Turning Water Around…®

April 18, 2018

Mr. Leo Cosentini
California State Water Resources Control Board
Division of Water Quality
P.O. Box 100
Sacramento, CA 95812-100

Re: Amended Application for Trash Treatment Control Device – Hydro Up-Flo® Filter

Dear Mr. Cosentini,

Hydro International® is pleased to submit this amended application for the Hydro Up-Flo® Filter for Certification as a Full Capture System - Trash Treatment Control Device. Documentation for this application is being submitted in accordance with the California State Water Resources Control Board *Trash Treatment Control Device Application Requirements* document that includes the following minimum required sections:

1. Cover Letter
2. Table of Contents
3. Physical Description
4. Installation Information
5. Operation and Maintenance Information
6. Reliability Information
7. Field/Lab Testing Information and Analysis

Please contact me with any questions or should additional information be required. Thank you for your consideration of this application.

Regards,

David Scott
Technical Product Manager
Hydro International®

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

1.0 COVER LETTER

1.A. A general description of the Device;

The Hydro Up-Flo® Filter is a multi-stage stormwater treatment Device that incorporates screening, sedimentation, physical filtration, adsorption and absorption in a treatment train approach to treating stormwater. Each Up-Flo® consists of a highly configurable array of filtration modules that can be connected in parallel to achieve the necessary treatment flow rate. The filtration modules are housed in precast concrete manholes, small/medium/large precast concrete vaults, or fiberglass vessels. The treatment train process begins with all stormwater first passing through perforated stainless steel screens affixed to the bottom of each filter module. The screen opening apertures do not exceed 4.0mm in size and all flows under the listed maximum treatment capacity must pass through the screens ensuring removal and retention of all particles 5.0mm in size or larger. From the screens, the stormwater is routed through the filtration modules, which contain engineered filtration media or filter membrane ribbons for removal of fine sediment, heavy metals, and nutrients. Various media configurations of the Up-Flo® are available and these configurations target a wide variety of pollutants but all configurations at a minimum target trash and all configurations remove and retain all particles 5.0mm in size or larger. The stormwater from each filtration module exits the Device through a combined centralized outlet. The Up-Flo® may be used off-line or in-line with the internal bypass configurations. The internal bypass configurations utilize a patented bypass siphon that has been proven to retain 100% of floating and neutrally buoyant trash and debris.

1.B. The applicant's contact information and location;

California Contact:
Phil O'Neill
Regional Sales Manager
Hydro International®
109 First Street
Solvang, California 93463
(805) 350-8163
poneill@hydro-int.com

Corporate Contact:
David Scott
Technical Product Manager
Hydro International®
94 Hutchins Drive
Portland, Maine 04102
(207) 756-6200
dscott@hydro-int.com

1.C. The Devices' manufacturing location;

Hydro International® utilizes a combination of contract manufacturers and component suppliers to produce the Hydro Up-Flo® stormwater treatment system. These partner facilities are located throughout the United States and Hydro selects the facility used based on proximity to the project as well as other factors. The facilities utilized for any particular project are selected to provide the most cost effective and convenient solution.

Hydro International® currently retains over 60 partner, manufacturing facilities. Four facilities currently provide support for the California market and these are located in San Diego, Santa Maria, Simi Valley, and Pleasanton.

1.D. A brief summary of any field/lab testing results that demonstrates the Device functions as described within the application;

The Hydro Up-Flo® was originally developed and tested in a controlled laboratory environment and during actual rainfall conditions under a Small Business Innovative Research funded grant by the US EPA. The Up-Flo® has subsequently been tested under laboratory and field conditions over a dozen times. Many of these tests place an emphasis on sediment, metals, and nutrient removals but others have focused on the hydraulics and trash and debris retention of the Device. The data from these tests were utilized to determine system limitations in regards to hydraulics, sedimentation, filtration, and trash capture and retention effectiveness. Additionally Hydro International® utilized this data to scale geometrically proportional models of the Up-Flo® considering equivalent surface and filter loading rates and screen open areas.

Copies of the test reports related to hydraulics and trash capture have been include with this Application in Appendix F. Other test reports pertaining to filtration may be made available on request.

1.E. A brief summary of the Device limitations, and operational, sizing, and maintenance considerations;

The Hydro Up-Flo® is an engineered stormwater treatment system developed to meet a wide variety of applications and water quality objectives. Proper design, application, sizing, installation, operation and maintenance are critical to ensuring water quality objectives are met.

The Hydro Up-Flo® is made from precast concrete and internal components are made from materials with long service lives. Designers should ensure application of the Device is within the strength and service limits of the precast concrete structure as well as the strength and service limits of the internal components. Adherence to Hydro International® design recommendations will ensure application within the design limits of the Up-Flo®.

The Hydro Up-Flo® is designed to remove sediment, heavy metals, nutrients, trash, debris, Oil and Grease, and other gross pollutants. Sizing of the system is dependent on the targeted pollutants of concern and the federal, state, and local regulations that govern the water quality objectives. Recommended sizing guidelines have been provided in this Application but adequate sizing should be confirmed prior to finalization of design and installation.

Maintenance is a critical component of any Trash Control Program. The Hydro Up-Flo® is an effective tool to help achieve Trash Control Program objectives but performance is dependent on routine maintenance and proper operation. Because the Hydro Up-Flo® retains 100% of captured trash, extended maintenance cycles may be achievable. Additionally, the design of the Up-Flo® allows for easy access for inspection and maintenance.

1.F. A description or list of locations, if any, where the Device has been installed. Include the name and contact information of as many as three municipality(s) purchasing the Device, and

Project 1: Harrington Corp Five Module, 4ft-Diameter Up-Flo® Filter Manhole
3721 Cohen Place
Lynchburg Virginia 24501
Troy Daniel
(434) 845-7094 ext. 413
tdaniel@harcofittings.com

Project 2: University at Albany, 4ea X Six Module, 4ft-Diameter Up-Flo® Filter Manhole
University at Albany, State University of New York
Frank Fazio, P.E.
(518) 442-3400
ffazio@albany.edu

Project 3: KPH Six Module, 4ft-Dimaeter Up-Flo® Filter Manhole
KPH Healthcare Services, Inc.
2912 James Street
Syracuse, New York 13206
Mark Smith
(315) 287-3600 ext. 2805
marksmith@kphhealthcareservices.com

Additional installations of the Trash Capture version of this device are pending SWRCB Certification.

1.G. The certification below:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons that manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

_____ 04/18/2018

David Scott, Technical Product Manager Date

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2.0 TABLE OF CONTENTS

Contents

3.0 PHYSICAL DESCRIPTION

3.A. Design drawings for all standard Device sizes including dimensions, and alternative configurations;

Design drawings for all standard devices and configurations are included in Appendix A.

3.B. Description on how the Device works to trap all particles that are 5 mm or greater in size and how it is sized for varying flow volumes;

The Hydro Up-Flo® Filter is a multi-stage stormwater treatment Device that incorporates screening, sedimentation, physical filtration, adsorption and absorption in a treatment train approach to treating stormwater. Each Up-Flo® consists of a highly configurable array of filtration modules that can be connected in parallel to achieve the necessary treatment flow rate. The filtration modules are housed in precast concrete manholes, small/medium/large precast concrete vaults, or fiberglass vessels. The treatment train process begins with all stormwater first passing through perforated stainless steel screens affixed to the bottom of each filter module. The screen opening apertures do not exceed 4.0mm in size and all flows under the listed maximum treatment capacity must pass through the screens ensuring removal and retention of all particles 5.0mm in size or larger. From the screens, the stormwater is routed through the filtration modules, which contain engineered filtration media or filter membrane ribbons for removal of fine sediment, heavy metals, and nutrients. Various media configurations of the Up-Flo® are available and these configurations target a wide variety of pollutants but all configurations at a minimum target trash and all configurations remove and retain all particles 5.0mm in size or larger. The stormwater from each filtration module exits the Device through a combined centralized outlet. The Up-Flo may be used off-line or in-line with the internal bypass configurations. The internal bypass configurations utilize a patented bypass siphon that has been proven to retain 100% of floating and neutrally buoyant trash and debris.

Figure 1 illustrates the main components of an Up-Flo® manhole configuration. Operation of the Up-Flo® Filter is initiated during a rainfall event when stormwater is conveyed into the treatment chamber from a pipe (1) or grated inlet (9). As stormwater flow enters the chamber, internal components act as baffles to force gross debris and sediment to settle into the sump (3) and floating debris to rise to the surface. As flow continues into the chamber, a water column builds above the modules (6). This water column provides the potential energy to drive flow upward through the angled 4.0mm screens (8) and through the engineered media (2). All flows under the listed maximum treatment capacity must first pass through the screens (8) ensuring removal and retention of all particles 5.0mm in size or larger. Once flows pass the screens (8) they enter the media treatment area (2) of the module. The module is typically populated with media packs (2) that consist of granular media. The composition of the media can be a standard blend of CPZ (Carbon, Peat, and Zeolite) or a customized blend to treat site-specific pollutants of concern. If the only targeted pollutant is trash, the media area of the module remains populated with a flow

distributing media only which allows for increased flow rates. When configured with traditional media packs (2), upward flow causes the individual particles in the media to shift from a state where they are compressed by gravitational forces to a state where they achieve very minute separation from each other. As they become suspended in an upward-flowing column of water the media matrix becomes fluidized. This allows particulates to be trapped throughout the entire depth of the media bed, rather than just the first few inches, subsequently increasing filter longevity.

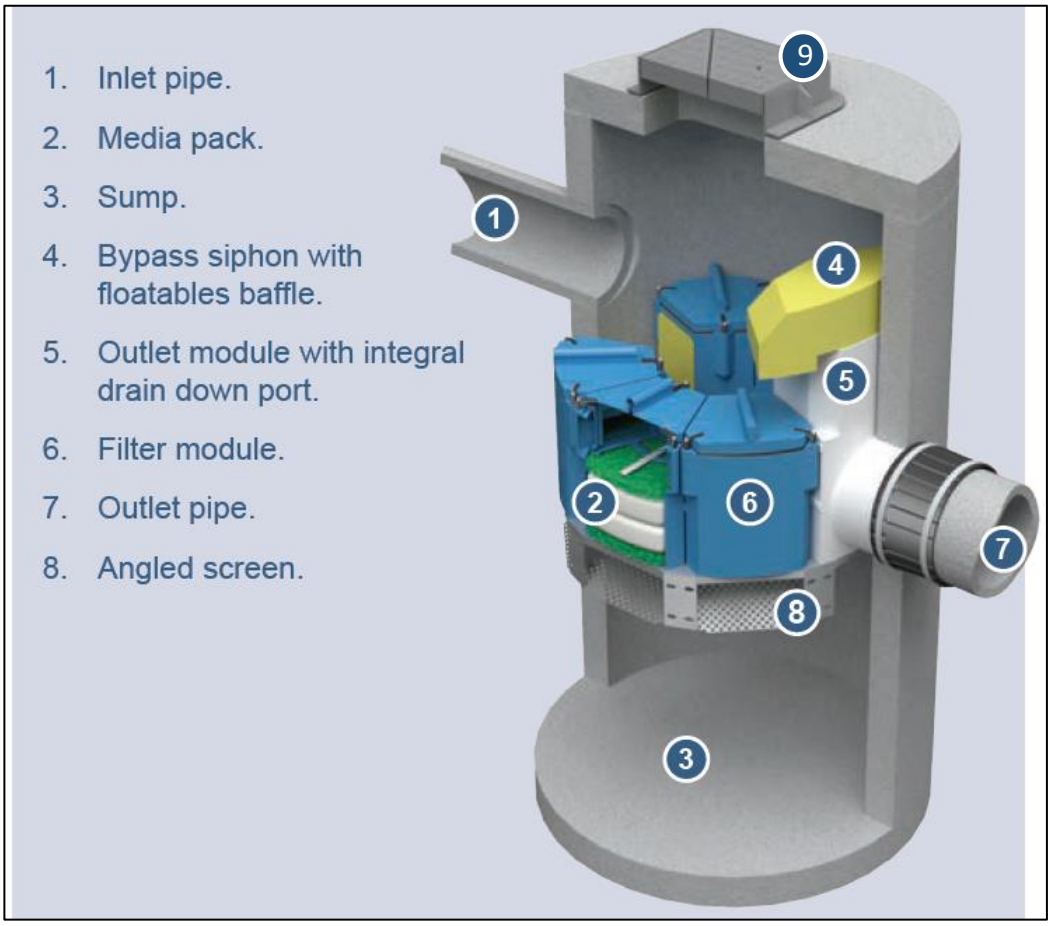


Figure 1 - Hydro Up-Flo® Component Diagram

The screened (and media treated) stormwater combines in a central conveyance channel located above the top of the media area that connects all of the modules together. This channel conveys treated flows to the exit module (5) for exit from the treatment area.

Flows in excess of the maximum treatment capacity discharge to the outlet module (5) via a hood (4) that mounts on top of the exit module. This hood (4) acts as a bypass siphon that incorporates a floatables baffle. Trapped buoyant, trash and debris floats on the surface of the water while the bypass water discharges directly beneath the surface through the exit at the bottom of the

hood (4). Water cannot discharge into the exit module until sufficient water elevation is achieved above the top of the hood (4) which prevents prevent re-entrainment of trash and debris. As the water surface elevation rises in the treatment chamber, air is displaced in the outlet module (5) and water is siphoned through the chute to the outlet (7) which accelerates the maximum discharge rate for larger storm events.

After a storm event, the water column drops to the top of the media packs (2) at which point there is no longer any head to drive flow. The Up-Flo® Filter can be provided with a filtered drain down module that allows the water level in the chamber to drop below the media packs between events preventing the media from becoming anaerobic. The flow control in the drain down allows remaining water through the drain down module (which incorporates a screen and filtration media) prior to discharging into the outlet. During the drain-down mode of operation, a light backwashing effect occurs that dislodges captured pollutants, trash and debris from the surface of the 4.0mm screen and filter bag (if any), helping to prevent blinding and prolong media life. Additionally, by draining the water out of the media, the weight of the media packs are reduced for easier removal during maintenance operations.

For simplification, the previous descriptions of the operation of the Up-Flo® covered the manhole version only. The Up-Flo® can also be provided in a vault configuration with standard vaults ranging in size 7ft X 8ft to 13ft X 15ft. Vaults can be configured with internal bypass or external bypass whereas manholes are internal bypass only. Vaults configured for external bypass

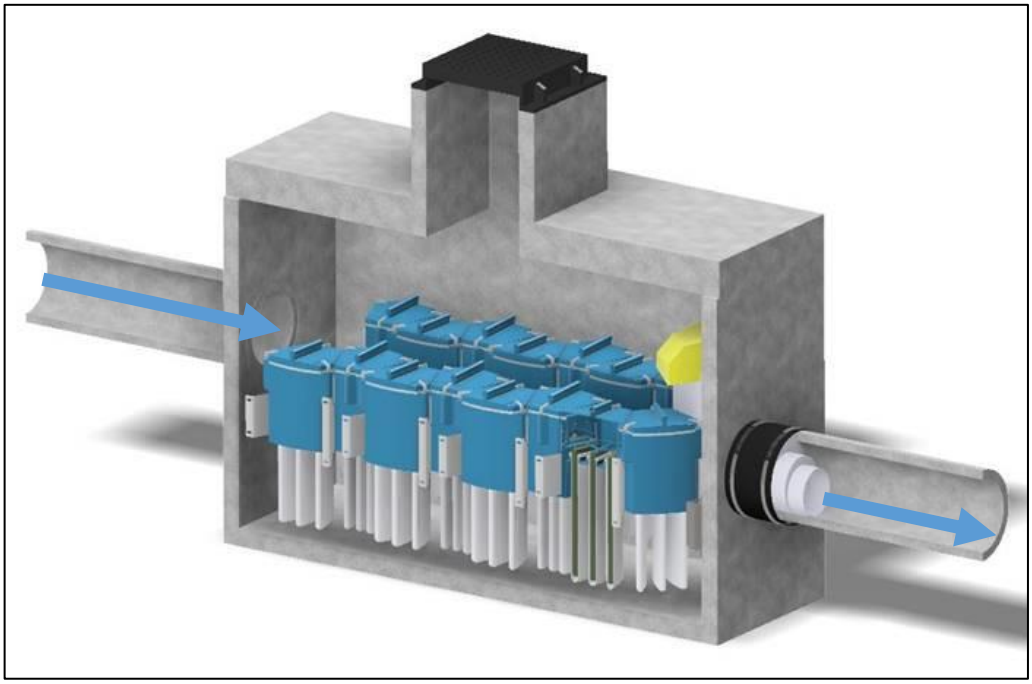


Figure 2 - Hydro Up-Flo® Vault Configured for Internal Bypass

function identically to the manhole configuration only at larger flows. Figure 2 illustrates an external bypass vault configuration. Stormwater flows enter and exit the vault in the same manner as the manhole configuration. The advantage of the vault configuration is more modules

may be utilized providing for increased maximum treatment capacities and greater pollutant storage capacities are realized. As with the manhole configuration, all flows under the listed maximum treatment capacity must first pass through the screens ensuring removal and retention of all particles 5.0mm in size or larger. Flows in excess of the maximum treatment capacity are siphoned from the treatment chamber as done in the manhole configuration.

Vaults configured for internal bypass function similarly to the manhole configuration and external bypass vault configuration. The internal bypass vault configuration treats the stormwater in the same manner as the manhole and external bypass vault but how water is routed to the treatment chambers and how flows in excess of the maximum treatment capacity are bypassed are different.

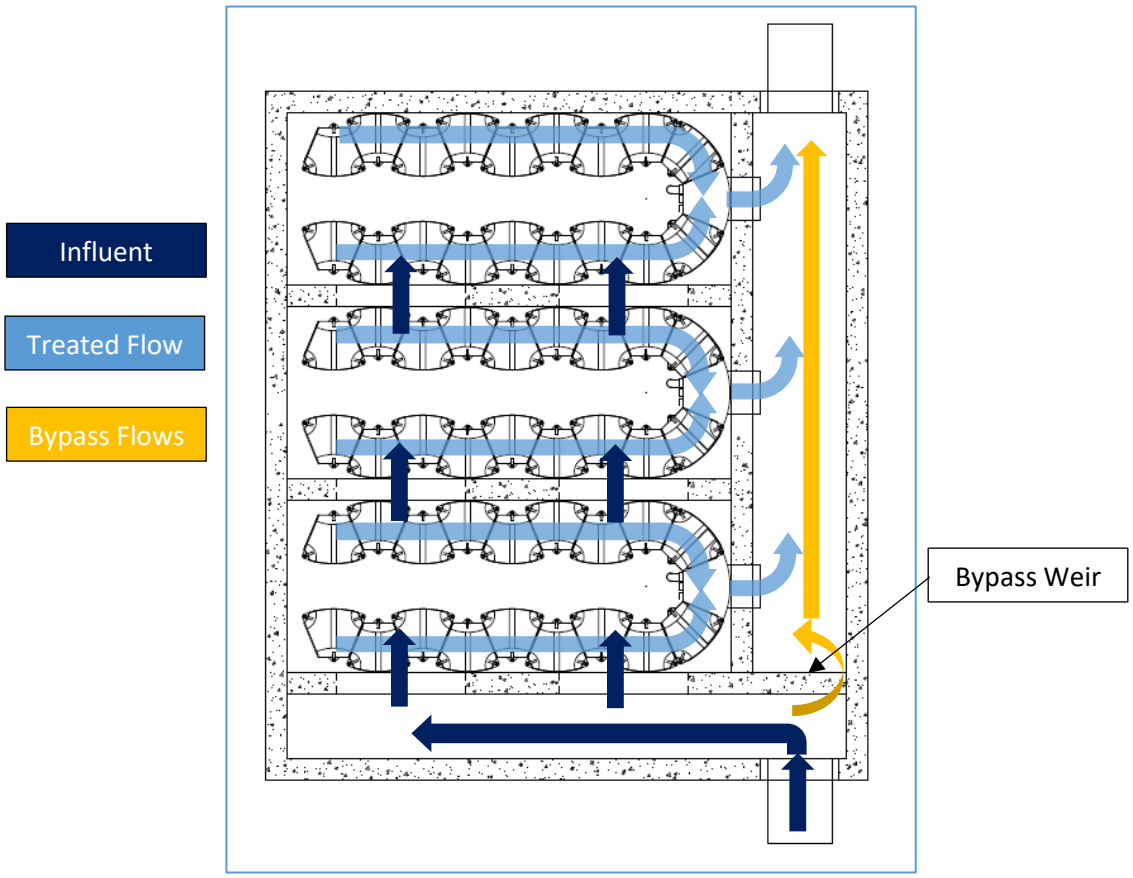


Figure 3 - Hydro Up-Flo® Vault Configured for External Bypass

Figure 3 provides an example of a vault configured for internal bypass with flow paths illustrated with different colored arrows. In the internal bypass configuration, the design flows are routed to the treatment chambers by a weir constructed in the main conveyance path of the vault. The weir height is set at an elevation that will cause all flows less than the maximum treatment

capacity (plus a safety factor) to be directed to the treatment chambers. Once the stormwater arrives in the treatment chamber, the typical treatment process ensues. Flows in excess of the maximum treatment capacity overtop the weir and continue, un-treated, down the main conveyance channel in the vault. Some flows within the treatment chamber will also bypass via the bypass hood mechanisms and some bypass flows will therefore be treated. Treated and bypass flows exit the treatment chamber and combine with the bypass flows in the main channel and exit the vault. Despite the altered flow path, all flows under the listed maximum treatment capacity must first pass through the screens in the treatment chambers thus ensuring removal and retention of all particles 5.0mm in size or larger.

A design chart for the Hydro Up-Flo® is included below in Table 1. The design chart includes characteristics and capacities for the Hydro Up-Flo® including sediment storage capacity, trash storage capacity, treatment module counts, maximum treatment capacity for Trash Full Capture removal and sediment removal, and blinding resilience.

Hydro Up-Flo® Design Chart
Table 1

Hydro Up-Flo® Sizes[1]	Module Quantity[2]		Maximum Treatment Capacity[3]	Blinding Resilience[4]	Minimum Bypass Capacity[5]	Trash Storage Capacity	Sediment Storage Capacity
Trash Only	Min	Max	(cfs)	Ratio	(cfs)	(ft^3)	(ft^3)
48-Inch Dia Manhole	2	6	1.4	3	3.4	24	17
7ft X 8ft Vault IB	2	7	1.4	3.5	3.4	32	22
4ft X 10.5ft Vault EB	2	19	1.4	9.5	AR	80	55
6ft X 13ft Vault IB	2	19	1.4	9.5	3.4	80	55
8.5ft X 13ft Vault EB	4	38	2.8	19	AR	166	114
11ft X 13ft Vault IB	4	38	2.8	19	6.8	166	114
13ft X 13ft Vault EB	6	57	4.2	28.5	AR	256	177
13ft X 15ft Vault IB	6	57	4.2	28.5	10.2	256	177
Trash & Sediment	(cfs)	(L/s)	(cfs)	Ratio	(cfs)	(ft^3)	(ft^3)
48-Inch Dia Manhole	1	6	0.34	3	3.4	24	17
7ft X 8ft Vault IB	1	7	0.39	3.5	3.4	32	22
4ft X 10.5ft Vault EB	1	19	1.06	9.5	AR	80	55
6ft X 13ft Vault IB	1	19	1.06	9.5	3.4	80	55
8.5ft X 13ft Vault EB	2	38	2.13	19	AR	166	114
11ft X 13ft Vault IB	2	38	2.13	19	6.8	166	114
13ft X 13ft Vault EB	3	57	3.19	28.5	AR	256	177
13ft X 15ft Vault IB	3	57	3.19	28.5	10.2	256	177

1. This table is intended as a guide for selecting standard model sizes. Contact Hydro International® for custom sizing needs.
2. Minimum and maximum module quantity are physical limitations only. Flow rate and blinding resilience may affect the minimum or maximum number of modules for a particular application.
3. The maximum treatment capacity is based on the maximum module quantity and is the maximum flow rate achievable in the Device to effectively remove the targeted pollutant of concern.
4. A larger blinding resilience number indicates greater resistance to screen blinding.
5. AR = As Required. External Bypass vaults can be configured with pipe sizes that meet the conveyance bypass requirements and bypass flow rates will vary as necessary based on the selected pipe size.

When the Up-Flo® is used as a Trash Treatment Control Device only, the modules are not populated with media. The rate of flow through the Device is solely controlled by the restrictions of the screen and the outlet control. This results in higher treatment flow rates and no claims

are made for sediment removal at these rates. The recommended maximum treatment capacity is 1.4cfs per filter array assuming a minimum of two filters modules in the array. The maximum treatment capacity for the most commonly used standard configurations of the Up-Flo® are listed in Table 1. These maximum treatment capacities for Trash Full Capture can be found in the upper portion of the table designated as "Trash Only".

Additional filter modules may be added to the array and treatment capacity will not increase for the "Trash Only" version but resilience to screen blinding will be enhanced. The "blinding resilience" of an Up-Flo® Filter is a comparison between the available module screen area and the conveyance channel area that connects the modules together. Each filter module screen has a surface area of 200 sq. inches. The opening apertures in the perforated mesh screen are 0.156 inches (4.0 mm) and open area void percentage of the screen is 63%. The resulting open area of the screen is thus 126 square inches. The dimensions of the conveyance slot in an Up-Flo module is 4-inches tall by 8-inches wide resulting in an open area of 32 square inches. Therefore, the open area of a single module screen is approximately four times greater than the open area of the module conveyance channel. The flow-limiting characteristic of the Device is thus the conveyance channel and not the module screen. This holds true for a newly commissioned Device or a Device that is well maintained with no screen blockages. An alternate way to analyze this is to determine the percentage of the screen that may be blinded before its open area is reduced enough to become a hydraulic restriction. Analyzed from this perspective single module screen may have up to 75% of the open area blocked before becoming a hydraulic restriction. A single filter module operating with 75% of its open area blocked will convey the maximum treatment capacity of the Device. Additional modules may be added to increase the resilience to blockage. Hydro International recommends a minimum resilience factor of two be utilized in design. The maximum resilience factor capability for common configurations of the Up-Flo® Device can be found in Table 1.

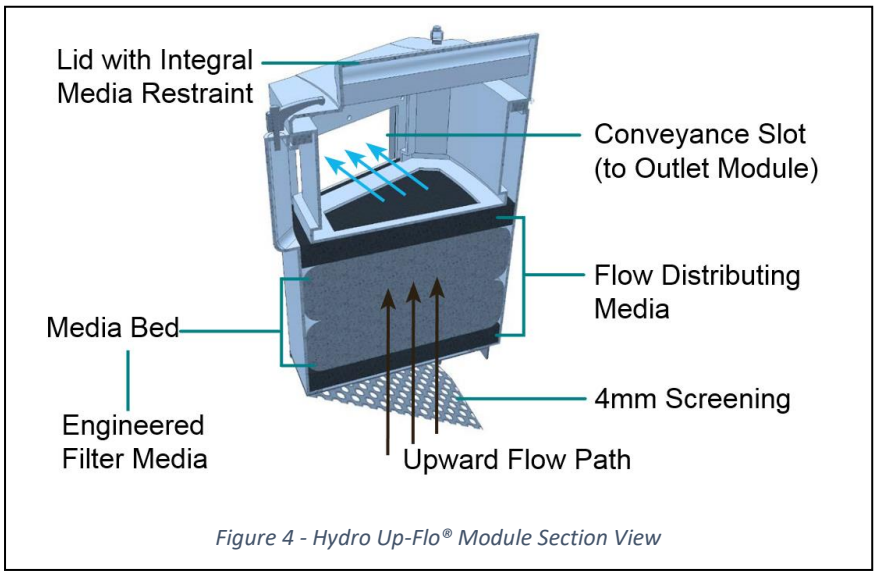


Figure 4 - Hydro Up-Flo® Module Section View

When installed with media packs, the hydraulic restriction of the modules and the Device becomes the flux of the media. With media installed, the Up-Flo® Filter is typically sized at 25 gpm (0.056cfs) per module. Vaults are designed to accept module arrays in chains up to nine modules long on both side of the outlet module. The maximum treatment capacity for the most commonly used standard configurations of the Up-Flo® with media modules are listed in Table 1 in the lower section labelled "Trash and Sediment". The flow rates to effectively remove sediment are below that of the flow rates to effectively capture Trash as well as the maximum capacity of the modules. As illustrated, the Up-Flo® can be effectively designed for other pollutants without concern of compromising the trash removal capabilities of the Device.

A video further illustrating the Up-Flo® operation can be found at the link listed below.

Hydro Up-Flo® Animation

Please note that clicking on this link will allow your browser to navigate to an external YouTube video animation of the Hydro Up-Flo®. An active internet connection is required.

3.C. The Device maximum trash capture capacity;

Table 1 lists the Device maximum trash capture capacity (ft^3) retained by each Up-Flo® model as "Trash Storage Capacity". The trash capture volumes listed in the table are maximum volumes that can be captured and retained without resuspension of trash and with consideration of the Maximum Treatment Capacity.

3.D. The Device hydraulic capacity (flow in cfs) at its maximum trash capture capacity for all standard Device sizes;

The maximum Device hydraulic capacity at the maximum trash capacity is listed as the "Maximum Treatment Capacity" in Table 1.

3.E. Conditions under which the Device re-introduces previously trapped trash;

Under normal design and operating condition the Hydro Up-Flo® will remove and permanently retain all trash and debris that is 5.0mm in size or larger. Conditions under which the Device may re-introduce previously trapped trash are as follows:

- Maintenance of Full Capture Devices is a critical component of any trash capture program. Adherence to the recommended maintenance requirements of the Device with special consideration for the maximum trash capacity is critical in ensuring previously trapped trash is not re-introduced into the stormwater. The listed maximum trash capacity for the Hydro Up-Flo® is the maximum manageable level the Device can

hold prior to experiencing adverse conditions including re-entrainment of previously trapped trash.

- Improper Design or Installation may cause the Device to operate improperly including re-introduction of previously trapped trash.
- Routine screen maintenance to ensure screens are not broken or damaged is critical to ensuring retained trash is not re-introduced into the environment. Missing, damaged, broken, or deteriorated screens and associated components should be routinely inspected and maintained to prevent reintroduction of retained trash.

3.F. Each material and material grade used to construct the Device (stainless steel, plastic, etc.);

The Hydro Up-Flo® is constructed of industry standard materials that are suitable for the harsh environment experienced by a subsurface stormwater treatment system. A detailed Specification for the Hydro Up-Flo® is included in Appendix B of this submittal. For convenience, a short listing of the major components and the materials used for those components is listed in this section:

- **Structure** – The Hydro Up-Flo® main structure is made from a concrete manhole conforming to ASTM C478 or concrete vault conforming to ASTM ASTM C857 and C858. The walls, floor, ceiling, and weirs are all made from concrete with a minimum 28 day compressive strength of 4,000psi or greater with aggregate per ASTM C33 and reinforcing steel per ASTM A615, Grade 60. The structure is designed to support traffic loads per AASHTO HS-25.

- **Metal Screens** – The metal screens are made from perforated stainless steel conforming to ASTM A240, Grade 304 with perforations not greater than 4.0mm (0.156 in) in size and a total open area not less than 63%.

- **Structural Mounting and Securing Components** – Frames, supports, mounting hardware and securing fasteners are made from stainless steel conforming to ASTM F593 and F594, Grade 304.

- **Modules, Module Lids, Bypass Hood & Outlet Structure** – The modules and related plastic components are rotationally mold from cross-linked polyethylene (XLPE).

- **Access Covers** – Manhole frames and covers are cast from iron in conformance with ASTM A48, CL358 and AASHTO M105. Hatches are made from aluminum. Either access system are designed to support traffic loads per AASHTO HS-25.

- **Media** – Flow Distributing media is made from random formed polypropylene fiber sheets and treatment media consists of a blend of granular carbon, peat and zeolite.

3.G. Estimated design life of the Device;

The design service life for the Hydro Up-Flo® is dependent on the materials, design, installation, and proper operation and maintenance. The Hydro Up-Flo® is constructed from materials with a design service life of between 50 and 100 years. The metal components are rated for the shorter span of 50 years while the concrete structure and plastic components are rated for 100 years. The media in the Device is considered to be a consumable and should be replaced as inspection necessitates.

3.H. Engineering plans/diagrams for a typical installation;

Typical installation drawings and diagrams for the Hydro Up-Flo® are included in Appendix C.

3.I. Photographs, if any, of pre- and post-installation examples; and

Photographs of the Up-Flo®during manufacturer, installation and operation are shown below:

Figure 5 - Up-Flo® Manhole Looking Down Through the Access Point

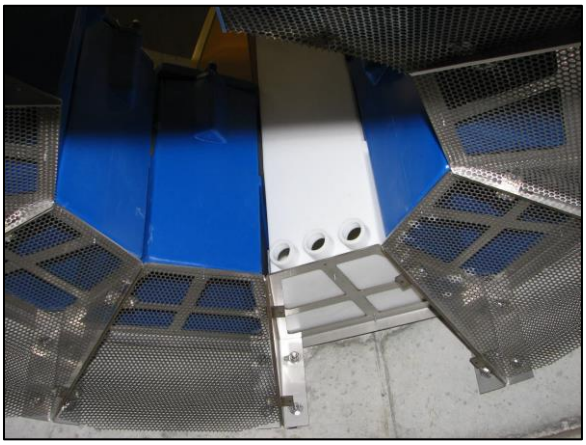


Figure 7 - Up-Flo® Filter Array View of Screens Looking Up

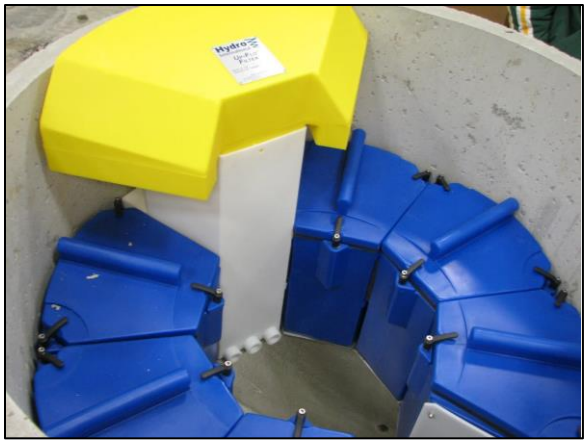


Figure 6 - Up-Flo® Close up View of Modules, Outlet, and Hood

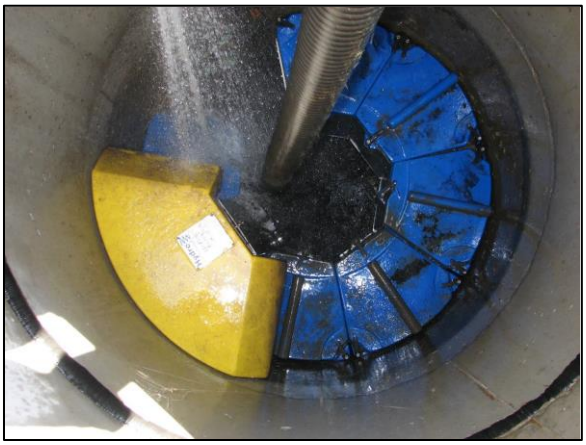


Figure 8 – Up-Flo® Manhole Undergoing Maintenance

Figure 9 - Up-Flo® Vault w/ Single Array Module Install

Figure 10 - Up-Flo® Vault w/ Double Array

3.J. If the device is designed with an internal bypass, explain how the bypass only operates with flows greater than the design storm.

The Hydro Up-Flo® is designed for in-line or off-line operation. When used in-line the Device is configured with an internal bypass to prevent upstream flooding and adverse hydraulic conditions during the occurrence of low probability storm events.

Figure 11 illustrates the Up-Flo® operation during the design storm and while in bypass for an

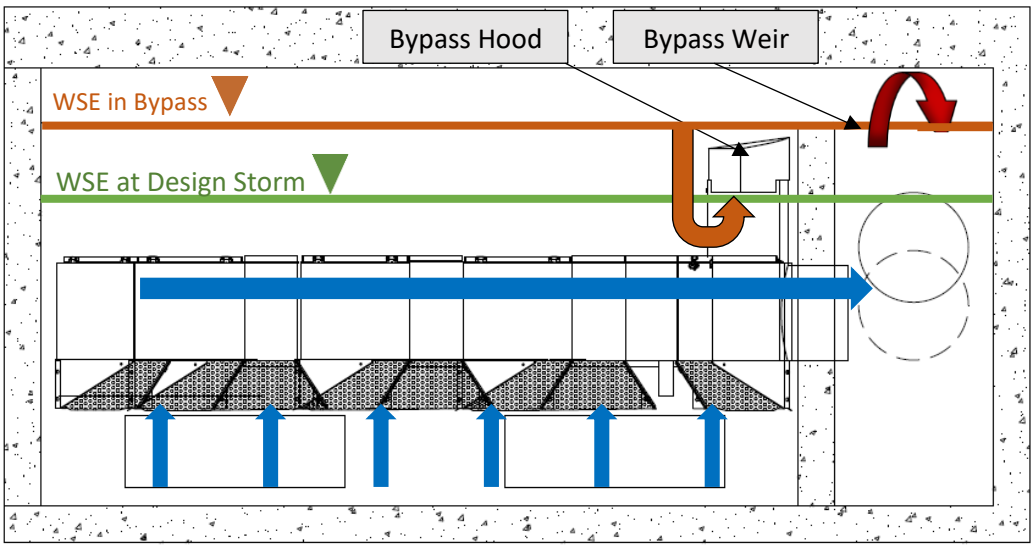


Figure 11 - Hydro Up-Flo® Internal Bypass Operation

internal bypass vault. During the design storm event the water service elevation may reach as high as just below the bottom of the bypass hood. In the Figure, the green line represents the maximum water level during the design storm event. This level will be different based on

drainage area, pipe size, number of modules, and the configuration of the Device selected. In all instances, the water surface elevation will be lower than the intake of the bypass hood. This ensures Full Capture and retention of Trash during the design storm event. When designing for use of the Up-Flo® the Maximum Treatment Flow Rate in Table 1 should always be equal to or larger than the flow generated by the design storm to ensure this scenario pertains.

The orange line in the Figure represents the water surface elevation while the Device is in bypass. Flows in excess of the maximum treatment capacity cause the water surface elevation to rise above the discharge opening of the bypass hood. Water does not begin to bypass however, until sufficient water elevation is reached above the hood. This is a design feature of the bypass that ensures captured buoyant trash and debris is at an elevation sufficiently high above the bypass inlet so that the material does not re-entrain. This flow path is illustrated with the orange colored arrow in the Figure.

During larger storm events, in vault configurations, a secondary bypass may become active. To prevent large bypass flows from entering the treatment chamber of the Device a secondary bypass is located within the vault but upstream of the treatment chamber. The bypass consists of a weir wall with an elevation which is higher than the outlet of the bypass hood. In the event the incoming flows are larger than the bypass capacity of the bypass hood, flows are allowed to enter then immediately exit the vault over this bypass weir preventing adverse hydraulic conditions from being experienced upstream of the Device as well as inside the treatment chamber of the Device.

4.0 INSTALLATION INFORMATION

4.A. Device installation procedures and considerations; and

The Up-Flo® Installation Manual is included in Appendix C of this submittal. Installation of the treatment Device is critical to ensuring a long service life for the structure and its components as well as ensuring expectations of treatment performance. The installation manual includes methods and practices for the following:

- Site Conditions
- Delivery, Offloading, & Handling
    - Pre-Inspection
    - Component Weight
    - Lifting Devices
    - Storage
- Site Preparation
    - Excavation
    - Bedding
- Installation
    - Placement
    - Jointing and Sealing

    - Pipe Connections
    - Access, Risers, & Manholes
    - Backfilling
- Installation Log

The Up-Flo® is intended to be a turnkey Device that arrives at the construction site complete for installation. Assembly of manhole or vault sections and access structures as well as inlet and outlet connections are required to be performed in the field as these cannot be completed at the manufacturing facility. Guidelines are provided to the Contractor to assist with installation. In all instances, Federal, State, and Local laws and regulations should be followed during installation.

All internal components come pre-assembled and installed. In some instances, internal components may need to be installed on site. During these instances a Hydro International® representative and/or contractor will be on site for the installation of these components. At no time should a Contractor be tasked with installation of the internal components unless the Contractor has received appropriate training and certifications from Hydro International. ®

Inspection is a critical component of the installation. Inspection should occur before, during and after installation to ensure proper installation and function of the Device. An installation log is provided in the Installation Manual to document the installation of the Device. This log should be provided to Hydro International® and the Owner and a copy should be retained by the Contractor for future reference.

4.B. Methods for diagnosing and correcting installation errors.

Installation errors of the Up-Flo® are not common provided installation is completed by a qualified Contractor and the installation is overseen by a knowledgeable Owner. Hydro International® has procedures in place to prevent installation errors but in the event an error occurs, immediate diagnosis and corrective action are required.

Prior to manufacture and delivery of the Up-Flo®, the Contractor and Owner are provided with design drawings and fabrication drawings. These drawings provide specific details for all aspects of the design and construction of the Device. A Hydro International® representative can be available for delivery and installation of the Up-Flo® Device. The Hydro representative will utilize these drawings to ensure conformance with the design and installation requirements. These drawings should be utilized by the Owner and Contractor as well to help diagnose errors.

Should an error be encountered, Hydro International® should be consulted for any necessary corrective action.

5.0 OPERATION AND MAINTENANCE INFORMATION

5.A. Device inspection procedures and inspection frequency considerations;

The Hydro Up-Flo® *Operation and Maintenance Manual* is included with this submittal in Appendix D. The manual provides detailed information for Hydro Up-Flo® Inspection procedures and frequency considerations. A summary of the requirements are listed below:

A thorough inspection program can be an effective practice to help ensure compliance with water quality objectives. A well-designed inspection program helps determine maintenance frequency, prevent anomalies from occurring during operation, and eliminates excessive costs from too frequent maintenance. The Hydro Up-Flo® design allows for quick inspection from surface level and requires no entry into the vault.

Inspection Frequency

- During the first year of operation, the Hydro Up-Flo® should be inspected every three to six months. This more frequent inspection is needed to determine the site-specific pollutant loading and is utilized to determine maintenance frequency.
- Inspection may be conducted during any season but is typically conducted prior to the start of the rainy season.

Inspection Procedures

- Set up any necessary safety equipment around the access hatches and/or manhole covers of the Hydro Up-Flo® as required by local ordinances. Safety equipment should notify pedestrians and vehicle traffic of work in the area.
- Remove the manhole covers or access hatches.
- Without entering the structure, visually inspect the main vault chamber for trash, debris, and other gross pollutants. Trash levels and volumes in the chamber should be noted. The high-water level should be noted and if the level indicates bypass further inspection may be warranted to determine if maintenance is required.
- Using a sediment probe, measure the depth of sediment in the sediment chamber(s). The maximum allowable sediment depth is 16-inches. Any measured depth greater than 16-inches warrants removal of the sediment.
- Using a pole with net or skimmer, remove trash, debris & other gross pollutants.
- Visually inspect for signs of abnormal operation such as excessively high water levels, broken or damaged internal components, or absence of any pollutants.
- Record the date, unit location, trash and debris volumes and levels, and sediment levels measured.
- If screens are clogged or obstructed minor maintenance may be conducted to unblock the screens using the probe pole with a brush and/or net attachment.
- Securely replace the access cover/hatches.

- Remove safety equipment.
- Contact the local Mosquito and Vector Control district should mosquito or vector be present in the vault.

5.B. Maintenance procedures, including a description of necessary equipment and materials;

The Hydro Up-Flo® *Operation and Maintenance Manual* is included with this submittal in Appendix D. The manual provides detailed information for Hydro Up-Flo® Maintenance procedures and frequency considerations. A summary of the requirements are listed below:

Maintenance of the Hydro Up-Flo ®should occur as determined during inspection of the Device. If no inspection records have been used to determine a maintenance frequency then maintenance should occur annually or when sediment and trash levels exceed 75% of the capacity listed in the Design Table.

Maintenance activities are grouped into two categories:

- Activities **NOT REQUIRING** manned entry into the Up-Flo® filter. These activities include floatables removal, oil removal, and removal of sediment from the sump.
- Activities **REQUIRING** manned entry into the Up-Flo® filter. These activities include media pack replacement and drain down filter replacement.

Maintenance Procedures

No Manned Entry Required:

- Set up any necessary safety equipment around the access ports as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.
- Remove access lids and visually inspect the inside of the vault. Document observations and take pictures. Estimate and record the screenings and sediment depths. Update the maintenance log.
- If the standing water level in the sump of the manhole or vault is above the base of the filter modules, tug the pull chain to release the drain down filter plugs. Allow the excess water to drain out of the chamber. Once drain down is completed, use a skimmer pole to re-fit the drain down filter plug back into position.
- Using a vactor removal system, first vacuum pollutants such as trash and debris, oil and grease, and other gross pollutants from the upper surface of the water.
- Continue to vactor removal process by lowering the vacuum tube to the bottom of the treatment chamber sump and remove all sediment and any gross pollutants, trash and debris that may have settled. A typical manhole version of the Up-Flo® can contain up to 0.3yd^3 of solids and up to 360 gallons of liquid. Vault configurations can hold significantly

larger amounts. Please consult the project specific details provided during delivery of the Device to determine and plan accordingly for the expected volumes of pollutants.

- With all water now removed, inspect the angled screens for blockages. If obstruction are present, use a pole with brush to clean the screen.
- Dispose of solids and liquids as necessary following all Federal, State, and Local laws and regulations.
- Document the cleaning with photographs and by completing the maintenance log included with the *Up-Flo® Operation and Maintenance Manual*.
- Replace the access covers/hatches and remove the safety equipment.

Manned Entry Required:

- Follow all procedures *No Manned Entry* maintenance guidelines.
- Following OSHA Confined Space Entry procedures, enter the treatment Device.
- Open the filter module by turning the three cam latches on the front and side of the module to the open position. Remove the lid to gain access to the media packs.
- Remove and discard the spent media packs.
- Insert new media packs supplied in advance by Hydro International® and return and secure the module lid.
- Use a screwdriver to unscrew the drain down filter from the face of the outlet modules.
- Install a new drain down filter supplied by Hydro International®.
- Safely exit the treatment Device.
- Document the cleaning with photographs and by completing the maintenance log included with the *Up-Flo® Operation and Maintenance Manual*.
- Replace the access covers/hatches and remove the safety equipment.

Recommended Maintenance Equipment and Materials

The following equipment is the minimum recommended equipment for routine maintenance of the Hydro Up-Flo®. Additional equipment may be necessary based on unique site or installation conditions.

- PPE (Personal Protective Equipment)
- Safety and Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Measuring stick or sludge sampler
- Long-handled net and brush
- Confined space entry equipment
- Vacuum truck
- Digital Camera
- Inspection/Maintenance Log

- Pressure Washer
- New media packs
- New drain down filter

5.C. Maintenance frequency considerations, including effects of delay; and

Generalized maintenance frequencies are included in Section 5.A. and 5.B as well as the *Operations and Maintenance Manual* in Appendix D. These generalized maintenance frequencies may be appropriate for most drainage areas. Pollutant loading is land use type and drainage area dependent. Hydro International® recommends developing a drainage area specific operation and maintenance plan. For designs meeting a Trash Full Capture requirement, it is recommended to base the design and sizing of the Device in part on the Waste Load Allocation for the drainage area. Additionally, the first year of Device operation should be closely monitored and inspected for accumulated pollutant levels to determine Device specific maintenance frequency. Maintenance activities should be reviewed annually to determine if the maintenance program is appropriate or may need adjustments.

Maintenance that is delayed or ignored may cause adverse effects in pollutant removal performance, premature bypass and release of captured pollutants, adverse hydraulic conditions such as increased HGL in the Device and upstream flooding.

5.D. Device maintenance and vector control accessibility.

The Hydro Up-Flo® is a subsurface stormwater treatment Device that maintains an accommodating environment for Mosquito and Vector. Conscious of this Hydro International® designed the Up-Flo® for quick and convenient access to inspect and abate for Mosquito and Vector.

The Hydro Up-Flo® is designed to provide unobstructed visual access and manned access to all areas of the treatment system. While manned access is not necessary for Mosquito and Vector inspection and abatement activities, the option is available with the standard design of the Device. Access is accomplished by outfitting the manhole or vault with manhole access covers or hatches located directly above each unique area of the treatment system. For manhole versions, the Device only contains one unique area that serves as both treatment and bypass. Figure 12 is an image of an Up-Flo® manhole with six

Figure 12 - Up-Flo® Manhole Viewed from the Manhole

filter modules in the array. As illustrated in the image, the modules of the array occupy only the perimeter portion of the manhole. The center portion and one perimeter section remain open for direct visual and physical access. Physical access is large enough for a vactor truck nozzle as well as manned entry. Should liquid or solid forms of larvacide need to be applied for Mosquito control, the visual and physical access is available.

Vault versions of the Up-Flo® are similarly constructed as the manhole versions but occupy larger areas and have segmented areas of the vault to isolate treatment from bypass. Proper planning is necessary to ensure access points are adequately located and provide the necessary visual and physical access to the critical areas of the vault for mosquito and vector inspection and abatement activities. Hydro International® has done this for all standard vault configurations. Custom configurations also follow the internal design guidelines in place for adequate access but it is recommended that the local Mosquito and/or Vector Control District be contacted to coordinate unique vault configurations.

Figure 13 is an image of an Up-Flo® vault from within the vault. The filter array contains a total of 18 modules with nine modules located on either side of the outlet module. As illustrated in the image, a channel is formed between the modules wide enough for manned entry. The access point is located directly above this channel at the top of the image. Should liquid or solid forms of larvacide need to be applied for Mosquito control, they can be applied directly to the wet sump with no obstructions.

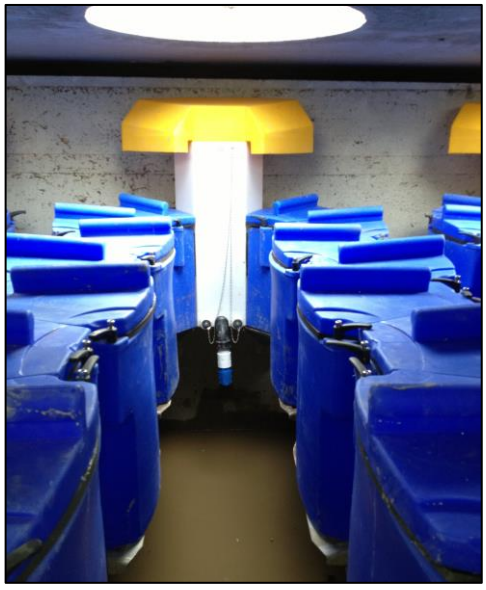


Figure 13 - Up-Flo® Vault Viewed from Inside the Treatment Chamber

Figure 14 is a top down view of a typical Hydro Up-Flo® vault configuration. The access covers are shown in this Figure as semi-transparent so that the internal features of the treatment Device can be visualized relative to the access points. There are three unique areas to a vault

configuration Up-Flo® consisting of an (1) inlet chamber, (2) treatment chamber and (3) outlet chamber. Each of the areas have isolated sumps but each of the areas are visually and physically accessible.

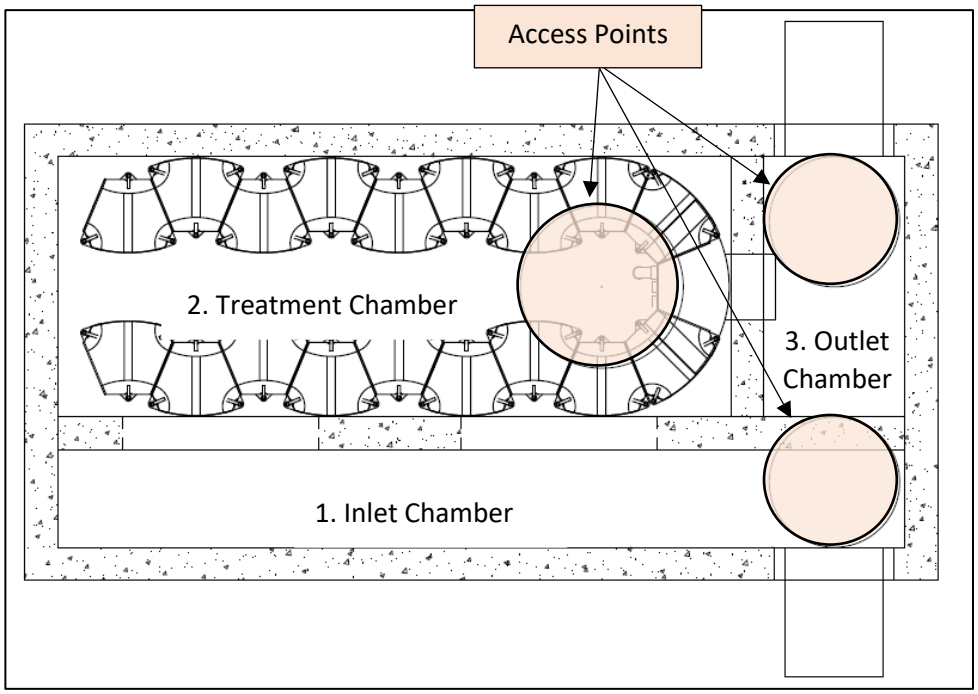


Figure 14 - Up-Flo® Vault Top Down View of Vault Compartments in Relation to Access Points

While access to inspect and abate for Mosquito and Vector are key design features of the Device, the Hydro Up-Flo® also helps prevent entry and subsequent breeding as well. The manhole covers and access hatches utilized on the Hydro Up-Flo® are solid and are sealed with gaskets. Small pick holes are large enough for Mosquito and other vector to enter the vault and are not recommended. Hydro International supplies all vaults with solid and gasket sealed covers to prevent Mosquito and Vector entry.

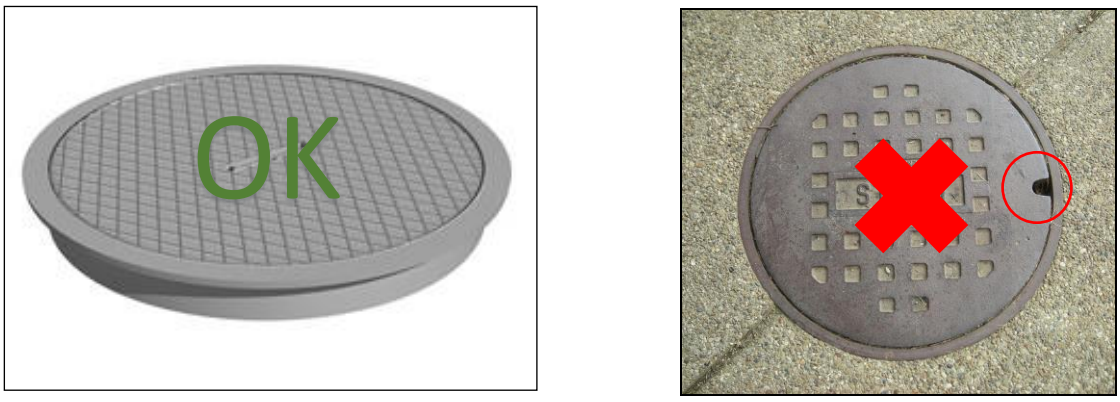


Figure 15 - Example of a Mosquito Proof Manhole Access Cover (Left) and Manhole Access Cover with an Open Pick Hole (Right)

Inlet and outlet pipes are another possible entry point to the Device for Mosquito and Vector. The Device is suitable for application of third party exclusion devices such as nets, collapsible membranes or other devices. Hydro International® should be contacted in the design phase should a third party exclusion device be a consideration for review and evaluation of compatibility.

6.0 RELIABILITY INFORMATION

6.A. Device sensitivity to loadings other than trash (i.e., leaves, sediment);

The Hydro Up-Flo® targets trash but also other pollutants such as debris, grass clippings, branches, twigs, and other gross pollutants. The treatment train approach of the design also targets suspended sediment, heavy metals, and oil and grease. Pollutants that are removed using the same removal mechanism, such as trash and leaves through screening, have no negative interactions with trash when encountered in the same stormwater flow. Some gross pollutant material may make the screens more susceptible to blinding and blockage and maintenance frequency may need to be adjusted based on the specific pollutant mix experienced by the Device.

Other pollutants such as sediment, heavy metals, and oil and grease are removed via different removal mechanisms such as filtration, adsorption and absorption. When utilizing the Device to target and remove these other pollutants of concern, maximum treatment capacities for these pollutants will control design. Removal of these other pollutants does not make the Device less efficient at removing trash and debris. However, removal of trash and debris or clogged screens may make the Device less efficient at removing these other pollutants.

6.B. Warranty Information; and

The warranty for the Hydro Up-Flo® is a two (2) year limited warranty. A copy of the warranty is included in Appendix E.

6.C. Applicant's customer support.

Hydro International® Stormwater has a corporate office located in Portland, Maine and representatives throughout the country.

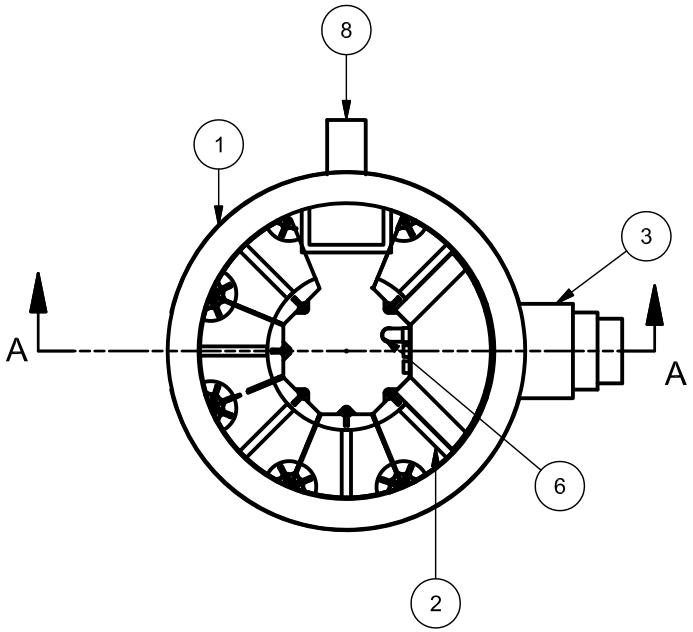
Hydro International® Americas Stormwater Headquarters
94 Hutchins Drive
Portland, Maine 04102
Phone: (207) 756-6200
Fax: (207) 756-6212
inquiries@hydro-int.com

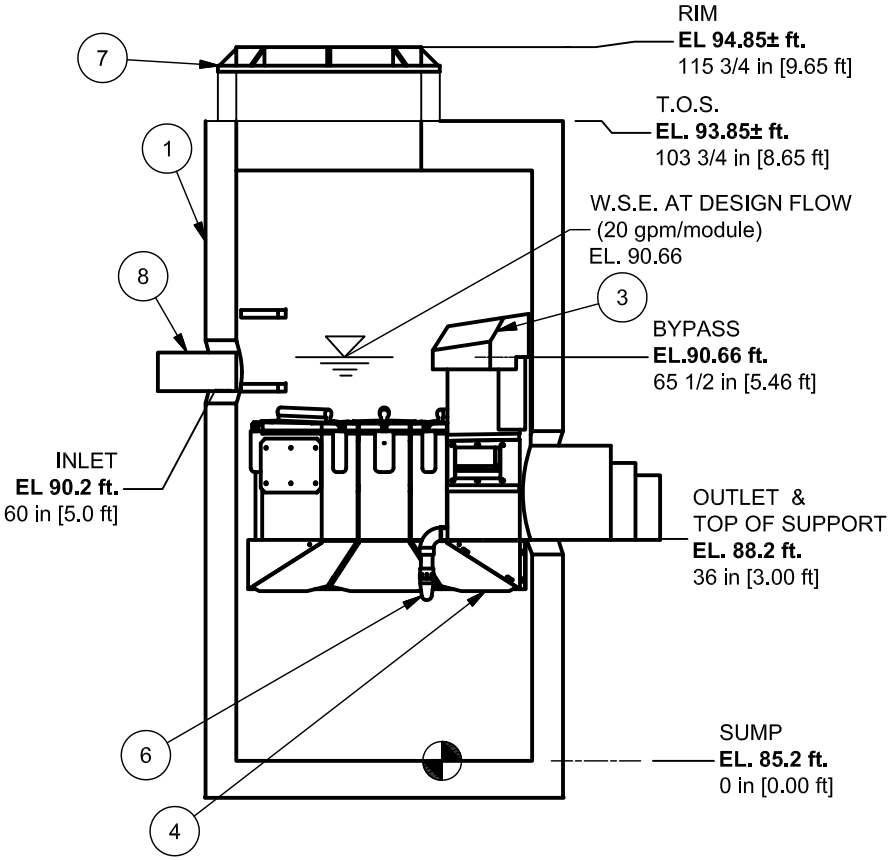
7.0 FIELD/LAB TESTING INFORMATION AND ANALYSIS

The Hydro Up-Flo® was originally developed and tested in a controlled laboratory environment and during actual rainfall conditions under a Small Business Innovative Research funded grant by the US EPA. The Up-Flo® has subsequently been tested under laboratory and field conditions over a dozen times. Many of these tests place an emphasis on sediment, metals, and nutrient removals but others have focused on the hydraulics and trash and debris retention of the Device. The data from these tests were utilized to determine system limitations in regards to hydraulics, sedimentation, filtration, and trash capture and retention effectiveness. Additionally Hydro International® utilized this data to scale geometrically proportional models of the Up-Flo® considering equivalent surface and filter loading rates and screen open areas.

Copies of the test reports related to hydraulics and trash capture have been include with this Application in Appendix F. Other test reports pertaining to filtration may be made available on request.

APPENDIX A





SECTION A-A

Parts List			
ITEM	QTY	SIZE	DESCRIPTION
1	1	48 in	CONCRETE MANHOLE
2	6		FILTER MODULE
3	1		OUTLET MODULE AND PIPE STUB
4	1		SINGLE SUPPORT BRACKET
5	1		OUTLET SUPPORT BRACKET
6	1		DRAINDOWN FILTER
7	1	30 in	FRAME AND COVER
8	1	12 in	INLET PIPE

EQUIPMENT PERFORMANCE
The stormwater filtration system shall adhere to the parameters listed below:
Minimum Performance Criteria: 80% removal of Sil-Co-Sil 106 at the peak treatment flow.
Peak Treatment Flow for 6 Filter Modules: 150 gpm (9.48 l/s)
Minimum Bypass Capacity: 1527 gpm (96.20 l/s)
Minimum Sediment Storage Capacity: 16.6 cu. ft. (0.47 cu. m.)
Minimum Oil Storage Capacity: 50 gal. (189 liters)
Media Type: CPZ

OUTLET PIPE STUB SIZE INFORMATION
Outside Diameter: 10.5", 12.5" or 15.3" OD
Concrete Penetration: Pipe Boot (by Hydro)
Hook-up: Fernco-type coupling (by others)

Notes

REVISION HISTORY			
REV	BY	DATE	DESCRIPTION
B	JL	2/02/15	NOTES

Date	Scale
03/30/12	3/8" = 1'0"

Drawn	Checked	Approved
MJ		

Title

4-FT DIAMETER
UP-FLO FILTER®

GENERAL ARRANGEMENT

Hydro International

Stormwater Solutions
94 Hutchins Drive
Portland, Maine 04102
Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

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CAD Ref: GA2-6M
Project No.
Drawing No. GA2-6M Rev. B

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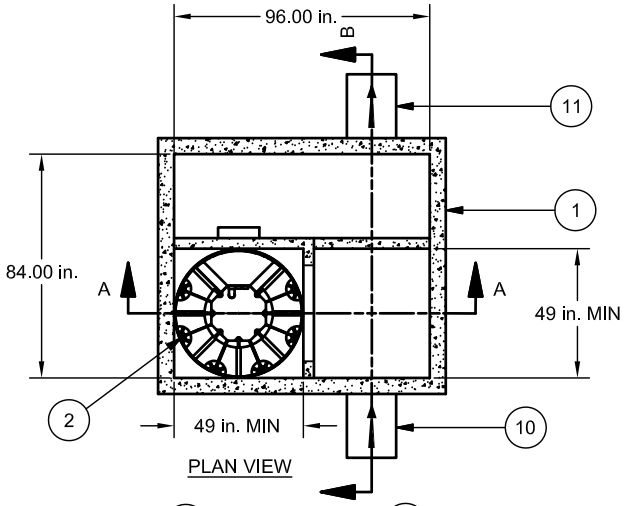
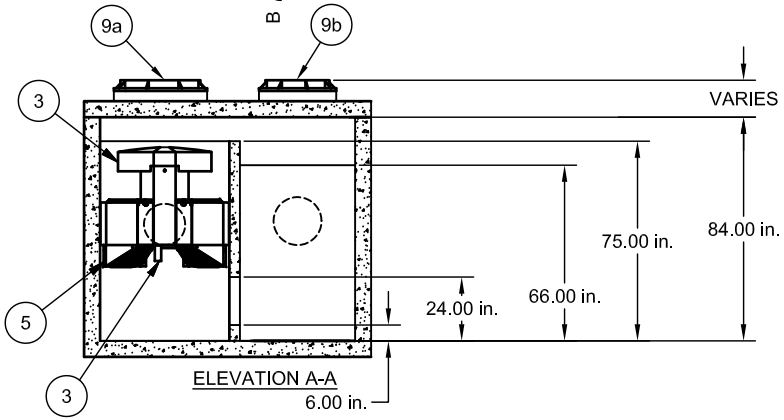
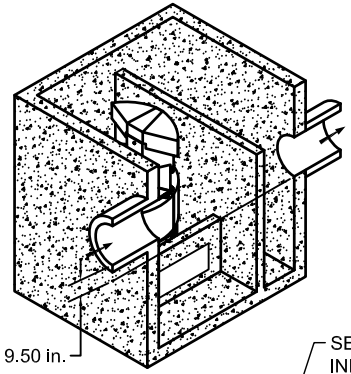
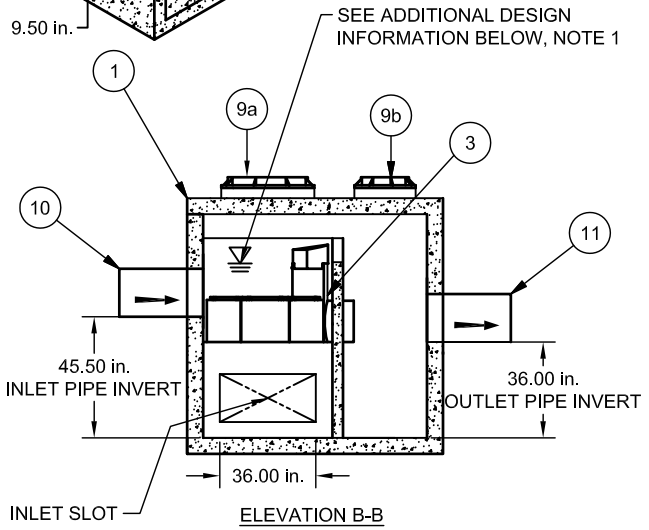


PLAN VIEW



ELEVATION A-A





ELEVATION B-B

	Parts List		
ITEM	QTY	DESCRIPTION	SIZE
1	1	PRECAST VAULT (BY HYDRO VIA PRECASTER)	84 in x 96 in
2	1-7	FILTER MODULE (7 SHOWN)	
	1-7	FILTER BAG SET	
3	1	OUTLET MODULE W/ BRACKET, BYPASS HOOD, DRAINDOWN	
4	0	DUAL SUPPORT BRACKET W/ ANGLED SCREEN	
5	1-7	SINGLE SUPPORT BRACKET W/ ANGLED SCREEN	
6	1-7	BACKER PLATE FOR SINGLE SUPPORT	
7	1	MOUNTING SPOOL	
8	0	ADDITIONAL DRAINDOWN	
9a, 9b	1,2	FRAME AND COVERS	30 in, 24 in
10	1	INLET PIPE (BY OTHERS)	12 in
11	1	OUTLET PIPE (BY OTHERS)	12 in

CAPACITIES:

1. Minimum performance: 80% removal of Sil-Co-Sil 106 (d50 = 22 microns) at the peak treatment flow.
2. NJDEP peak treatment flow: 0.056 cfs/module * OR 0.66 acres of imperviousness/module, whichever results in the greater number of modules.
3. Maximum number of modules: 7 **

ADDITIONAL DESIGN INFORMATION:

1. * Normal operating W.S.E. is 2.46' above the outlet invert at the peak treatment flow of 0.056 cfs/module. For a given flow the head requirement can be reduced by adding additional filters.
2. ** Treatment flows that require more modules will require a larger vault design.
3. Media Type: CPZ

Notes

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.

REVISION HISTORY			
REV	BY	DATE	DESCRIPTION
B	JLL	2/02/15	NOTES

Date	Scale
12/28/2011	NTS

Drawn	Checked	Approved
EMH	MRJ	MRJ

Title

7-FT x 8-FT VAULT
UP-FLO FILTER
1-7 MODULES

GENERAL ARRANGEMENTS

Hydro International

Stormwater Solutions
94 Hutchins Drive
Portland, Maine 04102
Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

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CAD Ref: **UFGA - 1RV**

Project No.

Drawing No. Rev. B

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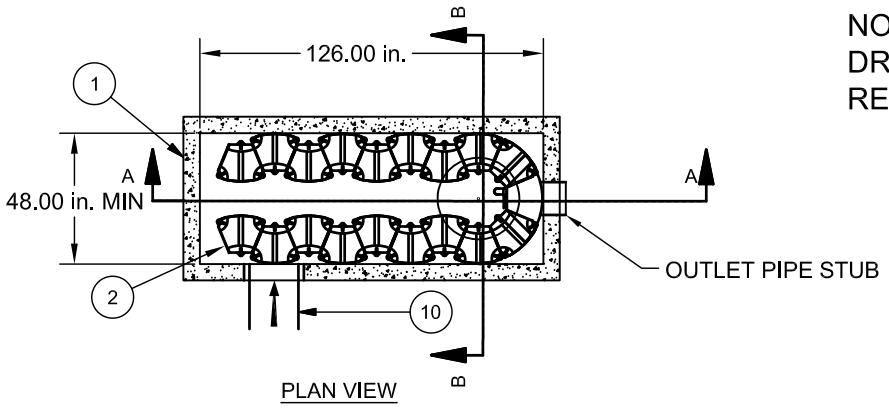
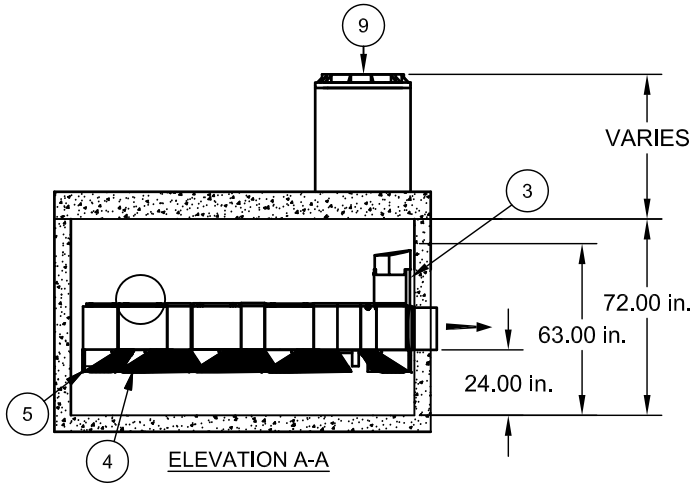
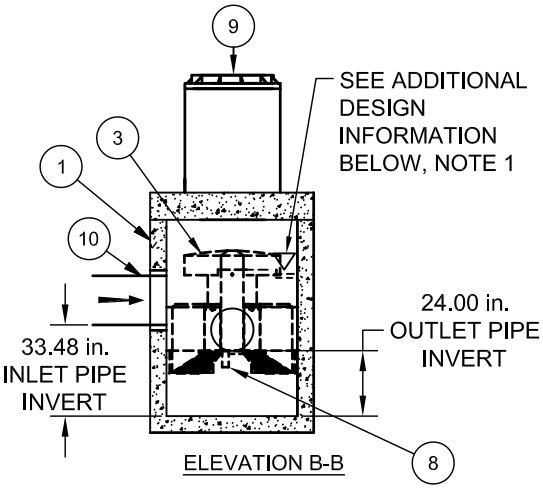


OUTLET PIPE STUB SIZE INFORMATION
Outside Diameter: 10.5", 12.5" or 15.3" OD
Concrete Penetration: Pipe Boot (by Hydro)
Hook-up: Fernco-type coupling (by others)





	Parts List		
ITEM	QTY	DESCRIPTION	SIZE
1	1	PRECAST VAULT (BY HYDRO VIA PRECASTER)	48 in x 124 in
2	18	FILTER MODULE	
	18	FILTER BAG SET	
3	1	OUTLET MODULE w/ BRACKET, BYPASS HOOD & DRAINDOWN	
4	4,4	DUAL SUPPORT BRACKET W/ ANGLED SCREEN	RIGHT, LEFT
5	2	SINGLE SUPPORT BRACKET W/ ANGLED SCREEN	
6	2	BACKER PLATE FOR SINGLE SUPPORT	
7	2	TRIANGULAR MOUNTING BRACKET	
8	0	ADDITIONAL DRAINDOWN	
9	1	FRAME AND COVERS	30 In
10	1	INLET PIPE (BY OTHERS)	15 in
11	1	OUTLET PIPE (BY OTHERS)	15 in

CAPACITIES:

1. Minimum performance: 80% removal of Sil-Co-Sil 106 (d50 = 22 microns) at the peak treatment flow.
2. NJDEP peak treatment flow: 0.056 cfs/module * OR 0.66 acres of imperviousness/module, whichever results in the greater number of modules.
3. Maximum number of modules: 19 **
4. Exact vault and pipe sizes may vary. Inlet and Outlet locations may vary.

ADDITIONAL DESIGN INFORMATION:

1. * Normal operating W.S.E. is 2.46' above the outlet invert at the peak treatment flow of 0.056 cfs/module. For a given flow the head requirement can be reduced by adding additional filters.
2. ** Treatment flows that require more modules will require a larger vault design or different arrangement.
3. Media Type: CPZ

Notes

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.

REVISION HISTORY

REV	BY	DATE	DESCRIPTION
B	JL	2/02/15	NOTES

Date 6/13/13 | Scale NTS

Drawn JLL3 | Checked | Approved

Title

4-FT x 10.5-FT VAULT
UP-FLO FILTER
18 MODULES (19 MAX)

1-ROW VAULT
EXTERNALLY BYPASSED

Hydro International

Stormwater Solutions
94 Hutchins Drive
Portland, Maine 04102
Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

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Project No.
Drawing No. 19MZ, UFF Rev. B

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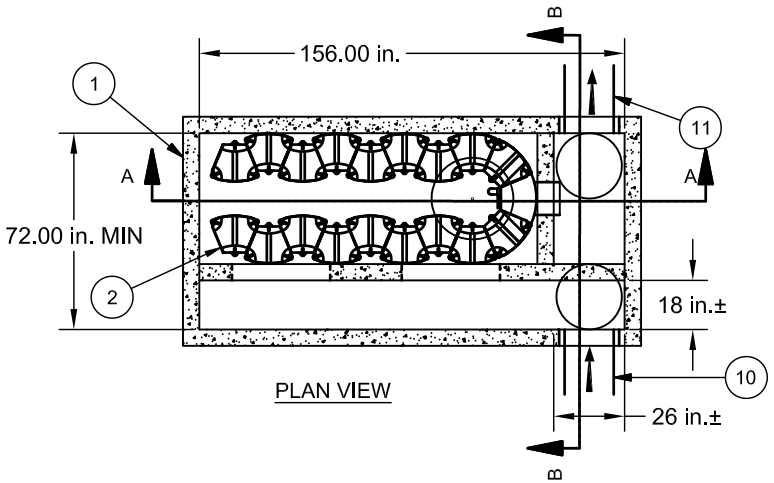

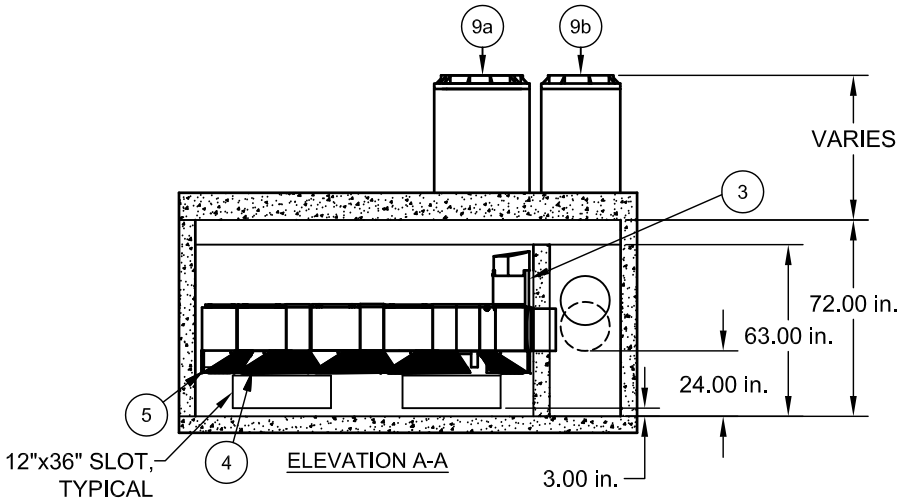

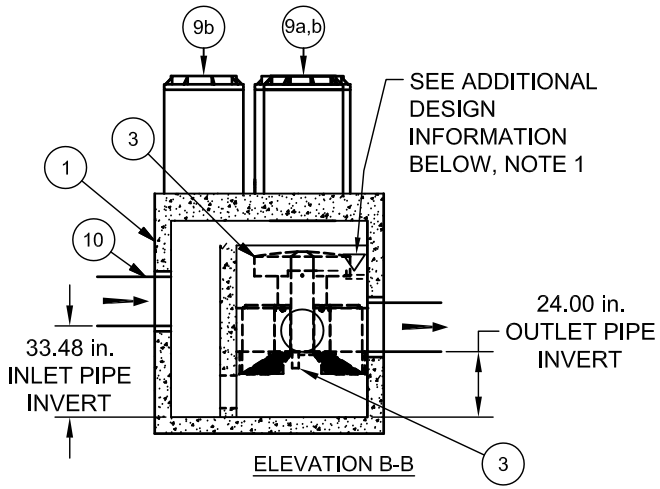

	Parts List		
ITEM	QTY	DESCRIPTION	SIZE
1	1	PRECAST VAULT (BY HYDRO VIA PRECASTER)	72 in x 156 in
2	18	FILTER MODULE	
	18	FILTER BAG SET	
3	1	OUTLET MODULE w/ BRACKET, BYPASS HOOD & DRAINDOWN	
4	4,4	DUAL SUPPORT BRACKET W/ ANGLED SCREEN	RIGHT, LEFT
5	2	SINGLE SUPPORT BRACKET W/ ANGLED SCREEN	
6	2	BACKER PLATE FOR SINGLE SUPPORT	
7	2	TRIANGULAR MOUNTING BRACKET	
8	0	ADDITIONAL DRAINDOWN	
9a, 9b	1, 2	FRAME AND COVERS	30 in, 24 in
10	1	INLET PIPE (BY OTHERS)	15 in
11	1	OUTLET PIPE (BY OTHERS)	15 in

CAPACITIES:

1. Minimum performance: 80% removal of Sil-Co-Sil 106 (d50 = 22 microns) at the peak treatment flow.
2. NJDEP peak treatment flow: 0.056 cfs/module * OR 0.66 acres of imperviousness/module, whichever results in the greater number of modules.
3. Maximum number of modules: 19 **
4. Exact vault and pipe sizes may vary.

ADDITIONAL DESIGN INFORMATION:

1. * Normal operating W.S.E. is 2.46' above the outlet invert at the peak treatment flow of 0.056 cfs/module. For a given flow the head requirement can be reduced by adding additional filters.
2. ** Treatment flows that require more modules will require a larger vault design or different arrangement.
3. Media Type: CPZ

Notes

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.

REVISION HISTORY

REV	BY	DATE	DESCRIPTION
C	JL	2/02/15	NOTES

Date 3/19/13 | Scale NTS

Drawn RC | Checked | Approved

Title

6-FT x 13-FT VAULT
UP-FLO FILTER
18 MODULES (19 MAX)

1-ROW VAULT

Hydro International

Stormwater Solutions
94 Hutchins Drive
Portland, Maine 04102
Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

CAD Ref: GA, 19MZ-UFF

Project No.

Drawing No. 19MZ-UFF Rev. C

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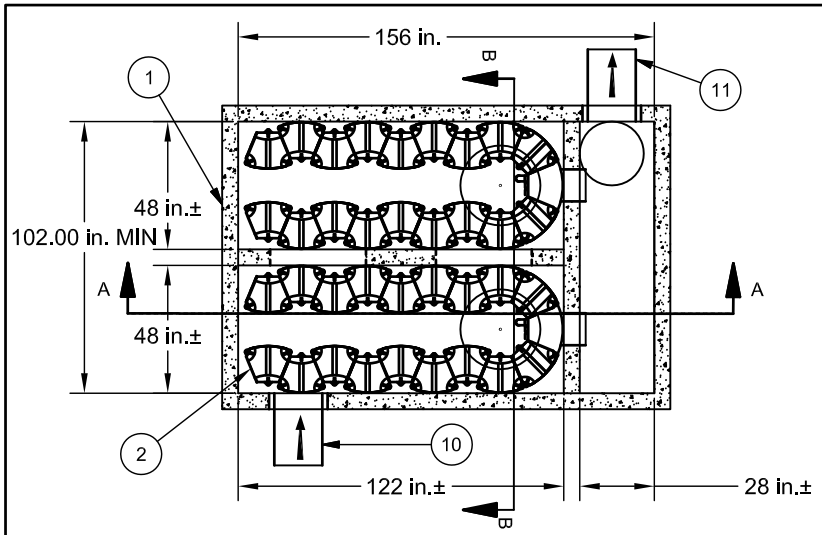

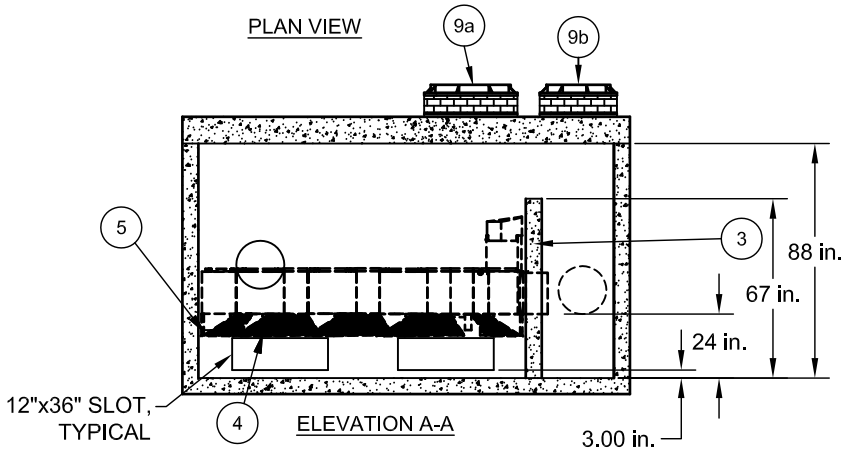

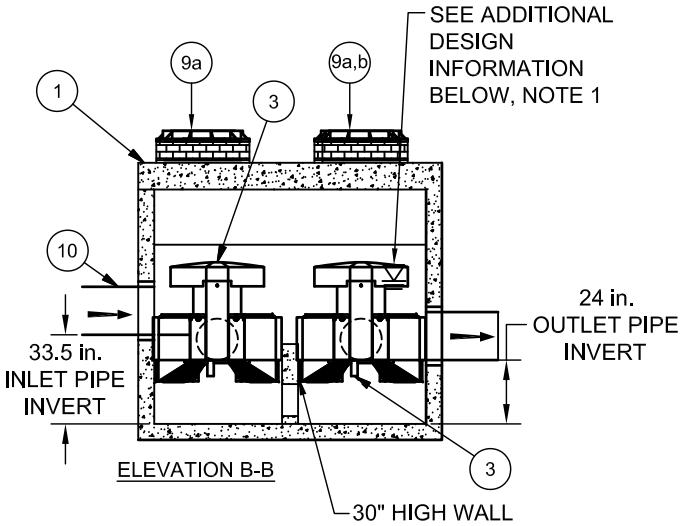

	Parts List		
ITEM	QTY	DESCRIPTION	SIZE
1	1	PRECAST VAULT (BY HYDRO VIA PRECASTER)	102 in x 156 in
2	36	FILTER MODULE	
	36	FILTER BAG SET	
3	2	OUTLET MODULE w/ BRACKET, BYPASS HOOD & DRAINDOWN	
4	8,8	DUAL SUPPORT BRACKET W/ ANGLED SCREEN	RIGHT, LEFT
5	4	SINGLE SUPPORT BRACKET W/ ANGLED SCREEN	
6	4	BACKER PLATE FOR SINGLE SUPPORT	
7	4	TRIANGULAR MOUNTING BRACKET	
8	0	ADDITIONAL DRAINDOWN	
9a, 9b	2, 1	FRAME AND COVERS	30 in, 24 in
10	1	INLET PIPE (BY OTHERS)	15 in
11	1	OUTLET PIPE (BY OTHERS)	15 in

CAPACITIES:

1. Minimum performance: 80% removal of Sil-Co-Sil 106 (d50 = 22 microns) at the peak treatment flow.
2. NJDEP peak treatment flow: 0.056 cfs/module * OR 0.66 acres of imperviousness/module, whichever results in the greater number of modules.
3. Maximum number of modules: 38 **
4. Exact vault and pipe sizes may vary. Inlet and outlet locations may vary.

ADDITIONAL DESIGN INFORMATION:

1. * Normal operating W.S.E. is 2.46' above the outlet invert at the peak treatment flow of 0.056 cfs/module. For a given flow the head requirement can be reduced by adding additional filters.
2. ** Treatment flows that require more modules will require a larger vault design or different arrangement.
3. Media Type: CPZ

Notes

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.

REVISION HISTORY			
REV	BY	DATE	DESCRIPTION
B	JL	2/02/15	NOTES

Date 6/13/13	Scale NTS

Drawn JLL3	Checked	Approved

Title

8.5-FT x 13-FT VAULT
UP-FLO FILTER
36 MODULES (38 MAX)

2-ROW VAULT
EXTERNALLY BYPASSED

Hydro International

Stormwater Solutions
94 Hutchins Drive
Portland, Maine 04102
Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

CAD Ref: GA, 38MZ-UFF, External
Project No.
Drawing No. 38MZ-UFF Rev. B

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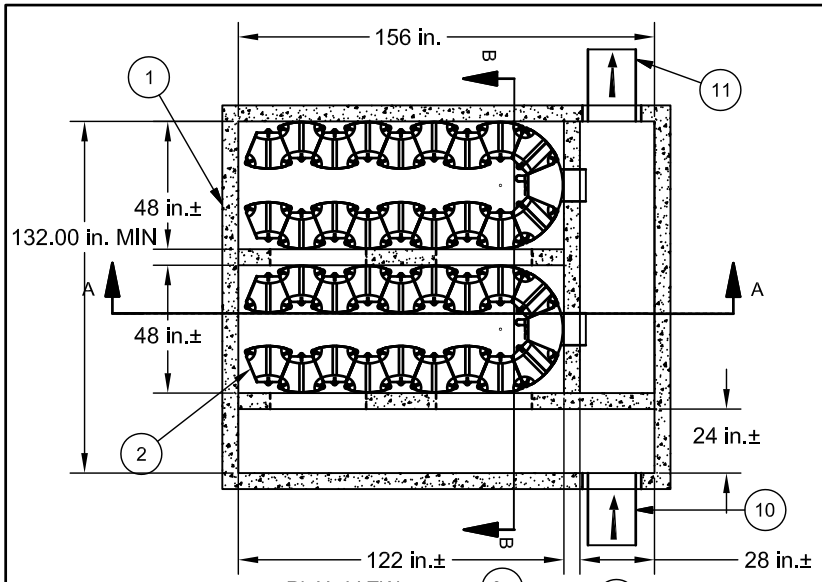
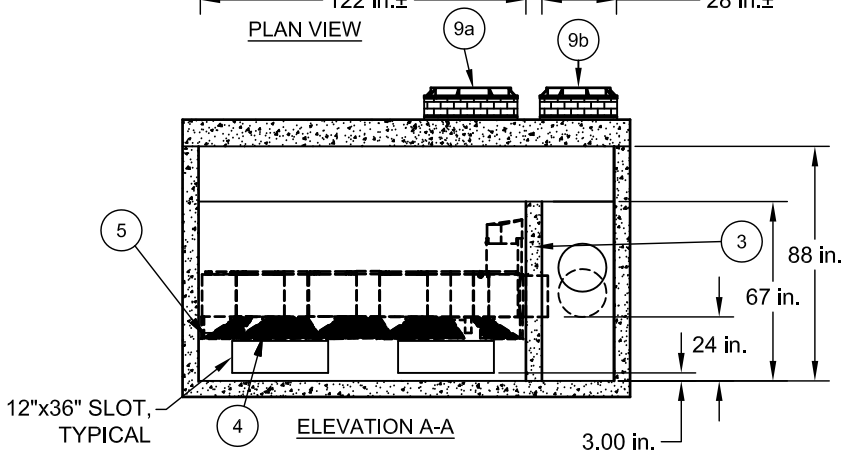
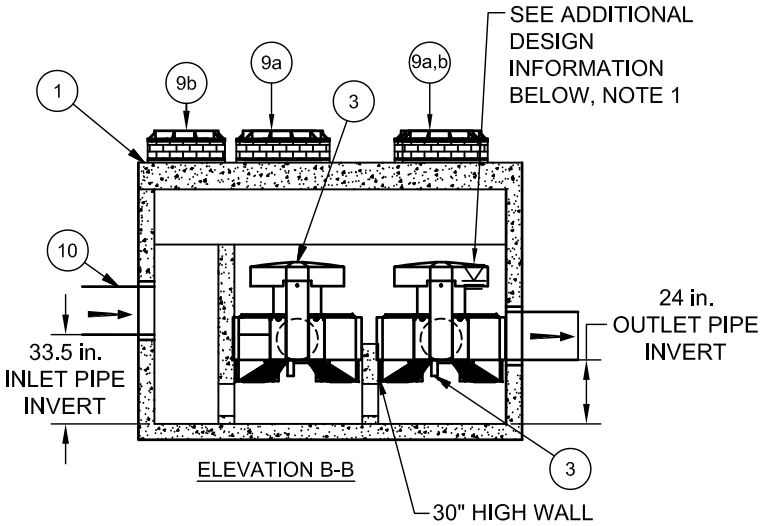


PLAN VIEW



ELEVATION A-A



ELEVATION B-B

	Parts List		
ITEM	QTY	DESCRIPTION	SIZE
1	1	PRECAST VAULT (BY HYDRO VIA PRECASTER)	132 in x 156 in
2	36	FILTER MODULE	
	36	FILTER BAG SET	
3	2	OUTLET MODULE w/ BRACKET, BYPASS HOOD & DRAINDOWN	
4	8,8	DUAL SUPPORT BRACKET W/ ANGLED SCREEN	RIGHT, LEFT
5	4	SINGLE SUPPORT BRACKET W/ ANGLED SCREEN	
6	4	BACKER PLATE FOR SINGLE SUPPORT	
7	4	TRIANGULAR MOUNTING BRACKET	
8	0	ADDITIONAL DRAINDOWN	
9a, 9b	2, 2	FRAME AND COVERS	30 in, 24 in
10	1	INLET PIPE (BY OTHERS)	15 in
11	1	OUTLET PIPE (BY OTHERS)	15 in

CAPACITIES:

1. Minimum performance: 80% removal of Sil-Co-Sil 106 (d50 = 22 microns) at the peak treatment flow.
2. NJDEP peak treatment flow: 0.056 cfs/module * OR 0.66 acres of imperviousness/module, whichever results in the greater number of modules.
3. Maximum number of modules: 38 **
4. Exact vault and pipe sizes may vary.

ADDITIONAL DESIGN INFORMATION:

1. * Normal operating W.S.E. is 2.46' above the outlet invert at the peak treatment flow of 0.056 cfs/module. For a given flow the head requirement can be reduced by adding additional filters.
2. ** Treatment flows that require more modules will require a larger vault design or different arrangement.
3. Media Type: CPZ

Notes

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.

REVISION HISTORY			
REV	BY	DATE	DESCRIPTION
C	JL	2/02/15	NOTES

Date 3/19/13	Scale NTS

Drawn RC	Checked	Approved

Title

11-FT x 13-FT VAULT
UP-FLO FILTER
36 MODULES (38 MAX)

2-ROW VAULT

Stormwater Solutions
94 Hutchins Drive
Portland, Maine 04102
Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

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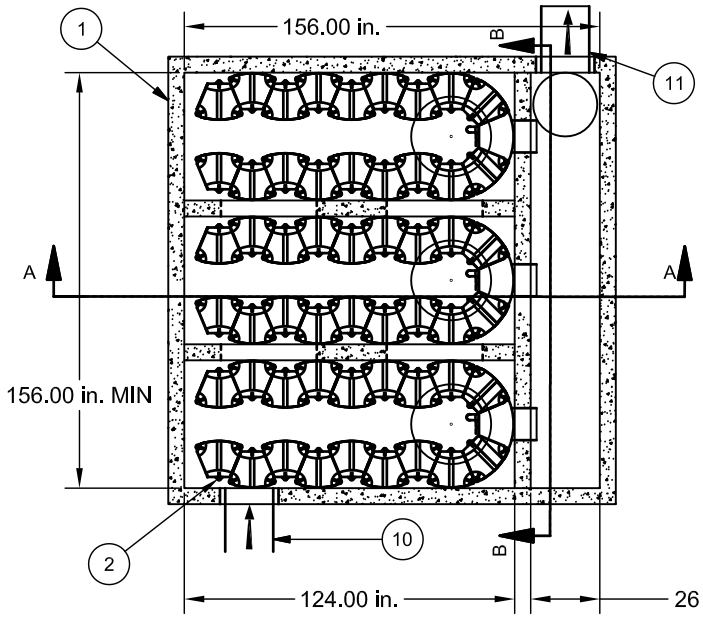
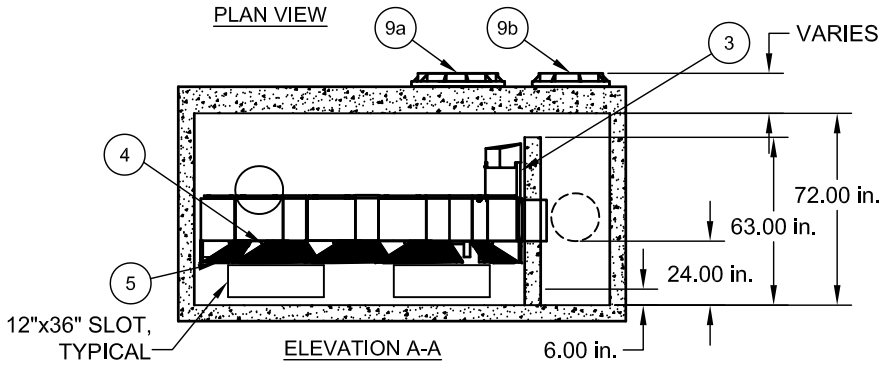
CAD Ref: GA, 38MZ-UFF

Project No.

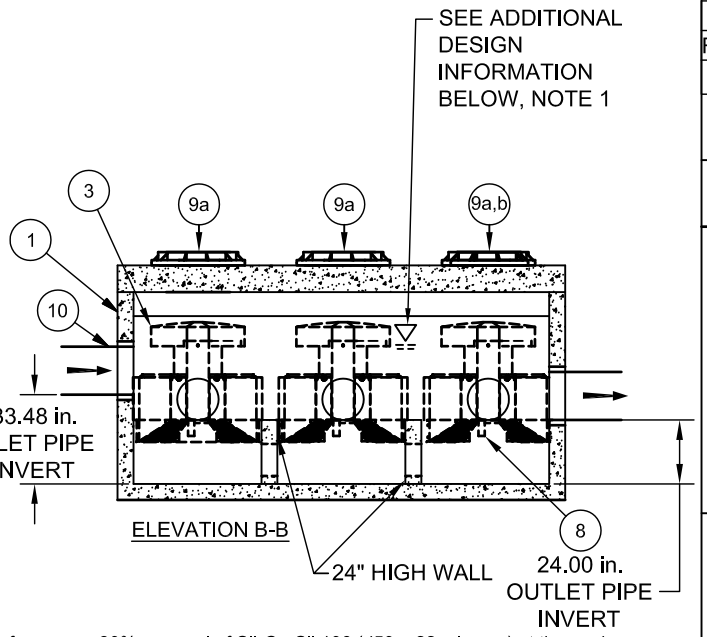
Drawing No. 38MZ-UFF Rev. C



PLAN VIEW



ELEVATION A-A



ELEVATION B-B

	Parts List		
ITEM	QTY	DESCRIPTION	SIZE
1	1	PRECAST VAULT (BY HYDRO VIA PRECASTER)	156 in x 156 in
2	54	FILTER MODULE	
	54	FILTER BAG SET	
3	3	OUTLET MODULE w/ BRACKET, BYPASS HOOD & DRAINDOWN	
4	12,12	DUAL SUPPORT BRACKET W/ ANGLED SCREEN	RIGHT, LEFT
5	6	SINGLE SUPPORT BRACKET W/ ANGLED SCREEN	
6	6	BACKER PLATE FOR SINGLE SUPPORT	
7	6	TRIANGULAR MOUNTING BRACKET	
8	0	ADDITIONAL DRAINDOWN	
9a, 9b	3, 1	FRAME AND COVERS	30 in, 24 in
10	1	INLET PIPE (BY OTHERS)	15 in
11	1	OUTLET PIPE (BY OTHERS)	15 in

CAPACITIES:

1. Minimum performance: 80% removal of Sil-Co-Sil 106 (d50 = 22 microns) at the peak treatment flow.
2. NJDEP peak treatment flow: 0.056 cfs/module * OR 0.66 acres of imperviousness/module, whichever results in the greater number of modules.
3. Maximum number of modules: 57 **
4. Exact vault and pipe sizes may vary. Inlet and Outlet locations may vary.

ADDITIONAL DESIGN INFORMATION:

1. * Normal operating W.S.E. is 2.46' above the outlet invert at the peak treatment flow of 0.056 cfs/module. For a given flow the head requirement can be reduced by adding additional filters.
2. ** Treatment flows that require more modules will require a larger vault design or different arrangement.
3. Media Type: CPZ

Notes

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.

REVISION HISTORY			
REV	BY	DATE	DESCRIPTION
B	JL	2/2/15	FIRST ISSUE

Date	Scale
6/13/13	NTS

Drawn	Checked	Approved
JLL3		

Title

13-FT x 13-FT VAULT
UP-FLO FILTER
54 MODULES (57 MAX)

3-ROW VAULT
EXTERNALLY BYPASSED

Hydro International

Stormwater Solutions
94 Hutchins Drive
Portland, Maine 04102
Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

CAD Ref: GA, 57MZ-UFF, External
Project No.
Drawing No. 57MZ-UFF Rev. B

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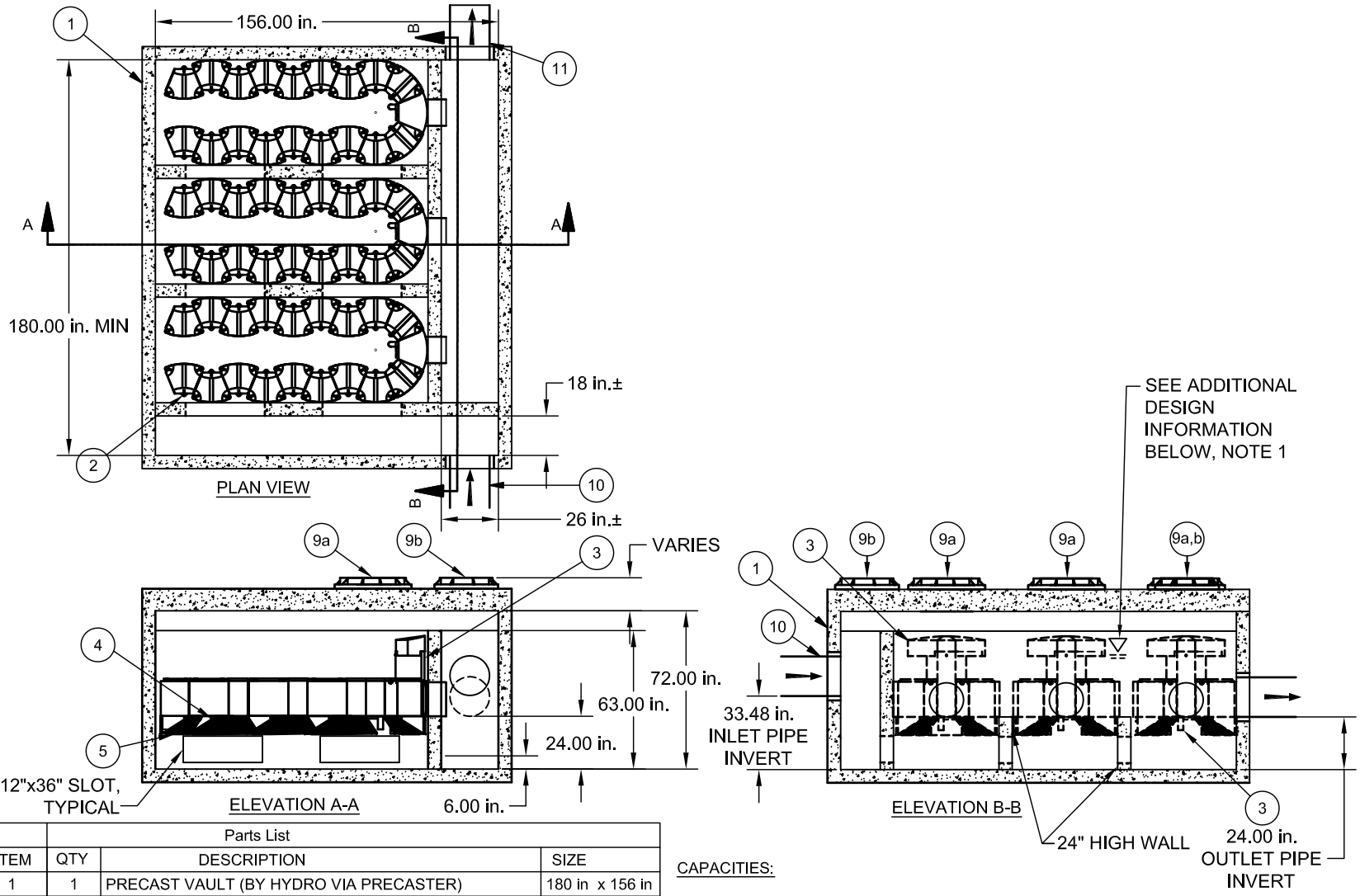

	Parts List		
ITEM	QTY	DESCRIPTION	SIZE
1	1	PRECAST VAULT (BY HYDRO VIA PRECASTER)	180 in x 156 in
2	54	FILTER MODULE	
	54	FILTER BAG SET	
3	3	OUTLET MODULE w/ BRACKET, BYPASS HOOD & DRAINDOWN	
4	12,12	DUAL SUPPORT BRACKET W/ ANGLED SCREEN	RIGHT, LEFT
5	6	SINGLE SUPPORT BRACKET W/ ANGLED SCREEN	
6	6	BACKER PLATE FOR SINGLE SUPPORT	
7	6	TRIANGULAR MOUNTING BRACKET	
8	0	ADDITIONAL DRAINDOWN	
9a, 9b	3, 2	FRAME AND COVERS	30 in, 24 in
10	1	INLET PIPE (BY OTHERS)	15 in
11	1	OUTLET PIPE (BY OTHERS)	15 in

CAPACITIES:

1. Minimum performance: 80% removal of Sil-Co-Sil 106 (d50 = 22 microns) at the peak treatment flow.
2. NJDEP peak treatment flow: 0.056 cfs/module * OR 0.66 acres of imperviousness/module, whichever results in the greater number of modules.
3. Maximum number of modules: 57 **
4. Exact vault and pipe sizes may vary.

ADDITIONAL DESIGN INFORMATION:

1. * Normal operating W.S.E. is 2.46' above the outlet invert at the peak treatment flow of 0.056 cfs/module. For a given flow the head requirement can be reduced by adding additional filters.
2. ** Treatment flows that require more modules will require a larger vault design or different arrangement.
3. Media Type: CPZ

Notes

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.

REVISION HISTORY			
REV	BY	DATE	DESCRIPTION
C	JL	2/02/15	NOTES

Date	Scale
03/19/13	NTS

Drawn	Checked	Approved
RC		

Title

15-FT x 13-FT VAULT
UP-FLO FILTER
54 MODULES (57 MAX)

3-ROW VAULT

Hydro International

Stormwater Solutions
94 Hutchins Drive
Portland, Maine 04102
Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

CAD Ref: GA, 57MZ-UFF

Project No.

Drawing No. 57MZ-UFF Rev. C

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APPENDIX B

Project Name
Project Location
Hydro Ref. #

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 stormwater filtration system as shown on the drawings and specified herein. The manufacturer shall design and supply the equipment listed in Part 4.A. and the Contractor shall install the equipment in accordance with the manufacturer's Handling, Storage, and Installation Instructions.

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 stormwater filtration system shall be a precast, modular, upward flow, fluidized media bed filtration system, with integrated pretreatment, siphon activated bypass and drain down. The system shall be self-activating with no mechanical parts or external power requirements.

B. The stormwater filtration system shall be supplied by a manufacturer regularly engaged in such work and who has furnished stormwater filtration systems that have been in successful and continuous operation for a minimum period of five years.

C. Upon request, independently certified performance data and 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 filtration system.

2. Plan and elevation drawings of the filtration 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 filtration system shall be manufactured under the direction of an ISO 9001 Certified Company.

B. Inspection

The stormwater filtration 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 filtration 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 filtration system adheres to the specifications required herein and complies with the project's stormwater management permit.

1.05 MANUFACTURER

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

B. Alternate stormwater filtration systems must demonstrate compliance with the specifications herein and be approved by the Engineer of Record. Request for alternative filtration 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. Verified/certified product evaluations that demonstrate proposed sizing and performance that adheres to section 2.02.

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 filtration system shall be the Contractor's or alternative Manufacturer's responsibility.

PART 2 – STORMWATER FILTRATION SYSTEM

2.01 General

A. The stormwater filtration system shall be an Up-Flo® Filter that provides three modes of treatment; sedimentation, screening and high-rate upward flow filtration all within the same structure. Internal components shall provide a minimum 2-ft sediment storage sump, adjustable bypass hood, siphon-activated high-flow bypass hood, and drain down with integrated flow control.

B. An inlet pipe or grated surface inlet cover shall be used to convey surface runoff into a precast cylindrical or rectangular vault. Capture pollutants that settle shall be stored in a location that does not contain filtration components. Water elevations within the precast structure will be controlled with a vertical bypass chute. A water-lock baffle shall prevent the loss of captured pollutants that float on the water surface from escaping through the bypass chute.

C. The upward flow filtration system shall provide protected storage regions for captured pollutants that float and for those that settle and shall not release captured floating pollutants during surcharge conditions. The upward flow filtration system shall operate as intended and perform as specified herein as pollutants accumulate.

D. The upward flow filtration system 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. Minimum 24-inch openings shall provide access to the sediment storage volumes from the surface for inspection and maintenance. Hand removal of media from the treatment system shall be possible; no heavy lifting equipment will be required when media exchange is required.

2.02 Performance

1. Sizing of the upward flow filtration system shall be based on independent full-scale laboratory testing. 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).
2. Independent full-scale field monitoring results shall demonstrate greater than 80% TSS removal based on a median particle size of 29 microns and removal of fine particulate matter down to 5 microns. Field performance results shall demonstrate a performance life of at least 6 years or 130 lbs of particulate material captured per Filter Module before 10% filter occlusion. Field monitoring test protocol shall adhere to, "Total Suspended Solids Removal Based on Field Testing Amendments to TARP Protocol Dated August 5, 2009".

3. Performance of the upward flow filtration system shall be based on treating the Water Quality Flow rate (WQF) without internally bypassing. The maximum filtration rate shall be greater than or equal to the WQF for an operating head of less than 30-inches. The upward flow filtration system shall remove greater than or equal to 80% of TSS based on the Target Particle Size (TPS) of 20 microns and demonstrate removal of particles down to 5 microns.
4. The upward flow filtration system shall treat all flows without internally bypassing up to the WQF and shall provide sufficient bypass capacity to convey the peak runoff flow rate without risk of flooding.

PART 3 – EQUIPMENT

A. The Up-Flo® Filter shall consist of a hollow, cylindrical or vaulted vessel with internal components.

(i) The internal components to be supplied by Hydro International shall include the Support Frames, Filter Modules, Filter Media Packs, Siphon Activated Bypass Chute with Floatables Hood, and Draindown Filter.

Materials of construction for the above components excluding the support frame shall be cross-linked polyethylene (XLPE). The component support frame and screen 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.

(ii) The precast concrete structure shall be 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.

B. Each stormwater Filter Module shall be supported by a Type 304 stainless steel frame which shall consist of an angled screen with perforations less than 5mm to retain all neutrally buoyant material and debris greater than 5mm in diameter.

C. The upward flow filtration system shall have a flow controlled Draindown Filter to drain down the water level in the chamber between storm events. The filter media shall be positioned above the standing water level between storm events to prevent anoxic conditions in the media.

D. The stormwater filtration system shall have a self-activated siphonic bypass to convey flows in excess of the peak treatment flow rate. The bypass shall be equipped with a floatables baffle to prevent the escape of buoyant litter and debris.

E. Each stormwater filter module shall be furnished with a media pack. The media pack shall consist of the media bags placed between flow distribution media.

F. The stormwater filtration system media bags shall be one of the following:

i. Carbon-peat-zeolite (CPZ™ Mix)
ii. Hydro Filter Sand (HFS™)

PART 4 - EQUIPMENT DELIVERY

A. The Up-Flo® Filter components shall be delivered within eight weeks from the date of approved technical submittal.

B. The Up-Flo® Filter components shall be delivered to the site fully fabricated and pre-assembled within the host precast structure, with exception of the media filter bags.

C. Off-loading, storage, installation of the media filter bags, and final 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 preassembled equipment and all necessary site connections.

B. Hydro International 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 subbase in accordance with local requirements for standard manhole installation.

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

E. Non-shrink grout shall be used to provide a water tight seal in the lifting holes and around the concrete knock-outs for the inlet and outlet pipes.

F. The Contractor shall be responsible for installing the flow distribution media and media bags for each filter module as per the manufacturer's recommendations. The maximum dry weight of each filter bag shall be no greater than 36 lbs.

APPENDIX C

Installation Manual v1.01

Contents

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DISCLAIMER: Information and data contained in this manual is exclusively for the purpose of assisting in the installation of Hydro International plc's Up-Flo®. 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.

INTRODUCTION

The Hydro Up-Flo® Filter is a multi-stage stormwater treatment Device that incorporates screening, sedimentation, physical filtration and adsorption in a treatment train approach to treating stormwater. The Device consists of a precast concrete manhole or vault that house internal components for conducting the treatment processes. There are eight standard precast model sizes ranging from the smallest 48-inch diameter manhole footprint to the largest vault having a footprint of 12-ft. X 20-ft. The precast manholes and vaults are made in sections that must be assembled on site. Internal components are typically factory installed. Delivery is made to the site for offloading and setting by the Contractor.

Proper installation of the Up-Flo® Filter is critical for maintaining the manufactured integrity of the precast concrete manhole or vault but also critical for ensuring in place structural integrity of the finished product as well ensuring storm water treatment performance. Installation should be performed in accordance with ASTM C 1821 *Standard Practice for Installation of Underground Circular Precast Concrete Manhole Structures*, *ASTM C891 – Standard Practice for Installation of Underground Precast Concrete Utility Structures* and the supplementary recommendations in this manual. Many problems associated with poorly performing or malfunctioning storm water treatment devices can be attributed to improper installation. Improper installation and installation methods can result in damage to the structure or safety hazards. This manual, along with the applicable ASTM standards, should be reviewed and utilized for the entirety of the installation process.

INSTALLATION PROCEDURES

SITE CONDITIONS

The construction site and installation area must be accessible to large, heavy trucks, cranes and other construction equipment. The construction area should be free of trees, overhead electrical and communications wires, and other potential obstructions that could interfere with the delivery and installation of the vault. The site and immediate area surrounding the excavation must be stable and unyielding. The area surrounding the site should be able to accommodate temporary closure during the installation.

DELIVERY, OFFLOADING, & HANDLING

PRE-INSPECTION

The Up-Flo® Filter(s) will be delivered to the site in a condition suitable for installation. Inspection of the Up-Flo® should occur immediately upon arrival of the delivery and prior to offloading. Inspection should include the precast concrete vault as well as all internal components and necessary accessory components required for installation included with the delivery. Any damage, missing components, or non-conformance with the approved shop drawings and documented on the packing list. If concerns

related to damage, missing components, or non-conformance cause are related to the integrity of the structure or Device, Hydro International® should be contacted immediately for consultation.

COMPONENT WEIGHT

Hydro International shop drawings should be consulted for each components weight and lifting detail. This information should be compared to this same information as marked or permanently affixed to the precast concrete structure. Any discrepancies between the information and the drawings should be verified prior to lifting or handling any delivered material. The component weight should be considered prior to selection and use of any lifting devices.

LIFTING DEVICES

Lifting apparatus such as slings, cables, chains, clevis, hooks, shackles, spreader bars, etc… should be verified for adequate lifting capacity including all required safety factors and capacity reductions for site-specific conditions. The capacity for all apparatus must be clearly marked on all equipment. All apparatus and usage thereof should conform to the requirements of *OSHA Code of Federal Regulations, Title 29, Part 1926*, Current Edition as well as any applicable state and local regulations.

Slings, cables, and chains should be of adequate length to prevent contact with the concrete while still being utilized at appropriate lifting angles.

STORAGE

The Up-Flo® Device and associated components may be installed directly into the excavation or may be stored on site for installation at a later date. Should the Up-Flo® need to be stored on site, appropriate precautions should be taken to prevent damage to the structure and its components.

The precast structure should be placed on firm, level ground or on appropriately placed dunnage to keep the device supported and level. All components should be stored in a location to prevent damage by vehicles and equipment that have access to the construction site. Internal components should be protected, covered or kept in a location where direct exposure to the outdoor environment is limited.

SITE PREPARATION

EXCAVATION

Prior to excavation, all buried utilities should be located and identified. Excavations should be made no wider than what is necessary to safely and adequately compact the backfill material on all sides of the concrete manhole or vault including associated piping. The excavation depth and horizontal alignment should be coordinated with the Plans and the vault design. Should the excavation bottom be unstable or yielding, over-excavation may be necessary. The excavation should be sloped, stepped, or shored as necessary to comply with all Federal, State, and Local safety laws and regulations. If the excavation requires shoring, the excavation width should be necessary to accommodate the addition of shoring.

BEDDING

Proper bedding material is necessary to ensure long-term performance of the treatment Device. The native in-situ material may be suitable for bedding provided it meets the project requirements as outlined by the Engineer. Should the native in-situ material be determined unsuitable, an imported, engineered

bedding material should be utilized that will provide a uniform bearing surface and adequate soil bearing capacity for the expected load of the precast manhole or vault including all internal components while in operation. Bedding is typically designed with a minimum 6-inch sand or gravel bedding per ASTM D2321 and compacted to a minimum 90% SPD unless otherwise specified by the Engineer. The bedding should be placed uniformly and placed level.

The treatment Device should not be bedded on large boulders or rock. Excavations that encounter silty clay material in the area of the bedding or other similar material with poor bearing capacities may require a thicker bedding or different bedding material. If ground water should be encountered during excavation, the excavation should be de-watered prior to placement and compaction of the bedding. Additionally, the in-situ material should be evaluated for appropriateness.

INSTALLATION

PLACEMENT

The Device orientation should be verified prior to placement in the excavation. Placement of the Up-Flo® is dependent on the configuration of the Device and whether the system is Internal or External Bypass. Manhole and Vault Internal Bypass configurations are single structures places in-line with the main line storm drain. External Bypass configurations involve multiple separate structures. Figure 3 is an example of an External Bypass manhole configuration. The installation of this system includes the placement of

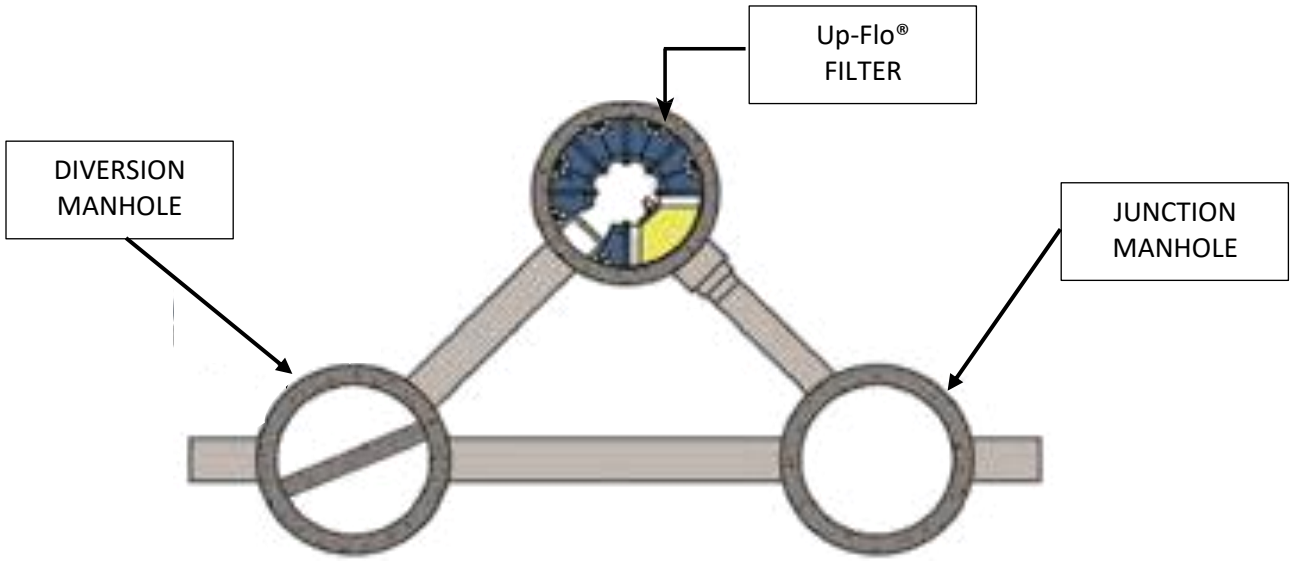


Figure 1 - Example External Bypass Configuration

the Up-Flo®, a diversion manhole, and a junction manhole. Correct placement of all structures is critical to ensure proper function of the Device.

With all installations, concrete bottom, inlet elevation, outlet elevation, weir elevation, and finished surface elevations should be verified prior to placement. Inlet and outlet alignments as well as proper flow orientation should be confirmed prior to placement as well. The bedding material, compaction, and system level should be checked. After placement, the manhole or vault base should be checked to determine the structure is level in two directions.

Subsequent sections of the manhole, vault, and other structures (if any) should be placed with orientation, elevations, and alignment determined the same as the base. Care should be taken to avoid damaging internal components while placing subsequent sections of the manhole, vault or other structures (if any).

JOINTING & SEALING

All manhole or vault sections should be joined and sealed to ensure a watertight vault. Manhole or vault sections will be joined with a butyl mastic material conforming to ASTM C990. Manhole or vault sections should be sealed with a non-shrink, hydraulic grout conforming to ASM C1107. Joints may be supplied as either shiplap or tongue and groove style.

The tongue and groove surfaces and shiplap mating surfaces should be inspected and cleaned. All mating surfaces should be free of dirt and debris. On tongue-up manhole or vault sections, the butyl mastic material should be placed directly in the center of the of the horizontal tongue surface. On groove-up manhole or vault sections, the butyl mastic should be placed directly in the center of the horizontal groove. On shiplap joints, the butyl mastic should be placed directly beside the vertical mating surface. Examples of butyl mastic placement can be seen in Figure 1.

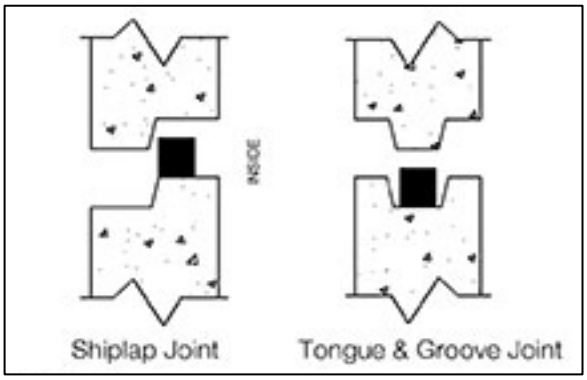


Figure 2 - Example Jointing Details

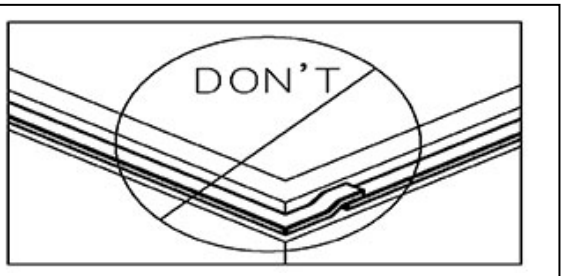


Figure 3 - Example Butyl Mastic Placement

The mastic should be placed completely around the circumference of the manhole or perimeter of the vault inside of the groove, on top of the tongue, or next to the vertical surface of the shiplap joint. For vaults, the mastic placement should start at least 12-inches away from the corner. To complete placement, the ends of the mastic should abut one another. The ends should not overlap. See Figure 2. The abutted ends should be kneaded together to form a spliced section with a depth no greater than a singular piece of mastic. All protective paper wrapping should be removed. The next section of the manhole or vault should be carefully lowered onto the lower manhole or vault section. The section should be checked for elevations and level.

PIPE CONNECTIONS

Pipe connections should be made per the Plans or local requirements:

- *Outlet Module Connections* – The Up-Flo® Filter manhole configuration and external bypass vault configurations utilize the Outlet Module for pipe connections. See Figure 3. The white Outlet Module is installed during manufacturing by Hydro International® and prior to delivery. When installed, the outlet pipe of the Outlet Module protrudes from the exterior surface of the manhole or vault by approximately 18-inches allowing for connection to the downstream conveyance pipe. The exterior of the outlet pipe is sealed to the manhole using a flexible boot connector. This connector arrives factory installed and no work is required. The installing Contractor should inspect the connections and re-tighten the steel band as necessary. The outlet stub is stepped down in size three times from 15.3" OD to 12.5" OD to 10.5" OD. The stub is designed to be cut to the necessary diameter for connection to the downstream conveyance pipe. This connection should be made utilizing a flexible coupler such as a Fernco type coupling. (The flexible coupling is the responsibility of the Contractor.)

  To complete this, the flexible coupler should be attached to the outlet stub of the Up-Flo® first. The exterior surface of outlet stub should be cleaned and the rubber coupler slipped onto the stub completely. Once installed on the outlet stub the steel connector band(s) should be tightened per the manufacturer's recommendations. The mating pipe should then be cleaned and inserted into the coupler taking care not to disturb the connection to the outlet stub. Once inserted, the steel connector band(s) should be tightened per the manufacturer's recommendations. Some jurisdictions require an additional step, which consists of pouring a concrete lug around the flexible connection and the connection to the manhole or vault. Please contact the Local regulatory agency for specific details of this connection type.

Figure 4 - Example Outlet Module Connection w/ Flexible Boot

- *Flexible Boot Connections* – Clean the pipe surface and the inside of the flexible boot and insert the pipe into the boot. Insert the pipe flush with the inside of the vault wall keeping the pipe centered in the connector. Install all take up clamps in the grooves in the boots. Tighten the clamps to the manufacturer's recommended torque.

Figure 5 - Example Flexible Boot Connection to Pipe

Figure 6 - Example Boot Connection to Vault

- *Compression Type Connector* – Miter cut a ¾" bevel to the end of the pipe on the exterior side of the pipe wall. Clean the pipe exterior surface and the inside of the compression connector. Lubricate the inside of the connector and the exterior of the pipe with lubricant provided by the manufacturer. The beveled end of the pipe should be centered in the connector. Keeping the pipe level, the pipe and connector should be pushed into the pipe opening until the edge of the connector is flush with the inside of the vault wall.

- *Mortar* – The pipe should be inserted into the pipe opening so that the end of the pipe is positioned flush with the inside wall of the vault. The elevation of the pipe should be set and the pipe secured in place to prevent movement from the correct alignment and elevation. A non-shrink, hydraulic grout conforming to ASTM C1107 should be applied liberally to the exterior of the vault. Grout applied to the interior of the vault should make the pipe flush with the vault wall and the grout should be smoothed to blend with the interior vault wall. Proper curing time should be allowed prior to backfilling.

ACCESS, RISERS & MANHOLES

Access risers and manhole risers are necessary to bring the vault to finished grade. Square and round riser manhole sections and grade rings should be utilized as necessary to reach finished grade. Sections should be placed, joined and sealed with the same methods as the vault sections. Access and manhole covers should be set in place and shimmed to finished grade and level. Gaps between the last riser section and access covers should be filled with a non-shrink, hydraulic grout with sufficient strength to handle the expected surface loads.

BACKFILLING

Backfill should be placed in uniform, mechanically compacted layers in lifts no greater than 18-inches. Backfill material should be clean and free from rocks, debris and deleterious material. Care should be taken to ensure backfill is placed and adequately compacted beneath of connecting pipes to prevent differential settlement.

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:

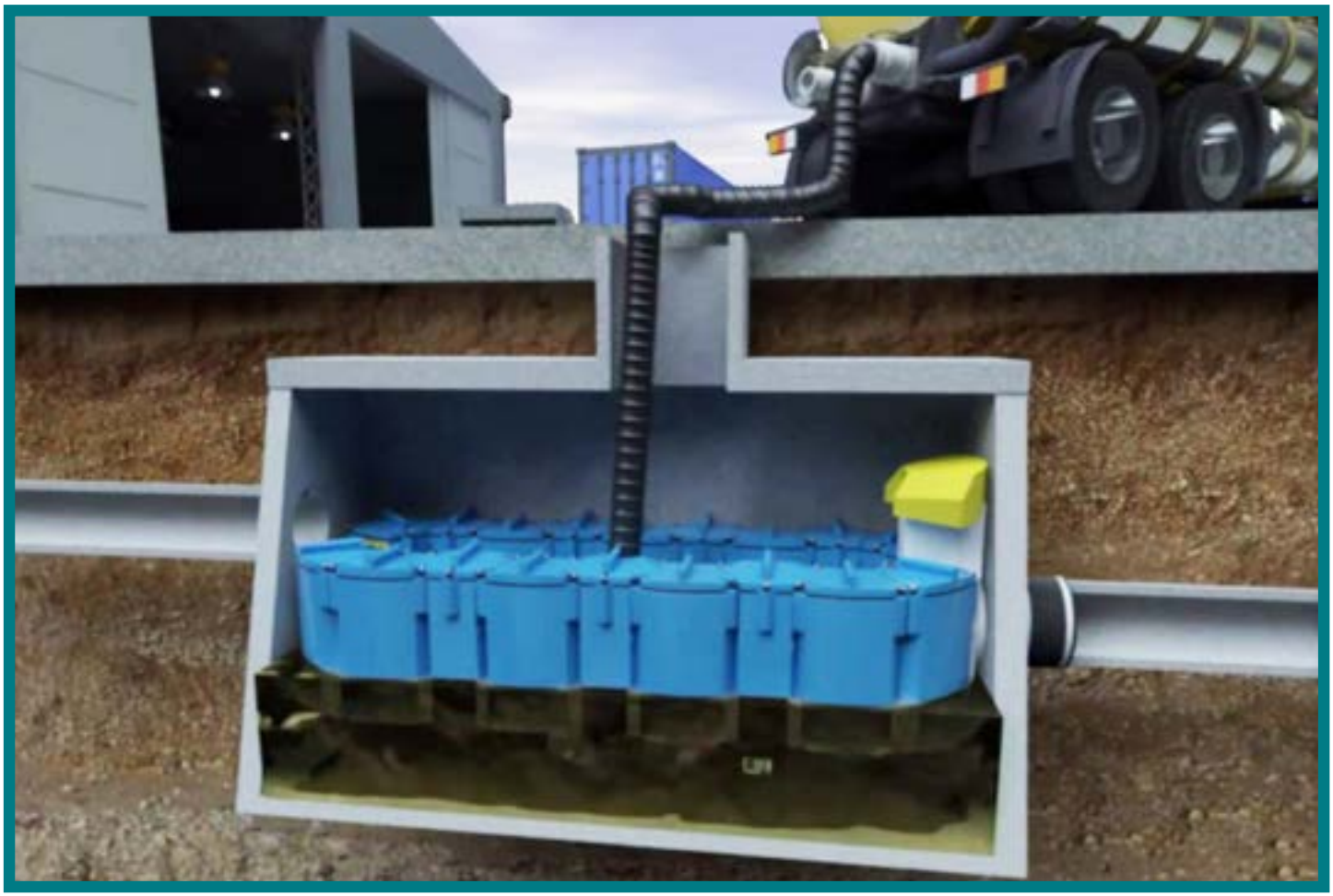
INSTALLATION DATE: _____

CONFIGURATION (CIRCLE ONE): MANHOLE VAULT

BYPASS (CIRCLE ONE): INTERNAL EXTERNAL

TOTAL NUMBER OF UP-FLO® FILTER MODULES: _____

APPENDIX D



Operation and Maintenance Manual

Up-Flo® Filter

Filtration System for Stormwater Treatment

Stormwater Solutions

94 Hutchins Drive
Portland, ME 04102

Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

www.hydro-int.com

Table of Contents

IMPORTANT - ORDER REPLACEMENT PARTS FOR MAINTENANCE - IMPORTANT

Annual maintenance requires replacement of the Media Packs and the Drain Down Filter. Contact Hydro International to order replacements. Allow 2-4 weeks for delivery.

Office hours Monday thru Friday 8:00 A.M. to 5:00 P.M. EST
Toll free: 1-888-382-7808
Phone: 207-756-6200
Fax: 207-756-6212
Email: services@hydro-int.com

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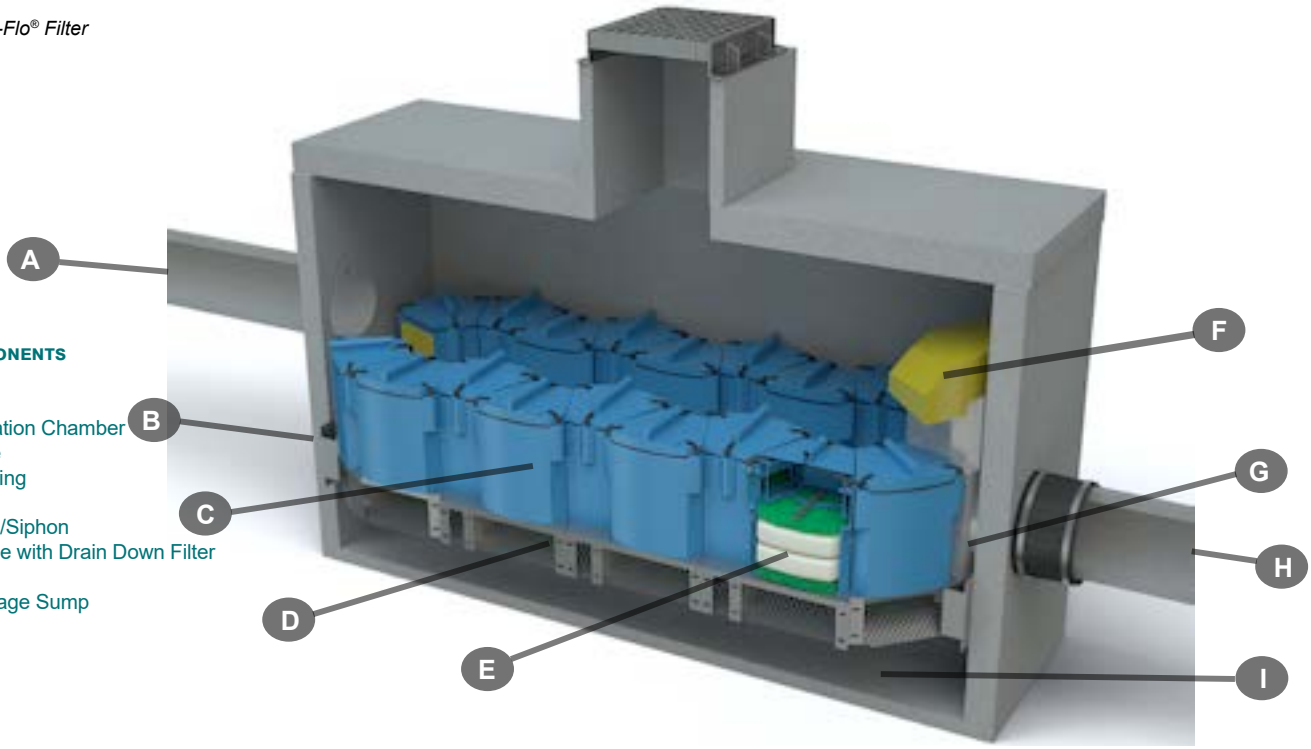
Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Overview & Product Description

The Up-Flo® Filter is a modular high-rate stormwater filtration device designed to capture trash, oil, sediment and remove fine pollutants such as dissolved and particulate metals and nutrients from stormwater runoff. Designed with efficiency, longevity and upkeep in mind, this high performance, low maintenance filter option that offers higher loading rates and longer media life for higher quality stormwater for longer periods between servicings.

In general, a minimum of two inspections are required per year to monitor sediment and gross pollutant accumulations. In order to achieve an annual TSS removal rate of 80% for the Up-Flo® Filter, the minimum maintenance frequency specified in the maintenance section for replacement of the Media Pack and removal of accumulated sediment from the sump is mandatory.

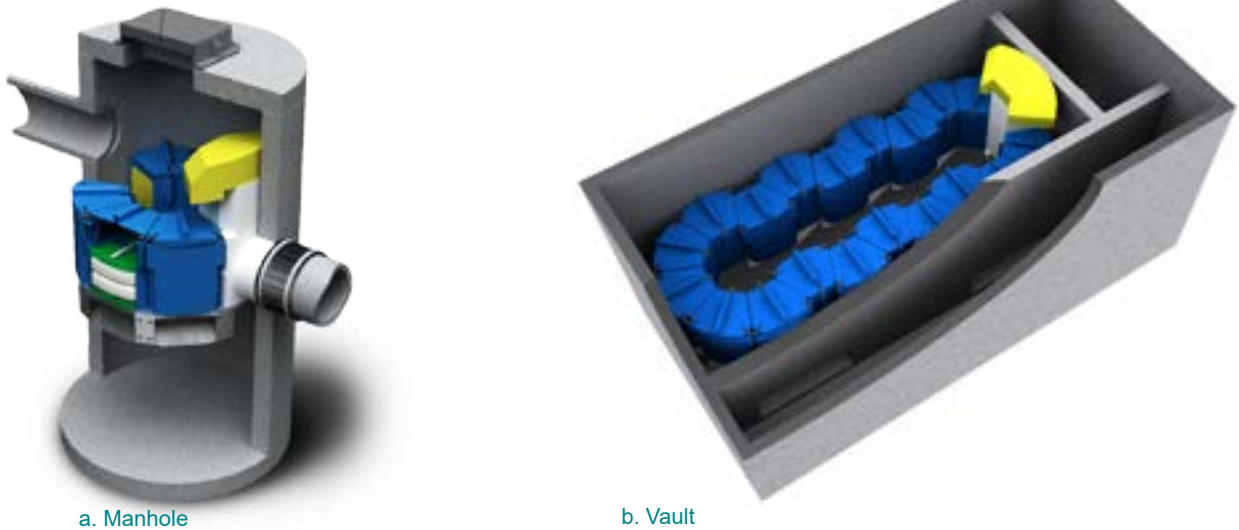
Fig.1 *The Up-Flo® Filter*



System Components

A. Inlet Pipe
B. Precast Filtration Chamber
C. Filter Module
D. 4mm Screening
E Media bag
F. Bypass Hood/Siphon
G. Outlet Module with Drain Down Filter
H. Outlet pipe
I. Pollutant Storage Sump

Product Configurations



a. Manhole

b. Vault

Fig.2 *The Up-Flo® Filter is installed in a) 4-ft (1.2m) round manholes or b) in rectangular precast vaults. Both configurations have a wide central opening in the Up-Flo® Filter.*

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

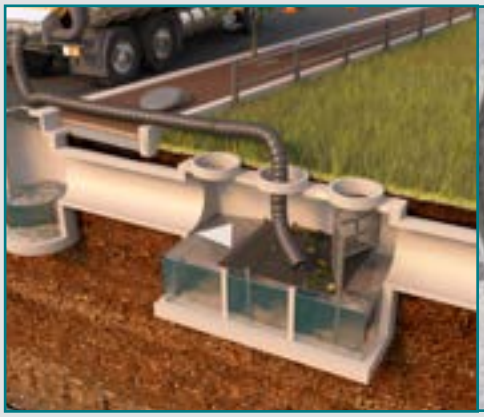
Trash, sediment and polluted water is stored inside treatment systems until they are removed by our team with a vactor truck. Sometimes teams must physically enter the system chambers in order to prepare the system for maintenance and install any replacement parts. Services include are are not limited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

- Stormwwater 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 (800) 382-7808

LEARN MORE AT HYDRO-INT.COM/SERVICE

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 non-corrosive components. Personnel are 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 **Fig.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 minimize the occurrence of clogging and blinding and employs a unique Drain Down Filter that allows the water level in the chamber to drop below the filter media between events. The Drain Down Filter mechanism creates a reverse flow that flushes captured pollutants off the surface of the Media Bag, helping to prevent blinding. By allowing the water to drain out, the Drain Down Filter also reduces the weight of the Media 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 and 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 Hood is designed to convey high enough flow to minimize the risk of large storm creating upstream flooding.

Best Practices

Good housekeeping upstream of the Up-Flo® Filter can significantly extend Media Bag life. For example, sweeping paved surfaces, collecting leaves and grass trimmings, and protecting bare ground from erosion will reduce loading to the system. Media Packs should not be installed in the Filter Modules until construction activities are complete and site stabilization is effective.

Damage Due to Lack of Maintenance

Delayed maintenance would result in clogged Media Bags and/or blinded Angled Screens. In that situation, the Up-Flo® Filter would go into bypass and there would be no treatment of the incoming stormwater. Because the Bypass Weir can easily convey all of the flow to the Outlet Module, there would be no lasting damage to the system. Replacement of the Media Bags and removal of sediment from the sump would restore the Up-Flo® Filter to its original treatment efficiency. Establishing and adhering to a regular maintenance schedule ensures optimal performance of the system.

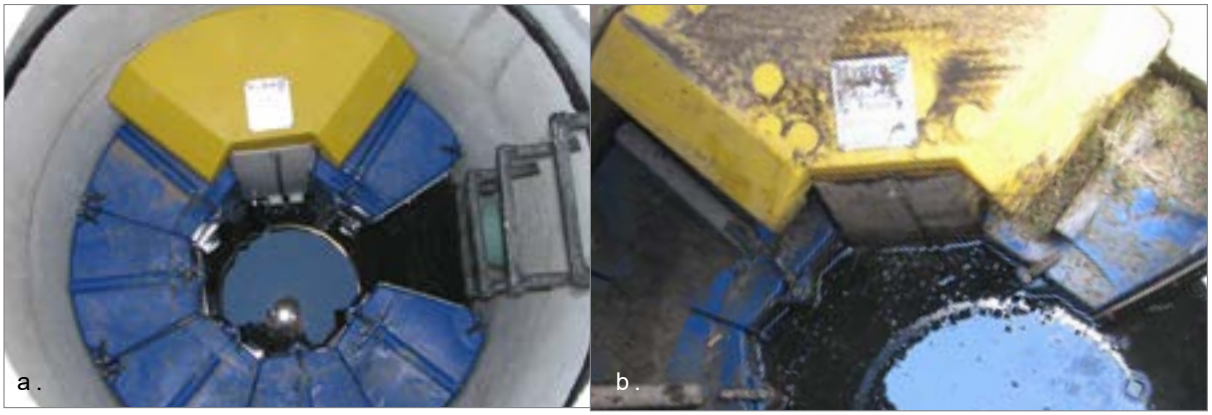


Fig.3 a) The water level in a properly functioning Up-Flo® Filter will drain down to the base of the Filter Modules. b) When the Drain Down Filter becomes clogged, the base of the Filter Modules will be submerged in standing water. Note, above right, that the Drain Down Filter is submerged in standing water.

Inspection & 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.

Maintenance activities can be categorized as those that may be performed from outside the Up-Flo® vessel and those that are performed inside the vessel. Maintenance performed from outside the modules includes removal of floatables and oils that have accumulated on the water surface and removal of sediment from the sump. Maintenance performed inside the vessel includes removal and replacement of Media Bags, Flow Distribution Media and the Drain Down Filter. A vactor truck is required for removal of oils, water, sediment, and to completely pump out the vessel to allow for maintenance inside. If you are not using Hydro Internatioanl or a trained servcie provider you must follow OSHA Confined Space Entry procedures when entering the Up-Flo® vessel.

The Up-Flo® Filter design has a wide central opening between the Filter Modules for easy access to all of the components (see **Fig.3**). In the case of inspection and floatables removal, a vactor truck is not required. Otherwise, a vactor 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.

The minimum required frequency for replacement of the Media Pack is annually, whereas the minimum required frequency for removal of accumulated sediment from the sump is dependent on the Up-Flo® Filter configuration. Configurations with a larger sediment storage volume per module will require less frequent removal of accumulated sediment. Regardless, whenever sediment depth in the sump is found to be greater than 16 inches, sediment removal is required.

At a minimum, media bags must be replaced at least once a year.

Fig.4 a) A new Media Bag of Hydro Filter Sand. b) A spent media bag of Hydro Filter Sand.

Make Sure your System was Installed Correctly

First Year Inspection and Maintenance

The frequency of inspection and maintenance can be determined in the field after installation. The frequency of ongoing maintenance needs is based on site characteristics such as contributing area, types of surfaces (e.g., paved and/or landscaped), site activities (e.g., short-term or long-term parking), and other site maintenance (e.g., sanding and sweeping). At a minimum, inspection and maintenance should be conducted at intervals of no more than six months during the first year of operation. Maintenance personnel should observe and record pollutant accumulations during the first year of service in order to benchmark the maintenance intervals that will later be established for the site. Pollutant accumulations should be measured or monitored using the following procedures:

- Measurement of sediment depth in the sump: A minimum of 8 inches (20 cm) should separate the Drain Down Filter inlet from stored sediment in the sump in order to minimize sediment migration into the Drain Down Filter. A simple probe, such as the Sludge-Judge®, can be used to determine the depth of the solids in the sump. In a typical 4-ft (1.2m) diameter manhole installation, the sediment depth should be no more than 16 inches (41 cm).

- Maintenance personnel should then enter the structure, remove the Media Pack from one of the Filter Modules, and weigh the Media Bags. Media Bags with a wet weight of approximately 40 lbs (18 kg) or more are an indication that the filter media has become full and that the Media Packs in all of the Filter Modules will require replacement (Fig.4). Minimum filtration rate is generally reached when the Media Bags have accumulated approximately 20 lbs (9 kg) of sediment. Determining the amount of accumulated sediment will be accomplished by removing both of the Media Bags from one of the Media Packs and weighing the bags separately. Since a new Media Bag weighs approximately 30 lbs (14 kg) wet, the difference in weight will approximately equal the weight of solids that have accumulated in the bag. A spent Media Bag weighs approximately 50 lbs (23 kg) wet.

- Measurement of oil layer on water surface: Since water in the Up-Flo® vessel drains down to an elevation below the bottom of the Filter Modules when the system is idle, the amount of accumulated oil must be minimized so that oil is not entrained in the Media Pack when stormwater begins to fill the vessel at the start of a storm event. Oil accumulation should be limited to 1.5 inches (4 cm) or less. Probes can be used to measure oil thickness.

- Monitoring for Drain Down Filter clogging: The water level in the Up-Flo® Filter should be monitored to ensure that the Drain Down Filter is operating properly. The Drain Down Filter is designed to lower the water level in the Up-Flo® vessel to an elevation below the bottom of the Filter Modules between storm events. Periodically conduct an inspection one to two days after a storm event during the first year of operation. Approximately 36 hours after a 1-in (2.5-cm) 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 (Fig.5 a and b). If there is no evidence of trash or debris around the Drain Down Filter inlet, then it has likely become clogged with particles.

- Monitoring for slime and debris covering the Flow Distribution Media or Angled Screens: After removal of the Media Bags, the bottom Flow Distribution Media should be removed and inspected to determine if it is coated with slime or debris. Similarly, the Angled Screen should be inspected for blockages and ragging.

Find out how Frequently your System Needs Maintenance

Monitoring for floatables on the water surface: Similar to oil, the amount of accumulated floatables must be minimized to prevent trash and loose debris from becoming trapped on the Angled Screens when stormwater begins to fill the Up-Flo® vessel at the start of a storm event. Visual inspection is adequate to determine the amount of floatables. Floatables should be removed before they form a mat on the surface of the water.

The solids loading rate in the sump will be calculated by measuring the sediment depth in the sump and dividing the depth by the correlating interval of time since the sump was last cleaned. Similarly, starting with fresh Media Bags, the solids loading rate in the Media Packs will be calculated by weighing the Media Bags and dividing the weights by the correlating interval of time since they were installed. The wet weight of the heaviest bag will be used to determine the loading rate. As previously mentioned, a spent Media Bag weighs approximately 50 lbs (23 kg) wet. The spent Media Bag weight estimate was based on calculations of sediment loading in an Up-Flo® Filter that was run to exhaustion during laboratory testing.

The rate of oil accumulation will be calculated by measuring the thickness of the oil layer and dividing the thickness by the correlating interval of time since the sump was last cleaned. Ordinarily, oil thickness will not be measurable unless a spill has occurred. Consequently, any oil will typically be removed along with water when cleaning the sump.

Monitoring the Drain Down Filter for clogging, monitoring the Flow Distribution Media and Angled Screens for slime and debris, and monitoring the accumulation of floatables will provide an estimate of how long the Up-Flo® Filter can operate before its performance can become impaired by one of these factors.

Routine Inspection and Maintenance

After completion of the first year of operation, determining and then following the established inspection and maintenance intervals will keep pollutant loadings within their respective limits. Removal of oils and floatables, replacement of the Drain Down Filter, replacement of Flow Distribution Media (see Fig.9, pg 11), and cleaning of Angled Screens will occur at the same frequency as cleaning of the sump and replacement of Media Bags unless the first year of operation indicates otherwise. Keeping to the established maintenance intervals will keep treatment flow rates at, or above, the design flow rate. Typically, annual maintenance is adequate.

In addition to scheduled maintenance, occasional checks for Up-Flo® Filter clogging can be performed by removing the manhole cover during a storm, monitoring the water level in the manhole or vault, and determining whether the filter is in bypass. A properly-sized filter (on-line or off-line) that is in bypass during a storm that is producing runoff at, or below, the filter's design filtration rate needs maintenance.

DON'T WANT TO GO IT ALONE? CALL HYDRO AND WE'LL TAKE CARE OF INSPECTION, REPLACEMENT MEDIA AND CLEANOUT.

CALL 1 (888) 382-7808 FOR A QUOTE

Inspection & Maintenance

Routine 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.

The following instructions are intended for non-Hydro maintenance service providers and/or those intending to maintain thier own Up-Flo® Filter:

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.

Necessary Equipment

- Safety Equipment and Personal Protective Equipment (traffic cones, work gloves, etc.)
- Scale to measure the weight of the Media Bags
- Crow bar 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

Routine Inspection 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 and to determine whether the high-water level indicator has been activated. Make note of any irregularities. See Fig.6 for a typical Inspection View.
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 16 inches (41 cm).
6. If the high-water level indicator has been activated after two consecutive storms, remove the Filter Module lid by turning the cam latch and remove the Filter Media Pack (*refer to page 11 Replacement Procedures*). Weigh the Media Bags from one or two modules. Media Bags should be replaced if the wet weight exceeds 40 lbs (18 kg).
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 (see Fig.6 for the standard standing water level).
8. Securely replace the grate or lid.
9. Remove safety equipment.
10. Contact Hydro International at (800) 848-2706 to discuss any irregularities noted during inspection.

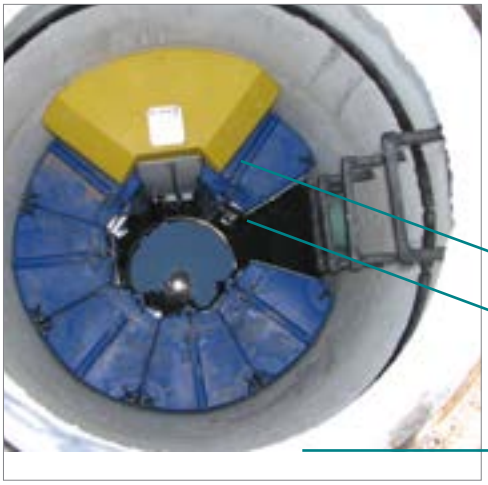


Fig.6 Inspection view of the Up-Flo® Filter.

Routine Maintenance

Maintenance activities are grouped into two categories:

- *Activities **Not Requiring** Man Entry Into the Up-Flo® Filter*
  These activities include floatables removal, oil removal and removal of sediment from the sump.
- *Activities **Requiring** Man Entry Into the Up-Flo® Filter*
  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 floatables removal, a vactor truck is not required. Floatables and loose debris can be netted with a skimmer and pole.

A vactor truck is normally required for oil removal, removal of sediment from the sump, and to dewater the vessel for replacement of the Media Packs and Drain Down Filter (Fig.7). All inspection and maintenance activities would be recorded in an Inspection and Maintenance Log.

Completion of all the maintenance activities for a typical 4-ft (1.2m) diameter manhole installation takes less than one hour. Approximately 360 gallons of water and up to 0.6 yd^3 (0.5 m^3) of sediment may be removed in the process. In an installation equipped with six Filter Modules, 12 Media Bags (2 bags per module) would be removed and replaced. Assuming a spent Media Bag weight of 50 lbs (23 kg), up to 600 lbs (272 kg) of spent Media Bags would be removed. All consumables, including Media Bags, Flow Distribution Media, and replacement Drain Down Filters are supplied by Hydro International.

The access port located at the top of the manhole provides unobstructed access for a vactor hose and/or skimmer pole to be lowered to the base of the sump.

Maintenance Activities Not Requiring Man Entry

These activities include floatables removal, oil removal and removal of sediment from 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)
- Crow bar 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 (flexible hose preferred)
- Pressure nozzle attachment or other screen-cleaning device

Fig.7 Sediment is removed from the sump with a vactor hose. Man entry is not required for this step.

No Man Entry Required: Floatables, Oil and Sediment:

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 (see Fig.8), tug the Pull Chain(s) to release the Drain Down Filter plug(s). Allow the excess water to drain out of the chamber.

5. Use the skimmer pole to fit the Drain Down Filter plug back into the open port.

6. Once all floatables and oil have been removed, drop the vactor hose to the base of the sump. Vactor out the sediment and gross debris from the sump floor. Up to 0.3 yd^3 (0.2 m^3) of sediment and 360 gallons (1,363 L) of water will be removed from a typical manhole Up-Flo® Filter during this process.

7. Retract the vactor hose from the vessel.

8. Inspect the Angled Screens for blockages and ragging. If present, remove the obstruction or ragging 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, oils, 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. Remove safety equipment.

11. Dispose of sediment and gross debris following local regulations.

12. Dispose of oil and sump water at a licensed water treatment facility or following local regulations.

13. Contact Hydro International at (800) 848-2706 to discuss any irregularities noted during cleanout.

Maintenance Activities Requiring Man Entry

These activities include replacement of the Media Packs and Drain Down Filter.

Unless the Up-Flo® Filter has been installed as a very shallow unit, it is necessary to have an OSHA-confined space entry trained person enter the vessel to replace Media Packs.

The access port located at the top of the manhole or vault provides access to the Up-Flo® vessel for maintenance personnel to enter the vessel and remove and replace Media Packs. The same access would be used for maintenance personnel working from the surface to net or skim debris and floatables or to vactor out sediment, oil, and water. Unless the Up-Flo® Filter has been installed in a very shallow configuration, it is necessary to have personnel with OSHA Confined Space Entry training performing the maintenance that occurs inside the vessel.

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.

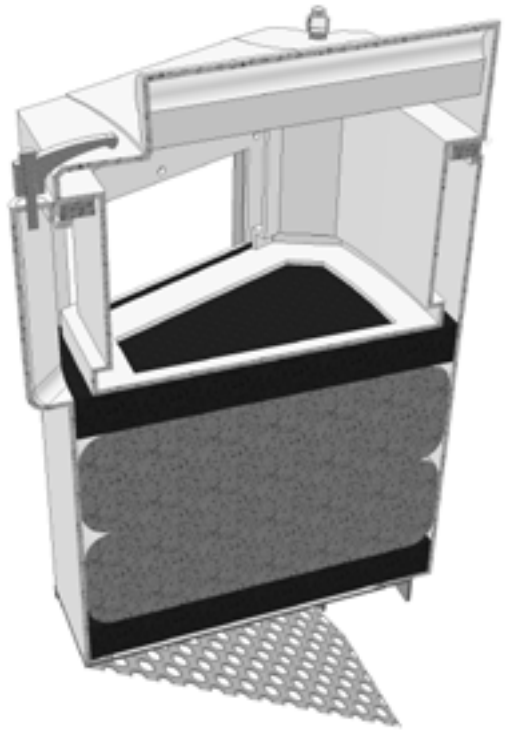


Fig.8 Cutaway view of the Filter Module

Recommended Equipment

- Safety Equipment (traffic cones, etc.)
- Crow bar to remove grate or lid
- Pole with skimmer or net (if floatables removal is not to be done with vactor hose)
- Sediment probe (such as a Sludge-Judge®)
- Vactor truck (flexible hose preferred)
- OSHA 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

Man Entry Required: Media Pack and Drain Down Filter

1. Follow Floatables and Sump Cleanout Procedures, 1 – 13.
2. Following OSHA 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 (Fig.9).
4. Remove and discard the spent Media Pack. The Media Pack contents include:
    - A top layer of (A) Flow Distributing Sheets
    - Two (2) Media Bags (B) equipped with nylon handles.
    - A bottom layer of (A) 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 (2) 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.

1. Filter Module Cover and Media Restraint

2. Replaceable Media Pack:
    a) Flow distribution sheets
    b) Filter Media Bags

3. Cam Latch

4. Conveyance Channel

5. Filter Module

6. Support Bracket / Angled Screen

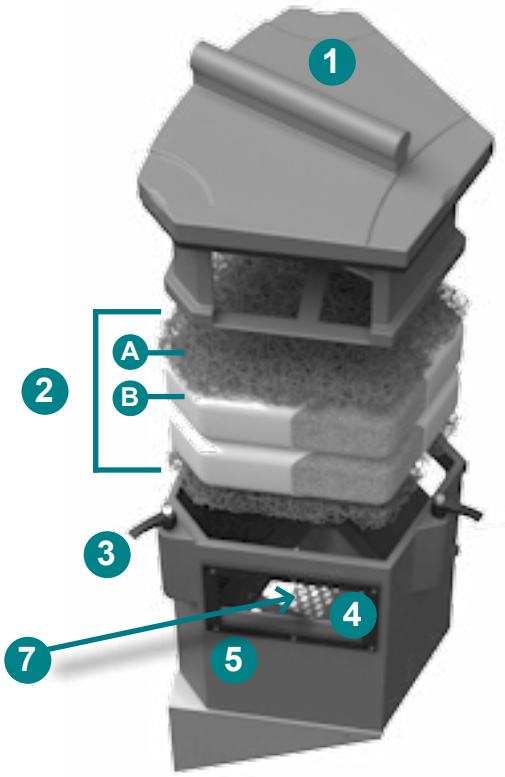


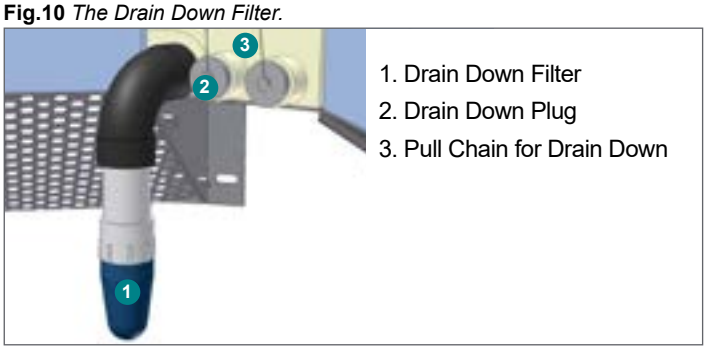
Fig.9 The Filter Module houses the Media Restraint and the Media Pack.

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 (see Fig.10). 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.

Fig.10 *The Drain Down Filter.*



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. Contact Hydro International to discuss any irregularities noted during annual maintenance.

Solids Disposal

Sediment, floatables, gross debris, and spent Media Bags can generally be disposed of at the local landfill in accordance with local regulations. The toxicity of the residues captured will depend on the activities in the contributing drainage area, and testing of the residues may be required if they are considered potentially hazardous.

Sump water can generally be disposed of at a licensed water treatment facility but the local sewer authority should be contacted for permission prior to discharging the liquid. Significant accumulations of oil removed separately from sump water should be transported to a licensed hazardous waste treatment facility for treatment or disposal. **In all cases, local regulators should be contacted about disposal requirements.**

Maintenance at a Glance

Activity	Frequency
Inspection	- Regularly during first year of installation - Every 6 months after the first year of installation
Floatables/Oils Removal	- Twice per year or as needed - Following a contaminated spill in the drainage area
Sediment Removal	- Every six to 12 months, depending on the Up-Flo® Filter Configuration - The maximum allowable sediment depth in any Up-Flo Filter configuration is 16 inches (41 cm) - Following a contaminated spill in the drainage area
Media Pack Replacement	- Once per year - Replacement is required anytime inspection reveals that the high-water level indicator has been activated after two consecutive storms and the subsequent weighing of the Media Bags shows a wet weight greater than 40 lbs - Following a contaminated spill in the drainage area
Drain Down Filter Replacement	- Once per year with Media Pack replacement - Replacement is required anytime inspection reveals that the water level inside the vessel has not reached a level equal with the base of the Filter Modules approximately 36 hours after a 1-inch (2.5 cm) rainfall - As needed, in the event of continuous base flow conditions

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

Up-Flo® Filter Installation Log

SITE REFERENCE NAME OR NUMBER FOR THIS UP-FLO® FILTER LOCATION:	
SITE NAME:	
SITE LOCATION:	
OWNER:	**SITE CONTRACTOR:**
CONTACT NAME:	**CONTACT NAME:**
COMPANY NAME:	**COMPANY NAME:**
ADDRESS:	**ADDRESS:**
TELEPHONE:	**TELEPHONE:**
FAX:	**FAX:**

INSTALLATION DATE: / /

CONFIGURATION (CIRCLE ONE): **MANHOLE** **VAULT SYSTEM**

TOTAL NUMBER OF UP-FLO® FILTER MODULES: _____

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

Up-Flo® Filter Inspection Log

Site Name: _____ Owner Change since last inspection? Y N

Location: _____

Owner Name: _____

Address: _____ Phone Number: _____

Site Status: _____

Date: _____ Time: _____ Site conditions*: _____

(Stable, Under Construction, Needing Maintenance, etc.)

Inspection Frequency Key: A=annual; M=monthly; S=after major storms

Inspection Items	Inspection Frequency	Inspected? (Yes/No)	Maintenance Needed? (Yes/No)	Comments/Description
Debris Removal				
Adjacent area free of debris?	M			
Inlets and Outlets free of debris?	M			
Facility (internally) free of debris?	M			
Vegetation				
Surrounding area fully stabilized? (no evidence of eroding material into Up-Flo® Filter)	A			
Grass mowed?	M			
Water retention where required				
Water holding chamber(s) at normal pool?	A			
Evidence of erosion?	A			
Sediment Deposition				
Filtration Chamber free of sediments?	A			
Sedimentation sump not more than 50% full?	A			
Structural Components				
Any evidence of structural deterioration?	A			
Grates in good condition?	A			
Spalling or cracking of structural parts?	A			
Outlet/Overflow Spillway	A			
Other				
Noticeable odors?	A			
Any evidence of filter(s) clogging?	M			
Evidence of flow bypassing facility?	A			

Inspector Comments: _____

_____

_____

_____

Overall Condition of Up-Flo® Filter**: ☐ Acceptable ☐ Unacceptable

***"Acceptable" would mean properly functioning; "unacceptable" would mean damaged or required further maintenance.*

If any of the above Inspection Items are checked "Yes" for "Maintenance Needed", list Maintenance actions and their completion dates below or on the Maintenance Log provided on page 15 of the Up-Flo® Filter Operation & Maintenance Manual:

Maintenance Action Needed	Due Date

The next routine inspection is schedule for approximately: (date) _____

Inspected by: (signature) _____

Inspected by: (printed) _____

Up-Flo® Filter Maintenance Log

Site Name: _____ Owner Change since last inspection? Y N

Location: _____

Owner Name: _____

Address: _____ Phone Number: _____

Site Status: _____

Date: _____ Time: _____ Site conditions: _____
**(Stable, Under Construction, Needing Maintenance, etc.)*

Estimated volume of oil/floatable trash removed: _____

Sediment depth measured in sump prior to removal: _____

Number of Filter Modules fitted with new media packs: _____

Inspector Comments: _____

_____

_____

_____

Overall Condition of Up-Flo® Filter: ☐ Acceptable ☐ Unacceptable
***"Acceptable" would mean properly functioning; "unacceptable" would mean damaged or required further maintenance.*

Maintained by: (signature) _____

Maintained by: (printed) _____

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
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Do it Right the First Time

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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...®

UFF_OMM_D1608

APPENDIX E

Turning Water Around…®

Stormwater Equipment Limited Product Warranty

Hydro International's equipment including the DOWNSTREAM DEFENDER®, FIRST DEFENSE®, UP-FLO® FILTER, REG-U-FLO® Vortex Valve, HYDRO DRYSCREEN®, HYDRO BIOINFILTRATOR®, is backed by the following warranty:

Hydro International warrants all of its products to be free from defects in materials and workmanship; and will replace, repair, or reimburse at its discretion any part or parts which, after Hydro's examination, Hydro shall have determined to have failed under normal use and service by the original user within two years following initial installation. Such repair or replacement shall be free of charge for all items except for (i) those items that are consumable and normally replaced during maintenance, (ii) labor costs incurred by Hydro to obtain access to the part or unit for repair or replacement, (iii) any costs to repair or replace any surface treatment / cover after repair or replacement or (iv) other charges that Hydro may incur incident to such repair or replacement. Repair or replacement of such consumable items shall be subject to assessment of a pro-rated charge based upon Hydro International's estimate of the percentage of normal service life realized by the item. Hydro International's obligation under this Warranty is conditioned upon (a) its receiving prompt notice of claimed defects which shall in no event be later than thirty (30) days following expiration of the above warranty period and (b) owner of the product properly operating, inspecting, maintaining and caring for the product and is limited to repair or replacement as aforesaid. Purchaser agrees that the foregoing warranty is Purchaser's sole remedy under any legal theory whether pleaded in contract, tort, or otherwise.

THIS WARRANTY IS EXPRESSLY MADE BY HYDRO INTERNATIONAL AND ACCEPTED BY PURCHASER IN LIEU OF ALL OTHER WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, WHETHER WRITTEN, ORAL, EXPRESS, IMPLIED, OR STATUTORY. HYDRO INTERNATIONAL NEITHER ASSUMES, NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT, ANY OTHER LIABILITIES WITH RESPECT TO ITS EQUIPMENT INCLUDING NEGLIGENCE IN DESIGN OR MANUFACTURE AND PURCHASER AGREES THAT THIS WARRANTY AND THE OBLIGATIONS OF HYDRO INTERNATIONAL SET FORTH HEREIN ARE THE SOLE REMEDIES AVAILABLE TO PURCHASER FOR THE FAILURE OF ANY PRODUCT TO PERFORM AS WARRANTED. HYDRO INTERNATIONAL SHALL NEITHER BE LIABLE FOR NORMAL WEAR AND TEAR NOR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGE DUE TO USE OR INOPERABILITY OF ITS EQUIPMENT FOR ANY REASON WHATSOEVER.

This Warranty shall not apply to equipment or parts thereof which have been altered or repaired outside of an authorized Hydro International facility or fabricator, or damaged by improper handling, installation, or application, or subject to misuse, abuse, neglect, accident or improper or inadequate maintenance. 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.

APPENDIX F

UP-FLO™ FILTER

HYDRAULIC CHARACTERIZATION OF VARIOUS FILTRATION MEDIA

FEBRUARY 2007

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TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

The Up-Flo™ Filter is a high rate, modular filtration system designed to meet the most stringent stormwater treatment regulations. It incorporates multiple elements of a treatment train into a single, small-footprint device. The Up-Flo™ Filter is engineered to remove over 80% of fine TSS and associated pollutants at a reasonably high filtration rate. Filter media may be customized to target other site-specific pollutants such as metals and organics.

2.0 OBJECTIVES

Upflow filters typically have a greater flow-through capacity than a down-flow or radial-flow filter with the same surface area. The hydraulic capacity of an upflow filter is dependent upon the surface area, particle size, density, porosity, expansion velocity, depth of and pressure head acting on its filtration media.

One of the key attributes of the Up-Flo™ Filter is that its filtration media may be customized to target site-specific pollutants. However, different media will have different flow-through capacities. Because the Up-Flo™ Filter is most often sized to meet a treatment flow rate, it is imperative to derive a comprehensive hydraulic characteristic for each media in the Up-Flo™ Filter portfolio.

The objective of the Hydraulic Characterization is to determine the flow rate in gallons per minute per square foot of different media through the Up-Flo™ Filter. This testing program evaluated the filtration rate of two separate media mixes: Filter Sand and Hydro International's CPZ Mix™.

3.0 THE UP-FLO™ FILTER TEST FACILITY DESCRIPTION

3.1 LABORATORY SET UP

The Hydro International test facility contains a 23,000-gallon clean water storage reservoir equipped with a Flygt submersible pump to distribute feed water. The 3-inch Flygt pump delivers water to the Up-Flo™ Filter through an 8-inch PVC pipe network that freely discharges into the open top of the test tank. The 8-inch PVC delivery line is equipped with clear standpipes and a Hershey VP-820 butterfly valve that redirects flows in excess of the desired influent flow rate back into the feed reservoir.

3.2 UP-FLO™ FILTER CONFIGURATION

The 4-ft x 4-ft polypropylene test tank stands 7-ft high and houses from one (1) to six (6) Up-Flo™ Filter Modules. The test tank has a 12-inch outlet pipe that discharges into a large underflow basin on the floor of the lab. Two, 2-inch Flygt pumps send water from the underflow basin back into the feed reservoir.

A Catch Basin configuration Up-Flo™ Filter equipped with one (1) Filter Module is used for testing. The Filter Module is filled with two (2) Media Bags and latched shut. A more detailed description of the laboratory set-up can be seen in Appendix A.

3.3 EFFLUENT MONITORING ARRANGEMENT

The hydraulic monitoring program determines the flow characteristic of the Up-Flo™ Filter on a per Filter Module basis. The flow rate of a single module is predicted to be in the 15-25 gpm range. Due to the low flow rates expected, the methodology of using flow monitoring sensors to determine the flow rate per Filter Module was rejected for the more reliable Volumetric Time-To-Fill test method.

A compartmentalized underflow tank is situated next to the test tank. The Up-Flo™ Filter outlet pipe discharges directly into one of two 18-cubic foot compartments. A 4-gallon bin is also kept on hand to use when filtration flows are suitably low.

3.4 INFLUENT FLOW RATE

The flow rate to the Up-Flo™ Filter can be adjusted from 0-450 gpm (0.0 - 1.0 cfs) using the notched Hershey VP-820 butterfly valve fixed to the delivery pipework.

The chosen influent flow rate will vary with the number of Filter Modules included in the Up-Flo™ Filter test tank. The testing takes place under steady-state conditions, where the influent flow rate equals the filtration flow rate. The filtration flow rate of each Filter Module is approximately 20 gpm. Accordingly, the target influent flow rate is 20 gpm multiplied by the number of Filter Modules in the test tank.

4.0 TESTING PROCEDURE

4.1 MEDIA

Two (2) media bags of a specified filtration media were filled and placed into the Up-Flo™ Filter Module.

4.2 INFLUENT FLOW RATE CALIBRATION

A 3-inch, non-variable Flygt pump delivers flows at a constant rate of 448 gpm (1.0 cfs). A series of butterfly valves, a Hersey VP-820 valve and a notched Hershey VP-812 valve, are used to step the flow down to the desired influent flow rate. Excess flows are directed back to the storage reservoir. When the butterfly valves are being used, the flow rate is calibrated using the Volumetric Time-To-Fill Method. After the valves have been set to their desired notches, time to fill the tank to the 8-cubic feet mark is recorded. The flow rate equals the volume divided by the time-to-fill the volume.

4.3 FILTRATION FLOW RATE MONITORING

The filtration rate is determined by monitoring the effluent flow rate of an Up-Flo™ Filter consisting of one (1) Filter Module.

4.3.1 EFFLUENT MONITORING

The following procedure is used:

1. Place two (2) filled media bags in the Filter Module and latch the Filter Module shut.
2. Plug the weep holes located at the bottom of the Outlet Module.
3. Start the 3” submersible pump and allow it to pump water into the Up-Flo™ Filter test tank until there is enough driving head to start pushing water up through the filter.
4. Continue to pump flows into the tank until the desired operating head of 20 inches is reached. When the water is at 20 inches of operating head, use the butterfly valves to reduce the influent flows until they are equal to the effluent flows, stabilizing the water level within the Up-Flo™ Filter test tank.
5. Decant flows from the underflow collection tank by switching on the 2-inch Flygt pump.
6. When the underflow collection tank is decanted, start the stopwatch and turn off the decanting pumps, allowing the effluent to fill the volumetric bin.
7. Be sure to keep the water head in the test tank level at 20 inches by adjusting the butterfly valve on the influent line.
8. Record the amount of time it takes to fill the volumetric bin.
9. Let the water level in the tank drop one (1) inch so that there is an operating head of nineteen (19) inches acting on the filter. Repeat Steps 6-8.
10. Repeat Step 9 until there is less than one (1) inch of driving head remaining.
11. Stop influent pump. Drain the test unit and prepare to repeat hydraulic characterization.

4.3.2 EFFLUENT FLOW RATE CALCULATION

Calculate the flow rate, Q, for a given operating head using the following calculation:

$$Q_{(gpm)} = \text{Volume of bin}_{(gal)} / \text{time-to-fill}_{(min)} \qquad \textbf{Equation 1}$$

5.0 RESULTS

5.1 CPZ Mix™

The CPZ Mix™ is Hydro International's custom blend of granular activated Carbon, Peat, and manganese-coated Zeolite. The mix is designed to remove fine sediments, metals, nutrients and organics from stormwater runoff.

The flow rate through the CPZ Mix™ was determined to be 24.7 gpm per module at an operating head of 20 inches. The flow rate per Filter Module of the CPZ Mix™ is shown below in Figure 1. The critical driving head, defined to be the driving head required to initiate flow through the media, was determined to be 6 inches. The critical driving head is denoted by the red data point in Figure 1.

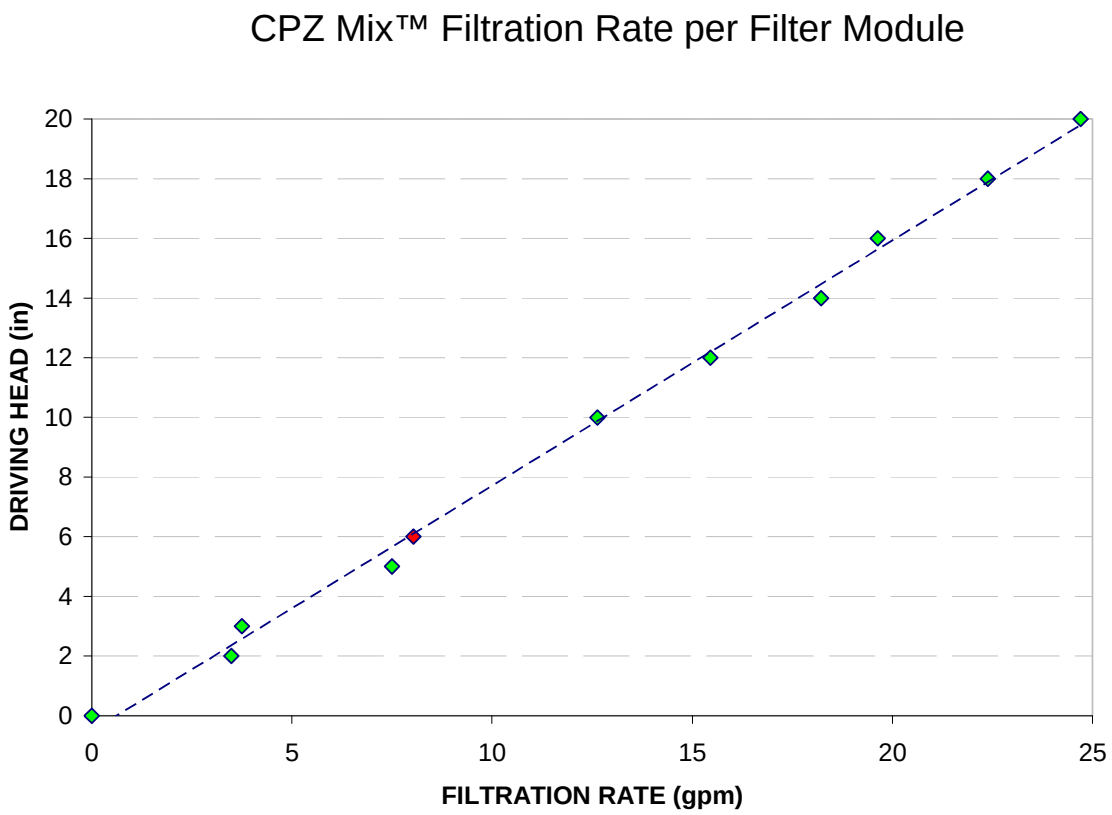


Figure 1 – Flow Rate per Unit Area of the CPZ Mix™

5.2 Filter Sand

The filter sand used in the Up-Flo Filter™ is a commercially available filter sand that is sized and graded to meet the stringent specifications of AWWA B-100 and the ANSI standards for consistently uniform and chemically inert filter media.

The flow rate through the filter sand was determined to be 23.1 gpm per module at an operating head of 20 inches. The flow rate per Filter Module of the filter sand is shown below in Figure 2. The critical driving head, defined to be the driving head required to initiate flow through the media, was determined to be 10 inches. The critical driving head is denoted by the red data point in Figure 2.

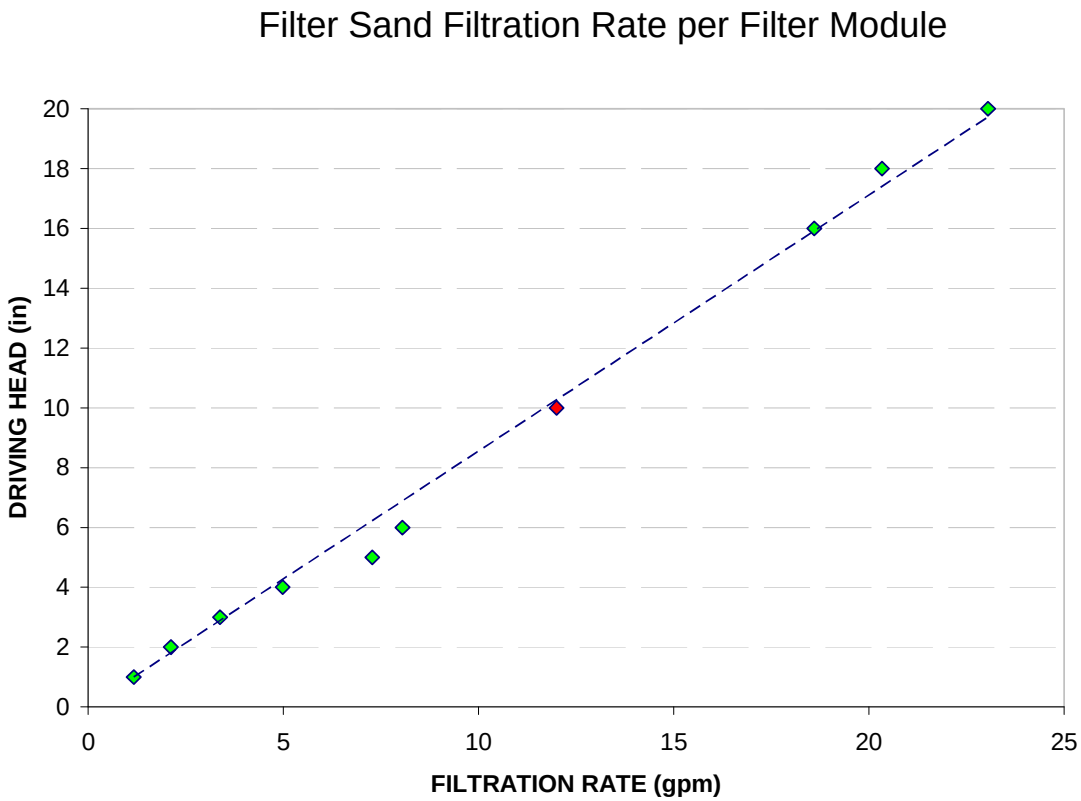


Figure 2 – Flow Rate per Module of Filter Sand

5.3 CPS Mix™

The CPS Mix™ is Hydro International's custom blend of granular activated Carbon, Peat, and Filter Sand. The mix is designed to remove fine sediments, metals, nutrients and organics from stormwater runoff.

The flow rate through the CP Mix™ was determined to be 19.6 gpm per module at an operating head of 20 inches. The flow rate per Filter Module of the CPS Mix™ is shown below in Figure 3. The critical driving head, defined to be the driving head required to initiate flow through the media, was determined to be 6 inches. The critical driving head is denoted by the red data point in Figure 3.

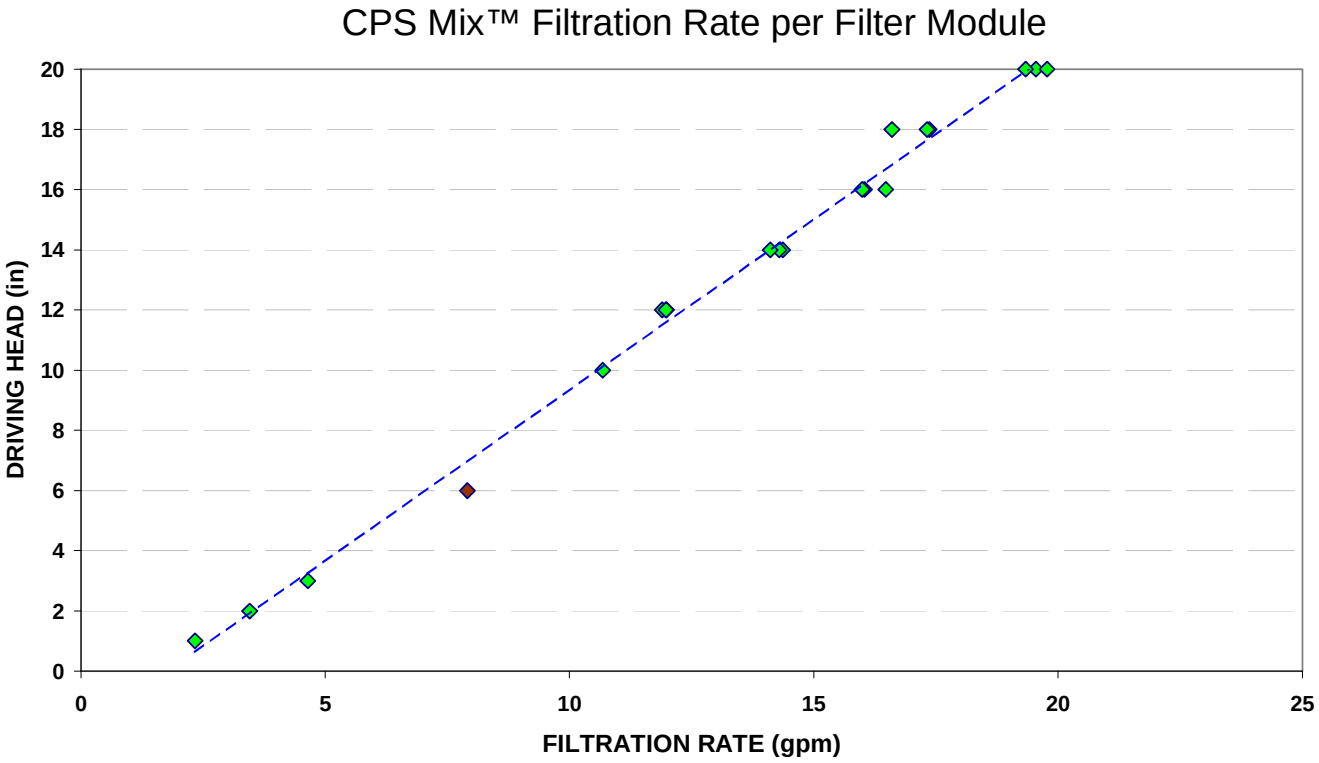


Figure 3 – Flow Rate per Module of CPS Mix™

5.4 Perlite

The flow rate through the Perlite was determined to be 28 gpm per module at an operating head of 20 inches. The flow rate per Filter Module of the Perlite is shown below in Figure 4. The critical driving head, defined to be the driving head required to initiate flow through the media, was determined to be 5 inches. The critical driving head is denoted by the red data point in Figure 4.

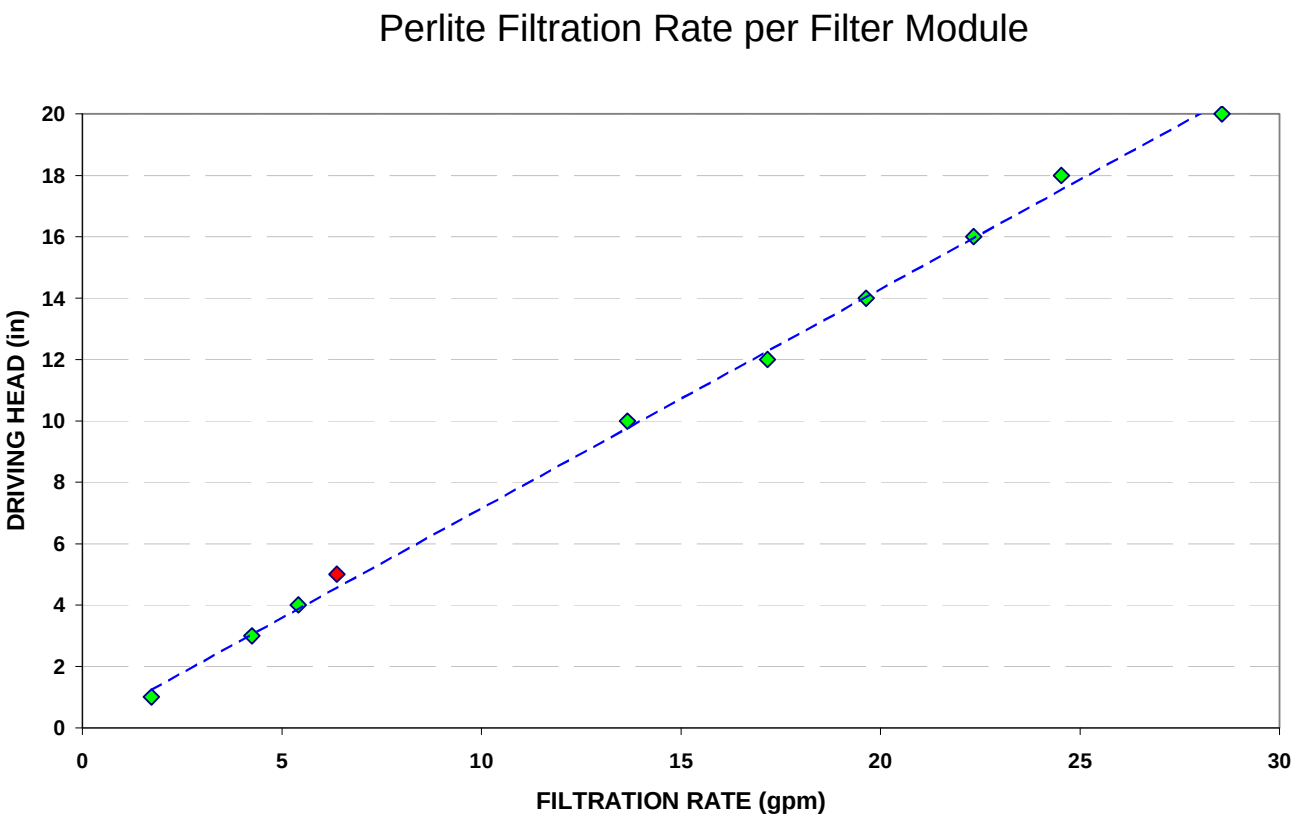


Figure 4 – Flow Rate per Module of Perlite

6.0 CONCLUSIONS

A full-scale Up-Flo™ Filter has been hydraulically characterized for different media. Steady-state influent and effluent flow conditions were established with a driving head of 20 inches or 29.5 inches from the outlet invert. CPZ Mix™, Filter Sand and Perlite show hydraulic flow-through capacities of 25 gpm, 23 gpm, and 29 gpm, respectively, per Filter Module.

APPENDIX A - TEST UNIT DESCRIPTION

DESCRIPTION OF THE Up-Flo™ FILTER

A full description of the system components and functionality of the Up-Flo™ Filter is presented in a Flash Animation File found on Hydro International's web page http://www.hydro-international.biz/.

TEST UNIT DESCRIPTION

The test unit is fabricated from polypropylene and takes the form of a 4-ft x 4-ft square chamber cylinder approximately 7 ft (2.1m) high. The internal polypropylene components, 4mm perforated, Type 304 stainless steel screen and Type 304 stainless steel support frame are the same as found in actual units. There is no inlet. The set-up simulates a catch-basin insert technology which treats stormwater runoff pouring into a chamber from an overhead grate. The outlet is flanged with a 12 in. (300mm) NP16 flange. The relevant levels are as shown in the drawings and flash animation.

In order to clean out the unit and view the sediment storage area, an 18 in. (460mm) access hatch with a clear viewing port is located at sump level.

BYPASS CAPACITY CALCULATIONS

The Up-Flo™ Filter test unit has an effective siphonic bypass capacity, Q, equal to:

$$Q = c_d\, A(2g \cdot h)^{0.5}$$

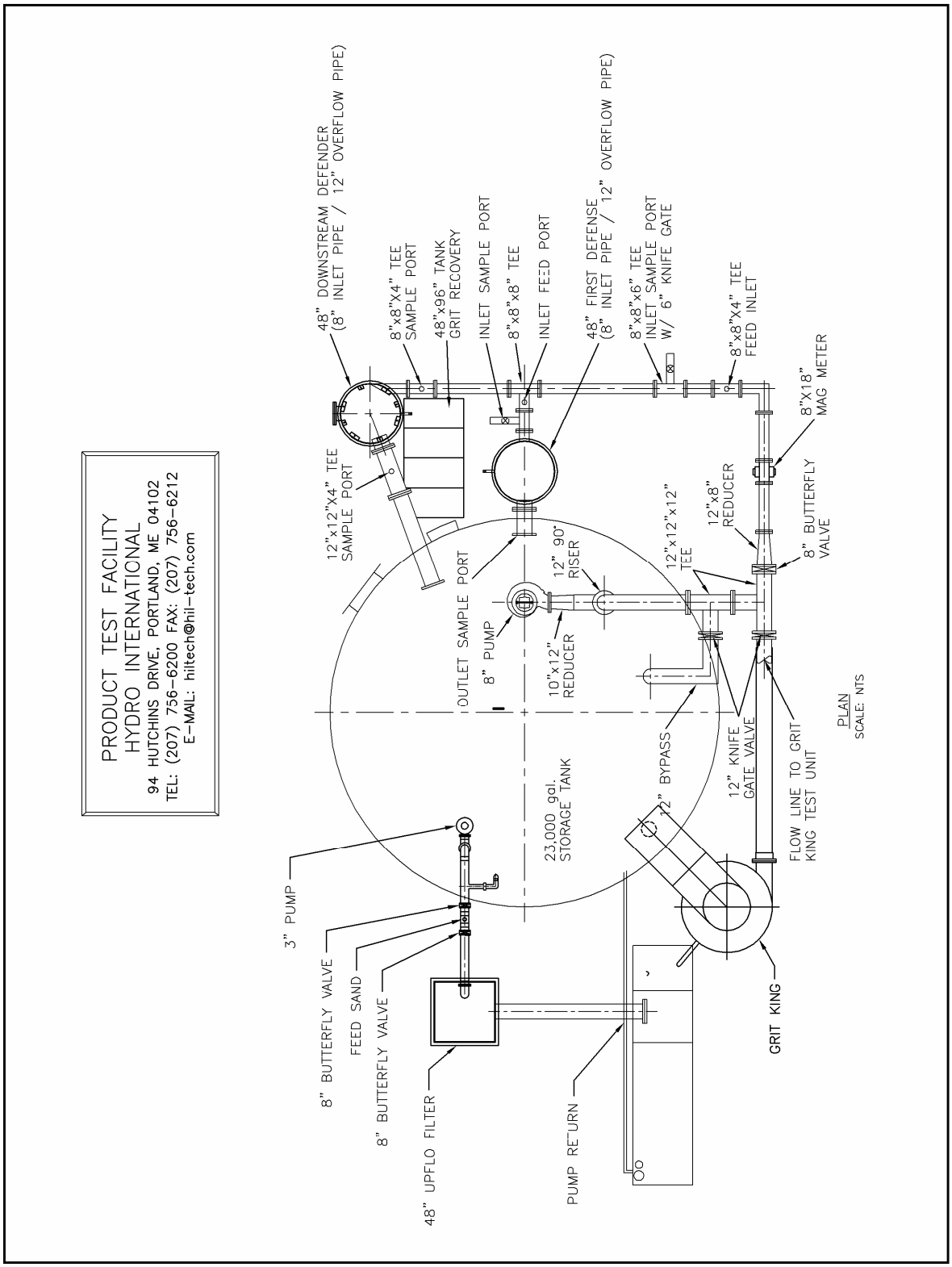
$$= 4.0\ ft^3/s$$

where; c_d = coefficient of discharge = 0.6
A = area of 12-inch outlet pipe = 0.7854 ft^2
g = acceleration due to gravity = 32.2 ft/s^2
h = height of Outlet Module/Siphon Colum = 1.125ft*

*(Measured from centre-line of the outlet pipe to the bypass weir in the outlet module)

APPENDIX B - TEST FACILITY DESCRIPTION

TEST FACILITY GENERAL ARRANGEMENT



TEST UNIT PHOTOGRAPHS

Figure A-2: View showing Up-Flo™ Filter overhead Inlet Pipe, Outlet Pipe and Collection Basin

Figure A-3: View Showing a One-Filter Module Set-Up

Figure A-4: View showing closed and opened Filter Modules

Figure A-5: View showing media bag with Filter Sand being installed in the Filter Module

Figure A-6: A close-up view of the Filter Sand

Figure A-7: A close-up view of the Hydro International *CPZ Mix*™

TECHNICAL BULLETIN // **UP-FLO™ FILTER**

EVALUATION OF FLOATABLES RETENTION DURING OVERFLOW CONDITIONS

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EVALUATION OF FLOATABLES RETENTION DURING OVERFLOW CONDITIONS

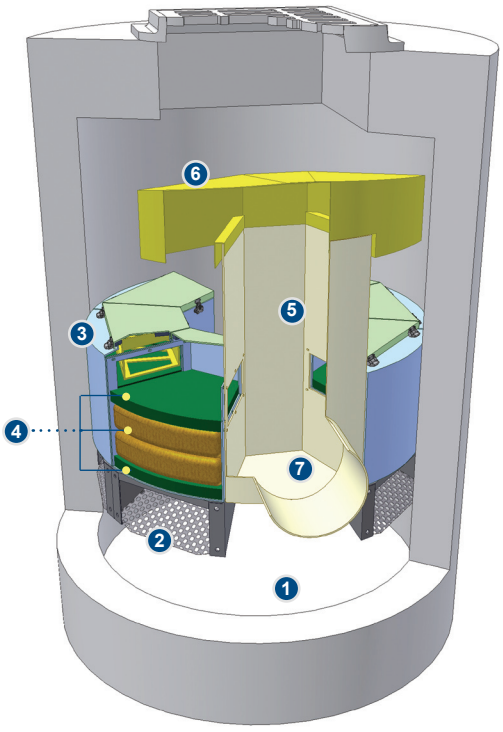
INTRODUCTION

The Up-Flo™ Filter is a high rate, modular filtration system designed to meet the most stringent stormwater treatment regulations. It incorporates the multiple elements of a treatment train approach into a single, small-footprint device. The various components of the Up-Flo™ Filter are designed to target the removal of materials from multiple stormwater pollutant classifications (see Figure 1). The Up-Flo™ Filter is equipped with a high-capacity siphonic bypass to guard against upstream ponding during intense overflow conditions. The siphon also serves as a floatables baffle to prevent buoyant debris and trash from escaping during overflow conditions. The objective of this experiment was to evaluate the floatables retention of the Up-Flo™ Filter during overflow conditions.

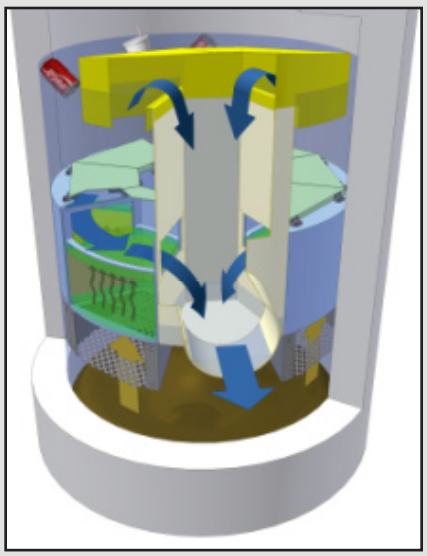
TESTING ARRANGEMENT

A full-scale, 4-ft x 4-ft catch basin configuration Up-Flo™ Filter equipped with Filter Module was used for this test.

A 3-inch Flygt pump delivered influent from the 23,000 gallon clean water reservoir to a free discharge point above the open top of the Up-Flo™ Filter test tank through an 8-inch PVC pipe network. The pipe network was equipped with a Hershey VP-820 butterfly valve to return flows in excess of the desired influent flow rate to



1. Sump
2. Angled Screen
3. Filter Module
4. Media Pack
5. Outlet Module
6. Bypass Siphon with Floatables Baffle
7. Drain Down Port



Bypass Operation

Figure 1: The internal components of the Up-Flo™ Filter

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the feed reservoir. The chamber of the Up-Flo™ Filter was preloaded with 20 gallons of floatable trash and debris, including pastic containers, syrofoam packing peanuts, paper coffe cups, lids and straws (see Figure 2).

Figure 2: Up-Flo™ test unit preloaded with trash

The outlet pipe of the Up-Flo™ Filter freely discharged into a compartmentalized underflow collection tank. The water from the underflow tank was then recirculated back into the feed reservoir.

POLLUTANT RETENTION

The floatable trash retention capability of the Up-Flo™ Filter was measured at 150 gpm (0.33 cfs), 300 gpm (0.66 cfs), and 450 gpm (1 cfs). To simulate a range of bypass overflow intensities, each of the flow rates tested was well above the 25 gpm filtration rate of one Filter Module. For each trial, flows were piped into the Up-Flo™ Filter at a constat flow rate. The water level in the Up-Flo™ test tank would rise until the it reached the height of the inner weir of the bypass siphon, where the water level would reach steady state.

The floatables retention capability was evaluated by measuring the amount of floatable material that escaped through the bypass siphon while the water levels in the Up-Flo™ test tank were rising (see Table 1).

Table 1: Floatable Retention of the Siphonic Bypass

Flow Rate (gpm/cfs)	Volume of Escaped Material (gal)	% Retention
150 / 0.33	0.0	100
300 / 0.66	0.0	100
450 / 1.0	0.0	100

As shown in Table 1, there was no escape of floatable trash, including the smaller material such as Styrofoam packing peanuts. Due to chamber dynamics, floatable material was prohibited from escaping out of while water level was rising. At overflow water levels, the intake to the bypass siphon is lower than the surface level of the water (see Figure 3). Thus, once steady state overflow conditions were reached, 100% capture of all floatable material at all flow rates was observed for all flow rates.

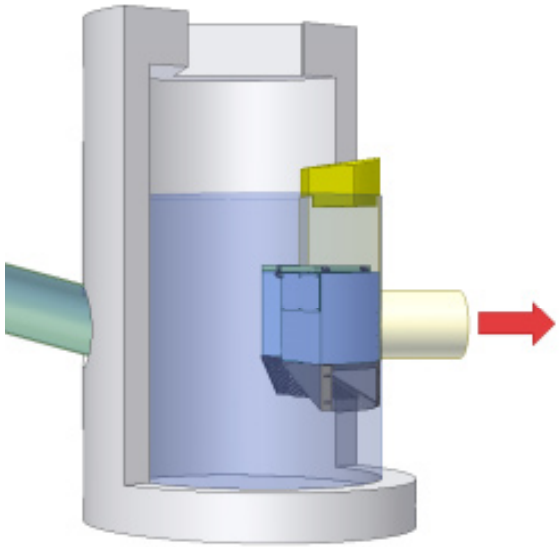

Figure 3: Water level in the Up-Flo™ Filter during bypass

CONCLUSIONS

The Up-FloTM Filter will retain 100% of floatable material due to the unique design of the siphonic bypass siphon.