Quantifying the Benefits of Surface versus Underground Low Impact Development Practices

Tim Van Seters
TRIECA
March 26, 2014

The Living City Foundation

Toronto and Region Conservation for The Living City

Presentation Overview

- Summary of early results from a controlled study of two LID practices:
  - Vegetated bioretention with prepared soil filter media
  - Infiltration Trench with pretreatment via a stone inlet
- Compare with respect to:
  - Hydrology
  - Water quality
  - Water temperature
  - Maintenance
  - Cost
- Interpret results in relation to earlier studies

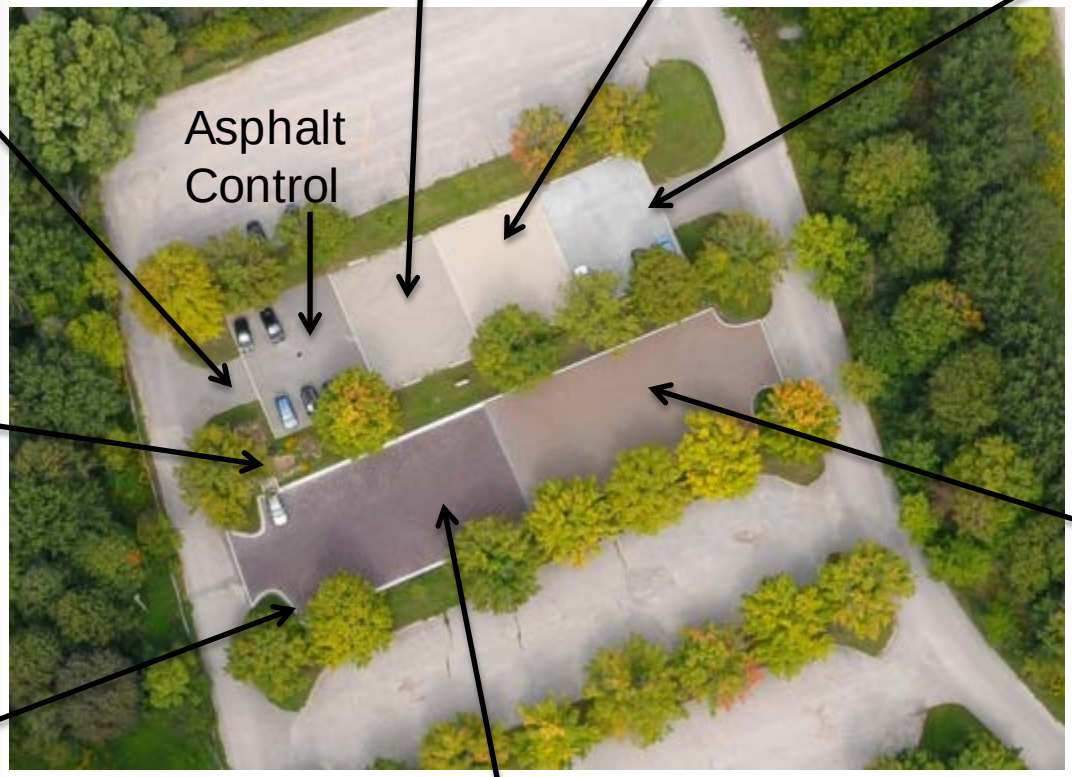
Living City Campus Parking Lot, Vaughan

Narrow Joint PICP

Wide Joint PICP

Pervious Concrete

Sampling Vault



Asphalt Control

Bioretention

Infiltration Trench

Recycled Rubber Non-perm. Pavers

Recycled Rubber Perm. Pavers

Earth Rangers on the Living City Campus

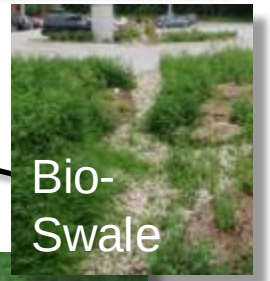
Compact and car pooling stalls

Electric Car Charging Stations

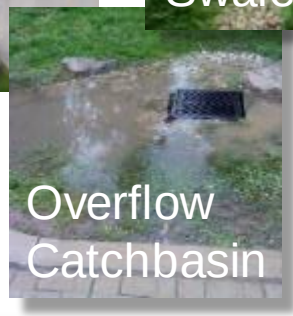
58 kW solar trackers

Bioretention Cell

Rainwater Cistern



Bio-Swale



Overflow Catchbasin

Green Roof

Permeable Pavers

Geothermal Energy

Monitoring Vault

Other LID sites


Schollen and Company


Cultec

What they Offer

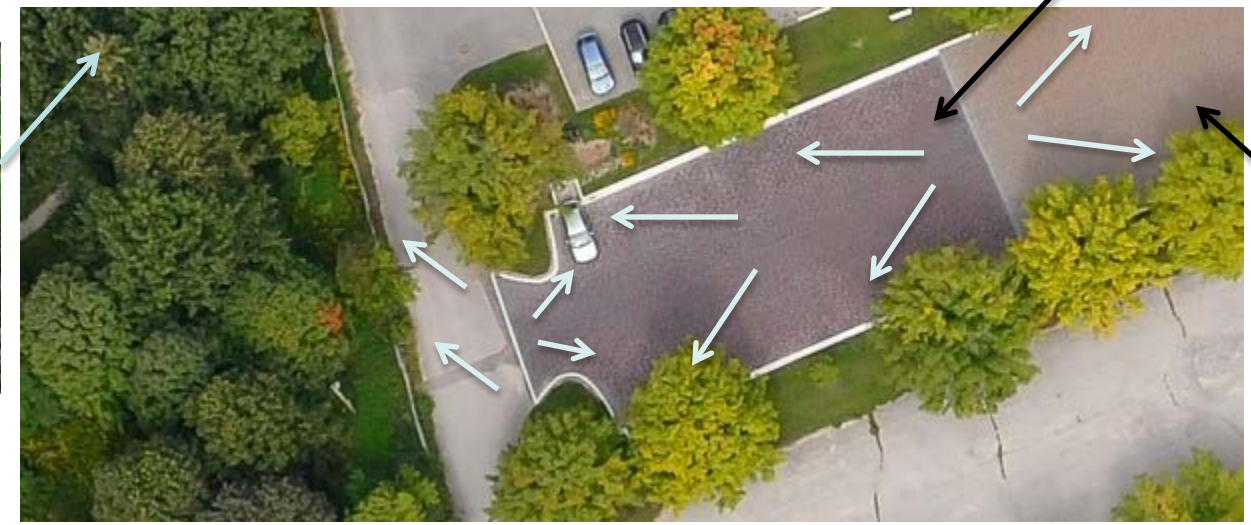
Vegetated Practices		Underground Practices
Larger surface footprint	⟺	Smaller surface footprint
Treatment through filtration, sedimentation, bio-degradation; plant uptake	⟺	Treatment through filtration, sedimentation
Volume reduction through evapotranspiration, infiltration	⟺	Volume reduction primarily through infiltration
Supports biodiversity, provides deep root moisture	⟺	Can provide deep root moisture
High visibility and aesthetic value; reduces heat island	⟺	Low Visibility and aesthetic value
Routine plant, soil and inlet maintenance required	⟺	Routine maintenance of pre-treatment practice

Study Areas

Bioretention

Study Drainage Area

Monitoring Hut

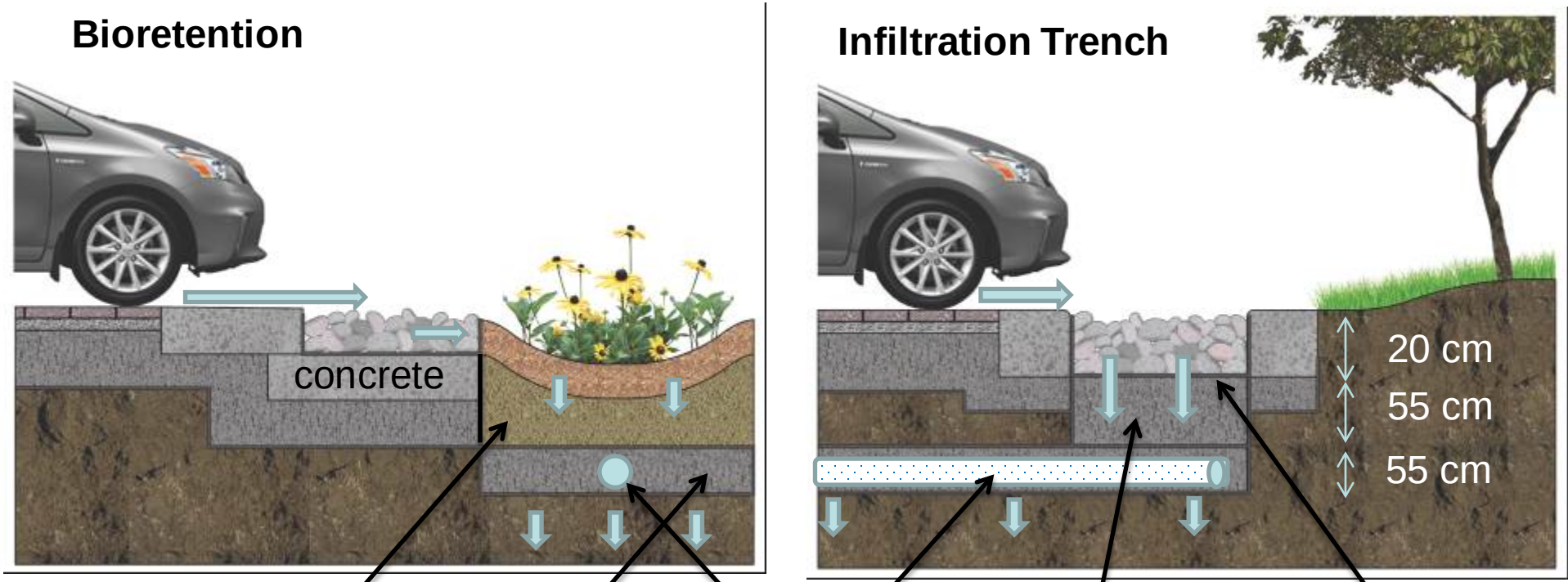


Permeable Pavers

Infiltration Trench

Practice Profiles

Identical infiltration footprints (30 m^2)



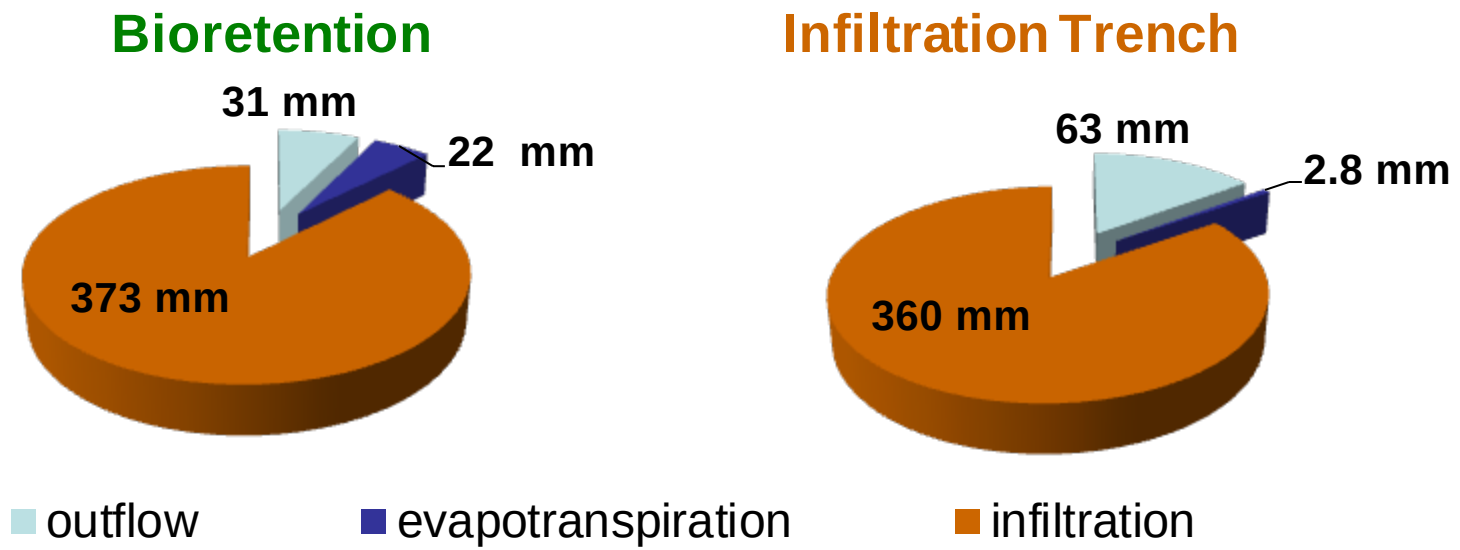
Hydrologic Performance

Evapotranspiration

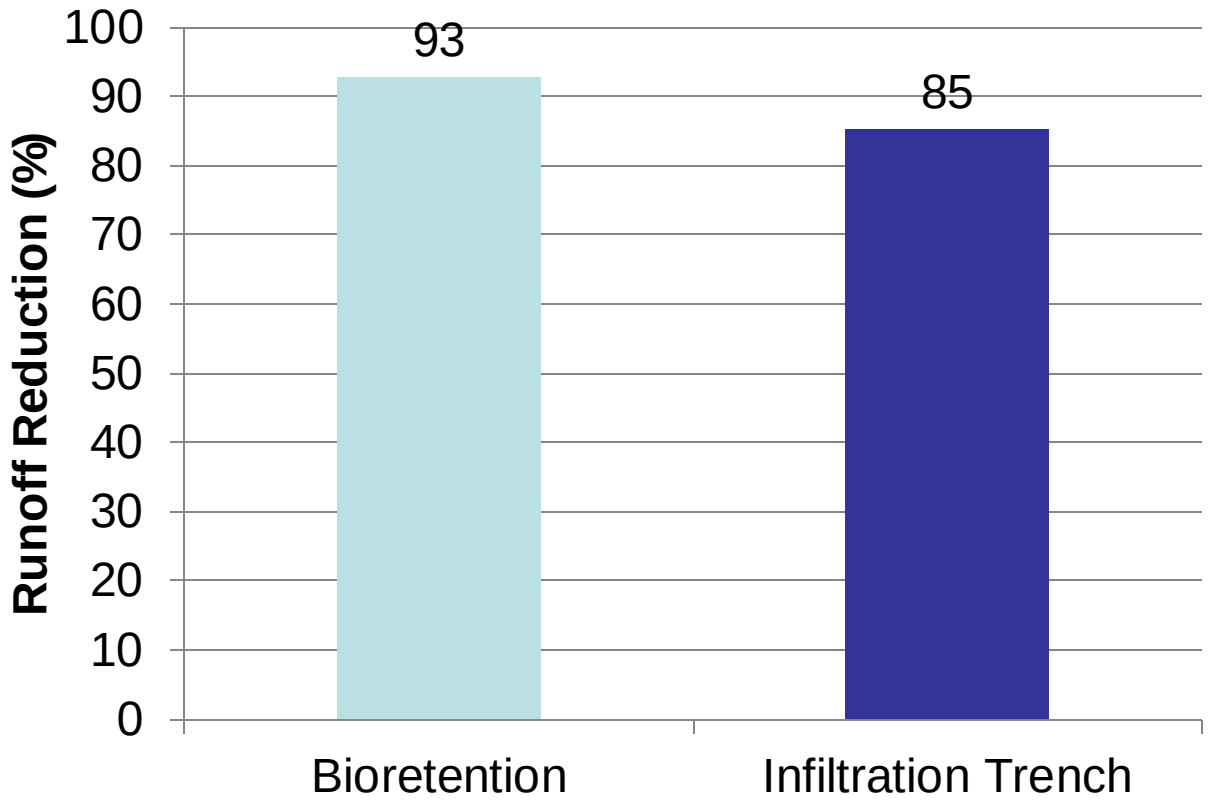
- Based on actual measurements in a field at Kortright and a gravel roof at Downsview
- Bioretention Et = 4194 L
- Stone inlet evaporation = 112 L

Water Balance

- May 28 to October 31, 2013
- Based on measured precipitation, asphalt runoff, underdrain outflows and estimated evapotranspiration

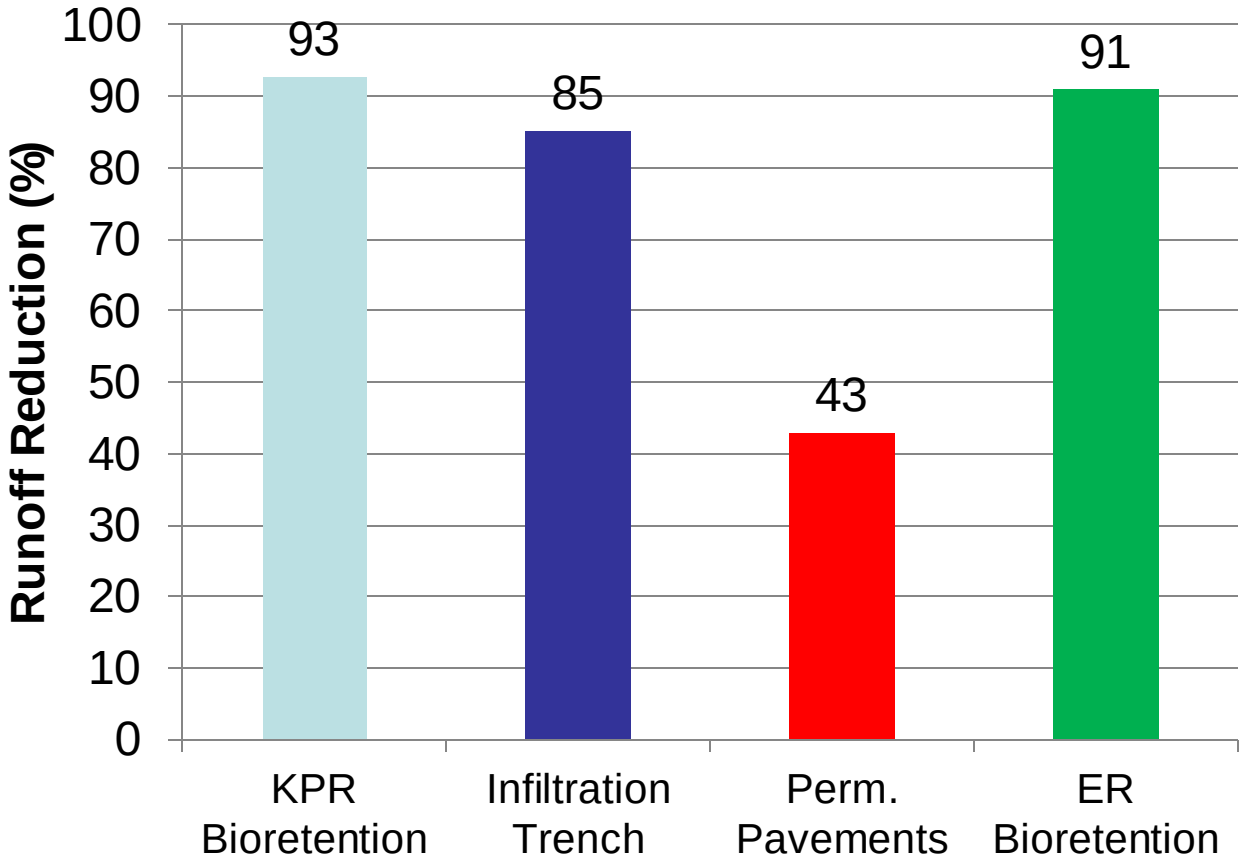


Runoff Reduction – warm season



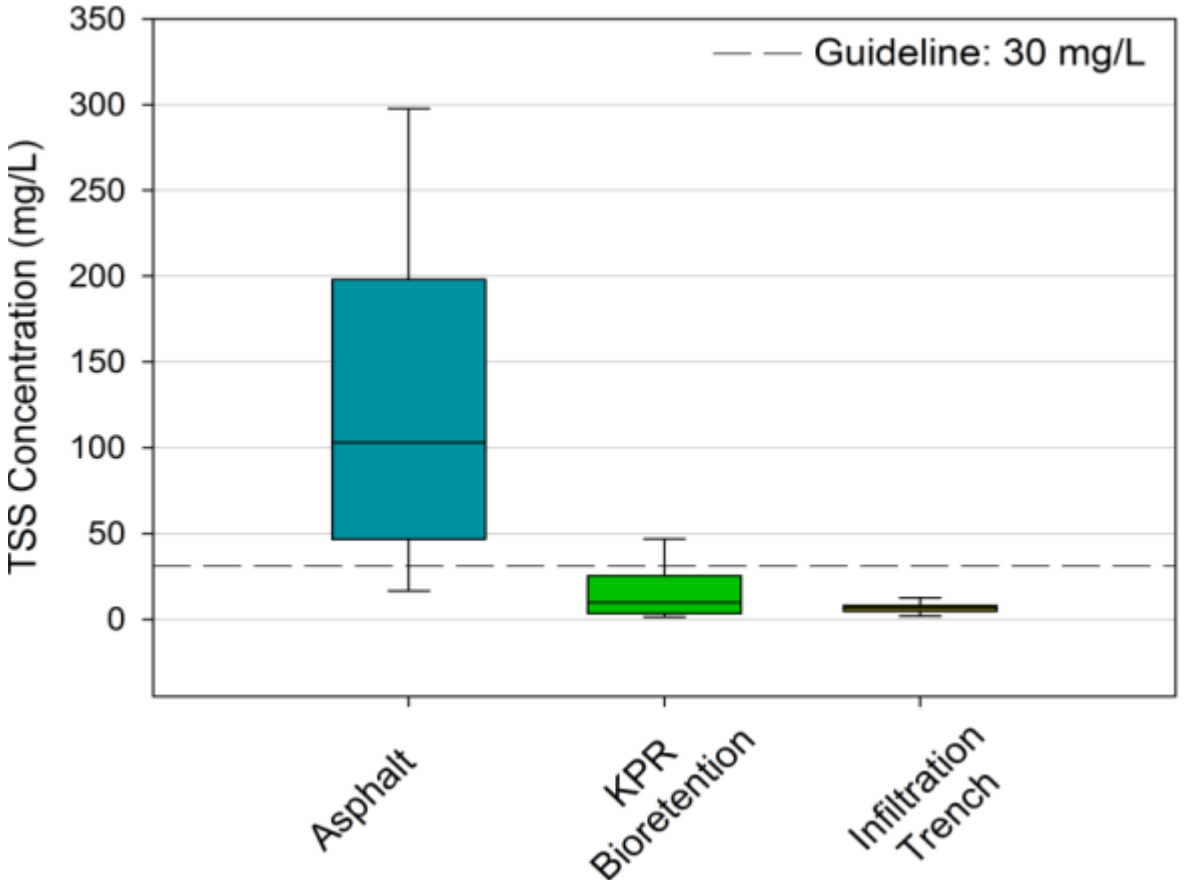
May 28 – Oct 31, 2013

Runoff Reduction – warm season

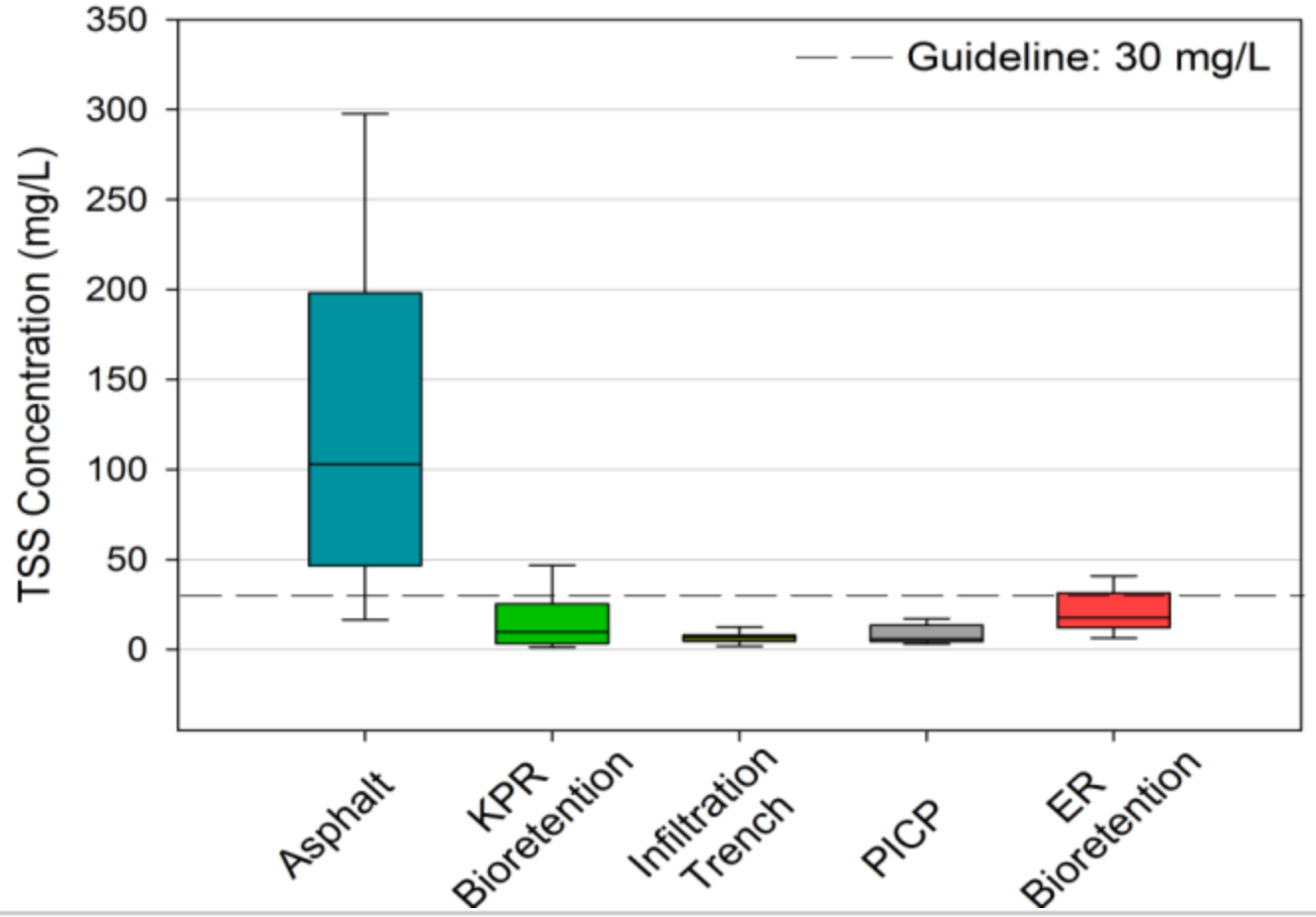


Water Quality Performance

Water Quality Concentrations - TSS

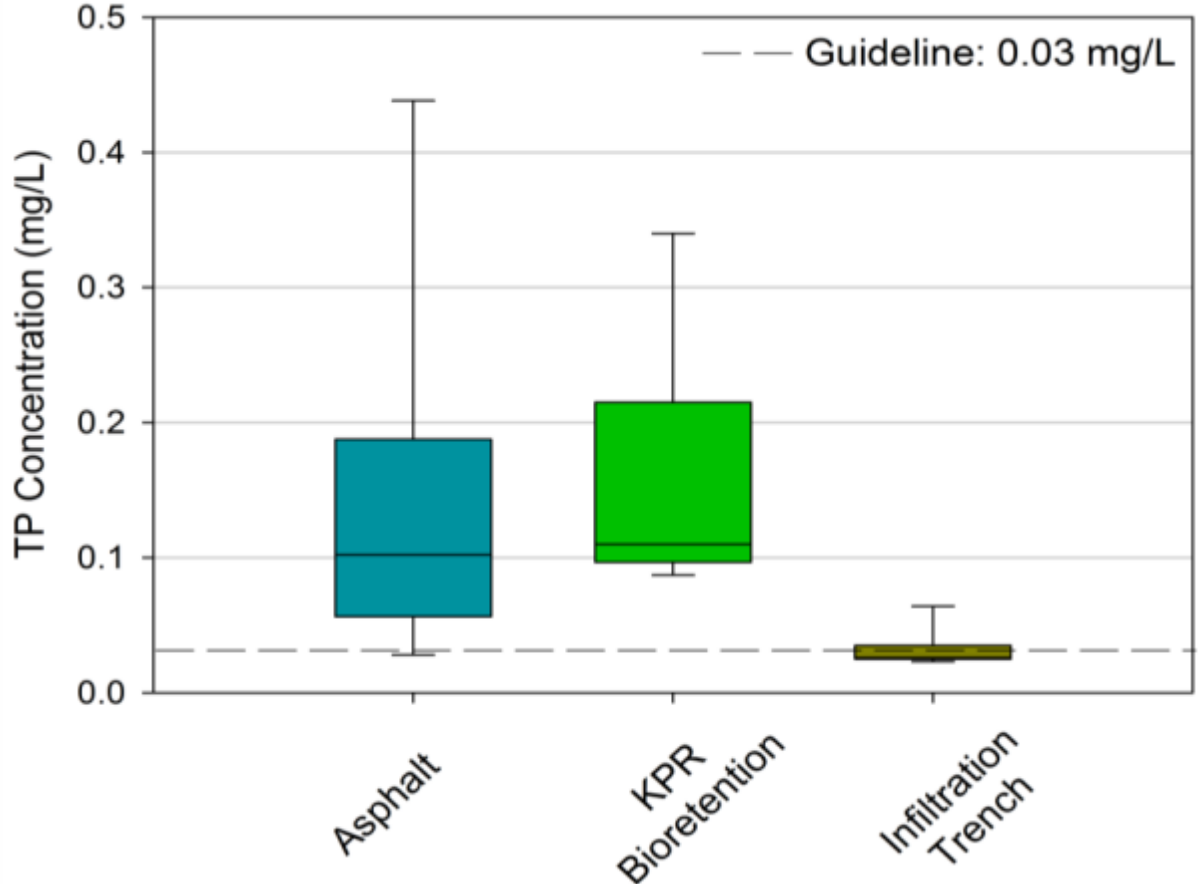


Water Quality Concentrations - TSS

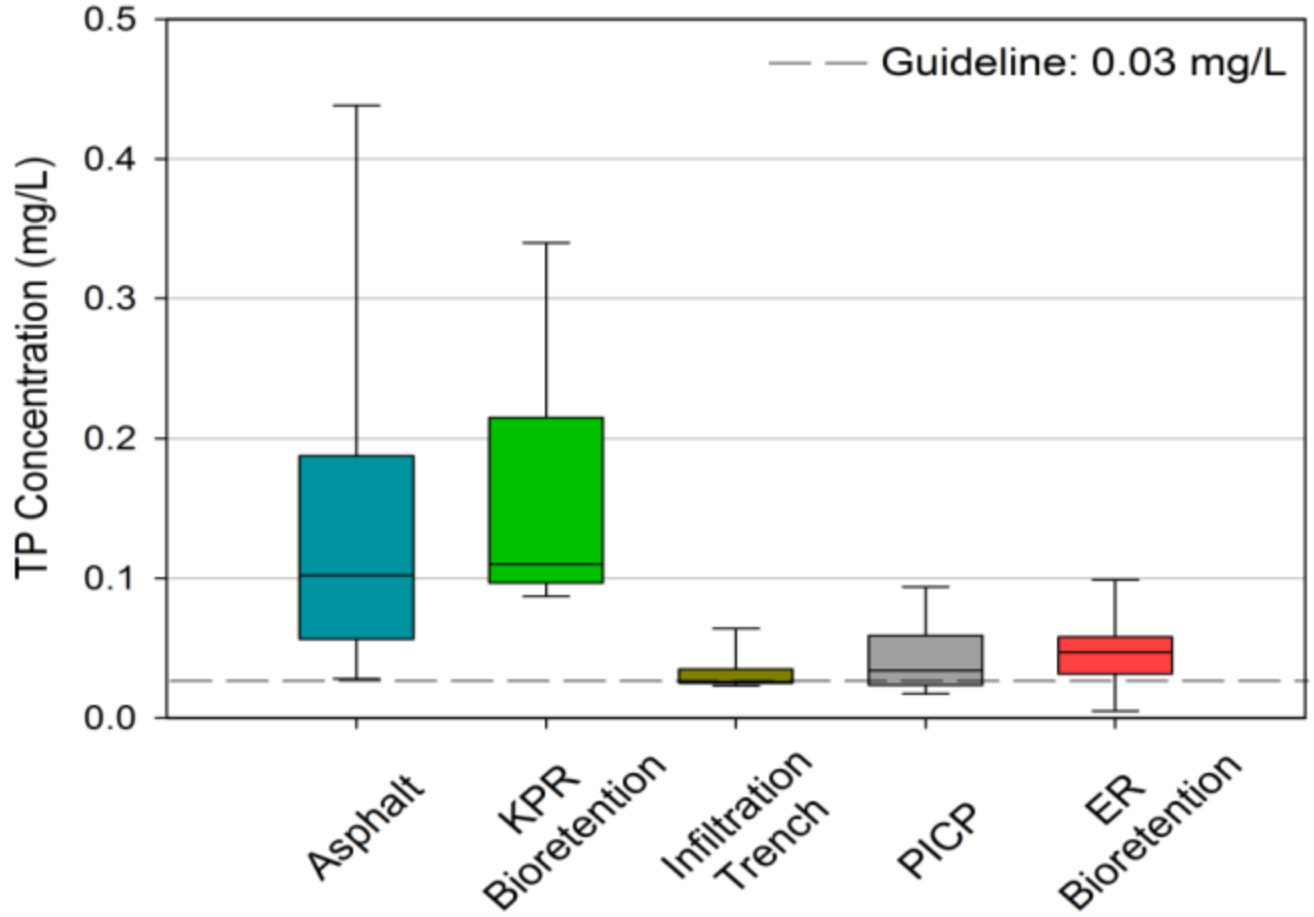


Water Quality Concentrations - TP

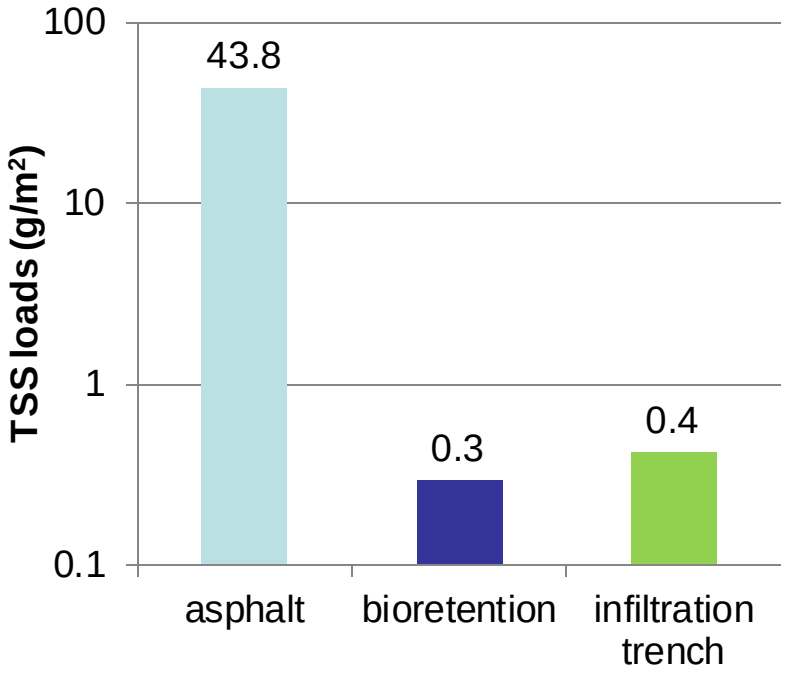


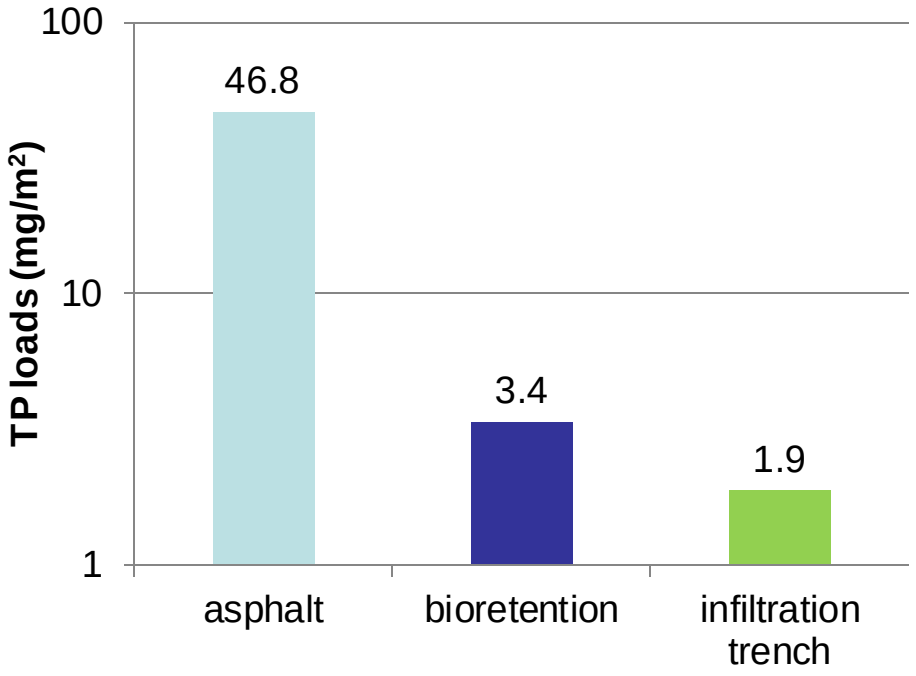


Water Quality Concentrations - TP



Seasonal Pollutant Loads



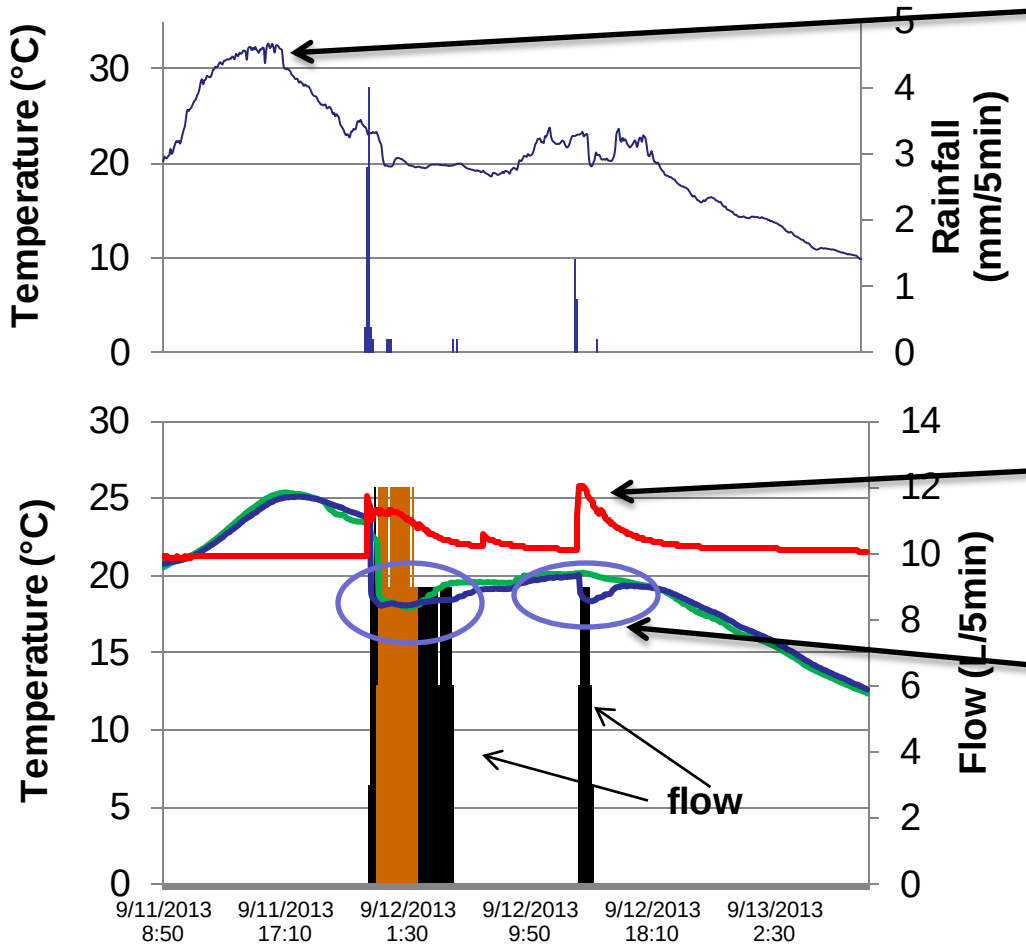


Water Temperature

Thermal Effects on Receiving Waters

- Urbanization dramatically alters the stream thermal regime
- Thermal pollution
  - Impacts aquatic species adapted to certain temperature ranges
  - Disrupts aquatic food webs
  - Disrupts ecological functions that support spawning and growth
  - Alters physical habitat (e.g. DO, restricts movement)
  - Chemical changes in water brought about by temperature shifts

Water Temperature



Air temp. > 30°C

Asphalt temp. increases to 25°C

Bioretention and Trench temperatures fall to 18°C

Maintenance

Inlet Maintenance - Trench

Bioretention Maintenance

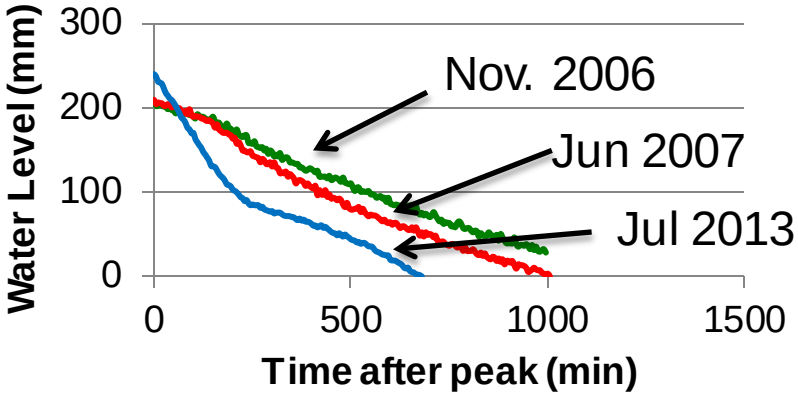
- Irrigation until plants are established
- Plant maintenance
- Weeding
- Addition of mulch
- Full rehabilitation may only be required after 20 + years

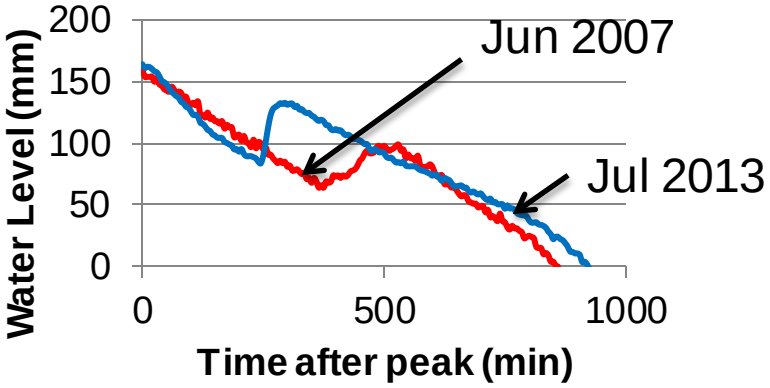
Bioretention Infiltration over Time

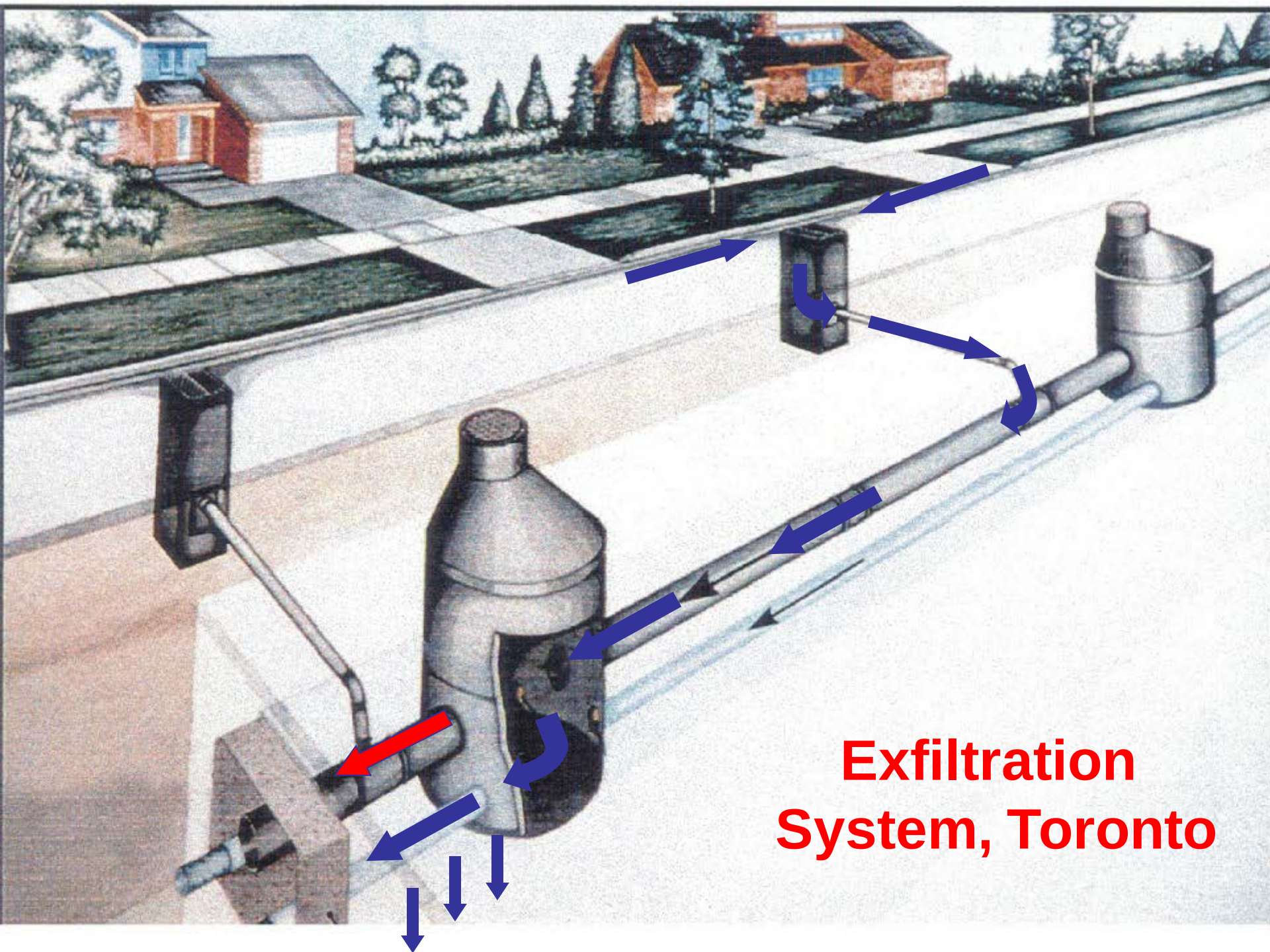
- Seneca College Bioretention
- No soil maintenance over seven years
- Drawdown of surface ponding levels after rain events in 2013 roughly the same as in 2006 and 2007

2007

2013

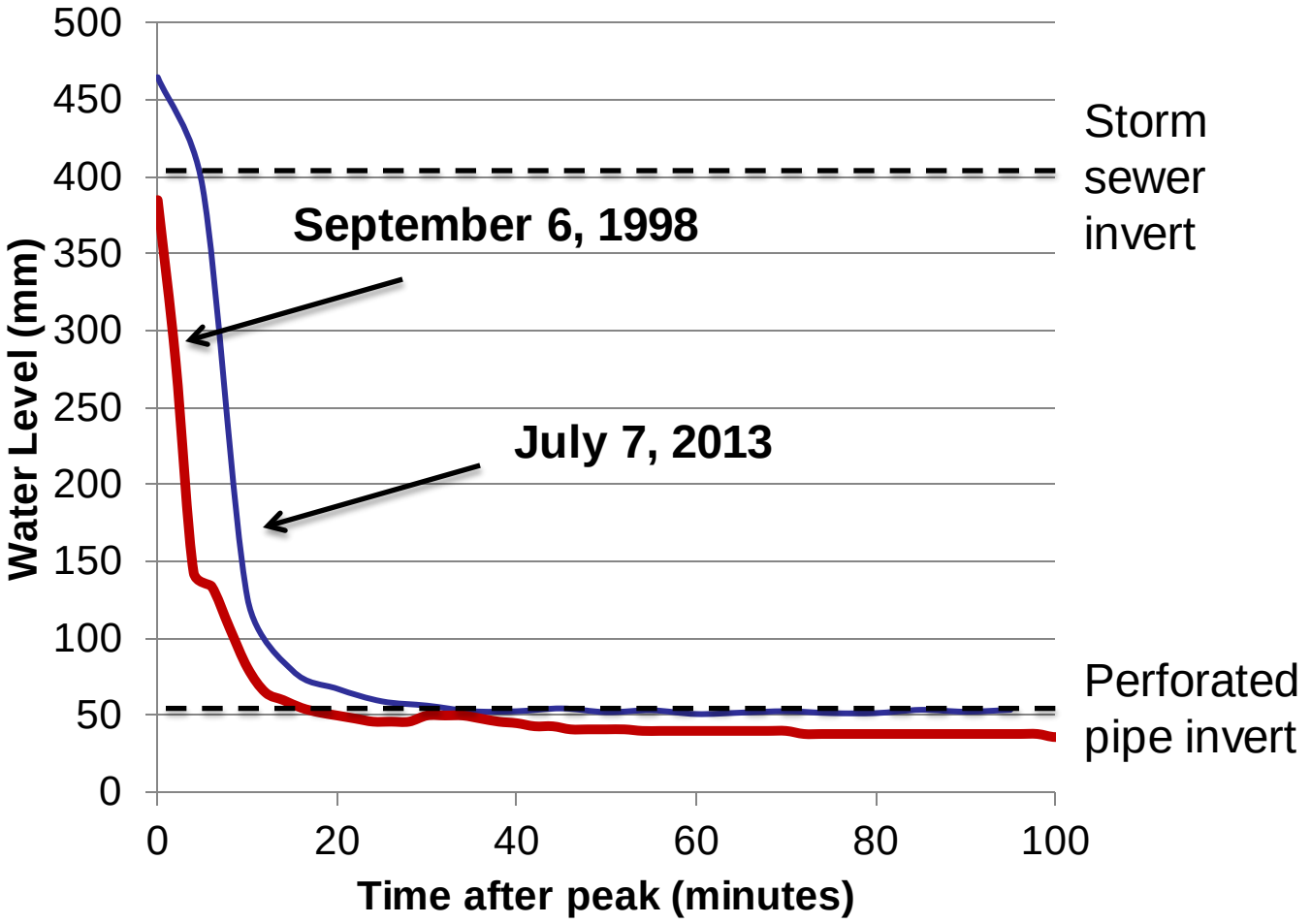





Exfiltration
System, Toronto

Exfiltration System Long Term Performance

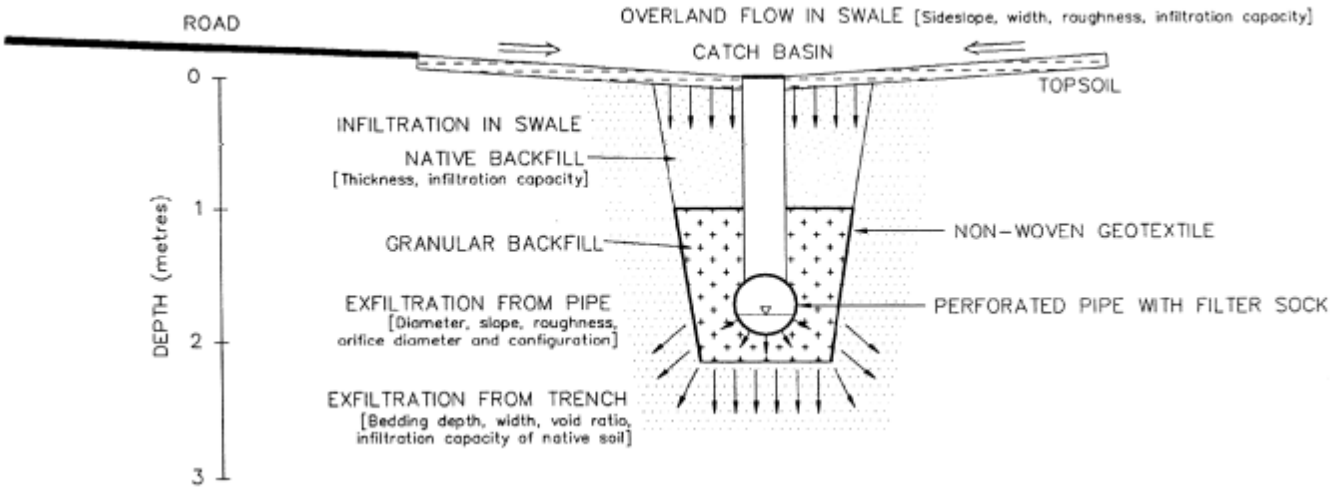
- Installed in 1994, limited maintenance
- Still infiltrating well after 19 years



Exfiltration Systems, Ottawa

- Curbless system with pretreatment through a grass swale

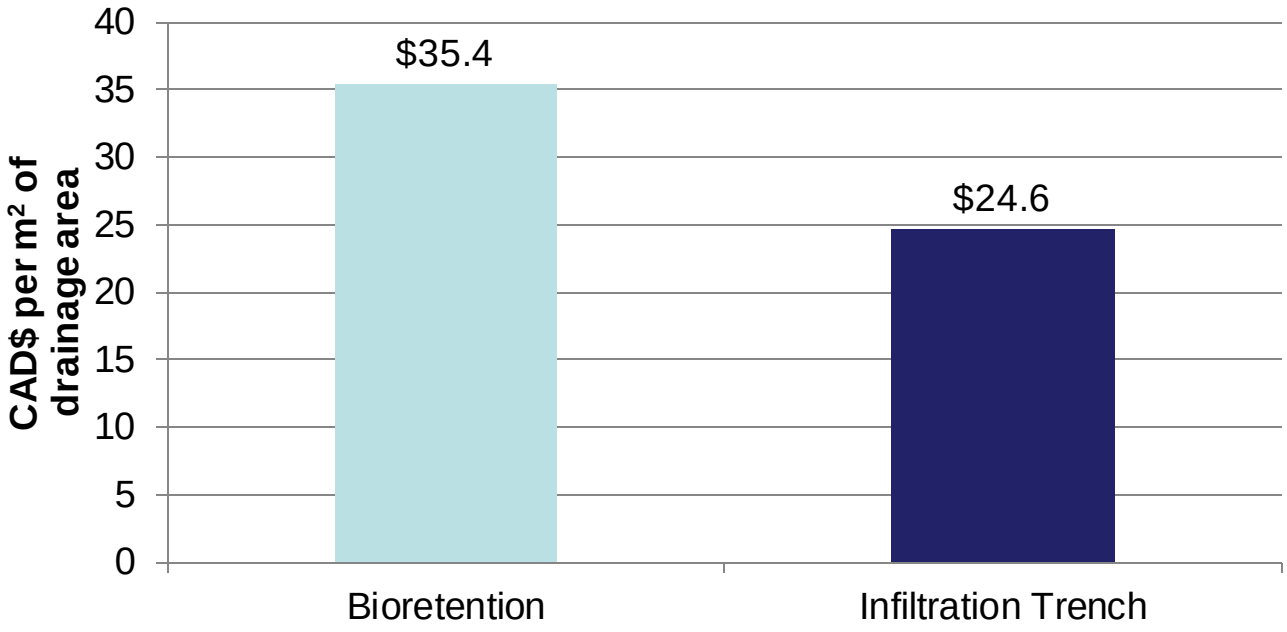
- After 20 years, and limited maintenance, the system continues to function very well



J.F. Sabourin & Associates, 2008

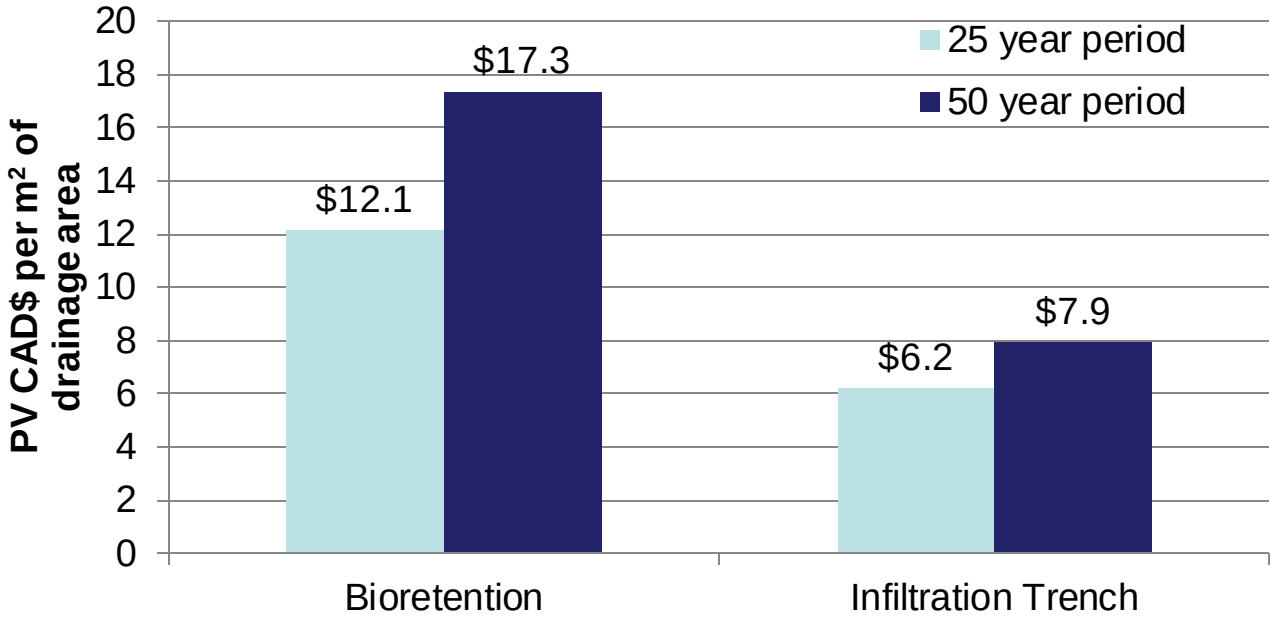
Life Cycle Costs

Initial capital costs



Hurdle rate = 5%

Life Cycle Maintenance and Rehabilitation Costs



Hurdle rate = 5%

Conclusions and Design Implications

- Bioretention and Infiltration Trench practices performed better than expected
- Treatment benefits of high permeability stone filters may be similar to those provided by traditional bioretention
- Concentrations of some water quality variables, such as TP, were lower in the trench outflows
- Granular filter inlets with overflows may provide inexpensive and effective pre-treatment to underground infiltration practices
- Combining the rapid infiltration properties of stone filters with the benefits of vegetation can preserve the aesthetic values of bioretention while reducing its surface footprint and long term maintenance burden

The Best of Both Worlds

Schollen and Company

Schollen and Company

Thank you to our Project Partners

- Ontario Ministry of the Environment
- Region of Peel
- York Region
- City of Toronto
- Government of Canada's Great Lakes Sustainability Fund
- Ontario Tire Stewardship
- Eco-Flex Recycled Rubber Pavers
- Azek Permeable Pavers
- Schollen and Company Inc.
- EMCO (pipes)
- Filtrexx (terraseeding)
- Terrafix (geotextile)
- Pickseed (grass seed)

Questions

Tim Van Seters
Phone: 289-268-3902
Email: tvanseters@trca.on.ca

STEP website:

www.sustainabletechnologies.ca

Toronto and Region Conservation for The Living City

STEP Sustainable Technologies Evaluation Program