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Misunderestimating Maintenance: An empirical approach to q antif empirical approach to quantify maintenace expectaions for SMCs

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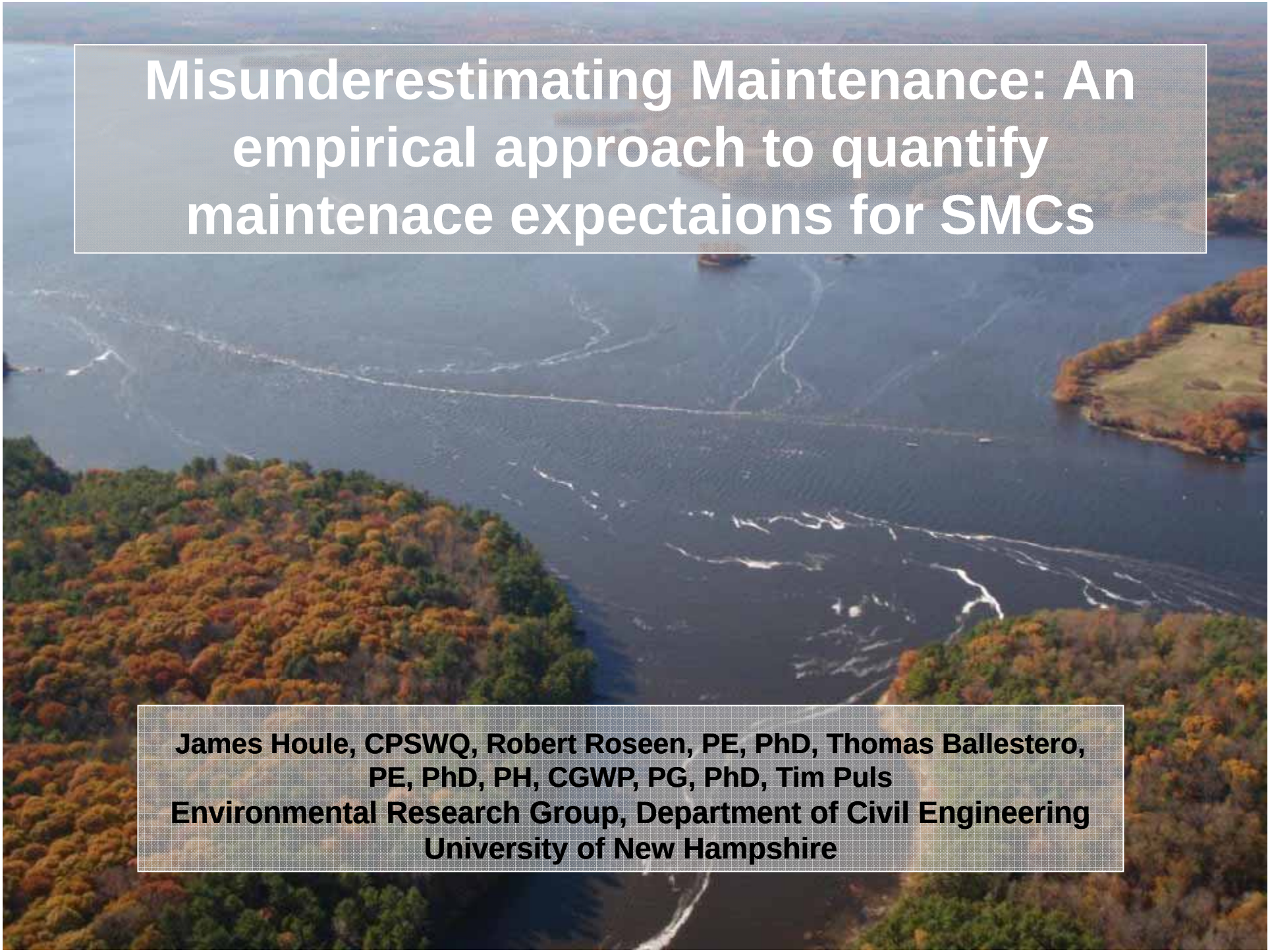

Misunderestimating Maintenance: An empirical approach to quantify maintenace expectaions for SMCs

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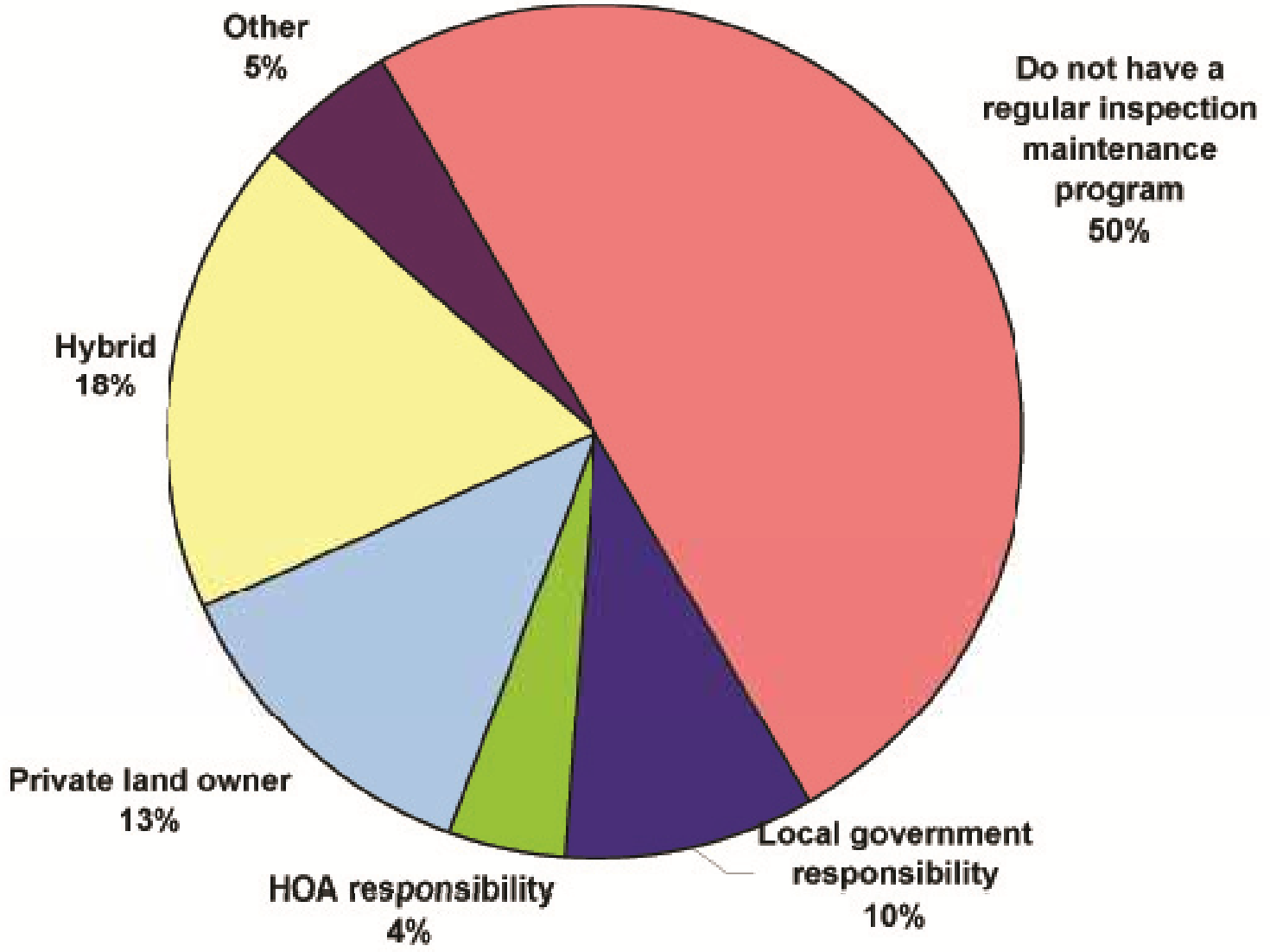
1,000 Pound Gorilla

Who has primary responsibility for maintenance?

- Most local governments or public agencies haven't figured it out yet?
- States and the Federal Government hasn't figured it out yet?
- Private property owners and associations haven't figured it out yet?

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



The Maintenance Myth

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

- Crack sealing
- CB cleaning
- Filling pot holes
- Resetting curbs
- Lanscape maintenance beatification of street scape
- Culver reinforcement/replacement/renewal
- Pipe lining/repair
- All of which can be reduced or duplicated by green infrastructure

Factors that impact maintenance costs

- Inspection frequency
- Required routine maintenance (frequency and complexity).
- Specialized equipment and speculative unknowns
- Non-routine and rehabilitative maintenance
- Regulatory climate
- Extreme storms
- The fudge factor…

Critical components of a best- case scenario:

1. Appropriate Design
2. Installation

…. Then

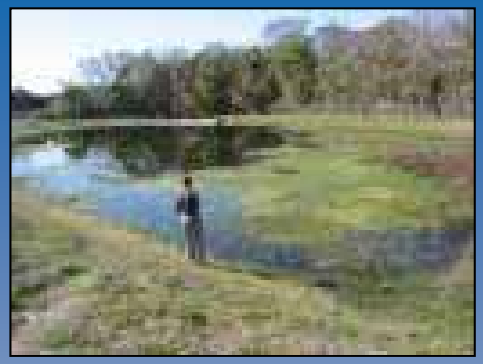
Maintenance

Economic impacts of land use change (increased runoff)

1.) Loss of revenue due to impacts to tourism and natural resources

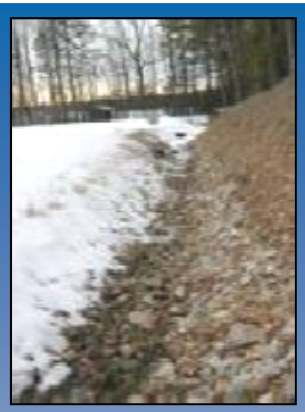
2) Expenses from stress to municipal infrastructure

3) Costs of impaired waters/TMDL implementation



Detention Basin

Retention Pond



Stone Swale

Veg Swale

Porous Asphalt

PICP

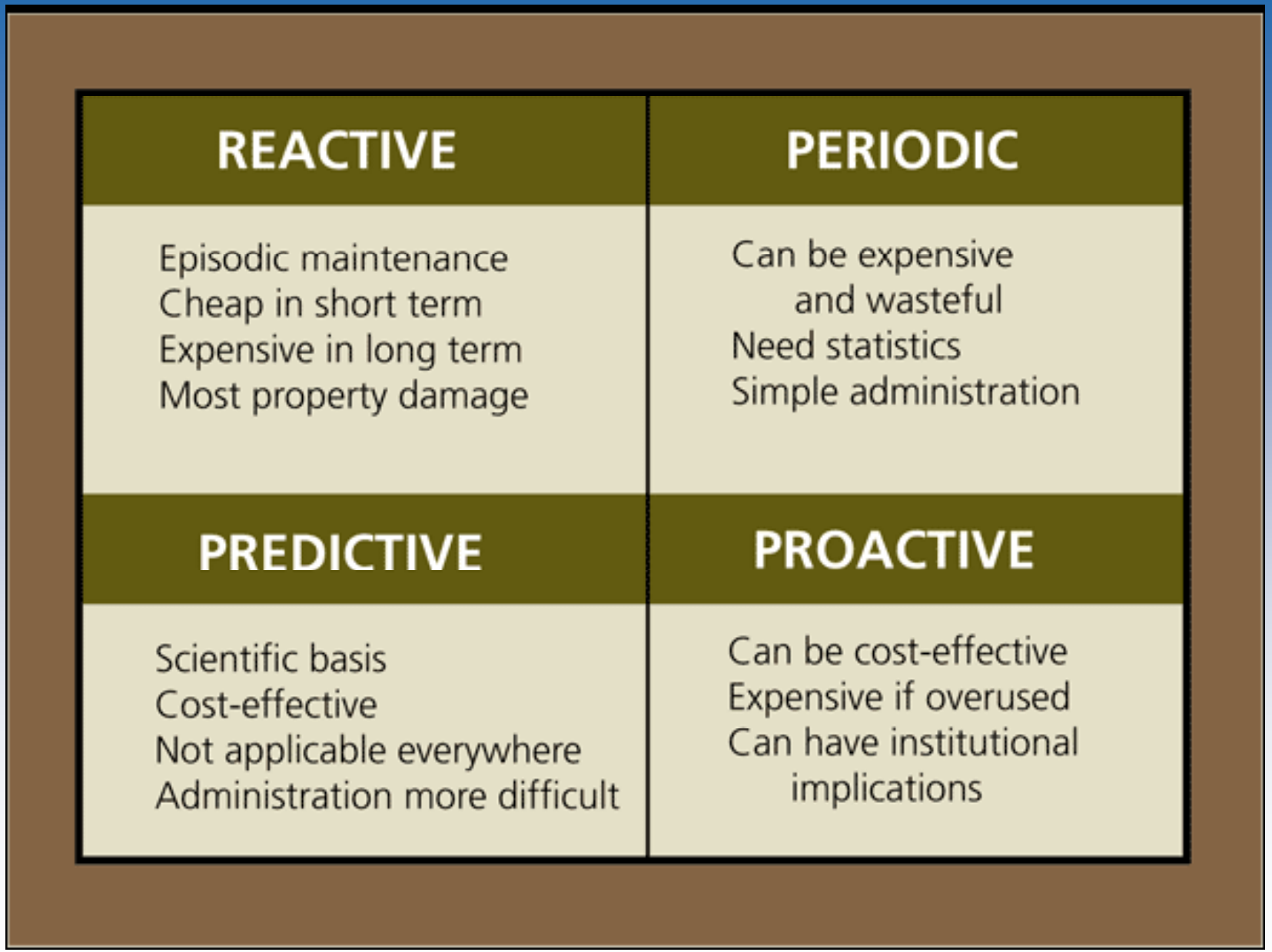
Pervious Concrete

Gravel Wetland

Sand Filter

Bioretention Unit (3)

Maintenance Data



Reese, A.J., Presler, H.H., 2005

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

Assumptions

Category of Maintenance	Type of Maintenance	complexity	price ($)
Reactive maintenance	Structural Repairs	complicated	135
	Partial Rehabilitation	complicated	135
	Rehabilitation	complicated	135
Periodic maintenance	Inspection	simple	95
	Mowing	minimal	75
	Vegetation Management	minimal	75
Predictive maintenance	Solids and Debris Removal	moderate	115
Proactive maintenance	Pavement Vacuuming	moderate	115
	Erosion control & bank stabi	simple	95

Tabular Data

Maintenance Year	BMP	Category of Maintenance	Type of Maintenance	Specific Maintenance	Complexity of Maintenance	Hours of Maintenance	Cost
2005	Unit D2: Bioretention Pond	Periodic maintenance	Mowing	side slope and perimeter mowing (Bi-Annualy 3 hrs each)	Minimal	3.0	$225
2005	Unit D2: Bioretention Pond	Periodic maintenance	Mowing	side slope and perimeter mowing (Bi-Annualy 3 hrs each)	Minimal	3.0	$225
2005	Unit D2: Bioretention Pond	Periodic maintenance	Inspection	Maintenance Forms	Simple	1.0	$95
2005	Unit D2: Bioretention Pond	Periodic maintenance	Inspection	Maintenance Forms	Simple	1.0	$95
2005	Unit D2: Bioretention Pond	Periodic maintenance	Inspection	Maintenance Forms	Simple	1.0	$95
2005	Unit D2: Bioretention Pond	Periodic maintenance	Inspection	Maintenance Forms	Simple	1.0	$95
2005	Unit D2: Bioretention Pond	Proactive maintenance	Vegetation Management	erosion control, seeding, etc	Simple	3.0	$285
2005	Unit D2: Bioretention Pond	Proactive maintenance	Vegetation Management	erosion control, seeding, etc	Simple	3.0	$285
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2006	Unit D2: Bioretention Pond	Periodic maintenance	Mowing	side slope and perimeter mowing (Bi-Annualy 3 hrs each)	Minimal	3.0	$225
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2006	Unit D2: Bioretention Pond	Proactive maintenance	Vegetation Management	erosion control, seeding, etc	Simple	3.0	$285
2007	Unit D2: Bioretention Pond	Periodic maintenance	Mowing	side slope and perimeter mowing (Bi-Annualy 3 hrs each)	Minimal	3.0	$225
2007	Unit D2: Bioretention Pond	Periodic maintenance	Mowing	side slope and perimeter mowing (Bi-Annualy 3 hrs each)	Minimal	3.0	$225
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2007	Unit D2: Bioretention Pond	Periodic maintenance	Inspection	Maintenance Forms	Simple	1.0	$95
2007	Unit D2: Bioretention Pond	Proactive maintenance	Vegetation Management	erosion control, seeding, etc	Simple	3.0	$285
2008	Unit D2: Bioretention Pond	Periodic maintenance	Mowing	side slope and perimeter mowing (Bi-Annualy 3 hrs each)	Minimal	3.0	$225
2008	Unit D2: Bioretention Pond	Periodic maintenance	Mowing	side slope and perimeter mowing (Bi-Annualy 3 hrs each)	Minimal	3.0	$225
2008	Unit D2: Bioretention Pond	Periodic maintenance	Inspection	Maintenance Forms	Simple	1.0	$95
2008	Unit D2: Bioretention Pond	Periodic maintenance	Inspection	Maintenance Forms	Simple	1.0	$95
2008	Unit D2: Bioretention Pond	Periodic maintenance	Inspection	Maintenance Forms	Simple	1.0	$95
2008	Unit D2: Bioretention Pond	Periodic maintenance	Inspection	Maintenance Forms	Simple	1.0	$95
2008	Unit D2: Bioretention Pond	Proactive maintenance	Vegetation Management	erosion control, seeding, etc	Simple	3.0	$285
					TOTAL	64.0	$5,600.0

Detailed Breakdown

Type of Maintenance	SMC Standard	Sand Filter	Retention Pond	Dry Pond	Vegetated Swale	Bioretention	Gravel Wetland	Porous Asphalt
Inspection	Quarterly	●	●	●	●	●	●	●
Mowing	bi-annual	●	●	●	●	●	●	❍
Veg Management	1-3 yrs	❍	❶	❶	❶	❶	❸	❍
ESC	3-4 x/yr 1, 2 x/yr2	●	●	●	⊙	●	●	❍
Solids Removal	as necessary/yr	❷	❶	❶	⊙	❶	⊙	❍
Structural Repairs	as necessary	⊙	●	❍	❍	❍	❍	❍
Partial Rehabilitation	as necessary	●	●	❍	❍	❍	❍	❍
Rehabilitation	as necessary	❍	❍	❍	❍	❍	❍	❍

Key	
●	Yes
⊙	Partial
❍	No
❶	1 x
❷	2 x
❸	3 x

Tools of the trade…


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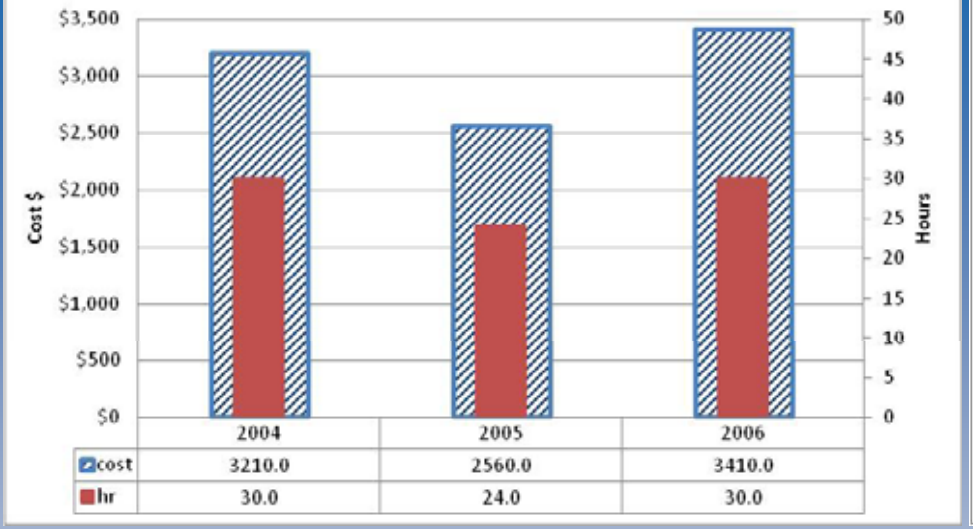
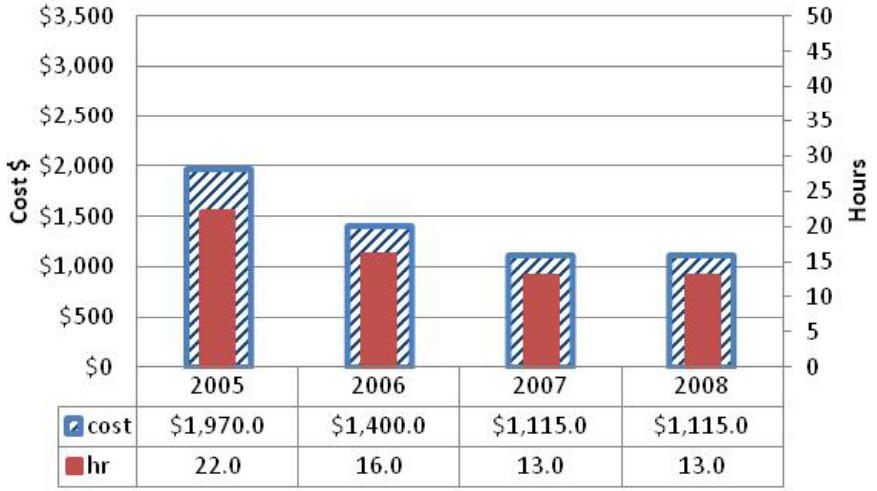
PUBLIC WORKS
WATER / SEWER DIVISION

Retention Pond



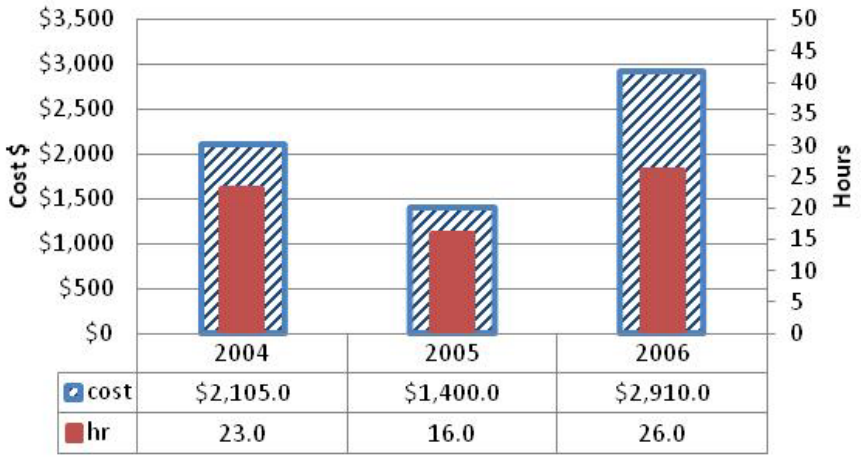
	2004	2005	2006
cost	3210.0	2560.0	3410.0
hr	30.0	24.0	30.0

Bioretention



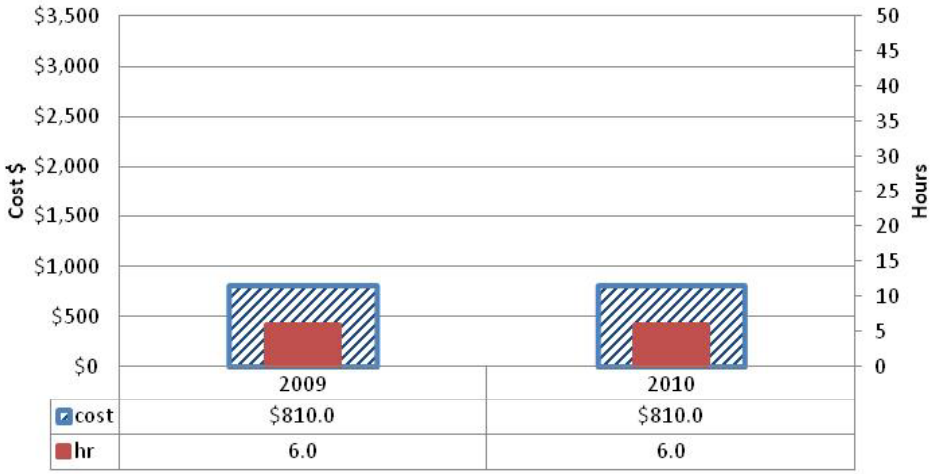
	2005	2006	2007	2008
cost	$1,970.0	$1,400.0	$1,115.0	$1,115.0
hr	22.0	16.0	13.0	13.0

Gravel Wetland

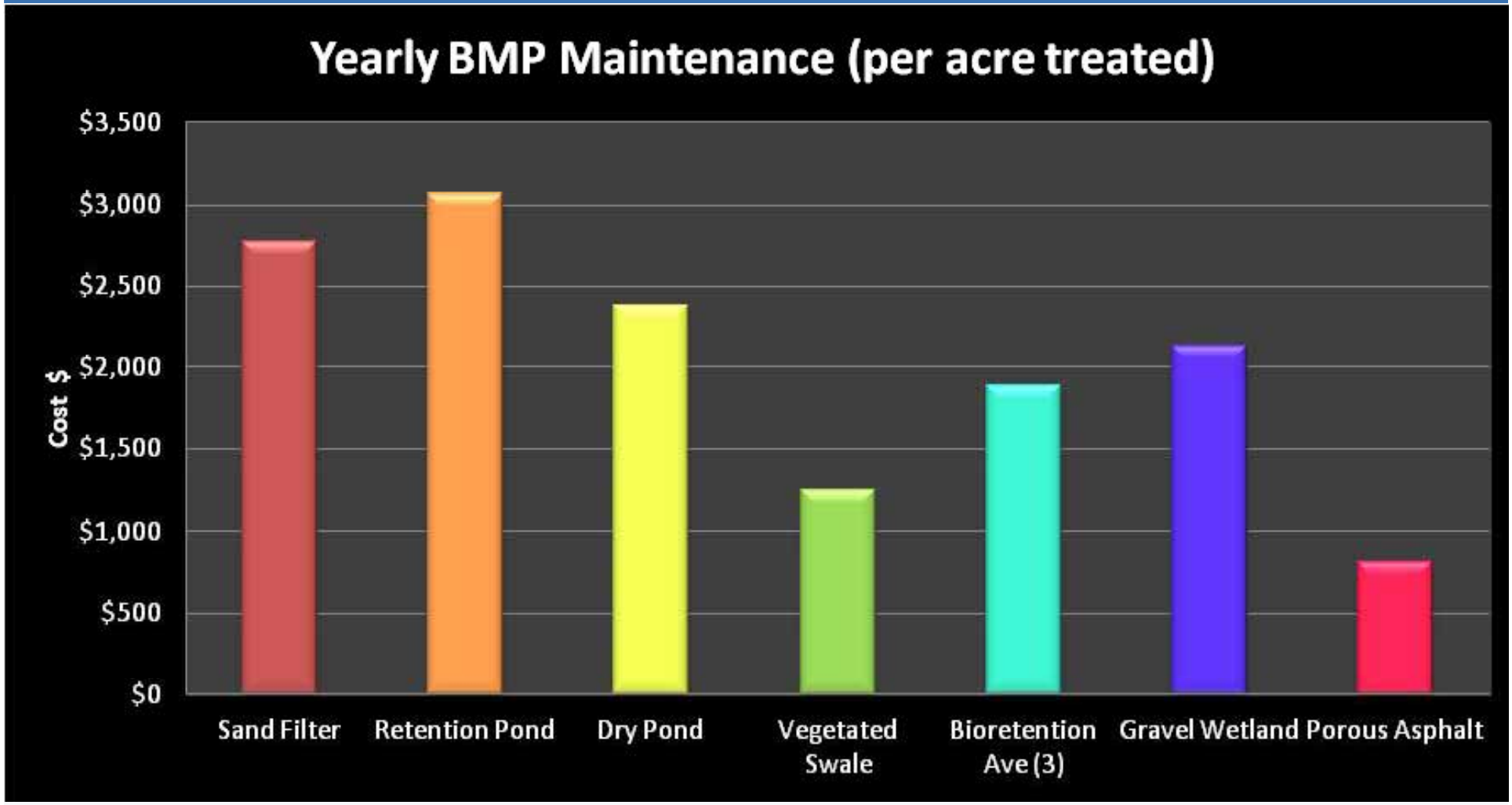


	2004	2005	2006
cost	$2,105.0	$1,400.0	$2,910.0
hr	23.0	16.0	26.0

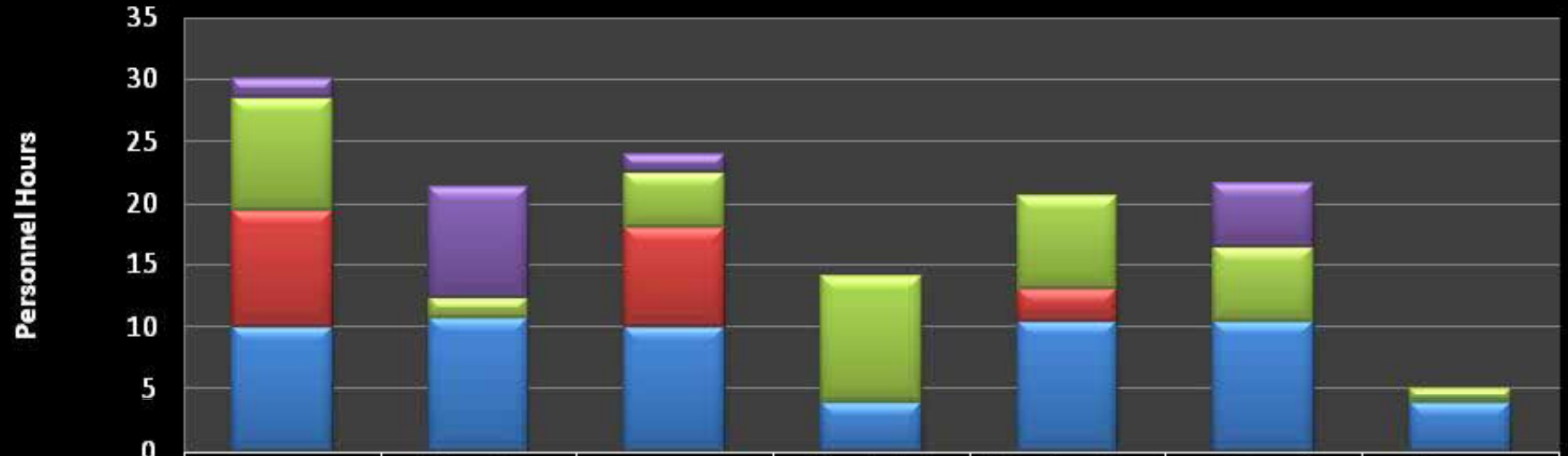
Porous Asphalt



	2009	2010
cost	$810.0	$810.0
hr	6.0	6.0


Yearly BMP Maintenance (per acre treated)
Cost $
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
Sand Filter
Retention Pond
Dry Pond
Vegetated Swale
Bioretention Ave (3)
Gravel Wetland
Porous Asphalt

BMP Maintenance/acre/yr by Catagory



	Sand Filter	Retention Pond	Dry Pond	Vegetated Swale	Bioretention (3)	Gravel Wetland	Porous Asphalt
Reactive	1.5	9	1.5	0	0	5	0
Proactive	9	2	4.5	10	8	6	1
Predictive	9.5	0	8	0	3	0	0
Periodic	10	11	10	4	10	10	4

Conclusions

- All advanced stormwater systems require maintenance
- LID maintenance is often simple, low cost consistent with standard landscaping practices
- Estimations based on % of capital costs are not reliable
- Consider requiring permanent sureties
- Fine filter media systems may have reduced service life due to clogging—easily serviced—sand filters and bioretention
- Every site and system is different
- The more system maintenance can be standardize the lower the anticipated maintenance costs.

Questions???