Statewide LID Training Program
Statewide LID Training Program

INSTRUCTORS

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Senior Scientist
Key project experience: Research specialist in the performance and design of LID practices.

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Associate Scientist
Key project experience: Stormwater monitoring and proprietary treatment verification and certification specialist.
ADVANCED TOPICS IN LID DESIGN:
BIORETENTION MEDIA AND COMPOST AMENDED SOILS

Statewide LID Training Program

DEPARTMENT OF ECOLOGY
State of Washington
introduction

media primer

water quality treatment strategies

performance

wrap-up
PROPRIETARY MEDIA FILTERS

BMP Selection

- Ecology sets guidance for which BMPs can be used
- Specific BMPs are required for specific pollutants
- Most BMPs are grandfathered in

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Statewide LID Training Program

6.2 BIORETENTION MEDIA

ADVANCED LID DESIGN
BMP Selection

PROPRIETARY MEDIA FILTERS

Statewide LID Training Program

BIORETENTION MEDIA

ADVANCED LID DESIGN
PROPRIETARY MEDIA FILTERS

BMP Selection

Something Doesn’t Quite Look Right...
PROPRIETARY MEDIA FILTERS

BMP Selection

Ecology attempts to verify BMP effectiveness with 2007 permit required monitoring

Phase I Municipal Stormwater Permit Monitoring: Stormwater Treatment and Hydrologic Management Best Management Practice (BMP) Evaluation Monitoring (SB.F)

BMP requires Phase I Municipal Stormwater Permittees to measure the effectiveness of stormwater treatment and hydrologic management BMPs. Permittees are required to collect influent and effluent water quality and flow data from each BMP. Effective July 1, 2002, Ecology added the following requirements in order to verify the effectiveness of BMPs included in Phase I Permittees’ Phase I permits. The requirement for BMPs includes a requirement for Phase I Permittees (with the exception of those BMPs added following the effective date of the rule) to monitor BMPs for a minimum of three years. ERCowners are required to verify BMP effectiveness through monitoring, low impact development, bioretention media, permeable pavements, or other means. These methods include the monitoring of BMP effectiveness conditions such as water quality, water quantity, or both. For Phase I Permittees, the following describes each Phase I Permittee’s effectiveness study with links to each GARP.

King County

King County is monitoring two large sand filters and two, pre-verdant basins. These stormwater facilities are located at a multi-family development on the East Lake Samish Basin.

Id 77.7 Flow Reduction Strategy

King County is monitoring two basins. One is a basin located in an urban planned housing development (part of the Redmond Ridge project). The other basin is an attempt to mitigate the traditional clearing and grading of land for building that leaves little organic soil in place after construction has been completed. The study hypothesis is that adding organic compost to native soils will absorb more stormwater than un-composted soil and enhance the growth of the planted landscape that will additionally prevent more runoff. Flow will be monitored from a basin with compost-amended soils and from a basin in a similar development without compost-amended soils (control). The paired data will be compared to determine differences between the basins.

King County’s GARR for SB.F and SF.P.T

Snohomish County

Snohomish County is monitoring four modified wet ponds to determine which design is most effective at removing pollutants from stormwater. These wet ponds are located northeast of Mill Creek, southeast of Mill Creek and two ponds located south of Everett.

Id 77.7 Flow Reduction Strategy

For flow reductions, the County is monitoring a modified drainage structure in a suburban southeast of Mill Creek to determine if a reduction in stormwater volume is occurring from retrofits designed to encourage infiltration.

Snohomish County’s GARR for SB.F and SF.P.T

Clark County

Clark County is monitoring two treatment wetlands located in the City of Vancouver, WA. A two-facility treatment train located near the Kinzua Bridge on Salmon Creek on highway 99. The first treatment facility is a biofiltration media followed by a stormwater media filter vault system equipped with 2x media filter cartridges with granular-activated carbon filtration media.

Clark County’s GARR for SB.F

Id 77.7 Flow Reduction Strategy

The County is also monitoring the flow reduction capability of permeable pavers as a low impact development (LID) practice at the Vancouver Toyota car dealership.

Clark County’s GARR for SB.F
Emerging Technology

- Testing program first established in 2002
- Most recent revision in 2011, next due this year
- Most rigorous and active testing protocol in the nation
BMP Testing - TAPE

Jurisdictions that recognize TAPE

1. Washington
2. Oregon
3. New York
4. Virginia
5. New Hampshire
6. Rhode Island
7. Many smaller jurisdictions
Certifications

• General Use – GULD
  - use at will

• Conditional Use – CULD
  - install up to 10, monitor 1

• Pilot Use – PULD
  - install up to 5, monitor all
PROPRIETARY MEDIA FILTERS

BMP Testing -TAPE

Table 2. Basic, dissolved metals, phosphorus, and oil treatment and pretreatment performance goals and required water quality parameters for TAPE monitoring.

<table>
<thead>
<tr>
<th>Performance Goal</th>
<th>Influent Range</th>
<th>Criteria</th>
<th>Required Water Quality Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Treatment</td>
<td>20-100 mg/L TSS</td>
<td>Effluent goal &lt; 20 mg/L TSS</td>
<td>TSS</td>
</tr>
<tr>
<td></td>
<td>100-200 mg/L TSS</td>
<td>&gt; 80% TSS removal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 200 mg/L TSS</td>
<td>&gt; 80% TSS removal</td>
<td></td>
</tr>
<tr>
<td>Dissolved Metals</td>
<td>Dissolved copper</td>
<td>Must meet basic treatment</td>
<td>TSS</td>
</tr>
<tr>
<td>Treatment</td>
<td>0.005 - 0.02 mg/L</td>
<td>goal and better than basic treatment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dissolved zinc</td>
<td>(0.02 - 0.3 mg/L)</td>
<td>currently defined as &gt; 30%</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Total phosphorus (TP)</td>
<td>Must meet basic treatment</td>
<td>TSS, TP, orthophosphate</td>
</tr>
<tr>
<td>Treatment</td>
<td>0.1 to 0.5 mg/L</td>
<td>goal and exhibit = 50% TP removal</td>
<td></td>
</tr>
<tr>
<td>Oil Treatment</td>
<td>Total petroleum hydrocarbons (TPH)</td>
<td>1) No ongoing or recurring visible sheen in effluent</td>
<td>NWTPTH-Ox, visible sheen</td>
</tr>
<tr>
<td></td>
<td>&gt; 10 mg/L</td>
<td>2) Daily average effluent TPH concentration &lt; 10 mg/L.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Maximum effluent TPH concentration of 15 mg/L.** for a</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>discrete (grab) sample</td>
<td></td>
</tr>
<tr>
<td>Pretreatment</td>
<td>50-100 mg/L TSS</td>
<td>Effluent goal &lt; 50 mg/L TSS</td>
<td>TSS</td>
</tr>
<tr>
<td></td>
<td>&gt; 100 mg/L TSS</td>
<td>&gt; 50% TSS removal</td>
<td></td>
</tr>
</tbody>
</table>

* | ** | ***


Technology Assessment Protocol – Ecology (TAPE)

August 2011 revision of Publication no. 02-10-037
Publication no. 11-10-061

Statewide LID Training Program

6.2 BIORETENTION MEDIA

ADVANCED LID DESIGN 12
BMP Testing - TAPE

What Does TAPE Monitoring Look Like?
PROPRIETARY MEDIA FILTERS

BMP Testing - TAPE

• Continuous Flow Monitoring
• Collect flow-weighted composite samples
### BMP Testing - TAPE

**Proprietary Media Filters**

**Rigorous Acceptance Criteria**

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**Table 5. Storm event guidelines for TAPE monitoring.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Guideline *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum storm depth</td>
<td>Total rainfall amount during the storm event</td>
<td>0.15 inches</td>
</tr>
<tr>
<td>Storm start (antecedent dry-period)</td>
<td>Defines the storm events beginning as designated by minimum time interval without significant rainfall</td>
<td>6 hours minimum with less than 0.04 inches of rain</td>
</tr>
<tr>
<td>Storm end (post storm dry period)</td>
<td>Defines the storm event's end as designated by minimum time interval without significant rainfall</td>
<td>6 hours minimum with less than 0.04 inches of rain</td>
</tr>
<tr>
<td>Minimum storm duration</td>
<td>Shortest acceptable rainfall duration (e.g., inches per hour)</td>
<td>1 hour</td>
</tr>
<tr>
<td>Average storm intensity</td>
<td>Total rainfall amount divided by total rainfall duration (e.g., inches per hour)</td>
<td>Range of rainfall intensities *</td>
</tr>
</tbody>
</table>

* Provide justification in the Technical Evaluation Report (TER) for storm event data that does not meet the storm event guideline, but is included in the data analysis.

* To assure performance on an annual average basis and performance of the system's peak design rate, proponents should collect samples over a range of rainfall intensities.

**Table 6. Sample collection requirements for automated, flow proportional composite sampling.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum aliquot number</td>
<td>The number of equal-volume samples collected during a storm event that are combined to create a composite sample</td>
<td>10 aliquots *</td>
</tr>
<tr>
<td>Storm event coverage</td>
<td>The percentage of the total storm volume that the collected aliquots represent.</td>
<td>For storm events lasting less than 24 hours, samples shall be collected for at least 75% of the storm event hydrograph (by volume). For storm events lasting longer than 24 hours, samples shall be collected for at least 75% of the hydrograph (by volume) of the first 24 hours of the storm.</td>
</tr>
<tr>
<td>Maximum sampling duration</td>
<td>Time in hours between the collection of the first and last aliquots</td>
<td>28 hours</td>
</tr>
<tr>
<td>Minimum number of samples</td>
<td>Number of storm events with successfully collected flow-proportional composite samples that meet the influent concentration ranges and the storm event guidelines</td>
<td>12 samples *</td>
</tr>
</tbody>
</table>

* Ecologists accept as few as 7 aliquots. Proponents must include rationale in the TER why less than 10 aliquots were collected, but the sample accepted.

* Rainfall influent and effluent data from more than one site can be combined (pooled) to meet the minimum number of samples.
BMP Testing - TAPE

**Good Pacing**
- Storm volume = 1300 cf
- Pacing = 100 cf
- Samples = 13
- Coverage = 100%

**Too High**
- Storm volume = 1300 cf
- Pacing = 200 cf
- Samples = 6
- Coverage = 100%
Storm volume = 1300 cf
Pacing = 20 cf
Samples = 30 (Max. that autosampler can hold)
Coverage = 46%
PROPRIETARY MEDIA FILTERS

BMP Testing - TAPE

Basic Treatment
- 80% removal of TSS (influent = 100 to 200 mg/L)
- 20 mg/L TSS effluent goal (influent <100 mg/L)

Enhanced Treatment
- Influent dissolved copper range = 0.003 to 0.02 mg/L
- Influent dissolved zinc range = 0.02 to 0.3 mg/L
- Significantly higher removal rates than basic treatment

Oil Treatment
- No ongoing or recurring visible sheen
- Daily average TPH <10 mg/L
- Maximum TPH discrete (grab) sample = 15 mg/L
PROPRIETARY MEDIA FILTERS
BMP Testing - TAPE
Murphys’ Law and Field Work
PROPRIETARY MEDIA FILTERS
BMP Testing - TAPE
Labor and Tech Intensive

- $15,000 equipment
- $200,000 total cost
PROPRIETARY MEDIA FILTERS

BMP Selection

TAPE Testing of Three Proprietary Media Filters
BMP Selection

TAPE Testing of Three Proprietary Media Filters

Filterra
Proprietary Media Filters

Filterra - Tacoma

- Inlet
- Concrete container
- Surface storage
- Mulch layer
- Filter media
- Vegetation
- Underdrain
- Bypass
PROPRIETARY MEDIA FILTERS

Filterra - Tacoma

- November 2006
  - Conditional Short-Term Use Level Designation (CULD) for basic and phosphorus treatment
  - Pilot Use Level Designation (PULD) for enhanced and oil treatment

Two Filterra test systems installed at the Port of Tacoma (POT) in Tacoma, WA
Hydrologic and water quality monitoring from May 2008 through May 2009
27 storm events sampled
  - 29 grab samples
  - 35 composite samples
PROPRIETARY MEDIA FILTERS

Filterra - Tacoma
PROPRIETARY MEDIA FILTERS

Filterra - Tacoma
## Basic Treatment (TSS) Results

<table>
<thead>
<tr>
<th>Test System</th>
<th>Storm Events</th>
<th>Influent TSS (mg/L)</th>
<th>Effluent TSS (mg/L)</th>
<th>TSS Removal Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>POT1</td>
<td>22</td>
<td>11 – 40</td>
<td>1.7 – 7.8</td>
<td>65 – 90</td>
</tr>
<tr>
<td>POT2</td>
<td>13</td>
<td>0.83 – 8.0</td>
<td>0.5 U – 5.0</td>
<td>-79 – 91</td>
</tr>
<tr>
<td>Meets TAPE</td>
<td>10</td>
<td>20 – 40</td>
<td>2.0 – 7.8</td>
<td>79 – 90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(median = 28)</td>
<td>(median = 4.2)</td>
<td>(median = 86)</td>
</tr>
</tbody>
</table>
**Proprietary Media Filters**

**Filterra - Tacoma**

- Irreducible = 20-40 mg/L using conventional stormwater treatment technologies (Schueler 1996)

- Based on the POT data, influent TSS concentrations as low as 5.0 mg/L resulted in TSS removal efficiencies that met or exceeded the 80% goal

- Effluent concentrations were consistently reduced to less than 8.0 mg/L regardless of influent concentration
Enhanced Treatment Results (Diss. Copper)

<table>
<thead>
<tr>
<th>Test System</th>
<th>Storm Events</th>
<th>Influent Dissolved Cu (mg/L)</th>
<th>Effluent Dissolved Cu (mg/L)</th>
<th>Dissolved Cu Removal Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>POT1</td>
<td>18</td>
<td>0.0029 – 0.017</td>
<td>0.0015 – 0.10</td>
<td>24 – 74</td>
</tr>
<tr>
<td>POT2</td>
<td>11</td>
<td>0.001 U – 0.0056</td>
<td>0.001 U – 0.0033</td>
<td>27 – 62</td>
</tr>
<tr>
<td>Meets TAPE</td>
<td>23</td>
<td>0.0029 – 0.017 (median = 0.0056)</td>
<td>0.0015 – 0.0099 (median = 0.0033)</td>
<td>24 – 74 (median = 44)</td>
</tr>
</tbody>
</table>
## Enhanced Treatment Results (Diss. Copper)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>n</th>
<th>Median Dissolved Cu Removal (%)</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filterra</td>
<td>23</td>
<td>44</td>
<td>NA</td>
</tr>
<tr>
<td>Biofilter – Grass Strip</td>
<td>151</td>
<td>20</td>
<td>Filterra &gt; Basic</td>
</tr>
<tr>
<td>Biofilter – Grass Swale</td>
<td>86</td>
<td>7</td>
<td>Filterra &gt; Basic</td>
</tr>
<tr>
<td>Filter – Peat Mixed with Sand</td>
<td>9</td>
<td>15</td>
<td>Filterra &gt; Basic</td>
</tr>
<tr>
<td>Filter – Sand</td>
<td>78</td>
<td>14</td>
<td>Filterra &gt; Basic</td>
</tr>
<tr>
<td>Wet Pond</td>
<td>56</td>
<td>33</td>
<td>Filterra &gt; Basic</td>
</tr>
<tr>
<td>Wet Vault</td>
<td>29</td>
<td>19</td>
<td>Filterra &gt; Basic</td>
</tr>
<tr>
<td>Ecology Embankment</td>
<td>10</td>
<td>39.2</td>
<td>Filterra &gt; EE</td>
</tr>
</tbody>
</table>
Proprietary Media Filters

Filterra - Tacoma

General Use Level Designation

- GULD for basic, enhanced, and oil treatment received in December 2009

- May be installed anywhere in the state of Washington (subject to Ecology’s conditions)

- CULD extended for phosphorus monitoring until December 2011
Filterra - Bellingham

The Search for Phos Treatment
PROPRIETARY MEDIA FILTERS

Filterra - Tacoma

- Filterra test system installed at Hayward Dr., Bellingham, WA
- Hydrologic and water quality monitoring from Jan 2013 through July 2013
- 22 storm events sampled
PROPRIETARY MEDIA FILTERS

Filterra - Bellingham

Statewide LID Training Program

6.2 BIORETENTION MEDIA

ADVANCED LID DESIGN
Filterra - Bellingham

- Only 3 samples with influent > 100
- NC LCL95 TSS Removal
- 85% mean removal
- UCL95 effluent = 5.2 mg/L
Filterra - Bellingham

- 66% LCL95 TP Removal
- 73% mean removal
Filterra Summary

- Certified for Basic, Phosphorus, Enhanced, and Oil treatment
- 3 monitoring installations
- Maintenance is simple
- Dual structure design can be difficult for engineers
- Mulch is an effective prefilter and bioturbation keeping infiltration rate high. A living filter!
Modular Wetland System

MWS-Linear
PROPRIETARY MEDIA FILTERS

Modular Wetland System
PROPRIETARY MEDIA FILTERS

Modular Wetland System
Modular Wetland System

- One test system installed in Portland, OR in a city maintenance yard
- Hydrologic and water quality monitoring from April 2012 through May 2013
- 28 storm events sampled
PROPRIETARY MEDIA FILTERS

Modular Wetland System
Moduley Wetland System

Figure 7: Plan view diagram of the MW5 monitoring site (MW5).

Legend:
- Presence of transversal and sampling wells
- Pumping and pit line wells
- Direction of flow
- 3’ conduct
PROPRIETARY MEDIA FILTERS

Modular Wetland System

- Highly turbid inflow
- BioMediaGREEN blocks coated with fines
- Ribbed BioMediaGREEN blocks coated with fines
- Installation of temporary particle prefilter with new cartridge design
- Cubed BioMediaGREEN ready for installation
- High sediment loading in drainage basin

Statewide LID Training Program

BIORETENTION MEDIA

ADVANCED LID DESIGN 48
PROPRIETARY MEDIA FILTERS

Modular Wetland System
Modular Wetland System

- Only 7 samples with influent > 100
- NC LCL95 TSS Removal
- 85% mean removal
- UCL95 effluent = 12.8 mg/L
Modular Wetland System

- 17 qualifying samples
- LCL95 removal = 58%
Modular Wetland System

- 11 qualifying samples
- LCL95 removal = 60.5%
PROPRIETARY MEDIA FILTERS

Modular Wetland System

- 14 qualifying samples
- LCL95 removal = 32.5%

Copper

Statewide LID Training Program
MWS Summary

- Certified for Basic, Phosphorus, Enhanced treatment
- Maintenance is relatively simple
- Flexible design options
- Two stage filter and large surface area extend the life of the filter
- Living filter?
Old Castle Perk Filter

Perk Filter
Old Castle Perk Filter

PROPRIETARY MEDIA FILTERS

Statewide LID Training Program

6.2 BIORETENTION MEDIA

ADVANCED LID DESIGN
PROPRIETARY MEDIA FILTERS

Old Castle Perk Filter
Old Castle Perk Filter

- System installed on Bainbridge Island
- Hydrologic and water quality monitoring from May 2009 through Feb 2010
- 22 storm events sampled
PROPRIETARY MEDIA FILTERS

Old Castle Perk Filter
PROPRIETARY MEDIA FILTERS

Old Castle Perk Filter
PROPRIETARY MEDIA FILTERS

Old Castle Perk Filter
Old Castle Perk Filter

- Our Unique Challenge
PROPRIETARY MEDIA FILTERS

Old Castle Perk Filter
PROPRIETARY MEDIA FILTERS

Old Castle Perk Filter

Statewide LID Training Program

6.2 BIORETENTION MEDIA
ADVANCED LID DESIGN
PROPRIETARY MEDIA FILTERS
Old Castle Perk Filter
Old Castle Perk Filter
Old Castle Perk Filter

**TSS**

Only 7 samples with influent > 100
- NC LCL95 TSS Removal
- 81% median removal
### Old Castle Perk Filter

#### Table 19. Total suspended solids summary statistics for 16 sampling events at the BIPF test system with influent total suspended solids concentrations of 20 mg/L or greater.

<table>
<thead>
<tr>
<th></th>
<th>All Data</th>
<th>Influent (mg/L)</th>
<th>Effluent (mg/L)</th>
<th>Percent Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Mean</td>
<td>95</td>
<td>14</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>71</td>
<td>12</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>57.5</td>
<td>9.8</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>COV</td>
<td>60.5</td>
<td>70</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Bootstrapped Median Lower CI</td>
<td>53</td>
<td>7</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Bootstrapped Median</td>
<td>71</td>
<td>12</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>Bootstrapped Median Upper CI</td>
<td>139</td>
<td>19</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>25th Percentile</td>
<td>49.5</td>
<td>6.4</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>75th Percentile</td>
<td>153.5</td>
<td>21.8</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>IQR</td>
<td>104.0</td>
<td>15.4</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>28</td>
<td>3</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>190</td>
<td>36</td>
<td>95</td>
<td></td>
</tr>
</tbody>
</table>

mg/L: milligrams per liter
n: number of samples
COV: coefficient of variance
CI: 95% confidence interval
IQR: interquartile range
Old Castle Perk Filter

**TP**

- 13 samples with influent > 0.1
- 64% median removal
**Old Castle Perk Filter**

Table 21. Total phosphorus summary statistics for 11 sampling events at the BIPF test system with influent total phosphorus concentrations between 0.100 and 0.500 mg/L.

<table>
<thead>
<tr>
<th></th>
<th>Influent (mg/L)</th>
<th>Effluent (mg/L)</th>
<th>Percent Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n</strong></td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>0.237</td>
<td>0.083</td>
<td>62</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>0.174</td>
<td>0.059</td>
<td>71</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>0.138</td>
<td>0.058</td>
<td>25</td>
</tr>
<tr>
<td><strong>COV</strong></td>
<td>0.138</td>
<td>0.058</td>
<td>25</td>
</tr>
<tr>
<td><strong>Boostrapped Median Lower CI</strong></td>
<td>0.113</td>
<td>0.048</td>
<td>60</td>
</tr>
<tr>
<td><strong>Boostrapped Median</strong></td>
<td>0.174</td>
<td>0.059</td>
<td>71</td>
</tr>
<tr>
<td><strong>Boostrapped Median Upper CI</strong></td>
<td>0.381</td>
<td>0.126</td>
<td>78</td>
</tr>
<tr>
<td><strong>25th Percentile</strong></td>
<td>0.113</td>
<td>0.048</td>
<td>60</td>
</tr>
<tr>
<td><strong>75th Percentile</strong></td>
<td>0.381</td>
<td>0.126</td>
<td>78</td>
</tr>
<tr>
<td><strong>IQR</strong></td>
<td>0.268</td>
<td>0.078</td>
<td>18</td>
</tr>
<tr>
<td><strong>Minimum</strong></td>
<td>0.107</td>
<td>0.017</td>
<td>-1</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>0.464</td>
<td>0.203</td>
<td>88</td>
</tr>
</tbody>
</table>

mg/L: milligrams per liter  
n: number of samples  
COV: coefficient of variance  
CI: 95% confidence interval  
IQR: interquartile range
Perk Filter Summary

- Certified for Basic and Phosphorus treatment
- Flexible design options
- Fluidized media inhibits occlusion
- Cheaper than StormFilter
- Maintenance relatively involved
Filter Longevity

Treatment is all well and good, but what if the thing clogs after 1 month?
PROPRIETARY MEDIA FILTERS

Filter Longevity

- City of Seattle
  CatchBasin
  StormFilter Study
- Studies 15 CBSF units across the City
- Conducted quarterly testing
- Tested rate of clogging
Filter Longevity
**Filter Longevity**

- 6-months old loading
- Sized right = 120%
- Undersized = 74%

---

**Figure 5.3a – Hydrologic Performance Compared to Cartridge Deficit – 6 months (with trend lines)**

- Flow-based Deficit
- Mass-based Deficit

**Statewide LID Training Program**

**6.2 BIORETENTION MEDIA**

**ADVANCED LID DESIGN** 75
Filter Longevity

- 12.5-months old loading
- Sized right = 68%
- Undersized = 18%

Figure 5.3b – Hydrologic Performance Compared to Cartridge Deficit – 12.5 months
Filter Longevity

Once maintained then back to full capacity!

Perk Filter

Treated Flow Rate during Bypass (cubic feet/second) vs. Precipitation Depth (inches)

Solid red line – Lowess fit, dashed red line – linear fit

Statewide LID Training Program

6.2 BIORETENTION MEDIA

ADVANCED LID DESIGN 77
Filter Longevity

Only 2% annual bypass, but occurred near end
Filterra Bellingham

<table>
<thead>
<tr>
<th>Storm Start Date &amp; Time</th>
<th>Storm Depth (inches)</th>
<th>Peak Storm Intensity (in/hr)</th>
<th>Total Volume (gpm)</th>
<th>Bypass Volume (gallons)</th>
<th>% of Total Volume Bypassed</th>
<th>Peak Treated Flow Rate during Bypass (gpm)</th>
<th>Peak Infiltration Rate during Bypass (in/hr)</th>
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</thead>
<tbody>
<tr>
<td>1/9/2013 7:35</td>
<td>1.42</td>
<td>0.48</td>
<td>14,076</td>
<td>368</td>
<td>2.8</td>
<td>60</td>
<td>222</td>
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<tr>
<td>3/10/2013 17:30</td>
<td>0.5</td>
<td>0.48</td>
<td>3,300</td>
<td>144</td>
<td>4.4</td>
<td>42</td>
<td>155</td>
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<tr>
<td>4/8/2013 17:25</td>
<td>1.38</td>
<td>0.48</td>
<td>14,491</td>
<td>618</td>
<td>4.3</td>
<td>52</td>
<td>102</td>
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<tr>
<td>5/11/2013 22:20</td>
<td>0.7</td>
<td>0.72</td>
<td>5,890</td>
<td>52</td>
<td>0.9</td>
<td>151</td>
<td>559</td>
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</table>

New media installed on 12/11/2012

Much replaced and routine maintenance on 8/31/2013
The Take Home

• All certified systems are high performance and use state of the science media
• BMPs are systematically undersized
• Proprietary BMPs are sized to sell
• Sediment loading to polishing systems is their downfall
• “Living” filters may last longer, but when will the main filter clog?
• TAPE style testing should be applied to all BMPs