STORMWATER '09

PLATINUM SPONSOR

Rocla Water Quality

The Up-Flo Filter

An Advanced Novel High-Rate Filtration System for Stormwater Treatment

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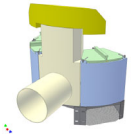
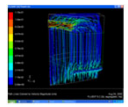
Hydro International

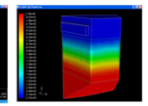
1

Presentation Overview

- Upflow Filtration
  - Background
  - ***Key Differentiation****!*
- Development and Verification
  - EPA SBIR Research – Bob Pitt
    - *Phase 1 & Phase 2*
  - Commercialization by Hydro
    - *Further Developments..*
- Verifications
  - *TARP Testing – NJCAT*
  - *Bama Belle*
- Discussion and Q&A







2

Background to Development

MCTT work by Bob Pitt

EPA's SBIR Funded Research

3

Sand Filters

Delaware sand filter, edge drain

Early Austin, TX, sand filter

4

Conventional Surface Filtration

- Requires a low filtration rate and large volume to increase residence time
- Prone to clogging
- High Maintenance
- Requires Pretreatment
- "Wormhole" Phenomenon
- Intermittent Flows
  - Compression of media
  - Less of filter depth dries

5

Development of New Control Devices for Critical Source Areas

- Multiple treatment processes that could be incorporated into stormwater treatment units sized for various applications.
  - Gross solids and floatables control (screening)
  - Capture of fine solids (settling or filtration)
  - Control of targeted dissolved pollutants (sorption/ion exchange)

6

Multi-Chambered Treatment Tank

Pilot and Lab Scale Treatment Tests

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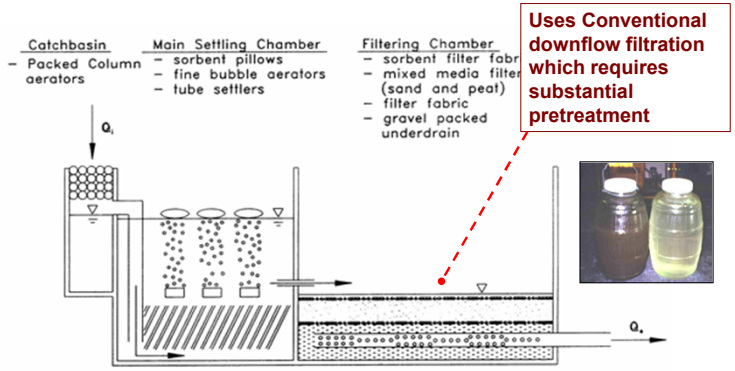
Multi-Chambered Treatment Tank

Pilot Scale Filters Examining Different Media

8

Multi-Chambered Treatment Train (MCTT)



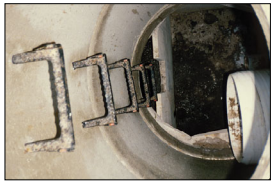
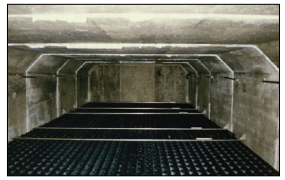
Uses Conventional downflow filtration which requires substantial pretreatment

- developed during EPA-funded research to protect groundwater during infiltration

9

MCTT

Minocqua, WI, MCTT (2.5 acre commercial parking)

10

MCTT

- System works
- Perceived to be too costly
- Need for device or system that can be utilized upstream to address source critical areas

Stormwater runoff from critical source areas, such as parking lots, vehicle fueling and maintenance stations, and public works storage areas, may contain pollutant loadings of hydrocarbons, toxic trace metals, nutrients, pathogens, and/or other toxicants and pollutants that are greater than the loadings of "normal" stormwater runoff.

(Bannerman, et al. 1993; Pitt, et al. 1995; Claytor and Schueler 1996)

11

Further Work at Univ. of Alabama

- Side by Side comparision of Upflow and Downflow Filtration modes.

12

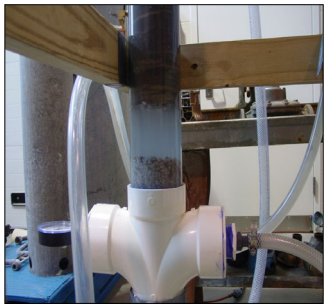
Benefits of Upflow Technology

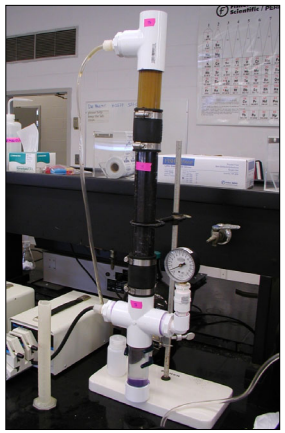
- Side by Side comparision showed benefits of upflow:
  - Longer filter runs
  - Higher treatment flow capacities
  - Pollutants 'fall away' during drain-down period
  - Media drains down between events
    - Minimizes re-release of captured materials
    - Minimizes media degradation and leaching

13

Lab Scale Upflow Filter

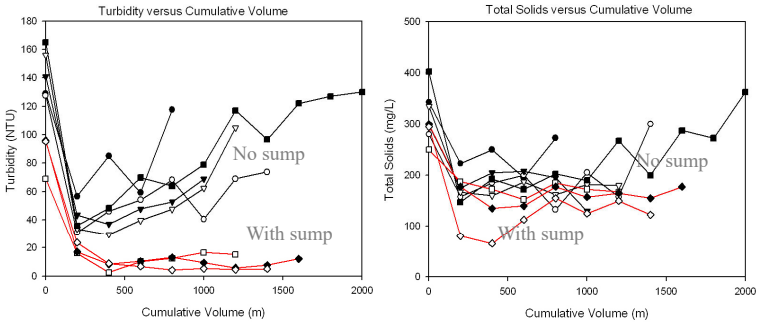
- Important attributes and features determined, such as…





14

Enhanced Upflow Filtration using Sumps as part of Pretreatment

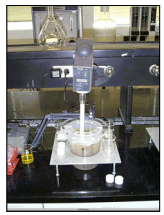


The use of a sump results in much better and more consistent effluent quality.

15

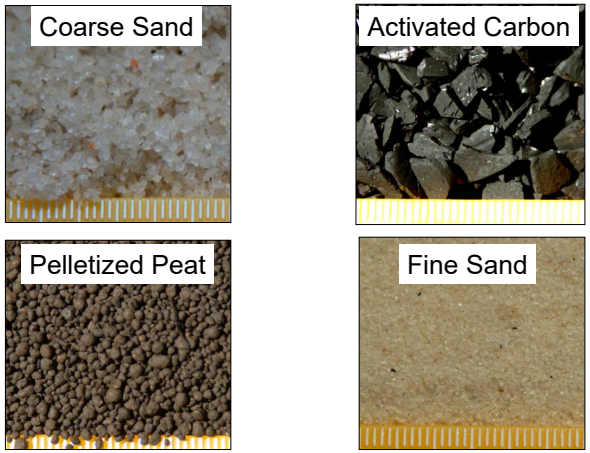
Laboratory Media Studies

- Rate and extent of metals capture
  - (variable for different concentrations)
- Capacity studies
- Effect of pH
- Packed bed breakthrough studies
- Physical properties and surface area determinations



16

Tests on Different Media



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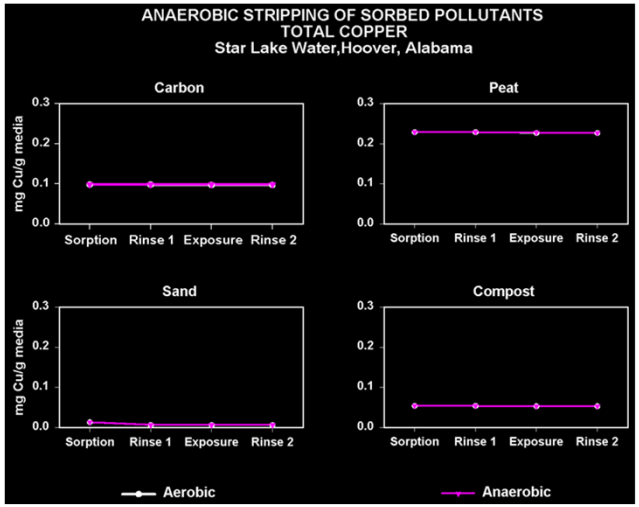
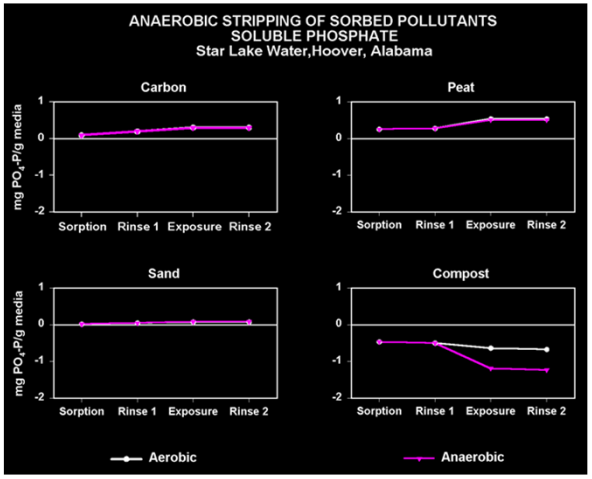


Most metals are strongly and permanently sorbed under both aerobic and anaerobic conditions

18



However, some nutrients are lost during anaerobic conditions on some media.

19

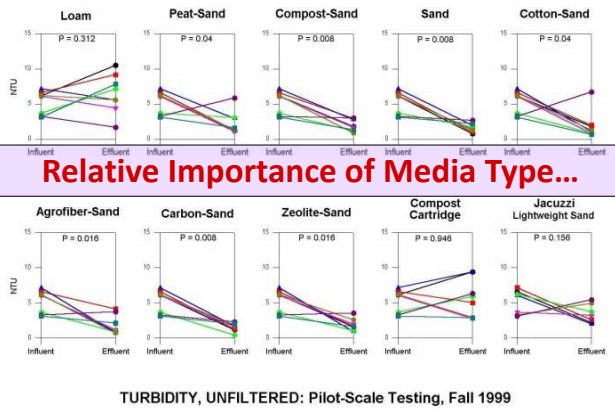
Media Studies

Close up of Sil-Co-Sil particles Settling in Carbon Reef Media

20

Filter Media Research

University of Alabama



Relative Importance of Media Type…

TURBIDITY, UNFILTERED: Pilot-Scale Testing, Fall 1999

21

Prototype Development

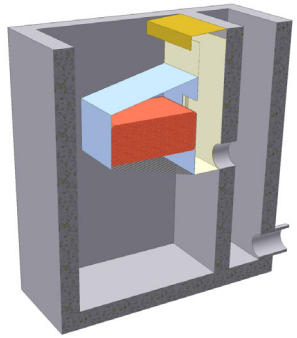
22

Upflow Filter Prototype Development

23

Important Attributes of Upflow Filtration Systems

- Should have features of a multi-treatment train
  - Screening, Settling, Filtration, Absorption/ion-exchange ..
- Incorporate a Sump
- Should use non-leaching media
- Media should be restrained
- Should prevent anaerobic conditions in media (i.e., drain down between events)
- Should be readily accessible for maintenance
- Should have overflow bypass capacity to prevent upstream flooding
- Have retrofit capabilities



24

Site of Prototype Installation

25

Field Monitoring of Prototype

- Data collected through extensive field testing by the University of Alabama
  - No chemical exhaustion of media after 12 months of field testing
  - Greater than 70% removal of particulate metals & nutrients and fine TSS
  - Filtration rate steady at 20 gpm/ft^2 after 12 months in the field

26

Hydro International

Commercialization of Upflow

by

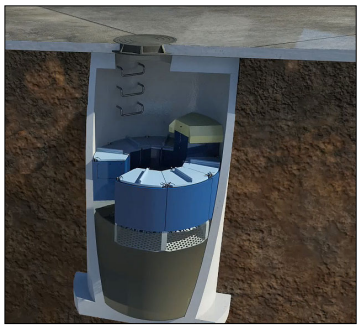
Hydro International

Rocla

27

Ideal Filtration Systems

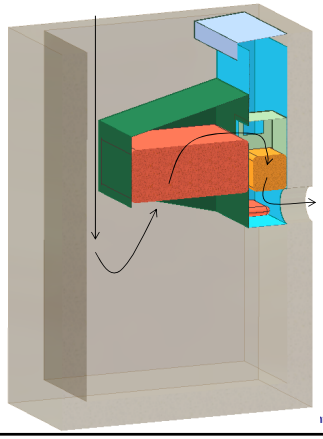
- **Should have features of a multi-treatment train**
  - **Screening, Settling, Filtration, Absorption/ion-exchange ..**
- **Incorporate a Sump**
- **Should use non-leaching media**
- **Media should be restrained**
- **Should prevent anaerobic conditions in media**
- **Should be readily accessible for maintenance**
- **Should have overflow bypass capacity to prevent upstream flooding**
- **Have retrofit capabilities**



The *Up-Flo®* Filter – *has these attributes*

28

From *Prototype* to Product

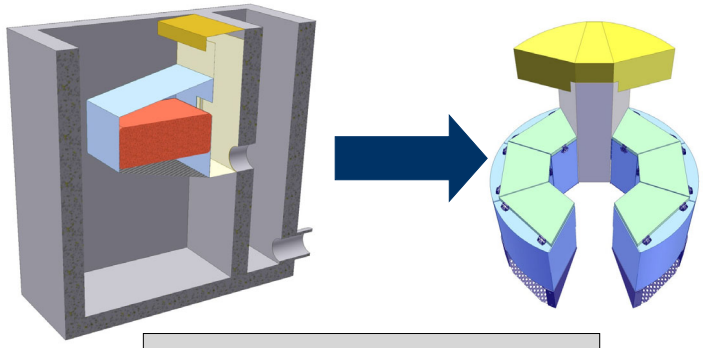


- Sump
- Screen
- Upflow Filter
  - Media Bags
- Weephole
- Bypass
- Floatables Trap
- *Secondary Media*

29

From *Prototype* to Product

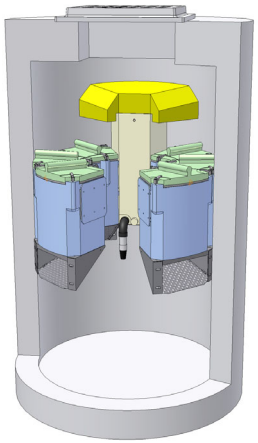
Up-Flo® Filter



Upflow Stormwater Filter

30

Hydro International



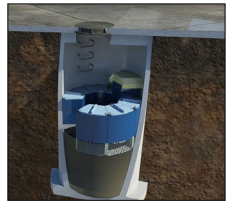
Up-Flo™ Filter

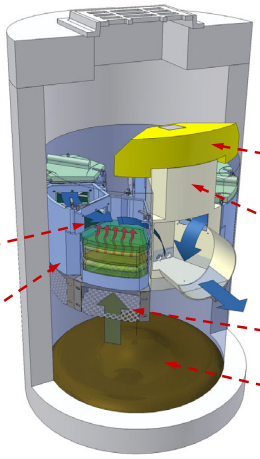
Fluidized Bed Filtration

optimal design :: *unparalleled performance*

31

Up-Flo® Filter

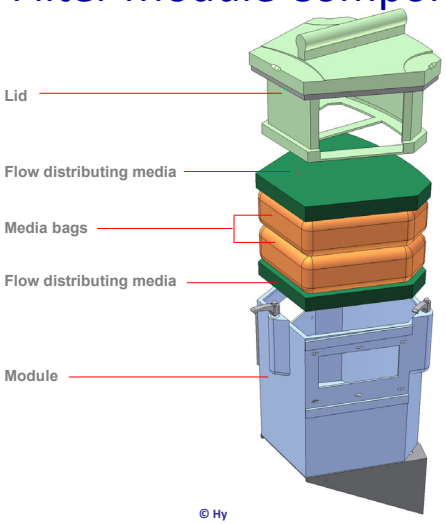




- High Capacity Bypass
- Outlet Module
- Conveyance Slot
- Filter Module
- Inclined Screen
- Sedimentation Sump

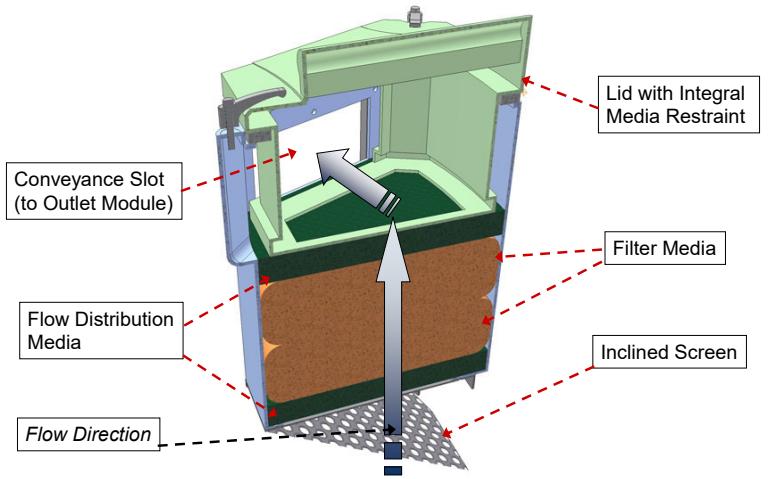
32

Filter Module Components



33

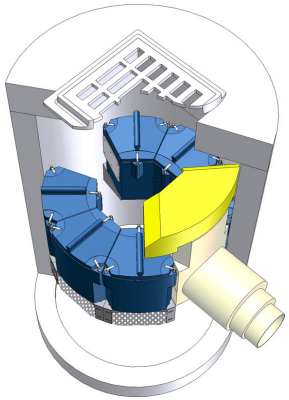
Up-Flo® Filter Module



34

Designed for Maintenance

- Components fit through standard manhole access port.
- Wide central access region to facilitate maintenance.
- No lifting gear required to maintain.



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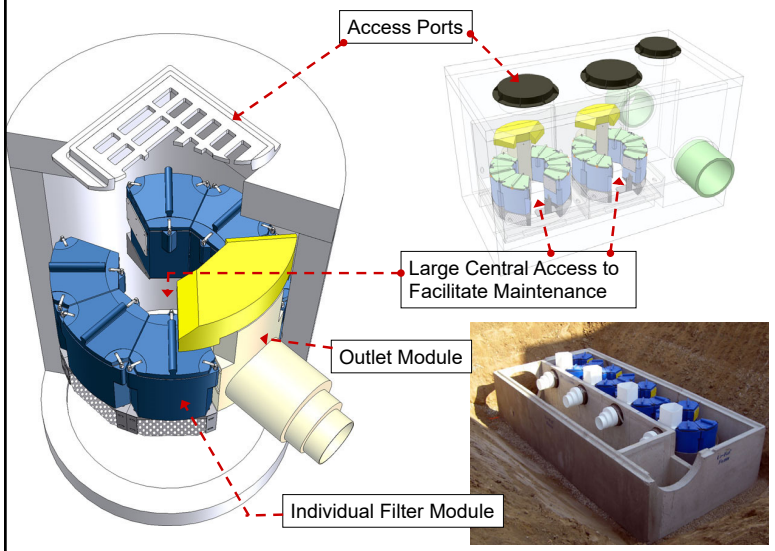
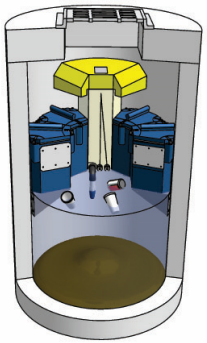


36

Multi-Stage Treatment

- Chamber – Floatables and trash
- Angled Screens – Neutrally buoyant materia
- Sump – Coarse grit and gross debris
- Filter media:
  - Fine sediment
  - Hydrocarbons
  - Metals
  - Organics (pesticides, herbicides)
  - Nutrients (particulate phosphorus)



37

Media Options

CPZ™ Mix

Carbon, Peat, Manganese Coated Zeolite

CPS™ Mix

The cold climate alternative to our CPZ™ Mix

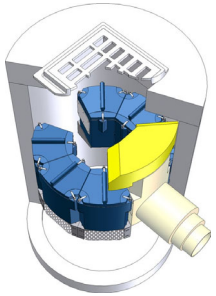
HFS™ Mix

Hydro Filter Sand

Perlite

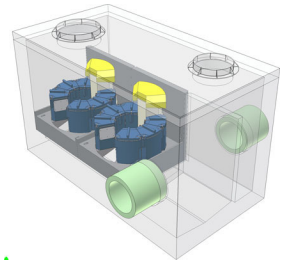
38

Configurations



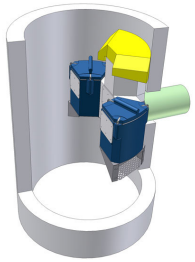
Standard Manhole

(1 Ring) Upstream source control small drainage sites



Vault

(2 -3 Rings)
Larger catchments



Up-Flo Retro

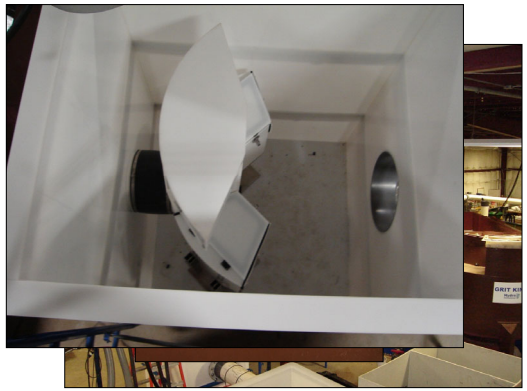
Retrofit applications for small or irregular catch basins

39

Performance Verification

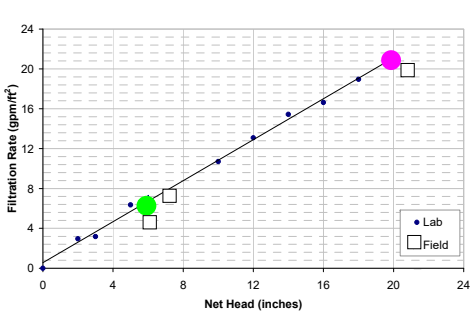
40

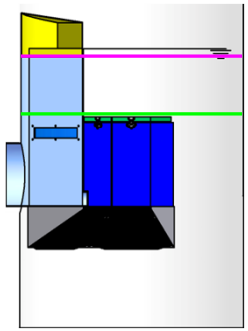
Lab. Characterization



41

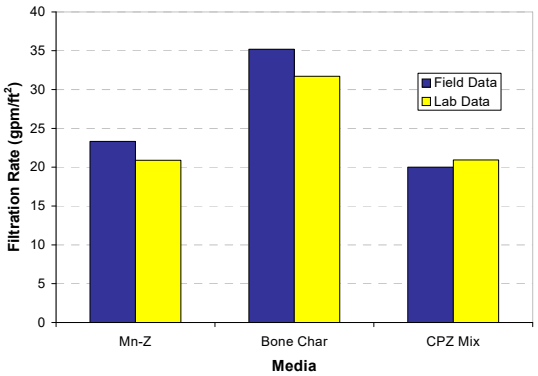
CPZ Mix Filter Media





42

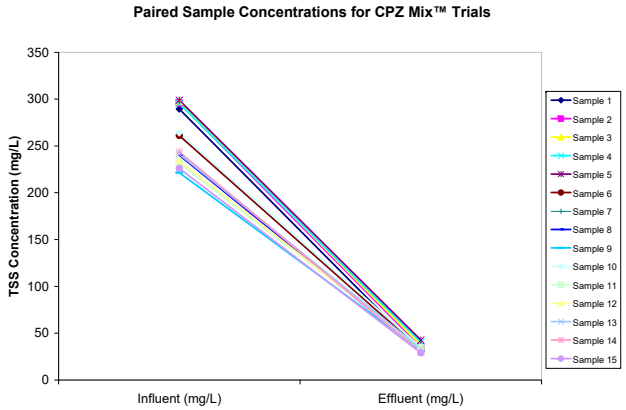
Benchmarking of Filter Media



43

Sil-Co-Sil 106 Testing Results

Average removal of 87% at 25 gpm per Filter Module



44

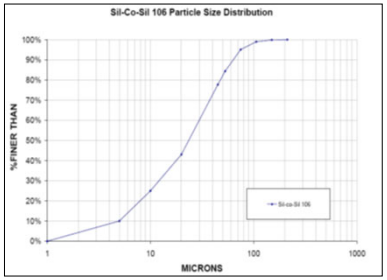
TSS Removal Rates

CPZ™ Mix
- Over 85% removal of Sil-Co-Sil 106
- 1.6 l/s per module

CPS™ Mix
- Over 80% removal of Sil-Co-Sil 106
- 1.26 l/s per module

Filter Sand
- Over 90% removal of Sil-Co-Sil 106
- 1.45 l/s per module

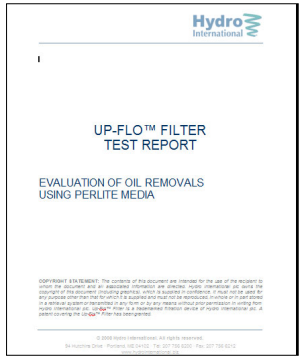
Perlite
- Over 85% removal of Sil-Co-Sil 106
- 1.77 l/s per module



45

Perlite Studies

Preliminary Results for Oil


Hydro International

UP-FLO™ FILTER
TEST REPORT

EVALUATION OF OIL REMOVALS
USING PERLITE MEDIA

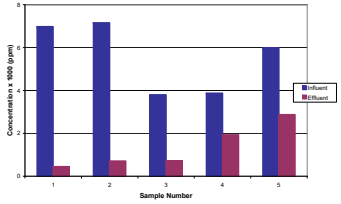
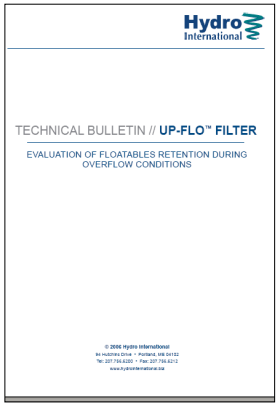


Figure 1: Influent and effluent concentrations for perlite oils testing

46

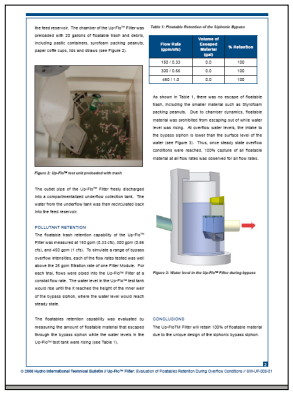
Floatables Removal

During Bypass Operation


Hydro International

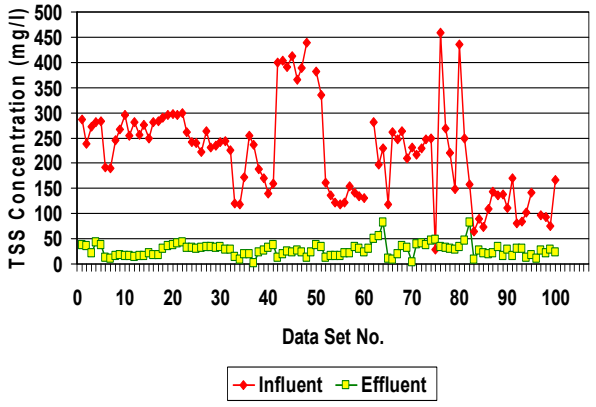
TECHNICAL BULLETIN // **UP-FLO™ FILTER**

EVALUATION OF FLOATABLES RETENTION DURING OVERFLOW CONDITIONS



47

Pre-commercialization Test Data

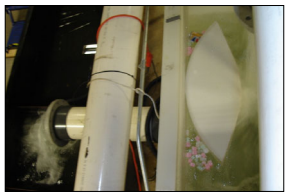


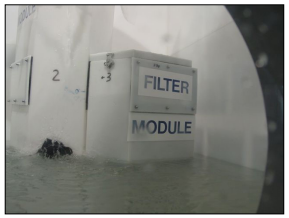
Data Set No:	Media
1 - 41	CPZ
42 -49	Perlite
50 -61	Sand & Perlite
62 - 71	Mycelex
72 - 81	CPS
82 - 107	CPZ (ETV Phase 1)

48

Verification Tests

- Hydraulic characterizations benchmark well (both Lab and Field)
- Filtration rate of up to ~25 gpm per Filter Module (150 gpm per 4-ft manhole system) confirmed.
  - Upflow filtration is a higher-rate filtration alternative to surface filtration such as down-flow and radial-flow
- >80% removal Sil-Co-Sil 106 at ~ 20 gpm per Filter Module
- Upflow filtration provides a high degree of TSS removal and control at high filtration rates





49

Nutrient & Metals

- Phosphorus Removal:
  - Particulate Phosphorus

- Metals Removal:
  - Associated with removal of fines
  - Typically greater than 70%
    - Iron
    - Chromium
    - Lead
    - Zinc
    - Copper

50

…how do I know the Up-Flo® Filter Works?

Performance Verification

51

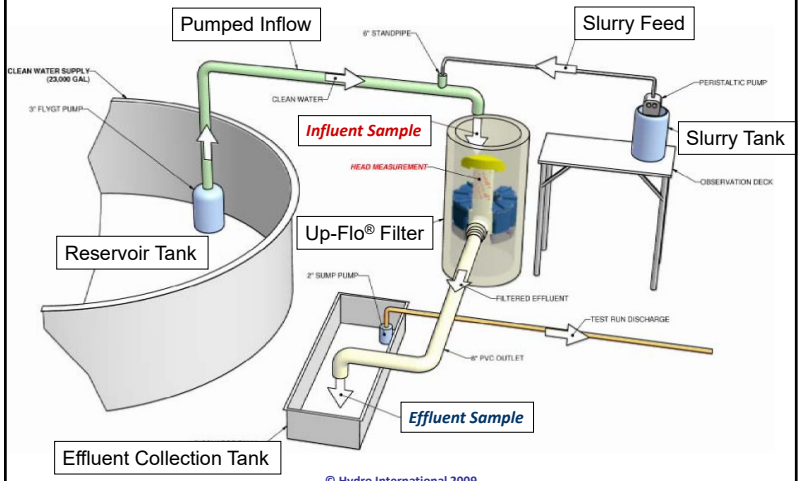
NJCAT Verification

TARP Tier 1 Testing

52

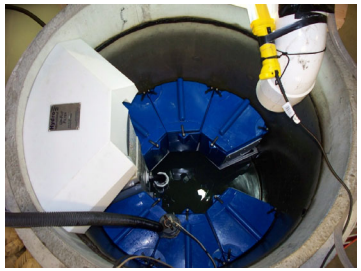
Test Rig

53



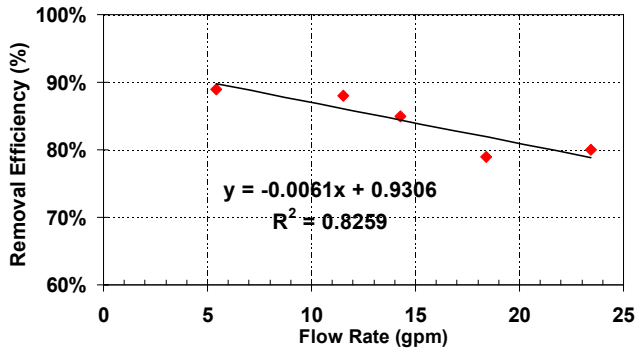
54

Test Rig: 6-Modules



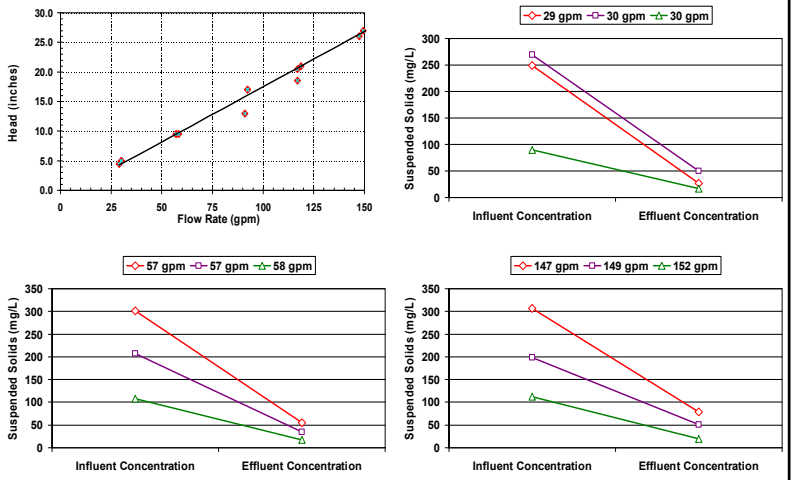
55

One module test results



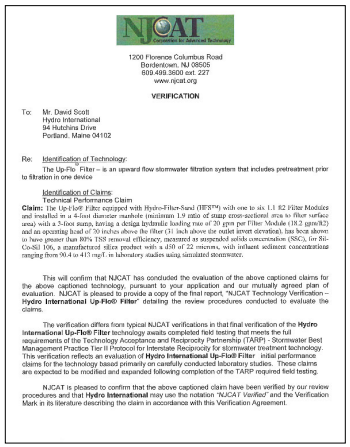
56

Results for 6 - modules



57

NJCAT Verification



NJCAT

1200 Florence Columbus Road
Bordentown, NJ 08505
609.499.3600 ext. 227
www.njcat.org

VERIFICATION

To: Mr. David Scott
Hydro International
94 Hutchins Drive
Portland, Maine 04102

Re: Identification of Technology:
The Up-Flo Filter – is an upward flow stormwater filtration system that includes pretreatment prior to filtration in one device

Identification of Claims:
Technical Performance Claim
Claim: The Up-Flo® Filter equipped with Hydro-Filter-Sand (HFST™) with one to six 1.1 ft2 Filter Modules and installed in a 4-foot diameter manhole (minimum 1.9 ratio of sump cross-sectional area to filter surface area) with a 3-foot sump, having a design hydraulic loading rate of 20 gpm per Filter Module (18.2 gpm/ft2) and an operating head of 20 inches above the filter (31 inch above the outlet invert elevation), has been shown to have greater than 80% TSS removal efficiency, measured as suspended solids concentration (SSC), for Sil-Co-Sil 106, a manufactured silica product with a d50 of 22 microns, with influent sediment concentrations ranging from 90.4 to 413 mg/L in laboratory studies using simulated stormwater.

This will confirm that NJCAT has concluded the evaluation of the above captioned claims for the above captioned technology, pursuant to your application and our mutually agreed plan of evaluation. NJCAT is pleased to provide a copy of the final report, "NJCAT Technology Verification – **Hydro International Up-Flo® Filter**" detailing the review procedures conducted to evaluate the claims.

The verification differs from typical NJCAT verifications in that final verification of the **Hydro International Up-Flo® Filter** technology awaits completed field testing that meets the full requirements of the Technology Acceptance and Reciprocity Partnership (TARP) - Stormwater Best Management Practice Tier II Protocol for Interstate Reciprocity for stormwater treatment technology. This verification reflects an evaluation of **Hydro International Up-Flo® Filter** initial performance claims for the technology based primarily on carefully conducted laboratory studies. These claims are expected to be modified and expanded following completion of the TARP required field testing.

NJCAT is pleased to confirm that the above captioned claim have been verified by our review procedures and that **Hydro International** may use the notation *"NJCAT Verified"* and the Verification Mark in its literature describing the claim in accordance with this Verification Agreement.

NJCAT Verified
Corporation for Advanced Technology

VERIFIED

Hydro International agrees that the notation "NJCAT Verified" and the Verification Mark will only be used in connection with the above-captioned claims, and the above-captioned technology. Breach by Hydro International of these conditions of use may result in the withdrawal of this verification and the right to use the notation "NJCAT Verified" and the Verification Mark. Hydro International agrees to provide NJCAT, upon request, with sample copies of any literature in which the notation "NJCAT Verified" or the Verification Mark are used. Any third party, who submits a written inquiry to NJCAT concerning this Verification, may be provided with a copy of this Verification Agreement, the final report, and any subsequent correspondence and/or invocation of Hydro International rights hereunder, upon terms and conditions established by NJCAT.

In consideration for participation in the NJCAT Technology Verification Program, the undersigned hereby releases and holds harmless NJCAT, its officers, directors, trustees, employees, members, and subcontractors from any and all damages, claims and liabilities arising out of participation by Hydro International in the NJCAT Technology Verification Program.

Please confirm your acceptance of this Verification Agreement by executing the enclosed copy of this Verification Agreement and returning the same to NJCAT.

New Jersey Corporation for Advanced Technology

By: _____
RHEA WEINBERG BREKKE
Executive Director

Date: November 10, 2008

Hydro International

Accepted: _____
David Mongeau
General Manager
US Stormwater Division

Date: 11/10/2008

58

NJCAT Verification

Identification of Claims:
Technical Performance Claim

Claim: The Up-Flo® Filter equipped with Hydro-Filter-Sand (HFST™) with one to six 1.1 ft2 Filter Modules and installed in a 4-foot diameter manhole (minimum 1.9 ratio of sump cross-sectional area to filter surface area) with a 3-foot sump, having a design hydraulic loading rate of 20 gpm per Filter Module (18.2 gpm/ft2) and an operating head of 20 inches above the filter (31 inch above the outlet invert elevation), has been shown to have greater than 80% TSS removal efficiency, measured as suspended solids concentration (SSC), for Sil-Co-Sil 106, a manufactured silica product with a d50 of 22 microns, with influent sediment concentrations ranging from 90.4 to 413 mg/L in laboratory studies using simulated stormwater.

- > 80% TSS Removal
- 20 gpm per Module

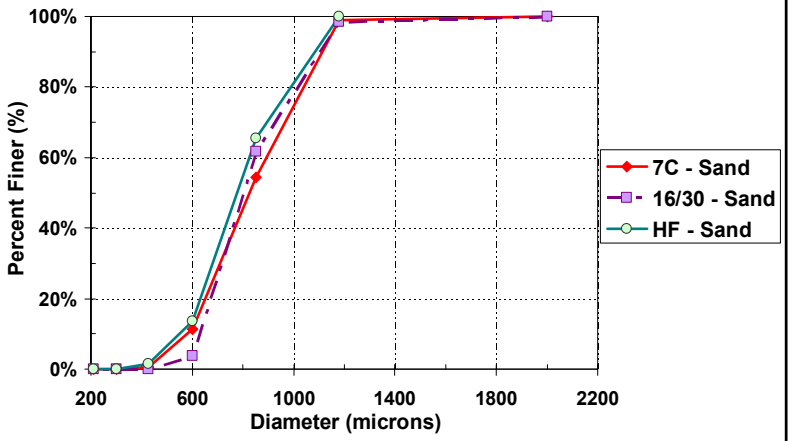
59

Australian Up-Flo® Filter Media

How does the proposed media to be used by Rocla compare?

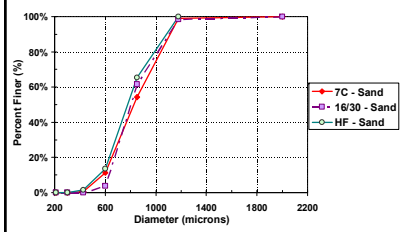
60

Filter Media Particle Size Distribution

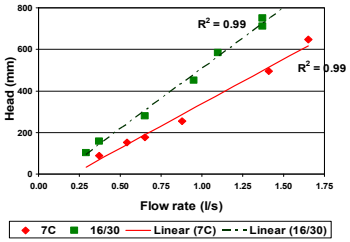


61

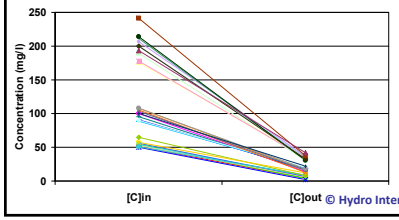
Filter Media Particle Size Distribution



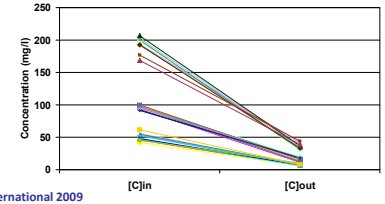
Hydraulic Characterization



7C - Sand Media Suspended Solids



16/30 - Sand Media Suspended Solids



62

University of Alabama

- Unit installed *(new module)*
- Controlled sediment testing underway
- Storm event testing to begin this summer
- Scope to test different media types
- Protocols to both TARP & TAPE

63

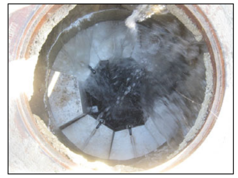
Bama Belle Site

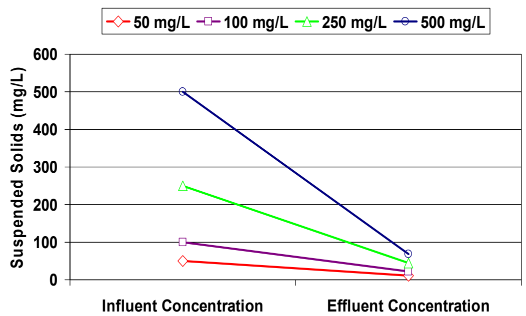
64

Bama Belle Site

65

Bama Belle Site - UAB





66

Test Site Makes News!

Device reduces stormwater pollutants

UA professor's system filters debris to keep it from draining into river

By Robert DeWitt
Staff Writer

TUSCALOOSA | A University of Alabama engineering professor and the Office of the City Engineer are working together on a project that can reduce storm drain pollutants ending up in the Black Warrior River.

Robert Pitt, Cudworth Professor of Urban Water Systems in UA's civil engineering department, developed a prototype for a filtering system that fits in a catch basin. He tested it in a parking lot next to City Hall and found it effective.

"How many people make the connection between the storm drains downtown and the water quality in the

SEE DRAIN | 7B

A series of honeycomb filters are seen in a drain near the Bama Belle along the Black Warrior River. The filters are being used to test a system to keep debris from the streets from washing into the river through storm drains.

STAFF PHOTO | DAN LOPEZ

WEDNESDAY, MARCH 11, 2009 | THE TUSCALOOSA NEWS

DRAIN

CONTINUED FROM PAGE 1B

67

Up-Flo® Filter in New Zealand

68

Water Quality Control

Up-Flo™ Filter
(Auckland Harbor, New Zealand)

69

Two Person Team

retired couple maintenance crew

70

Vactor Pump Out

71

Servicing & Maintenance

72

Bottom Mattala

73

Top Mattala

74

Spent Filter Bags

75

New Media Bags

76

Replacing Bags

77

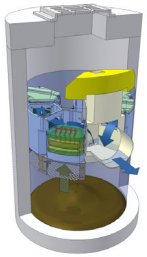
Spent Media - Disposal

78

Close up of Media Bags

79

Up-Flo® Filter Technology



- Conclusions
  - The Up-Flo™ Filter is an advanced, novel, passive, high capacity, proprietary *upflow* filtration system that incorporates multiple elements of a treatment train (*screening, sedimentation and high-rate filtration*) in a compact modular device.
  - The device uses a sedimentation sump and screening system to pre-treat stormwater runoff before it flows up through the filter media where final polishing via filtration occurs.
  - A high-capacity siphoning bypass safeguards against upstream ponding or flooding during high-flow events. The siphon also serves as a floatables baffle to prevent the escape of floatable trash.

80

Up-Flo® Filter Technology

81