

WEF/WE&RF: LIFECYCLE COST ANALYSIS OF GREEN INFRASTRUCTURE Oct. 1, 2017

WORKSHOPS



U.S. EPA NATIONAL STORMWATER CALCULATOR: LOW IMPACT DEVELOPMENT STORMWATER CONTROL COST ESTIMATION MODULE & FUTURE ENHANCEMENTS

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Presentation Outline

- Stormwater Calculator Background Information
- Potential Applications
- Cost Estimation Module
- Using the Calculator: Baltimore, MD (May 2017 Application)
- Development of Mobile Web Application
- Discussion & Questions



National Stormwater Calculator Website

SEPA United States Environmental Protection Agency



National Stormwater Calculator

EPA's National Stormwater Calculator (SWC) is a desktop application that estimates the annual amount of rainwater and frequency of runoff from a specific site anywhere in the United States (including Puerto Rico). Estimates are based on local soil conditions, land cover, and historic rainfall records.



http://www2.epa.gov/water-research/national-stormwater-calculator



Training and Outreach Materials: User's Guide & Fact Sheet



EPA/600/R-13/085d | Revised January 2017 | www.epa.gov/research

National Stormwater Calculator User's Guide



v.epa.gov/research INNOVATIVE RESEARCH FOR A SUSTAINABL





The National Stormwater Calculator shows users how land use decisions and green infrastructure practices affect the amount of stormwater runoff produced. Green infrastructure, such as the street planter and porous pavers shown above (Image 1), are low impact development controls that promote the natural movement of water within an ecosystem or watershed, instead of allowing it to wash into streets and down storm drains, as it does with traditional grey infrastructure shown above (Image 2)

These practices allow the stormwater to be used as a resource rather than a waste product. Having less water runoff into storm drains and roadways can help prevent contamination of waterways, infrastructure degradation, flooding, and overwhelming of treatment plants.

Monte format feature
 Prove (and the set of the

National Stormwater Calculator (SWC)

science in ACTION

Tool that helps users control runoff to promote the natural movement of water

Stormwater discharges continue to cause impairment of our Nation's waterbodies. In order to reduce impairment, EPA has developed the National Stormwater Calculator (SWC) to help support local, state, and national stormwater management objectives and regulatory efforts to reduce runoff through infiltration and retention using green infrastructure practices as low impact development (LID) controls. The primary focus of the SWC is to inform site developers on how well they can meet a desired stormwater retention target with and without the use of green infrastructure. It can also be used by landscapers and homeowners.

Platform. The SWC is a Windows-based desktop program that requires an internet connection. A mobile web application version that will be compatible with all operating systems is currently being developed.

Cost Module. An LID cost estimation module within the application allows planners and managers to evaluate LID controls based on comparison of regional and national project planning level cost estimates (capital and average annual maintenance) and predicted LID control performance. Cost estimation is accomplished based on user-identified size configuration of the LID control infrastructure and other key project and site-specific variables. This includes whether the project is being applied as part of new development or redevelopment and if there are existing site constraints.

Climate Scenarios. The SWC allows users to consider how runoff may vary based both on historical weather and potential future climate conditions. To better inform decisions, it is recommended that the user develop a range of SWC results with various assumptions about model inputs such as percent of impervious surface, soil type, sizing of green infrastructure, as well as historical weather and future climate scenarios. Please check with local authorities about whether and how use of these tools may support local stormwater management goals.

The SWC is comprised of ten tabbed pages:

1-Location. This step has an address lookup feature that allows the user to easily navigate to a site selected anywhere within the United States.

2–Soil Type. In this step, soil type is identified and is used to infer infiltration properties. It can be selected based on local knowledge or from the online database.

3-Soil Drainage. This step identifies how quickly water drains into the soil. Conductivity can be selected based on local knowledge or retrieved from the online database.

4-Topography. Here, the site's surface topography is characterized, as measured by the surface slope. The user can rely on the slope data display as a guide or can use local knowledge to describe the site's topography.



What Developed and Why?

- Stormwater Management (Green Infrastructure/Low Impact Development) Design and Planning Tool
 - Model post-construction urban stormwater runoff discharges
 - Allow for screening-level analysis of various green infrastructure practices, including planning level costs (green roofs, rain gardens, cisterns, etc.) throughout the U.S.
 - Allow non-technical professionals to conduct screening level stormwater runoff for small to medium sized (less than 1 12 acres) sites



Who We Created the Calculator for...

- Local planners
- Land developers
- Landscape architects
- Homeowners, etc.

...to assist meeting stormwater design and planning goals or requirements



Potential Applications

- State or MS4 (Municipal Separate Storm Sewer System) Post Construction Stormwater Design Standards
- Voluntary Stormwater Retrofits for private property owners
- Voluntary Programs: LEED (US Green Building Council)
- Climate Resiliency Planning: Rockefeller Foundation's 100 Resilient Cities
- LID/Green Infrastructure Design Competitions: Campus EPA RainWorks Challenge



Storm Water Management Model (SWMM)

SEPA United States Environmental Protection Agency

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Storm Water Management Model (SWMM)

Version 5.1.012 with Low Impact Development Controls

- Description
- <u>Capabilities</u>
- <u>Applications</u>
- Add-in Tool
- <u>Support</u>
- <u>Downloads</u>
- <u>Documentation</u>
- Helpful Resources
- <u>Contact</u>



- The calculator is based on SWMM: dynamic rainfall-runoff simulation model for long-term simulation of runoff quantity
- SWMM produces stormwater runoff estimates in the background of the Stormwater Calculator



National Stormwater Calculator (SWC): Site Parameters and Embedded GIS Data-sets

- Location: Bing Maps
- Soils: NRCS SSURGO
- Slope: NRCS SSURGO
- Hydraulic Conductivity: NRCS SSURGO
- Precipitation and Temperature: National Climate Center (NCDC)-NOAA from EPA's BASINS Model
- Evaporation: calculation based on meteorological data
- Climate Change Future Scenarios: precipitation & evaporation
- Land-Cover/Use: user provided
- LID Practices (*new costing module available*): user provided



SWC Desktop Application

😌 National Stormwater Calculator

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Overview Location Soil Type Soil Drainage Topography Precipitation Evaporation Climate Change Land Cover LID Controls Results



Select the Location tab to begin analyzing a new site.

Analyze a New Site Save Current Site Exit



• Intended Uses:

- Planning level cost estimates (magnitude of costs between planning scenarios)
- Limitations:
 - Not final construction/build costs
 - Not lifecycle costs (gives annual O & M costs, not replacement costs)
 - Regional costs not available for all areas of the US (many of the Western states)

Intended Audience

• Planners, landscape architects, homeowners, developers, students, etc.



SWC Cost Estimation Module: Site Complexity Effects on Costs of Stormwater Projects

Criteria	Degree of Complexity				
	Simple	Typical	Complex		
New vs. existing development	New	Existing	Existing		
<i>(Pretreatment)</i> Outflow and overflow discharge safety constraints	Safe & unconstrained	Slightly constrained & may require some grading or pipe infrastructure for safe discharge	Likely constrained & may require significant grading or pipe infrastructure for safe discharge		
Equipment accessibility	Easy access	Fairly easy	Difficult access		
Slope for LID control placement	Flat to moderately flat (0 – 4%)	Moderately flat (4 – 7%)	Steeper slope (greater than 7%)		
Soil infiltration rate	High infiltration (HSG: A)	Moderate infiltration (HSG: B)	Low infiltration (HSG: C and D)		



Accounting for Uncertainty with Cost Estimates (Regression Cost Curves)





Development of Regionalized Low Impact Development/Green Infrastructure Costs

- Utilization of Bureau of Labor Statistics (BLS) Data for regional costs
 - —National Producer Price Index: outputs of service, construction, utilities, and other goods producing entities
 - Examples include: concrete storm sewer pipe, construction sand and gravel, etc.
 - -Consumer Price Index: regional/city data (23 major US cities)
 - Examples include: fuels and utilities, energy, and diesel fuel
- Data easily updated and maintained annually by EPA
- Development of regional costs comparable to Engineering News Record (ENR) and RS Means







• Street planters as part of a complete street





MAIN STREET



SWC Case Study: Green & Complete Streets Building Blocks Workshop (April, 2017): Pigtown Neighborhood - Baltimore, MD





Existing Planning Costs for Bio-retention at Scott Street (Pigtown Mainstreet consultant team, 2017)



*Costs do not include annual maintenance and operations

SWC Analysis: Scott Street <u>Project Location</u>





SWC Analysis: Scott Street Soil Runoff Potential





Select a soil type for the site.

Analyze a New Site Save Current Site Exit

SWC Analysis: Scott Street Soil Drainage





Enter the soil's drainage rate.

SWC Analysis: Scott Street Topography





SWC Analysis: Scott Street *Historical Precipitation*





Select a source of long-term hourly rainfall data.

Analyze a New Site Save Current Site Exit

SWC Analysis: Climate Change Impacts for the Northeast







SWC Analysis: Scott Street Climate Change Scenarios





SWC Analysis: Scott Street Existing Land Cover



SWC Analysis: Scott Street Low Impact Development Controls (LID)





Assign LID practices to capture runoff from impervious areas.

Analyze a New Site Save Current Site Exit

SWC Analysis: Scott Street LID: Redevelopment Project





Assign LID practices to capture runoff from impervious areas.

Analyze a New Site Save Current Site Exit

SWC Analysis: Scott Street LID: Site Suitability (Poor)





Assign LID practices to capture runoff from impervious areas

Analyze a New Site Save Current Site Exit



SWC Analysis: Scott Street LID: US Bureau of Labor Statistics Regional Cost Centers

🐣 National Stormwater Calculator

Overview Location Soil Type Soil Drainage Topography Precipitation Evaporation Climate Change Land Cover LID Controls Results





Assign LID practices to capture runoff from impervious areas.

Analyze a New Site Save Current Site Exit

SWC Analysis: Scott Street **Runoff Reduction Results**



SWC Analysis: Scott Street Capital Costs Summary (Poor Site Suitability)

🐣 National Stormwater Calculator									- 🗆 🗙
Overview Location Soil Type Soil Drainage	Topography Precipitation Evapora	tion Climate Change	Land Cover LID C	ontrols Results					
Options Years to Analyze Event Threshold (inches)		Estin	nate of Proba	able Capital	Costs (estima	tes in 2016 L	JS.\$)		
Ignore Consecutive Days		Drainage Area Has Pre-trt? Current Scenario (C) % Area Treated 0.60 ac		cenario (C) ted 0.60 ac	Baseline Scenario (B) Area Treated ac		Difference (C - B) Area Treated 0.60 ac		
Refresh Results	Cost By LID Control Type	Current / Baseline	Current / Baseline	Low	High	Low	High	Low	High
Use as Baseline Scenario	Disconnection	NA / NA	No / NA	\$0	\$0	-	-		-
Print Results to PDF File	Rain Gardens	NA / NA	No / NA	\$0	\$0	-	-	-	-
Reports	Green Roofs Street Planters	NA / NA 75 / NA	No / NA No / NA	\$0 \$24,478	\$0 \$34,036	-	-	-	•
O Site Description	Infiltration Basins	NA / NA	No / NA	\$0 \$0	\$0	-	-		-
Summary Results Rainfall / Runoff Events	Total	75 / NA	Varies	\$24,478	\$34,036	-	-		-
Rainfall / Runoff Frequency	Note: site complexity variables that affec	t cost shown below:							
Rainfall Retention Frequency Runoff By Rainfall Percentile Extreme Event Rainfall / Runoff	Current Scenario Dev. Type Re-development Site Suitability Poor				Baseline Scenario - -				
Cost Summary	Soil Type C Cost Region Washington (40 miles) 0.92				- -				
<u>Help</u>									Hel



Runoff results are up to dat

Analyze a New Site Save Current Site Exit

SWC Analysis: Scott Street Annual Maintenance Costs Summary (Poor Site Suitability)

🐣 National Stormwater Calculator — 🗆 🕹								
Overview Location Soil Type Soil Drainage	Topography Precipitation Evaporation Climate Change Land	Cover LID Controls	Results					
Options Years to Analyze 8 • Event Threshold (inches) 0.10 •	Estimate of Probable Maintenance Costs (estimates in 2016 US.\$) <u>Capital Costs Graphical View</u>							
Ignore Consecutive Days	Current Scenario (C) Baseline Scenario (B) Difference (C - B)							
Actions	Cost By LID Control Type	Low	High	Low	High	Low	High	
Refresh Results	Disconnection	\$0	\$0	-	-	-	-	
Use as Baseline Scenario	Rainwater Harvesting	\$0	\$0	-	-	-	-	
	Rain Gardens	\$0	\$0	-	-		-	
Remove Baseline Scenario	Green Roofs	\$0	\$0	-	-	-	-	
Print Results to PDF File	Street Planters	\$49	\$1,169	-	-	-	-	
Reports	Infiltration Basins	\$0	\$0	-	-	-	-	
Site Description	Permeable Pavement	\$0	\$0	-	-	-	-	
	lotal	\$49	\$1,109	-	-	-	-	
	Note: site complexity variables that affect cost shown below.							
	Current Scenario Baseline Scenario							
C Rainfall / Runoff Frequency	Dev. Type Re-development -							
O Rainfall Retention Frequency	Topography Mod. Flat (5% Slope) - Soil Type C -							
O Runoff By Rainfall Percentile								
O Extreme Event Rainfall / Runoff	Cost Region Washington (40 miles) 0.92 -							
Cost Summary								
<u>Help</u>							<u>Help</u>	



Runoff results are up to date

Analyze a New Site Save Current Site Exit

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Interpreting the Results

- Informing next steps for finalizing costs of stormwater projects
- Comparing the relative magnitude of planning level costs (capital & operations/maintenance costs) for different stormwater management solutions.
- Comparisons may be made between national and regional cost estimates:
 - Using local knowledge in selection of regional BLS cost multipliers
 - Washington, DC, Philadelphia, PA, etc.



SWC Mobile Web App Development







Discussion and Questions Thank You!

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National Stormwater Calculator Website:

https://www.epa.gov/water-research/national-stormwater-calculator

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