Chesapeake Stormwater Network

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Technical Documentation of Cost Estimates to Derive Stormwater Offset Fees

This appendix analyzes the cost of providing stormwater management for six different land development scenarios, for the express purpose of defining an offset fee for redevelopment sites where full ESD compliance is not possible. The six scenarios are used to estimate the cost of managing stormwater at:

- Ultra-urban redevelopment sites, using ESD practices
- New development in a green-field setting, using traditional stormwater practices
- New development in a green-field setting, using ESD practices to the full MEP
- Retrofitting green-field development using storage retrofits
- Retrofitting ultra-urban development using green streets
- Comprehensive stream restoration

The scenarios were run based on past and current stormwater sizing criteria in Maryland, so the results would differ slightly in other Bay states. The purpose of the analysis is to provide a technical basis for deriving a local offset fee when full compliance with ESD requirements is not possible. The six stormwater design scenarios presented here enable local stormwater managers to set an appropriate fee based on the kind of development they experience and the mitigation methods they intend to employ.

Caveats and Sources of Cost Data

It can be a challenge to estimating the actual cost of complying with stormwater requirements, as they vary with respect to development intensity, drainage area treated, the type of practices used and the complexity and constraints of individual development or redevelopment sites. Consequently, it is not surprising that there are greatly contrasting projections about the incremental cost to comply with new LID or ESD requirements, with some sources indicating little or no increased costs (US EPA, 2007 and MacMullan and Reich, 2007), and developers and some consultants responding that compliance costs will increase enormously.

Four primary sources of cost estimating data were used in this analysis. The first source was a large survey of actual retrofit costs contained in Schueler (2007) which included both storage and LID retrofit projects from the Chesapeake Bay and Pacific Northwest. The retrofit cost database included both the base construction costs, and costs incurred for design, engineering and permitting. The second source was updated unit cost equations for a range of stormwater practices serving new development, as reported in Appendix E of Schueler (2007). The unit costs were developed from three independent studies of stormwater costs, and were updated to reflect construction inflation. The third source was actual bid costs to construct green streets obtained from Montgomery County, MD and Baltimore City. The source for stream restoration costs was Schueler (2005), and was based on historical cost surveys in the East Coast.

The total cost for stormwater compliance was based on the volume of stormwater (cubic feet) that must be treated for a unit acre of impervious cover. The treatment volume was then multiplied by unit treatment cost that reflects the typical combination of stormwater practices that would be employed in the development scenario. The resulting construction cost was then adjusted upwards to reflect costs related to design, engineering and permitting. Additional costs were added to public sector construction, to reflect costs for project contracting and future maintenance. Land costs were not considered in any scenario, however, the mix of practices in each scenario were selected based on reasonable assumptions of land consumption, (particularly with respect to redevelopment). It should also be noted that costs for stormwater conveyance and any detention storage needed for flood control were not computed in this analysis.

The remainder of this appendix describes the specific assumptions associated with each scenario and the projected total cost.

Scenario 1: Redevelopment Using ESD Practices Cost to Treat One Impervious Acre

Scenario Assumptions:

- High Density Urban Redevelopment Project (85 to 90% impervious cover)
- No Increase in Impervious Cover from Existing Condition
- Infiltration of stormwater is not possible due to past soil disturbance
- A composite of ESD practices is used to treat the redevelopment water quality volume (i.e., 0.5 inch of runoff, or 1815 cubic feet of water quality volume per acre of impervious cover)
- The unit costs contained in Table E.4 in Appendix E of Schueler et al (2007) were used
- A composite of five space intensive ESD practices was applied to the redevelopment site, with unit costs as shown in the Table below.
- Costs for design, engineering and permitting were assumed to 40% of base construction cost, which is consistent with regional and national surveys.

Composite ESD Practices Applied in the Redevelopment Scenario		
BMP	Percent of Site	Unit Cost ($/cf)
Permeable Paver	20%	120
Green Roof	20%	170
IC Removal	20%	20
Street Bioretention	20%	30
Foundation Planter	20%	26
	100%	75.2

Based on these assumptions, the unit cost to treat runoff at a redevelopment site in Maryland is approximately **$190,938** per impervious acre

Scenario 2 New Development, Pre-ESD (2000 Manual) Cost to Treat One Impervious Acre

Scenario Assumptions:

- New Development
- Suburban residential subdivision with moderate impervious cover and high turf cover

- Site designed to water quality and channel protection sizing requirements contained in the 2000 MDE design manual
- A composite of BMPs is used to treat the water quality volume (3630 cubic feet), and an ED Pond is used to meet the channel protection volume (assumed to be equivalent to be 1.2 times the water quality volume- see Figure 1.3 in Schueler, 2007)
- The composite BMP used to treat the water quality volume includes an equal split of bioretention (@ $ 18,150 per impervious acre) and a dry swale (@ $ 25,400 per impervious acre) for a mean unit cost of $21,775 per impervious acre. To this is added the cost of constructing an ED pond for the channel protection volume (@ $3800 per impervious acre) to arrive at a base construction cost of $25,575
- The new development unit cost equations contained in Table E.2 of Appendix E of Schueler et al (2007) were used
- Design, engineering and permitting for new development projects are assumed to 25% of construction cost

Based on these assumptions, the unit cost to treat runoff at a typical new residential development under the 2000 Maryland stormwater rules is approximately **$31,689** per impervious acre

Scenario 3
New Development Using ESD to the MEP
Cost to Treat One Acre of Impervious Cover

Scenario Assumptions

- Same basic residential subdivision layout described in scenario 2
- A composite of micro-ESD practices are used to collectively treat a Pe of 2 inches at the site (7260 cubic feet), as shown in the Table below.
- 25% of the treatment volume is achieved through disconnection credits, although some engineering costs are incurred to increase filtering and infiltration in the filter path or strip.
- The design, engineering and permitting for ESD practices at new development projects are expected to be slightly higher, and are assumed to be 30% of the base construction cost

Composite ESD Practices Applied in the New Development Scenario		
ESD Practice	Percent of Site Treated	Unit Cost ($/imp acre) [2]
Bioretention	25%	25,400
Infiltration	25%	25,000
Dry Swale	25%	18,150
Disconnection Credit [1]	25%	3,000
	100%	17,888

[1] This is a rough estimate of expected costs for filter strip improvements (grading, soil amendments, berms, etc)
[2]Derived from new development unit cost equations contained in Table E.2 of Appendix E of Schueler et al (2007)

Based on these assumptions, the unit cost to treat runoff at a typical new residential development under the new 2010 Maryland ESD stormwater rules is approximately **$46,509** per impervious acre. At first glance, it would appear that the ESD requirements increase the cost of compliance by about 45%, compared to the pre-ESD stormwater design era (Scenario 2). It should be kept in mind, however, that the ESD design is expected to significantly reduce the size and cost of the conveyance and detention components of the stormwater system at the site, compared to the pre-ESD design era.

Scenario 4
Public Sector Cost to Install Storage Retrofits
One Acre of Existing Impervious Cover

Scenario Assumptions:

- Locality constructs storage retrofit on public land
- Storage retrofit treats the full water quality volume (3630 cubic feet per acre of impervious cover).
- Locality seeks to recover the full retrofitting cost, including planning, design, engineering permitting, contract administration, installation and ten years of future maintenance.
- Storage retrofit costs as described in Table E.1 of Appendix E of Schueler et al (2007) that reflect a split between existing and new pond retrofits.
- The costs for retrofit investigations based on data presented in Schueler (2005)
- Costs for contract administration and maintenance from local sources
- DEP costs derived from retrofit cost database in Schueler (2007)

The public sector cost for each stage of the retrofitting process is thus estimated at:

A. Cost to Find Retrofits:	$ 1,500
B. Storage Retrofit Installation:	$ 15,000
C. Design, Engineering, Permitting (40% of B)	$ 6,000
D. Municipal Contracting /Inspection (7.5% of B+C)	$ 1,600
E. 10 years Maintenance (4% of B +C x 10)	$ 8,400

Based on these assumptions, the unit cost to construct storage retrofits to treat runoff from existing, untreated suburban development is approximately **$32,500** per impervious acre.

Scenario 5
Public Sector Cost for Green Street Construction
One Acre of Impervious Cover Treated

Scenario Assumptions

- Municipal construction of green streets that treat the water quality volume (3630 cubic feet per impervious acre)
- Construction costs based on median value reported from ten green street construction bids in Baltimore and Montgomery County, MD.
- Locality seeks to recover the full green street implementation cost, including planning, design, engineering permitting, contract administration, and installation. These costs were directly estimated from the actual municipal costs incurred in the demonstration projects.

- No data were available to estimate whether green streets have additional maintenance costs compared to traditional streets. Consequently, the debatable assumption was made that there was no additional future maintenance costs for green streets

The public sector cost for each stage of the green street implementation process is thus estimated at:

A. Cost to Find Candidate Streets	$ 2,785
B. Green Street Installation:	$ 111,415
C. Design, Engineering, Permitting (40% of B)	$ 44,566
D. Municipal Contracting /Inspection (7.5% of B+C)	$ 8,356
E. Maintenance (Same Level)	$ -0-

Based on these assumptions, the unit cost to construct green streets to treat runoff from existing, untreated and highly urban development is approximately **$167,123** per impervious acre. It should be noted that initial green street projects are subject to the "prototype" effect associated with many new technologies, in that the unit cost generally drops over time as designers, contractors and reviewing agencies gain more experience and standardize construction methods

Scenario 6
Public Sector Cost for Comprehensive Stream Restoration Per Equivalent Acre of Impervious Cover of Nutrient Loading

Recent field studies by BDPW (2006) have evaluated the degree of nutrient reduction achieved by comprehensive urban stream restoration when compared to the in-stream nutrient load generated from un-restored and degraded urban streams. This allows one to equate stream restoration with impervious cover, at least on a nutrient loading basis. For example, the nutrient load from one acre of impervious cover can be computed using the Simple Method (Schueler, 1987).

- TP Load from One Acre of IC = 2.0 lbs/yr
- TN Load from One Acre of IC = 15.4 lbs/yr

The Baltimore stream research indicates that each linear feet of comprehensive stream restoration reduces TP loads by 0.068 lbs/yr, and TN loads by 0.20 lbs/yr. This is accomplished through enhanced in-stream nutrient processing and reduced stream bank erosion of nutrients. This suggests that

- Each 75 linear feet reach of stream restoration would reduce TN by 15 lbs
- Each 30 linear feet reach of stream restoration would reduce TP by 2 lbs/year

The nitrogen loading rate should be used as a more conservative number, and as a factor of safety, it was increased to 100 feet equals one acre of impervious cover (since there is some question as to whether nutrient reductions would persist after a degraded urban stream reached some kind of equilibrium).

Comprehensive stream restoration is defined here as using natural channel design on an entire urban stream reach that is still actively enlarging in response to upstream development. The typical application is on first or second order streams.

The public sector cost for comprehensive stream restoration was estimated as follows, using data obtained from municipal stream restoration projects in Maryland.

A. Cost To Find Candidate Streams:	$ 1,500
B. Comprehensive Stream Restoration, 100 @ $200 per lf	$ 20,000
C. Design, Engineering, Permitting (40% of B)	$ 8,000
D. Municipal Contracting /Inspection (7.5% of B+C)	$ 2,100
E. 10 years Maintenance (2% of B x 10)	$ 4,000

Based on these assumptions, the public sector cost to construct urban stream restoration that provide a nutrient reduction equivalent to that generated by one acre of impervious cover is approximately **$ 35,600** per impervious acre, which is roughly the same as the public sector cost for installing storage retrofits.

Making Sense of the Numbers

Depending on the scenario selected, the level of the offset fee could range from $32,500 to nearly $191,000 per impervious acre treated. Each community needs to balance equity with revenue recovery, and select the scenario that best reflects their development intensity and available restoration opportunities.

At a minimum, it is recommended that the fee be set at the cost of retrofitting existing development or at the cost of installing ESD in green-field settings. It may make sense to establish a higher fee in ultra-urban communities where the opportunities for more cost effective storage retrofits or comprehensive stream restoration are much more limited. More guidance on establishing the right offset fee based on local needs will be provided in CSN Technical Bulletin No. 5.

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