THANKS FOR YOUR TIME

CITY OF DURHAM, NC
AND
GUESTS

<table>
<thead>
<tr>
<th>Project</th>
<th>Location</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Hall Plaza</td>
<td>Durham, NC</td>
<td>Activated</td>
</tr>
<tr>
<td>Harvard Avenue</td>
<td>Durham, NC</td>
<td>Activated</td>
</tr>
<tr>
<td>McDonald’s Roxboro St</td>
<td>Durham, NC</td>
<td>Activated</td>
</tr>
<tr>
<td>Hawkings Creek Restoration</td>
<td>Swansboro, NC</td>
<td>Activated</td>
</tr>
<tr>
<td>Wilmington Streetscape-N.Front St.</td>
<td>Wilmington, NC</td>
<td>Activated</td>
</tr>
<tr>
<td>Edenton Retrofit</td>
<td>Edenton, NC</td>
<td>Activated</td>
</tr>
<tr>
<td>Children’s Museum</td>
<td>Graham, NC</td>
<td>Activated</td>
</tr>
</tbody>
</table>
The Latest from Filterra

Filterra BioPave
Filterra Curb Internal Bypass
Filterra Roofdrain System
Street Tree Filterra
Bacterra
What is Filterra?

- Filterra is an Advanced Stormwater Bioretention Treatment System consisting of:
  - Concrete Landscape Container
  - Engineered Media
  - Underdrain System
  - Landscape Tree or Shrub
  - Protective Grate
Filterra bioretention bed
How Does It Work?
Key Benefits of Filterra

✓ Small, Shallow Footprint
  ✓ 6’x6’ for 0.25 acres
  ✓ 3.5’ TOC-INV standard units

✓ High Pollutant Removal Rates
✓ Low Maintenance
Pollutant Removal Mechanisms

- Physical/Chemical Processes
  - Filtration
  - Adsorption/Absorption
  - Cation/Anion exchange
  - Metals complexing

- Biological Processes
  - Degradation/Decomposition
  - Plant/Bacteria uptake
High Pollutant Removal Rates

All Third Party Studies To Date

✓ Total Phosphorus: 60% - 70%
✓ Total Nitrogen: 43%
✓ Total Suspended Solids: 85%
✓ Total Metals: 33% - 82%
✓ Predicted Oil & Grease: > 85%
Filterra State Approvals

• State of Virginia: 2002
• State of Maryland: 2002
• State of Washington: 2008
• State of New York: 2009
• State of WA (GULD): 2010
• TX Edwards Aquifer: 2011
• TX San Antonio: 2011
# Filterra Sizing - NC

## Piedmont/Sandhills Region - 1” Rainfall

<table>
<thead>
<tr>
<th>Available Filterra® Box Sizes (feet)</th>
<th>Maximum Impervious Area (Acres)</th>
<th>Outlet Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>4x6 or 6x4</td>
<td>up to 0.21</td>
<td>4” SDR-35 PVC</td>
</tr>
<tr>
<td>4x8 or 8x4</td>
<td>0.22 to 0.28</td>
<td>4” SDR-35 PVC</td>
</tr>
<tr>
<td>Standard 5x6</td>
<td>0.29 to 0.32</td>
<td>4” SDR-35 PVC</td>
</tr>
<tr>
<td>6x8 or 8x6 or 4x12 or 12x4</td>
<td>0.33 to 0.43</td>
<td>4” SDR 35 PVC</td>
</tr>
<tr>
<td>6x10 or 10x6</td>
<td>0.44 to 0.54</td>
<td>6” SDR-35 PVC</td>
</tr>
<tr>
<td>6x12 or 12x6</td>
<td>0.55 to 0.64</td>
<td>6” SDR-35 PVC</td>
</tr>
<tr>
<td>7x13 or 13x7</td>
<td>0.65 to 0.82</td>
<td>6” SDR-35 PVC</td>
</tr>
</tbody>
</table>

## Coastal Region - 1.5” Rainfall

<table>
<thead>
<tr>
<th>Available Filterra® Box Sizes (feet)</th>
<th>Maximum Impervious Area (Acres)</th>
<th>Outlet Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>4x6 or 6x4</td>
<td>up to 0.14</td>
<td>4” SDR-35 PVC</td>
</tr>
<tr>
<td>4x8 or 8x4</td>
<td>0.15 to 0.19</td>
<td>4” SDR-35 PVC</td>
</tr>
<tr>
<td>Standard 5x6</td>
<td>0.20 to 0.21</td>
<td>4” SDR-35 PVC</td>
</tr>
<tr>
<td>6x8 or 8x6 or 4x12 or 12x4</td>
<td>0.22 to 0.28</td>
<td>4” SDR-35 PVC</td>
</tr>
<tr>
<td>6x10 or 10x6</td>
<td>0.29 to 0.35</td>
<td>6” SDR-35 PVC</td>
</tr>
<tr>
<td>6x12 or 12x6</td>
<td>0.36 to 0.42</td>
<td>6” SDR-35 PVC</td>
</tr>
<tr>
<td>7x13 or 13x7</td>
<td>0.43 to 0.54</td>
<td>6” SDR-35 PVC</td>
</tr>
</tbody>
</table>
Low Maintenance

- First year maintenance included
- Remove trash/mulch twice a year
- Easy access – no confined space
- No specialized equipment needed
- Extended maintenance services provided
- Optional maintenance training
- Minimal cost
Maintenance

Four Safe and Easy Steps

Step 1:
Open grate & inspect

Step 2:
Remove mulch & trash

Step 3:
Add new mulch

Step 4:
Sweep & replace grate

1/2 Man Hour Per Visit
Per Plant
(Excluding Travel)
### Cumulative Annual Maintenance

**EPA Study 1999 (quoted in Dec 08 VT Economic Impact Study on VA New SW Regs)**

<table>
<thead>
<tr>
<th>BMP</th>
<th>NPV Maintenance as % Installed</th>
<th>Cost</th>
<th>NPV per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>WET POND AND CONSTRUCTED WETLANDS</td>
<td>40 - 85%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENG. BIORETENTION AND SWALES</td>
<td>70-100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SANDFILTERS</td>
<td>70-280%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FILTERRA</td>
<td>23%</td>
<td>$6,974</td>
<td></td>
</tr>
<tr>
<td>PROPRIETARY FILTRATION</td>
<td>87%</td>
<td>$32,730</td>
<td></td>
</tr>
</tbody>
</table>
Flow Line Relationship

Filtterra top of curb must be higher than inlet top of curb.

Filtterra flow line must be higher than inlet flow line.

4”-6” throat opening at Filtterra.

LEED Credits with Filterra

• 1 point in full:
  – Sustainable Sites Credit 6.2
    • 90% annual stormwater volume treated
    • 85% TSS removal.

• Filterra Supports:
  – Sustainable Sites Credits 5.1, 6.1 & 7.1
  – Water Efficiency Credits 1.1 & 1.2
  – Materials & Resources Credit 5.1
Filterra Pricing

- Units delivered FOB to job site with media
- Cost includes activation (tree planting) plus two maintenance visits
- Contractor responsible for off-loading, unit placement and pipe connections

<table>
<thead>
<tr>
<th>Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>4’ x 6’</td>
<td>$8,500</td>
</tr>
<tr>
<td>4’ x 8’</td>
<td>$9,100</td>
</tr>
<tr>
<td>4’ x 12’</td>
<td>$13,600</td>
</tr>
<tr>
<td>6’ x 6’</td>
<td>$9,500</td>
</tr>
<tr>
<td>6’ x 8’</td>
<td>$12,350</td>
</tr>
<tr>
<td>6’ x 10’</td>
<td>$15,300</td>
</tr>
<tr>
<td>6’ x 12’</td>
<td>$17,750</td>
</tr>
<tr>
<td>7’ x 13’</td>
<td>$21,000</td>
</tr>
</tbody>
</table>
A wearing surface that doubles as a Stormwater Management System.
- High Pollutant Removal
- 60-70% TP
- 43% TN
- 85% TSS removal rate
- 15 hr. Drain down of BioPave

Step 3:
Detained Stormwater Treated by Filterra

- 100% treatment of detained stormwater
- Outfall flow provides channel protection

Filtrera Section  BioPave Section
BioPave “L”: Fully Functioning Wearing Surface

*Performance beyond typical PICP’s*

- Strongest Possible Interlocking PICP Shape
  - Light Vehicular
  - Heavy Vehicular
  - Secondary Urban Streets
- Joint/Void System carries forward the disciplines of Interlock
- Eliminates Faulting, twisting and turning
- Super efficient economical mechanical installation
**KEY BENEFITS: Function & Design**

**Stormwater Management System**
- Q10 Detention
- Channel Protection Volume (CPv)
- Maximum infiltration
- Quality treatment through Q10 (>80% TSS, >70% TP)
- Shallow Invert (TOC-INV ~ 4.5 feet)
- Treatment train possible for max PR (>90% TP)

**Wearing Surface**
- Heavy-duty capacity (up to 1 million ESALs)
- Interlock feature on BioPave “L” design
- Standard cross-section components

**Both Components - Filterra and BioPave**
- Design review - Wearing Surface and Stormwater Management Design
- LEED points
- Aesthetics - FT recessed tops, BioPave colors / SRI compliant
KEY BENEFITS: Installation

Filtrerra
- Installed similar to Curb Inlet
- Bioretention System protected throughout construction

Wearing Surface
- Preferred Installers using mechanical installation equipment
- Accepted Industry Practices
KEY BENEFITS: Maintenance

Filtterra

- Low-cost, Low-tech & simple
- Annual due to pretreatment from BioPave section

Wearing Surface

- Annual sweeping using standard VAC truck equipment
- Reduced de-icing salts (no standing water or ice)
- Seamless access to below-grade utilities
Filterra Curb Internal Bypass

- Internal bypass
- Handles quality and quantity storms (Q10)
- Patented
- All benefits of standard Filterra
Filterra Roofdrain System

• Green roof 1/200th the size with twice the TP removal
• Internal bypass
• Above or below grade
• All benefits of standard Filterra
**Filterra Roofdrain System**

**DESIGN RQMTS**

- Match FRD size with rooftop DA
- Spec inlet piping for quantity design storm (6”, 8” or 10” dia)
- Spec install at grade or super-structure
- Spec plant from FT plant list (by Hardy Zone)
Filterra Roofdrain System (custom)
Superstructure design
# Filterra Roofdrain Pricing

- Units delivered FOB to job site with media
- Cost includes activation (tree planting) plus two maintenance visits
- Contractor responsible for off-loading, unit placement and pipe connections

<table>
<thead>
<tr>
<th>Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>6’ x 4’</td>
<td>$10,450</td>
</tr>
<tr>
<td>8’ x 4’</td>
<td>$11,000</td>
</tr>
<tr>
<td>12’ x 4’</td>
<td>$15,200</td>
</tr>
<tr>
<td>6’ x 6’</td>
<td>$11,900</td>
</tr>
<tr>
<td>8’ x 6’</td>
<td>$14,500</td>
</tr>
<tr>
<td>10’ x 6’</td>
<td>$17,300</td>
</tr>
<tr>
<td>12’ x 6’</td>
<td>$19,600</td>
</tr>
</tbody>
</table>
Street Tree - Filterra
Street Tree - Filtterra
Street Tree - Filterra

• Irrigation Recommended
• Tree Caliper Sizes 1.5” to 3” DBH
• Structural Soil Sections
• TOC-INV 1’ or 2’ deeper than standard
• 6” high x 3-4’ wide knockouts for roots
• Street Tree List available
Street Tree - Filterra
Bacterra

- 95+% bacteria removal rate
- Filterra performance on other pollutants
- Reduces bacteria in surface stormwater
  - Reduces nutrients feeding bacteria (TP, TN)
  - Free-draining design – no bacterial regrowth
Filterra® Pre-treatment Chamber
Recessed Top & Custom Grates
The Urban Solution to Low Impact Development

- Small Footprint
- High Pollutant Removal
- Aesthetically Pleasing
- Low Maintenance
- LEED compliant
- Sustainable Design
- Well Engineered

Questions?
Filterra® Bioretention Systems Research & Development
Media Quality Control

Filterra® Media Batch MA0810

Meets the hydraulic performance specifications for media quality control

Meets proprietary Filterra® specifications for media composition quality control

Certified:

Mindy Ruby
Research & Development Manager
Filterra® Bioretention Systems

4/23/2009

Filterra units manufactured for project ________________ used
Filterra® Media Batch MA0810.

Duane Vincent
Engineering Support
Filterra® Bioretention Systems
Small Footprint

- FSA to DA ratio of 0.3% vs 3 to 5% for Bioretention cells
- A 6’ X 6’ unit treats ¼ to ½ acre
- Top of curb to invert is 3.5’
- Full use of land
- Ideal for urban retrofit
TSS – Particle Size Test

- Performed by GeoSyntec Consultants
- Used Sil-Co-Sil 106
  - 80% < 50 microns,
  - 30% < 10 microns

Results (Approved by MDE)

<table>
<thead>
<tr>
<th>15 Tests</th>
<th>Median (mg/L) ± 95% CI</th>
<th>Min (mg/L)</th>
<th>Max (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent</td>
<td>75 ± 27.5</td>
<td>8.3</td>
<td>260</td>
</tr>
<tr>
<td>Effluent</td>
<td>7.8 ± 3.2</td>
<td>&lt;2.0</td>
<td>18</td>
</tr>
<tr>
<td>Average Removal</td>
<td>86.9%</td>
<td>72.4%</td>
<td>95.5%</td>
</tr>
</tbody>
</table>
# Field Test Sites – Pollutant Removal

**All Third Party Studies To Date**

<table>
<thead>
<tr>
<th>Site Description</th>
<th>Third Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>FILTERRA</td>
<td></td>
</tr>
<tr>
<td>TARP - Northern VA Community Center</td>
<td>University of Virginia</td>
</tr>
<tr>
<td>TAPE - WA Industrial Port Development</td>
<td>Herrera Env. Consultants</td>
</tr>
<tr>
<td>Wetland Protection, MA</td>
<td>GeoSyntec Consultants</td>
</tr>
<tr>
<td>Proposed DOT Right-of-way in northern CA</td>
<td>CALTRANS &amp; County</td>
</tr>
<tr>
<td>Proposed Commercial Development in Gainesville, FL</td>
<td>University of Florida</td>
</tr>
<tr>
<td>Proposed Residential Site in Cary, NC</td>
<td>NC State University</td>
</tr>
</tbody>
</table>

| Proposed Coastal Town Retro-fit, NC       | NC State University                  |
| Street Retro-fit in Los Angeles, CA       | Commercial Laboratory                |
| Mount Trashmore                           | City of VA Beach                     |

BACTERRA
Field Testing - Flowrates

- Field flow testing to ensure the Filterra system operates at the design flow rate after installation

<table>
<thead>
<tr>
<th>Months since activation</th>
<th>12</th>
<th>18</th>
<th>24</th>
<th>30</th>
<th>36</th>
<th>42</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Site 1</td>
<td>&gt;100</td>
<td></td>
<td>&gt;100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Site 2</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td></td>
<td>&gt;100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Site 3</td>
<td></td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Test Site 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Flowrates are inches/hour
## Media Quality Assurance/Control

- Field flow testing to ensure the Filtterra system operates at the design flow rate after installation.

Laboratory and pilot scale testing is performed on each new batch of Filtterra media.

<table>
<thead>
<tr>
<th>Months since activation</th>
<th>6</th>
<th>12</th>
<th>18</th>
<th>24</th>
<th>30</th>
<th>36</th>
<th>42</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Site 1</td>
<td>N/A</td>
<td>✔</td>
<td>N/A</td>
<td>✔</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Test Site 2</td>
<td>N/A</td>
<td>N/A</td>
<td>✔</td>
<td>N/A</td>
<td>✔</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Test Site 3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>✔</td>
<td>N/A</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Test Site 4</td>
<td>✔</td>
<td>N/A</td>
<td>N/A</td>
<td>✔</td>
<td>N/A</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Lab: flow tests, fertility and PSD analysis  

Pilot: flow tests

Note: ✔ indicates exceedance of design flow rate.
Aesthetically Pleasing

- A green solution
- Trash contained and out of sight
- Uses wide variety of plants (Native or Ornamental)
- Roots contained
- Optional custom grates & tops
Sustainable Design

- Readily available media, mulch & plants
- Self regenerating media
- Simple underdrain design
- Quality precast concrete
- No moving parts
Well Engineered

- Standard precast designs ensure quality and simplify specs and installation
- Media protected prior to activation
- Contractor instructions attached
- Reliable performance
- Inspected for quality assurance
- Final design approved by Filterra
Plant Considerations

- Shallow fibrous roots
- Shrubs or small to medium sized trees
- Common landscaped plants
- Traffic visibility
- Typical irrigation needs
- Regional plant list available
Filtterra Activation
The Final Step
Activation

Activation of the Filterra® unit is performed **ONLY** by the supplier.

This process cannot commence until the project is fully stabilized and cleaned (full landscaping, grass cover, final paving, and street sweeping completed), negating the chance of construction materials contaminating the Filterra® system.
Activation

Step 1:
Inspect & remove tree grate and bracing

Step 2:
Install specified plant

Step 3:
Install 3” of mulch

Step 4:
Final inspection and clean up
Other Application Options

Infiltration

**SDR-35 PVC Coupling**
- Cast into precast box wall (outlet pipe location varies)
- Internal perforated piping included with Filterra unit

**FILTERRA STORMWATER TREATMENT SYSTEM AS PROVIDED BY AMERICAST**
- Refer to precast Filterra unit drawings for details not shown

**Infiltration**
- To appropriate outfall — potentially through other infiltration cell(s)

**Top of Infiltration Cell(s)**
- To be at a lower elevation than bottom of Filterra unit

**Perforated piping**
- Within the limits of the infiltration cell

**Optional observation and/or cleanout**

**Section View**
- Remote Infiltration Cell
Standard Filterra
Recessed Top
Recessed Top & Custom Grates