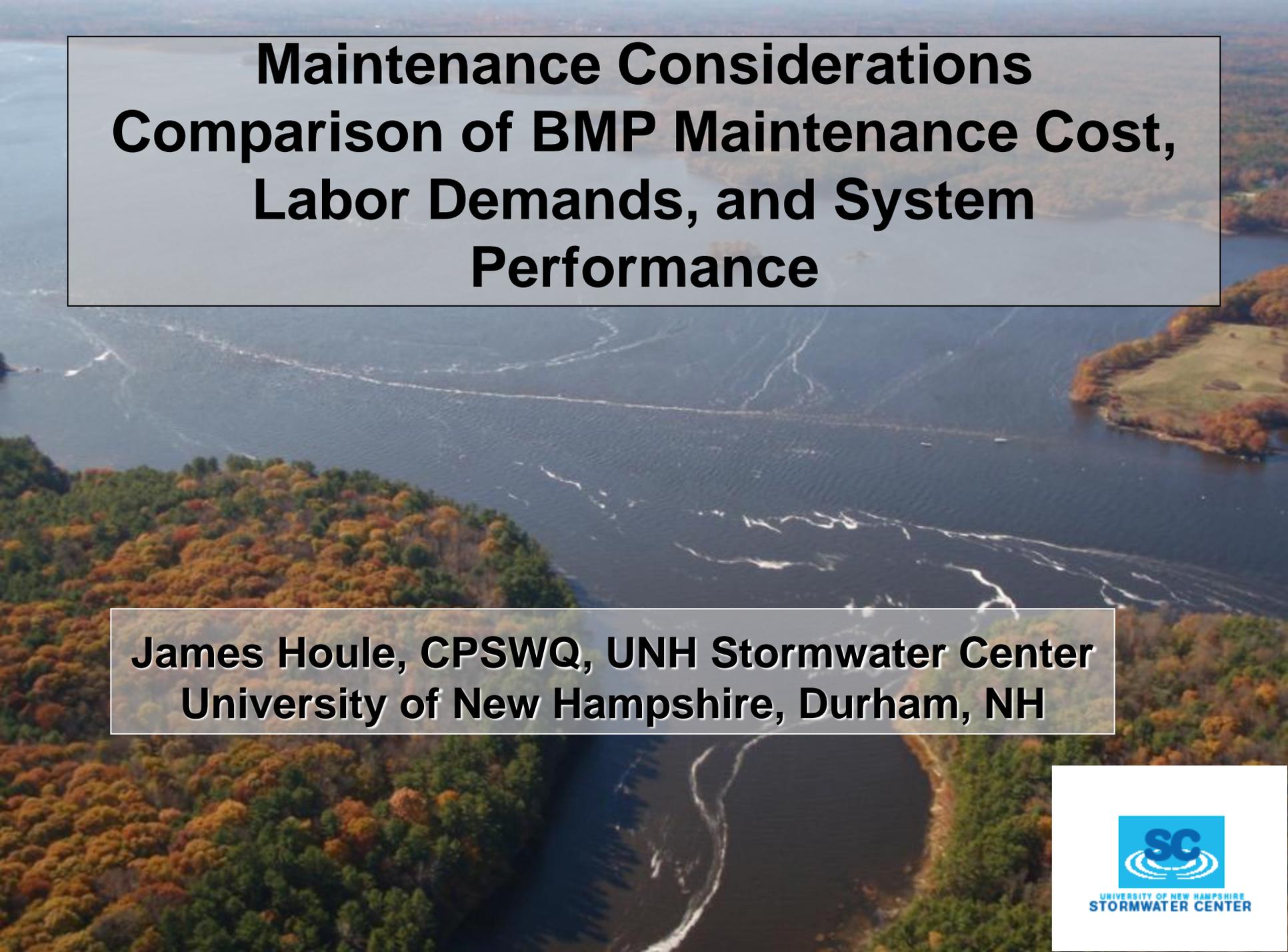




UNIVERSITY *of* NEW HAMPSHIRE

James Houle  
Program Manager  
UNH Stormwater Center



# **Maintenance Considerations Comparison of BMP Maintenance Cost, Labor Demands, and System Performance**

**James Houle, CPSWQ, UNH Stormwater Center  
University of New Hampshire, Durham, NH**

# Acknowledgements

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- **Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET)**
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- **Dr. Robert Roseen, Dr. Tom Ballestero and Tim Puls**

# Imagine the Ultimate System...

**Low Cost and NO Maintenance Ever!**

**100%  
Removal  
Guaranteed**



**eliminating everything in it's path since 1776**

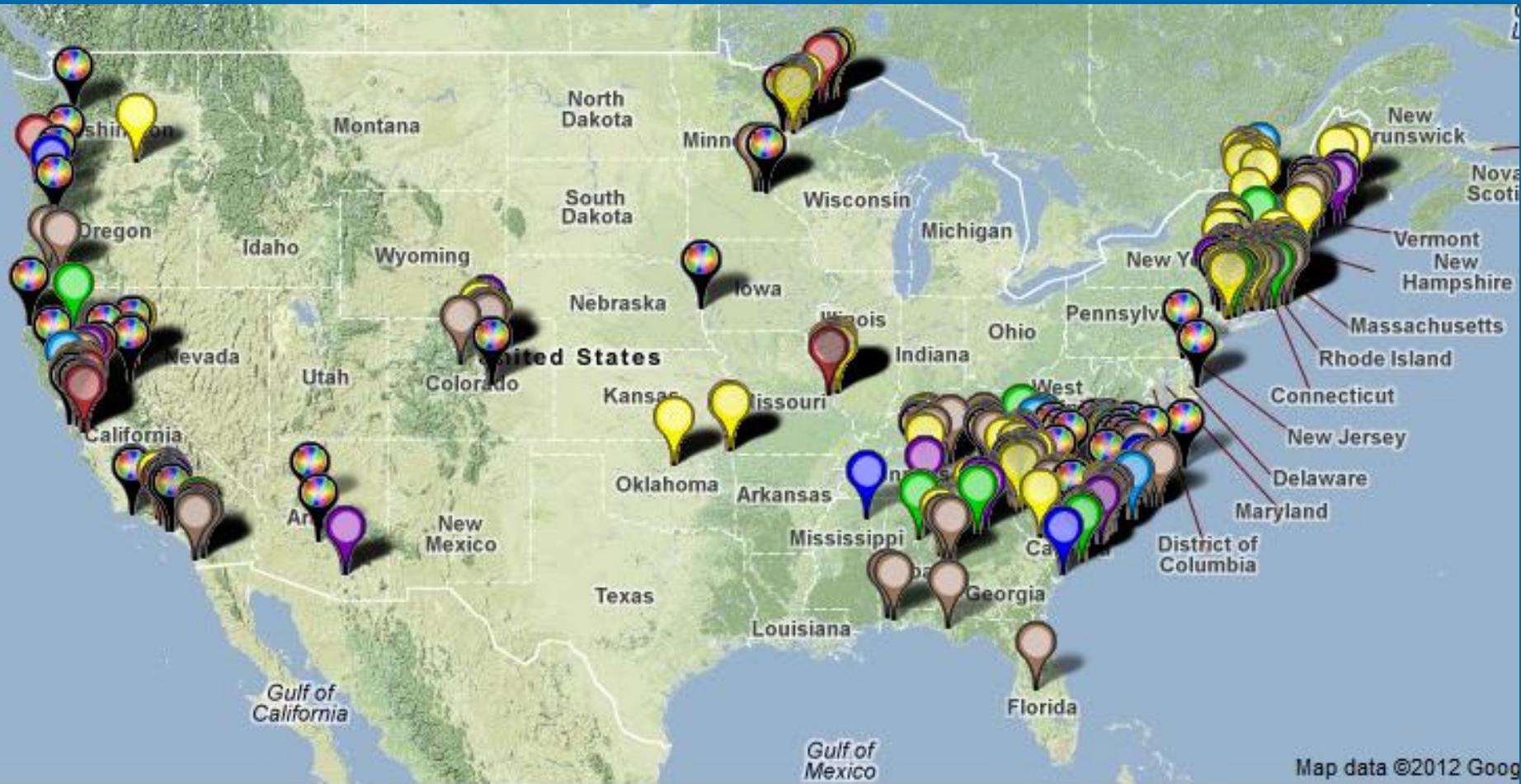


# The Maintenance Myth





# LID in Now



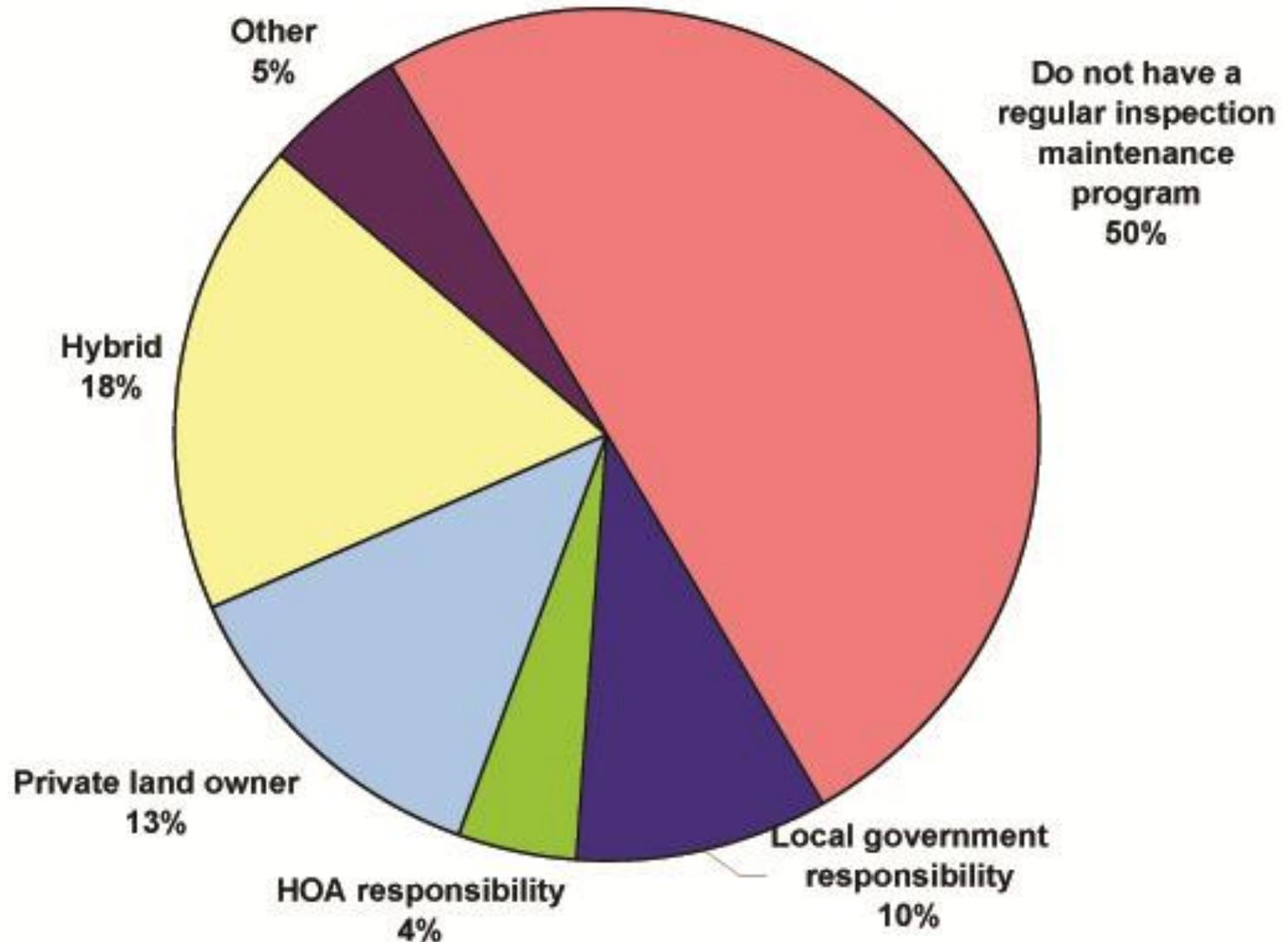
# 1,000 Pound Gorilla

Who has primary responsibility for maintenance?

- local governments or public agencies?
- States and the Federal Governments?
- Private property owners and associations?



# Who is responsible for maintenance of post-construction stormwater facilities? (# of responses = 94)



# What is Maintenance

- Often Maintenance only occurs when there is failure
- There is a perception that LID systems require more maintenance
- Some claim LID systems fail and will require expensive repairs
- Our current practices have a high degree of failure and significant cost impacts—however we are familiar with it





# Stormwater Systems Studied

## Conventional Systems



Detention Basin



Retention Pond



Stone Swale



Veg Swale

## Low Impact Development Systems



Porous Asphalt



Gravel Wetland



Sand Filter



Bioretention Unit (3)

# Maintenance Complexity is defined as:

Minimal	Simple
Stormwater Professional or Consultant is seldom needed ☐	Stormwater Professional or Consultant is occasionally needed
Moderate	Complicated
Stormwater Professional or Consultant is needed half the time	Stormwater Professional or Consultant is always needed

## Reactive

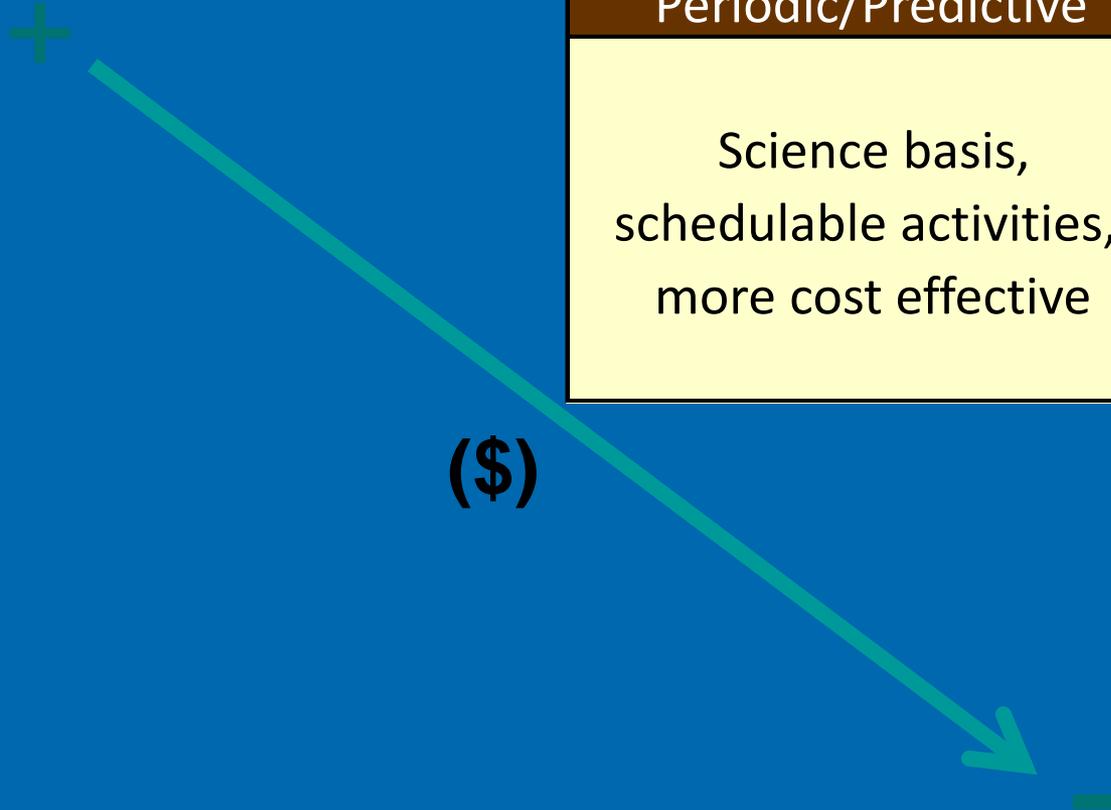
Episodic maintenance,  
cheap in short term,  
expensive in the long  
term

## Periodic/Predictive

Science basis,  
schedulable activities,  
more cost effective

## Proactive

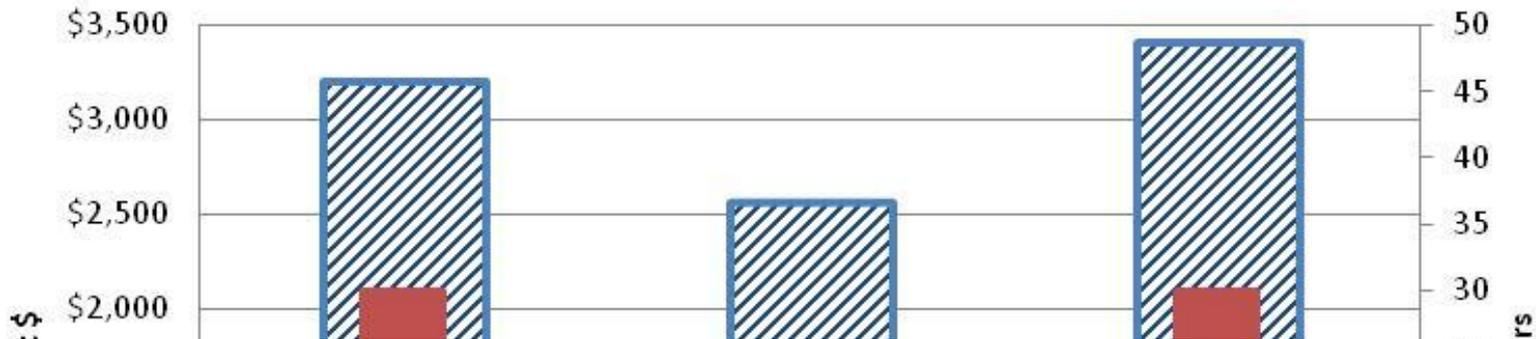
Cost effective,  
preventative operations



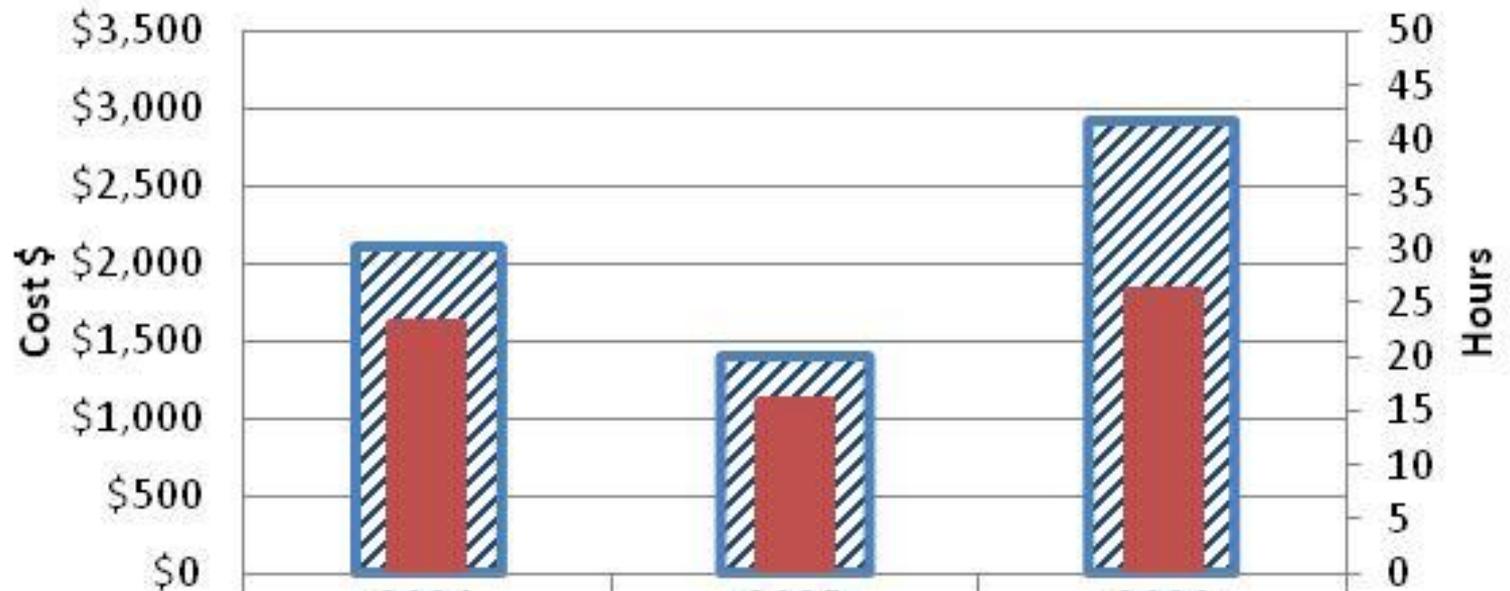
# Reactive Maintenance

- + Crack sealing
- + Filling pot holes
- + Resetting curbs
- + Culvert reinforcement/replacement/renewal
- + Pipe lining/repair
- + Outlet repair
- + Redesign for erosive blowouts
- + Massive vegetation removal
- + Clogged outlet structures
- + Structural repairs or rehabilitation

## Retention Pond



## Gravel Wetland



cost	\$2,105.0	\$1,400.0	\$2,910.0
hr	23.0	16.0	26.0

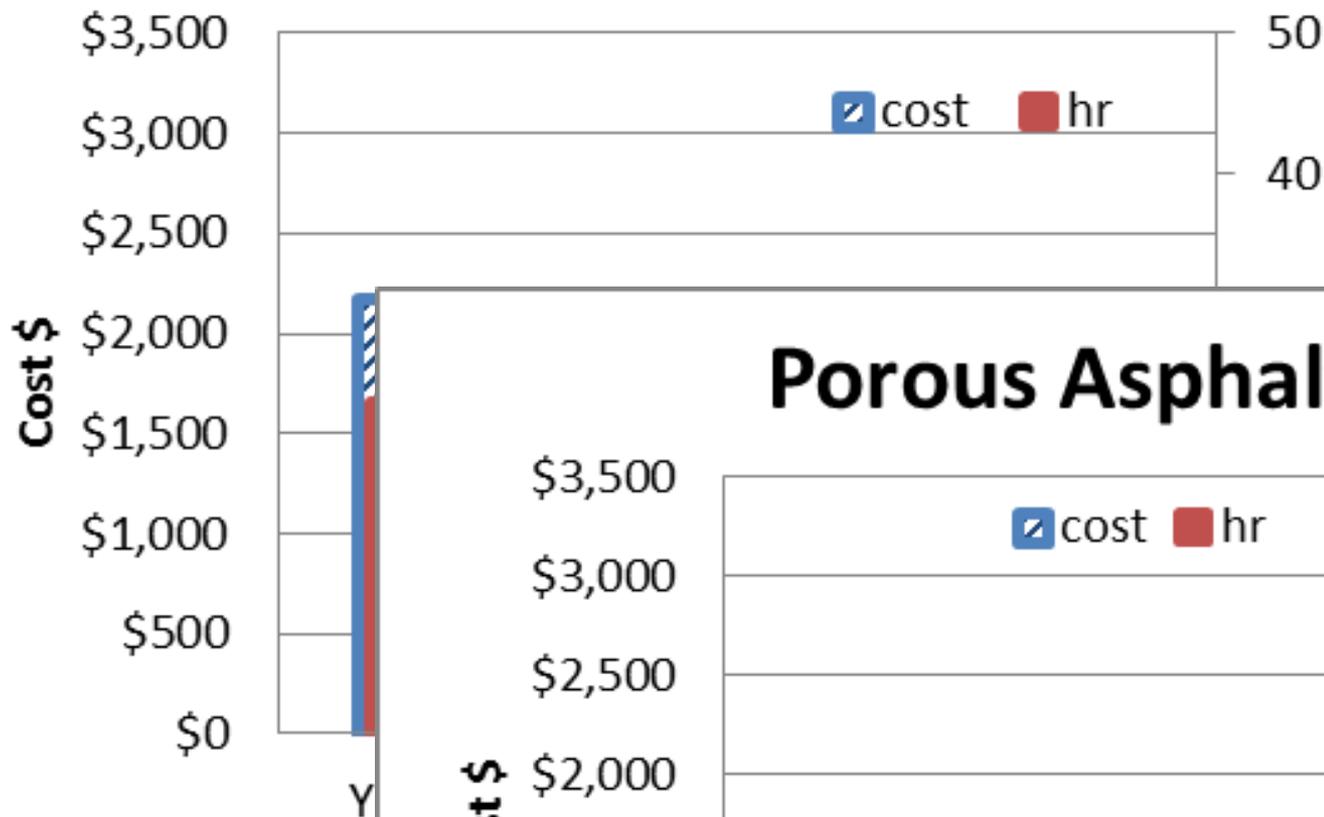
# **Periodic/Predictive Maintenance**

- + Solids or debris removal**
- + Routine inspection**
- + Mowing**
- + Planned vegetation removal**

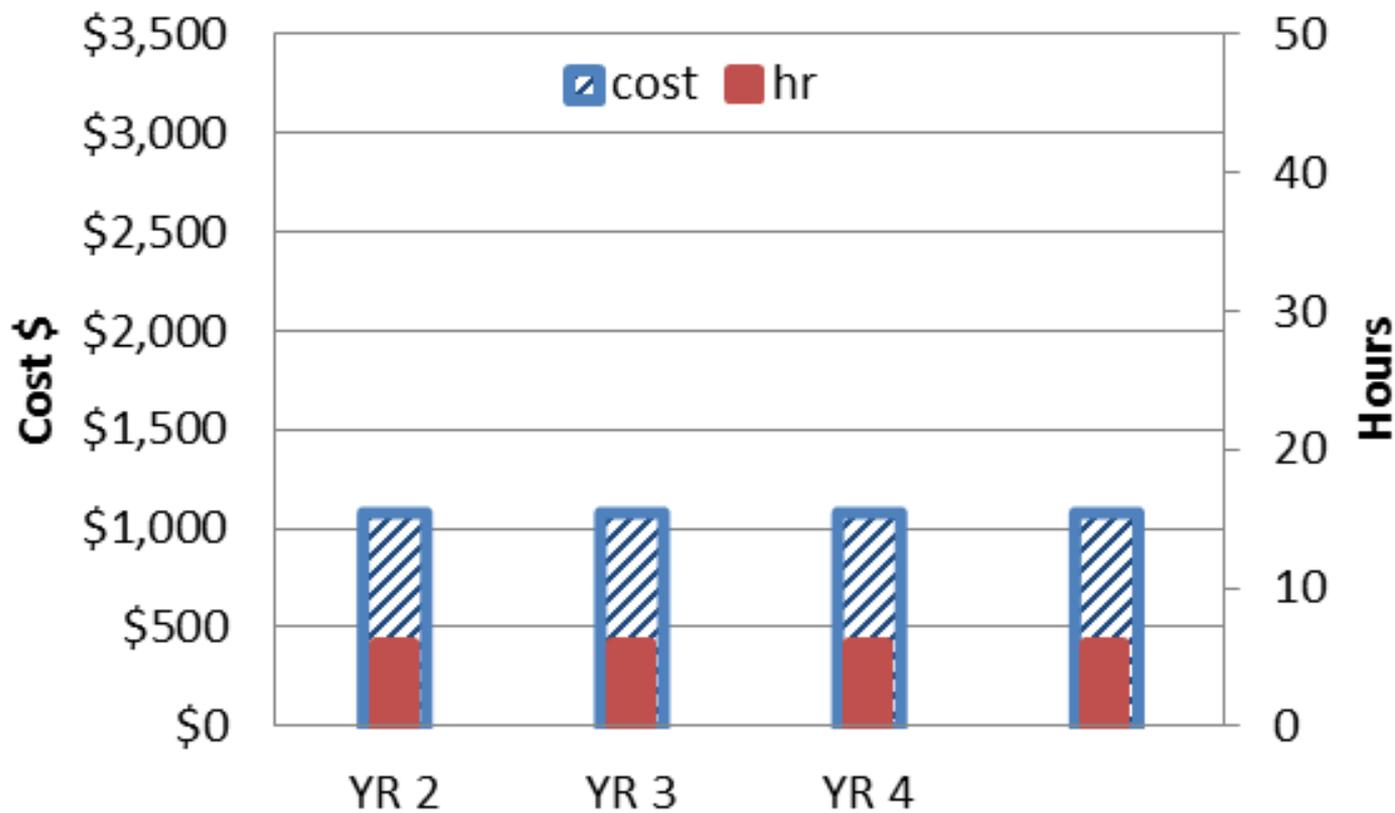
# **Proactive Maintenance**

- + Street cleaning and vacuuming**
- + Snow removal**
- + Erosion and sediment control**
- + Reseeding**

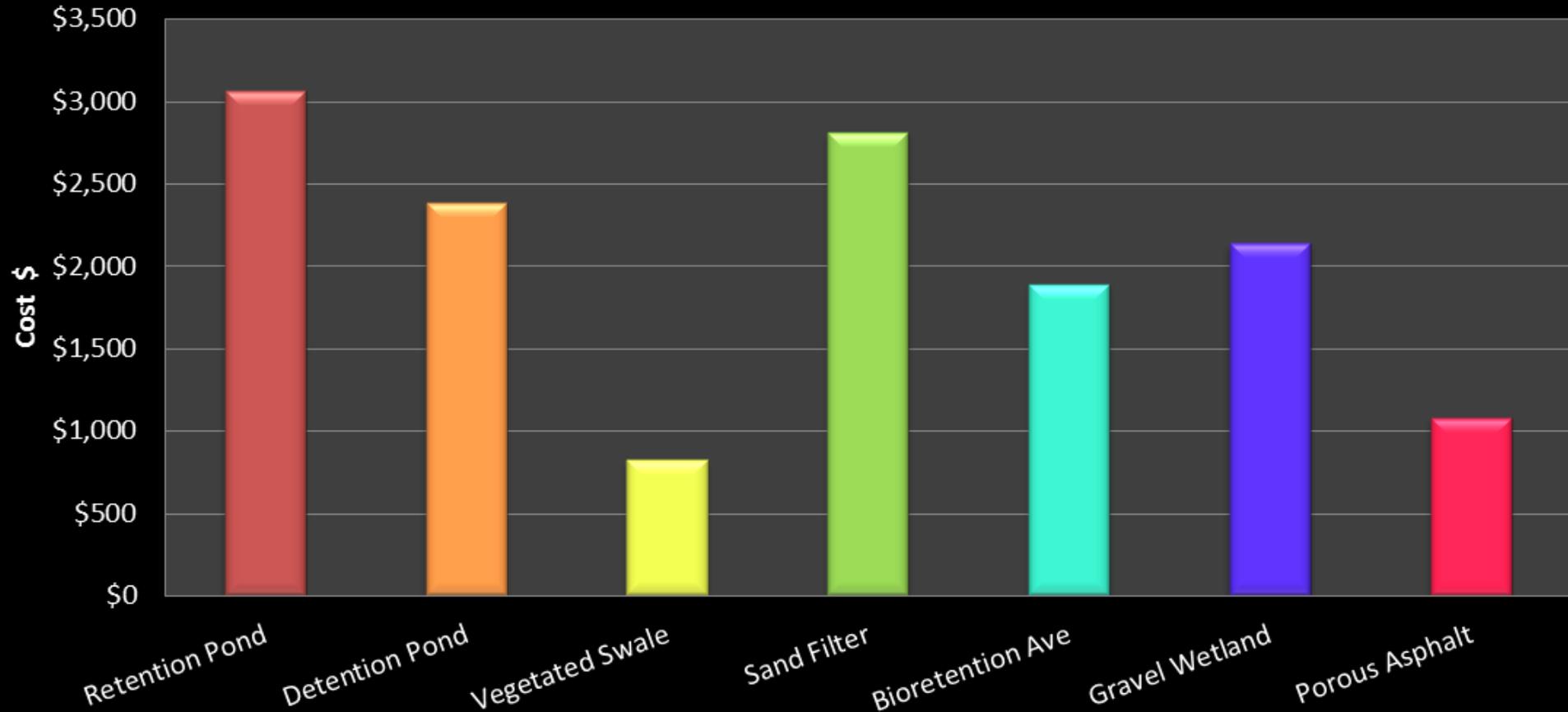
# Bioretention



# Porous Asphalt



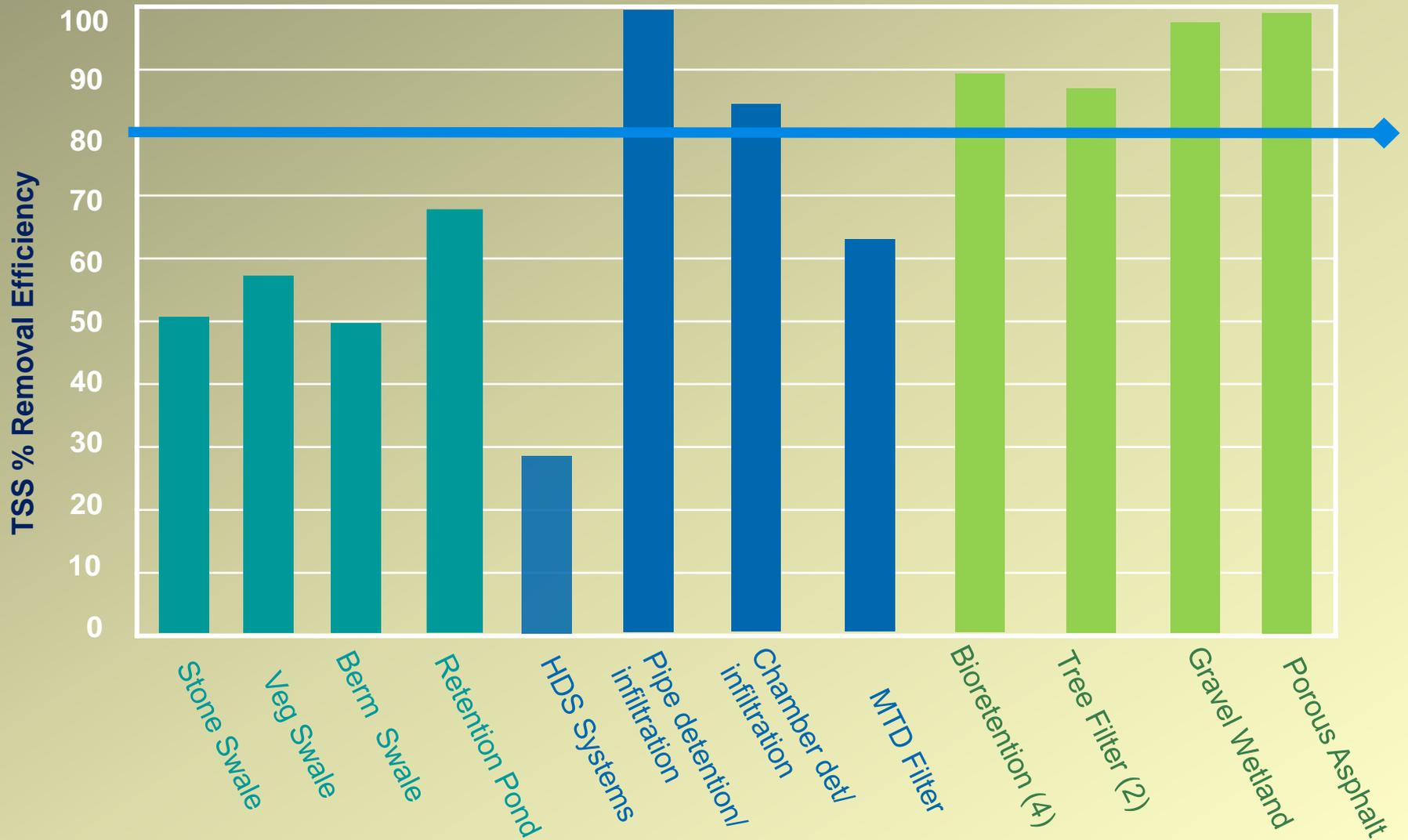
## Yearly BMP Maintenance (per acre treated)



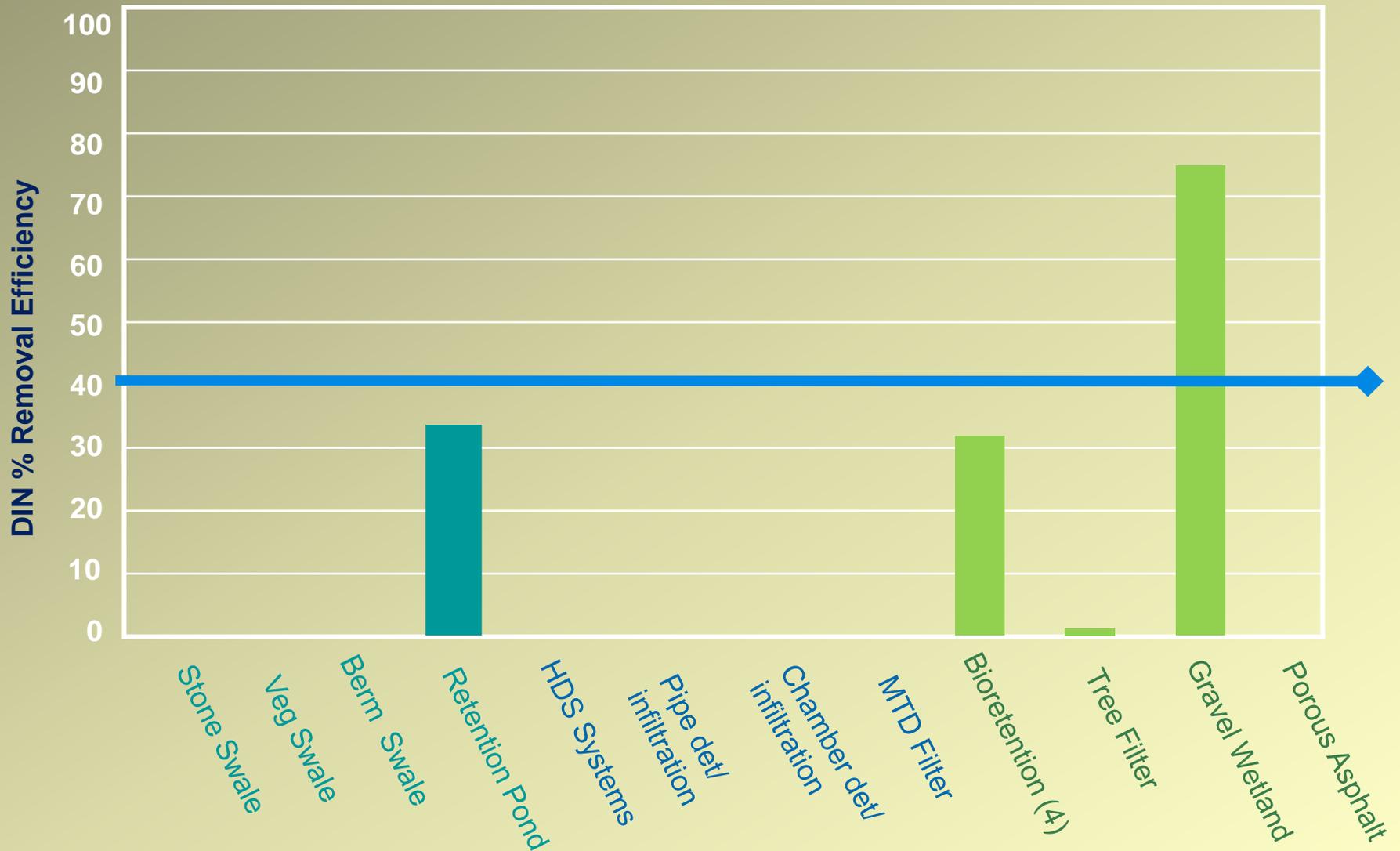
# Economics of Installation vs Maintenance Costs, normalized by area

<b>Parameter</b>	<b>Vegetated Swale</b>	<b>Wet Pond</b>	<b>Dry Pond</b>	<b>Sand Filter</b>	<b>Gravel Wetland</b>	<b>Bioretention</b>	<b>Porous Asphalt</b>
Capital Cost (\$)	12,000	13,500	13,500	12,500	22,500	21,550	21,800
Inflated 2012 Capital Cost	14,600	16,500	16,500	15,200	27,400	25,600	26,600
Maintenance and Capital Cost Comparison	17.8	5.4	6.9	5.4	12.8	13.5	24.6
Personnel (hr/yr)	9.5	28.0	24.0	28.5	21.7	20.7	6.0
Personnel (\$/yr)	823	3,060	2,380	2,808	2,138	1,890	380
Subcontractor Cost (\$/yr)	0	0	0	0	0	0	700
Total Operational Cost (\$/yr)	823	3,060	2,380	2,808	2,138	1,890	1,080
Operation/Capital Cost (%)	6%	19%	14%	18%	8%	8%	4%

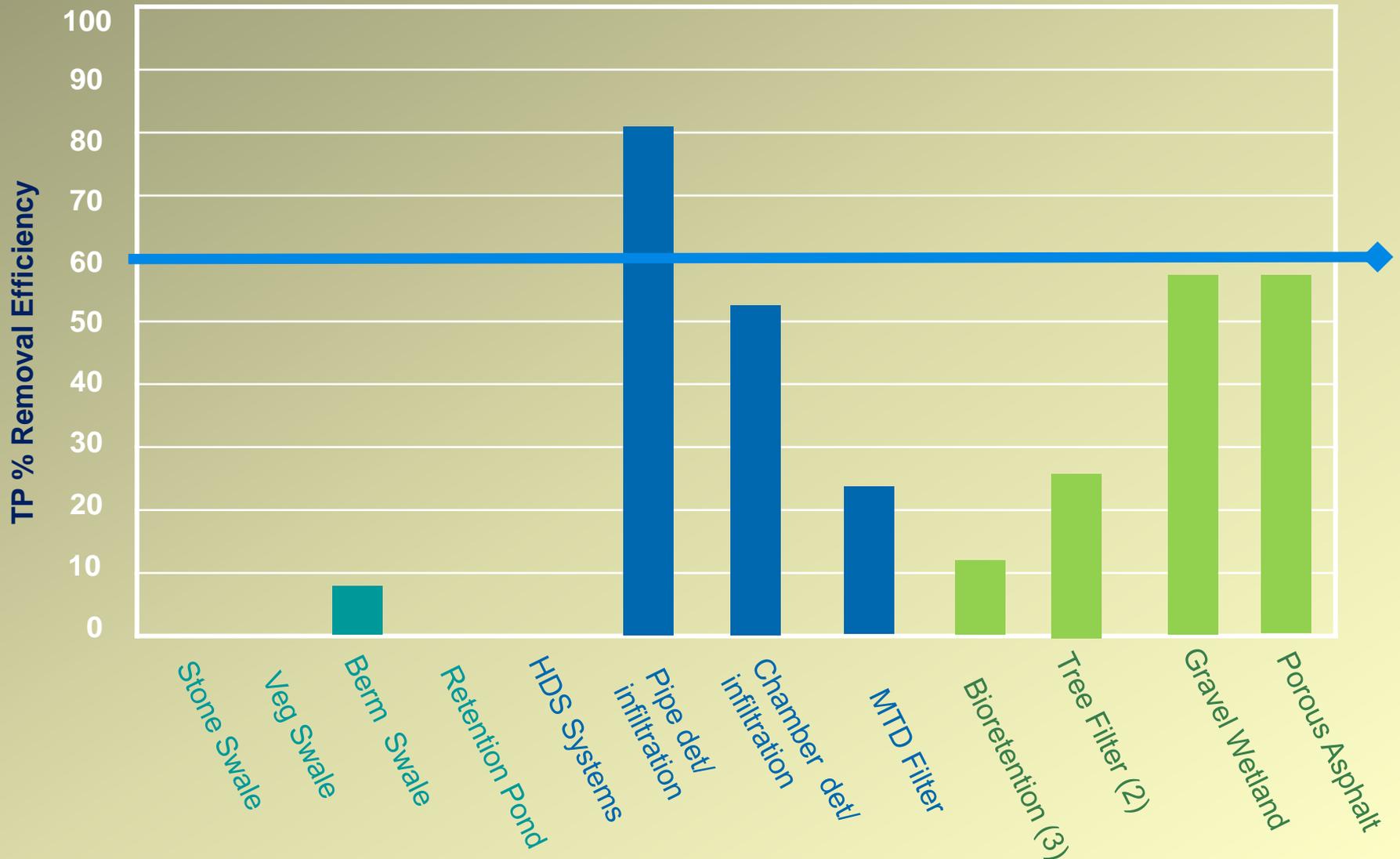
# TSS Removal Efficiencies



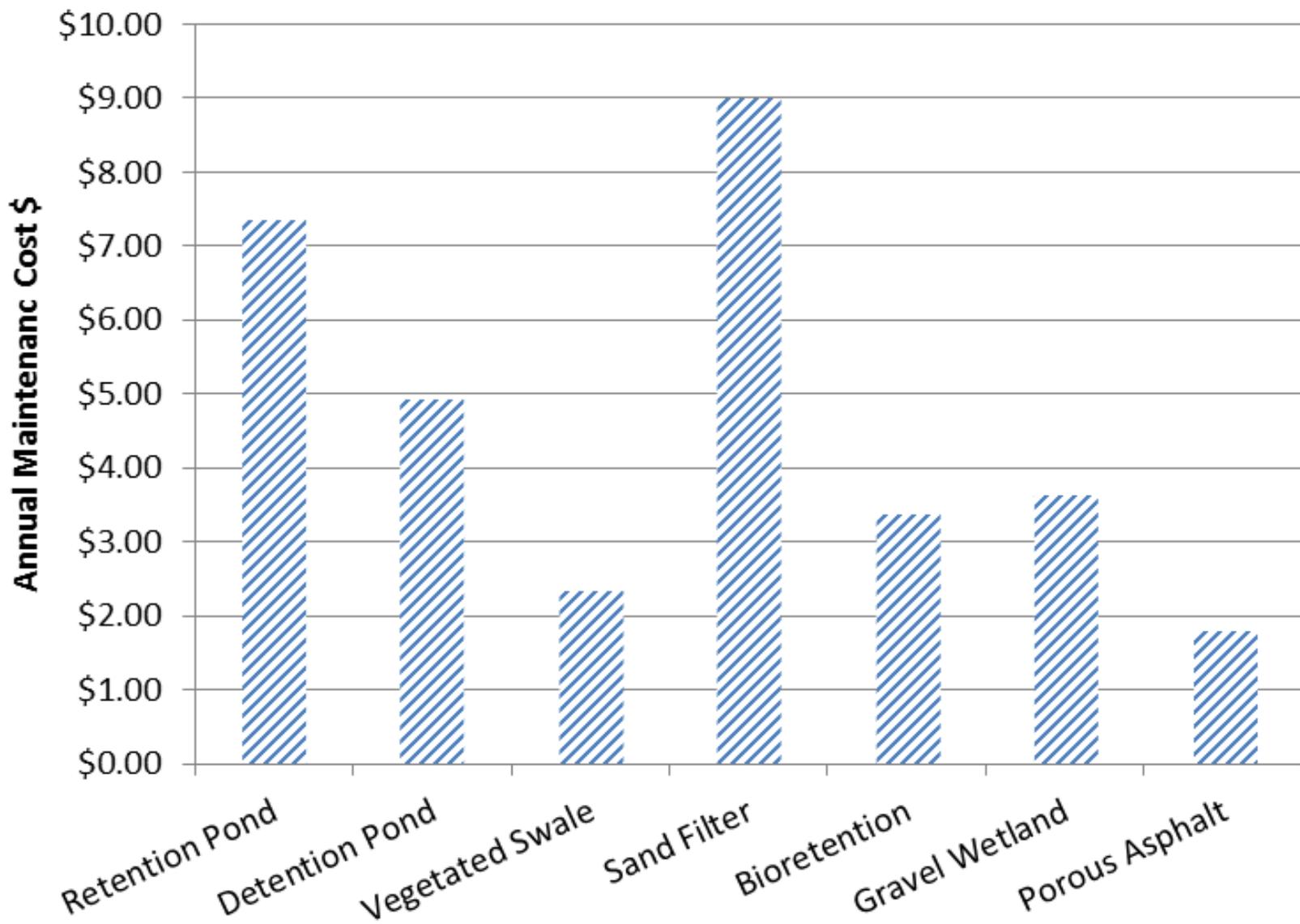
# DIN Removal Efficiencies



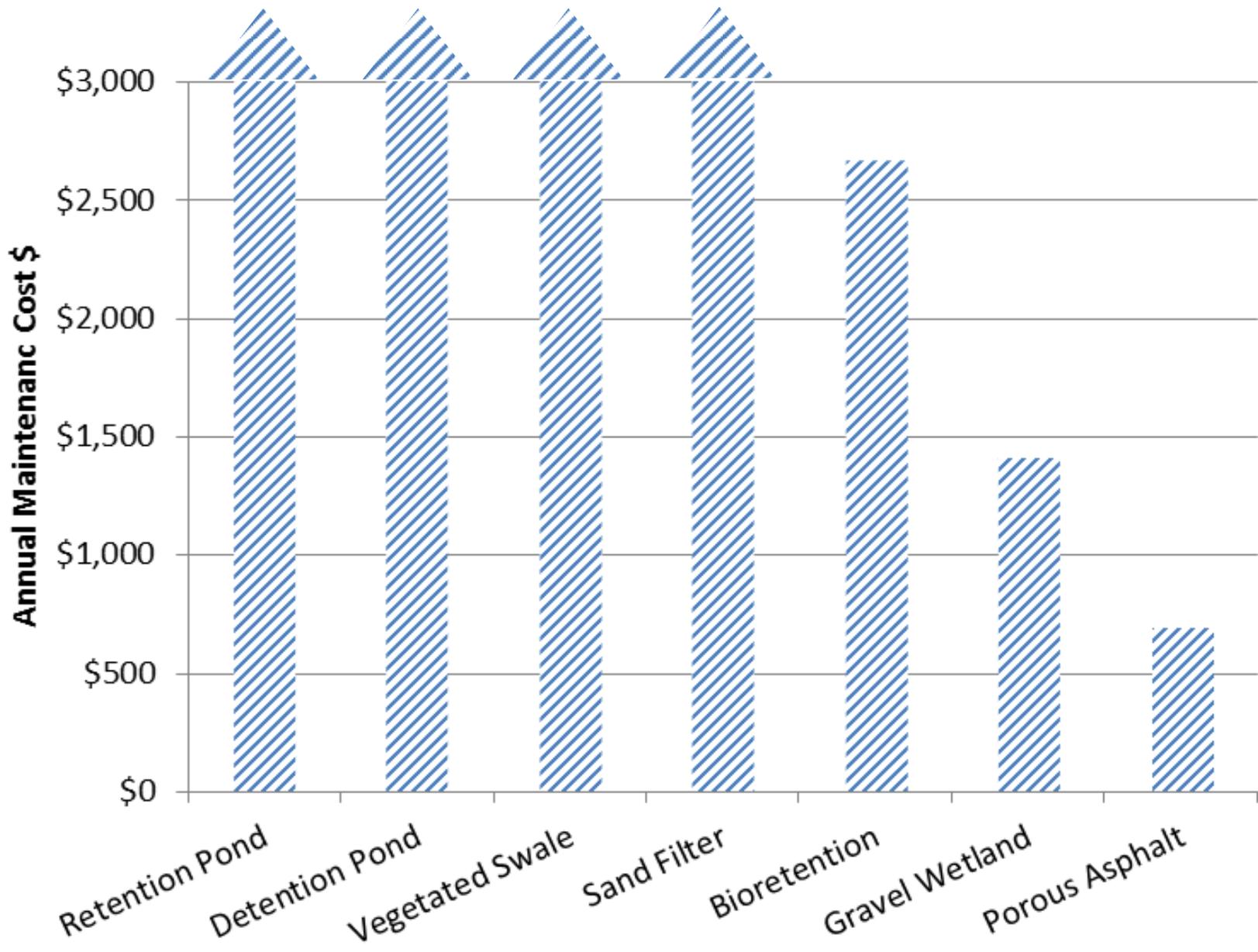
# TP Removal Efficiencies



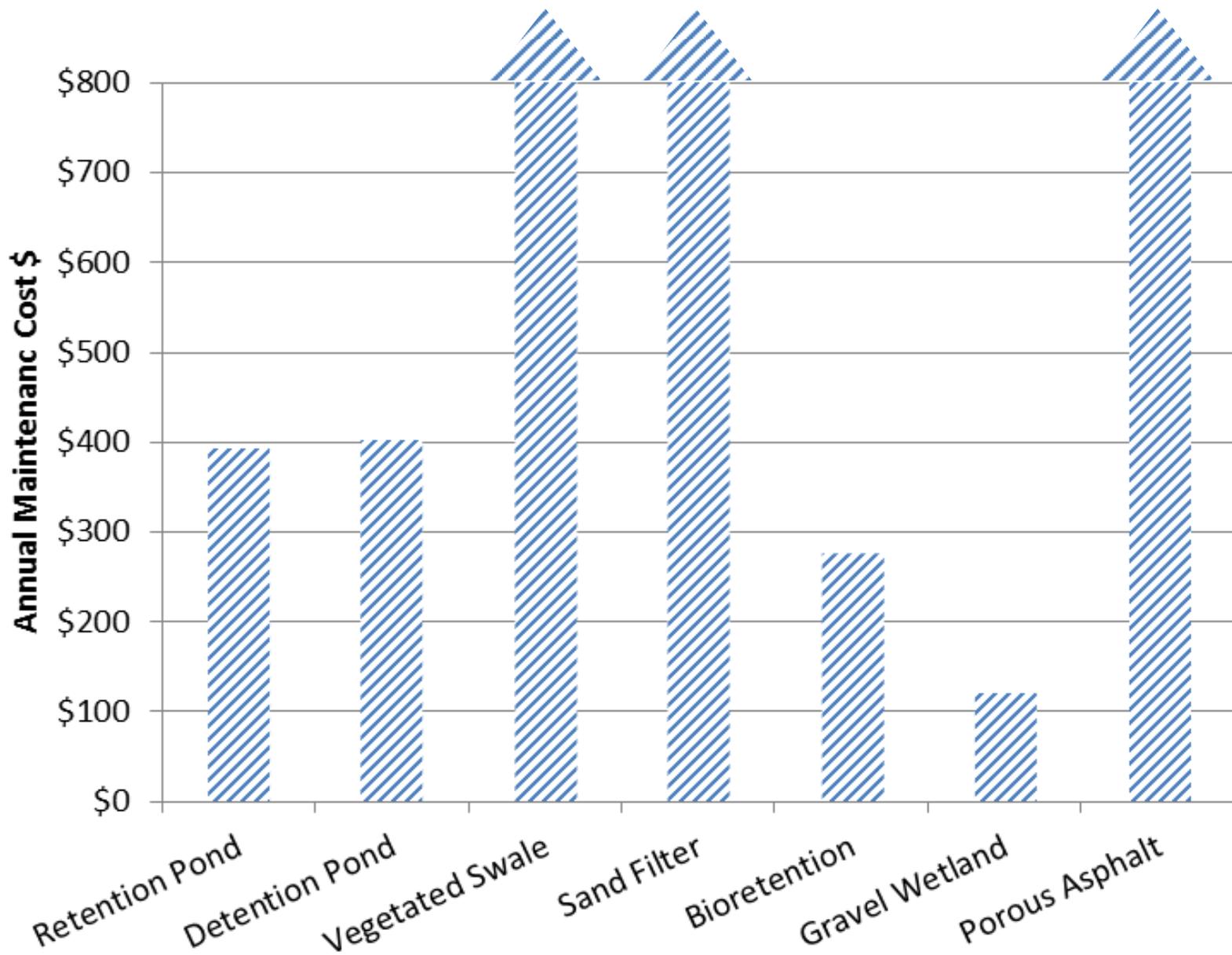
▨ Maintenance Cost/yr/acre/lb TSS



▨ Maintenance Cost/yr/acre/lb TP



▨ Maintenance Cost/yr/acre/lb DIN as TN



# Maintenance Case Studies



# A tale of two raingardens



# Maintenance solved?



# Tools of the trade...

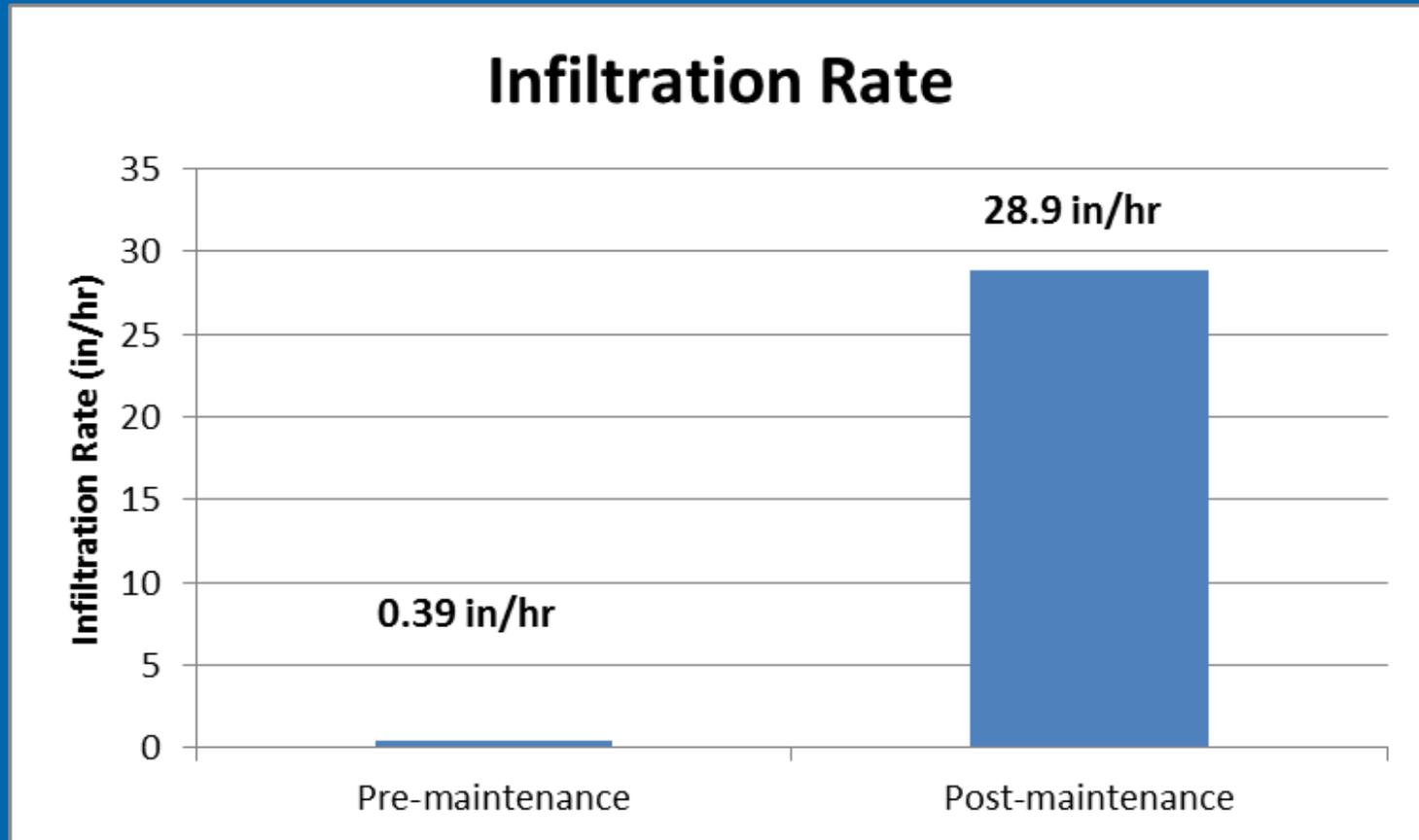


# Tools of the trade...

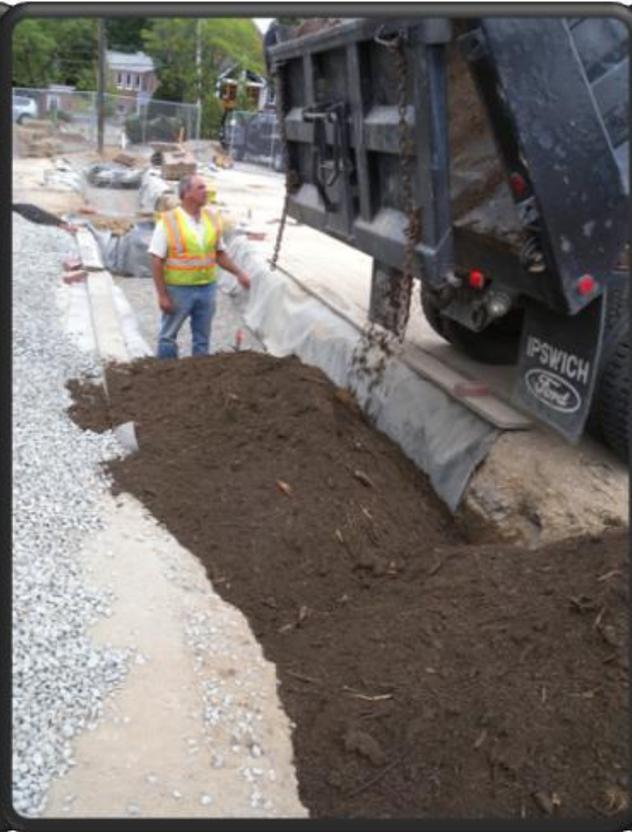




# Result of Maintenance



# Bioretention Parking Lot Retrofit, Durham, NH



Maintenance Activity	Minimum Frequency	Estimated Time Commitment	Number of Employees
Inspection	2 times per year	30 minutes taking time to fill out checklist in UNHSC document <sup>1</sup>	1
Clean Pretreatment Trash Screens and Pick Up Trash in system	1 time per month on average	30-60 minutes per visit	1
Spring Cleaning	1 time per year	4 hours	2

**Total personnel hours per year: 16-21 hours**  
**Estimated \$1,500 – \$2,000 (30,000 sf of IC Treated)**

**Pollutant  
(per year)**

**Amount**

**TSS**

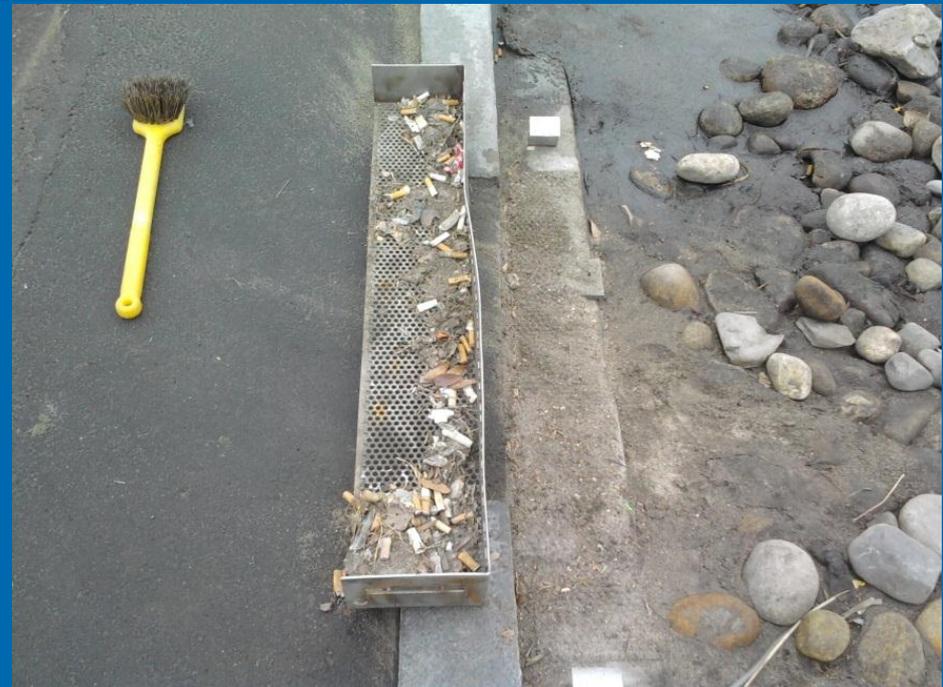
179 lbs.

**Cigarette Butts**

4,392

**Misc. Trash**

752



# The Unexpected



# Questions?

