PARAMETRIX

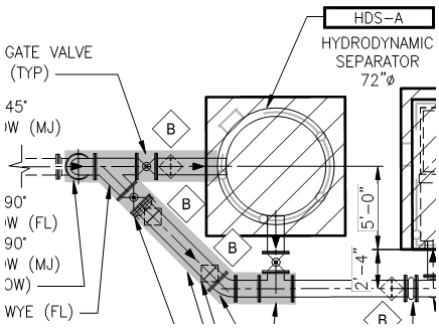
SUBMITTAL REVIEW COMMENTS

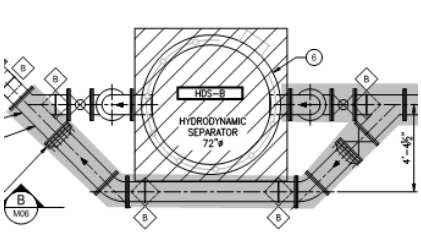
Date:	4/6/18	
Owner:	Northwest Seaport Alliance	
Project:	West Sitcum Stormwater Treatment	
Contractor:	Titon	
Submittal Title:	Vortex Type Hydrodynamic Separators	
Submittal Number:	PO#81368 TE-001 Shop Drawings REV2 TE-002 Maintenance Schedule	
Reviewer:	C. Simmons	
Review:	TE-001 Shop Drawings REV2: TE-002 Maintenance Schedule:	Revise and Resubmit No Exceptions Taken

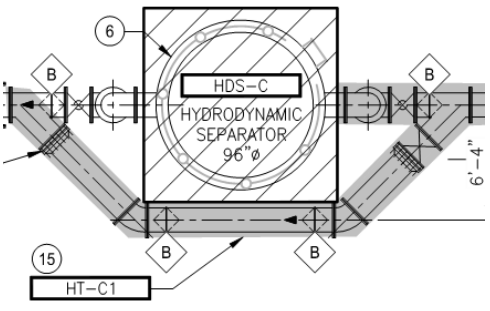
Comments:

TE-001 Shop Drawings REV2:

1. Please provide the most up-to-date GULD certification sheet. Attached to this submittal form is our understanding of the most up-to-date GULD. Confirm.
2. Please provide AutoCAD dwg files of the units.
3. Submit cut sheet of proposed eccentric reducing coupling
4. Confirm Titan understands that these HDS units will be installed with the bottom of the pre-cast at or above grade and that the structural calculations will reflect this.
5. The submitted Titan units appear to have inlet pipes entering the chamber tangentially to the circular pre-cast concrete structure. Confirm and provide additional design details of how this non-circular penetration is to be sealed. Please be reminded that the basis of design for project pipe penetrations is Link-seal.
6. The submitted Titan units have angles between the inlet and outlet that do not align with the design for Basins A, B, and C. See sheets M01, M02 and M03. Snips are provided below showing the design angles between the inlet and outlet for all three basins. Provide confirmation that the location of the inlet and outlet is adjustable. Provide any constraints. Provide a proposed re-design to align with our design. We request a conference call with you on this comment prior to you developing a proposed re-design.
7. The proposed HDS has a different top of concrete and appears to have a different discharge out elevation. It appears the pre-cast units will need to be lifted further to match our required hydraulic grade line. We request a conference call with you on this comment.







TE-002 Maintenance Schedule:

No Exceptions Taken

End of comments

WASHINGTON STATE DEPARTMENT OF ECOLOGY

November 2017

GENERAL USE LEVEL DESIGNATION FOR PRETREATMENT (TSS)
For
Hydro International's Downstream Defender®

Ecology's Decision:

Based on Hydro International's application submissions, Ecology hereby issues the following Use Level Designation for the Hydro International Downstream Defender®:

1. **General Use Level Designation (GULD) for pretreatment, as defined in the Ecology's 2011 *Technical Guidance Manual for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE)* Table 2, (a) ahead of infiltration treatment, or (b) to protect and extend the maintenance cycle of a Basic or Enhanced Treatment device (e.g., sand or media filter). This GULD applies to Downstream Defender units sized in accordance with the following table at the Water Quality design flow rate.**

Downstream Defender System Sizing	
Unit Diameter (ft)	**Flowrate (cfs)**
4	**1.3**
6	**4.1**
8	**9.4**
10	**17.7**

2. **Ecology approves Downstream Defender systems for treatment at the hydraulic loading rates shown in the above Table, and sized based on the water quality design flow rate. Calculate the water quality design flow rate using the following procedures:**

   - **Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.**

   - **Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.**

   - **Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.**

3. **The pretreatment GULD designation has no expiration date, but Ecology may amend or revoke the designation at any time.**

4. **The GULD is subject to the conditions specified below.**

5. **Properly designed and operated Downstream Defender systems may also have applicability in other situations (example: low-head situations such as bridges or ferry docks), for TSS and oil/grease removal where, on a case-by-case basis, it is found to be infeasible or impracticable to use any other approved practice. Local jurisdictions should follow established variance or exception procedures in approving such applications.**

6. **Ecology finds that the Downstream Defender, sized in accordance with the above table could also provide:**
    - **Water quality benefits in retrofit situations.**
    - **The first component in a treatment train.**
    - **Effective removal of deicing grit/sand.**

<u>Ecology's Conditions of Use</u>:

Downstream Defenders shall comply with these conditions:

1. **Design, assemble, install, operate, and maintain the Downstream Defender systems in accordance with Hydro International's applicable manuals and documents and the Ecology Decision and Conditions specified herein.**

2. **Discharges from the Downstream Defender system shall not cause or contribute to water quality standards violations in receiving waters.**

Applicant: Hydro International.

Applicant's Address: 94 Hutchins Drive
Portland, Maine 04102
(207) 756-6200 ext. 226

Application Documents:

- Application letter from Ms. Deahl dated November 23, 2004

- *Downstream Defender-Submittal to WA State Department of Ecology*, Hydro International, November 2004. Note: This submittal includes reports on seven studies on the Downstream Defender reported from 1997-2002.

- *Downstream Defender Testing Using Feed Sand with Mean Particle Size of 50 microns,* Hydro International, December 2004

- *Comparison: Downstream Defender and Vortechs*, Hydro International, November 2004

- *The Development of a Mathematical Model for the Prediction of the Residence Time Distribution of a Vortex Hydrodynamic Separator*, R.M. Alkhaddar et. al., 2001.

You may request a CD-ROM of the submittal reports from Hydro International.

Applicant's Use Level Requests:

- General Use Level Designation (GULD) for pretreatment.

Applicant's Performance Claims:

- Based on full-scale laboratory trials, a 4-ft diameter Downstream Defender will achieve at least an 80% TSS removal efficiency for 125-micron mean particle size sand, at an operating flow rate of 583 gpm and 50% TSS removal efficiency for 50 micron mean particle size sand at an operating flow rate of 980 gpm.

- Based on full-scale laboratory trials, a 4-ft. diameter Downstream Defender will achieve at least 80% TSS removal efficiency for 50-micron mean particle size sand at an operating flow rate of 400 gpm.

- The Downstream Defender increases retention time and removal efficiency compared to a simple swirl-type device. Its three-dimensional geometry and internal components decrease turbulence and ensure that any fluid element passes through an extended flow path to get from the inlet to the outlet. This geometry is increased proportionately in all three dimensions, as units get larger In addition, the components create isolated zones outside of the separation chamber where solids are directed and stored and are protected from re-entrainment. These areas also increase in all three dimensions as the units get larger but remain separate from the treatment volume. Therefore, you cannot accurately predict the removal efficiency of any size by simply applying the same surface-loading rate of another size. When scaling up to larger units, you must maintain residence in order to achieve consistent solids removal. An independent peer-reviewed study concludes that the appropriate scaling law for Hydro International's separators approaches theoretical volumetric loading and can be calculated by:

$Q = Q_{test} (D/ D_{test})^{2.85}$, where:

Q = flow rate at which a different sized device achieves the same performance
Qtest = flow rate of tested device (583 gpm)
D = internal diameter in feet of the different sized device
Dtest = diameter of the tested device (4 feet)

Hydro International based the maximum pretreatment flow rates for Downstream Defenders on 80% removal of 125-micron mean particle size sand.

Ecology's Recommendations:

Based on the weight of the evidence and using its best professional judgment, Ecology finds that:

- The Downstream Defender system, sized in accordance with the table above should provide, at a minimum, equivalent performance to a presettling basin as defined in the most recent *Stormwater Management Manual for Western Washington*, Volume V, Chapter 6.

Findings of Fact:

- Hydro International conducted full-scale laboratory test on a 4-ft diameter Downstream Defender. Appendix 5 of the submittal includes independent Maine DEP OK-110 laboratory results verifying the company's performance claim. The submittal also documents the removal of portions of heavy metals and nutrients associated with fine particles.
- The submittals also demonstrate that the Downstream Defender provides significantly better protection from pollutant re-entrainment compared to simple swirl-type devices (SVS). Therefore, Hydro International considers the Downstream Defender to be an advanced vortex separator (AVS).
- Hydro International conducted full-scale laboratory test on a 4-ft diameter Downstream Defender verifying the company's performance claim on material with a mean particle size of 50 microns.
- Hydro International used laboratory testing using 15 and 30-inch diameter systems to derive a scaling factor of 2.85 to determine flow rates for untested models.
- Owners of the Downstream Defender may easily maintain the system using a vacuum truck.
- There are over 2,000 Downstream Defender systems installed nationwide, with over 150 in the Pacific Northwest.

Technology Description:

You can download Design Manual and technical bulletins from company's web site.

Contact Information:

Applicant:	Mr. Dave Scott Hydro International (207) 756-6200 ext. 250 dscott@hydro-int.com
Applicant website:	http://www.hydro-int.com
Ecology web link:	http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html
Ecology Contact:	Douglas C. Howie, P.E. Department of Ecology Water Quality Program douglas.howie@ecy.wa.gov (360) 407-6444

Revision History

Date	Revision
February 2005	Original Draft use-level-designation document: CULD for Pretreatment
November 2007	Updated use-level to GULD
December 2012	Modified Design Storm Description, added Revision Table
November 2017	Updated Applicant Contact Information

Transmittal

Titan Earthwork
1585 Valentine Ave SE Pacific, WA 98047

Project Name: Vortex Type Hydrodynamic Separators
Client Project Number: PO#81368
General Contractor: N/A
Owner: Port of Tacoma

Submittal No.: ***TE-001 Shop Drawings REV2***
Per Specification: **33 44 43 1.03 A: 1, 3, 4, 5 & 6**
Date: **04/05/18**

To: Hughes Wike
Cc: N/A

Remarks: Note that TITAN cannot release this product for production without approval of this submittal. In order to meet the specified date window provided within the bid documents, we need an approval of this submittal right away. As such, we are requesting an expedited review and response to this submittal. **REV2 CHANGES INCLUDE:** Added email response from manufacturer addressing flow rates and outlet stubs. Updated basin call outs and job name. Added DD GULD listing.

Prepared by: Chris Pierce

By:

SPACE BELOW FOR RESIDENT ENGINEER

Parametrix
ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES
150 NW Pacific Park Lane, Suite 110 Bend, Oregon 97701
Main Phone: (541) 508-7710

SUBMITTAL REVIEW

Checking is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for dimensions which shall be confirmed and correlated at the job site, fabrication processes and techniques of construction, coordination of his work with that of all other trades, and the satisfactory performance of his work.

- ☐ No Exceptions Taken
- ☒ Revise and Resubmit
- ☐ Make Corrections Noted
- ☐ Rejected—See Comments
- ☐ Submit Specified Item

Date: 4/6/18 By: C. Simmons
Project #: 553-8001-001 Submittal #:

From: Lourens, Deon <Deon.Lourens@oldcastle.com>
Sent: Wednesday, April 4, 2018 12:23 PM
To: Chris Pierce <chris.pierce@titanearth.com>
Cc: Katrina Walker <katrina.walker@titanearth.com>; Thompson, Matthew <Matthew.Thompson@oldcastle.com>
Subject: RE: HDS Questions

Hi Chris / Katrina,

Please see our responses in red below.

Let us know if you have any more questions.

Regards

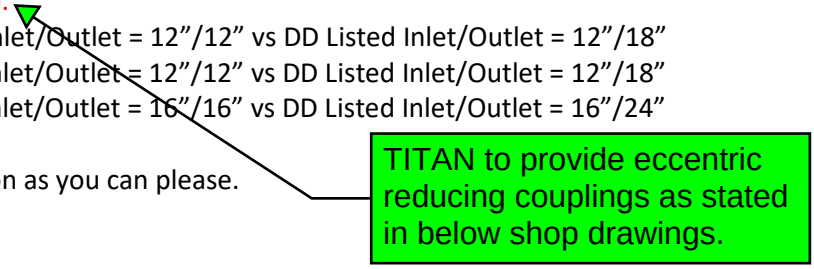
Deon Lourens
Area Technical Manager | **Oldcastle Precast, Inc.** | Stormwater | Cell: 503.537.8550
28499 Boberg Road| Wilsonville, OR | 97070 | **OldcastleStormwater.com**

Deon,

I spoke with the engineer regarding our shop drawing submittals and she had the following questions:

1) The treatment capacities listed in the specifications are fixed due to pump discharge and the peak hydraulic capacities listed on the shop drawings are much higher. I need an email or data sheet of some kind from your end stating that the functionality of the Downstream Defender will not be affected at these lower rates. Basically, the engineer is raising her eyebrows because of the distance between her published flow rates and the DD peak capacity rates and wants to be assured that we won't have any functionality issues with the DD product vs the Contech CDS that was originally specified. The peak rates are as stated, Peak. CDS peak rates are more than double than what is required but are not listed. In any given HDS unit, the slower the flow, the better the removal. The focus should be on Required Treatment Flow and WADOE approval list, in which case the DD is sized "As-Required".
    a. Basin A Specified Rate = 3.8 CFS vs DD Listed Peak Capacity = 8.0 CFS
    b. Basin B Specified Rate = 2.5 CFS vs DD Listed Peak Capacity = 8.0 CFS
    c. Basin C Specified Rate = 6.0 CFS vs DD Listed Peak Capacity = 15.0 CFS
2) The outlet pipe sizes on your drawing do not match those on the plans. Is it a problem with the functionality of the DD to lower the diameter to match the pipe sizes called out on the plans? No, it's not a problem hydraulically. The DD has a set outlet stub diameter. To get to 12" and 16" outlet stubs you would need to incorporate an eccentric reducer coupling to use the outlet pipe sizes per plan. NOTE: The outlet invert elevation should remain as detailed per plan (hence the eccentric coupling adapter).
    a. Basin A Specified Inlet/Outlet = 12"/12" vs DD Listed Inlet/Outlet = 12"/18"
    b. Basin B Specified Inlet/Outlet = 12"/12" vs DD Listed Inlet/Outlet = 12"/18"
    c. Basin C Specified Inlet/Outlet = 16"/16" vs DD Listed Inlet/Outlet = 16"/24"

Take a look and let me know as soon as you can please.



Thank you,

Deon Lourens
Area Technical Manager | **Oldcastle Precast, Inc.** | Stormwater | Cell: 503.537.8550
28499 Boberg Road| Wilsonville, OR | 97070 | **OldcastleStormwater.com**

From: Chris Pierce [mailto:chris.pierce@titanearth.com]
Sent: Tuesday, April 3, 2018 1:44 PM
To: Lourens, Deon <Deon.Lourens@oldcastle.com>
Cc: Katrina Walker <katrina.walker@titanearth.com>
Subject: [EXT] HDS Questions
Importance: High

CAUTION: this email originated from outside of the organization. Do not click links or open attachments unless you are expecting this email and know the contents are safe.

Deon,

I spoke with the engineer regarding our shop drawing submittals and she had the following questions:

1) The treatment capacities listed in the specifications are fixed due to pump discharge and the peak hydraulic capacities listed on the shop drawings are much higher. I need an email or data sheet of some kind from your end stating that the functionality of the Downstream Defender will not be affected at these lower rates. Basically, the engineer is raising her eyebrows because of the distance between her published flow rates and the DD peak capacity rates and wants to be assured that we won't have any functionality issues with the DD product vs the Contech CDS that was originally specified.
    a. Basin A Specified Rate = 3.8 CFS vs DD Listed Peak Capacity = 8.0 CFS
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    c. Basin C Specified Rate = 6.0 CFS vs DD Listed Peak Capacity = 15.0 CFS
2) The outlet pipe sizes on your drawing do not match those on the plans. Is it a problem with the functionality of the DD to lower the diameter to match the pipe sizes called out on the plans?
    a. Basin A Specified Inlet/Outlet = 12"/12" vs DD Listed Inlet/Outlet = 12"/18"
    b. Basin B Specified Inlet/Outlet = 12"/12" vs DD Listed Inlet/Outlet = 12"/18"
    c. Basin C Specified Inlet/Outlet = 16"/16" vs DD Listed Inlet/Outlet = 16"/24"

Take a look and let me know as soon as you can please.

Thank you,

Chris Pierce
TITAN EARTHWORK
DEMOLITION • EARTHWORK • UTILITIES
1585 Valentine Ave. SE · Pacific, WA 98047
253-720-0523 (M) 888-325-3004 (F)

WASHINGTON STATE DEPARTMENT OF ECOLOGY

February 2005
(Updated November 2007)

GENERAL USE LEVEL DESIGNATION FOR PRETREATMENT (TSS)
For
Hydro International's Downstream Defender®

Ecology's Decision:

Based on Hydro International's application submissions and recommendations by the Technical Review Committee (TRC), Ecology hereby issues the following Use Level Designation for the Hydro International Downstream Defender®:

1. **General Use Level Designation (GULD) for pretreatment, as defined in the Ecology Manual Volume I, (a) ahead of infiltration treatment, or (b) to protect and extend the maintenance cycle of a Basic or Enhanced Treatment device (e.g., sand or media filter). This GULD applies to Downstream Defender units sized in accordance with the following table at the Water Quality design flow rate as determined using the Western Washington Hydrology Model (WWHM).**

Downstream Defender System Sizing	
Unit Diameter (ft)	Flowrate (cfs) $Q=583\ (D/4)^{2.85}$
4	1.3
6	4.1
8	9.4
10	17.7

2. **The pretreatment GULD designation has no expiration date, but it may be amended or revoked by Ecology.**

3. **The GULD is subject to the conditions specified below.**

4. **Properly designed and operated Downstream Defender systems may also have applicability in other situations (example: low-head situations such as bridges or ferry docks), for TSS and oil/grease removal where, on a case-by-case basis, it is found to be infeasible or impracticable to use any other approved practice. Local jurisdictions should follow established variance or exception procedures in approving such applications.**

5. **Ecology finds that the Downstream Defender, sized in accordance with the above table could also provide:**

- **Water quality benefits in retrofit situations.**
- **The first component in a treatment train.**
- **Effective removal of deicing grit/sand.**

<u>Ecology's Conditions of Use</u>:

Downstream Defenders shall be designed, installed, and maintained to comply with these conditions:

1. **Downstream Defender systems must be designed, assembled, installed, operated, and maintained in accordance with Hydro International's applicable manuals and documents and the Ecology Decision and Conditions specified herein.**

2. **Discharges from the Downstream Defender system shall not cause or contribute to water quality standards violations in receiving waters.**

Applicant: Hydro International.

Applicant's Address: 94 Hutchins Drive
Portland, Maine 04102
(207) 756-6200 ext. 226

Application Documents:

- Application letter from Ms. Deahl dated November 23, 2004

- "Downstream Defender-Submittal to WA State Department of Ecology", Hydro International, November 2004. *Note: This submittal includes reports on 7 studies on the Downstream Defender reported from 1997-2002.*

- "Downstream Defender Testing Using Feed Sand with Mean Particle Size of 50 microns", Hydro International, December 2004

- "Comparison: Downstream Defender and Vortechs", Hydro International, November 2004

- "The Development of a Mathematical Model for the Prediction of the Residence Time Distribution of a Vortex Hydrodynamic Separator," R.M. Alkhaddar et. al., 2001.

A CD-ROM of the submittal reports may be requested from Hydro International.

Applicant's Use Level Requests:

- Functional equivalence of the Downstream Defender to other vortex enhanced sedimentation technologies.
- General Use Level Designation (GULD) for pretreatment.

Applicant's Performance Claims:

Based on full-scale laboratory trials, a 4-ft diameter Downstream Defender will achieve at least an 80% TSS removal efficiency for 125-micron mean particle size sand, at an operating flow rate of 583 gpm and 50% TSS removal efficiency for 50 micron mean particle size sand at an operating flow rate of 980 gpm.

Based on full-scale laboratory trials, a 4-ft. diameter Downstream Defender will achieve at least 80% TSS removal efficiency for 50-micron mean particle size sand at an operating flow rate of 400 gpm.

The Downstream Defender increases retention time and removal efficiency compared to a simple swirl-type device. Its three-dimensional geometry and internal components decrease turbulence and ensure that any fluid element passes through an extended flow path to get from the inlet to the outlet. This geometry is increased proportionately in all three dimensions, as units get larger In addition, the components create isolated zones outside of the separation chamber where solids are directed and stored and are protected from re-entrainment. These areas also increase in all three dimensions as the units get larger but are kept separate from the treatment volume. Therefore, the removal efficiency of any size cannot be accurately predicted by simply applying the same surface-loading rate of another size. When scaling up to larger units, residence times must be maintained in order to achieve consistent solids removal. An independent peer-reviewed study concludes that the appropriate scaling law for Hydro International's separators approaches theoretical volumetric loading and can be calculated by:

$Q = Q_{test} (D/ D_{test})^{2.85}$, where:

Q = flow rate at which a different sized device achieves the same performance
Q_{test} = flow rate of tested device (583 gpm)
D = internal diameter in feet of the different sized device
D_{test} = diameter of the tested device (4 feet)

The maximum pretreatment flow rates for Downstream Defenders are based on 80% removal of 125-micron mean particle size sand.

Technical Review Committee Recommendations: The TRC, based on the weight of the evidence and using its best professional judgment, finds that:

- Pretreatment guidelines are needed to assess facilities performing at less-than-Basic treatment levels, but adequate to serve as presettling facilities ahead of infiltration treatment.

The TRC recommends guidelines be set at 50% removal of 50-micron particles and 80% removal of 125-micron particles. The TRC further recommends these guidelines be applied uniformly to this and all future technology submissions.

- The Downstream Defender system, sized in accordance with the table above should provide, at a minimum, equivalent performance to a presettling basin as defined in the most recent *Stormwater Management Manual for Western Washington, Volume V, Chapter 6.*

Findings of Fact:

- Full-scale laboratory test have been conducted on a 4-ft diameter Downstream Defender. Appendix 5 of the submittal includes independent Maine DEP OK-110 laboratory results verifying the company's performance claim. The submittal also documents the removal of portions of heavy metals and nutrients associated with fine particles.
- The submittals also demonstrate that the Downstream Defender provides significantly better protection from pollutant re-entrainment compared to simple swirl-type devices (SVS). Therefore, Hydro International considers the Downstream Defender to be an advanced vortex separator (AVS).
- Full-scale laboratory test have been conducted on a 4-ft diameter Downstream Defender verifying the company's performance claim on material with a mean particle size of 50 microns.
- Laboratory testing using 15 and 30-inch diameter systems derived a scaling factor of 2.85, which is used to determine flow rates for untested models.
- The system is easily maintained using a vacuum truck.
- There are over 2000 Downstream Defender systems installed nationwide, with over 150 in the Pacific Northwest.

Technology Description:

Design Manual and technical bulletins can be downloaded from company's web site.

Contact Information:

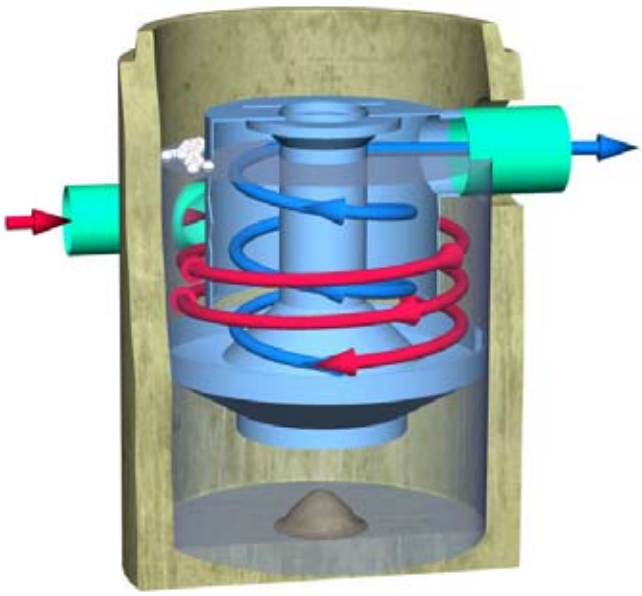
Applicant:	Mr. John MacKinnon Hydro International (207) 756-6200 ext. 250 jmackinnon@hil-tech.com
Applicant website:	http://www.hydro-international.biz

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology Contact:	Mieke Hoppin Water Quality Program mhop461@ecy.wa.gov (360) 407-6435

Downstream Defender®

SUBMITTAL PACKAGE

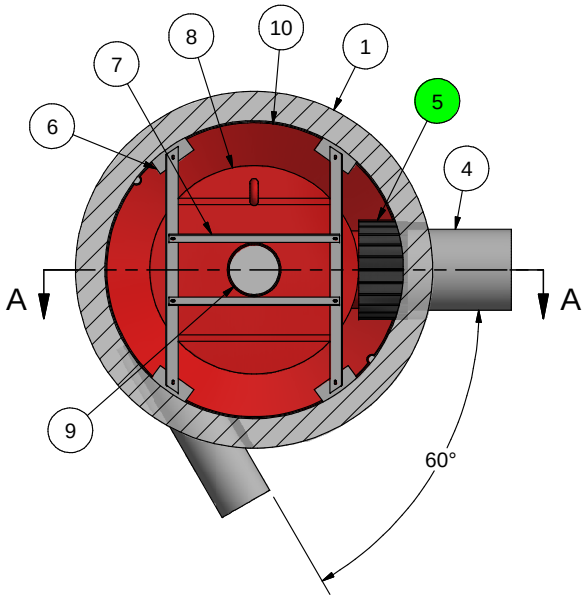


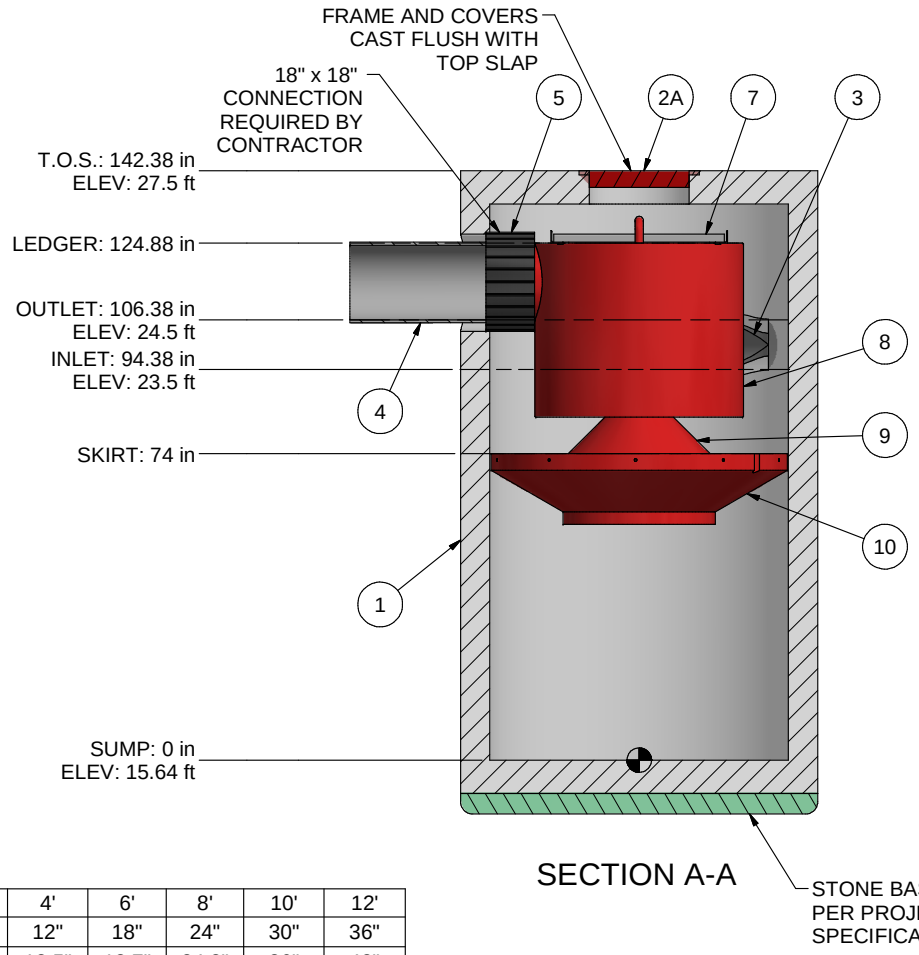
Oldcastle Precast - Stormwater
(800) 579-8819
OldcastleStormwater.com

Oldcastle Precast®

Stormwater

PIPE DETAILS					
PIPE	MATERIAL	LENGTH	INV UP	INV DOWN	SLOPE
INLET	DIP	4.0 ft	23.50 ft	23.50 ft	0.00
OUTLET	DIP	2.0 ft	24.50 ft	24.50 ft	0.00





SECTION A-A

PARTS LIST		
ITEM	DESCRIPTION	SIZE (in)
1	PRECAST MANHOLE (BY HYDRO VIA PRECASTER)	72
2A	FRAME AND COVER	24
2B	FRAME AND COVER	18
3	INLET PIPE (BY OTHERS)	12
4	OUTLET PIPE (BY OTHERS)	18
5	PIPE COUPLING (BY OTHERS)	
6	LEDGER ANGLE	
7	SUPPORT FRAME	
8	DIP PLATE	
9	CENTER SHAFT AND CONE	
10	BENCHING SKIRT	

DD SIZE	4'	6'	8'	10'	12'
OUTLET STUB ID	12"	18"	24"	30"	36"
OUTLET STUB OD	12.5"	18.7"	24.8"	36"	42"

EQUIPMENT PERFORMANCE

The stormwater treatment unit shall adhere to the hydraulic parameters given in the chart below and provide the removal efficiencies and storage capacities as follows:

1. Performance objectives: The unit shall be capable of treating the peak flow rate listed below.
2. Peak Hydraulic Capacity: 8.0 cfs (227 l/s)
3. Sediment Storage Capacity: 5.24 cu. yd. (3.97 cu. m)
4. Continuous Oil Storage Capacity: 216 gal. (818 liters)
5. Sediment shall be stored in a zone that is isolated from the main flow path and protected from reintrainment by a benching skirt.

TITAN to provide an eccentric PVC gasketed reducer coupling to connect the 18.7" OD outlet to the 12" ductile iron (13.2" OD) that will be connected under the installation contract.

ANY WARRANTY GIVEN BY HYDRO INTERNATIONAL WILL APPLY ONLY TO THOSE ITEMS SUPPLIED BY IT. ACCORDINGLY HYDRO INTERNATIONAL CANNOT ACCEPT ANY RESPONSIBILITY FOR ANY STRUCTURE, PLANT, OR EQUIPMENT, (OR THE PERFORMANCE THERE OF) DESIGNED, BUILT, MANUFACTURED, OR SUPPLIED BY ANY THIRD PARTY. HYDRO INTERNATIONAL HAVE 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 ANY DESIGN SPECIFICATION. HYDRO INTERNATIONAL OWNS THE COPYRIGHT OF THIS DRAWING, 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, WITHOUT PRIOR PERMISSION IN WRITING FROM HYDRO INTERNATIONAL.
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DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES. TOLERENCES ARE:

FRACTIONS ± 1/16
DECIMALS ± .06
ANGLES ± 1°

PROJECTION

COMMENTS:

1. MANHOLE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.
2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING DOWNSTREAM DEFENDER MANHOLE.
3. CONTRACTOR TO CONFIRM RIM, PIPE INVERTS, PIPE DIA. AND PIPE ORIENTATION PRIOR TO RELEASE OF UNIT TO FABRICATION.

REVISION HISTORY			
REV	BY	DESCRIPTION	DATE
-		FIRST RELEASE	

DATE: 3/30/2018
SCALE:
DRAWN BY: KDO
CHECKED BY:
APPROVED BY

Title
6-ft DIAMETER DOWNSTREAM DEFENDER

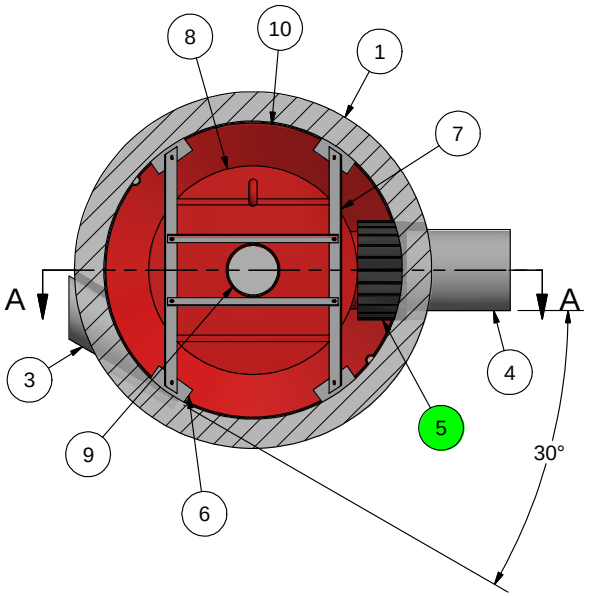
BASIN A
WEST SITCUM
SW TREATMENT
TACOMA, WA

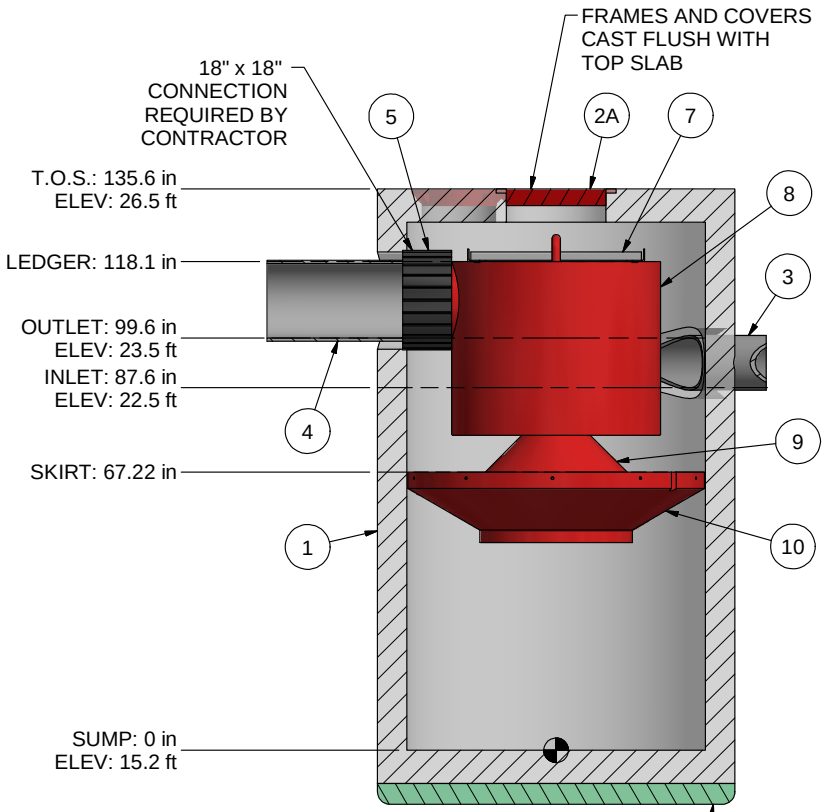
Hydro International

94 Hutchins Drive
Portland, ME 04102
Tel: +1 (207) 756-6200
Fax: +1 (207) 756-6212
hydro-int.com

APPROX WEIGHT: N/A
MATERIAL:
NEXT ASSEMBLY: 18_12_0579-NEXT ASSY
DRAWING NO.: 18_12_0579-DD GA
SHEET SIZE: B
SHEET: 1 OF 3
Rev: -

PIPE DETAILS					
PIPE	MATERIAL	LENGTH	INV UP	INV DOWN	SLOPE
INLET	DIP	4.0 ft	22.50 ft	22.50 ft	0.00
OUTLET	DIP	2.0 ft	23.50 ft	23.50 ft	0.00





SECTION A-A

PARTS LIST		
ITEM	DESCRIPTION	SIZE (in)
1	PRECAST MANHOLE (BY HYDRO VIA PRECASTER)	72
2A	FRAME AND COVER	24
2B	FRAME AND COVER	18
3	INLET PIPE (BY OTHERS)	12
4	OUTLET PIPE (BY OTHERS)	18
5	PIPE COUPLING (BY OTHERS)	
6	LEDGER ANGLE	
7	SUPPORT FRAME	
8	DIP PLATE	
9	CENTER SHAFT AND CONE	
10	BENCHING SKIRT	

DD SIZE	4'	6'	8'	10'	12'
OUTLET STUB ID	12"	18"	24"	30"	36"
OUTLET STUB OD	12.5"	18.7"	24.8"	36"	42"

EQUIPMENT PERFORMANCE

The stormwater treatment unit shall adhere to the hydraulic parameters given in the chart below and provide the removal efficiencies and storage capacities as follows:

1. Performance objectives: The unit shall be capable of treating the peak flow rate listed below.
2. Peak Hydraulic Capacity: 8.0 cfs (227 l/s)
3. Sediment Storage Capacity: 4.65 cu. yd. (3.52 cu. m)
4. Continuous Oil Storage Capacity: 216 gal. (818 liters)
5. Sediment shall be stored in a zone that is isolated from the main flow path and protected from reintrainment by a benching skirt.

TITAN to provide an eccentric PVC gasketed reducer coupling to connect the 18.7" OD outlet to the 12" ductile iron (13.2" OD) that will be connected under the installation contract.

ANY WARRANTY GIVEN BY HYDRO INTERNATIONAL WILL APPLY ONLY TO THOSE ITEMS SUPPLIED BY IT. ACCORDINGLY HYDRO INTERNATIONAL CANNOT ACCEPT ANY RESPONSIBILITY FOR ANY STRUCTURE, PLANT, OR EQUIPMENT, (OR THE PERFORMANCE THERE OF) DESIGNED, BUILT, MANUFACTURED, OR SUPPLIED BY ANY THIRD PARTY. HYDRO INTERNATIONAL HAVE 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 ANY DESIGN SPECIFICATION. HYDRO INTERNATIONAL OWNS THE COPYRIGHT OF THIS DRAWING, 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, WITHOUT PRIOR PERMISSION IN WRITING FROM HYDRO INTERNATIONAL.
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DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES. TOLERENCES ARE:

FRACTIONS ± 1/16
DECIMALS ± .06
ANGLES ± 1°

PROJECTION

COMMENTS:

1. MANHOLE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.
2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING DOWNSTREAM DEFENDER MANHOLE.
3. CONTRACTOR TO CONFIRM RIM, PIPE INVERTS, PIPE DIA. AND PIPE ORIENTATION PRIOR TO RELEASE OF UNIT TO FABRICATION.

REVISION HISTORY			
REV	BY	DESCRIPTION	DATE
-		FIRST RELEASE	

DATE: | SCALE:

DRAWN BY: KDO | CHECKED BY: | APPROVED BY

Title
6-ft DIAMETER
DOWNSTREAM DEFENDER

BASIN B
WEST SITCUM
SW TREATMENT
TACOMA, WA

Hydro International

94 Hutchins Drive
Portland, ME 04102
Tel: +1 (207) 756-6200
Fax: +1 (207) 756-6212
hydro-int.com

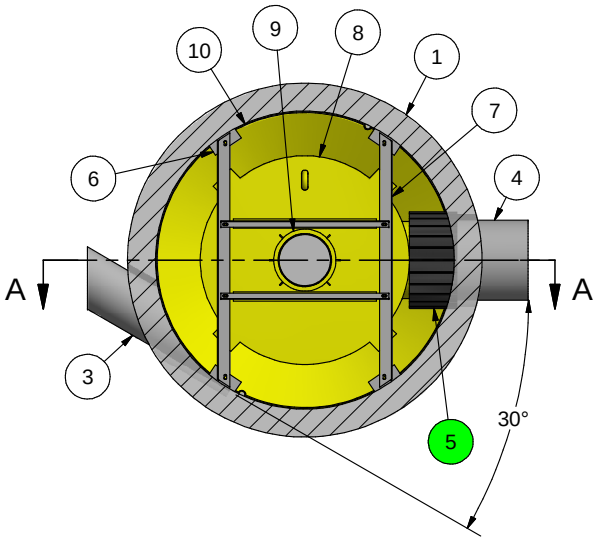
APPROX WEIGHT: N/A | MATERIAL:

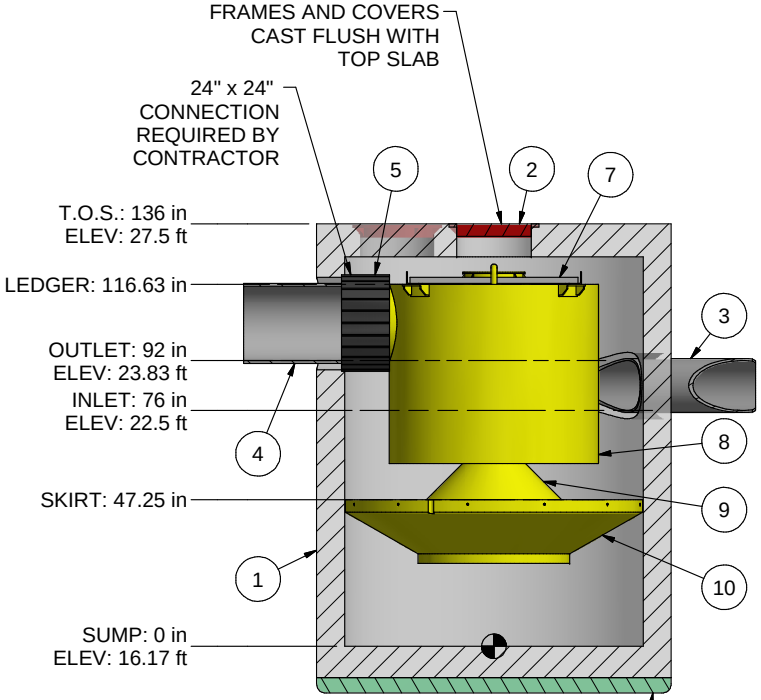
NEXT ASSEMBLY: 18_12_0579-NEXT ASSY

DRAWING NO.: 18_12_0579-DD GA

SHEET SIZE: B | SHEET: 1 OF 3 | Rev: -

PIPE DETAILS					
PIPE	MATERIAL	LENGTH	INV UP	INV DOWN	SLOPE
INLET	DIP	6.0 ft	22.50 ft	22.50 ft	0.00
OUTLET	DIP	2.0 ft	23.83 ft	23.83 ft	0.00





SECTION A-A

STONE BASE PER PROJECT SPECIFICATIONS

PARTS LIST		
ITEM	DESCRIPTION	SIZE (in)
1	PRECAST MANHOLE (BY HYDRO VIA PRECASTER)	96
2	FRAME AND COVER	24
3	INLET PIPE (BY OTHERS)	16
4	OUTLET PIPE (BY OTHERS)	24
5	PIPE COUPLING (BY OTHERS)	
6	LEDGER ANGLE	
7	SUPPORT FRAME	
8	DIP PLATE	
9	CENTER SHAFT AND CONE	
10	BENCHING SKIRT	

DD SIZE	4'	6'	8'	10'	12'
OUTLET STUB ID	12"	18"	24"	30"	36"
OUTLET STUB OD	12.5"	18.7"	24.8"	36"	42"

EQUIPMENT PERFORMANCE

The stormwater treatment unit shall adhere to the hydraulic parameters given in the chart below and provide the removal efficiencies and storage capacities as follows:

1. Performance objectives: The unit shall be capable of treating the peak flow rate listed below.
2. Peak Hydraulic Capacity: 15.0 cfs (425 l/s)
3. Sediment Storage Capacity: 4.65 cu. yd. (3.52 cu. m)
4. Continuous Oil Storage Capacity: 540 gal. (2044 liters)
5. Sediment shall be stored in a zone that is isolated from the main flow path and protected from reintrainment by a benching skirt.

TITAN to provide an eccentric PVC gasketed reducer coupling to connect the 24.8" OD outlet to the 16" ductile iron (17.4" OD) that will be connected under the installation contract.

ANY WARRANTY GIVEN BY HYDRO INTERNATIONAL WILL APPLY ONLY TO THOSE ITEMS SUPPLIED BY IT. ACCORDINGLY HYDRO INTERNATIONAL CANNOT ACCEPT ANY RESPONSIBILITY FOR ANY STRUCTURE, PLANT, OR EQUIPMENT, (OR THE PERFORMANCE THERE OF) DESIGNED, BUILT, MANUFACTURED, OR SUPPLIED BY ANY THIRD PARTY. HYDRO INTERNATIONAL HAVE 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 ANY DESIGN SPECIFICATION. HYDRO INTERNATIONAL OWNS THE COPYRIGHT OF THIS DRAWING, 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, WITHOUT PRIOR PERMISSION IN WRITING FROM HYDRO INTERNATIONAL.
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DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES. TOLERENCES ARE:

FRACTIONS ± 1/16
DECIMALS ± .06
ANGLES ± 1°

PROJECTION

COMMENTS:

1. MANHOLE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.
2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING DOWNSTREAM DEFENDER MANHOLE.
3. CONTRACTOR TO CONFIRM RIM, PIPE INVERTS, PIPE DIA. AND PIPE ORIENTATION PRIOR TO RELEASE OF UNIT TO FABRICATION.

REVISION HISTORY			
REV	BY	DESCRIPTION	DATE
-		FIRST RELEASE	

DATE: 4/2/2018
SCALE:
DRAWN BY: KDO
CHECKED BY:
APPROVED BY

Title
8-ft DIAMETER DOWNSTREAM DEFENDER

BASIN C
WEST SITCUM
SW TREATMENT
TACOMA, WA

Hydro International

94 Hutchins Drive
Portland, ME 04102
Tel: +1 (207) 756-6200
Fax: +1 (207) 756-6212
hydro-int.com

APPROX WEIGHT: N/A
MATERIAL:
NEXT ASSEMBLY: 18_12_0579-NEXT ASSY
DRAWING NO.: 18_12_0579-DD GA
SHEET SIZE: B
SHEET: 1 OF 3
Rev: -

TABLE OF CONTENTS

SECTION 1

FEATURES & BENEFITS

Downstream Defender®

High-Level Treatment in a Small Footprint

Product Profile

The Downstream Defender® is an advanced vortex separator used to treat stormwater runoff in pretreatment or stand-alone applications. Its unique flow-modifying internal components distinguish the Downstream Defender® from conventional and simple swirl separators that typically bypass untreated peak flows to prevent washout of captured pollutants. Its wide treatment flow range, low headloss, small footprint and low-profile make it a compact and economical solution for capturing nonpoint source pollution.

Components

1. Inlet to Precast Vortex Chamber
2. Cylindrical Baffle
3. Center Shaft
4. Outlet Pipe
5. Sediment Storage Sump
6. Access Lid

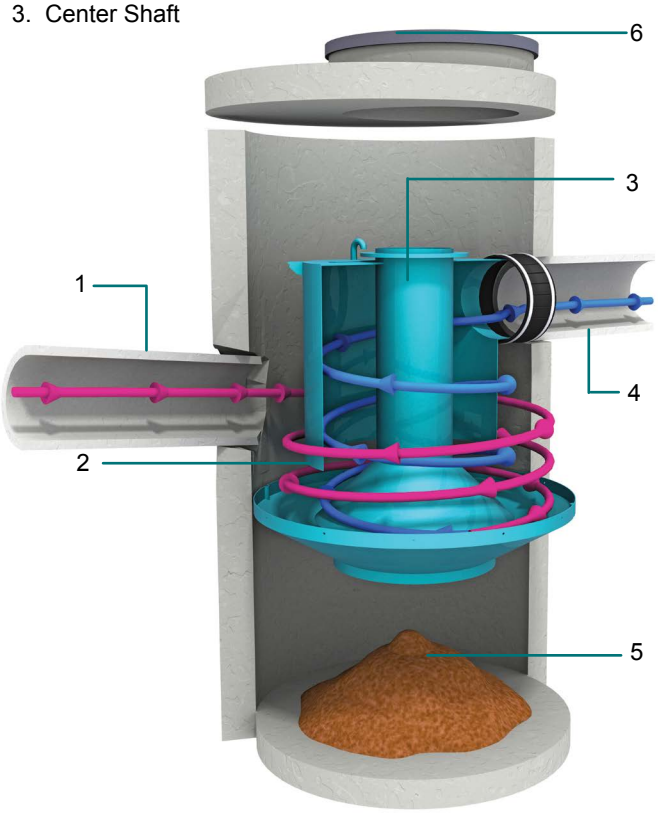

Fig.1 The Downstream Defender® has internal components designed to maximize pollutant capture and minimize pollutant washout.

Applications

- Removal of total suspended solids (TSS), floatable trash and petroleum products from stormwater runoff
- New construction or redevelopment of commercial and residential sites
- Pollutant hotspots such as maintenance yards, parking lots, gas stations, streets, highways, airports and transportation hubs
- Site constrained LID or green infrastructure based developments
- LEED® development projects

Advantages

- Special internal components maximize pollutant capture and minimize footprint, headloss and washout
- Captures and retains a wide range of TSS particles
- High peak treatment flow rates
- Treats the entire storm with no washout or untreated bypass flows
- Low maintenance requirements - no dredging required, and no screens or media to block
- Variable inlet/outlet angles for ease of site layout

How it Works

Advanced hydrodynamic vortex separation is a complex hydraulic process that augments gravity separation with low-energy rotary forces. The flow modifying internal components used in the Downstream Defender® harness the energy from vortex flow and maximize the time for separation to occur while deflecting high scour velocities (**Fig.1**).

Polluted stormwater is introduced tangentially into the side of the precast vortex chamber to establish rotational flow. A cylindrical baffle with an inner center shaft creates an outer (magenta arrow) and inner (blue arrow) spiraling column of flow and ensures maximum residence time for pollutant travel between the inlet and outlet.

Oil, trash and other floating pollutants are captured and stored on the surface of the outer spiraling column. Low energy vortex motion directs sediment into the protected sump region. Only after following a long three-dimensional flow path is the treated stormwater discharged from the outlet pipe. Maintenance ports at ground level provide access for easy inspection and clean-out.

Downstream Defender®

Drainage Profile

The Downstream Defender® is designed with a submerged tangential inlet to minimize turbulence within the device. Turbulence increases system headlosses and reduces performance by keeping pollutant particles in suspension.

The inlet elevation of the Downstream Defender® is located one inlet pipe diameter lower than the elevation of the outlet invert (**Fig.2**). This arrangement ensures that influent flows are introduced to the treatment chamber quiescently below the water surface elevation, minimizing turbulence.

The unique flow-modifying internal components also minimize hydraulic losses. There are no internal weirs or orifices; large clear openings ensure low headloss at peak flow rates with little risk of blockages that cause upstream flooding.

Inspection and Maintenance

Nobody maintains our systems better than we do. To ensure optimal, ongoing device performance, be sure to recommend Hydro International as a preferred service and maintenance provider to your clients.

Call **1 (800) 848-2706** to schedule an inspection and cleanout or learn more at **hydro-int.com/service**

Sizing & Design

The Downstream Defender® can be used to meet a wide range of stormwater treatment objectives. It is available in 5 precast models that fit easily into the drainage network (**Table 1)**. Selection and layout of the appropriate Downstream Defender® model depends on site hydraulics, site constraints and local regulations. Both online (**Fig.3a)** and offline (**Fig.3b**) configurations are common.

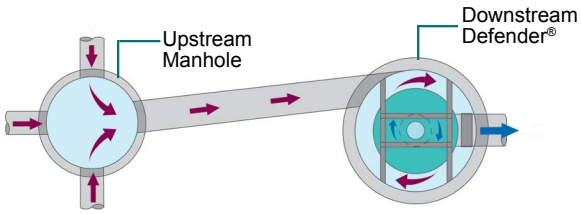

Fig.3a The Downstream Defender® in an online configuration.

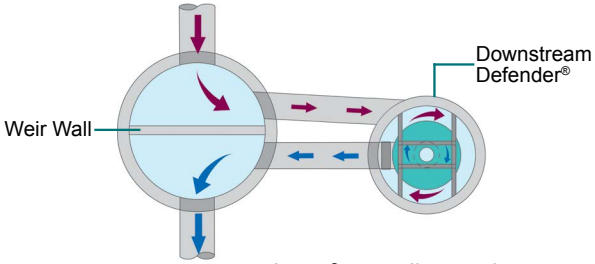

Fig.3b The Downstream Defender® in an offline configuration.

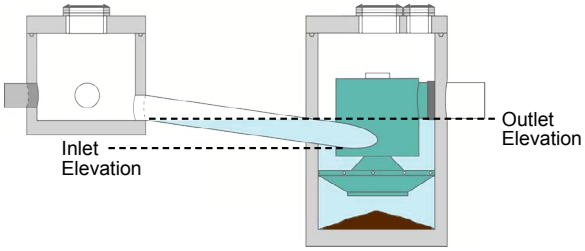

Fig.2 The Downstream Defender® has a submerged inlet that reduces headloss and improves efficiency of pollutant capture.

Free *Stormwater Sizing Tool*

This simple online tool will recommend the best separator, model size and online/offline arrangement based on site-specific data entered by the user.

Go to hydro-int.com/sizing to access the tool.

Table 1. Downstream Defender® Design Chart.

Model Number and Diameter		Peak Treatment Flow Rate		Maximum Pipe Diameter		Oil Storage Capacity		Sediment Storage Capacity		Minimum Distance from Outlet Invert to Top of Rim		Standard Height from Outlet Invert to Sump Floor	
(ft)	(m)	(cfs)	(L/s)	(in)	(mm)	(gal)	(L)	(yd^3)	(m^3)	(ft)	(m)	(ft)	(m)
4	1.2	3.0	85	12	300	70	265	0.70	0.53	2.8	0.85	4.1	1.25
6	1.8	8.0	227	18	450	216	818	2.10	1.61	3.2	0.98	5.9	1.80
8	2.4	15.0	425	24	600	540	2,044	4.65	3.56	4.2	1.28	7.7	2.35
10	3.0	25.0	708	30	750	1,050	3,975	8.70	6.65	5.0	1.52	9.4	2.85
12*	3.7	38.0	1,076	36	900	1,770	6,700	14.70	11.24	5.6	1.71	11.2	3.41

*Not available in all areas. Contact Hydro International for details.

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

SECTION 2

PRODUCT SPECIFICATIONS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this section includes furnishing all labor, equipment, materials, tools and incidentals required for a complete and operable installation of the Downstream Defender® stormwater treatment system (treatment system, system, Advanced Hydrodynamic Vortex Separator, or AHVS) as shown on the drawings and specified herein.

B. The manufacturer shall design and supply the equipment listed herein and the Contractor shall install the equipment in accordance with the manufacturer's Handling, Storage, and Installation Instructions.

1.02 GENERAL REQUIREMENTS

A. The treatment system shall use an induced vortex to separate pollutants from stormwater runoff. The system shall be self-activating with no mechanical parts or external power requirements.

B. The treatment system shall be supplied by a manufacturer regularly engaged in such work who has furnished similar installations that have been in successful and continuous operation for a minimum period of fifteen years.

C. Upon request, independently certified performance data and references shall be made available to the Engineer of Record for use in determining that the treatment system meets the design criteria and performance requirements stated herein.

1.03 SUBMITTALS

A. Submittals shall be provided and shall include the following:

1. General arrangement and dimensional drawings of the treatment system.

2. Plan and elevation drawings of the treatment system as it shall be incorporated into the stormwater drainage system. The elevation drawing shall indicate the top of water level both upstream and downstream of the treatment system at the flow conditions specified herein.

3. Handling, Storage and Installation Instructions.

4. Operation and Maintenance Instructions and a Maintenance video.

1.04 QUALITY ASSURANCE

A. The stormwater treatment system shall be manufactured under the direction of an ISO 9001 Certified Company.

B. Inspection

The stormwater treatment system shall be subject to inspection by the Engineer of Record or the owner's representative at either the place of manufacture or the project site. Any and all observed defects shall be repaired to the satisfaction of the owner or owner's representative or replacement shall be made available.

C. Warranty

The manufacturer shall guarantee the treatment system from defects in materials and workmanship for a period of two years following installation. If during the warranty period defects in materials or workmanship are noted, then the manufacturer shall be promptly notified. The decision to repair or replace affected units shall be made at the discretion of the manufacturer.

D. Patent Indemnity

Upon request, the manufacturer shall warrant that the treatment system does not infringe upon or violate any patent, copyright, trade secret or any other proprietary right of any third party and shall indemnify the Owner against any loss, cost, expense or liability arising out of such claim whether or not such claim is successful.

E. Certificate of Compliance

Upon request, the manufacturer shall provide a "Letter of Certification" to certify that the stormwater treatment system adheres to the specifications required herein and complies with the project's stormwater management permit.

1.05 MANUFACTURER

A. The stormwater treatment system shall be the Downstream Defender® as designed by Hydro International located at 94 Hutchins Drive, Portland, Maine 04102. Telephone (207) 756-6200. Fax (207) 756-6212.

B. Alternate stormwater treatment systems must demonstrate compliance with the specifications herein and be approved by the Engineer of Record. Request for alternative systems shall include:

i. Revised site plan showing location and orientation of proposed alternative, pipe sizes, connections and excavation limits.

ii. Product installation drawings showing plan and elevation views with water elevations for the flow conditions specified herein.

iii. Performance data as required in Part 2.

iv. Maintenance manual including inspection and clean out costs, maintenance video and three references for verifying successful completion of the procedures and associated costs.

C. Costs for reviewing submittals for alternative treatment system shall be the Contractor's or Manufacturer's responsibility.

PART 2 – STORMWATER TREATMENT SYSTEM

2.01 General

A. The stormwater treatment system shall be an Advanced Hydrodynamic Vortex Separator (AHVS) with flow-modifying internal components that minimize turbulence and prevent any flow from internally bypassing the separation region within the vortex chamber.

B. A tangential inlet pipe shall be used to establish rotational flow within a cylindrical vortex chamber. All polluted flow entering the vortex chamber through the inlet pipe shall follow a controlled three-dimensional flow path. Internal baffles will prevent flow entering the vortex chamber from discharging directly to the outlet pipe.

C. The tangential inlet pipe shall be positioned to convey flow into the vortex chamber beneath the internal water elevation. The AHVS shall not exceed the pressure drop (headloss) for the design flow rates specified herein as determined by ASTM C1745 / C1745M – 11.

D. The AHVS shall fit within the limits of excavation (area and depth) as shown in the project plans and will not exceed the dimensions for the design flow rates specified herein.

E. The AHVS shall provide separate and protected storage regions for captured pollutants that float and for those that settle and shall prevent re-suspension and washout of stored pollutants for the specified flow rates. The AHVS shall not release captured floating pollutants during surcharge conditions.

F. The storage capacities for pollutants that settle (sediment) and float (oil) shall not be less than the volumes listed in Table 1. The AHVS shall operate as intended and perform as specified herein as pollutants accumulate. The storage capacity for pollutants that settle shall not reduce the volume required in the vortex chamber for separation and for preventing re-suspension and washout, or reduce the floatables storage volume capacity.

G. Minimum 24-inch openings shall provide access to the sediment storage volumes from the surface for inspection and maintenance. Two access openings shall be provided for systems larger than 4 feet in diameter. Removal of pollutants from the treatment system shall be possible without requiring confined space entry.

2.02 Performance

A. Performance of the AHVS shall be based on independent full-scale laboratory and/or field testing and shall adhere to the Performance Specifications listed in Table 1. The laboratory testing used as the basis of product performance shall be undertaken in accordance with testing protocols approved or endorsed by the Stormwater Equipment Manufacturers Association (SWEMA) or acceptable State agency, such as a State Department of Environmental Protection (DEP) or recognized verification agency (e.g: ETV, NJCAT, NETE).

B. Performance of the AHVS shall be based on treating the Water Quality Flow rate (WQF) without internally bypassing and without re-suspension and washout of

captured pollutants (scour). The Maximum Treatment Flow Rate(s) (MTFR-50 and/or MTFR-100) shall be greater than or equal to the WQF. The AHVS shall remove greater than or equal to 80% of TSS based on the Target Particle Size (TPS) of 50 microns and/or 100 microns at MTFR-50 and MTFR-100, respectively.

C. The AHVS shall treat all flows without internally bypassing up to the Peak Treatment Flow Rate (PTFR). Full-scale independent laboratory scour testing shall demonstrate effluent control of less than or equal to 20 mg/L for all flows up to 150% of MTFR-100 without internal or external bypass.

D. The AHVS shall be capable of capturing and retaining fine silt and sand size particles. Analysis of captured sediment from full-scale field installations shall demonstrate particle sizes predominately in the 20-micron range.

E. The AHVS shall capture and retain 100% of all floating trash and debris and remove greater than 80% of hydrocarbons up to its rated storage capacities under conditions of a catastrophic spill such as might be experienced in an automobile or truck accident spill like conditions.

Table 1.

Downstream Defender® Performance Specifications

Model (feet)	Depth[1] (feet)	MTFR-50[2] (cfs)	MTFR-100[2] (cfs)	Scour Flow Rate[3] (cfs)	PTFR[4] (cfs)	Headloss[5] (feet)	Oil Storage Capacity[6] (gal.)	Sediment Storage Capacity[6] (gal.)
4	4.1	1.2	1.6	2.4	3	0.68	70	141
6	5.9	3.4	4.3	6.5	8	0.95	216	424
8	7.7	6.9	8.8	13.3	15	1.1	540	939
10	9.4	12	15	23.3	25	1.2	1,050	1,757
12	11.2	19	24	38	38	1.4	1,770	2,970

Notes:

1. Depth measurement is from the outlet invert to top of the bottom slab.
2. MTFR-50 and MTFR-100 are the Maximum Treatment Flow Rates for removing target particle sizes of 50 microns and 100 microns, respectively.
3. Scour Flow Rates are based on testing that demonstrates retention of captured sediment having a D50 of 100. Effluent concentrations shall not exceed 20 mg/L.
4. PTFR or Peak Treatment Flow Rate is based on the treatment system maintaining positive removal efficiencies and headlosses no greater than those listed above for each model.
5. Headlosses are the difference in water elevations upstream and downstream of the AHVS as determined by ASTM C1745 / C1745M – 11. The headlosses listed above for any particular model are for that treatment system operating at the Peak Treatment Flow Rate.
6. Refer to 2.01 E.

PART 3 – EQUIPMENT

A. The Downstream Defender shall consist of a hollow, cylindrical vessel with internal components.

(i) The internal components to be supplied by Hydro International shall include the center shaft and cone, dip plate, benching skirt, floatables lid and component support frame.

Materials of construction for the above components excluding the support frame shall be cross-linked polyethylene (XLPE). The component support frame members and all metal parts shall be Type 304 stainless steel or carbon steel powder coated in accordance with ASTM 775/ ASTM A775M with a resulting thickness of 8-12 mils. All components shall be designed to withstand all normal loadings associated with fabrication, shipping, site installation, and normal operation of the equipment. The component support frame shall withstand a live load of 500 pounds.

(ii) The hollow cylindrical vessel shall be a precast concrete structure manufactured with concrete that has attained a compressive strength of 4,000 psi after 28 days. The structure shall be reinforced to withstand an HS20-44 loading. Shiplap joints shall be sealed with butyl rubber mastic sealant conforming to ASTM C990. Slab tops shall be suitably reinforced and provided with manhole openings and covers as required. The cast iron manhole frames and covers shall be sized as per the manufacturer's drawings and shall be in accordance with ASTM A48, CL.35B and AASHTO M105. The masonry fixing bolts shall be Type 304 stainless steel.

(iii) All piping connections and ancillary items not listed herein shall be provided by the Contractor.

PART 4 - EQUIPMENT DELIVERY

A. The Downstream Defender components shall be delivered within six weeks of date of approved technical submittal.

B. The Downstream Defender components shall be delivered to the site fully fabricated or shall be ready for the final assembly of the support frames within the host manhole structure.

C. Off-loading, storage, and installation shall be by the Contractor.

D. The Contractor shall inspect and provide signed acceptance of equipment prior to unloading, or notify Hydro International of any damage to equipment to effect proper remedial action. Failure to notify Hydro International of damage to equipment prior to unloading will void all warranties pertaining to subject equipment.

PART 5 - EQUIPMENT INSTALLATION

A. The system shall be installed in strict accordance with the site plans, and the manufacturer's general arrangement drawings and Handling, Storage and Installation Instructions. The Contractor shall be responsible for installing the equipment and all necessary site connections.

B. The Manufacturer shall be notified immediately of any equipment which is damaged during unloading, storage, or installation. The damaged equipment shall be repaired or replaced at the discretion of Hydro International and entirely at the Contractor's expense.

C. The precast concrete structure shall be set on a granular or compacted sand sub-base in accordance with local requirements for standard manhole installation. In no instances shall the compacted sub-base material have a thickness of less than 12 inches.

D. The precast concrete structure shall be set level and plumb to within 0.5%.

E. Non-shrink grout or hydraulic cement conforming to ASTM C 595 shall be used to provide a water tight seal in the lift holes, any drain holes and around the concrete knock-outs for the inlet and outlet pipes.

F. The Contractor shall, at the discretion of the owner or owner's representative, test the concrete structure for water tightness before backfilling.

SECTION 3

INSPECTIONS & MAINTENANCE

Hydro International®

Operation and Maintenance Manual

Downstream Defender®

Vortex Separator for Stormwater Treatment

Turning Water Around ...®

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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
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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.

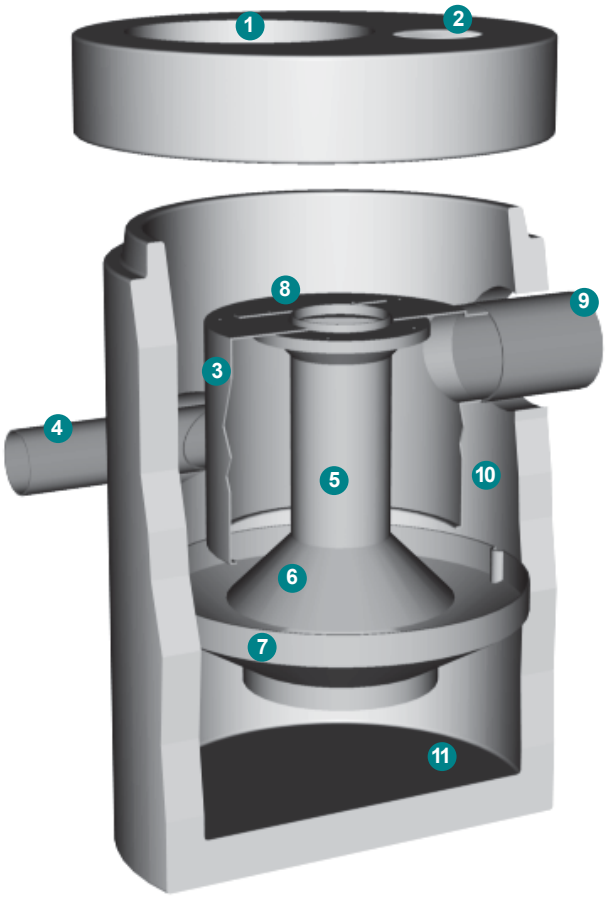
The high removal efficiencies and inherent low headlosses of the Downstream Defender® allow for a small footprint making it a compact and economical solution for the treatment of non-point source pollution.

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 ranges 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)

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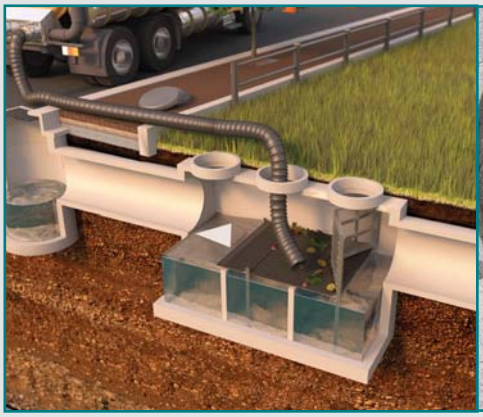
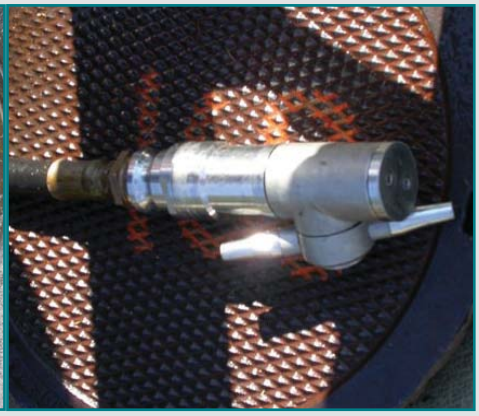
Better Tools, Better Results

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:

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



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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 adsorbant 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.

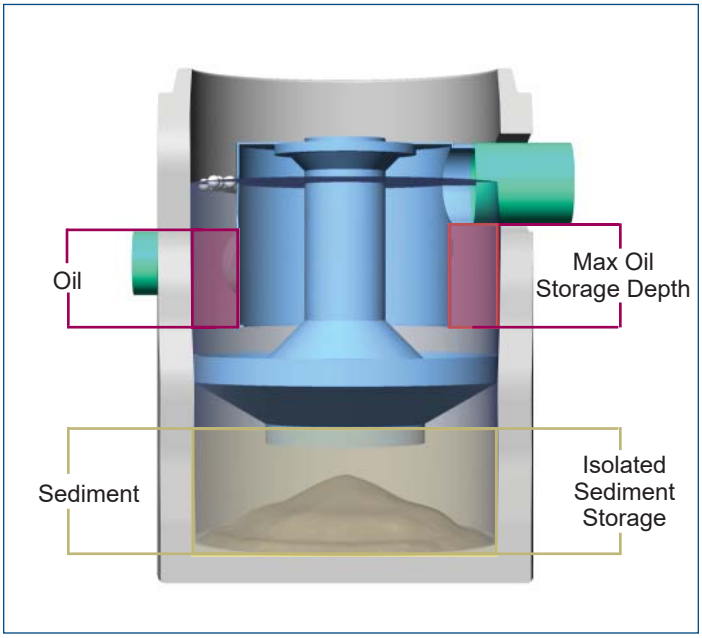

Fig.1 Pollutant storage volumes of the Downswtream Defender®.

The Downstream Defender® allows for easy and safe inspection, monitoring and clean-out procedures. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables. Access ports are located in the top of the manhole. On the 6-ft, 8-ft and 10-ft units, the floatables access port is above the outlet pipe between the concrete manhole wall and the dip plate. The sediment removal access ports for all Downstream Defender® models are located directly over the hollow center shaft.

Maintenance events may include Inspection, Oil & Floatables Removal, and Sediment Removal. Maintenance events do not require entry into the Downstream Defender®, nor do they require the internal components of the Downstream Defender® to be removed. In the case of inspection and floatables removal, a vactor truck is not required. However, a vactor truck is required if the maintenance event is to include oil removal and/or sediment removal.

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/flotables removal, for a 6-ft Downstream Defender® typically takes less than 30 minutes and removes a combined water/oil volume of about 500 gallons.

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

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

1. Refer to Dowmstream Defender® Clean-out Detail (Fig. 1) for measurement of depths.

2. Oil accumulation is typically less than sediment, however, removal of oil and sediment during the same service is recommended.

3. Remove floatables first, then remove sediment storage volume.

4. 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.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities. See Fig.7 and 8 for typical inspection views.

4. Without entering the vessel, use the pole with the skimmer net to remove floatables and loose debris from the outer annulus of 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 (Fig.5).

6. On the Maintenance Log (see page 9), 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 blockages.

7. Securely replace the grate or lid.

8. Take down safety equipment.

9. Notify Hydro International of any irregularities noted during inspection.

Floatables and Sediment Cleanout

Floatables cleanout 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 cleanout 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 cleanout 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 (Pg.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).
7. Retract the vactor hose from the vessel.
8. 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 blockages.
9. Securely replace the grate or lid.

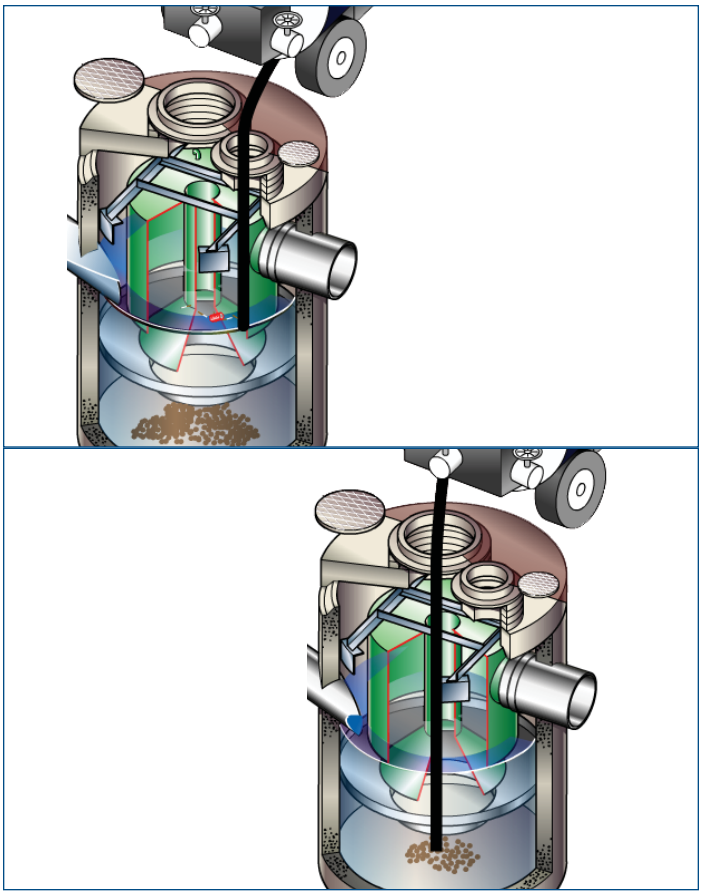

Fig.9 Floatables and sediment are removed with a vactor hose

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**

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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.

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