C-5. GSI Planning-level Cost Estimating Technical Memorandum

Jacobs

TECHNICAL MEMORANDUM

Green Stormwater Infrastructure Planning Level Baseline Capital Costs

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Purpose and Introduction

This technical memorandum (TM) was developed to propose a basis for planning-level capital costs for widespread, publicly-implemented green stormwater infrastructure (GSI). These costs will be used to support ALCOSAN's GSI/Source Control Program, the Controlling the Source plan, as well as Preliminary Planning analyses. This TM builds off previous work by ALCOSAN and Pittsburgh Water and Sewer Authority (PWSA) and considers information from other regional GSI programs. When developing costs for specific locations, the specific GSI technologies and site-specific cost implications should be identified as soon as possible to develop an accurate cost estimate. Life-cycle and operations & maintenance costs are also important and are discussed in ALCOSAN's GSI Guidance Document.

In addition to stormwater and sewer overflow reductions, GSI can also provide other social, economic, and environmental co-benefits. However, since these benefits do not directly relate to capital costs, they are not included in the planning-level costs of this report.

Reported GSI Costs

Information from a variety of sources was reviewed as part of this effort since there is not widespread published data on actual GSI capital costs in the Pittsburgh region. Table 1 includes Pittsburgh area cost estimates from Pittsburgh Water and Sewer Authority (PWSA) and ALCOSAN's Starting at the Source report, as well as summary data based primarily on actual GSI constructed costs in Philadelphia, Lancaster, and Onondaga County, NY. The costs were compared on an impervious acre (IA) managed basis since that is a common metric that can be readily compared from distinct locations (as opposed to something like cost per gallon of overflow reduction which is very dependent on the local collection system). As has been noted previously, there is a wide variation in reported GSI costs in the literature. For example, Starting at the Source (ALCOSAN, 2015) concluded that:

> ...site specific variations make it difficult to consider GSI costing within the intended planning level accuracy range (+50/-30% of the estimated cost) for any single site. However, GSI cost estimation within the intended planning level accuracy range is suited for planning larger concentrations of GSI technologies over several sites in terms of the dollars per impervious acres managed.

The data included in Table 1 continues to support this conclusion. The reported costs in Table 1 were adjusted to be representative of the Pittsburgh region in December 2017 (Engineering News Record 20-City Construction Cost Index: 10873; RS Means Location Factor: 102.3). This allows for the GSI costs from different years and various locations to be compared side-by-side and is consistent with other costing being done as part of Preliminary Planning.

Table 1. Summary of reported public GSI capital costs from the region

Source	Document	Document Date	Reported Construction Costs ($/IA managed)	Construction Cost Adjusted to Pittsburgh Dec. 2017 ($/IA)	Notes	Other Assumptions
PWSA	City-Wide Draft "Green First" Report	11/10/16	$300,000	$316,000	$200,000 "base construction cost" plus construction contingency listed at 25% and 20% project contingency.	No cost basis reported, assumed June 2016 ENR CCI with estimated RS Means Factor of 102.0. Assumed to be based on 1.5 inches of capture.
ALCOSAN	Starting at the Source (now Clean Water Plan Section 10)	Aug. 2015	$238,800	$309,000	Retrofit cost, including 20% project contingency for consistency w/ other values in table	All costs in 2010 Dollars: ENRCCI 8641; RS Means factor 99.6, assumes no beneficial learning curve. Capture assumed to be 1 inch.
Philadelphia Water Department	Green City, Clean Waters Pilot Program Final Report	March 2018	$354,000	$341,000	Median Philadelphia Water 5-year costs (2015 dollars)	ENRCCI is 10035 and RS Means factor is 115. Capture typically 1 to 1.5 inches.
Lancaster, PA	Green It! Lancaster	February 2019	$230,000	$240,000	Average GSI program costs for Lancaster, includes many integrated projects	ENRCCI for Sept 2018 (11183), 2018 RS Means factor is 95.2 (Lancaster). Projects average 1.1 inches of capture.
Onondaga County, NY	The real cost of green infrastructure	2016	$190,000	$230,000	Average GSI program costs for Onondaga County, includes many integrated projects	Assume ENR CCI for December 2012; 2013 RS Means factor is 97.6. Capture is typically 1 to 1.25 inches.
Average (nearest $1,000)				$287,000		
Median (nearest $1,000)				$309,000		

Integrated versus Stand-Alone GSI

Unless otherwise noted, the costs in Table 1 are assumed to be largely based on stand-alone GSI projects – those in which GSI is the driver and which consist mostly of GSI and the associated ancillary work (these were referred to as "retrofit" GSI projects in Starting at the Source). Integrated GSI projects are those judiciously integrated with other capital projects such as transportation improvements, school renovations, water and sewer rehabilitation, and park restorations. Integrated GSI projects have the potential for significant cost savings (integrated GSI was referred to as "redevelopment" GSI in Starting

at the Source). In fact, the lower GSI costs in Table 1 (those for Lancaster and Onondaga County) may be attributed to higher levels of integrated projects in those programs. As shown in Table 2, cost savings of 21 to 44% have been reported for integrated GSI.

Table 2. Estimated cost savings through integrating GSI with other capital projects

Source	Document	Predicted/Estimated Cost Savings (%) for Integrated over Stand-Alone GSI	GSI Types
MMSD, 2013	Milwaukee Regional Green Infrastructure Plan	30%	rain gardens, bioretention, and permeable pavement
ALCOSAN, 2015	Starting at the Source	21%	bioretention, permeable pavement, and subsurface infiltration
Capital Region Water, 2018	City Beautiful H2O Program Plan	25% (Median) - 31% (Mean)	
City of Lancaster, 2011	City of Lancaster Green Infrastructure Plan	44%	Various

Beneficial Learning Curves

As with other emerging practices or technologies, there is a potential that the cost of GSI may decrease as implementation ramps up. Cost decreases could result from a number of factors, including:

- refinements to the project selection and design process,
- reduced material costs through the creation or expansion of local markets and supply chains,
- increased contractor familiarity and competition, and
- reduction in perceived risks.

While there is a potential for cost reductions over time, larger market forces, reduced availability of the most suitable GSI sites, and other factors may counteract them. For these reasons and due to a deficiency of available data on this topic, we recommend that a beneficial learning curve not be assumed at this time but that actual costs in the region be tracked over time and planning-level costs adjusted periodically.

Planning-Level Baseline GSI Costs

For the purposes of planning-level construction cost estimating for widespread, publicly-implemented GSI, the median December 2017 cost from Table 1 of $309,000 per impervious acre managed is proposed as the baseline cost for stand-alone ("retrofit") GSI. Applying ALCOSAN's 20% multiplier for engineering and implementation yields a baseline capital cost of $371,000 per acre. This is relatively consistent with the middle of the cost range reported in PWSA's Draft Green First Plan (adjusted to Dec. 2017). Also consistent with the Draft Green First Plan and Starting at the Source, we do not recommend separating out planning-level capital costs for the three primary types of GSI (bioretention, porous pavement, and subsurface storage/infiltration) since there is not a lot of data to support different costs and because the specific mix of GSI types for future projects is often not yet determined.

Baseline planning-level capital costs for integrated GSI are proposed to average 30% less than the stand-alone cost, rounded to $260,000 per impervious acre managed. These recommended baseline planning-level costs are shown in Table 3. For finer-level analyses, these baseline costs should be adjusted as appropriate based on localized information such as project size, constraints, and project setting. Life-cycle and operations & maintenance costs are also important and are discussed in ALCOSAN's GSI Guidance Document.

Table 3. Proposed baseline planning-level public GSI capital costs[1]

Type of GSI Implementation	Baseline Construction Cost ($/impervious acre managed)	Baseline Planning-Level Capital Cost ($/impervious acre managed)
Stand-alone (retrofit)	$309,000	$371,000
Integrated (redevelopment)	$216,000	$260,000

[1] Assumes 1 to 1.5 inches of capture from the contributing impervious area, different capture depths may require a cost adjustment

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