

# INVESTIGATION OF OPERATION AND MAINTENANCE COST COMPONENTS FOR GREEN STORMWATER INFRASTRUCTURE

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January 16, 2013

## Question

Do operation and maintenance (O & M) costs for green stormwater infrastructure (GSI) practices reported in the “WRIA 9 Stormwater Retrofit BMP Cost Assumptions (12/13/2012)” memorandum include indirect expenses such inspection, enforcement, documentation, and record keeping, as well as the direct costs of performing the maintenance work? If not, what amounts should be added to the costs reported for rain barrels, cisterns, rain gardens (also known as bioretention cells), biofiltration swales, and porous pavements to cover indirect expenses?

## Background

The trend in the stormwater management field is toward the use of more smaller, widely distributed GSI practices closer to runoff sources and less larger, centralized conventional facilities located down-gradient and separated from sources. The latter facilities are often on public property and easily accessible to stormwater agency staff for O & M functions, whereas many of the decentralized practices will be established on private property. Agency staff are concerned that in this situation access will be more difficult and time-consuming, and thus more demanding on budgets. Access could be restricted by such circumstances as lack of right of entry, fencing and locked gates, and threatening dogs.

The WRIA 9 Stormwater Retrofit project is applying the SUSTAIN model to select retrofit strategies based on cost-effectiveness optimization relative to meeting designated biological and water quality targets in receiving waters. Early model runs showed certain GSI options to be important components of optimum strategies. However, if the O & M cost inputs to the model are not all-inclusive, these results could be misleading. It is, hence, important to make sure the costs are realistic, both to get reliable model output and to provide a foundation for realistic agency budgeting.

## “WRIA 9 Stormwater Retrofit BMP Cost Assumptions (12/13/2012)” Memorandum Data

- Rain barrels and cisterns—These BMPs were assumed to be on private property normally. O & M costs were considered to be negligible, presumably because these simple devices would not be subject to the usual demands of stormwater unit maintenance, like sediment removal, replacing vegetation or filter media, etc. In any event, maintenance or replacement would be a private responsibility. If these facilities are to be in the inspection system, costs must be added to represent the public agency tasks.

- Bioretention—The memorandum anticipated two types of bioretention units, a cellular “rain garden”, most often on private land, and a linear form on public road right of way. The latter type is equivalent to a conventional biofiltration swale, but with soil amendment if needed to boost performance on less favorable soils. An O & M cost of  $\$1.10 \text{ ft}^{-2} \text{ yr}^{-1}$  was assigned to both, mostly borne by private owners of rain gardens and public agencies for roadside swales.
- Porous pavements—Porous asphalt or concrete pavements are being considered in the study for private parking lots and driveways. Review of available data yielded a consensus O & M cost of  $\$0.02 \text{ ft}^{-2} \text{ yr}^{-1}$ , a private expense under this project’s scenario.

Inclusiveness of “WRIA 9 Stormwater Retrofit BMP Cost Assumptions (12/13/2012)”  
Memorandum Data

The reports reviewed to select representative O & M costs rarely, if ever, itemized the components included. There were no indications that the question raised in this memorandum regarding indirect costs was considered. The author discussed this point with John Lenth and Rebecca Dugopolski of Herrera Environmental Consultants, a key source of the data adopted for use in this project. They conducted a study with objectives similar to this project’s, also using SUSTAIN, and are two of the authors of the report “SUSTAIN Modeling for Controlling Toxic Chemicals in Small Streams”. These correspondents expressed the definite opinion that the O & M costs they used, and were largely adopted in this project, do not include the indirect factors.

A Basis for Adding Indirect O & M Costs

Dave Hancock of King County Stormwater Services Section has been developing “Flow Control Best Management Practices Protocols”, with GSI practices included. He provided the author extensive insights on aspects of this memorandum’s question based on his experience and professional judgment. He is anticipating that 2 hours will be needed for routine inspection of relatively small GSI facilities, including administration before and after the inspection and documentation and record keeping, but not repeat visits or enforcement if necessary.

Dave estimated the need for return visits, also taking 2 hours each, at no more than 10 percent of the cases. He further judged that the enforcement rate would run somewhat higher, about 15 percent, and would typically take 16 hours.

He recommended considering inspection frequencies of every year for porous pavements, every 2 years for rain gardens and biofiltration swales, and every 5 years for cisterns and rain barrels. Finally, he quoted labor rates of about \$80-85/hour for inspections and \$90-100 for enforcements.

This information provides a basis for adding indirect O & M expenses to the direct costs documented in the “WRIA 9 Stormwater Retrofit BMP Cost Assumptions (12/13/2012)” memorandum, as follows. Both components are annualized; but the direct costs are on a footprint basis (per  $\text{ft}^2$  of surface), while the indirect costs would be per individual unit.

- Rain barrels and cisterns—Indirect cost = (2 hours/unit inspection) x (1 unit inspection/5 years) x (1.1 multiplier for repeat inspections) x (\$85/hour) + (16 hours/enforcement) x (1 potential enforcement/5 years) x (0.15 multiplier for expected enforcement frequency) x (\$100/hour) = \$85.40 unit<sup>-1</sup> yr<sup>-1</sup>
- Private bioretention (rain gardens)—Indirect cost = (2 hours/unit inspection) x (1 unit inspection/2 years) x (1.1 multiplier for repeat inspections) x (\$85/hour) + (16 hours/enforcement) x (1 potential enforcement/2 years) x (0.15 multiplier for expected enforcement frequency) x (\$100/hour) = \$213.50 unit<sup>-1</sup> yr<sup>-1</sup>
- Public bioretention (biofiltration swales)<sup>1</sup>—Indirect cost = (2 hours/unit inspection) x (1 unit inspection/2 years) x (\$85/hour) = \$85.00 unit<sup>-1</sup> yr<sup>-1</sup>
- Porous pavements—Indirect cost = (2 hours/unit inspection) x (1 unit inspection/1 year) x (1.1 multiplier for repeat inspections) x (\$85/hour) + (16 hours/enforcement) x (1 potential enforcement/1 year) x (0.15 multiplier for expected enforcement frequency) x (\$100/hour) = \$427.00 unit<sup>-1</sup> yr<sup>-1</sup>

#### O & M Cost Summary

| Unit                        | Direct Cost (ft <sup>-2</sup> yr <sup>-1</sup> ) | Indirect Cost (unit <sup>-1</sup> yr <sup>-1</sup> ) |
|-----------------------------|--|--|
| Rain barrels and cisterns   | ~\$0 <sup>a</sup>                                | \$85.40 <sup>b</sup>                                 |
| Private Rain gardens        | \$1.10 <sup>c</sup>                              | \$213.50 <sup>b</sup>                                |
| Public biofiltration swales | \$1.10 <sup>b</sup>                              | \$85.00 <sup>b</sup>                                 |
| Porous pavements            | \$0.02 <sup>c</sup>                              | \$427.00 <sup>b</sup>                                |

<sup>a</sup> Any replacement or repairs would be a private expense.

<sup>b</sup> Public agency cost

<sup>c</sup> Private cost

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<sup>1</sup> It is assumed that there will be no need for repeat visits or enforcement for public facilities.