WRIA 9 Stormwater Retrofit BMP Cost Assumptions

Unit BMP costs for use in SUSTAIN were estimated using costs summarized from the Puget Sound Stormwater BMP Cost Database (Herrera 2011), additional sources of information and the expertise of a technical workgroup formed for the purpose of developing Best Management Practice (BMP) designs and design unit costs.[1] The intent is to use the designs and unit cost estimates in BMP optimization scenarios to identify cost effective BMP treatments that will reduce stream flashiness and reduce sediment and associated contaminant loading. Another objective of the BMP modeling effort is to parse the total cost of any particular BMP scenario into public and private costs. The proposed costs and the approach to distinguishing between costs to the public and private sector are described below.

Unit cost estimates were developed based on available information on the costs of 1) design and permitting, 2) construction (including materials) and 3) annual operation and maintenance (O&M) costs. The unit cost estimate for storm water ponds also includes an estimate of land cost per unit pond assuming that retrofit construction of storm water ponds will require the public acquisition of private property. The total Present Value (PV) unit cost of a particular BMP was determined using a discount rate of 5% and a 30-year O&M period following the approach described by Pomeroy and Houdeshel (2009). This assumes no replacement costs during the life of the 30 year project. Also note that the PV cost model does not account for inflation.

Private costs will be equal to the cost of all BMPs developed on private property, which will include on-site detention facilities such as rain barrels or custom on-site detention facilities, bioretention (i.e., rain gardens) and conversion of driveways and parking lots to porous pavement. Public costs will be the costs associated with bioretention facilities that treat road runoff and detention ponds[2].

Residential On-site Detention Facilities

Two types of residential on-site detention BMPs, both representing private sector costs, were designed for use in SUSTAIN modeling scenarios. One design represents a standard 55 gallon rain barrel. The second design represents a much larger receptacle that might be described as a custom on-site detention facility or cistern, although the design for use in SUSTAIN does not include any indoor water use; rather the stored water is drained for outdoor use.

Rain barrel unit costs summarized from the Puget Sound Stormwater BMP Cost Database (Puget Sound Database) ranged from $24.50 to $349.00 and averaged $168.65. Costs were also summarized for connection of the rain barrel to the gutter system (presumably materials only), which ranged from $2.50 to $30.00 and averaged $23.17. Installation costs (presumably labor only) ranged from $21.23 to $29.00

[1] The technical workgroup consisted of King County staff (Jeff Burkey, Curtis DeGasperi, Mark Wilgus), Dr. Rich Horner (University of Washington) and Ben Parrish (City of Covington) and the workgroup was facilitated by Tamie Kellog (Kellog Consulting).

[2] Detention ponds for this project are "stacked" ponds with a wet pond (standing water) with runoff storage available above the wet pond (often referred to as a dry pond). These types of ponds are used for water quantity and water quality treatment.

and averaged $25.12. No O&M costs were provided. Using the average costs for materials and labor results in a total construction cost of $216.94.

Cistern costs per cubic foot summarized from the Puget Sound Database are most relevant to estimating the cost of a custom on-site detention facility for this study and ranged from $2.00 to $45.00 per ft^3 and averaged $12.54 per ft^3. This suggests a cost of the approximately 3,000 gal (400 ft^3) on-site detention facility proposed for evaluation in this study (see companion design document) that would range from $800 to $18,000 and average approximately $5,000. This average cost appears high, especially considering the wide range of costs found in the Puget Sound Database. The lowest unit cost in the database was for an 81,000 gallon cistern, while costs for cisterns in the 3,000 gallon size range were $3, $4 and $11 per ft^3. Using the middle cost estimate of $4 per ft3 results in a unit cost of $1,600 for a 3,000 gallon custom residential on-site detention facility.

Costs selected for use in SUSTAIN were $220 unit cost for a rain barrel and $1,600 unit cost for a custom residential on-site detention facility. These costs conceptually represent round figures for cost of materials and construction, including the cost of labor to construct or install the systems. Operation and maintenance costs are considered to be negligible. Conceptually, these facilities will be constructed on available private land and will not require the purchase of additional land. Proposed total PV unit cost of the two residential on-site detention BMPs and associated cost details are presented in Table 1.

Bioretention Facilities

Two types of bioretention facilities will be considered in this study that represent private and public sector BMP costs. One type will represent a residential BMP (private sector) that would be characterized as a rain garden. The second type of facility will represent a public sector BMP that treats runoff from public roads. Depending on the underlying soil type, either facility may or may not have an underdrain. In areas underlain by very poorly drained soils (Type D soils), the facility will include an underdrain that will capture all of the infiltrated water. In all other areas, no underdrain will be included in the design.

Bioretention project cost information summarized from the Puget Sound Database ranged from $1.13 to $86.16 and averaged $30.55 per ft^2 (presumably for materials and construction), while design costs ranged from $0.52 to $54.13 and averaged $16.08 per ft^2. Operation and maintenance costs (presumably annual) ranged from $0.19 to $2.68 and averaged $1.22 per ft^2.

Proposed bioretention costs for use in SUTAIN as part of a parallel project to evaluate BMP treatment cost effectiveness in a Federal Way, WA drainage basin are $35.00 per ft^2 for construction and $1.10 per ft^2 for annual O&M (Herrera 2012). Herrera (2012) has not yet determined what design cost to use in their study, although they also present the average design cost of $16.08 per ft^2 derived from the Puget Sound Stormwater BMP Cost Database.

Assuming that the design cost is negligible or that it is included in the estimated construction cost of $35 per ft^2, then this unit cost implies that a 100 ft^2 (10x10 ft) rain garden (or 20x5 ft unit of road runoff bioretention BMP) costs $3,500 and $1,691 (O&M = $1.10 ft^{-2} yr^{-1}) to maintain over a 30-year period

assuming a discount rate of 5%. These are the costs proposed for use in SUSTAIN and assume that private land is available at no additional cost for rain gardens and that public right of way is available at no cost for road bioretention facilities. Proposed total PV unit cost of the bioretention BMP and associated cost details are presented in Table 1.

Porous Pavement

Porous pavement (consisting of concrete or asphalt) will be considered in this study and will represent replacement of impervious surfaces on private property, including parking lots and driveways with porous pavement. These will be considered private sector BMP costs. Depending on the underlying soil type, the porous pavement may or may not have an underdrain. In areas underlain by very poorly drained soils (Type D soils), the porous pavement will include an underdrain that will capture all of the infiltrated water. In all other areas, no underdrain will be included in the design.

Herrera (2012) is currently reporting construction costs for porous asphalt as $\$20/ft^2$ on outwash soil and $\$19/ft^2$ on till for use in the Federal Way SUSTAIN study. Herrera (2011) gave an average of $\$13.90/ft^2$ for construction (usually, including design) of porous concrete and asphalt systems, working from the Puget Sound Database. A single source reported an O&M cost of $\$0.02/ft^2$. These costs are not out of line with those reported in a survey of other sources.[3]

We plan to use a \$20 per ft^2 construction cost to develop our SUSTAIN porous pavement total cost estimate. Assuming that the design cost is negligible or that it is included in the estimated construction cost, then this unit cost implies that a 100 ft^2 (10x10 ft) unit of porous pavement costs \$2,000 and \$30.74 to maintain (O&M = \$0.02 ft^{-2} yr^{-1}) over a 30-year period assuming a discount rate of 5%. These are the costs proposed for use in SUSTAIN and assume that private land is available at no additional cost for rain gardens and that public right of way is available at no cost for road bioretention facilities. Proposed total PV unit cost of the porous pavement BMP and associated cost details are presented in Table 1.

Detention Pond

Public stormwater detention facilities (i.e., Wet Ponds in SUSTAIN) will be considered in this study to represent "gray" as opposed to the "green" or Low Impact Development (LID) BMPs addressed above. Although detention facilities are often built as part of stormwater treatment systems for larger commercial and residential developments, they will be considered a public BMP investment in this study that will also require the acquisition of private property for facility construction.

---

[3] http://www.crwa.org/projects/bmpfactsheets/crwa_permeable_pavement.pdf
http://www.projectcleanwater.org/pdf/lid/Permeable_Pavements.pdf
http://ntl.bts.gov/lib/43000/43500/43570/TSR-2011-permeable-pavements.pdf
www.region9wv.com/Bay/Calculators/**Permeable_Pavement**.xls
http://www.saveitlancaster.com/wp-content/uploads/2011/10/07_PorousPavement.pdf
www.lowimpactdevelopment.org/.../3-2_**permeablepavement**_draft.doc

We plan to consider three detention pond designs for use in different areas depending on the predominant level of development (i.e., Commercial/Industrial, Medium Density Residential, and Low Density Residential – High, Medium, and Low Development) identified in the 2007 GIS land cover data (Urban Ecology Research Laboratory) used to develop the HSPF models for this project. Land costs for each facility type were estimated by averaging the current assessed value of land for each of the three land cover types across the basin.

Detention pond construction costs per cubic foot summarized from the Puget Sound Database are most relevant to estimating the cost of wet ponds for this study and ranged from \$1.22 to \$39.41 per ft^3 and averaged \$7.97 per ft^3. Only one design and one O&M cost was reported – \$0.61 and \$0.03 per ft^3.

Proposed detention pond costs for use in SUSTAIN as part of the Federal Way project are \$8.00 per ft^2 for construction. Herrera (2012) has not yet determined what design or O&M cost to use in their study, although they also present the design and O&M costs of \$0.61 and \$0.03 per ft^3 derived from the Puget Sound Stormwater BMP Cost Database. They also stipulate that their cost estimate does not include the cost of property acquisition.

Our proposed detention pond cost estimates are similar to those proposed by Herrera (2012), but the assumed construction cost is much lower (\$0.47 per ft^3) and the property acquisition costs have been included and range from \$6.30 to \$22.20 per ft^3. Including the O&M cost and a 30-year planning period with a 5% discount rate resulted in total cost estimates for detention pond design, construction and O&M of \$0.77 per ft^3. Land costs will be input separately into sustain as the present value cost per ft^2 of land depending on the predominant land use type (and associated detention pond treatment design) in a particular basin. For example, the total present value unit cost for the treatment of Commercial/Industrial developed land, including land costs, would be \$93,250.

However, the land costs in SUSTAIN only account for the surface area of the pond, so some consideration may have to be made to adjust the land costs to account for necessary buffer areas around the ponds. Also, unit ponds as modeled in SUSTAIN using the aggregate BMP approach are conceptual and in reality several unit ponds might be aggregated and placed at a single site, which would affect assumptions made about necessary buffer areas.

References

Hererra. 2011. Draft (November 23). Technical Memorandum. Puget Sound Stormwater BMP Cost Database. Prepared for Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA. Herrera Environmental Consultants, Seattle, WA.

Hererra. 2012 Draft (July 2). Federal Way SUSTAIN Model Draft Optimization Approach. Prepared for Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA. Herrera Environmental Consultants, Seattle, WA.

Pomeroy, C.A. and C.D. Houdeshel. 2009. User's Guide to the BMP and LID Whole Life Cost Models. Version 2.0. Report #SW2R08. Water Environment Research Foundation, Alexandria, VA.

Table 1 Cost Assumptions for Low Impact Development BMPs (30-yr planning horizon with 5% discount rate)

	Residential On-site Detention Facility		Bioretention		Porous Pavement	
	Rain Barrel	**Custom design**	**Outwash / Till**	**D Soils**	**Outwash / Till**	**D Soils**
Design Unit Size	6.75 ft^3 (50 gal)	393 ft^3 (2,938 gal)	100 ft^2	100 ft^2	100 ft^2	100 ft^2
Total Present Value	$ 220 /unit	$ 3,200 /unit	$ 51.91 /ft^2	$ 51.91 /ft^2	$20.31 / ft^2	$20.31 / ft^2
Design and Permitting Cost	NA	NA	**a**	**a**	**a**	**a**
Construction Cost	$ 220/unit	$ 1,000 /unit	$ 35 /ft^2	$ 35 /ft^2	$20 /$ft^2$	$20 /$ft^2$
Annual Operation and Maintenance Cost	NA	NA	$ 1.1 /ft^2	$ 1.1 /ft^2	$0.02 /$ft^2$	$0.02 /$ft^2$
Land Cost	NA	NA	NA	NA	NA	NA

NA = Not applicable or assumed to be negligible.

a Conceptually included in construction cost?

Table 2 Cost Assumptions for Wet Ponds (30-yr planning horizon with 5% discount rate)

	Wet Pond		
	Commercial /Industrial	**Medium Density Residential**	**Low Density Residential**
Design Unit Volume	19,110 ft^3	12,852 ft^3	8,690 ft^3
Design Unit Area	3,539 ft^2	2,380 ft^2	1,704 ft^2
Total Present Value (Design, Construction and O&M)	\$0.77 /ft^3	\$ 0.77 /ft^3	\$0.77 /ft^3
Design and Permitting Cost	\$ 0.08 /ft^3	\$ 0.08 /ft^3	\$ 0.08 /ft^3
Construction Cost	\$ 0.47 /ft^3	\$ 0.74 /ft^3	\$ 0.91 /ft^3
Annual Operation and Maintenance Cost	\$ 0.05 /ft^3	\$ 0.08 /ft^3	\$ 0.10 /ft^3
Land Cost a	\$ 22.20 /ft^2	\$ 17.80 /ft^2	\$ 6.30 /ft^2

NA = Not applicable or assumed to be negligible.

a Land costs for wet ponds will vary depending on predominant level of development in basin, which is highly correlated with average land cost. There are three development level categories and three associated land costs.