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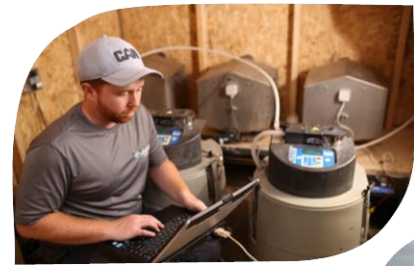


The Many Faces of Bioretention:

*What monitoring and research in
Ontario is telling us about design and
performance*

Tim Van Seters, TRCA
TRIECA 2017

STEP Water is a partnership between:



Presentation Overview

- What bioretention has to offer
- Monitoring sites and methods
- Compare with respect to:
 - Water quality
 - Hydrology
 - Winter Performance
 - Plant survivability
 - Maintenance
- Design considerations

What bioretention has to offer: The marketing pitch

- Flexible, adaptable
- Multi-functional
- Attractive and Alive
- Reduces urban heat island; VOC emissions
- Incorporates several treatment processes
- Resists clogging, long lasting



Monitored Sites



**CREDIT VALLEY
CONSERVATION**



Toronto and Region
Conservation
for The Living City®

Bioretention, Living City Campus

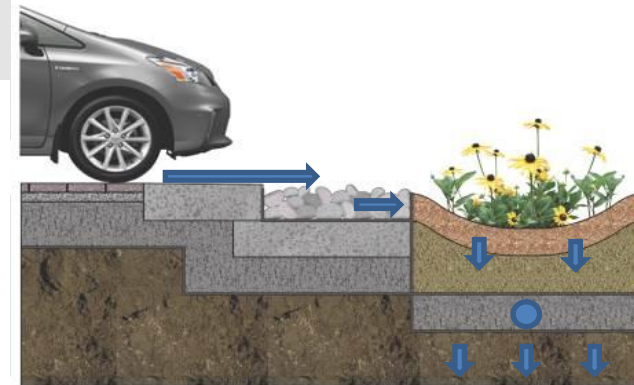
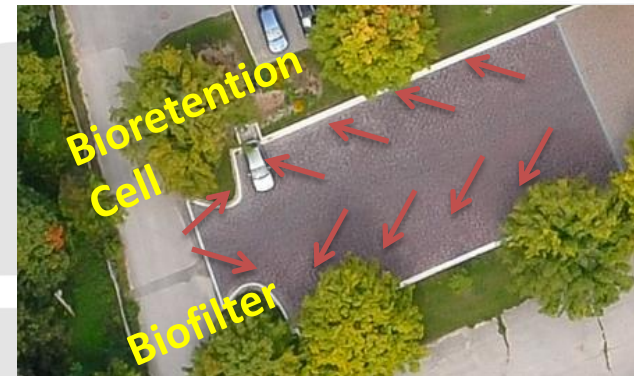


Brand name

*Pocket
Flow
Filter*

Site Characteristics

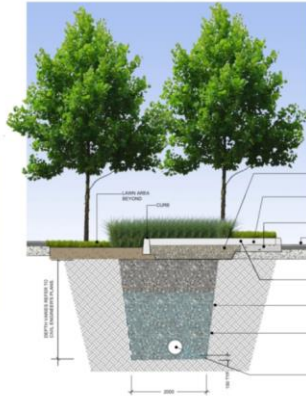
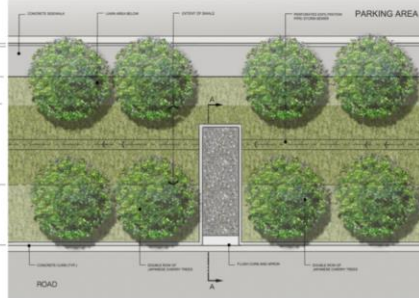
Drainage Area	Parking Lot
I:P Ratio	9:1
Cover	Plants/Mulch
Native Soils	Silty Clay
Filter Media	60% Sand



Honda Canada Biofilter

Biofiltration System

BIOFILTER IN TRAFFIC ISLAND



Brand name

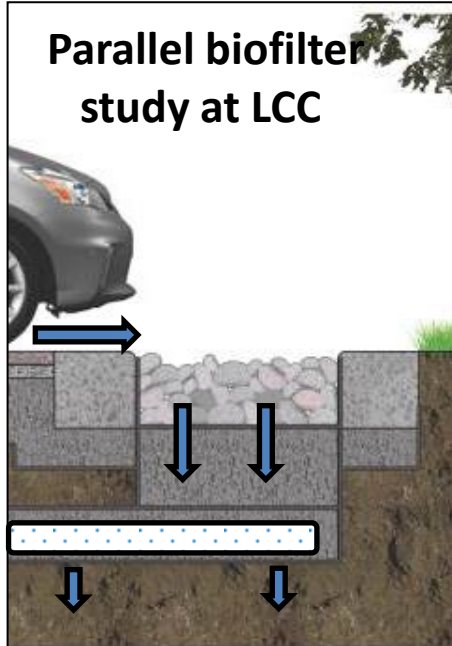
***Flood Filter-
Buster***

Site Characteristics

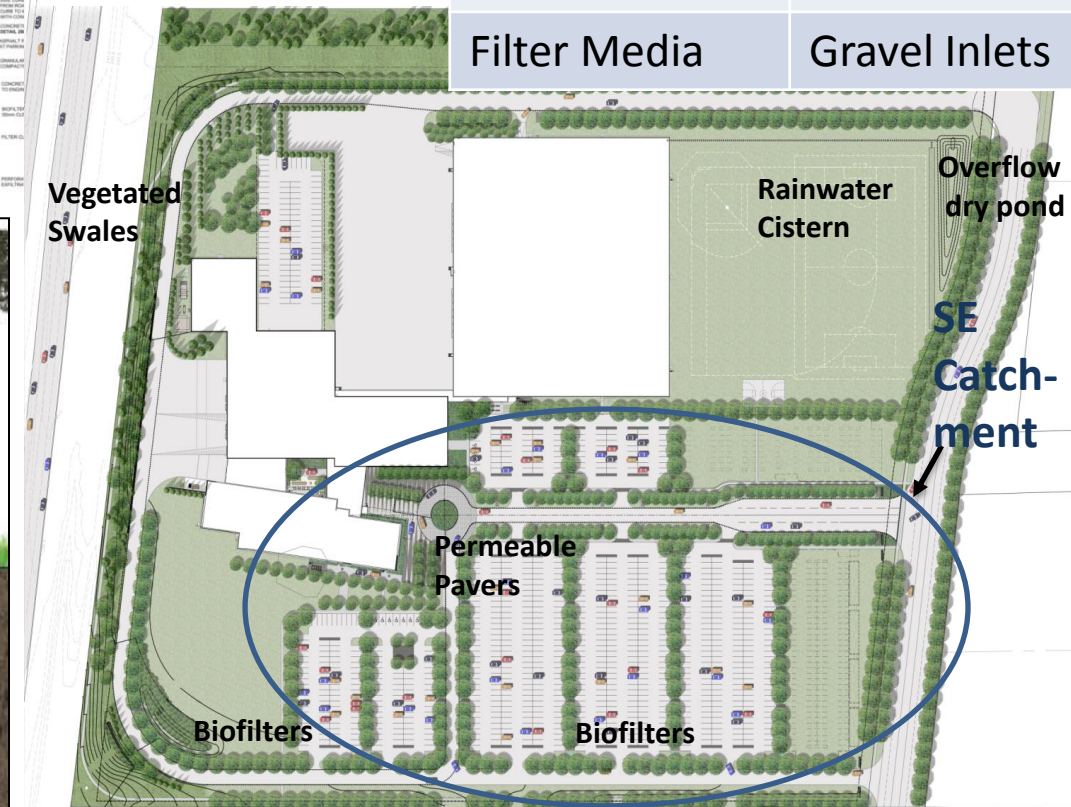
Drainage Area	Parking Lot
I:P Ratio	8 to 10:1
Cover	Trees/shrubs cobble inlets
Native Soils	Silty Clay
Filter Media	Gravel Inlets



**Parallel biofilter
study at LCC**



Vegetated
Swales



Courtesy: Schollen & Co.

North Bioretention, LCC

Site Characteristics

Drainage Area	Parking Lot
I:P Ratio	10:1
Cover	Plants/mulch
Native Soils	Silty Clay
Filter Media	>80% sand



Brand name

***Nutrient
Nixer***

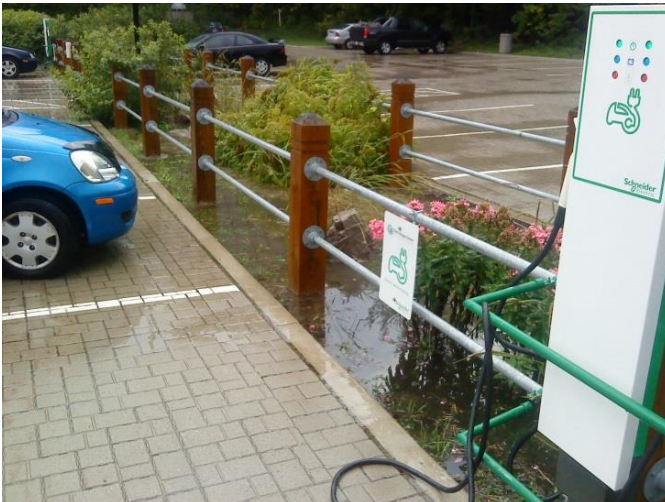


Earth Rangers Bioretention at LCC



Site Characteristics

Drainage Area	Parking Lot
I:P Ratio	11 to 13:1
Cover	Plants/Stone
Native Soils	Silty Clay
Filter Media	10–30% sand!



Brand name

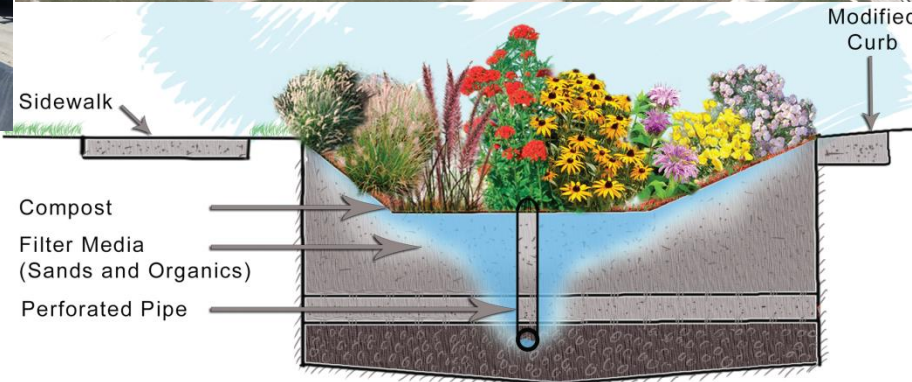
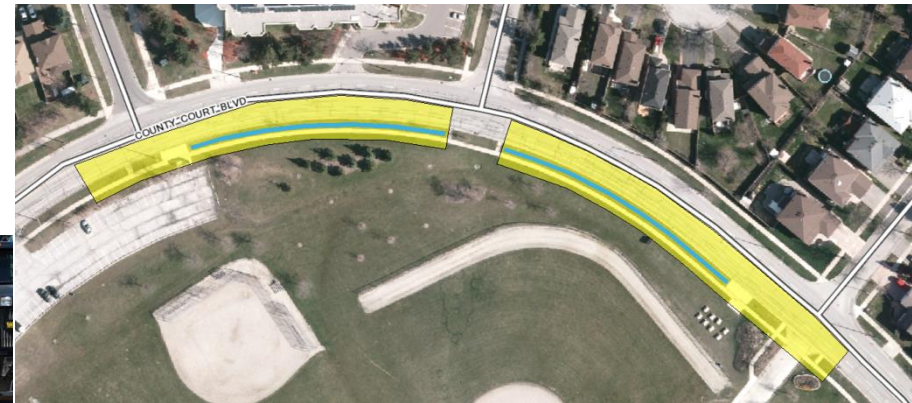
**River
Rocker**



County Court Filter Swale

Site Characteristics

Drainage Area	Road
I:P Ratio	5:1
Cover	Plants/stone
Native Soils	Imperm. liner
Filter Media	85% sand



Artist Illustration – may not be accurate. Rendering is to depict the filter swale design and plant choices only.



Brand name

**Lake Saver
Swale**

Seneca College Bioretention

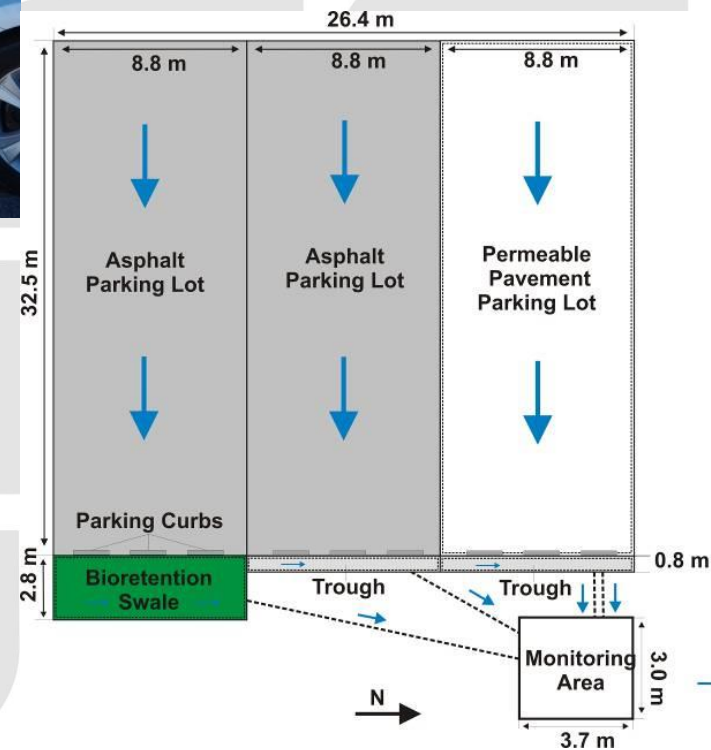


Brand name

**ORGANIC
OASIS**

Site Characteristics

Drainage Area	Parking Lot
I:P Ratio	10:1
Cover	Plants/Mulch
Native Soils	Silty Clay
Filter Media	Garden loam



Lakeview, Mississauga (CVC)



Vegetated bio-swales



Gardens with curb cuts



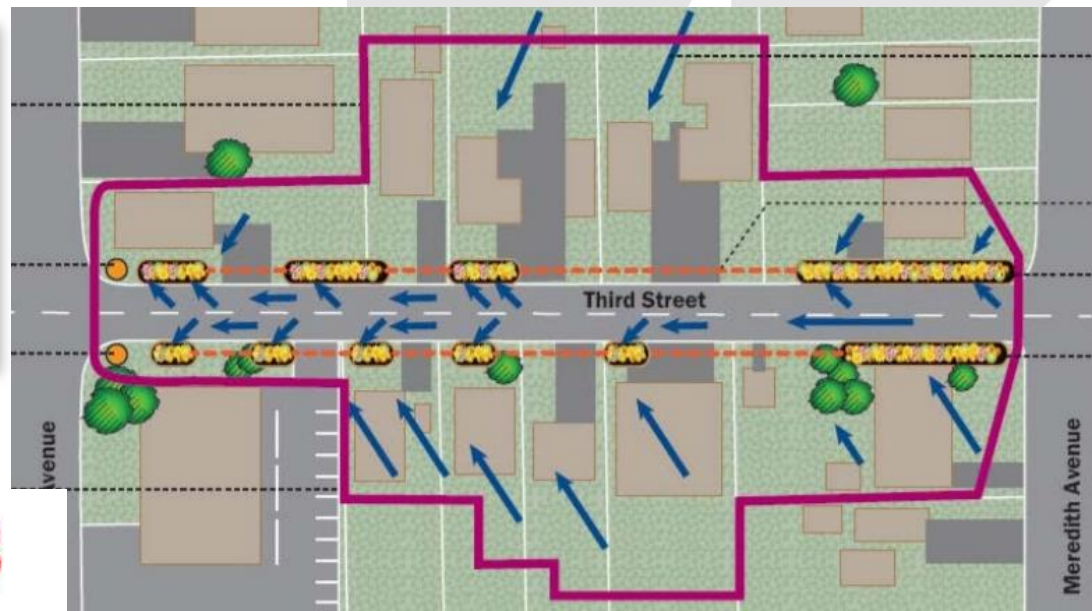
Grass swales

Brand name

Sunken Soakers

Site Characteristics

Drainage Area	Road/Lawn/ Roof
I:P Ratio	Approx: 10:1
Cover	Plants/mulch
Native Soils	Silty Clay
Filter Media	Sandy



Elm Drive Planter Boxes and Permeable Lay-bys (CVC)

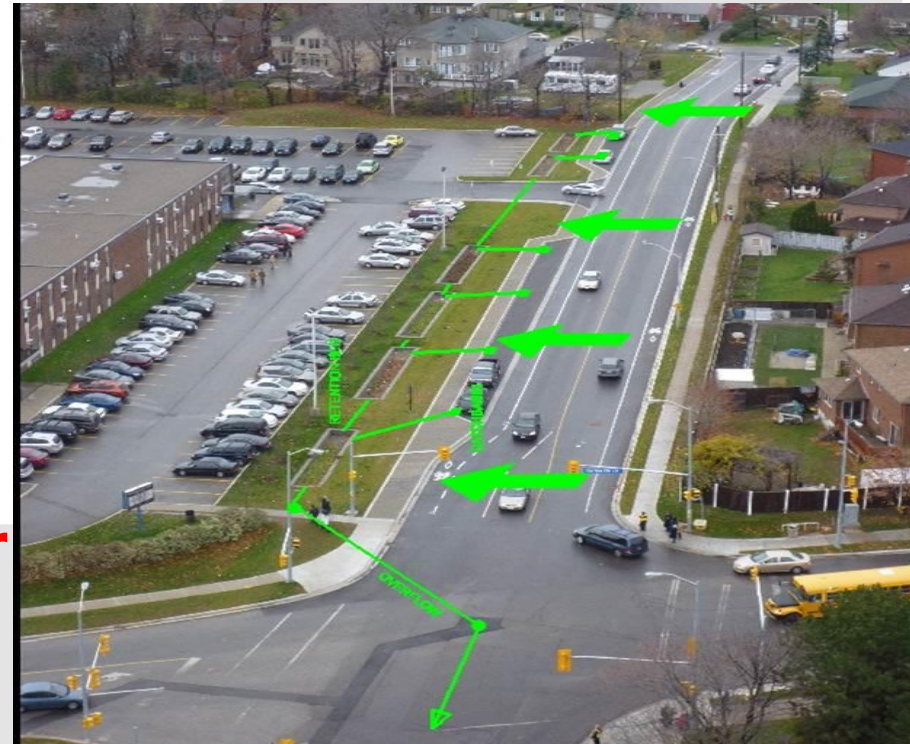


Site Characteristics

Drainage Area	Road/Lawn
I:P Ratio	Approx: 6:1
Cover	Plants/Mulch
Native Soils	Clayey silt on silt till
Filter Media	Sandy



Brand name
**Runoff
Redeemer**



Imax Bioretention (CVC)

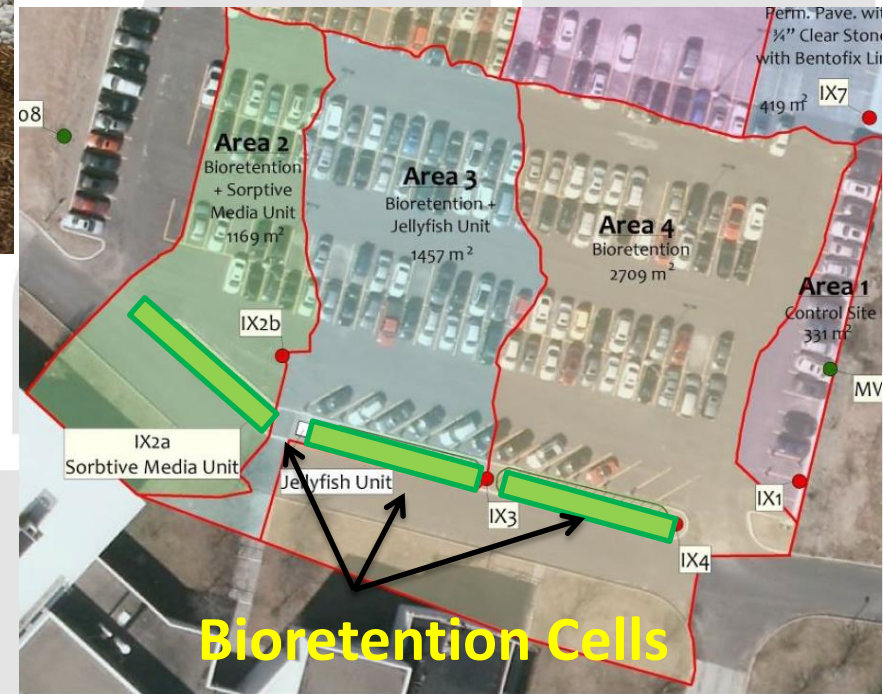


Brand name

Treatment
Trainer

Site Characteristics

Drainage Area	Parking Lot
I:P Ratio	22 - 30:1
Cover	Trees/shrubs /plants
Native Soils	Silty Clay fill over clay till
Filter Media	Sandy



Bioretention Cells

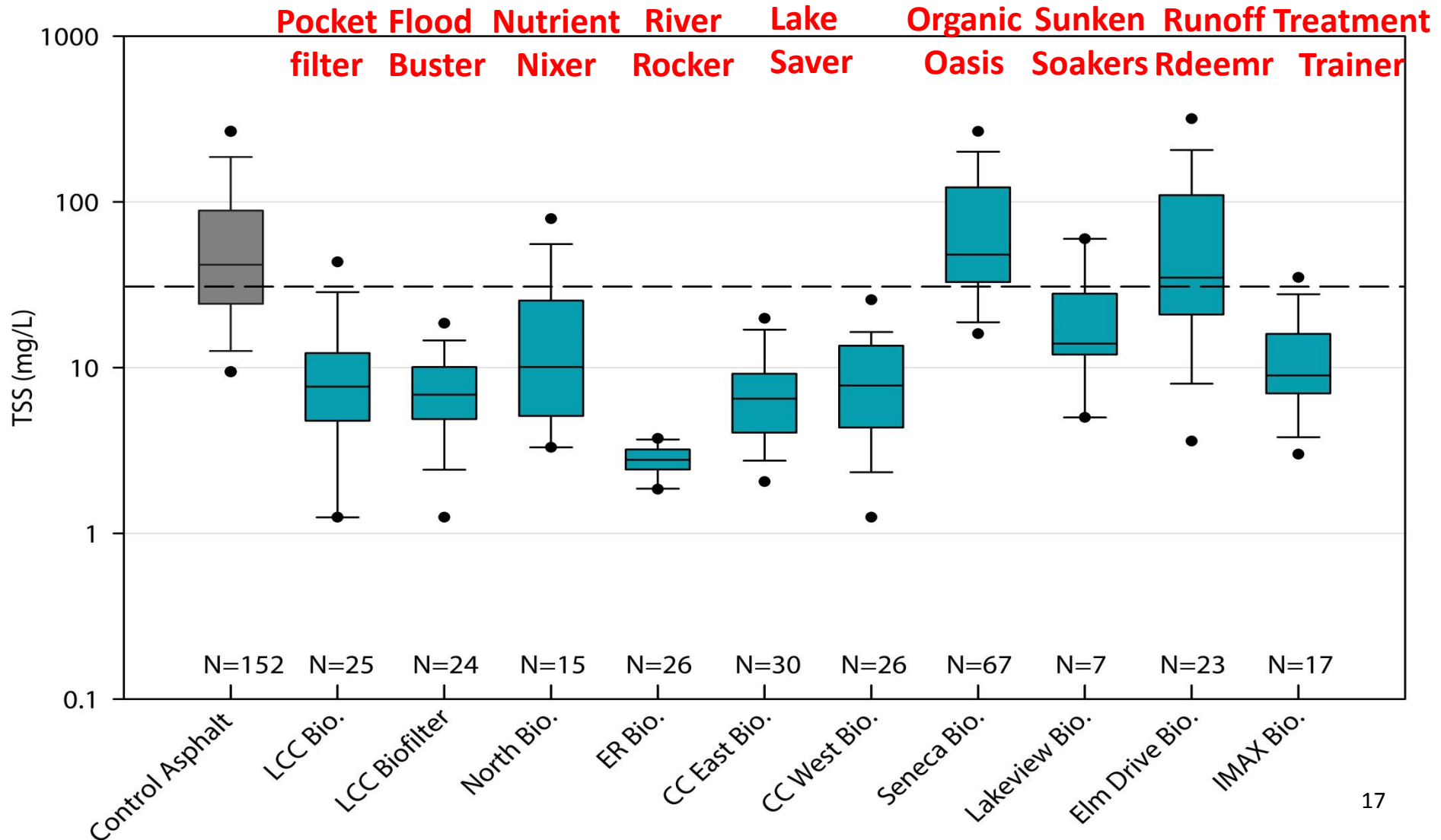
Monitoring Methods

- Continuous, long term monitoring
- Flow weighted water quality sampling
- Certified analytical laboratories
- Robust QA/QC field testing protocols
- Reference site controls where possible
- Parameters include: Water quality, quantity, temperature, surface ponding/infiltration, subsurface infiltration, plant survivability, O&M, Cost.

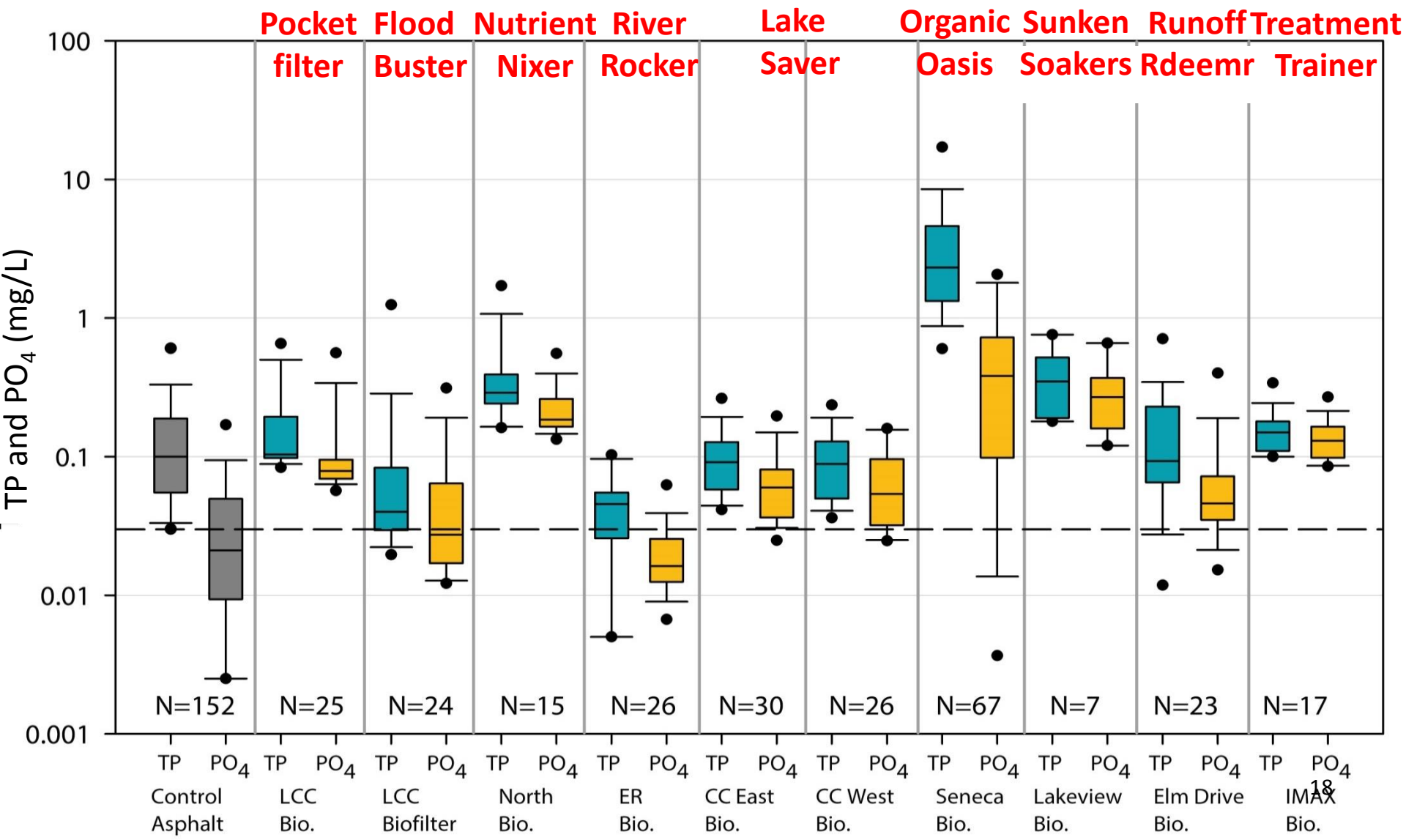


Performance Results

Total Suspended Solids Effluent Concentrations



TP and PO₄ Effluent Concentrations



Phosphorus Reactive Media Trials

North Bio @ LCC



Imbrium Sorbtive Media™



Red sand



Control Asphalt

IMAX Bio



Asphalt



Bioretention

Nov 21, 2012

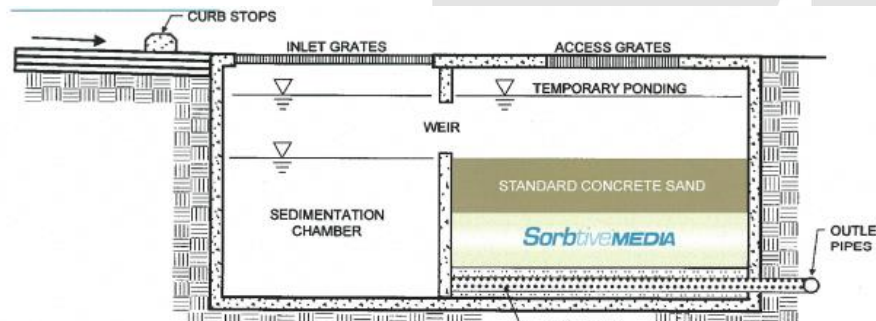


Asphalt to
Bioretention to
Sorbitive Media
Vault

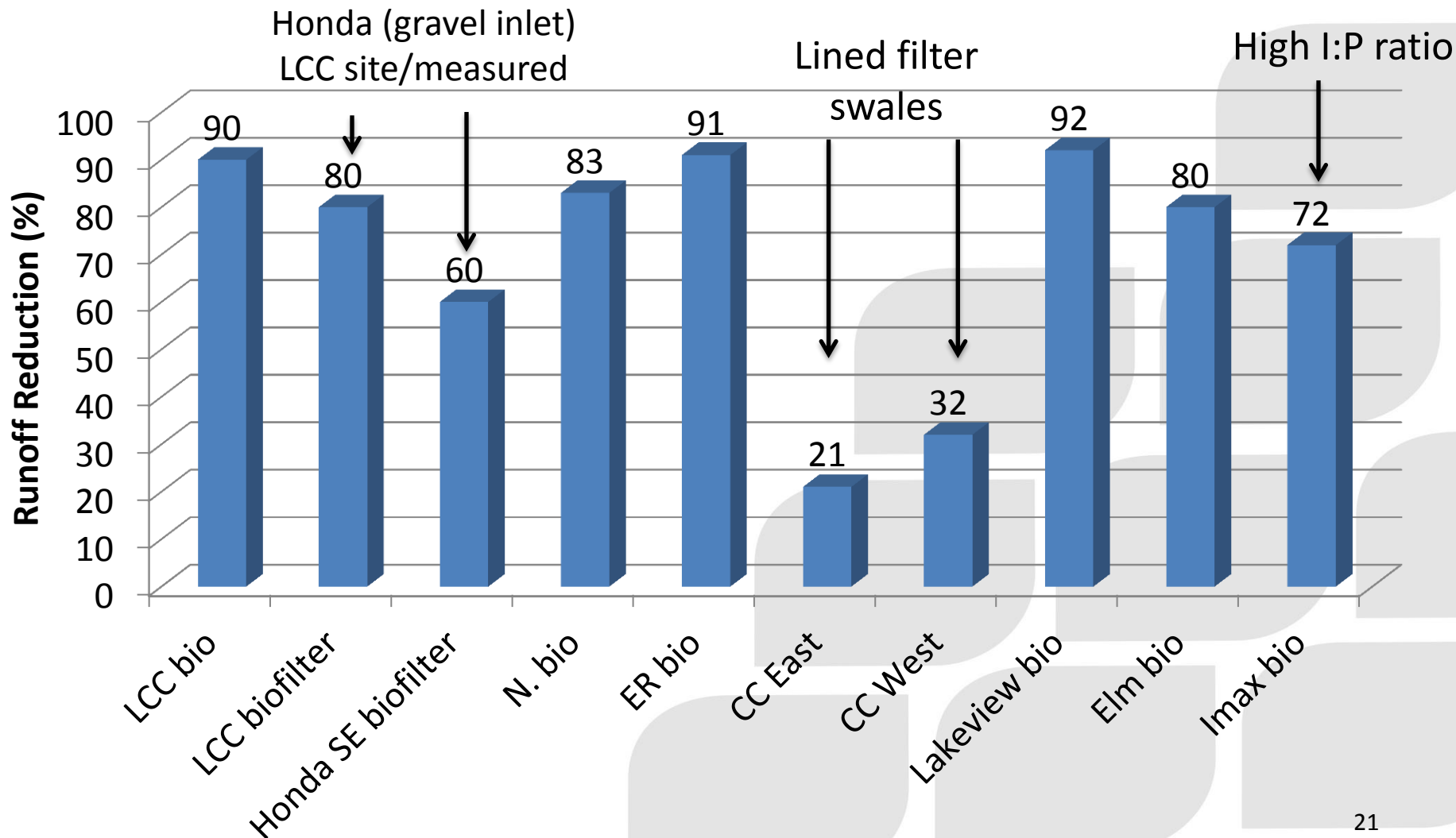
Bioretention
-Primary treatment

Sorbitive Media
Vault
- Dissolved nutrient
removal

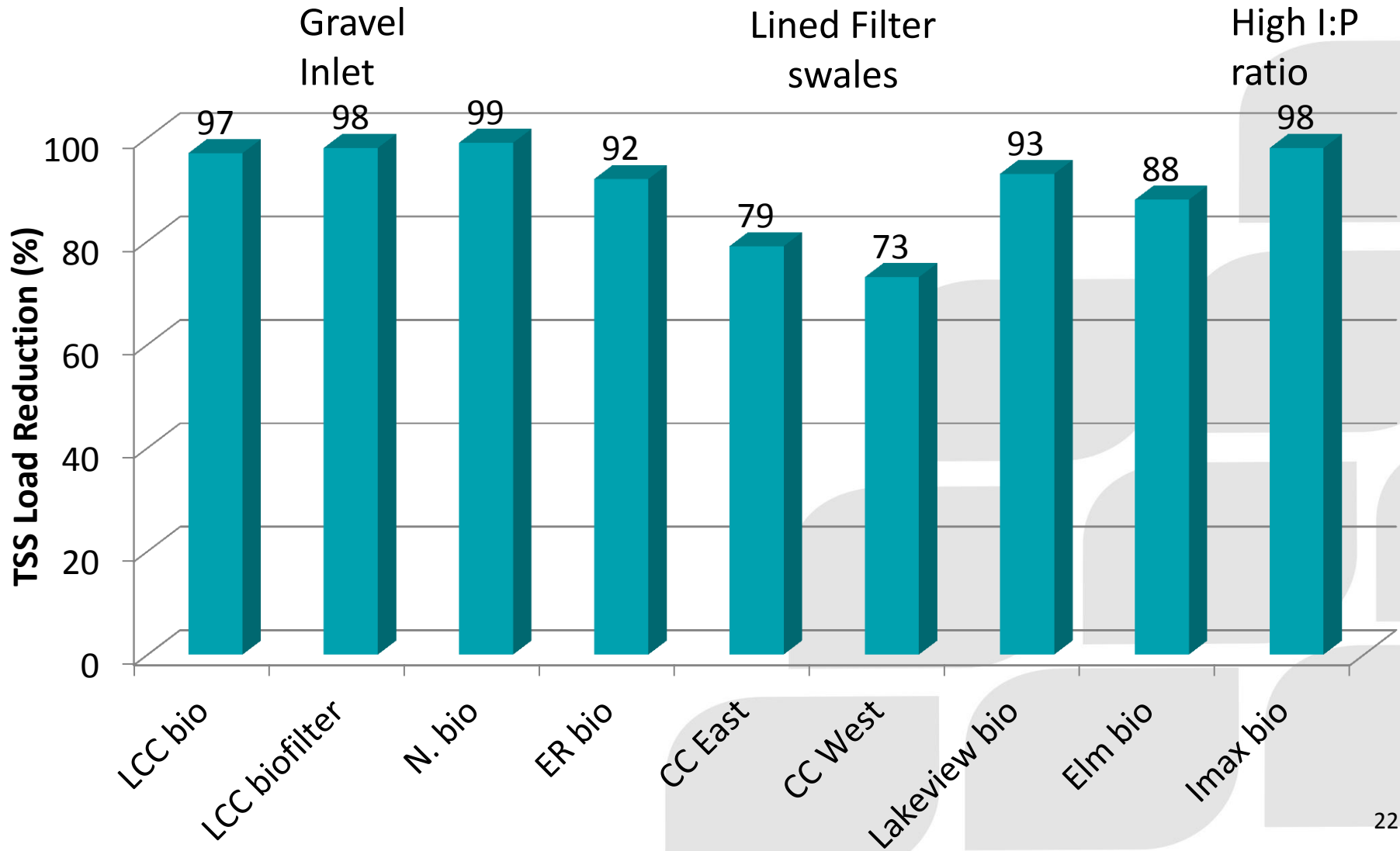
Overflow by-passes
Sorbitive Media
Vault



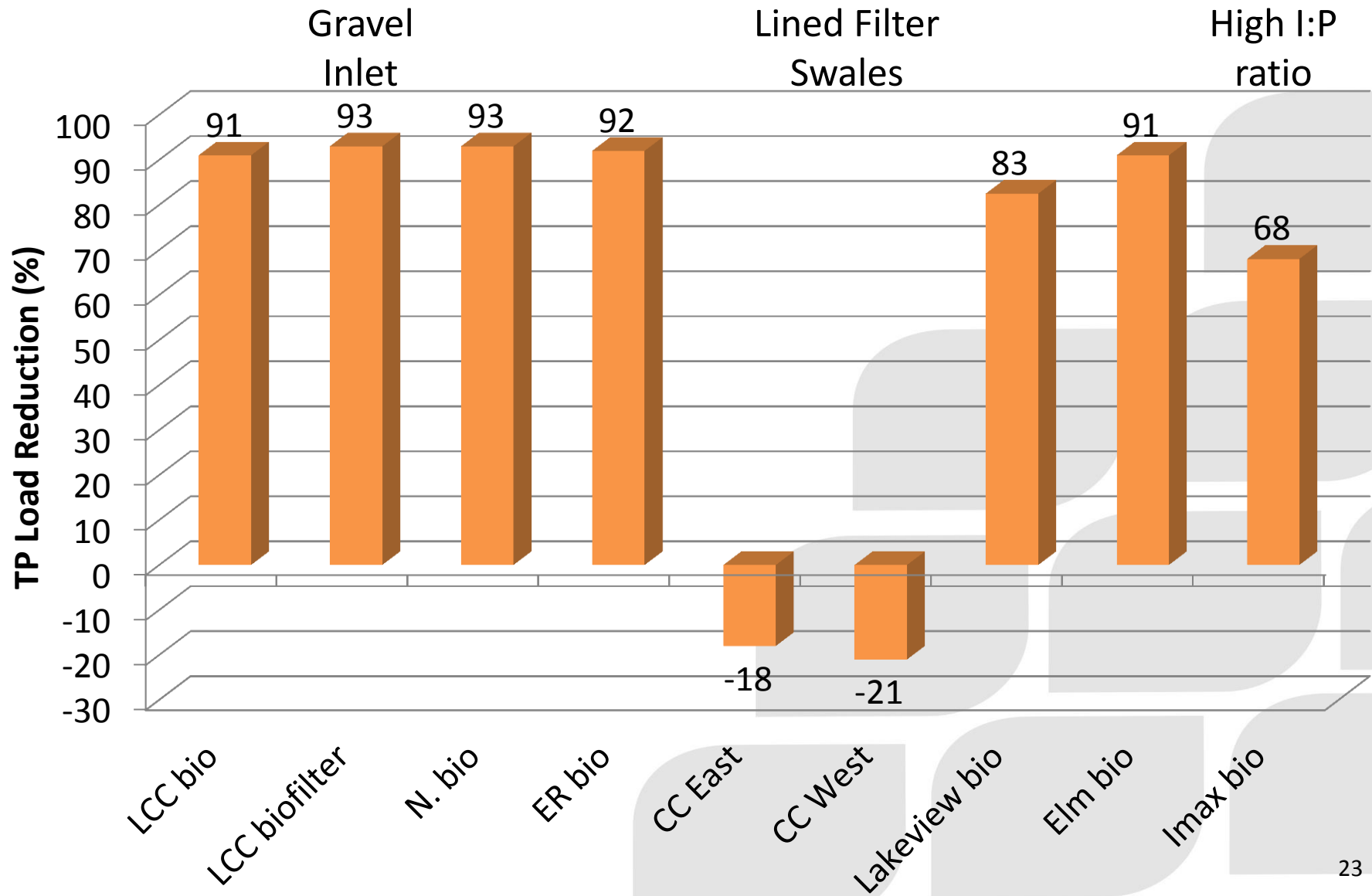
Runoff Volume Reduction



TSS Load Reductions



TP Load Reductions



Winter Performance

- Performance at least as good during the winter (96% runoff reduction at ER bio)
- Longer duration ponding can occur (up to 38 hours observed).
- Infiltration occurs throughout the winter; infrequent surface overflows
- Temperatures above zero at 50 cm depth
- Vegetation survives salt loading

ER Bio (River Rocker)



Seneca Bio (Organic Oasis)



Surface Infiltration over Time

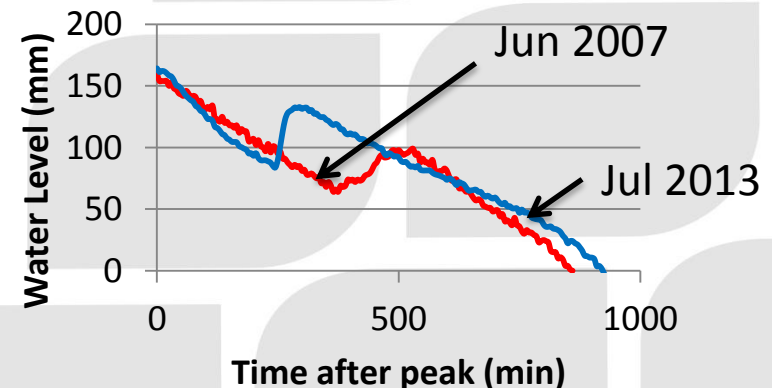
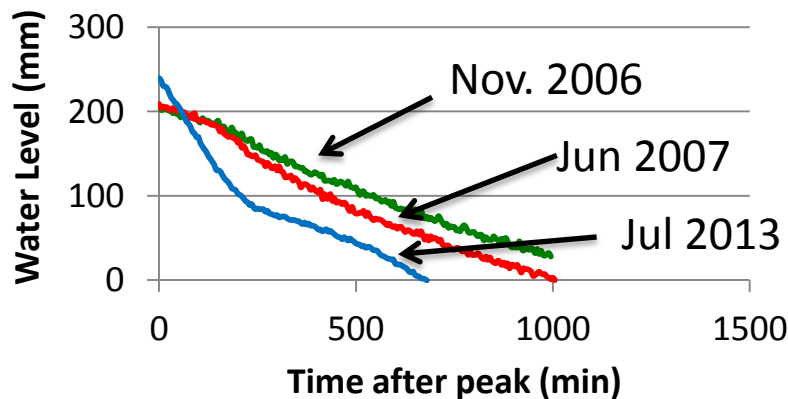
- No soil maintenance over seven years; limited veg. maintenance
- Drawdown of surface ponding levels after rain events in 2013 roughly the same as in 2006 and 2007



2007



2013



Upkeep and Maintenance

- Irrigation and replanting often necessary during establishment
- Top-ups of soil and mulch needed if settling occurs post construction
- Inspect and clean curb inlets, trash
- No need to replace media within at least first 10 years; low contaminant buildup in soils
- Occasional replanting, weeding...



The Takeaways

- Effluent concentrations not sensitive to influent concentrations; practice design more important
- Gravel and soil filter media perform similarly
- Substantial runoff reduction on tight soils
- Observed volume reduction differences relate to I:P ratio, liners and presence/absence of Et
- Winter performance as good as summer
- Plants/roots and microbes help maintain soil infiltration
- Be prepared to weed – gardens are not maintenance free!



More Takeaways... on Design

- Recommended I:P ratio up to 15:1 still considered reasonable; further increase to 20:1 may be justified
- Flood flow biofilter designs feasible – more examples needed
- Low infiltration or lined units can benefit from reactive media amendments to improve nutrient removal
- Filter media selection critical to success; need to better understand controlling factors on P retention
- Convey overflows through separate pipe, rather than through underdrain... and cover to prevent mulch from entering
- Install a standpipe for monitoring to facilitate inspections

Contact: