.



First Defense®
Vortex Separator



Downstream Defender®
Advanced Hydrodynamic
Vortex Separator

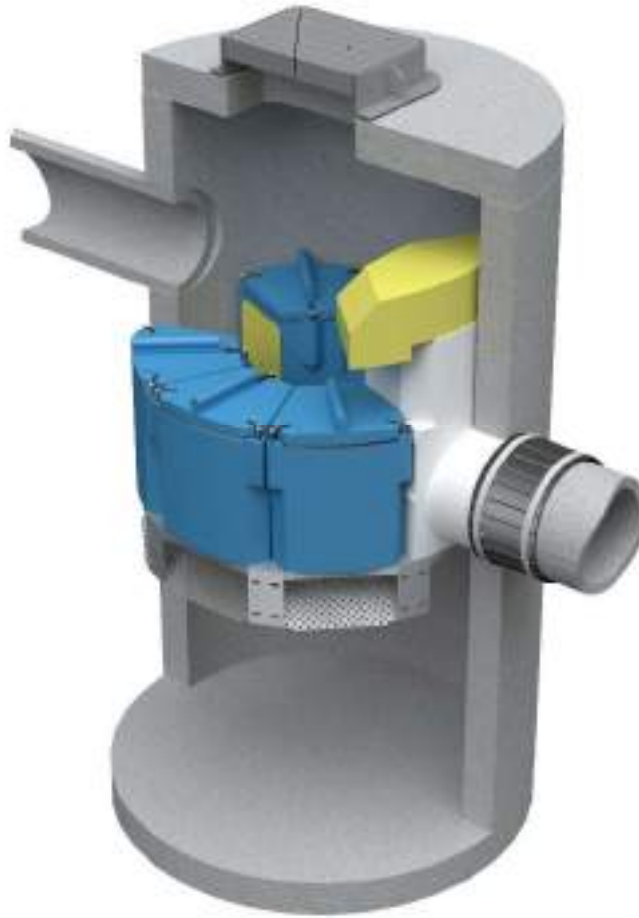


Up-Flo™ Filter
Fluidised Bed Up Flow
Filtration System



Hydro Biofilter™
Biofiltration System

Patent: www.hydro-int.com/patents



Up-Flo™ Filter

Operation & Maintenance Manual

Site Name:

Location on Site:

Hydro International Ref No:

COPYRIGHT STATEMENT: The contents of this manual, including the drawings and specifications contained herein or annexed hereto, are intended for the use of the recipient to whom the document and all associated information are directed. Hydro International owns the copyright of this document (including any drawings or graphics), which is supplied in confidence. It must not be used for any purpose other than that for which it is supplied and must not be reproduced, in whole or in part stored in a retrieval system or transmitted in any form or by any means without prior permission in writing from Hydro International. Up-Flo™ Filter is a trademarked advanced Stormwater treatment solution of Hydro International. A patent covering the Up-Flo™ Filter has been granted.

DISCLAIMER: Information and data contained in this manual is exclusively for the purpose of assisting in the operation and maintenance of Hydro International's Up-Flo™ Filter. No warranty is given nor can liability be accepted for use of this information for any other purpose. Hydro International have a policy of continuous product development and reserve the right to amend specifications without notice.

Up-Flo™ Filter Operation & Maintenance Manual

Table of Contents

Your Up-Flo™ Filter	5
How it Works	6
Benefits of the Up-Flo™ Filter	7
Exceptional treatment on any catchment	7
Two-stage treatment in a single unit	7
Save site space	7
Cut maintenance	7
Applications	7
Make it Smart.....	8
Get Monitoring Alerts from your Up-Flo™ Filter	8
Maintenance Services	8
Operation	9
Introduction	9
Pollutant Capture.....	9
Reduced Clogging.....	9
Overflow Protection	9
Maintenance	10
Overview	10
Determining Your Maintenance Schedule.....	11
Service - Inspection	12
Scheduling	12
Recommended Equipment	12
Up-Flo™ Filter Capacities.....	12
Inspection Guidance Procedures	13
Service – Oil, Floatables and Sump Cleanout.....	14
Scheduling	14
Recommended Equipment	14
Oil, Floatables and Sediment Clean Out Guidance Procedures.....	14
Service – Replacement of Media Packs and Drain Down Filter	15
Recommended Equipment	15
Maintenance at a Glance	16
Up-Flo™ Filter Installation Log.....	17
Up-Flo™ Filter Installation Location Record	18
Up-Flo™ Filter Inspection and Maintenance Log.....	20
Up-Flo™ Filter Inspection and Maintenance Log.....	21
Up-Flo™ Filter Inspection and Maintenance Log.....	22

Up-Flo™ Filter Inspection and Maintenance Log.....	23
Typical General Arrangement Drawing	24
Contact	25

Your Up-Flo™ Filter

Your Up-Flo™ Filter is an advanced stormwater treatment solution that combines sedimentation and screening with fluidised bed filtration to deliver exceptional surface water pollution removal.

Its innovative design delivers high efficiency across a wide range of flows in a much smaller footprint than conventional or other swirl-type devices and is the perfect choice for your site. Your Up-Flo™ Filter will remove and retain pollutants including:

Targeted Pollutants



Very fine particles



Liquid and sediment bound heavy metals



Gross pollutants



Liquid and sediment bound nutrients



Liquid and sediment bound hydrocarbons

How it Works

The Up-Flo™ Filter is a modular high-rate Stormwater filtration device. As shown below, it is installed into a 1200 mm diameter catch basin structure. Each Filter Module has a screen and support bracket that is attached to the concrete manhole and each contains a Media Pack that includes flow distribution and filtration media. Modules can attach to each other to form a “ring” of up to six modules. Up to two of the modules are attached to an Outlet Module that has a Bypass Hood and filtered Drain Down. The modular design can be supplied in different configurations depending on the application.

An upward flow path through the Filter Modules allows stormwater to be screened and filtered. In addition to the screening and filtering processes, gross pollutants will also settle into the sump or float to the surface of the water held within the manhole. The standard units are designed with a 900 mm sump to allow for sediment and gross pollutant accumulations between maintenance intervals.

This manual describes the operation of the Up-Flo™ Filter and provides general maintenance requirements that will ensure the filter will continue to operate and perform as intended. In general, a minimum of two inspections are required the first year to monitor sediment and gross pollutant accumulations in the manhole structure and inspect the Filter Media Pack and Drain Down Filter. The frequency of the maintenance interval is site specific as it will depend on the rate of pollutant accumulations. The first year of inspections and monitoring pollutant accumulations will determine future maintenance intervals.

- 1) Inlet pipe.
- 2) Media pack.
- 3) Sump.
- 4) Bypass siphon with floatables baffle.
- 5) Outlet module with integral drain down port.
- 6) Filter module.
- 7) Outlet pipe.
- 8) Angled screen.

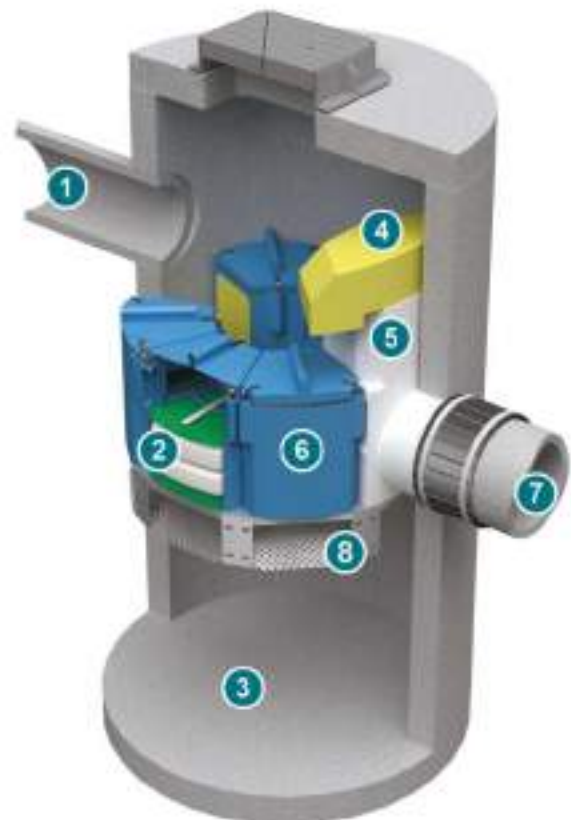


Figure 1 – the Up-Flo™ fluidised bed up flow filtration system – manhole configuration.

Benefits of the Up-Flo™ Filter

Exceptional treatment on any catchment

The Up-Flo™ Filter's modular filtration components allow you to adapt your design to meet the needs of any catchment area, capturing the specific levels of trash, silt and sediment, oils, metals and nutrients required.

Two-stage treatment in a single unit

The Up-Flo™ Filter combines pre-treatment, screening and filtration, delivering highly efficient multi-stage treatment in one device.

Save site space

The Up-Flo™ Filter's higher loading rates result in a smaller treatment footprint, which saves construction time and money, and makes for an easier installation.

Cut maintenance

No moving parts means that there's less opportunity for treatment disruption or breakage, while the system design is suited to long-term maintenance. Longer media life means longer service intervals, and media bags are easily removed and replaced while media cartridge modules stay put during maintenance.

Applications

The Up-Flo™ Filter is especially useful in high-density urban environments, where high pollutant loadings need to be managed in limited space or where it is difficult to control the quality of surface water runoff using conventional or natural SuDS techniques alone.

The Up-Flo™ Filter is perfectly suited to industrial sites, locations contributing runoff to wetlands/protected regions, or any area requiring a high level of treatment.

The Up-Flo™ Filter provides an effective solution in both newbuild or retrofit situations for residential, commercial or industrial developments, highways or car parks.

Make it Smart

Get Monitoring Alerts from your Up-Flo™ Filter

Your Up-Flo™ Filter will need regular inspection and maintenance to change the media packs, remove floatable debris, sediment and screenings from the sump.

Save time and money by only visiting your Up-Flo™ Filter when it actually needs emptying - add Smart Monitoring and receive automated alerts for maintenance.



Make it Smart

Add Hydro-Logic® Smart Monitoring and your Up-Flo™ Filter will let you know when it needs maintenance.



Maintenance Services

Hydro International offer service contracts to inspect, replace media packs and empty your Up-Flo™ Filter. Contracts can be tailored to your requirements.

To find out more about Smart Monitoring or our maintenance services, please call us on **+44 (0)1275 878371** or email **sudsservices@hydro-int.com**

Operation

Introduction

The Up-Flo™ Filter operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirements and is fabricated with durable noncorrosive components. Personnel is not required to operate the unit and maintenance is limited to periodic inspections, sediment and floatables removal, Media Pack replacement and Drain Down Filter replacement.

Pollutant Capture

The Up-Flo™ Filter is designed to operate as a “treatment train” by incorporating multiple treatment technologies into a single device. Trash and gross debris are removed by sedimentation and screening before they are introduced to the filtration media, preventing surface blinding of the filter media. The Up-Flo™ Filter is a wet-sump device. Between storm events, oil and floatables are stored on the water surface separate from the sediment storage volume in the sump (see Figure 1). The high-capacity bypass siphon acts as a floatables baffle to prevent washout of captured floatable pollutants during high-intensity events.

Reduced Clogging

The Up-Flo™ Filter has been designed to minimise the occurrence of clogging and blinding. The Up-Flo™ Filter employs a unique Drain Down design that allows the water level in the chamber to drop below the filter media between events. The Drain Down mechanism creates a reverse flow that flushes captured pollutants off the surface of the filter bag, helping to prevent blinding. By allowing the water to drain out, the drain-down mechanism also reduces the weight of the filter bags. This makes the bags easier and safer to remove during maintenance operations.

Overflow Protection

The Angled Screens are designed to prevent ragging and blinding. The Angled Screens are situated below the Filter Modules, sheltering them from the direct path of the influent. Coarse debris settles in the sump before the runoff flows up through the screens, protecting them from blinding. In the unlikely event of a blockage, the high capacity Siphonic Bypass is designed to convey high enough flow that large storm events will not create upstream flooding.

Maintenance

Overview

The Up-Flo™ Filter protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the proper functioning of the Up-Flo™ Filter. The Up-Flo™ Filter design allows for easy and safe inspection, monitoring and clean-out procedures. It has a wide central opening between the Filter Modules for easy and comfortable access to all of the components (See Figure 1).

Completion of all the maintenance activities for a typical manhole Up-Flo™ Filter takes less than one hour. Maintenance activities include inspection, floatables removal, oil removal, sediment removal, Media Pack replacement, and Drain Down Filter replacement.

Maintenance intervals are determined from monitoring the Up-Flo™ Filter during its first year of operation. Depending on the site, some maintenance activities may have to be performed on a more frequent basis than others. In the case of inspection and floatables removal, a Jet Vac truck is not required. Otherwise, a Jet Vac truck is normally required for oil removal, removal of sediment from the sump, and replacement of the Media Packs and Drain Down Filter. In most cases, entry into the Up-Flo™ Filter vessel is required for replacement of the Media Packs and Drain Down Filter, and Confined Space Entry procedures will have to be followed. Media Packs should not be installed in the modules until construction activities are complete and site stabilisation is effective.

We can provide full inspection and maintenance services for your Up-Flo™ Filter providing peace of mind and saving you time and money.



You can also make your Up-Flo™ 'Smart' by adding a Smart Monitoring Hydro-Logic® Flexi Logger to provide monitoring and alerts when maintenance is required.

To find out more about Smart Monitoring or our maintenance services, please call us on
+44 (0)1275 878371 or email
sudsservices@hydro-int.com

Determining Your Maintenance Schedule

Hydro International recommends that inspections be performed at least every six months during the first year of operation. Use the following guidelines for determining maintenance intervals:

- **Floatables and Oil Monitoring:** The water surface in the Up-Flo™ Filter should be monitored for accumulation of floatables and oil. Floatables should not be allowed to accumulate to the point where they completely cover the surface of the water. Oil should not be allowed to accumulate to the point where it has formed a measurable thickness on the surface of the water. The rate of floatables and oil accumulation can be estimated by dividing the surface area covered by floatables and/or oil by the number of months since the Up-Flo™ Filter was installed.
- **Sediment Monitoring:** A simple probe, such as the Sludge-Judge®, should be used to determine the depth of sediment in the sump. The maximum allowable sediment depth in a typical 1200 mm diameter manhole equipped with an Up-Flo™ Filter is 400 mm. In any case, sediment must be removed before it blocks the inlet to the Drain Down Filter. The rate of sediment accumulation can be estimated by dividing the measured depth of sediment by the number of months since the Up-Flo™ Filter was installed.
- **Media Pack Monitoring:** Filter bags should be weighed to determine the amount of particles that have been captured in the bags. Filter bags from one or two modules should be weighed. Spent filter bags weigh approximately 24 kgs wet. The rate of filter bag clogging can be estimated by subtracting the wet weight of a new bag (approximately 17 kg for filter sand and 14 kg for CPZ) from the measured wet weight of the bags being checked and dividing by the number of months since the bags were installed.
- **Drain Down Filter Monitoring:** The water level in the Up-Flo™ Filter should be monitored to ensure that the Drain Down Filter is operating properly. One to two days after a significant rainfall, the water level inside the vessel should have dropped to a point where it is equal with the base of the Filter Modules. If the water level has not reached that point, then the Drain Down Filter has either become clogged or blinded by trash or debris. If there is no evidence of trash or debris around the Drain Down Filter inlet, then it has likely become clogged with particles. The rate of Drain Down Filter clogging can be estimated by noting the number of months since the Up-Flo™ Filter was installed.

Hydro International recommends a maximum maintenance interval of one year for all maintenance activities but, based on the first-year monitoring, a shorter maintenance interval for some maintenance activities may be appropriate.

Service - Inspection

Inspection is a simple process that requires monitoring pollutant accumulations. Maintenance crews should be familiar with the Up-Flo™ Filter and its components prior to inspection.

Scheduling

- Inspection may be conducted during any season of the year but should occur shortly after a predicted rainfall to ensure components are operating properly.

Recommended Equipment

- Safety Equipment and Personal Protective Equipment (traffic cones, work gloves, etc.)
- Scale to measure the weight of the filter bags
- Tools to remove grate or lid
- Pole with skimmer or net
- Sediment probe (such as a Sludge Judge®)
- Hydro International Up-Flo™ Filter Maintenance Log
- Trash bags for removed floatables

Up-Flo™ Filter Capacities

Model	Chamber Size (m)	Number of Filter Modules	Treatment Flow Rate (l/s) ^{a)}	Hydraulic Capacity (l/s) ^{b)}	Operating Head (mm) ^{c)}	Oil Storage Capacity (l)	Sediment Storage Capacity (m ³)
Manhole	1.2m Diameter	1-6	1.3-7.8	170	750	190	0.7

Table 1. Up-Flo Filter Design Information

- a) Treatment flow rates based on >80% removal of Sil-Co-Sil 106 fine sand and silt ($D_{50} = 22\mu\text{m}$)
- b) Maximum flow rate that can pass through the chamber without surcharge to the upstream network
- c) Driving head for filter media

Inspection Guidance Procedures

1. Set up any necessary safety equipment (such as traffic cones) to provide access to the Up-Flo™ Filter. Safety equipment should notify passing pedestrian and road traffic that work is being done.
2. Remove the grate or lid to the manhole or vault.
3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities. Such as water level higher than the filter modules or open filter module lids
4. Without entering the vessel, use the pole with the skimmer net to remove floatables and loose debris from the chamber.
5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel. Maximum sediment depth is 400 mm.
6. Remove the Filter Module lid by turning the cam latch and remove the Filter Media Pack. Weigh the filter bags from one or two modules. Filter bags should be replaced if the wet weight exceeds 24kgs.
7. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components or a high standing water level.
8. Securely replace the grate or lid.
9. Remove safety equipment.
10. Notify us of any irregularities noted during inspection by calling us on +44 (0)1275 878371 or emailing us at sudsservices@hydro-int.com.

Service – Oil, Floatables and Sump Cleanout

A Jet Vac truck is used to remove captured sediment, oil and floatables.

Floatables and loose debris can also be netted with a skimmer and pole. The access port located at the top of the manhole provides unobstructed access for a Jet Vac truck hose and skimmer pole to be lowered to the base of the sump.

Scheduling

- Floatables and sump cleanout may typically be done during any season of the year - before and after rainy season.
- Floatables and sump cleanout should occur as soon as possible following a contaminated spill in the contributing drainage area

Recommended Equipment

- Safety Equipment (traffic cones, etc).
- Tools to remove grate or lid.
- Pole with skimmer or net (if only floatables are being removed).
- Sediment probe (such as a Sludge Judge®).
- Jet Vac truck (flexible hose preferred).
- Pressure nozzle attachment or other screen-cleaning device.
- Hydro International Up-Flo™ Filter Maintenance Log.

Oil, Floatables and Sediment Clean Out Guidance Procedures

1. Set up any necessary safety equipment (such as traffic cones) around the access of the Up-Flo™ Filter. Safety equipment should notify passing pedestrian and road traffic that work is being done.
2. Remove the grate or lid to the manhole or vault.
3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.
4. If the standing water level in the sump is above the base of the Filter Modules tug the Pull Chain(s) to release the Drain Down Plug(s). Allow the excess water to drain out of the chamber.
5. Use the skimmer pole to fit the Drain Down plug back into the open port.
6. Once all floatables have been removed, drop the Jet Vac truck hose to the base of the sump. Vacuum out the sediment and gross debris from the sump floor.
7. Retract the Jet Vac truck hose from the vessel.
8. Inspect the Angled Screens for blockages and ragging. If present, remove the obstruction or ragged materials from the surface using a hose or other screen-cleaning device.
9. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Note any apparent irregularities such as damaged components or blockages.
10. Securely replace the grate or lid.
11. Remove safety equipment.

12. Notify us of any irregularities noted during inspection by calling us on +44 (0) 1275 878371 or e-mailing us at sudsservices@hydro-int.com.

Service – Replacement of Media Packs and Drain Down Filter

Unless the Up-Flo™ Filter has been installed as a very shallow unit, it is necessary to have a competent person enter the vessel to replace Media Packs.

Scheduling

- Call Hydro International to order replacement Media Packs and Drain Down filter prior to scheduling maintenance.
- Because Media Pack replacement requires entry into the Up-Flo™ chamber, maintenance events should be scheduled during dry weather.
- Media Pack replacement should occur immediately after a contaminated spill in the contributing drainage area.

Recommended Equipment

- Safety Equipment (traffic cones, etc).
- Crowbar to remove grate or lid.
- Pole with skimmer or net (if floatables removal is not to be done with Jet Vac truck hose).
- Sediment probe (such as a Sludge Judge®).
- Jet Vac truck (flexible hose preferred).
- Confined Space Entry Equipment.
- Up-Flo™ Filter Replacement Media Packs (available from Hydro International).
- Hydro International Up-Flo™ Filter Maintenance Log.
- Screwdriver (flat head).
- Replacement Drain Down Filter components supplied by Hydro International.

Media Pack and Drain Down Filter Replacement Guidance Procedures

1. Follow Floatables and Sump Cleanout Procedures, 1 – 10.
2. Following Confined Space Entry procedures, enter the Up-Flo™ Filter Chamber.
3. Open the Filter Module by turning the three cam latches on the front and sides of the module. Remove the lid (1) to gain access to the Media Pack.
4. Remove and discard the spent Media Pack. The Media Pack contents include:
 - A top layer of green (2) Flow-Distributing Media.
 - Two Media Bags (3) equipped with nylon handles.
 - A bottom layer of green (2) Flow-Distributing Media.
5. Insert a new Media Pack, supplied by Hydro International.
 - First, insert a bottom layer of green Flow-Distributing Media. Be sure that the media sits snugly and level at the bottom of the Filter Module.
 - Next, insert the first of two replacement Media Bags. Smooth the bag out with your hands to make sure that the bag extends snugly to the walls and corners of the Filter Module.
 - Insert the second Media Bag, following the same procedure.
 - Insert the top layer of green Flow-Distributing Media. Be sure that the piece fits snugly against the walls and corners of the Filter Module.

- Put the lid on and secure the three latches. Check to make sure that the latches are closed properly.
- 6. Use a screwdriver to unscrew the Drain Down Filter from the face of the Outlet Module. **DO NOT DISCARD THIS PIECE.**
- 7. Install new Drain Down Filter supplied by Hydro International.
- 8. Exit the Up-Flo™ Filter chamber and securely replace the grate or lid.
- 9. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables, oil and gross debris removed, and the depth of sediment measured. Note the number of Media Packs replaced. Note any irregularities such as damaged components or blockages.
- 10. Remove safety equipment.
- 11. Dispose of spent media packs at your local landfill, following local regulations.
- 12. Return the spent Drain Down Filter to Hydro International.
- 13. Notify us of any irregularities noted during inspection by calling us on +44 (0) 1275 878371 or e-mailing us at sudsservices@hydro-int.com.

Maintenance at a Glance

Activity	Frequency
Inspection	- Regularly during first year of installation - Every 6 months after the first year of installation
Oil and Floatables Removal	- Twice per year, or as needed - Following a contaminated spill in the drainage area
Sediment Removal	- Twice per year or as needed - Following a contaminated spill in the drainage area
Media Pack Replacement	- Once per year or as needed - Following a contaminated spill in the drainage area
Drain Down Filter Replacement	- Once per year with Media Pack replacement - As needed, in the event of continuous base flow conditions

Up-Flo™ Filter Installation Log

Hydro International Reference Number			
Site Name			
Site Location			
Owner		Contractor	
Contact Name		Contact Name	
Company Name		Company Name	
Address		Address	
Telephone		Telephone	
Fax		Fax	
Installation Date			
Total Number of Up-Flo™ Filter Modules			

Up-Flo™ Filter Installation Location Record

Site Map	
Site Plan (include vehicle restrictions and lift heights)	

Photo 1

Photo 2

Up-Flo™ Filter Inspection and Maintenance Log

(Master Performance Control Record)

Date	Initials	Area / Depth of Floatables & Oils	Sediment Depth Measured (mm)	Volume of Sediment Removed (m ³)	Number of Media Packs Replaced	Site Activity and Comments

Up-Flo™ Filter Inspection and Maintenance Log

(Master Performance Control Record)

Date	Initials	Area / Depth of Floatables & Oils	Sediment Depth Measured (mm)	Volume of Sediment Removed (m ³)	Number of Media Packs Replaced	Site Activity and Comments

Up-Flo™ Filter Inspection and Maintenance Log

(Master Performance Control Record)

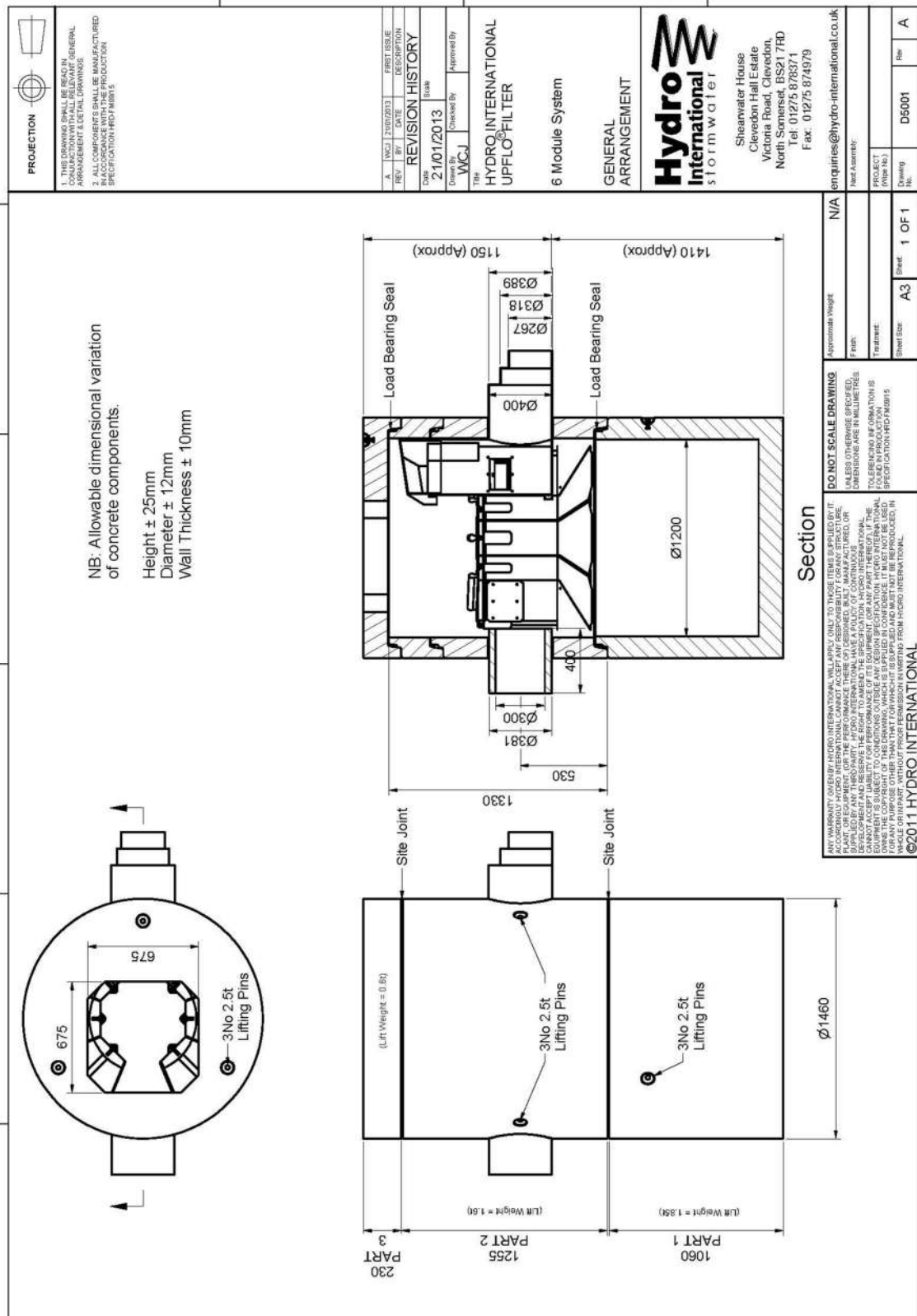
Date	Initials	Area / Depth of Floatables & Oils	Sediment Depth Measured (mm)	Volume of Sediment Removed (m³)	Number of Media Packs Replaced	Site Activity and Comments

Up-Flo™ Filter Inspection and Maintenance Log

(Master Performance Control Record)

Date	Initials	Area / Depth of Floatables & Oils	Sediment Depth Measured (mm)	Volume of Sediment Removed (m ³)	Number of Media Packs Replaced	Site Activity and Comments

Typical General Arrangement Drawing



Contact

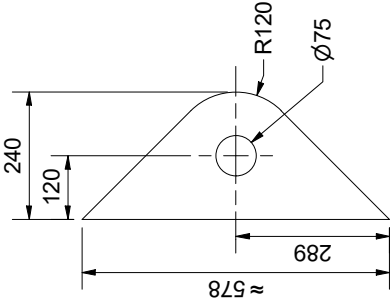
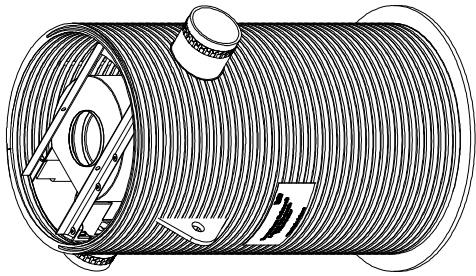
We're committed to excellence in water management, and we want to make sure that you are fully supported throughout your system's lifetime.

If you would like to discuss the operation and maintenance of your Up-Flo™ Filter or would like to learn more about how we can help you to optimise and maintain your sustainable drainage assets to ensure effective, long-term environmental compliance, please contact one of our support specialists:

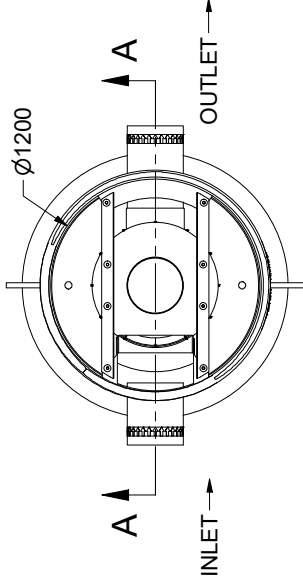
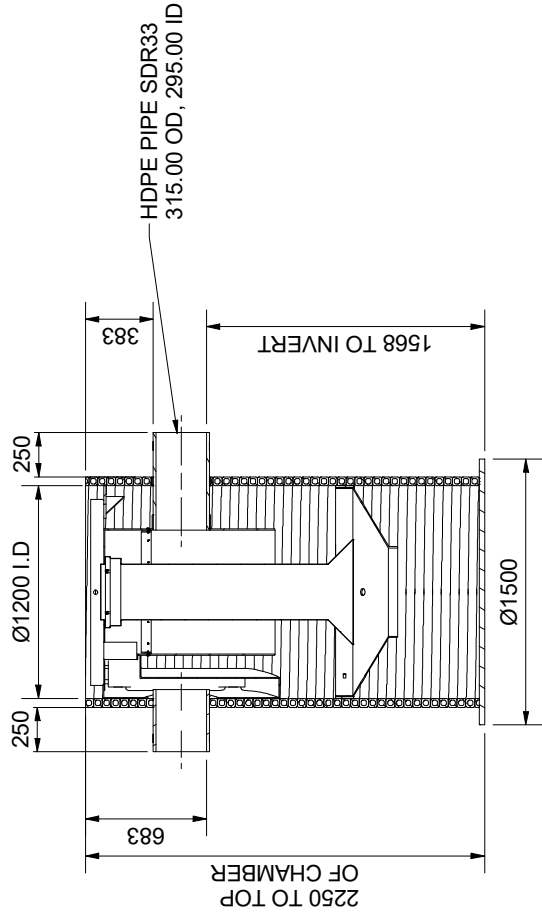
Tel: +44 (0)1275 878371

E-mail: sudsservices@hydro-int.com

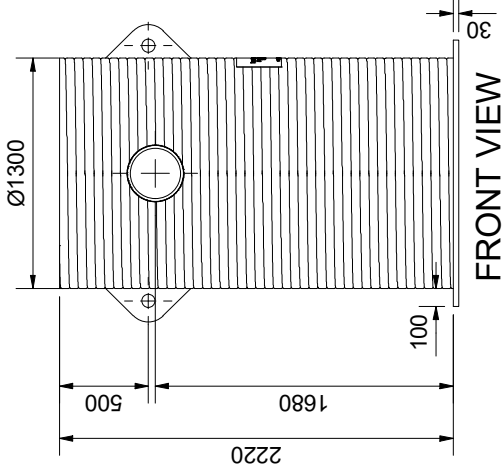
hydro-int.com



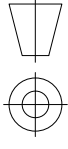
LIFTING LUG DETAIL
30mm THICK
SCALE 1:10



PLAN VIEW



SECTION A-A
SCALE 1:30



PROJECTION

- COMMENTS:
1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL RELEVANT GENERAL ARRANGEMENT & DETAIL DRAWINGS
 2. ALL COMPONENTS SHALL BE MANUFACTURED IN ACCORDANCE WITH PRODUCTION SPECIFICATION FM09.15
 3. ALL COMPONENTS SHALL BE MANUFACTURED FROM HDPE (BLACK PER8) UNLESS SHOWN OTHERWISE
 4. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH DRAWING NUMBER DDT25002-1, 1200
 5. ALL CHAMBER COMPONENTS SHALL BE LEAK TESTED USING EITHER AN AIR OR WATER TEST PROCEDURE

REVISION HISTORY			
REV	BY	DESCRIPTION	DATE
A	CRA	FIRST ISSUE	05 FEB 19

DATE: 15/10/2018
SCALE: 1:30

DRAWN BY: WCJ
CHECKED BY: DGE
APPROVED BY: WCJ

HYDRO INTERNATIONAL
DOWNSTREAM
DEFENDER®

1200 TWIN WALL
4 KN TUBE CHAMBER

GENERAL ARRANGEMENT

Hydro International

Shearwater House
Victoria Road
Cleveland, UK
BS21 7RD
Tel: +44 (0)1275 878371
Fax: +44 (0)1275 874979
hydro-int.com

WEIGHT: N/A	MATERIAL: HDPE
NEXT ASSEMBLY: -PQL 1320, 1025	
DRAWING NO.: TW 1320-1025-01001	
SHEET SIZE: A3	SHEET: 1 OF 1
Rev: A	A

ANY WARRANTY GIVEN BY HYDRO INTERNATIONAL WILL APPLY ONLY TO THOSE ITEMS SUPPLIED BY IT. ACCORDINGLY HYDRO INTERNATIONAL CANNOT ACCEPT ANY RESPONSIBILITY FOR ANY DAMAGE TO OR LOSS OF EQUIPMENT OR PERSONAL INJURY OR PROPERTY DAMAGE CAUSED BY THE EQUIPMENT OR PERSONS USING THE EQUIPMENT. HYDRO INTERNATIONAL HAS A POLICY OF CONTINUOUS DEVELOPMENT AND RESERVE THE RIGHT TO AMEND THE SPECIFICATION. HYDRO INTERNATIONAL CANNOT ACCEPT LIABILITY FOR PERFORMANCE OF ITS EQUIPMENT, (OR ANY PART THEREOF), IF THE EQUIPMENT IS SUBJECT TO CONDITIONS OUTSIDE THE SPECIFICATION. HYDRO INTERNATIONAL CANNOT ACCEPT LIABILITY FOR PERFORMANCE OF ITS EQUIPMENT, (OR ANY PART THEREOF), IF THE EQUIPMENT IS SUBJECT TO CONDITIONS OUTSIDE THE SPECIFICATION. HYDRO INTERNATIONAL CANNOT ACCEPT LIABILITY FOR PERFORMANCE OF ITS EQUIPMENT, (OR ANY PART THEREOF), IF THE EQUIPMENT IS SUBJECT TO CONDITIONS OUTSIDE THE SPECIFICATION. IT MUST NOT BE USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SUPPLIED AND IT MUST NOT BE REPRODUCED, IN WHOLE OR IN PART, WITHOUT PRIOR PERMISSION IN WRITING FROM HYDRO INTERNATIONAL.

©2019 HYDRO INTERNATIONAL

Downstream Defender® Advanced Hydrodynamic Vortex Separator

The Downstream Defender® is an advanced hydrodynamic vortex separator for the effective and reliable removal of fine particles, oils and other floatable debris from surface water runoff.

Its innovative design delivers high efficiency across a wide range of flows in a much smaller footprint than conventional or other swirl-type devices and it is the perfect choice for any catchment likely to convey high quantities of contamination.

1. Access for removal of floatables and sediments.
2. Inlet pipe.
3. Inlet chute.
4. Centre shaft.
5. Dip plate.
6. Centre cone.
7. Benching skirt.
8. Floatables and oil storage.
9. Isolated sediment storage zone.
10. Outlet pipe.

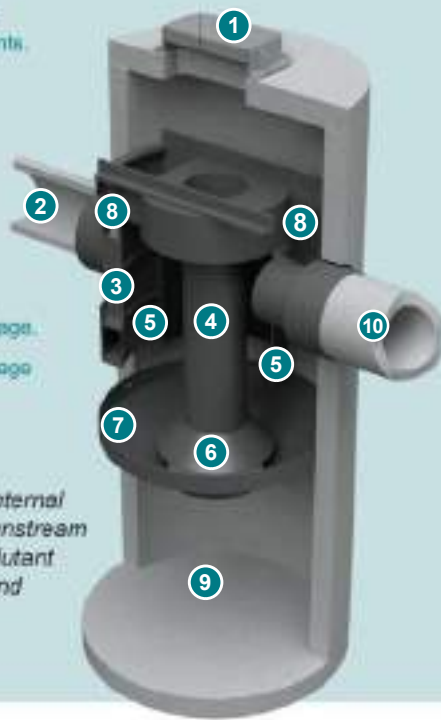


Figure 1 - The unique internal components of the Downstream Defender® enhance pollutant removal performance and prevent wash out.

Unique Flow Modifying Components

The Downstream Defender® consists of a choice of concrete or HDPE chamber with unique flow modifying internal components. It is these internal components that differentiate the Downstream Defender® from catchpits, sedimentation basins or sedimentation sumps. They facilitate advanced hydrodynamic vortex separation by reducing turbulence, lengthening the flow path to increase chamber residence time and introducing shear planes.

The internal components also ensure that the pollutant storage zones are isolated and protected from high flows that could cause pollutant re-entrainment or wash out.

Compared to devices that have poorly designed internal components, the Downstream Defender® captures and retains more of the annual pollutant load.

Watch a short video showing the Downstream Defender® components and operation at:

<http://www.hydro-int.com/en-gb/products/downstream-defender-0>



Repeatable, Reliable Performance

The Downstream Defender® delivers high removal of pollutants through advanced, hydrodynamic separation across a wide range of flows. The device has a proven track record of tackling an assortment of pollutants including:

Sediment (or Total Suspended Solids)



The Downstream Defender® is a highly effective sediment/TSS removal device. It can be sized in a number of ways to suit the application and level of protection required (see Table 1). **SuDS Mitigation Index = 0.5.**

Sediment Bound Hydrocarbons (including Polycyclic Aromatic Hydrocarbons - PAHs)



PAHs have low solubility in water and are readily adsorbed onto sediment particles. Effective removal of sediment particles will also ensure the removal of many PAHs.

Gross Pollutants



100% removal of floatable debris, such as food wrappers, Styrofoam cups and drinks cartons

Liquid Hydrocarbons



Effective spill containment device that meets the BS EN 858-1:2002 Class I and Class II effluent targets at low flow rates. Note these systems are not considered oil separators according to the BS EN 858-1 and must not be used in applications where full certification is required. **SuDS Mitigation Index = 0.8.**

Sediment Bound Heavy Metals and Nutrients

Heavy Metals

Nutrients

As an efficient device for removal of fine sediment, the Downstream Defender® is also effective for the removal of sediment bound pollutants. **SuDS Mitigation Index (Metals) = 0.4.**

No Risk of Pollutant Wash Out

The Downstream Defender® has been specially designed to isolate the pollutant storage zones and is proven to prevent pollutant wash out.

Sizing

The Downstream Defender® can be sized for different treatment goals and objectives.

For design purposes, the selected model's Treatment Flow Rate should be greater than or equal to the site's Water Quality Flow Rate.

The hydraulic capacity of the selected model should be considered with respect to the peak discharge flow rate from the site.

Model Diameter (m)	Treatment Flow Rate - Fine (l/s) ^(a)	Treatment Flow Rate - Coarse (l/s) ^(b)	Hydraulic Capacity (l/s) ^(c)	Minimum Oil Storage Capacity (l)	Minimum Sediment Storage Capacity (m³) ^(e)	Maximum Headloss at Treatment Flow Rate - Coarse (mm)
1.2	30	38	120	283	0.39	150
1.8	69	85	270	1356	0.73	225
2.55	138	171	542	2535	2.89	300
3.0	190	237	750	4693	3.10	375

Notes:

- a) Treatment Flow Rate - Fine is based on an annualised removal efficiency of >50% of all particles up to 1000 microns with a mass-median particle size (D₅₀) of 75 microns and a specific gravity of 2.65.
- b) Treatment Flow Rate - Coarse is based on an annualised removal efficiency of >80% of all particles between 50 and 1000 microns with a mass-median particle size (D₅₀) of 146 microns and a specific gravity of 2.65.
- c) Maximum flow rate that can pass through the chamber with a maximum headloss of 500mm.
- d) Alternative sizing based on different sediment grades available on request.
- e) Additional sediment storage capacity can be provided to extend maintenance intervals if required.

Table 1 - Downstream Defender® design information.

Expert Design Service

Hydro International's professional engineers are on hand to provide free support with the correct sizing and selection of the Downstream Defender® within each drainage design.

We can also provide estimated maintenance intervals, whole life cost estimates and predicted pollutant removal performance.

Call the StormTrain® Hotline on: 01275 337955 or email stormtrain@hydro-int.com

Design Data

Downstream Defender®

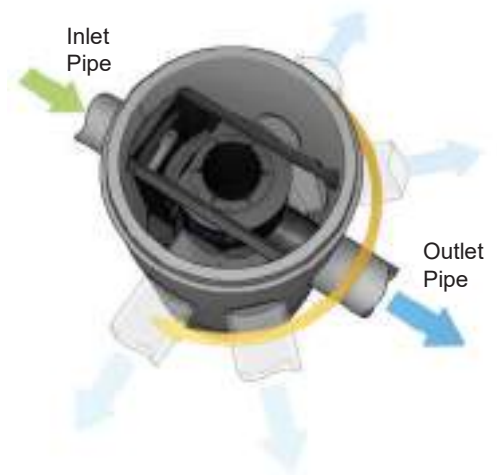
Advanced Hydrodynamic Vortex Separator

Setting Out

The Downstream Defender® can accommodate a change in pipe direction to suit site specific requirements. Combined with the high rate internal bypass, this helps to avoid the need for additional manholes on site. Head loss across the chamber is kept to a minimum (see Table 1). The inlet and outlet pipes should be sized in accordance with Table 2 (opposite), and a minimum of 90 degrees between inlet and outlet is required.

Inlet and outlet pipe connections are at the same invert level.

Additional manhole sections can be provided to extend the chamber to meet site cover and invert levels or provide additional pollutant storage where required.



Easy to Install

The Downstream Defender® is delivered to site as a near finished manhole with internal components already installed. Installation is therefore similar to any other manhole installation on site. Full installation guidelines are available.

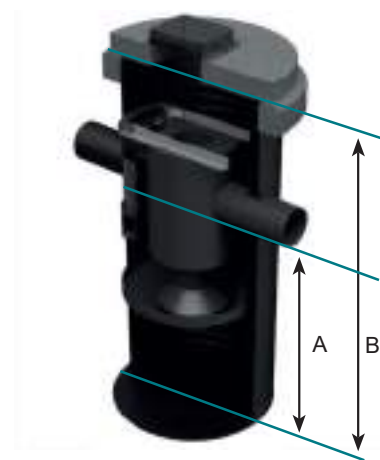
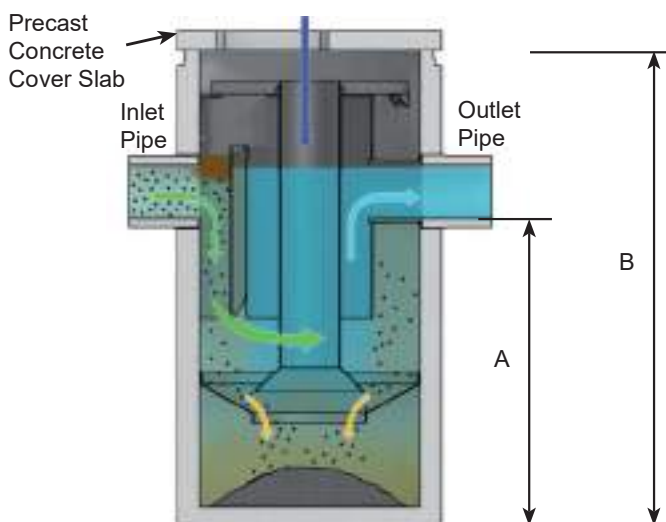
We can provide structural concrete systems for simple plug-and-play installation or choice of lightweight single and twin wall plastic chambers.

Easy to Maintain

Maintenance of the Downstream Defender® is simple, safe and cost-effective. Maintenance is carried out from the surface, using a standard vacuum tanker and personnel are not required to enter the device.

With a large capacity to store sediments and oils (see Table 1), and with a proven ability to prevent wash out, maintenance intervals can be years rather than months - depending on site conditions. The unit can also be fitted with a [Hydro-Logic™ Smart Monitoring](#) system to alert the site operator when maintenance is required and provide peace of mind that the unit is operating normally at other times.

Additional pollutant storage can be built into the chamber to extend maintenance intervals if required.



Dimensions and Weights

General arrangement drawings of all units are available for download from:
<http://www.hydro-int.com/en-gb/products/downstream-defender-0>

Model	Material	Chamber Diameter - Internal (mm)	Chamber Diameter - External (mm)	Inlet and Outlet ID (mm)	Depth to invert (m) (A) ⁽¹⁾	Chamber Depth (m) (B) ⁽²⁾	Max Component Lift Weight (kg)
PQL1320.1000	Concrete	1200	1460	300	1.916	2.830	2200
PQL1320.1030	Concrete	1800	2160	450	2.495	4.029	5450
PQL1320.1060	Concrete	2550	2850	600	2.95	4.95	8700
PQL1320.1090	Concrete	3000	3350	750	3.12	5.20	12100
PQL1320.1020	HDPE Single Wall	1188	1200	300	1.55	2.3	140
PQL1320.1051	HDPE Single Wall	1776	1812	500	2.11	3.41	460
PQL1320.1081	HDPE Single Wall	2530	2570	600	2.94	4.8	900
PQL1320.1111	HDPE Single Wall	2974	3000	800	3.13	5.3	1300
PQL1320.1025	HDPE Twin Wall	1200	1300	300	1.56	2.22	400
PQL1320.1055	HDPE Twin Wall	1800	2200	560	2.467	3.75	1100

Notes:
1) Minimum depth to invert shown. Depth to invert can be increased if required.
2) Minimum chamber depth shown. Additional sediment storage capacity or increased depth to invert can be provided if required.

Table 2 - Downstream Defender® unit types, dimensions and weights.

The Hydro StormTrain® Series of Surface Water Treatment Devices

The Downstream Defender® is one of the Hydro StormTrain® Series of surface water treatment devices. Each device delivers proven, measurable and repeatable surface water treatment performance. Each can be used independently to meet the specific needs of a site or combined to form a management train. They can be used alongside natural SuDS features to protect, enable or enhance them.



First Defense®
Vortex Separator



Downstream Defender®
Advanced Hydrodynamic
Vortex Separator



Up-Flo™ Filter
Fluidised Bed Up Flow
Filtration System



Hydro Biofilter™
Biofiltration System

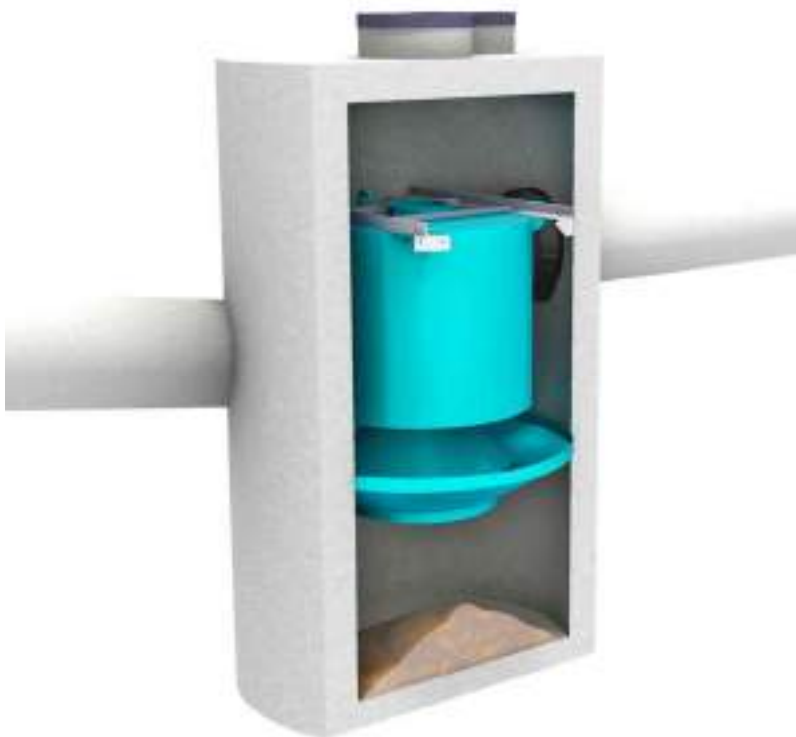
Patent: www.hydro-int.com/patents

Tel: +44 (0)1275 337955 stormtrain@hydro-int.com

Hydro International
Shearwater House, Clevedon Hall Estate, Victoria Road, Clevedon, BS21 7RD

Downstream Defender® Design Data O/0819

hydro-int.com/stormtrain



Operation and Maintenance Manual

Downstream Defender®

Vortex Separator for Stormwater Treatment

Turning Water Around ...®

Table of Contents

3	Downstream Defender® by Hydro International - Benefits of the Downstream Defender® - Applications - Downstream Defender® Components
4	Operation - Introduction - Pollutant Capture and Retention - Wet Sump - Blockage Protection
4	Maintenance - Overview - Determining Your Maintenance Schedule
5	Maintenance Procedures - Inspection - Floatables and Sediment Cleanout
8	Downstream Defender® Installation Log
9	Downstream Defender® Inspection and Maintenance Log

COPYRIGHT STATEMENT: The contents of this manual, including the drawings and specifications contained herein or annexed hereto, are intended for the use of the recipient to whom the document and all associated information are directed. Hydro International plc owns the copyright of this document (including any drawings or graphics), which is supplied in confidence. It must not be used for any purpose other than that for which it is supplied and must not be reproduced, in whole or in part stored in a retrieval system or transmitted in any form or by any means without prior permission in writing from Hydro International plc. Downstream Defender® is a trademarked hydrodynamic vortex separation device of Hydro International plc. A patent covering the Downstream Defender® has been granted.

DISCLAIMER: Information and data contained in this manual is exclusively for the purpose of assisting in the operation and maintenance of Hydro International plc's Downstream Defender®. No warranty is given nor can liability be accepted for use of this information for any other purpose. Hydro International plc have a policy of continuous product development and reserve the right to amend specifications without notice.

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Downstream Defender® by Hydro International

The Downstream Defender® is an advanced Hydrodynamic Vortex Separator designed to provide high removal efficiencies of settleable solids and their associated pollutants, oil, and floatables over a wide range of flow rates.

The Downstream Defender® has unique, flow-modifying internal components developed from extensive full-scale testing, CFD modeling and over thirty years of hydrodynamic separation experience in wastewater, combined sewer and stormwater applications. These internal components distinguish the Downstream Defender® from simple swirl-type devices and conventional oil/grit separators by minimizing turbulence and headlosses, enhancing separation, and preventing washout of previously stored pollutants.

The high removal efficiencies and inherent low headlosses of the Downstream Defender® allow for a small footprint making it a compact and economical solution for the treatment of non-point source pollution.

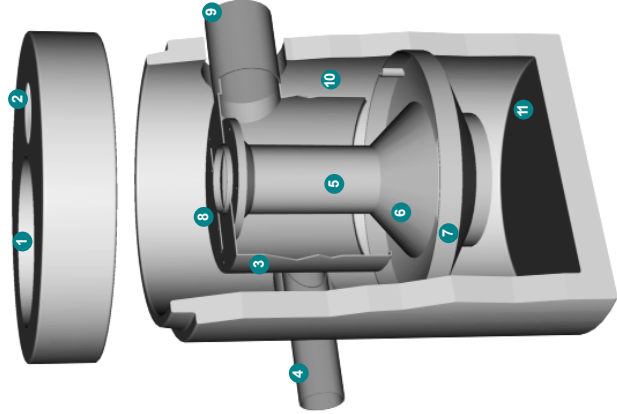
- Benefits of the Downstream Defender®**
- Removes sediment, floatables, oil and grease
 - No pollutant washouts
 - Small footprint
 - No loss of treatment capacity between clean-outs
 - Low headloss
 - Efficient over a wide range of flows
 - Easy to install
 - Low maintenance

Applications

- New developments and retrofits
- Utility yards
- Streets and roadways
- Parking lots
- Pre-treatment for filters, infiltration and storage
- Industrial and commercial facilities
- Wetlands protection

Downstream Defender® Components

1. Central Access Port
2. Floatables Access Port (6-ft., 8-ft. and 10-ft. models only)
3. Dip Plate
4. Tangential Inlet
5. Center Shaft
6. Center Cone
7. Benching Skirt
8. Floatables Lid
9. Outlet Pipe
10. Floatables Storage
11. Isolated Sediment Storage Zone



HYDRO MAINTENANCE SERVICES

Hydro International has been engineering stormwater treatment systems for over 30 years. We understand the mechanics of removing pollutants from stormwater and how to keep systems running at an optimal level.

NOBODY KNOWS OUR SYSTEMS BETTER THAN WE DO



AVOID SERVICE NEGLIGENCE

Sanitation services providers not intimately familiar with stormwater treatment systems are at risk of the following:

- Inadvertently breaking parts or failing to clean/replace system components appropriately.
- Charging you for more frequent maintenance because they lacked the tools to service your system properly in the first place.
- Billing you for replacement parts that might have been covered under your Hydro warranty plan
- Charging for maintenance that may not yet have been required.

LEAVE THE DIRTY WORK TO US

Trash, sediment and polluted water is stored inside treatment systems until they are removed by our team with a vactor truck. Sometimes teams must physically enter the system chambers in order to prepare the system for maintenance and install any replacement parts. Services include but are not limited to:

- Solids removal
- Removal of liquid pollutants
- Replacement media installation (when applicable)



Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

BETTER TOOLS, BETTER RESULTS

Not all vactor trucks are created equal. Appropriate tools and suction power are needed to service stormwater systems appropriately. Companies who don't specialize in stormwater treatment won't have the tools to properly clean systems or install new parts.



SERVICE WARRANTY

Make sure you're not paying for service that is covered under your warranty plan. Only Hydro International's service teams can identify tune-ups that should be on us, not you.

TREATMENT SYSTEMS SERVICED BY HYDRO:

- Stormwater filters
- Stormwater separators
- Baffle boxes
- Biofilters/biorention systems
- Storage structures
- Catch basins
- Stormwater ponds
- Permeable pavement



SAVE TIME & MONEY: CALL HYDRO FOR A QUOTE

1 (888) 382-7808

LEARN MORE AT HYDRO-INT.COM/SERVICE

Operation

Introduction

The Downstream Defender® operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirement and is fabricated with durable non-corrosive components. No manual procedures are required to operate the unit and maintenance is limited to monitoring accumulations of stored pollutants and periodic clean-outs. The Downstream Defender® has been designed to allow for easy and safe access for inspection/monitoring and clean-out procedures. Entry into the unit or removal of the internal components is not necessary for maintenance, thus safety concerns related to confined-space entry are avoided.

Pollutant Capture and Retention

The internal components of the Downstream Defender® have been designed to protect the oil, floatables and sediment storage volumes so that separator performance is not reduced as pollutants accumulate between clean-outs. Additionally, the Downstream Defender® is designed and installed into the storm drain system so that the vessel remains wet between storm events. Oil and floatables are stored on the water surface in the outer annulus separate from the sediment storage volume in the sump of the unit providing the option for separate oil disposal, and accessories such as adsorbent pads. Since the oil/floatables and sediment storage volumes are isolated from the active separation region, the potential for re-suspension and washout of stored pollutants between clean-outs is minimized.

Wet Sump

The sump of the Downstream Defender® retains a standing water level between storm events. The water in the sump prevents stored sediment from solidifying in the base of the unit. The clean-out procedure becomes more difficult and labor intensive if the system allows fine sediment to dry-out and consolidate. Dried sediment must be manually removed by maintenance crews. This is a labor intensive operation in a hazardous environment.

Blockage Protection

The Downstream Defender® has large clear openings and no internal restrictions or weirs, minimizing the risk of blockage and hydraulic losses. In addition to increasing the system headloss, orifices and internal weirs can increase the risk of blockage within the unit.

Maintenance

Overview

The Downstream Defender® protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the continuous, long-term functioning of the Downstream Defender®. The Downstream Defender® will capture and retain sediment and oil until the sediment and oil storage volumes are full to capacity. When sediment and oil storage capacities are reached, the Downstream Defender® will no longer be able to store removed sediment and oil. Maximum pollutant storage capacities are provided in Table 1.

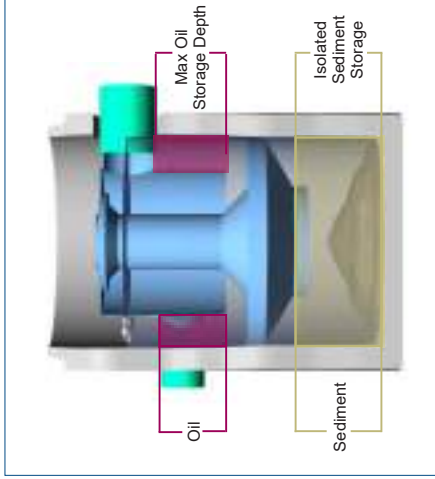


Fig. 1 Pollutant storage volumes of the Downstream Defender®.

Inspection Procedures

Inspection is a simple process that does not involve entry into the Downstream Defender®. Maintenance crews should be familiar with the Downstream Defender® and its components prior to inspection.

Scheduling

- It is important to inspect your Downstream Defender® every six months during the first year of operation to determine your site-specific rate of pollutant accumulation
- Typically, inspection may be conducted during any season of the year
- Sediment removal is not required unless sediment depths exceed 75% of maximum clean-out depths stated in Table 1

Recommended Equipment

- Safety Equipment and Personal Protective Equipment (traffic cones, work gloves, etc.)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net
- Sediment probe (such as a Sludge Judge®)
- Trash bag for removed floatables
- Downstream Defender® Maintenance Log

Determining Your Maintenance Schedule

The frequency of cleanout is determined in the field after installation. During the first year of operation, the unit should be inspected every six months to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge Judge® can be used to determine the level of accumulated solids stored in the sump. This information can be recorded in the maintenance log (see page 9) to establish a routine maintenance schedule.

The vactor procedure, including both sediment and oil/floatables removal, for a 6-ft Downstream Defender® typically takes less than 30 minutes and removes a combined water/oil volume of about 500 gallons.

Table 1. Downstream Defender® Pollutant Storage Capacities and Max. Cleanout Depths.

Unit Diameter	Total Oil Storage	Oil Clean-out Depth	Total Sediment Storage	Sediment Clean-out Depth	Max. Liquid Volume Removed
(feet)	(gallons)	(inches)	(gallons)	(inches)	(gallons)
4	70	<16	141	<18	384
6	216	<23	424	<24	1,239
8	540	<33	939	<30	2,884
10	1,050	<42	1,757	<36	5,546
12	1,770	<49	2,970	<42	9,460

NOTES

- Refer to Downstream Defender® Clean-out Detail (Fig. 1) for measurement of depths.
- Oil accumulation is typically less than sediment, however, removal of oil and sediment during the same service is recommended.
- Remove floatables first, then remove sediment storage volume.
- Sediment removal is not required unless sediment depths exceed 75% of maximum clean-out depths stated in Table 1.



Fig. 4



Fig. 5



Fig. 6

Inspection Procedures

1. Set up any necessary safety equipment around the access port or grate of the Downstream Defender® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.
2. Remove the lids to the manhole (Fig. 4). NOTE: The 4-ft Downstream Defender® will only have one lid.

Floatables and Sediment Cleanup

Floatables cleanup is typically done in conjunction with sediment removal. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables (Fig.6).

Floatables and loose debris can also be netted with a skimmer and pole. The access port located at the top of the manhole provides unobstructed access for a vactor hose and skimmer pole to be lowered to the base of the sump.

Scheduling

- Floatables and sump cleanup are typically conducted once a year during any season.
- If sediment depths are greater than 75% of maximum clean-out depths stated in Table 1, sediment removal is required.
- Floatables and sump cleanup should occur as soon as possible following a spill in the contributing drainage area.



Fig. 7 View over center shaft into sediment storage zone.



Fig. 8 View of outer annulus of floatables and oil collection zone.

Recommended Equipment

- Safety Equipment (traffic cones, etc)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net (If only floatables are being removed)
- Sediment probe (such as a Sludge Judge®)
- Vactor truck (6-inch flexible hose recommended)
- Downstream Defender® Maintenance Log

1. Set up any necessary safety equipment around the access port or grate of the Downstream Defender® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.
2. Remove the lids to the manhole (NOTE: The 4-ft Downstream Defender® will only have one lid).

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.

4. Using the Floatables Port for access, remove oil and floatables stored on the surface of the water with the vactor hose or the skimmer net (Fig.9).

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel and record it in the Maintenance Log (Fig.9).

6. Once all floatables have been removed, drop the vactor hose to the base of the sump via the Central Access Port. Vactor out the sediment and gross debris off the sump floor (Fig.6).

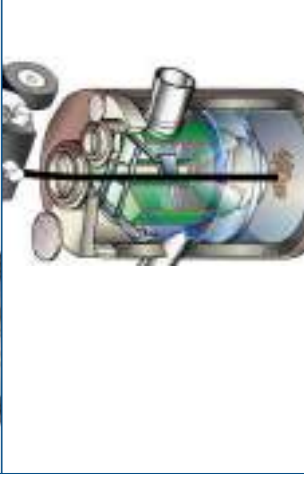


Fig. 9 Floatables and sediment are removed with a vactor hose

Maintenance at a Glance

Activity	Frequency
Inspection	- Regularly during first year of installation - Every 6 months after the first year of installation
Oil and Floatables Removal	- Once per year, with sediment removal - Following a spill in the drainage area
Sediment Removal	- Once per year or as needed - Following a spill in the drainage area

NOTE: For most cleanouts it is not necessary to remove the entire volume of liquid in the vessel. Only removing the first few inches of oils/floatables and the sediment storage volume is required.



Downstream Defender® Installation Log

HYDRO INTERNATIONAL REFERENCE NUMBER:	
SITE NAME:	
SITE LOCATION:	
OWNER:	CONTRACTOR:
CONTACT NAME:	CONTACT NAME:
COMPANY NAME:	COMPANY NAME:
ADDRESS:	ADDRESS:
TELEPHONE:	TELEPHONE:
FAX:	FAX:

INSTALLATION DATE: / /

MODEL (CIRCLE ONE): 4-FT 6-FT 8-FT 10-FT CUSTOM



Downstream Defender® Inspection and Maintenance Log

Date	Initials	Depth of Floatables and Oils	Sediment * Depth Measured	Volume of Sediment Removed	Site Activity and Comments

*Note: Sediment removal is not required unless sediment depths exceed 75% of maximum clean-out depths stated in Table 1.

DO IT RIGHT THE FIRST TIME

LEARN MORE AT HYDRO-INT.COM/SERVICE



CALL 1 (888) 382-7808 TO SCHEDULE AN INSPECTION

Stormwater Solutions

94 Hutchins Drive
Portland, ME 04102

Tel: (207) 756-6200

Fax: (207) 756-6212

stormwaterinquiry@hydro-int.com

www.hydro-int.com

Turning Water Around...®

©Hydro International DD_O+M_C1705

APPENDIX 10 – Standards and Limitations

STANDARDS AND LIMITATIONS

This report has been prepared solely for use by FI Real Estate.

It shall not be relied upon or transferred to any other party without the prior written authorisation of Integra Consulting.

The findings and opinions in the report are based on information derived from a variety of different sources. Integra Consulting do not accept any liability for the accuracy or otherwise of any information provided by third parties.

It should be noted that some of the aspects considered in this study may be subject to change with time. Therefore, if the development is delayed or postponed, consideration may need to be given to reviewing such issues to confirm that no changes have taken place, either at the site or within relevant legislation.

Further consultations with statutory bodies are likely as the scheme progresses. It should be noted that even where responses have been received from Regulators, these could be subject to change at a later date.