Costs of Maintaining Stormwater Control Measures

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SCM Maintenance

- North Carolina Department of Environmental Quality (NC DEQ) requires signed and notarized maintenance plan for all stormwater control measures (SCMs)
- SCMs also required to be inspected on annual basis by a Professional Engineer or Registered Landscape Architect
- For more information contact regional NC DEQ office (https://deq.nc.gov/contact/regional-offices)
  - Visit https://deq.nc.gov/sw-bmp-manual
    - Operation and Maintenance chapter
    - Stormwater Rules and Regulations

Impacts of Maintenance on SCMs

- Maintenance affects SCM performance
  - Johnson and Hunt (2019) discovered bioretention cell performance in NC improved 17 years later
  - Willard et al. (2017) found bioretention cell performance in VA improved 7 years later
  - Bean et al. (2007) determined permeable pavement infiltration improved from 2 in/hr to 3.5 in/hr after maintenance

The ‘Mow, Blow, and Go’ Method will NOT Work for SCMs

Nor Will the 'Spray and Pray Method'

SCM Maintenance vs. Landscaping

- Landscapers observe plant material and use soil and tissue analyses to fertilize for good plant nutrition
- SCMs built to *remove* nutrients (TN and TP); plant growth is secondary concern
- Adding fertilizer to SCMs causes nutrient export

SCM Maintenance vs. Landscaping

- Using SCM maintenance companies ensures:
  - Issues are identified and corrected before annual inspection
  - SCMs meet permit requirements while aesthetically pleasing
  - More cost effective to routinely maintain SCMs

Bioretention Cell/Rain Garden Maintenance

- Typical maintenance includes:
  - Trash removal
  - Inspecting components (inlet(s), outlet, cleanouts)
  - Pruning and replacing woody vegetation
  - Mowing
  - Removing sediment from surface

Sources of Sediment

- Sources include traffic and outparcels

Cistern/Rain Barrel Maintenance

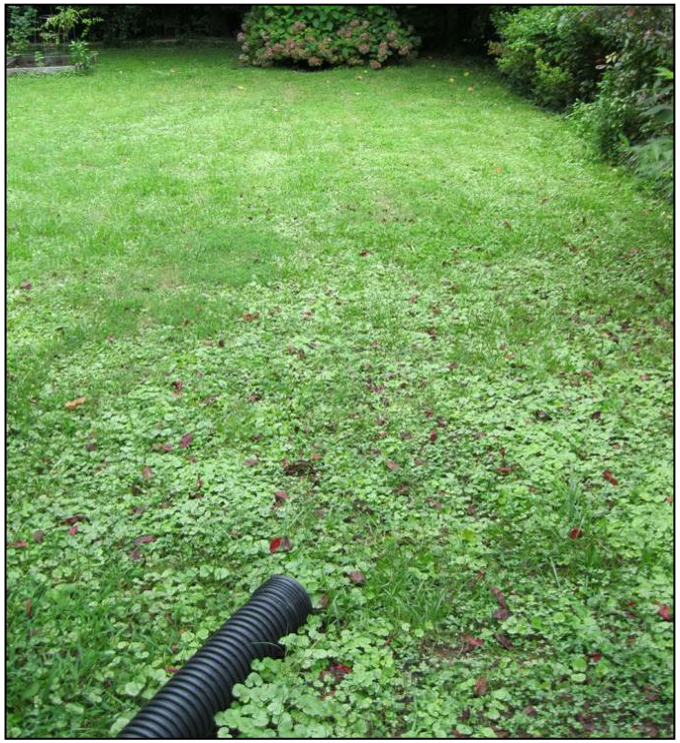
- Typical maintenance includes:
  - Inspecting and repairing all leaks
  - Cleaning gutters
  - Unclogging screens and filters
  - Inspecting distribution system (e.g. pump)
  - Flushing out tank

Permeable Pavement Maintenance

- Typical maintenance includes:
  - Stabilizing surrounding area
  - Vacuuming or sweeping surface
  - Inspecting observation well(s)
  - Annual infiltration testing

Downspout Disconnection/Swales

- Typical maintenance includes:
  - Unclogging gutters
  - Remove any trees or shrubs in designated vegetated area
  - Removing excess sediment or debris from drainage area
  - Maintaining non-clumping vegetation at height of 3 to 4 inches
    - Swale vegetation should be between 4 to 6 inches



A Little More About Mowing

- Don’t mow after rain/ soggy conditions
  - More water than nature intended
- Be careful with lowering mower – scarring

Wet Pond/Wetland Maintenance

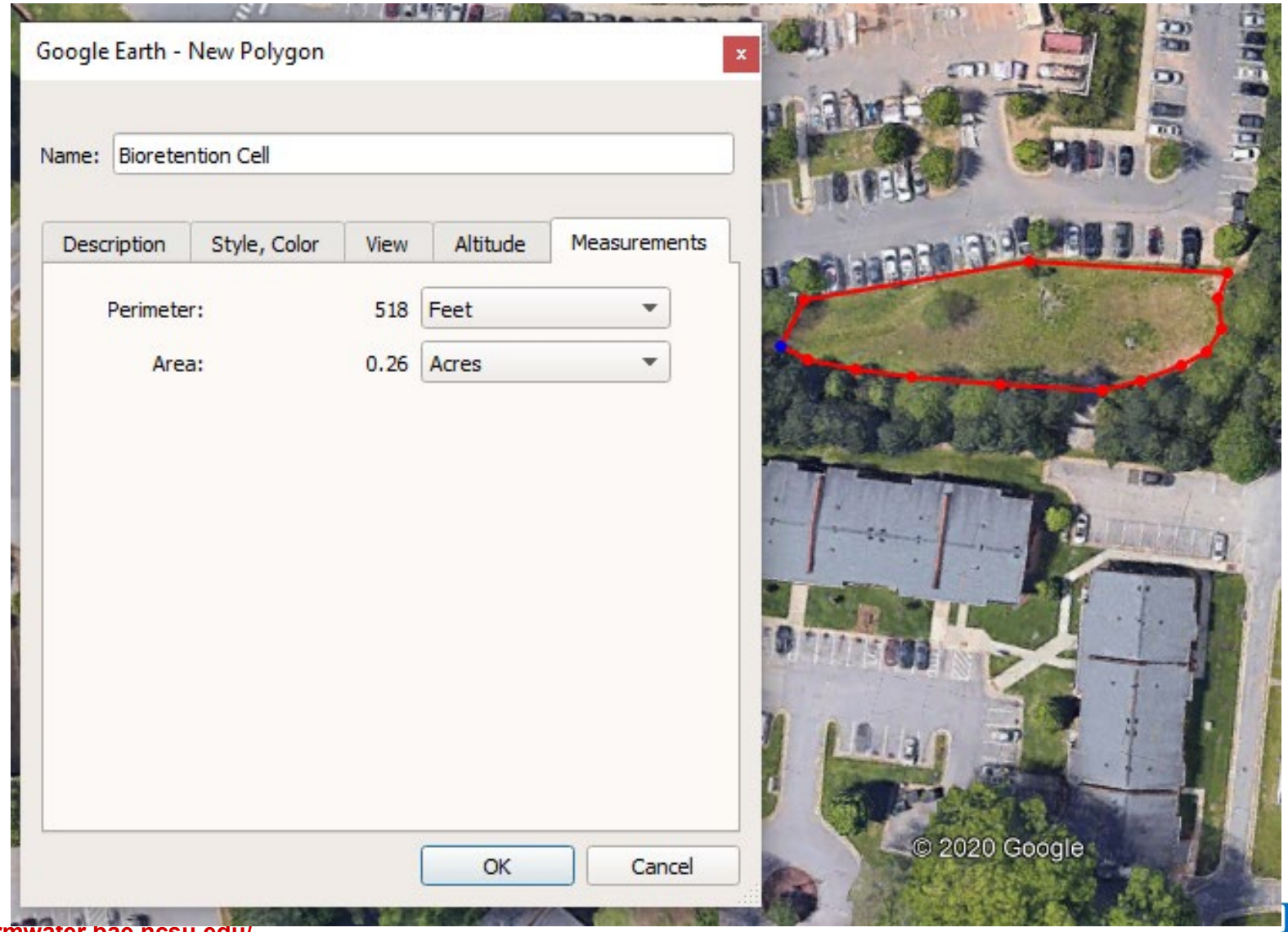
- Typical maintenance includes:
  - Trash and invasive vegetation removal
  - Mowing adjacent landscape and banks
  - Revegetation as needed
  - Inspecting components (inlets, outlet, forebay)
  - Removing vermin (beavers, muskrats) as needed

Maintenance Costs

- NCSU received grant from UNC WRRI to quantify maintenance costs for NC DEQ approved SCMs
- Identified costs for routine/proactive and restorative maintenance
- Compiling information into Excel based tool
  - Estimating lifespan of SCMs
  - Providing contingency factors
  - Accounting for inflation

Permeable Pavement			Type	PICP	Surface Area	1 Acre	Annual Cost
Category	Task	Resource	Frequency Per Year	Duration Hours per Visit	Cost $ Per Hour	Total Cost $	
Routine Maintenance	Inspection and Reporting	Manpower	4	0.5	20	40	305
		Equipment / Material/ Transportation				0	
	Litter and Debris Removal	Manpower	2	4	20	160	
		Equipment / Material / Transportation				0	
	Surface Cleaning (Mechanical/Regenerativ	Manpower	2	0.5	20	20	
		Equipment / Material / Transportation	2	0.5	85	85	
Non-Routine Maintanance	Restore Permeability	Manpower	0.2			0	140
		Equipment / Material / Transportation	0.2	1	700	140	

How to Use the Tool



Routine Bioretention Cell Costs

Parameter	Average	Median	Range
Age (yr)	14	15	10 to 15
Typical footprint (ac[1])	0.17	0.13	0.05 to 0.25
Maintenance frequency	Monthly	-	8 to 21 times per yr
Time spent on tasks- mulched (hr)	1	1	0.25 to 3
Number of employees maintaining SCM- mulched	3	2	1 to 9
Routine costs without mowing- mulched ($/ac[1])	11,867	12,000	9,200 to 14,400
Routine costs with mowing- mulched ($/ac[1])	12,400	12,000	12,000 to 14,400
[1]ac refers to bioretention cell surface area			

Routine Bioretention Cell Costs

Parameter	Average	Median	Range
Time spent on tasks- grassed (hr)	1	1	1 to 1.5
Number of employees maintaining SCM- grassed	3	2	1 to 9
Routine costs without mowing- grassed ($/ac[1])	13,467	12,000	9,200 to 19,200
Routine costs with mowing- grassed ($/ac[1])	15,600	12,000	10,800 to 24,000
[1]ac refers to bioretention cell surface area			

Task	Average	Median	Range
< 1 gal plant replacement ($/plant)	3	4	2.75 to 4
1 gal plant replacement ($/plant)	17	15	12 to 25
3 gal to 5 gal plant replacement ($/plant)	43	35	30 to 70
Tree replacement ($/tree)	325	300	100 to 600
Mulch replacement ($/cy[1])	80	75	40 to 150
Media testing ($/test)	183	200	150 to 200
[1]cy refers to mulch replaced			

Restorative Bioretention Cell Costs

Task	Average	Median	Range
Replace media ($/ton[1])	77	80	25 to 125
Replace media ($/hr[2])	300	-	-
Complete restoration ($/ac[3])	455,213	480,000	300,000 to 585,640
Camera underdrains ($/hr[2])	250	-	-
Flush out underdrains ($/lf[4])	20	-	-
Replace underdrains ($/lf[4])	7,000	-	-
[1]ton refers to media replaced			
[2]hr refers to work completed			
[3]ac refers to bioretention cell surface area			
[4]lf refers to underdrain length			

Calculating Maintenance Costs

Calculating Maintenance Costs

- Annual **routine** costs for mulched bioretention cell with mowing: $12,400 per ac
- **Restorative** costs for mulched bioretention cell: $455,213 per ac
- Estimated costs:
  - Typical bioretention cell surface area = 0.20 ac
  - Routine:

$$Annual\ Cost = \frac{\$12{,}400}{ac} * 0.20\ ac = \$2{,}480$$

  - Restorative:

$$Cost = \frac{\$455{,}213}{ac} * 0.20\ ac = \$91{,}043$$

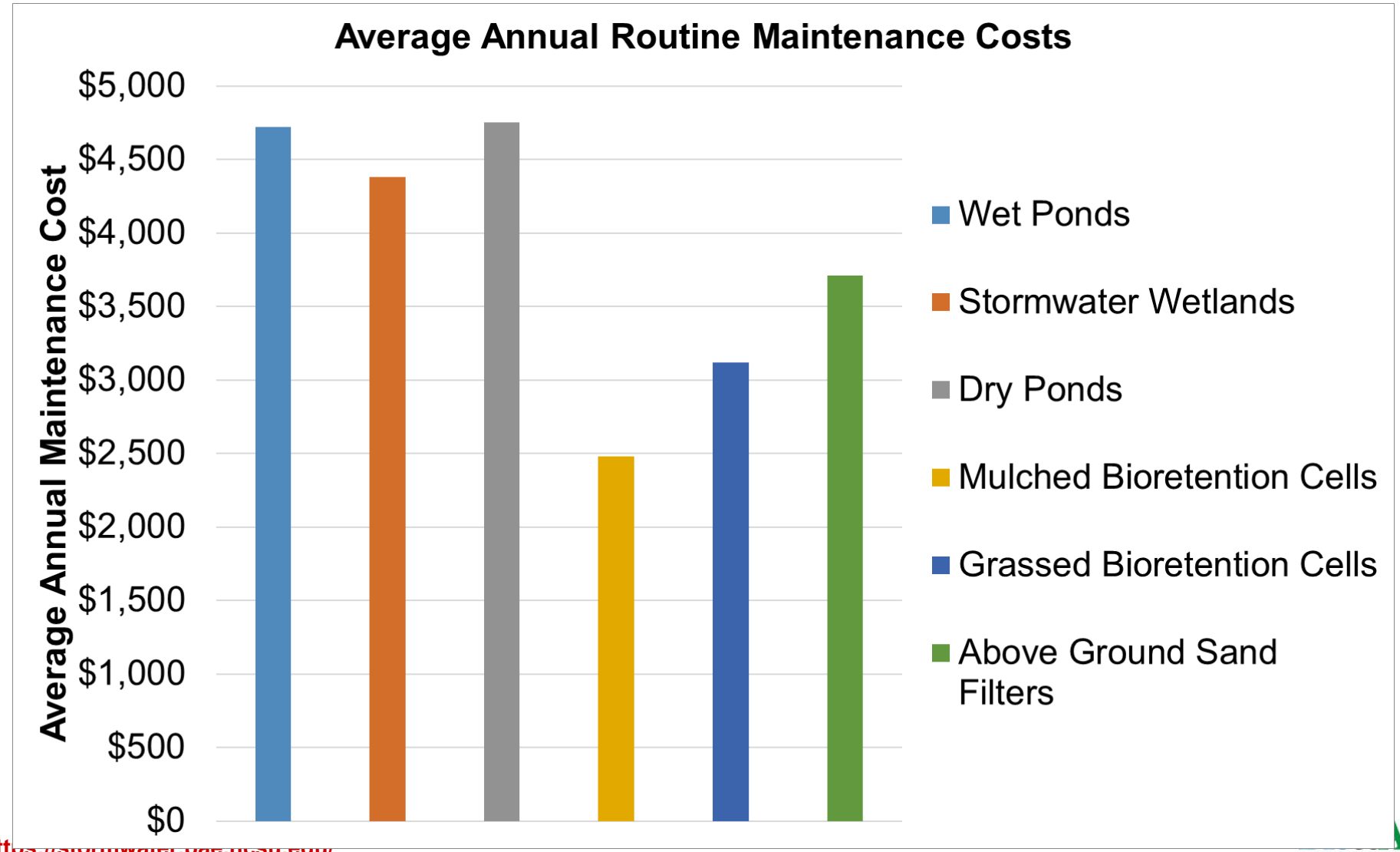
Routine Wet Pond Costs

Parameter	Average	Median	Range
Age (yr)	16	16	10 to 28
Typical footprint (ac)	0.50	0.50	0.25 to 0.75
Maintenance frequency	Monthly	-	8 to 21 times per yr
Time spent on tasks (hr)	2	1	0.25 to 6
Number of employees maintaining SCM	3	2	1 to 9
Routine costs w/o mowing ($/ac)	6,360	4,600	4,000 to 9,600
Routine costs with mowing ($/ac)	9,440	8,800	5,400 to 15,200
[1]ac refers to wet pond surface area			

Routine Dry Pond Costs

Parameter	Average	Median	Range
Age (yr)	14	15	10 to 18
Typical footprint (ac[1])	0.42	0.50	0.25 to 0.50
Maintenance frequency	Monthly	-	4 to 21 times per yr
Time spent on tasks (hr)	1	1	0.17 to 2
Number of employees maintaining SCM	3	4	1 to 9
Routine costs without mowing ($/ac[1])	6,920	6,000	5,400 to 9,600
Routine costs with mowing ($/ac[1])	11,320	10,400	6,600 to 18,000
[1]ac refers to dry pond surface area			

Cost Comparisons Between SCMs



Questions?

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https://www.bae.ncsu.edu/workshops-conferences/