A Highly Effective System

Filterra is well-suited for the ultra-urban environment with proven high removal efficiency for many toxic substances such as petroleum and heavy metals.

Expected Pollutant Removal
(Ranges Varying with Particle Size, Pollutant Loading and Site Conditions)

<table>
<thead>
<tr>
<th>Pollutant Removal</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS Removal</td>
<td>85%</td>
</tr>
<tr>
<td>Phosphorus Removal</td>
<td>60% - 70%</td>
</tr>
<tr>
<td>Nitrogen Removal</td>
<td>43%</td>
</tr>
<tr>
<td>Total Copper Removal</td>
<td>&gt; 58%</td>
</tr>
<tr>
<td>Dissolved Copper Removal</td>
<td>46%</td>
</tr>
<tr>
<td>Total Zinc Removal</td>
<td>&gt; 66%</td>
</tr>
<tr>
<td>Dissolved Zinc Removal</td>
<td>58%</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>&gt; 93%</td>
</tr>
</tbody>
</table>

Information on the pollutant removal efficiency of the filter soil/plant media is based on third party lab and field studies.

Filterra media has been TAPE and TARP tested and approved.

For more details, see the Sizing Table for your project's region.
**Design Assistance**

Visit www.filterra.com to receive your Filterra DAKit (Design Assistance Kit). This includes placement “Do’s and Don’ts”, example scenarios, detail drawings, specifications, project information form, and other essential design information.

**Sizing Procedure**

1) Use your project’s Regional Filterra DAKit as a reference.

2) Determine Filterra locations (with effective bypass) in accordance with placement guidelines.

3) Determine contributing drainage areas to each Filterra.

4) Choose the corresponding size Filterra from the project’s Regional Sizing Table.

5) For best results, get us involved early in the design process. Please send your completed project information form along with plans to

**Proper Placement**

1) Do not place in a sump condition. The Standard Filterra cannot be used as a standalone inlet - it will need effective bypass during higher intensity rainfall events.

2) Do not direct surface flow to Filterra in a “head on” configuration. The ideal way to load Filterra to prevent system damage is a cross linear flow (left-to-right or right-to-left) in the gutter in front of the Filterra. This prevents the re-suspension and possible exit of the trapped pollutants, mulch, and engineered media from within Filterra during the high flow bypass stage.

3) Refer to example scenarios in the Filterra DAKit

**Standard Filterra Placement Example**

Standard Filterra System showing curb-inlet opening.

**Placement Review**

Because we want your project with Filterra to be a great success, we respectfully require that each Filterra project be reviewed by our placement/design staff. This review is mandatory, as proper placement ensures you of the most efficient and cost effective solution, as well as optimum performance and minimal maintenance.
Why Bacterra™?

Adverse economic and public health impacts are on the rise due to increasing bacterial contamination of our swimmable and fishable waters from urban runoff. In response to this growing problem, Filterra® Bioretention Systems has developed Bacterra media blend, an effective stormwater treatment technology for removal of bacteria from urban runoff. Designed to treat bacteria at the source, Bacterra can help meet local TMDLs, and reduce public health threats and sources of bacteria to beaches and rivers.

Removal Mechanisms

The standard Filterra media blend is currently designed to remove typical stormwater pollutants such as TSS, phosphorus, nitrogen, heavy metals, and oil and grease. Bacterra media blend has been optimized to capture and destroy bacteria, and relies on multiple pollutant removal mechanisms. Once the Bacterra media has matured, it develops a complex natural microbiological ecosystem that enhances predation, and other physical, chemical and biological processes that all contribute to the removal process. The coarse sand filtration media provides both pore space and a high degree of surface area to support biofilm development. The complex organics and plants support growth of an advanced biological population. Microscopic examination of mulch and media samples from in-service Bacterra units reveals the presence of a dynamic and diverse microbial population including flagellates, ciliates and amoebae (Figure 1). These results were notable for the high concentrations of protozoa, a higher order class of organisms that are known to prey upon bacterial populations as a primary food source.

Pollutant Removal

Like standard Filterra media blend which removes typical stormwater pollutants, Bacterra media blend is expected to remove as much or more pollutants with higher bacteria removal. Bacterra media blend is recommended if higher bacteria removal is desired.

(Ranges Varying with Particle Size, Pollutant Loading and Site Conditions)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Removal Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>99%(^1), 99%(^2)</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>98%(^1), 99%(^2)</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>95%(^1), 99%(^2)</td>
</tr>
<tr>
<td>TSS*</td>
<td>87%(^1), 92%(^2)</td>
</tr>
<tr>
<td>Predicted Phosphorus</td>
<td>60% - 70%</td>
</tr>
<tr>
<td>Predicted Nitrogen</td>
<td>42% - 45%</td>
</tr>
<tr>
<td>Predicted Oil &amp; Grease</td>
<td>&gt; 93%</td>
</tr>
<tr>
<td>Predicted Total Zinc</td>
<td>&gt; 66%</td>
</tr>
<tr>
<td>Predicted Total Copper</td>
<td>&gt; 58%</td>
</tr>
</tbody>
</table>

*For influent concentration >10mg/L \(^1\)Average \(^2\)Median percentages

Information on the pollutant removal efficiency of the filter soil/plant media is based on third party field studies and lab data.

Filterra standard media blend has been TAPE and TARP tested and approved.

---

Laboratory Findings

- Removal efficiencies ranging from 77% - 99%.

Field Findings

- Average Fecal coliform, E. coli, & Enterococcus removal efficiencies of 95% - 99%
- Average TSS removal efficiencies of 87% for influent concentration >10mg/L

Features and Benefits

Water Quality. Achieve receiving water quality goals and reduce sources of bacteria to beaches, rivers and fisheries.

Best Value. The most cost effective stormwater treatment system available featuring low cost, easy installation and maintenance.

Aesthetics. Landscaping enhances the appearance of your site making it more attractive while removing pollutants.

Maintenance Support. Maintenance is safe and inexpensive; a one year maintenance agreement is included free with the purchase of every unit.

Versatility. Use for new construction or as an urban retrofit device.

• Streetscapes • Urban settings
• Parking lots • Filterra® Roofdrains
• Highways • Combined Sewer
• Industrial settings • Overfl ows (CSO)

Design Support. KriStar engineers can assist you with all aspects of each Bacterra application, including flora selection and sizing. *Contact us to request a sizing table for your region.

Adaptability. May be used alone or in combination with other BMPs.

Selection. Varying configurations to meet both standard and unique site conditions.

More Information

Visit www.filterra.com for a list of FAQ’s about the standard Filterra system and Bacterra media blend, and a product animation featuring how the Filterra system works and maintenance.
**Filtroa® Roofdrain System**

The Filtroa Roofdrain System treats piped in stormwater runoff from rooftops. Using bioretention filtration the system captures and immobilizes pollutants of concern such as: TSS, nutrients and metals.

Stormwater continues to flow through the media and into the underdrain system, where treated water is discharged. Higher flows bypass the bioretention treatment via an overflow/bypass pipe design.

**Features and Benefits**

**Best Value for Rooftop Treatment.**
- compact size
- needs no external bypass
- easy installation
- simple maintenance

**Versatile.**
Filtroa Roofdrain can be used for:
- new construction
- retrofits
- commercial or residential applications.

Filtroa Roofdrain can be placed:
- At grade
- Above grade with effluent below grade to meet elevation challenges of high water tables
- Install next to or away from your building

**Maintenance.** Maintenance is simple and safe (at ground level), and the first year is provided FREE with the purchase of every unit. The procedure is so easy you can perform it yourself.

**Protection.** The Filtroa Roofdrain’s hydraulic configuration was tested by the Colorado State University Hydraulics Laboratory.

Below grade treatment using Filtroa Roofdrain avoids the slipping hazard liabilities of daylighted roofdrains during freezing weather.

Protect from erosion with Filtroa’s monolithic water tight design.

**Expected Pollutant Removal**

(Ranges Varying with Particle Size, Pollutant Loading and Site Conditions)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Removal (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS Removal</td>
<td>85%</td>
</tr>
<tr>
<td>Phosphorus Removal</td>
<td>60% - 70%</td>
</tr>
<tr>
<td>Zinc Removal</td>
<td>&gt; 66%</td>
</tr>
<tr>
<td>Copper Removal</td>
<td>&gt; 58%</td>
</tr>
<tr>
<td>Nitrogen Removal</td>
<td>43%</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>&gt; 93%</td>
</tr>
</tbody>
</table>

*Total Petroleum Hydrocarbons*

Information on the pollutant removal efficiency of the filter soil/plant media is based on third party lab and field studies.

**Filtroa media has been TAPE and TARP tested and approved.**

1. Influent Pipe from Roof Leader
2. Pipe slots allow treatment flow to media surface
3. Erosion Control
4. Perforated Underdrain for Treatment Flows
5. Protective Mulch Layer
6. Cast Iron Tree Grate for Maintenance Access
**Design Guidelines**

1) Use the Filterra Roofdrain Design Guidance as a reference available from design@filterra.com.

2) Select Filterra Roofdrain model according to your Regional Sizing Table, and according to the building's roof drainage area and associated roof drain pipe sizes.

3) Determine Filterra Roofdrain placement next to a building, or away from your building.

4) Ensure piping to and from Filterra Roofdrain system is free-draining at minimum 1% slope, or per local codes.

**Placement Review**

Because we want your project with Filterra to be a great success, we respectfully require that each Filterra Roofdrain project be reviewed by our placement/design staff. This review is mandatory, as proper placement ensures you of the most efficient and cost effective solution, as well as optimum performance and minimal maintenance.

**Proper Placement**

1) Pipe flow of the Filterra Roofdrain System eliminates the cross-linear flow requirements necessary with standard Filterra.

2) Filterra Roofdrain Systems should only receive piped in runoff.

3) Rooftop drainage should still be designed with emergency bypass relief prior to the Filterra Roofdrain System (e.g.: rooftop scuppers, etc.)

Always follow local plumbing codes for roof drainage requirements.

The Filterra System is not a substitute for rooftop overflow/bypass.

4) Send completed project information form along with plans to Filterra for placement and application review.
Features and Benefits


Versatility. Use for new construction or as an urban retrofit device for existing streetscapes and parking lots.

Green. Tree canopies produce shade, reduce thermal impacts, filter the air, create habitat, uptake pollutants and may reduce energy consumption, which can help toward LEED credits.

Maintenance Support. Includes a one year maintenance agreement FREE with the purchase of every unit.

Selection. Available in various configurations to meet both standard and unique site conditions.

Design. Underground slots direct root growth outside Filterra’s treatment area allowing larger canopy trees to be utilized*. To ensure a healthy root system, irrigation is highly recommended for all Filterra Street Tree Systems as required by local climates.

Design Support. Our engineers are available to assist with the design of each Filterra application, including flora selection and sizing.

Sustainability. Filterra’s sustainable design extends typical street tree life expectancy due to its engineered media.

* Slots may be left closed if root containment is desired.

A Highly Effective Treatment System

The Filterra Bioretention System is designed for the urban environment providing a high removal efficiency for many pollutants including petroleum, heavy metals, phosphorous, nitrogen and TSS. Similar in concept to bioretention, Filterra has been optimized for high volume/flow treatment and high pollutant removal. Filterra offers a small footprint and is well suited for highly developed sites, parking lots and streetscapes.

Expected Pollutant Removal
(Ranges Varying with Particle Size, Pollutant Loading and Site Conditions)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Removal (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS Removal</td>
<td>85%</td>
</tr>
<tr>
<td>Phosphorus Removal</td>
<td>60% - 70%</td>
</tr>
<tr>
<td>Nitrogen Removal</td>
<td>43%</td>
</tr>
<tr>
<td>Total Copper Removal</td>
<td>&gt; 58%</td>
</tr>
<tr>
<td>Dissolved Copper Removal</td>
<td>46%</td>
</tr>
<tr>
<td>Total Zinc Removal</td>
<td>&gt; 66%</td>
</tr>
<tr>
<td>Dissolved Zinc Removal</td>
<td>58%</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>&gt; 93%</td>
</tr>
</tbody>
</table>

Information on the pollutant removal efficiency of the filter soil/plant media is based on third party lab and field studies.

Filterra media has been TAPE and TARP tested and approved.

How Filterra Works

Stormwater runoff enters the Filterra Street Tree System through a curb-inlet opening and flows through a specially designed filter media mixture contained in a landscaped concrete container. The filter media captures and immobilizes pollutants; those pollutants are then decomposed, volatilized and incorporated into the biomass of the Filterra® system’s micro/macro fauna and flora. Stormwater runoff flows through the media and into an underdrain system at the bottom of the container, where the treated water is discharged.
POSSIBLE SCENARIOS FOR ROOT EXPANSION USING KNOCKOUTS:

- THE DESIGNATED AREA AROUND THE FILTERRA UNIT PROVIDES ADEQUATE SOIL VOLUME FOR TREE ROOTS UNDER THE SURROUNDING LANDSCAPE. THESE ARE RECOMMENDED VOLUMES, SUBJECT TO SITE CONDITIONS AND ANTICIPATED GROWTH REQUIREMENTS.

- IF THE DESIGNATED AREA AROUND THE FILTERRA UNIT WILL BE PAVED, BACKFILLING THIS AREA WITH STRUCTURAL SOILS WOULD ALLOW FOR IMPROVED ROOT GROWTH DUE TO NON-COMPACTED SOILS AND AERATION, AS WELL AS STABILIZATION OF THE TREE.

- THIS DESIGN COULD BE COMBINED WITH PERVIOUS CONCRETE TO ALLOW THE ROOTS ACCESS TO MORE WATER.

IRRIGATION OF ALL SHADE TREE UNITS IS HIGHLY RECOMMENDED AND IS THE OWNER'S RESPONSIBILITY

KNOCKOUTS ARE PRECASTED WITH A HEIGHT OF 6".
OVERALL LENGTH OF KNOCKOUTS VARY BASED ON FILTERRA UNIT DIMENSIONS.
ALL KNOCKOUTS ARE LOCATED 6" BELOW THE TOP OF FILTER MEDIA.

MODIFICATIONS OF DRAWINGS ARE ONLY PERMITTED BY WRITTEN AUTHORIZATION FROM FILTERRA

DATE: 06-19-08  DWG: EZ FTSHADE-1

Filtterra Street/Shade Tree Configuration with Knockouts - East Zone
## Filterra® Quick Sizing Table for Type I & Type II Street Trees

<table>
<thead>
<tr>
<th>Available Filterra Street/Shade Tree Box Sizes (ft.)</th>
<th>Maximum Contributing Drainage Area (acres) where ( C = 0.85 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>4x6 or 6x4</td>
<td>0.16</td>
</tr>
<tr>
<td>4x8 or 8x4</td>
<td>0.23</td>
</tr>
<tr>
<td>Standard 6x6</td>
<td>0.26</td>
</tr>
<tr>
<td>8x6 or 6x8, 4x12 or 12x4</td>
<td>0.36</td>
</tr>
<tr>
<td>10x6 or 6x10</td>
<td>0.46</td>
</tr>
<tr>
<td>12x6 or 6x12</td>
<td>0.56</td>
</tr>
<tr>
<td>13x7 or 7x13</td>
<td>0.71</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Available Filterra Street/Shade Tree Box Sizes (ft.)</th>
<th>Maximum Contributing Drainage Area (acres) where ( C = 0.50 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>4x6 or 6x4</td>
<td>0.28</td>
</tr>
<tr>
<td>4x8 or 8x4</td>
<td>0.39</td>
</tr>
<tr>
<td>Standard 6x6</td>
<td>0.45</td>
</tr>
<tr>
<td>8x6 or 6x8, 4x12 or 12x4</td>
<td>0.61</td>
</tr>
<tr>
<td>10x6 or 6x10</td>
<td>0.78</td>
</tr>
<tr>
<td>12x6 or 6x12</td>
<td>0.95</td>
</tr>
<tr>
<td>13x7 or 7x13</td>
<td>1.21</td>
</tr>
</tbody>
</table>

**Notes:**

1. Typical street tree standards recommend a 1.5” to 2.5” caliper. To accommodate these size requirements, Filterra has appropriately sized each unit at a 5’2” depth (INV to TC) for Type I and Type II Trees. (3” or greater caliper trees will require a 6’2” depth unit.)

2. A standard schedule - 40 pipe coupling is cast into the wall for easy connection to discharge drain.

3. Recommended Filterra street tree species are characteristic of shallow fibrous root systems preferable of well draining substrates. To aid in tree selection for your site, a list of Filterra approved street/shade tree species list showing expected mature tree height and spread with sun requirements is available upon request.

4. Dimensions shown are internal. Please add 1’ to each for external (using 6” walls)

5. In line with TR55 data, for commercial developments a minimum (runoff coefficient) C factor of 0.85 is recommended. For residential developments, use of C factors less than 0.50 require individual site review by Filterra.

6. For other target treatment goals, please contact us for Sizing Tables (e.g. uniform intensity 0.3 in/hr)

7. This sizing table is valid for VA (treating 90% of annual runoff) and typical for the Mid-Atlantic region.
Filterra® Street Tree Selections
Mid-Atlantic Region

Crape Myrtle in Filterra

Purpleleaf Plum in Filterra

Galaxy Magnolia in Filterra

Eastern Redbud

Red Maple

Callery Pear 'Chanticleer'

Thornless Honey Locust

Japanese Zelkova

Golden Raintree

Photos not featuring Filterra® are courtesy of Horticopia® Professional.

Filterra is protected by U.S. Patents #6,277,274 & #6,569,321 & #7,625,485 B2. Other Patents pending. A Division of

Corporate Headquarters
11352 Virginia Precast Road • Ashland, VA 23005
Toll Free: 866-349-3458 • Fax: 804-798-8400
E-mail: design@filterra.com • www.filterra.com