Stormwater Treatment in Maryland: Planning-Level County Cost Estimates

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Project Purpose

• Provide Maryland counties with economic information to help them make decisions about incorporating stormwater BMPs into County WIPs.

Project Focus

• **Part 1 –** Develop *planning level* estimates of **unit costs of stormwater BMPs** (cost per acre of impervious area treated).

• **Part 2 –** Assess **county financing alternatives** and funding sources to pay for stormwater BMPs, and describe their suitability and potential economic impacts on county households, businesses, and other entities.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Categories of Stormwater BMP Unit Costs

Initial Costs

- Pre-Construction
- Construction
- Land
  - Total Initial Costs

Maintenance Costs

- Routine annual
- Intermittent/Corrective

Annual County Implementation Costs

Total Life Cycle cost *- sum of the above over 20 years*

Annualized Life Cycle Cost –Average annual payment to finance life cycle costs over 20 year.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Overall Research Approach

Task 1: Review previous studies; apply stormwater BMP cost estimating software; interview stormwater engineers, vendors, contractors… and use results to develop preliminary ***planning level*** unit cost estimates for each stormwater BMP.

Task 2: Interview Maryland county and municipal stormwater experts and engineers to obtain additional cost information, and get reactions to Stage 1 results.

Task 3: Use the results of Stage 1 and Stage 2 to develop the best available planning level unit cost estimates for each stormwater BMPs, based on our best estimate of a **typical** size project undertaken at a **typical** site within a **typical** landscape context

Task 4 Present results in a report and also develop tools and criteria Maryland counties can use to:

- Refine cost estimates whenever better cost information is available.
- Use results to assess county financing needs and economic impacts
- Decide what role stormwater BMPs should play in their WIPS.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Sources of Cost Data

- Previous studies, publications, EPA & MDE Reports, accepted “rules of thumb”, etc.
- Maryland County MS4 Reports to MDE
- County costs for individual projects or averaged over many projects….over few projects, etc.
- Published cost estimates based on samples of projects inside and outside of Maryland.
- Runs of SWBMP cost estimating software from WERF, and published costing equations
- Cross-checked “rules of thumb”, e.g.:
  - Preconstruction Costs …. 10% to 50% of Construction Costs.
  - Annual Maintenance and Intermittent Repair Costs … 4% to 7% of Construction Costs.
  - One FTE needed to inspect and enforce 450 to 650 SWBMPs per year.
  - Costs increase from **rural** to **suburban** to **urban** to **ultra-urban** landscape contexts.

Sources provided “unit costs” in different units:

- Cost per cubic feet of water capacity
- Cost per acre of project area
- Cost per acre of drainage area treated
- Cost per acre of impervious area treated.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

What Affects Stormwater BMP Costs ?

- Preconstruction Effort required to locate, compare, gain access to potential project sites and get projects designed and permitted
- Land Needs & Land Value: Private or Public, Developable or not
- Landscape Context – Rural vs. suburban vs. urban vs. ultra-urban
- Site Conditions – Land cover, structures, soil type, clearing required, etc.
- Project Scale – Project size in acres or cubic feet of water capacity
- Project Capacity - Acres of land or impervious area treated
- Number of Projects – Few or many similar projects within a county
- Type of Project - Newly built or retrofit on private or public land
- Site Access - for surveying, construction, maintenance, inspection, repair
- Importance of Aesthetics – Want an attractive or ugly detention pond ?
- Safety and Public Health - Stagnant water, attractive nuisance, etc.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

What County Cost Adjustment Indices do not indicate*

- Differences in land costs or land access
- Differences in population density
- Unique local requirements
- Managerial efficiency
- Competitive Conditions
- Differences in automation
- Restrictive union practices
- Specific codes or permitting requirements

* Based on caveats in Means Construction Cost Indexes (Vol. 37, Number 1, January, 2011)

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Three Ways to Use Stormwater BMP Unit Cost Estimates

1) If you have better cost estimates use them. (But you may want to check our cost spreadsheets to determine if you've accounted for all costs.

2) If you have no better cost estimates, and no basis for adjusting the ones in our tables based on county characteristics… use our costs.

2) If you have county information you can use to modify cost estimates in our cost tables based on the criteria listed…go ahead and adjust them.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Initial Cost Table

Planning Level Unit Cost Development for Stormwater Best Management Practices (BMPs)[1]

PART 1: Initial Costs Per Impervious Acre Treated

Stormwater BMP	Initial Project Costs				
	Pre-Construction Costs[2]	Construction Costs[3]	Land Costs[4]	Total Initial Costs	Annualized Initial Costs[5]
Impervious Urban Surface Reduction	$ 8,750	$ 87,500	$ 50,000	$ 146,250	$ 9,830
Urban Forest Buffers	$ 3,000	$ 30,000	$ -	$ 33,000	$ 2,218
Urban Grass Buffers	$ 2,150	$ 21,500	$ -	$ 23,650	$ 1,590
Urban Tree Planting	$ 3,000	$ 30,000	$ 150,000	$ 183,000	$ 12,300
Wet Ponds and Wetlands (New)	$ 5,565	$ 18,550	$ 2,000	$ 26,115	$ 1,755
Wet Ponds and Wetlands (Retrofit)	$ 21,333	$ 42,665	$ 2,000	$ 65,998	$ 4,436
Dry Detention Ponds (New)	$ 9,000	$ 30,000	$ 5,000	$ 44,000	$ 2,957
Hydrodynamic Structures (New)	$ 7,000	$ 35,000	$ -	$ 42,000	$ 2,823
Dry Extended Detention Ponds (New)	$ 9,000	$ 30,000	$ 5,000	$ 44,000	$ 2,957
Dry Extended Detention Ponds (Retrofit)	$ 22,500	$ 45,000	$ 5,000	$ 72,500	$ 4,873
Infiltration Practices w/o Sand, Veg. (New)	$ 16,700	$ 41,750	$ 5,000	$ 63,450	$ 4,265
Infiltration Practices w/ Sand, Veg. (New)	$ 17,500	$ 43,750	$ 5,000	$ 66,250	$ 4,453
Filtering Practices (Sand, above ground)	$ 14,000	$ 35,000	$ 5,000	$ 54,000	$ 3,630
Filtering Practices (Sand, below ground)	$ 16,000	$ 40,000	$ -	$ 56,000	$ 3,764
Erosion and Sediment Control	$ 6,000	$ 20,000	$ -	$ 26,000	$ 1,748
Urban Nutrient Management[6]	$ -	$ 61,000	$ -	$ 61,000	$ 4,100
Street Sweeping[7]	$ -	$ 6,049	$ -	$ 6,049	$ 407
Urban Stream Restoration	$ 21,500	$ 43,000	$ -	$ 64,500	$ 4,335
Bioretention (New - Suburban)	$ 9,375	$ 37,500	$ 3,000	$ 49,875	$ 3,352
Bioretention (Retrofit - Highly Urban)	$ 52,500	$ 131,250	$ 3,000	$ 186,750	$ 12,553
Vegetated Open Channels	$ 4,000	$ 20,000	$ 2,000	$ 26,000	$ 1,748
Bioswale (New)	$ 12,000	$ 30,000	$ 2,000	$ 44,000	$ 2,957
Permeable Pavement w/o Sand, Veg. (New)	$ 21,780	$ 217,800	$ -	$ 239,580	$ 16,104
Permeable Pavement w/ Sand, Veg. (New)	$ 30,492	$ 304,920	$ -	$ 335,412	$ 22,545

[1] All costs are expressed per acre of impervious area treated, not per acre of BMP. Initial costs are assumed to take place in year T=0; annual costs are incurred from year T=1 through year T=20.

[2] Includes cost of site discovery, surveying, design, planning, permitting, etc. which, for various BMPs tend to range from 10% to 40% of BMP construction costs.

[3] Includes capital, labor, material and overhead costs, but not land costs, associated implementation; for street sweeping includes only the capital cost of purchasing a mechanical sweeper.

[4] For all stormwater BMPs that require land it is assumed that: 1) the opportunity cost of developable land is $100,000 per acre and 2) 50% of projects that require land take place on developable land with the rest taking place on land that is not developable. This brings the opportunity cost of land for stormwater BMPs that require land to $50,000 per acre. Actual county-specific land cost and percent developable land values can be filled in.
NOTE: The area of some BMPs may be significantly less than the impervious area treated.

[5] Initial BMP costs, including preconstruction, construction, and land costs, are amortized over 20 years at 3% to arrive at annualized initial costs.

[6] Best available data indicate that "retail" (i.e., direct mail) public outreach campaigns cost about $15 per household contacted. For an illustrative county, we assumed that each household has 5,941 sq ft of turf and 2,406 sq ft of impervious cover (medium density development). This means that 7.33 households need to adopt this BMP to potentially result in an acre of turf being treated, at a cost $109.98 per turf acre. Based on a review of direct mail response rates, we assumed that 2% of households contacted will respond positively to this outreach effort, bringing the cost per turf acre treated to $5,497.50/acre. The equivalent on a per-impervious-acre was based on the MDE June 2011 stormwater guidance document, which provides an equivalent for this practice of .09 acres impervious area per one acre of this practice. This estimate does not include any additional costs for soil tests by the homeowner to determine the appropriate amount of fertilizer required.

[7] Capital acquisition cost per impervious acre treated.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

One Row of Initial Cost Table

Planning Level Unit Cost Development for Stormwater Best Management Practices (BMPs)[1]

PART 1: Initial Costs Per Impervious Acre Treated

Stormwater BMP	Initial Project Costs				
	Pre-Construction Costs[2]	Construction Costs[3]	Land Costs[4]	Total Initial Costs	Annualized InitialCosts[5]
Bioretention (New)	$9,375	$37,500	$3,000	$49,875	$3,352

Land Value per Developable Acre	$100,000
Project Acres	.06 acres
% Project Acres Developable	50%

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Annual/Intermittent Maintenance and County Implementation Cost Table

Planning Level Unit Cost Development for Stormwater Best Management Practices (BMPs)

PART 2: Annual Maintenance Costs

Stormwater BMP	Routine and Intermittent Maintenance Costs			Average Annual County Implementation Costs[3]	Maintenance, Intermittent Repair, and Implementation Costs[4]	
	Annual Routine Maintenance[1]	Average Annual Intermittent Maintenance[2]	Total Annual Maintenance Costs		Total (Over 20 Years)	Average Annual (Over 20 Years)
Impervious Urban Surface Reduction	$ 875	$ -	$ 875	$ 10.34	$ 17,707	$ 885
Urban Forest Buffers	$ 600	$ 600	$ 1,200	$ 10.34	$ 24,207	$ 1,210
Urban Grass Buffers	$ 430	$ 430	$ 860	$ 10.34	$ 17,407	$ 870
Urban Tree Planting	$ 600	$ 600	$ 1,200	$ 10.34	$ 24,207	$ 1,210
Wet Ponds and Wetlands (New)	$ 371	$ 371	$ 742	$ 20.67	$ 15,253	$ 763
Wet Ponds and Wetlands (Retrofit)	$ 371	$ 371	$ 742	$ 20.67	$ 15,253	$ 763
Dry Detention Ponds (New)	$ 600	$ 600	$ 1,200	$ 31.01	$ 24,620	$ 1,231
Hydrodynamic Structures (New)	$ 1,750	$ 1,750	$ 3,500	$ 31.01	$ 70,620	$ 3,531
Dry Extended Detention Ponds (New)	$ 600	$ 600	$ 1,200	$ 31.01	$ 24,620	$ 1,231
Dry Extended Detention Ponds (Retrofit)	$ 600	$ 600	$ 1,200	$ 31.01	$ 24,620	$ 1,231
Infiltration Practices w/o Sand, Veg. (New)	$ 418	$ 418	$ 835	$ 31.01	$ 17,320	$ 866
Infiltration Practices w/ Sand, Veg. (New)	$ 438	$ 438	$ 875	$ 31.01	$ 18,120	$ 906
Filtering Practices (Sand, above ground)	$ 700	$ 700	$ 1,400	$ 31.01	$ 28,620	$ 1,431
Filtering Practices (Sand, below ground)	$ 800	$ 800	$ 1,600	$ 31.01	$ 32,620	$ 1,631
Erosion and Sediment Control	$ -	$ -	$ -	$ 10.34	$ 207	$ 10
Urban Nutrient Management	$ -	$ -	$ -	$ 31.01	$ 620	$ 31
Street Sweeping	$ 431	$ -	$ 431	$ 20.67	$ 9,030	$ 451
Urban Stream Restoration	$ -	$ 860	$ 860	$ 31.01	$ 17,820	$ 891
Bioretention (New - Suburban)	$ 750	$ 750	$ 1,500	$ 31.01	$ 30,620	$ 1,531
Bioretention (Retrofit - Highly Urban)	$ 750	$ 750	$ 1,500	$ 31.01	$ 30,620	$ 1,531
Vegetated Open Channels	$ 400	$ 200	$ 600	$ 10.34	$ 12,207	$ 610
Bioswale (New)	$ 600	$ 300	$ 900	$ 31.01	$ 18,620	$ 931
Permeable Pavement w/o Sand, Veg. (New)	$ 1,089	$ 1,089	$ 2,178	$ 10.34	$ 43,767	$ 2,188
Permeable Pavement w/ Sand, Veg. (New)	$ 1,525	$ 1,525	$ 3,049	$ 10.34	$ 61,191	$ 3,060

[1] Annual routine maintenance costs over 20 years; assumes a 3% discount rate, but also a 3% annual increase in maintenance cost which washes out the effect of discounting resulting in a constant present value annual cost throughout the 20 year period.

[2] Intermittent/corrective maintenance tasks are those that accrue every 3 to 5 years; these are averaged here over the 20 year period.

[3] Average annual county cost of inspecting and monitoring stormwater BMPs and enforcing construction and maintanance standards.

[4] Combined annual operating, implementation, and maintenance costs.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

One Row from Annual Maintenance and County Implementation Cost Table

Planning Level Unit Cost Development for Stormwater Best Management Practices (BMPs)
PART 2: Annual Maintenance Costs

Stormwater BMP	Routine and Intermittent Maintenance Costs			Average Annual County Implementation Costs[3]	Maintenance, Intermittent Repair, and Implementation Costs[4]	
	Annual Routine Maintenance[1]	Average Annual Intermittent Maintenance[2]	Total Annual Maintenance Costs		Total (Over 20 Years)	Average Annual (Over 20 Years)
Bioretention (New)	$750	$750	$1,500	$31.01	$30,620	$1,531

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Life Cycle and Annualized Total Costs

Planning Level Unit Cost Development for Stormwater Best Management Practices (BMPs)
PART 3: Life Cycle (20 years) and Annual Stormwater BMP Unit Cost Estimates

Stormwater BMP	Initial Costs (From Table 2a) Total	Initial Costs (From Table 2a) Annualized Initial Costs	Average Annual Maintenance Costs[1] (From Table 2b)	Total Stormwater BMP Costs per Impervious Acre Treated Costs (Over 20 Years)	Total Stormwater BMP Costs per Impervious Acre Treated Average Annual Cost
Impervious Urban Surface Reduction	$ 146,250	$ 9,830	$ 885	$ 163,957	$ 8,198
Urban Forest Buffers	$ 33,000	$ 2,218	$ 1,210	$ 57,207	$ 2,860
Urban Grass Buffers	$ 23,650	$ 1,590	$ 870	$ 41,057	$ 2,053
Urban Tree Planting	$ 183,000	$ 12,300	$ 1,210	$ 207,207	$ 10,360
Wet Ponds and Wetlands (New)	$ 26,115	$ 1,755	$ 763	$ 41,368	$ 2,068
Wet Ponds and Wetlands (Retrofit)	$ 65,998	$ 4,436	$ 763	$ 81,251	$ 4,063
Dry Detention Ponds (New)	$ 44,000	$ 2,957	$ 1,231	$ 68,620	$ 3,431
Hydrodynamic Structures (New)	$ 42,000	$ 2,823	$ 3,531	$ 112,620	$ 5,631
Dry Extended Detention Ponds (New)	$ 44,000	$ 2,957	$ 1,231	$ 68,620	$ 3,431
Dry Extended Detention Ponds (Retrofit)	$ 72,500	$ 4,873	$ 1,231	$ 97,120	$ 4,856
Infiltration Practices w/o Sand, Veg. (New)	$ 63,450	$ 4,265	$ 866	$ 80,770	$ 4,039
Infiltration Practices w/ Sand, Veg. (New)	$ 66,250	$ 4,453	$ 906	$ 84,370	$ 4,219
Filtering Practices (Sand, above ground)	$ 54,000	$ 3,630	$ 1,431	$ 82,620	$ 4,131
Filtering Practices (Sand, below ground)	$ 56,000	$ 3,764	$ 1,631	$ 88,620	$ 4,431
Erosion and Sediment Control	$ 26,000	$ 1,748	$ 10	$ 26,207	$ 1,310
Urban Nutrient Management	$ 61,000	$ 4,100	$ 31	$ 61,620	$ 3,081
Street Sweeping	$ 6,049	$ 407	$ 451	$ 15,079	$ 754
Urban Stream Restoration	$ 64,500	$ 4,335	$ 891	$ 82,320	$ 4,116
Bioretention (New - Suburban)	$ 49,875	$ 3,352	$ 1,531	$ 80,495	$ 4,025
Bioretention (Retrofit - Highly Urban)	$ 186,750	$ 12,553	$ 1,531	$ 217,370	$ 10,869
Vegetated Open Channels	$ 26,000	$ 1,748	$ 610	$ 38,207	$ 1,910
Bioswale (New)	$ 44,000	$ 2,957	$ 931	$ 62,620	$ 3,131
Permeable Pavement w/o Sand, Veg. (New)	$ 239,580	$ 16,104	$ 2,188	$ 283,347	$ 14,167
Permeable Pavement w/ Sand, Veg. (New)	$ 335,412	$ 22,545	$ 3,060	$ 396,603	$ 19,830

[1] Includes routine annual maintenance costs, average annual intermittent maintenance costs, and county implementation costs.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

One Row from Life Cycle and Annualized Total Costs

Planning Level Unit Cost Development for Stormwater Best Management Practices (BMPs)

PART 3: Life Cycle (20 years) and Annual Stormwater BMP Unit Cost Estimates

Stormwater BMP	Initial Costs (From Table 2a)		Average Annual Maintenance Costs[1] (From Table 2b)	Total Stormwater BMP Costs per Impervious Acre Treated	
	Total	Annualized Initial Cost		Costs (Over 20 Years)	Average Annual Cost
Bioretention (New)	$49,875	$3,352	$1,531	$80,495	$4,025

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Use of Planning Level Unit Stormwater BMP Costs with MAST Output to Compare WIP Alternatives

Planning Level Unit Cost Development for Stormwater Best Management Practices (BMPs)
Part 4: Integrating Unit Stormwater BMP Costs with MAST Output

Stormwater BMP		Reduction in Emissions per acre treated by each Stormwater BMP (1) Nitrogen	(2) Phosphorus	(3) Sediment	(4) Available Acres	(5) % of Available Acres Treated (County Decision Variable)	(6) Number of Acres Treated	Cost per Impervious Acre Treated: County-based Costs (7) Initial Cost	(8) Average Annual Maintenance Cost	Lifetime Costs (9) Total (Over 20 Years)	(10) Annual Costs (Over 20 Years)
Impervious Urban Surface Reduction							0	$ 146,250	$ 885	$ 163,957	$ 8,198
Urban Forest Buffers							0	$ 33,000	$ 1,210	$ 57,207	$ 2,860
Urban Grass Buffers							0	$ 23,650	$ 870	$ 41,057	$ 2,053
Urban Tree Planting							0	$ 183,000	$ 1,210	$ 207,207	$ 10,360
Wet Ponds and Wetlands (New)							0	$ 26,115	$ 763	$ 41,368	$ 2,068
Wet Ponds and Wetlands (Retrofit)							0	$ 65,998	$ 763	$ 81,251	$ 4,063
Dry Detention Ponds (New)							0	$ 44,000	$ 1,231	$ 68,620	$ 3,431
Hydrodynamic Structures (New)							0	$ 42,000	$ 3,531	$ 112,620	$ 5,631
Dry Extended Detention Ponds (New)							0	$ 44,000	$ 1,231	$ 68,620	$ 3,431
Dry Extended Detention Ponds (Retrofit)							0	$ 72,500	$ 1,231	$ 97,120	$ 4,856
Infiltration Practices w/o Sand, Veg. (New)							0	$ 63,450	$ 866	$ 80,770	$ 4,039
Infiltration Practices w/ Sand, Veg. (New)							0	$ 66,250	$ 906	$ 84,370	$ 4,219
Filtering Practices (Sand, above ground)							0	$ 54,000	$ 1,431	$ 82,620	$ 4,131
Filtering Practices (Sand, below ground)							0	$ 56,000	$ 1,631	$ 88,620	$ 4,431
Erosion and Sediment Control							0	$ 26,000	$ 10	$ 26,207	$ 1,310
Urban Nutrient Management							0	$ 61,000	$ 31	$ 61,620	$ 3,081
Street Sweeping							0	$ 6,049	$ 451	$ 15,079	$ 754
Urban Stream Restoration							0	$ 64,500	$ 891	$ 82,320	$ 4,116
Bioretention (New - Suburban)							0	$ 49,875	$ 1,531	$ 80,495	$ 4,025
Bioretention (Retrofit - Highly Urban)							0	$ 186,750	$ 1,531	$ 217,370	$ 10,869
Vegetated Open Channels							0	$ 26,000	$ 610	$ 38,207	$ 1,910
Bioswale (New)							0	$ 44,000	$ 931	$ 62,620	$ 3,131
Permeable Pavement w/o Sand, Veg. (New)							0	$ 239,580	$ 2,188	$ 283,347	$ 14,167
Permeable Pavement w/ Sand, Veg. (New)							0	$ 335,412	$ 3,060	$ 396,603	$ 19,830

Overall reduction for all Stormwater BMPs	0	0	0

Cost for all Stormwater BMPs	$ 2,539,274	$ 126,964
Cost per County Resident	#DIV/0!	#DIV/0!
Cost per County Household	#DIV/0!	#DIV/0!
Total Cost per 1,000 sq ft Impervious Area	#DIV/0!	#DIV/0!

County Population (2010)	0
Number of Households (2010)	0
Impervious Area (2010)	0

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Use of Planning Level Unit Stormwater BMP Costs with MAST Output to Compare WIP Alternatives

Planning Level Unit Cost Development for Stormwater Best Management Practices (BMPs)
Part 4: Integrating Unit Stormwater BMP Costs with MAST Output

Stormwater BMP		Reduction in Emissions per acre treated by each Stormwater BMP			(4) Available Acres	(5) % of Available Acres Treated (County Decision Variable)	(6) Number of Acres Treated	Cost per Impervious Acre Treated			
								County-based Costs		Lifetime Costs	
		(1) Nitrogen	(2) Phosphorus	(3) Sediment				(7) Initial Cost	(8) Average Annual Maintenance Cost	(9) Total (Over 20 Years)	(10) Annual Costs (Over 20 Years)
Bioretention (New)							0	$44,000	$931	$62,620	$3,131

Overall reduction for all Stormwater BMPs			

Cost for all Stormwater BMPs		
Cost per County Resident		
Cost per County Household		
Total Cost per 1,000 sq ft Impervious Area		

County Population (2010)	10
Number of Households (2010)	1
Impervious Area (2010)	100

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Common Misinterpretations of Unit Cost Estimates

	Stormwater BMP 1	Stormwater BMP 2
Unit Cost Per Impervious Area Treated (Illustrative – based on cost analysis)	$20,000	$100,000
Average Pound Reduction Per Impervious Area Treated (Illustrative - based on BMP efficiencies)		
Nitrogen	5	50
Phosphorus	10	20
Sediment	15	70
Cost per Pound of Reduction		
Nitrogen	$4,000	$2,000
Phosphorus	$2,000	$,5000
Sediment	$1,300	$1,400

Results:

- Lowest Cost per pound of Nitrogen discharge reduction is BMP 2
- Lowest Cost per pound of Phosphorus discharge reduction is BMP 1
- Cost per pound of Sediment discharge reduction is about the same.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

A typical stormwater BMP From MAST:

"Urban Filtering Practices *capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground…These systems require yearly inspection and maintenance to receive pollutant reduction credit."*

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

SWBMP # 11: Filtering Practices

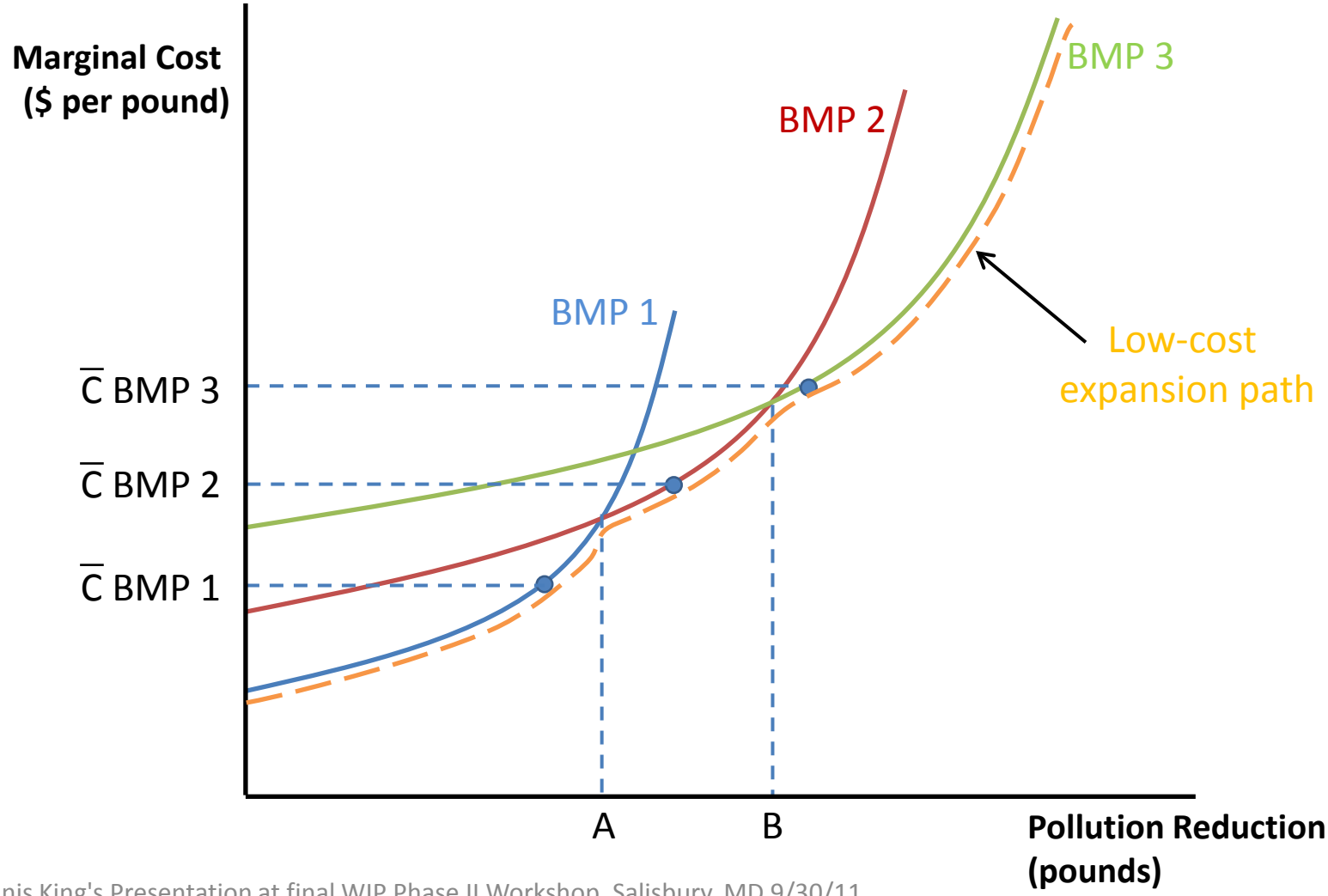
Different sand filter designs, such as above ground and below ground (shown below)

- **are similar** in terms of BMP effectiveness (MAST)
- **are dissimilar** in terms of construction, maintenance, and inspection cost and land cost.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Optimal Stormwater BMP Expansion Path

(Beware of using 'Average' Costs)



Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Unit Cost Research Needs

- At a minimum, standard BMP cost-reporting protocols (pre-construction, construction, land, annual and intermittent maintenance, inspection….)
- Where possible, need full-cost accounting, but at least for now, need to understand what costs are included
- Pre-construction and construction costs—new and retrofit difference
- Precise Information re: BMP size and IA Treated—Economies of Scale
- Factors Affecting Unit Costs: Unique local and site-specific requirements-region, geophysical, political, economic (i.e., land use restrictions)
- More data needed for some BMPs in particular
- Encourage full-cost-accounting cost submission to International Stormwater BMP Database, etc.

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11

Go to the following MDE website:

http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Pages/PhaseIIBayWIPDev.aspx

to access/download:

(1) "Costs of Stormwater BMPs in Maryland Counties" A report prepared for MDE by Dennis King and Patrick Hagan of UMCES

(2) King and Hagan presentation on Maryland county stormwater BMP costs and benefits and financing options at regional WIP workshops

(3) MD Stormwater BMP Cost estimating spreadsheets:

- **Table A** Initial Stormwater BMP Costs
- **Table B** Routine and Intermittent Annual Maintenance Costs
- **Table C** Life Cycle and Annual Stormwater BMP Unit Cost Estimates
- **Table D** Integrating Unit Costs with MAST Output to Assess WIP Options
- **Table E** Using Overall SWBMP Costs (From Cost Summary Worksheets Table D) to Estimate County Economic Impacts of Financing Alternatives: Impervious Area Fees vs Property Tax Increases

- *Note: Tables A, B, C, and D are linked. Table E is separate and not linked to the other tables.*

Source: Dennis King's Presentation at final WIP Phase II Workshop, Salisbury, MD 9/30/11