Geosyntec consultants

1111 Broadway, 6th Floor
Oakland, California 94607
PH 510.836.3034
FAX 510.836.3036
www.geosyntec.com

Memorandum

Date:	November 28, 2018
To:	Adele Ho and Courtney Riddle, Contra Costa Clean Water Program
Copies to:	Dan Cloak, Dan Cloak Consulting
From:	Lisa Austin, Principal; Kelly Havens, Senior Engineer; and Brian Rowley, Senior Engineer
Subject:	Green Infrastructure Cost Estimation Methodology Geosyntec Project Number: WW2407

1. INTRODUCTION

This memorandum provides a simple methodology for estimating green infrastructure capital (design and construction) and operations and maintenance (O&M) costs for use in green infrastructure (GI) planning.

To develop the methodology, GI facility cost data were gathered from several sources within the San Francisco Bay Area and Southern California to develop relationships between project size (tributary shed area) and total capital cost (construction and design). Likewise, O&M cost data were gathered from these sources, as well as through literature review.

2. COST ESTIMATE METHODOLOGY OVERVIEW

2.1 Projects Reviewed

Geosyntec assessed available cost information for 51 constructed projects, as follows:

- Ten projects constructed as part of the Caltrans BMP Retrofit Pilot Program;
- Fifteen projects constructed in the following California jurisdictions:
    - City of Concord,
    - City of El Cerrito,
    - City of La Mesa,
    - City of Los Angeles,
    - City of Oakley,
    - City of Pittsburg,

  - City of San Diego,
  - Union City, and
  - Unincorporated Contra Costa County;

- Six projects constructed as part of the BASMAA Clean Watersheds for a Clean Bay (CW4CB) Project (BASMAA, 2017); and
- Twenty constructed projects from Enhanced Watershed Management Plans (EWMPs) located in Southern California.

2.2 Cost Estimation Project Categories

Construction costs vary by facility type and project location. For example, green street projects often include ancillary construction costs associated with retrofitting the existing right-of-way and therefore are often relatively more expensive than other project types per unit area treated. Regional facilities have greater tributary areas and thus often have reduced costs per acre treated given fixed mobilization costs.

Information on facility type and location was used to group the projects into three cost estimation project categories: Green Street, Distributed Green Infrastructure, and Regional Stormwater Control. The following facility types that were included in each category include:

- Green Street: Projects built within the right-of-way, which include curb cutting and other costs associated with street retrofits. The treatment control measures may include infiltration trenches, bioretention, and infiltration galleries.

- Distributed Green Infrastructure: Biofilters, swales, infiltration strips, and bioretention installed within a parcel to treat runoff generated on that parcel.

- Regional Stormwater Control: Infiltration basins, large storage facilities, and treatment wetlands installed to treat runoff from a larger drainage area.

Projects with significant subsurface components were removed from the analysis for the Green Streets and Distributed Green Infrastructure categories due to large variances in overall trends. Subsurface green infrastructure work often involves shoring, utility relocations, and unforeseen costs associated with unknown subsurface conditions. These cost impacts did not appear to affect trends in the Regional Stormwater Control category, and thus projects with subsurface treatment facilities were included.

2.3 Source of Cost Data

Data sources varied for the projects that are summarized. For instance, for EWMP projects, data was collected from various sources, including the Proposition O monthly progress report from

August 2016 (Bureau of Engineering Prop O Clean Water Division, 2016) and publicly available online information, such as the project fact sheets provided by the City of Los Angeles stormwater program (http://www.lastormwater.org/). For CW4CB and Caltrans, cost data was published as part of Project Reports and "BMP Retrofit Pilot Program", respectively. For municipal projects, information was obtained via communication with relevant city staff.

3. COST ESTIMATE RESULTS

3.1 Design and Construction Cost Estimate

Table 1 below presents unit cost for design and construction, in 2018 dollars, for each project category. When analyzing these cost data, best professional judgment was used to distribute the design and construction costs when the information provided was unclear. If design costs were not available for a project, an estimate for design was inferred from other projects for which such costs were available. From these, the cost of design is approximately 30% of the construction cost.

Table 1: Statistical Summary of Unit Capital Cost for Each Project Category

Project Category	No. of Projects (n)	Unit Capital Cost ($/ac treated) in 2018 Dollars[1]					
		Minimum	25th-percentile	Median	75th-percentile	Maximum	Mean
Green Street	19	$25,000	$70,000	$137,000	$267,000	$1,290,000	$213,000
Distributed Green Infrastructure	21	$16,000	$90,000	$121,000	$176,000	$416,000	$153,000
Regional Stormwater Control	11	$15,000	$25,000	$61,000	$127,000	$427,000	$101,000

[1] Units have been rounded to the nearest $1,000.

3.2 Annual O&M Cost Estimate

Annual O&M costs are intended to account for activities necessary to maintain the effectiveness of a project that recur on a regular basis, such as routine maintenance on an annual basis or repairs following a large storm event. For this cost analysis, annual O&M costs do not include replacement (of portions) or rehabilitation of green infrastructure facilities, which occurs approximately every 20 to 30 years.

Data was compiled from the cost estimation sources listed in Section 2.1., when available, as well as from a literature review of reports and studies. Additionally, interviews were conducted in May and June of 2017 [City of Tacoma, Washington (J. Knickerbocker, personal communication, June 1, 2017, and the City of Portland, Oregon (M. Juon, personal communication, May 30, 2017)]. Sources of O&M data are summarized in Table 2.

For planning purposes, annual O&M costs are often assumed to be a percentage of the capital (design and construction) costs. As shown in Table 2 below, annual O&M costs range from approximately 1% to 6% of the capital costs, with an average of 4% of capital cost for the data sources reviewed.

Table 2: Comparison of O&M Cost Estimates

Source	Cost Estimation Category	O&M Annual Cost Factor (Percent of Capital Costs)
EWMP	Green Street	3.6 %
EWMP	Distributed GI	1.3 %
EWMP	Regional	1.3 %
City of Tacoma, Interview, 2017	Green Street	1.0 % - 4.6 %
City of Tacoma, Interview, 2017	Regional	5 %
City of Portland, Interview, 2017	Regional	1.5 % - 4.7 %
City of Portland, Interview, 2017	Green street	1.0 % - 3.1 %
Los Angeles Alliance for a New Economy (LAANE) Liquid Assets Report, 2018 (LAANE, 2018)	Not Specified	4.3 %
Comparison of Maintenance Cost, Labor Demands, and System Performance for LID and Conventional Stormwater Management, 2013 (Houle et al., 2013)	Not specified	4.1 % - 6.3 %
Caltrans BMP Retrofit Pilot Program Final Report, 2004 (Caltrans, 2004)	Not specified	3.2 %
EPA Green Streets Municipal Handbook, 2008 (EPA, 2008)	Not specified	5.6 %

3.3 Total Project Cost Estimation

The total cost of a project includes the capital costs and the annual O&M costs over the design life of the project.

$$Total\ Cost = Capital\ Cost + Present\ Value\ O\&M\ Cost$$

The capital cost, which includes both the design cost and the construction cost, is estimated for a new project based upon its cost estimation category and treatment area using the equations provided in Table 2. The annual O&M cost is calculated by multiplying the capital cost by the applicable fixed O&M cost factor of 4%, derived from the sources listed in Table 3. For the purposes of this analysis, a 20-year design life and a 3% inflation rate were used to calculate the total present value of the annualized O&M costs.

4. REFERENCES

BASMAA, 2017. Clean Watersheds for a Clean Bay (CW4CB) Final Report. May. Also available at: http://basmaa.org/Clean-Watersheds-for-a-Clean-Bay-Project/About-the-CW4CB-Project.

Beach Cities EWMP Group, 2015. Draft Enhanced Watershed Management Program (EWMP) for the Beach Cities Watershed Management Area (Santa Monica Bay and Dominguez Channel Watersheds). June.

Bureau of Engineering Prop O Clean Water Division, 2016. Proposition O – Clean Water Bond Program August 2016 Monthly Report. August. http://www.lacitypropo.org/

Caltrans, 2004. Caltrans BMP Retrofit Pilot Program Final Report. Available at: http://www.dot.ca.gov/hq/oppd/stormwtr/Studies/BMP-Retro-fit-Report.pdf

City of Portland, Stormwater Management Manual, 2016. Available at: https://www.portlandoregon.gov/bes/64040

Concord, 2018. E-mail communication from Kevin Marstall to Adele Ho. 29 August 2018.

Contra Costa, 2018. E-mail communication from Mitch Avalon to Kelly Havens. 27 August 2018.

El Cerrito, 2018. E-mail communication from Yvetteh Ortiz to Adele Ho. 20 August 2018.

EPA, 2008. Green Streets Municipal Handbook. Available at: https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_green_streets.pdf

Houle, James J., Roseen, Robert M., Ballestero, Thomas P., Puls, Timothy A., 2013. Comparison of Maintenance Cost, Labor Demands, and System Performance for LID and Conventional Stormwater Management. Available at: https://ascelibrary.org/doi/10.1061/%28ASCE%29EE.1943-7870.0000698

LAANE, 2018. Los Angeles Alliance for a New Economy. Liquid Assets Report. Available at: https://laane.org/wp-content/uploads/2018/03/LAANE_Liquid-Assets_Stormwater-Report.pdf

North Santa Monica Bay Coastal Watersheds EWMP Group, 2016. Enhanced Watershed Management Program (EWMP) for North Santa Monica Bay Coastal Watersheds. March.

Oakley, 2018. E-mail communication from Jason Kabalin to Kelly Havens. 12 September 2018.

Palos Verdes Watershed Management Group, 2015. Draft Enhanced Watershed Management Program (EWMP) for the Palos Verdes Watershed Management Group.

Pittsburg, 2018. E-mail communication from SM Saklaen to Adele Ho. 25 September 2018.

Union City, 2017. E-mail communication from Thomas Ruark to Shannan Young. 19 April 2017.

* * * * *