Chesapeake Bay Program STAC Workshop:
Monitoring and Assessing Impacts of Changes in Weather Patterns and Extreme Events on BMP Siting and Design

U.S. EPA National Stormwater Calculator

Jason Bernagros (Berner)
U.S. EPA's Office of Research and Development

Sept. 7, 2017

About The Presenter

EPA United States Environmental Protection Agency

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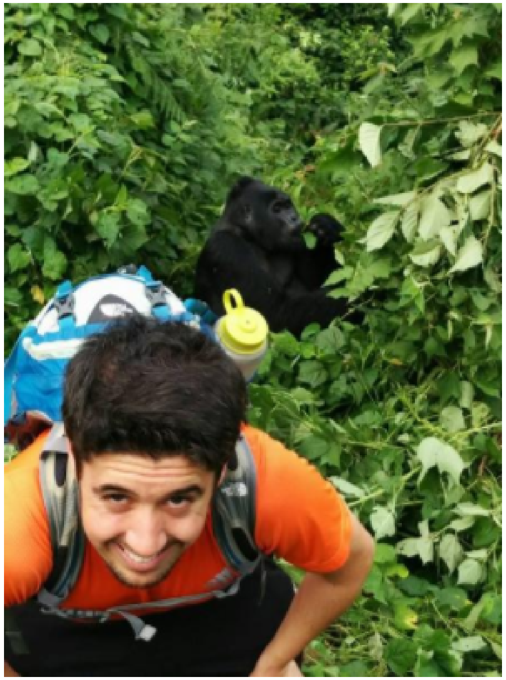
Meet EPA Scientist Jason Berner

Jason Berner likes that his science makes a difference on a local level by helping communities use green infrastructure to reduce stormwater runoff.

Tell us about your background.

I have a BS in natural resources and environmental science, and a MLA (masters of landscape architecture) with a focus on ecological design from the University of Illinois at Urbana-Champaign. I started at EPA in 2007 working on wetlands protection in Region 2. I worked on watershed management in the New York City drinking watershed, based in the Catskills Mountains. From there, I started doing work on urban stormwater management and planning tools that communities and water utilities could use- such as the National Stormwater Calculator.



When did you first know you wanted to be a scientist?

I first knew sometime during the middle of undergraduate studies. I took a course on environmental science that was focused on how the University of Illinois campus could be more environmentally sustainable and how ecological restoration could be done on campus. It really helped me get a better understanding of how scientists could make an impact locally.

How does your science matter?

Green infrastructure looks at how urban environments can be designed and planned to mitigate and adapt to some of the impacts of climate change, such as increased flooding. My research helps communities implement green infrastructure practices and looks at how the

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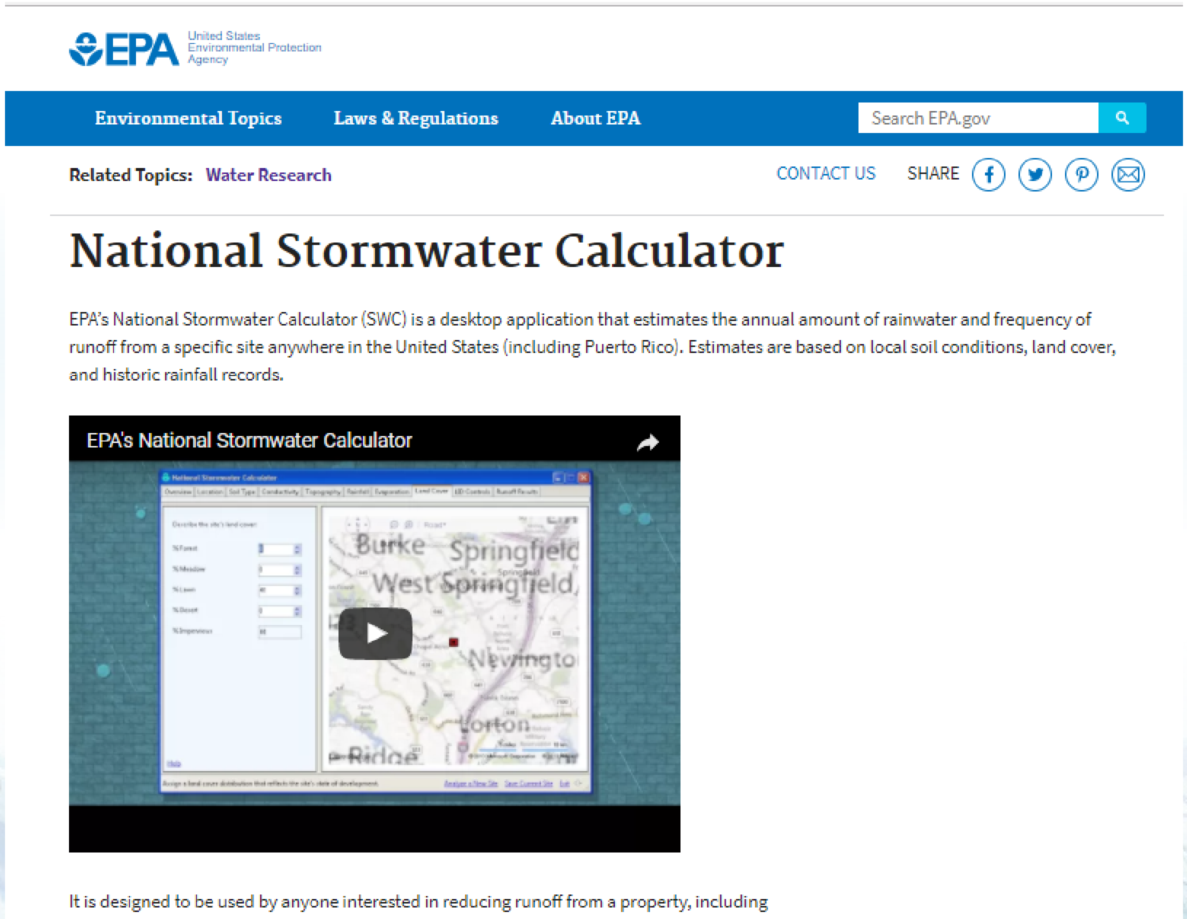
https://www.epa.gov/sciencematters/meet-epa-scientist-jason-berner

Outline

U.S. EPA National Stormwater Calculator

- **Stormwater Calculator Background Information**
- **Potential Applications**
- **Using the Calculator:** Baltimore, MD (Apr. 2017 Application)
- **Example Application:**
  - U.S. Climate Resilience Toolkit (Mount Rainier, MD)
- **Development of Mobile Web Application**
- **Discussion & Questions**

National Stormwater Calculator Website



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

United States Environmental Protection Agency

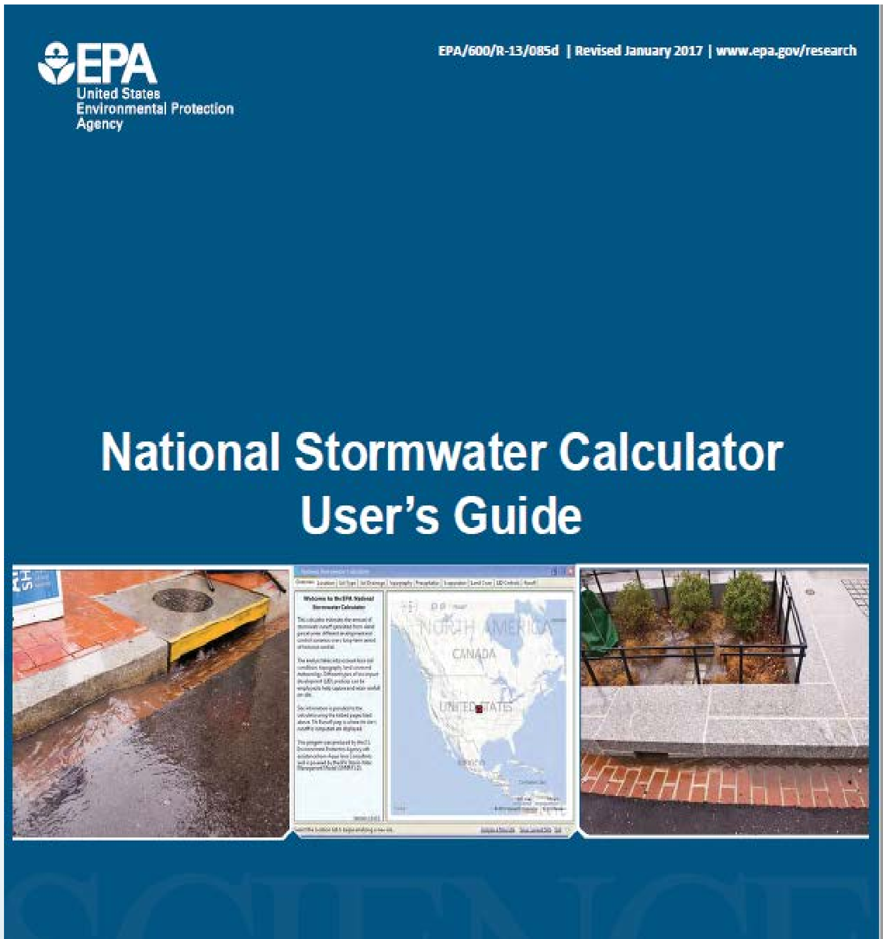
What Have We Created and Why?

- **Stormwater Management (Green Infrastructure/Low Impact Development (LID)) 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

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 (U.S. Green Building Council) and Sustainable Sites Initiative stormwater credits
- Climate Resiliency Planning: Rockefeller Foundation's 100 Resilient Cities
- LID/Green Infrastructure Design Competitions: Campus RainWorks Challenge, DC Water Green Infrastructure Challenge, etc.

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



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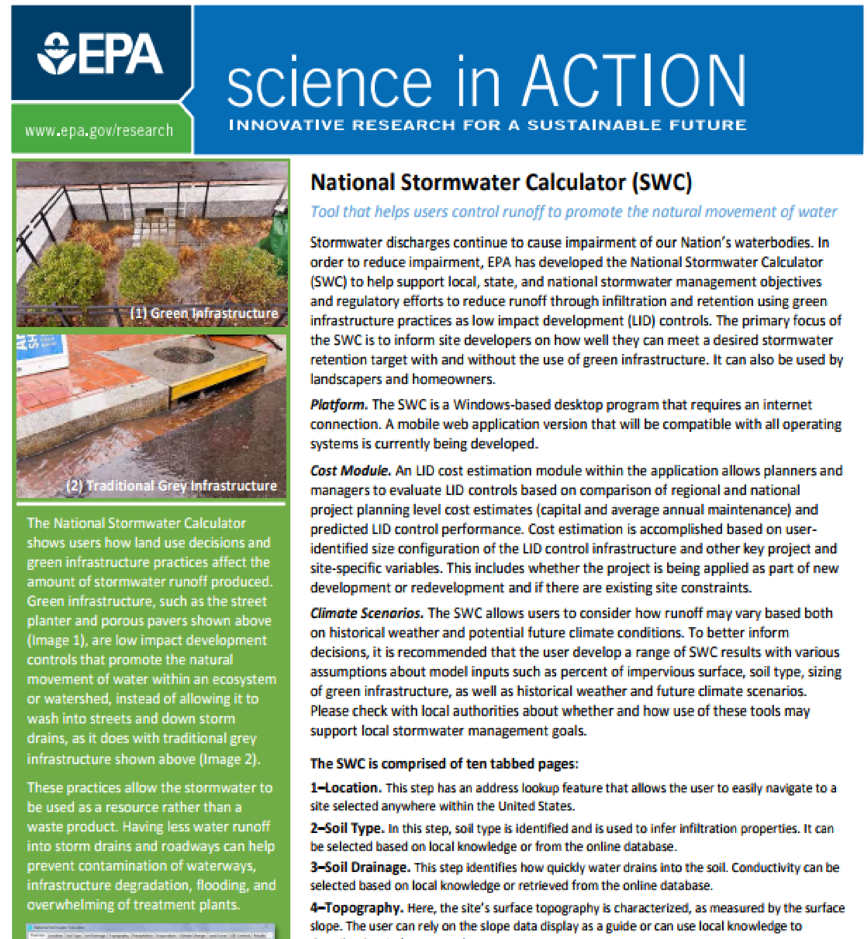
EPA/600/R-13/085d | Revised January 2017 | www.epa.gov/research

National Stormwater Calculator User's Guide



EPA

www.epa.gov/research

science in ACTION

INNOVATIVE RESEARCH FOR A SUSTAINABLE FUTURE

(1) Green Infrastructure

(2) Traditional Grey Infrastructure

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.

National Stormwater Calculator (SWC)

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:

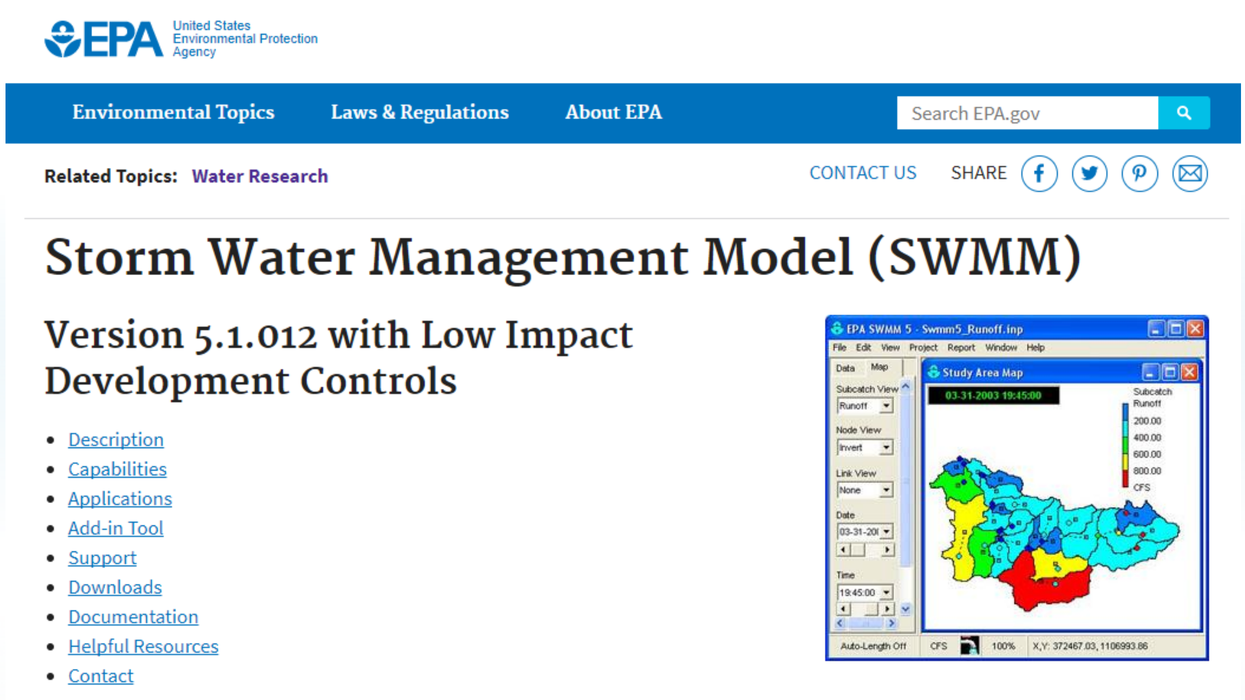
1–Location. This step has an address lookup feature that allows the user to easily navigate to a site selected anywhere within the United States.

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.

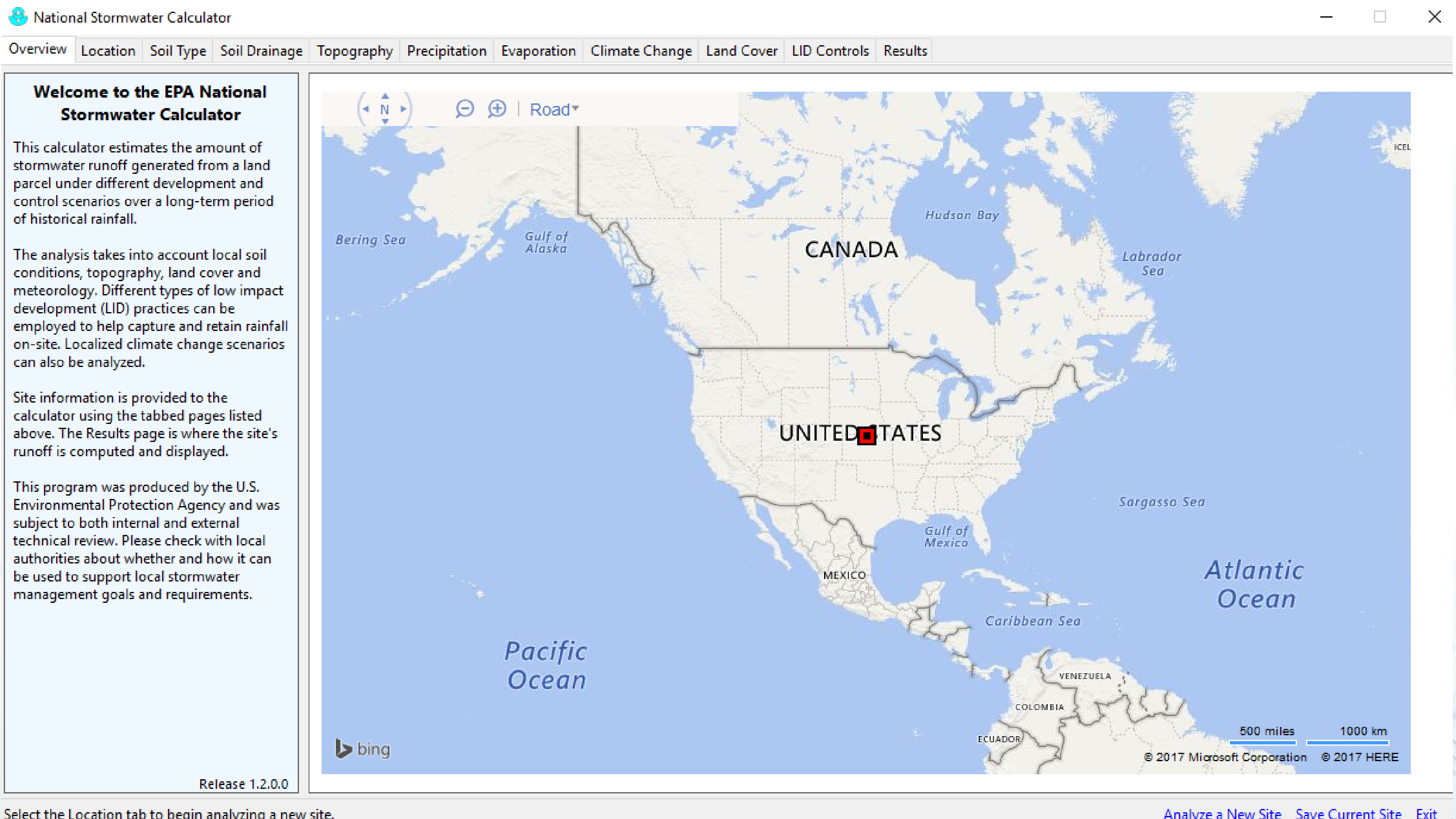
4–Topography. Here, the site's surface topography is characterized, as measured by the surface slope. The user can rely on the slope data display as a guide or can use local knowledge to describe the site's topography.

Storm Water Management Model (SWMM)



- 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

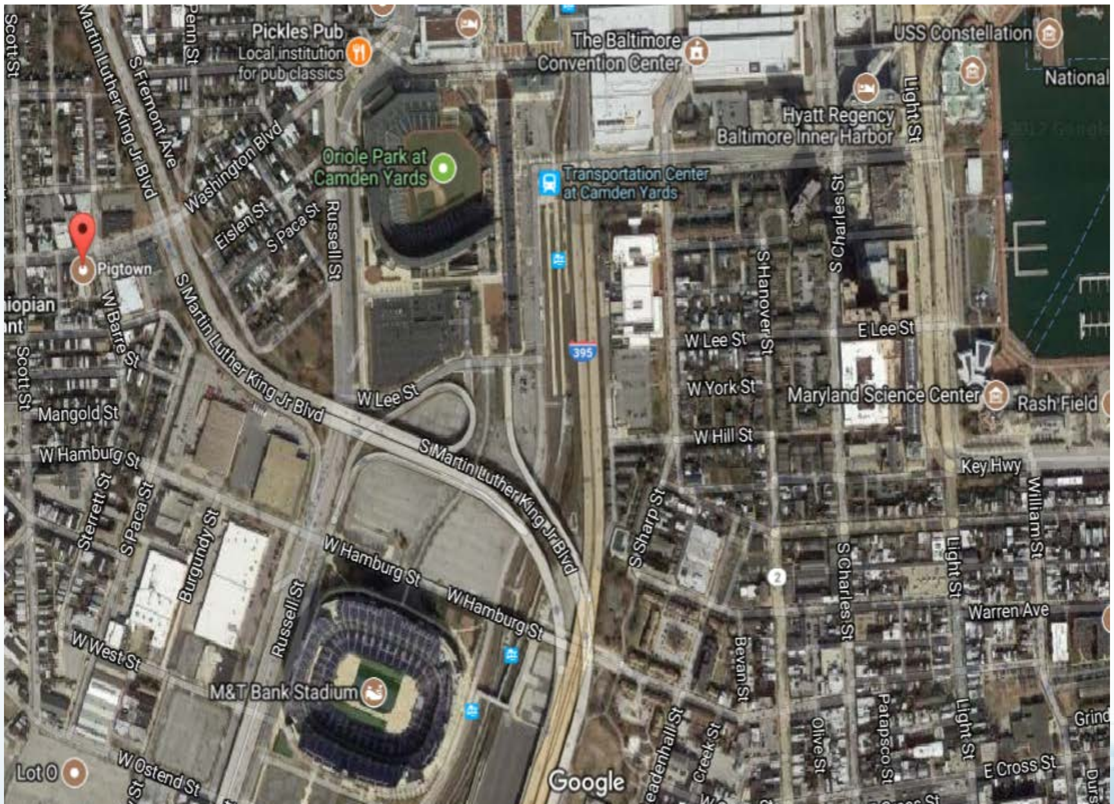
National Stormwater Calculator (SWC) Desktop Application



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

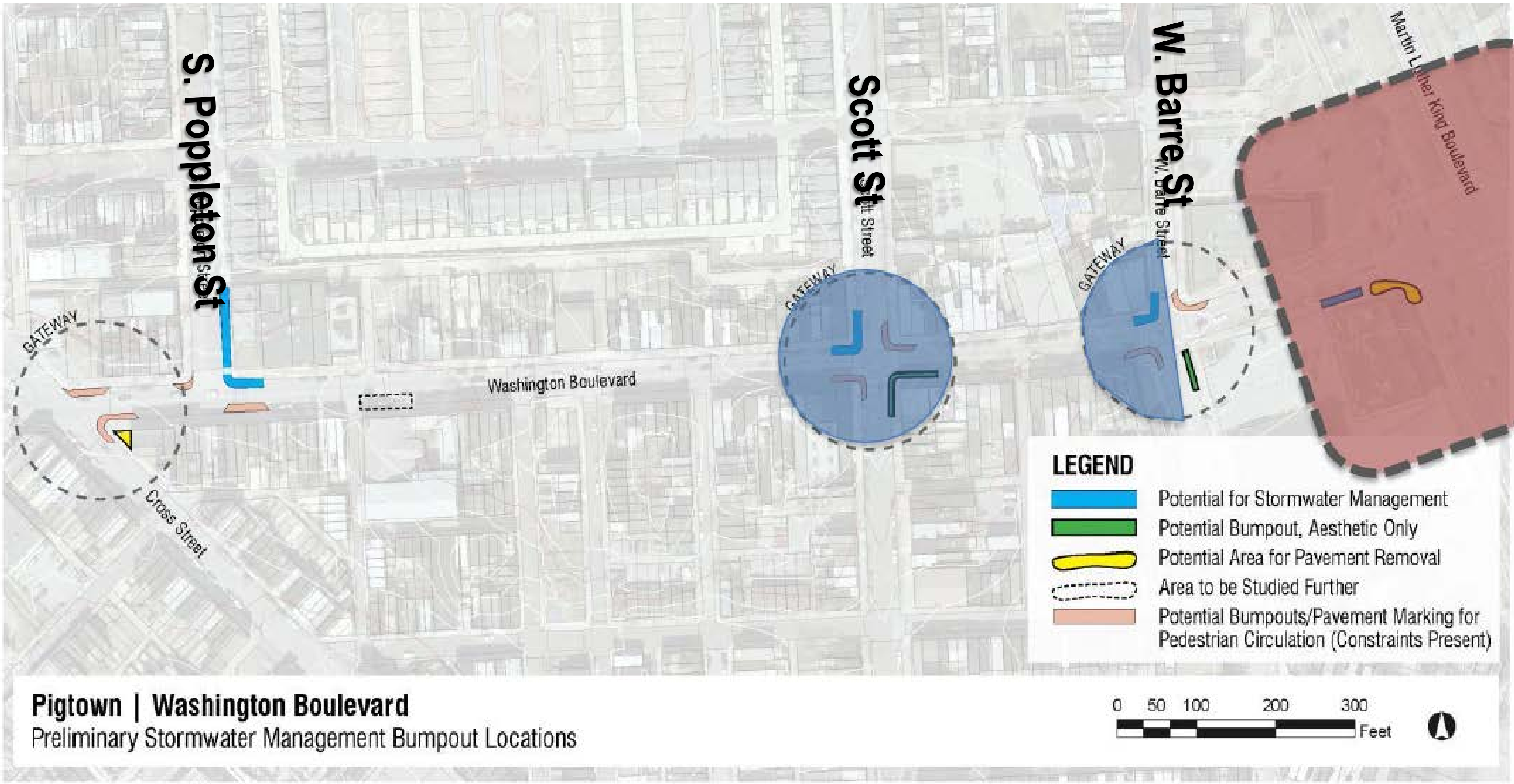
SWC Application: Baltimore, MD (Pigtown Neighborhood)
Green & Complete Streets Workshop (Apr. 2017)



- Street planters as part of a complete street

SWC Analysis:

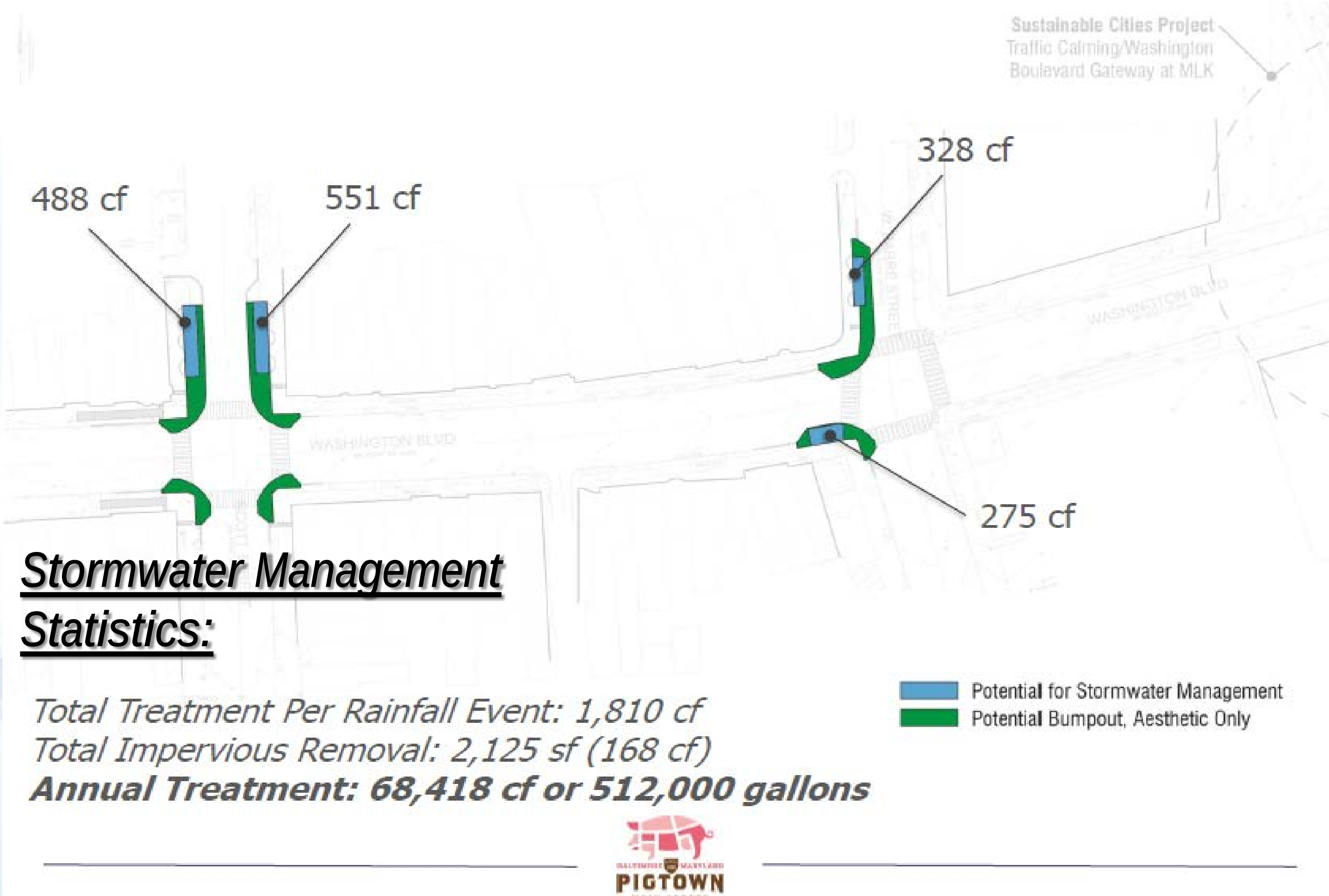
Green & Complete Streets Building Blocks Workshop (April, 2017)
Pigtown Neighborhood - Baltimore, MD



BALTIMORE MARYLAND PIGTOWN MAIN STREET

SWC Analysis:

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



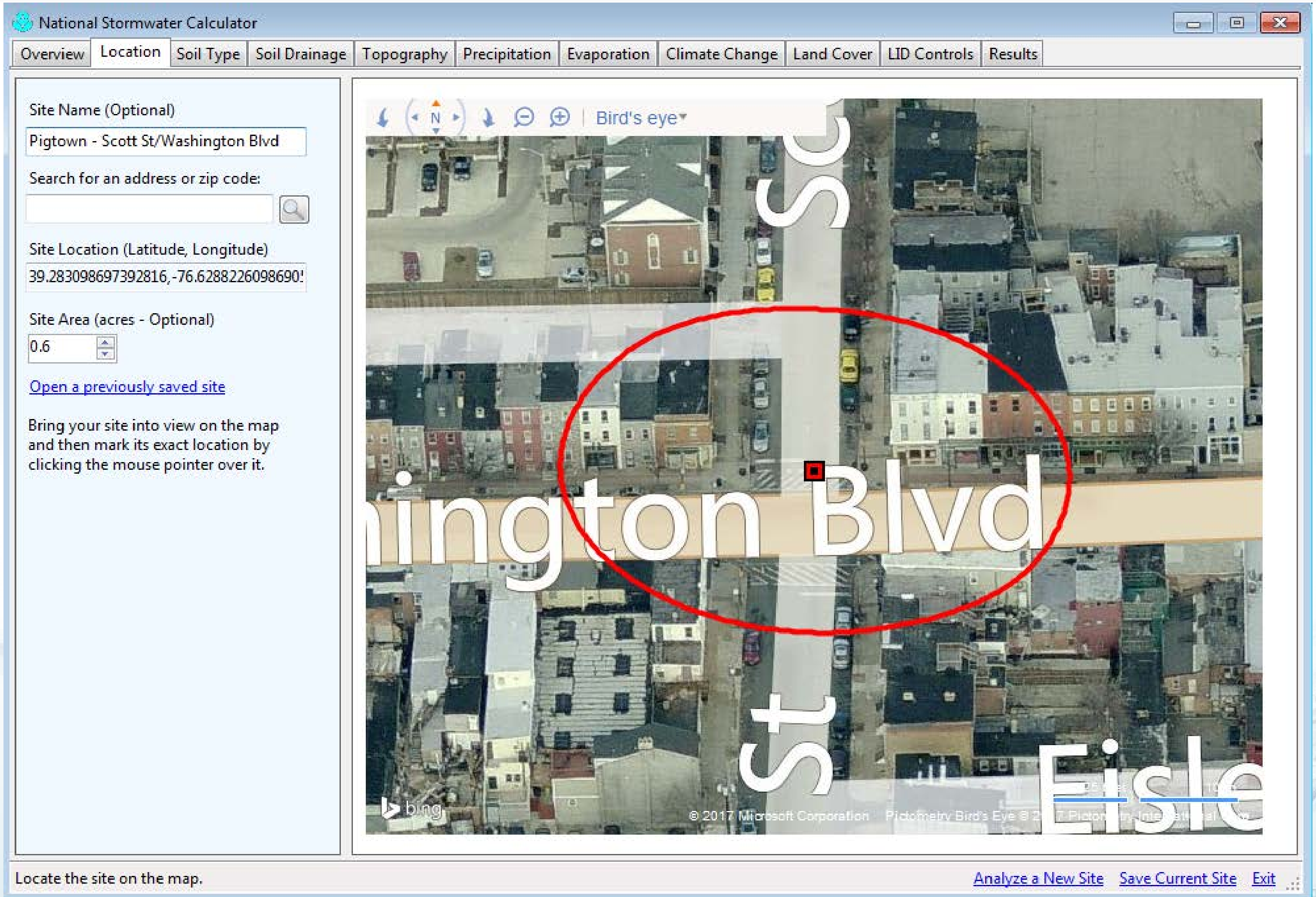
Existing Planning Costs for Bio-retention at Scott Street
(Pigtown Mainstreet consultant team, 2017)

CAT 3 – STORMWATER								
ITEM	QTY (H)		EXCA.	QTY	UNITS	COST	TOTAL COST	NOTES
MICROBIORETENTION AREAS	582	291	1.1	640	SF	$35	$22,407	includes plants

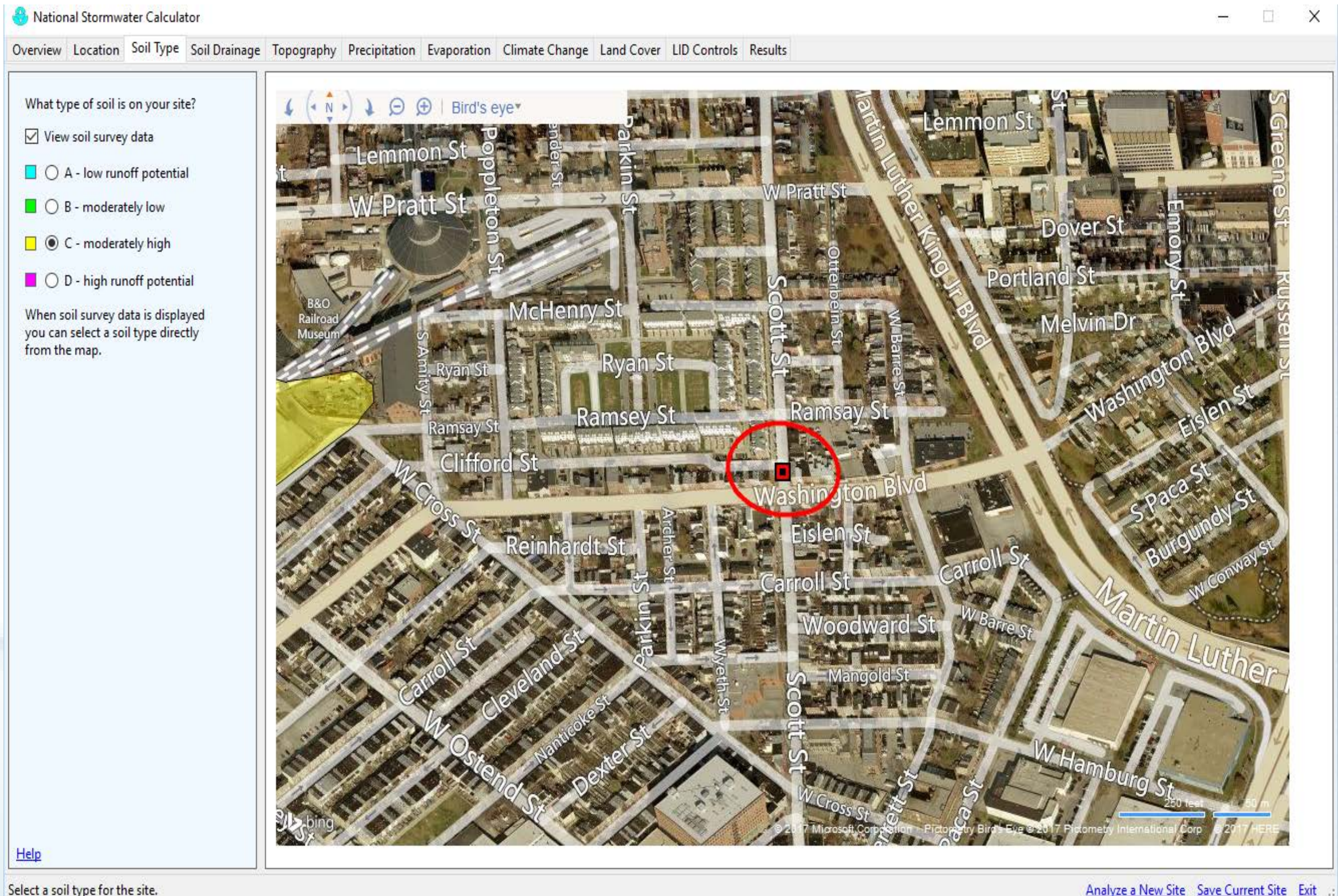
**Costs do not include annual maintenance and operations*

SWC Analysis: Scott Street

Project Location

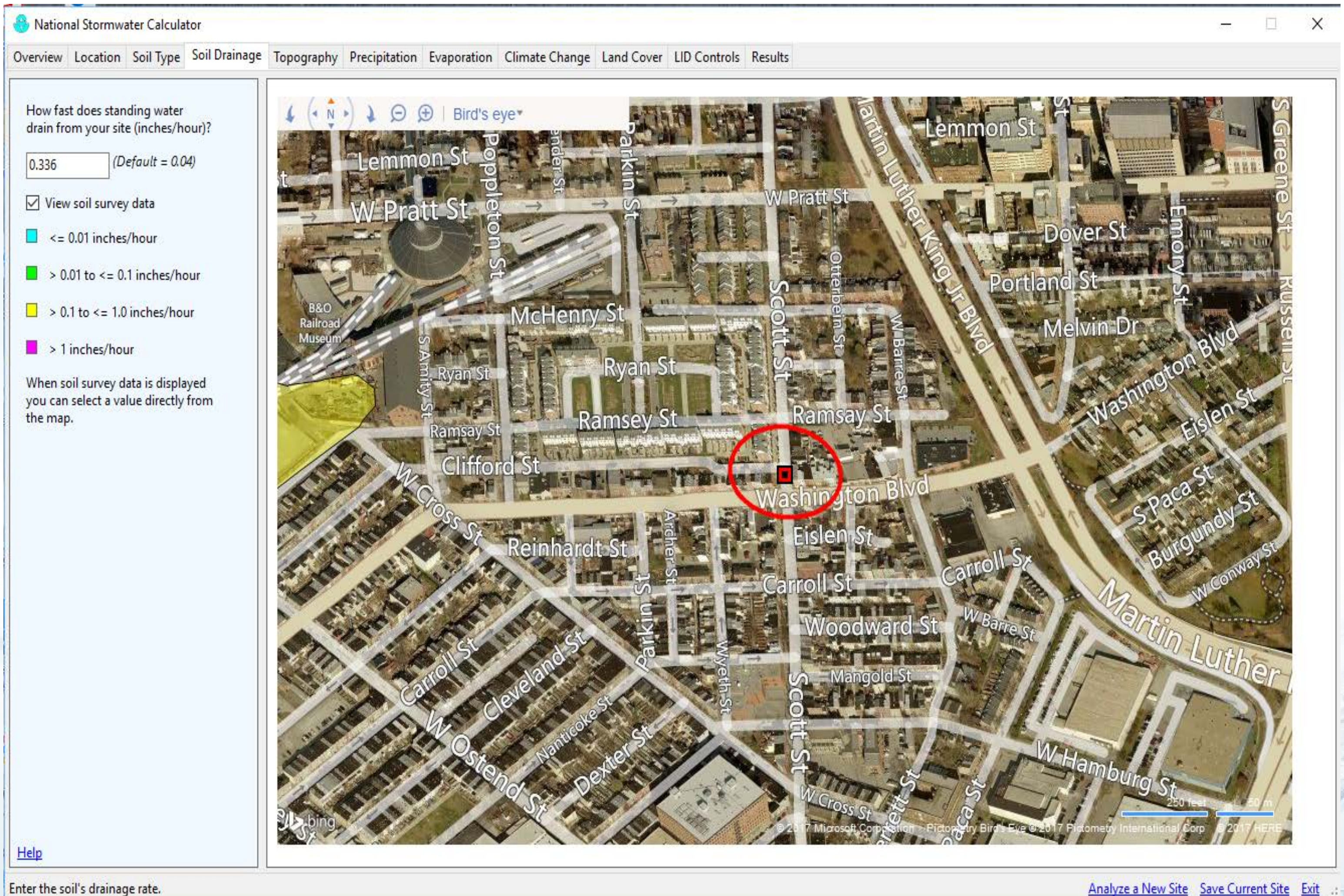


SWC Analysis: Scott Street
Soil Rainfall Runoff Potential



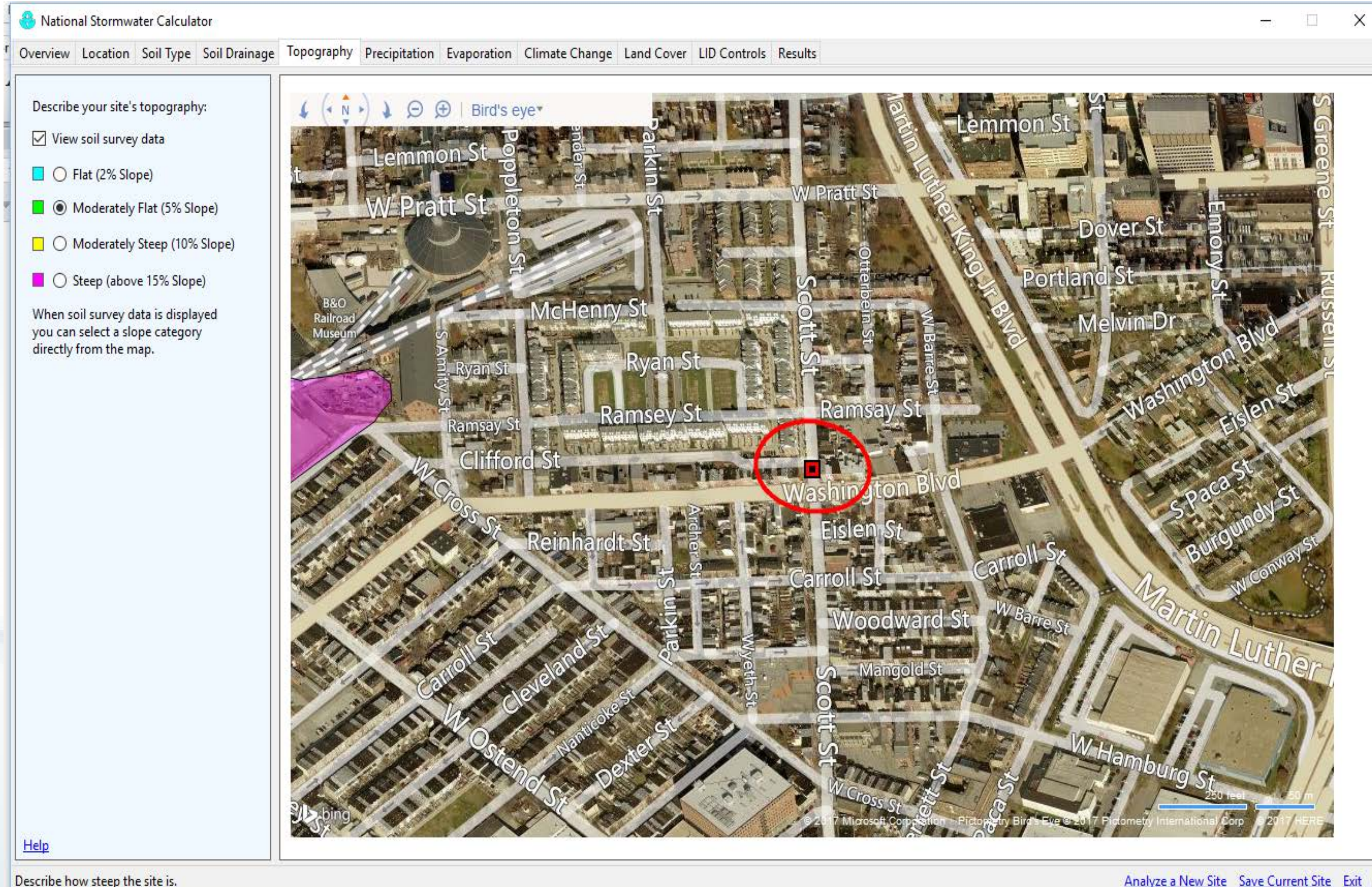
SWC Analysis: Scott Street

Soil Drainage



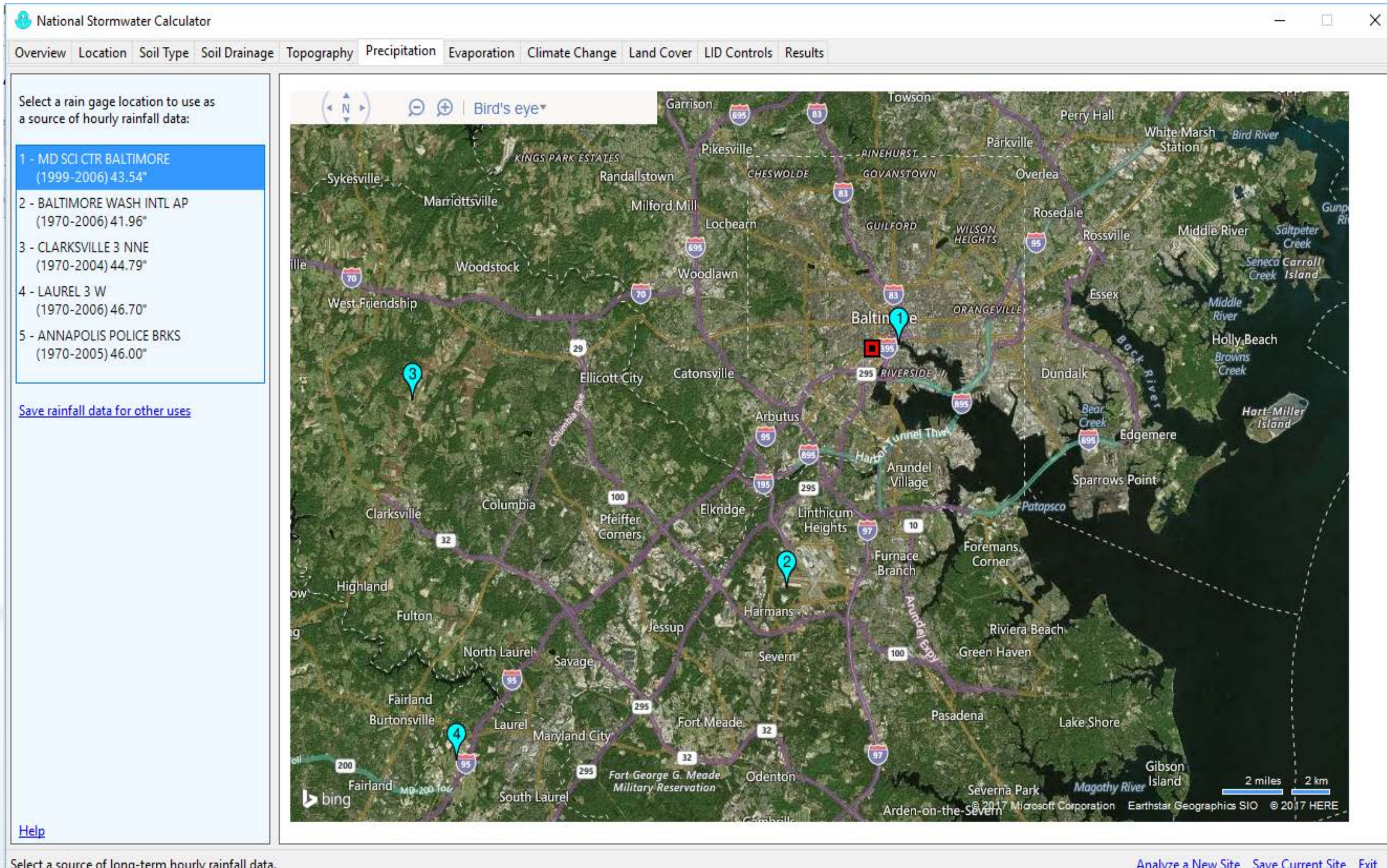
SWC Analysis: Scott Street

Topography



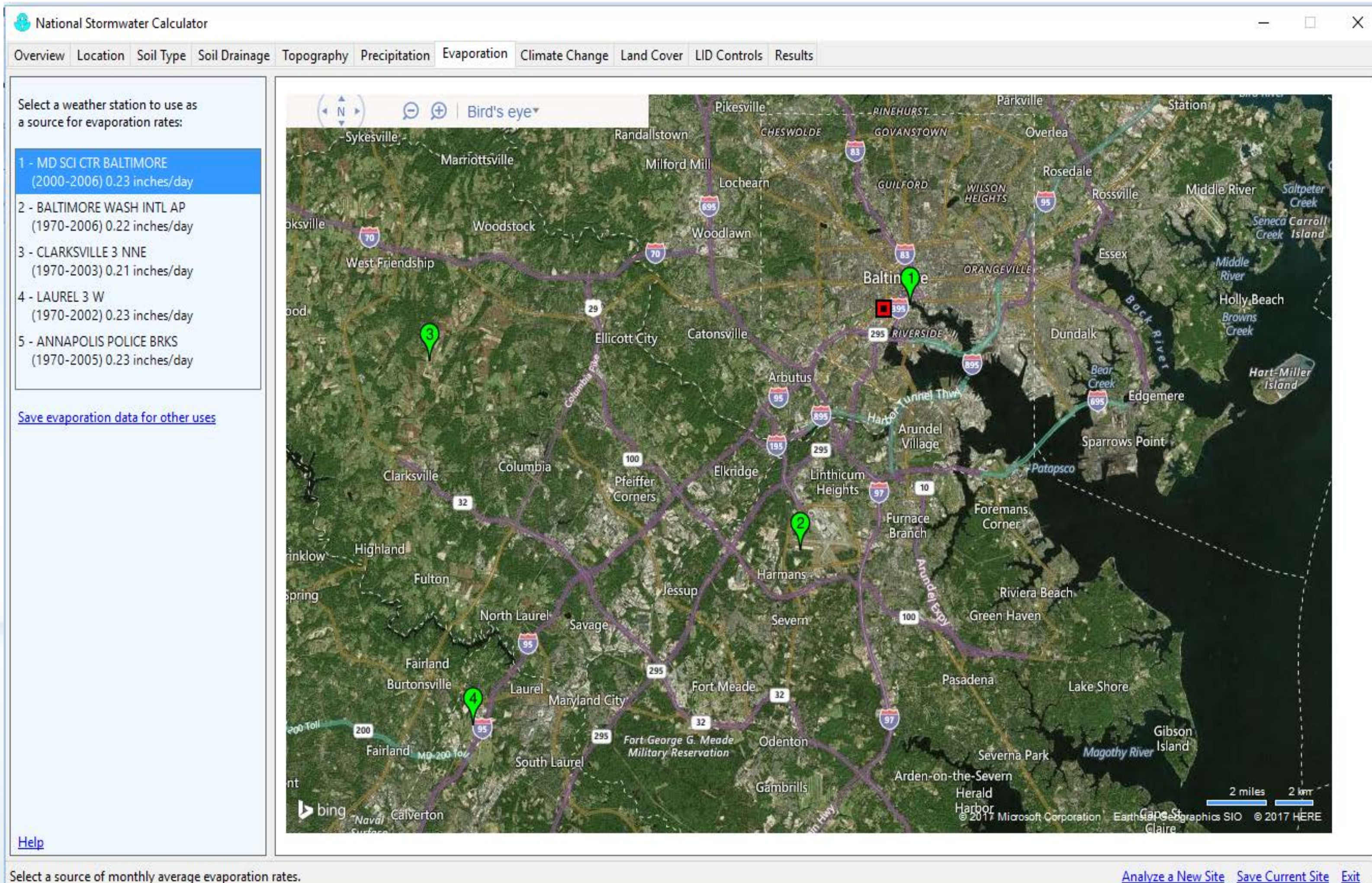
SWC Analysis: Scott Street

Historical Precipitation



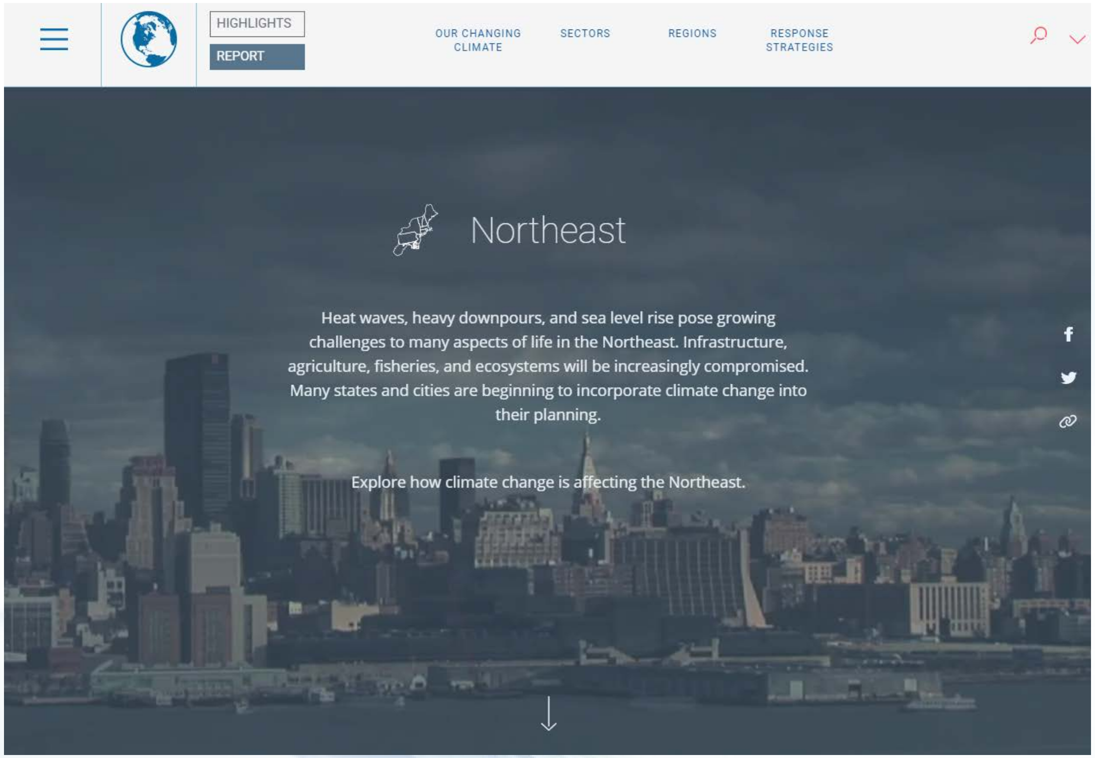
SWC Analysis: Scott Street

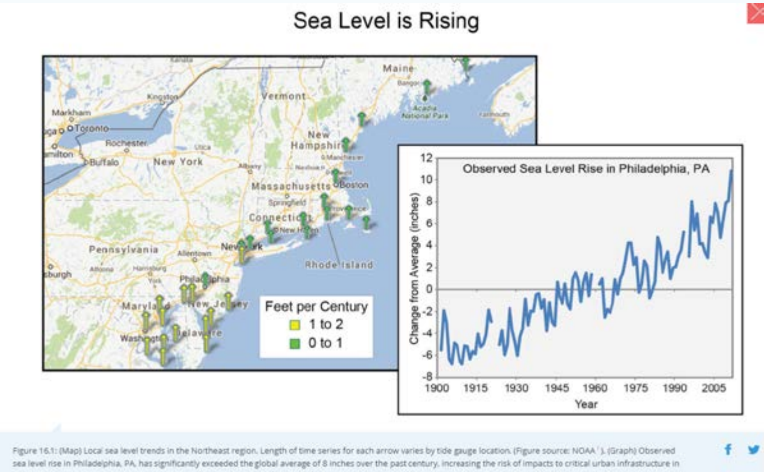
Historical Evaporation



SWC Analysis: Scott Street

Climate Change Impacts for the Northeast





http://nca2014.globalchange.gov/report/regions/northeast

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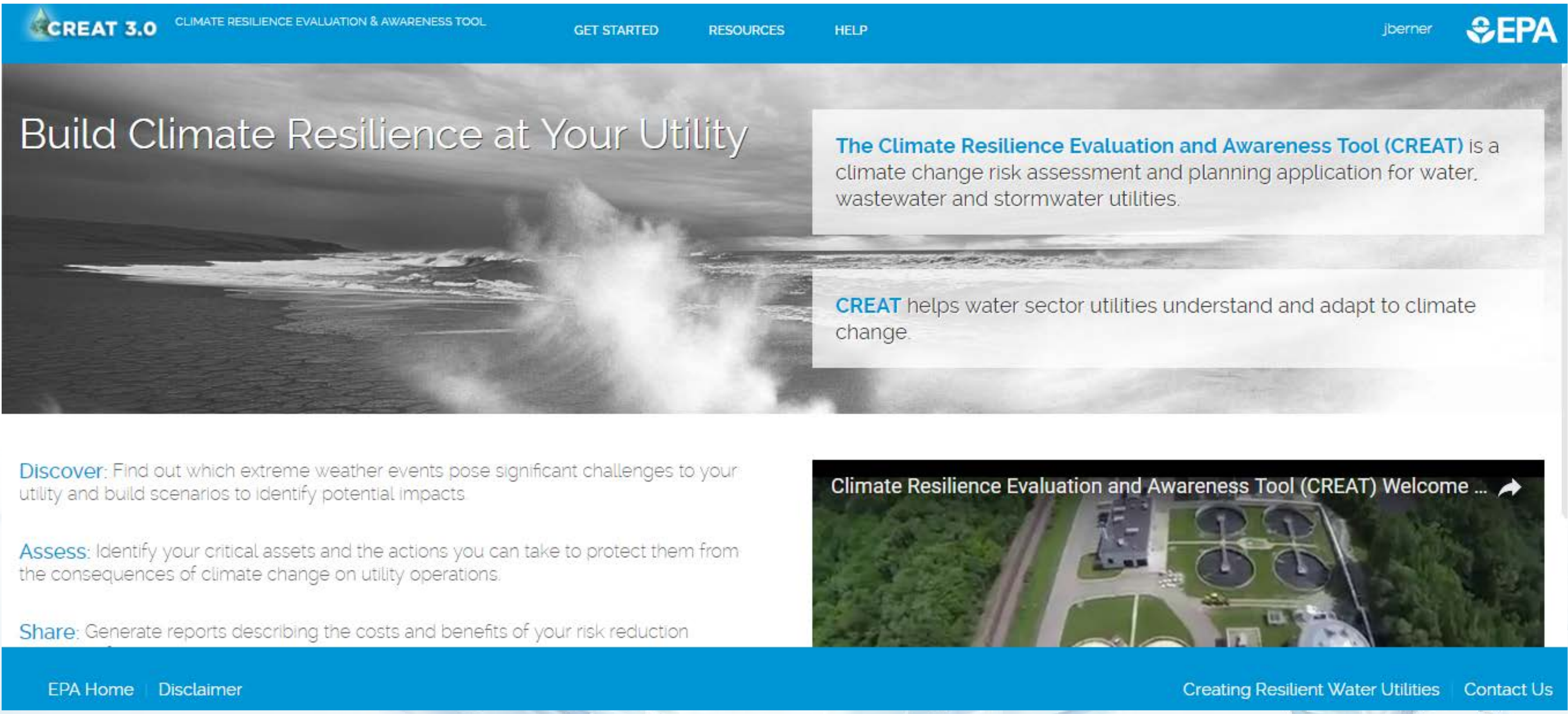
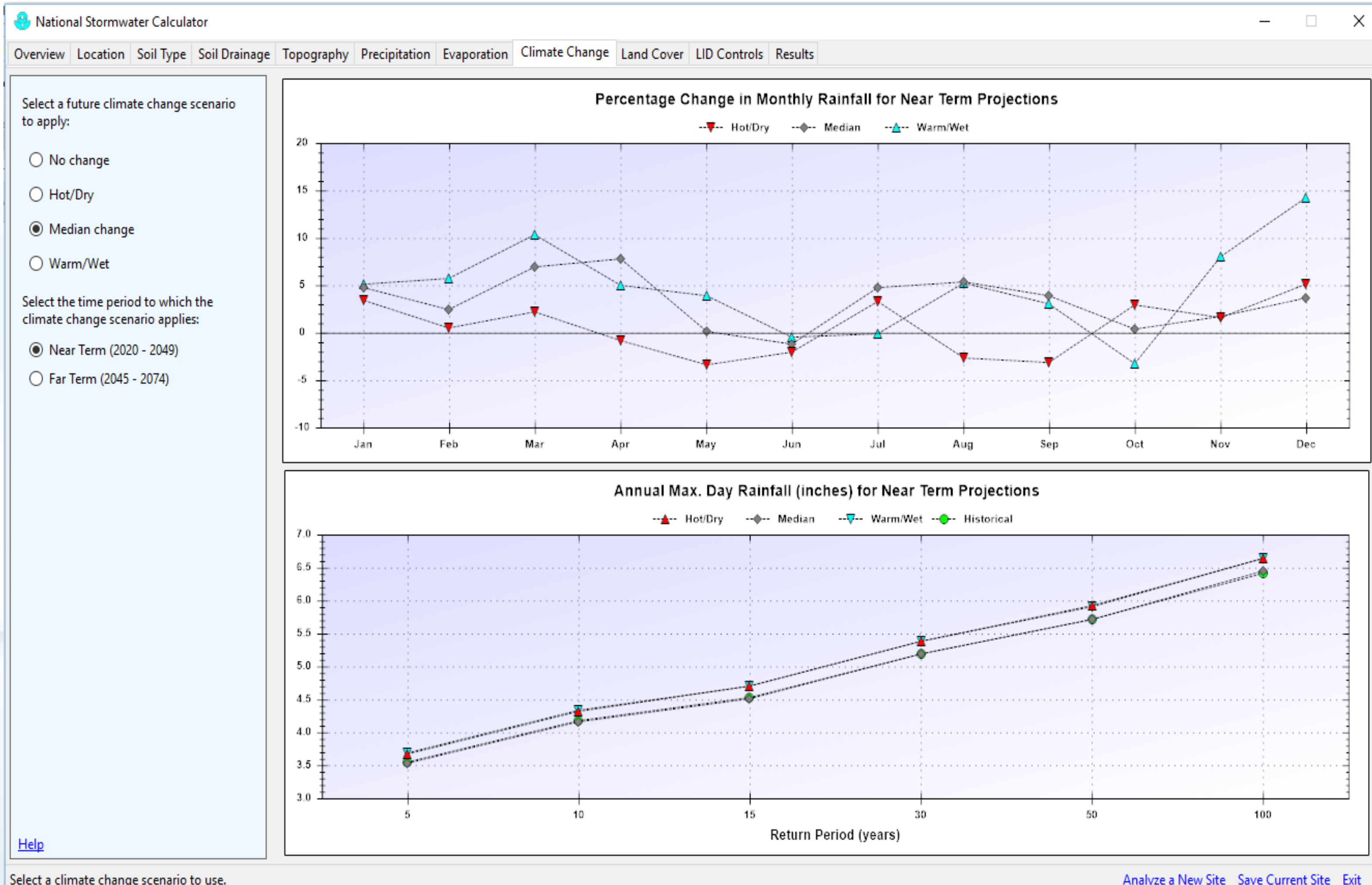
Climate Change Scenario Data: EPA's CREAT 2.0



https://creat.epa.gov/creat/

SWC Analysis: Scott Street
Climate Change Scenarios



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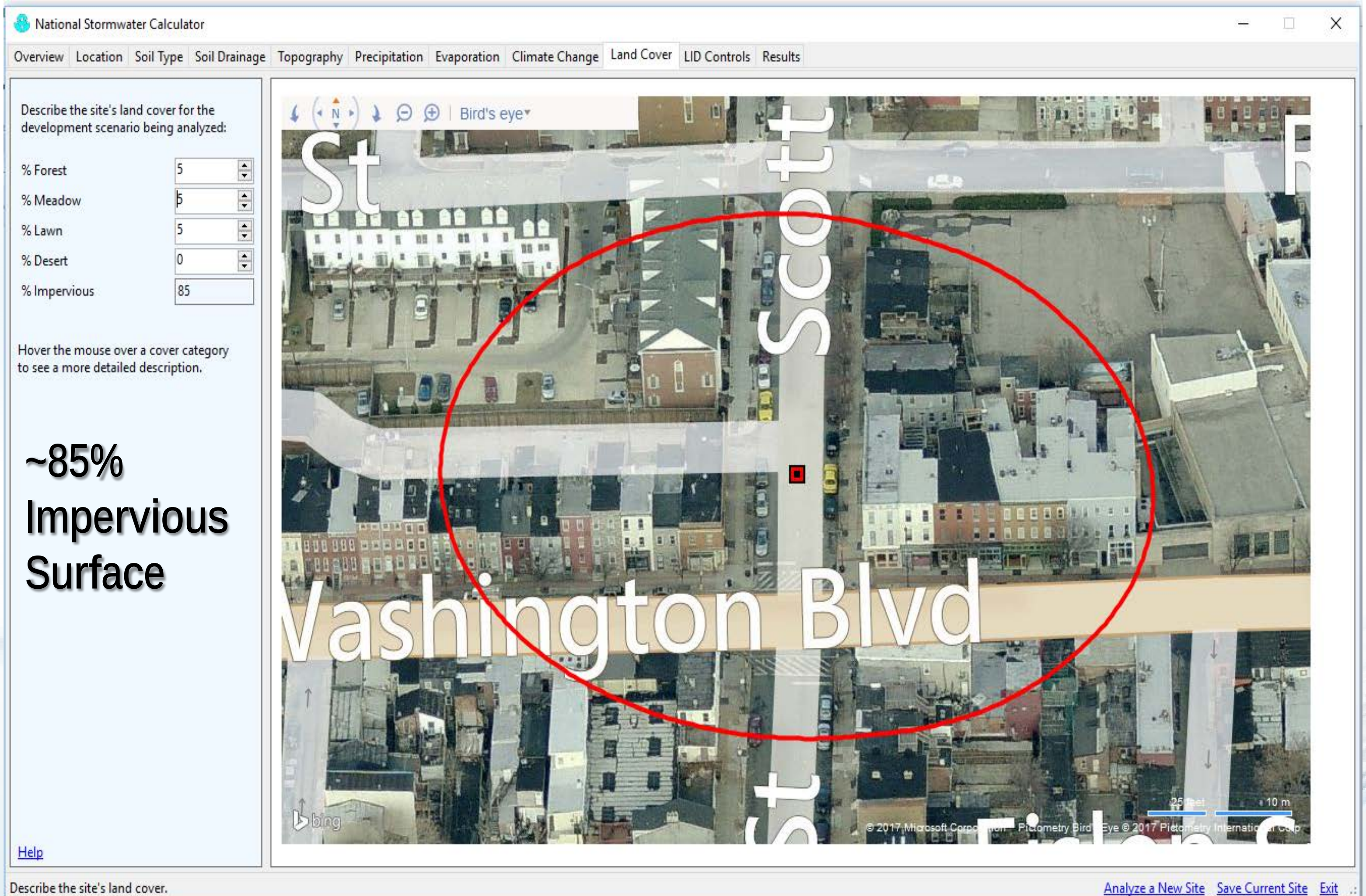
SWC Analysis: Scott Street

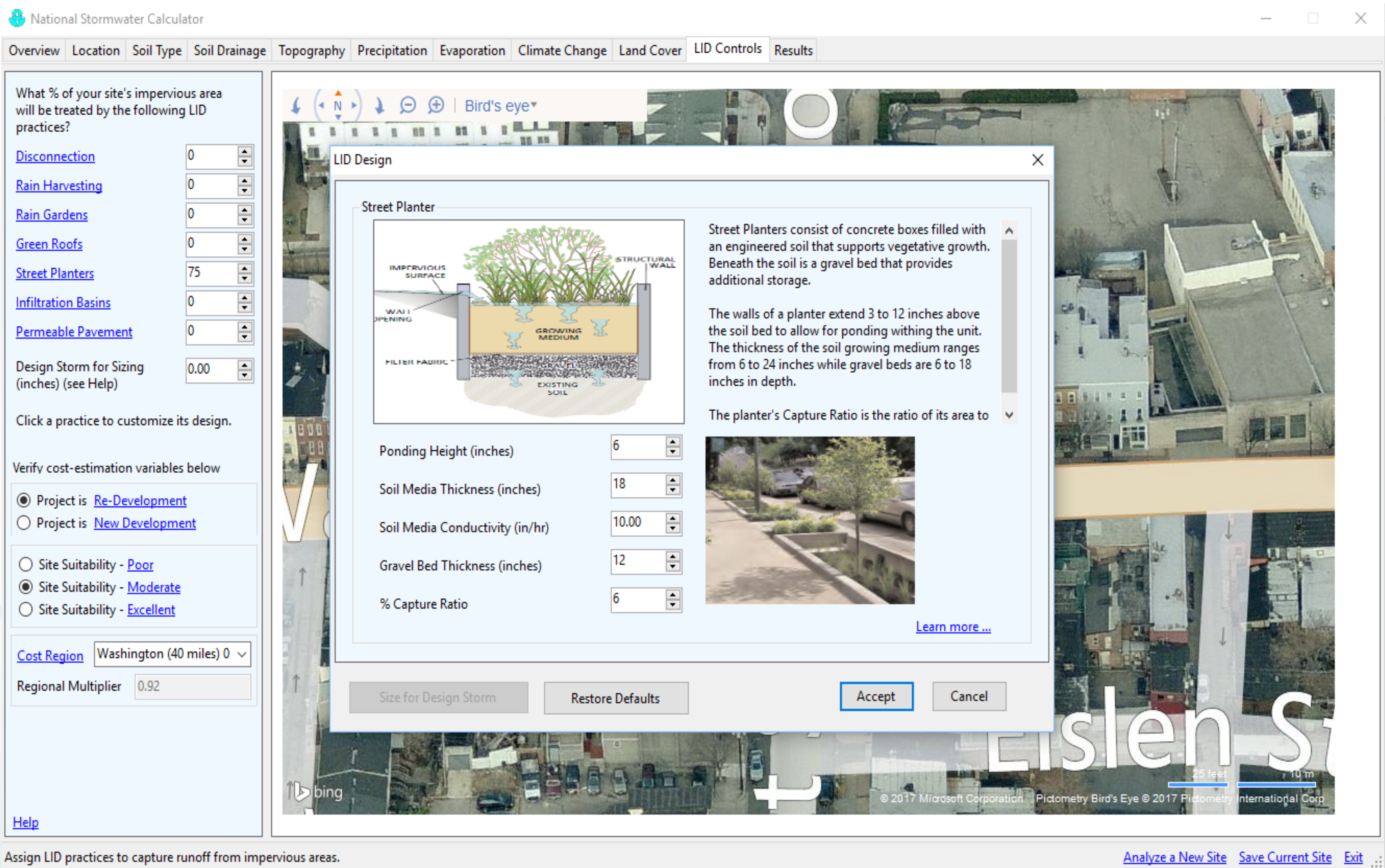
Existing Land Cover



~85% Impervious Surface

SWC Analysis: Scott Street

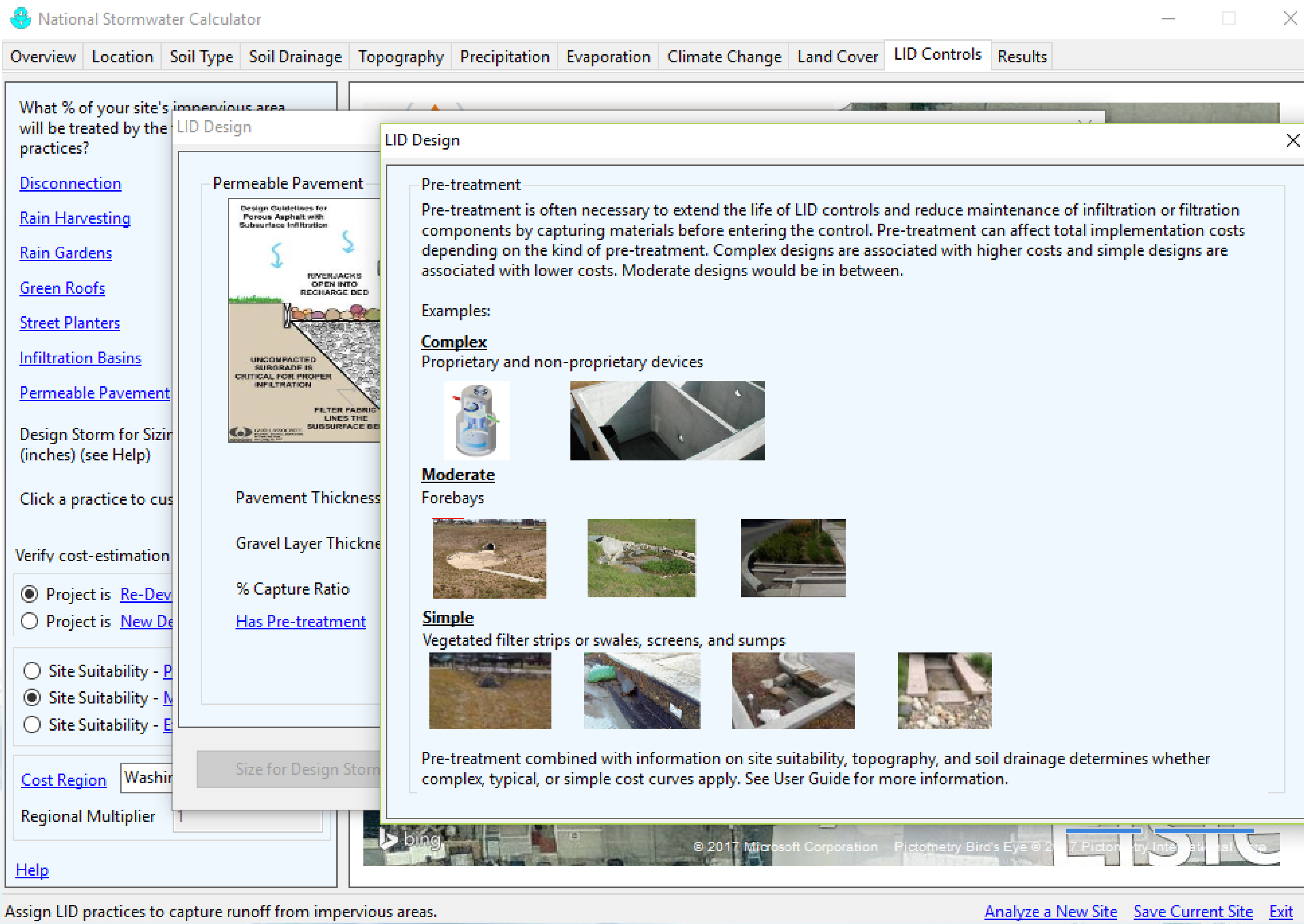
LID Controls



SWC Analysis: Scott Street

LID Controls: Pre-treatment

Pretreatment:
Rain garden, infiltration basin, and permeable pavement



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SWC: Cost Estimation Module

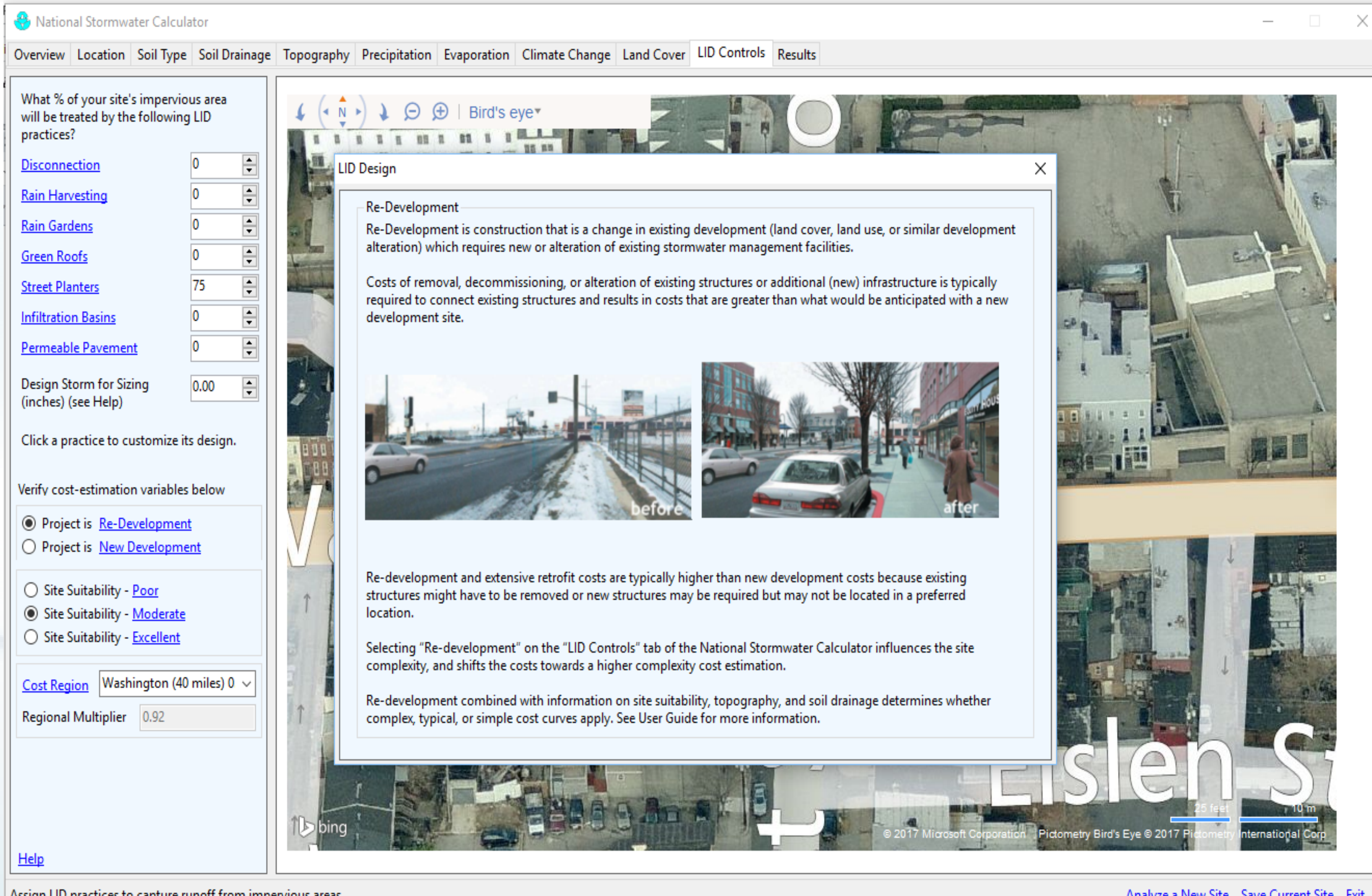
- **Intended Uses:**
  - Planning level cost estimates (magnitude of costs between planning scenarios)
- **Limitations:**
  - Doesn’t provide final construction costs
  - Doesn’t provide lifecycle costs (gives annual operations & maintenance (O&M) costs, not replacement costs)

Development of Regionalized Low Impact Development/Green Infrastructure Costs

- **Utilization of Bureau of Labor Statistics (BLS) Data for regional costs**
  - Outputs of service, construction, utilities, and other goods producing entities
    - Examples include: concrete storm sewer pipe, construction sand and gravel, etc.
  - Regional/city data (23 major U.S. cities)
    - Examples include: fuels and utilities, energy, and diesel fuel

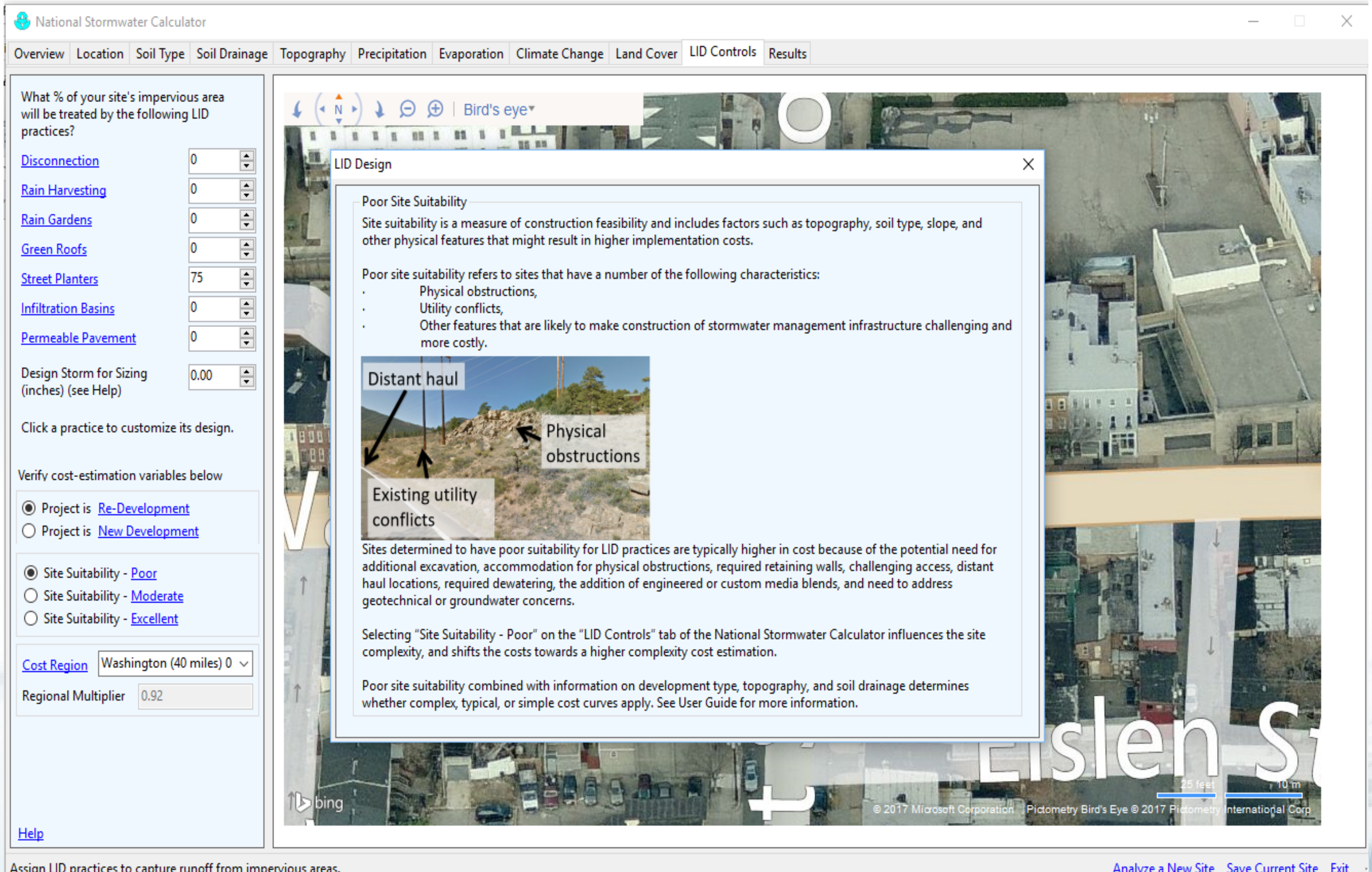
SWC Analysis: Scott Street

LID: Redevelopment Project



SWC Analysis: Scott Street

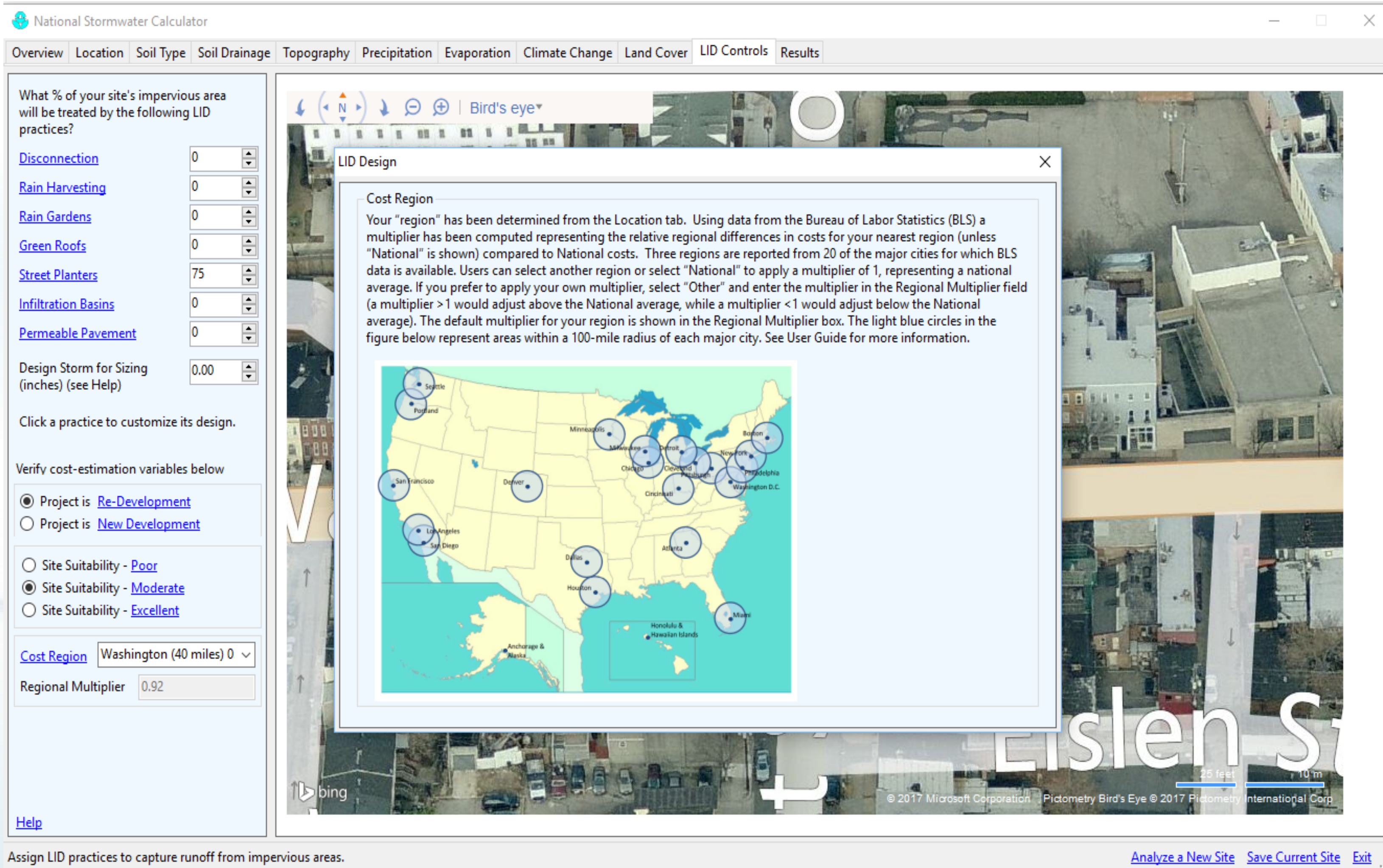
LID: Site Suitability (Poor)



*A lot of existing infrastructure/buildings and utilities present; compacted soil.

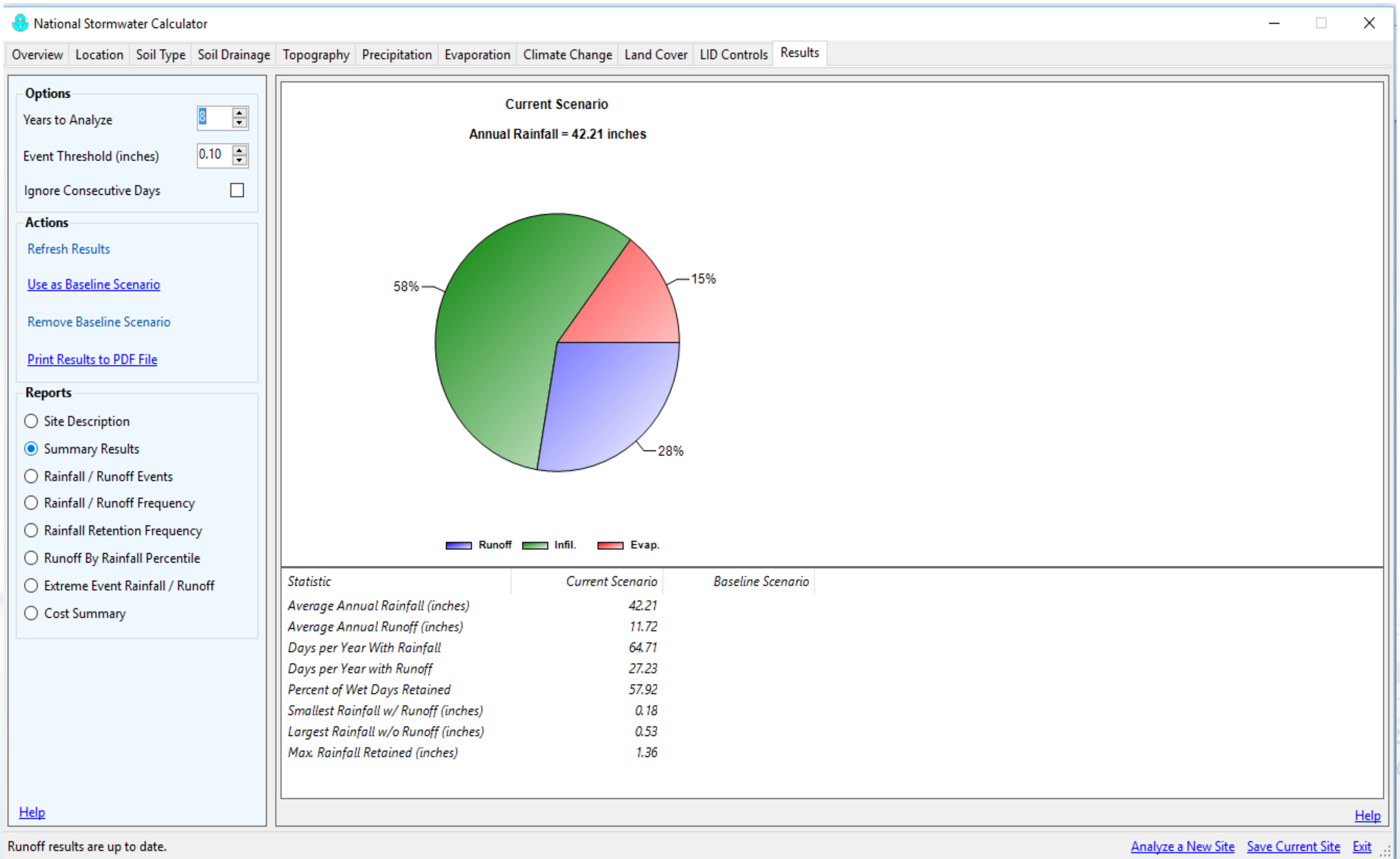
SWC Analysis: Scott Street

LID: US Bureau of Labor Statistics Regional Cost Centers



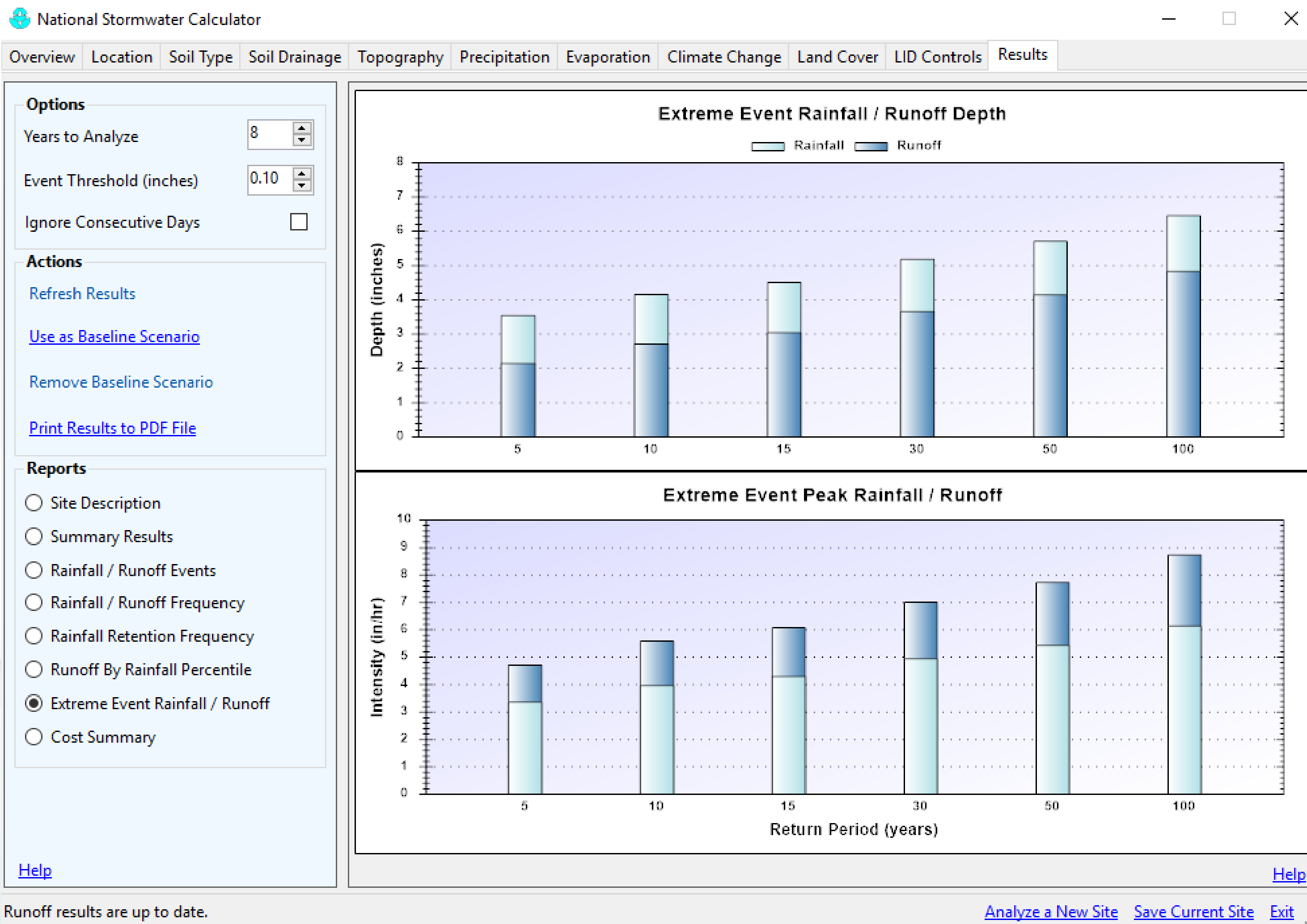
SWC Analysis: Scott Street

Runoff Reduction Results



SWC Analysis: Scott Street

Runoff Results: Extreme Storm Events



SWC Analysis: Scott Street

Capital Costs Summary

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

Ignore Consecutive Days

Actions

Refresh Results

Use as Baseline Scenario

Remove Baseline Scenario

Print Results to PDF File

Reports

- Site Description
- Summary Results
- Rainfall / Runoff Events
- Rainfall / Runoff Frequency
- Rainfall Retention Frequency
- Runoff By Rainfall Percentile
- Extreme Event Rainfall / Runoff
- Cost Summary

Help

Estimate of Probable Capital Costs (estimates in 2016 US.$)

Maintenance Costs | Graphical View

	Drainage Area %	Has Pre-trt?	Current Scenario (C) Area Treated 0.60 ac		Baseline Scenario (B) Area Treated ac		Difference (C - B) Area Treated 0.60 ac	
Cost By LID Control Type	**Current / Baseline**	**Current / Baseline**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Disconnection	NA / NA	No / NA	$0	$0	-	-	-	-
Rainwater Harvesting	NA / NA	No / NA	$0	$0	-	-	-	-
Rain Gardens	NA / NA	No / NA	$0	$0	-	-	-	-
Green Roofs	NA / NA	No / NA	$0	$0	-	-	-	-
Street Planters	75 / NA	No / NA	$24,478	$34,036	-	-	-	-
Infiltration Basins	NA / NA	No / NA	$0	$0	-	-	-	-
Permeable Pavement	NA / NA	No / NA	$0	$0	-	-	-	-
Total	**75 / NA**	**Varies**	**$24,478**	**$34,036**	-	-	-	-

Note: site complexity variables that affect cost shown below:

	Current Scenario	Baseline Scenario
Dev. Type	Re-development	-
Site Suitability	Poor	-
Topography	Mod. Flat (5% Slope)	-
Soil Type	C	-
Cost Region	Washington (40 miles) 0.92	-

Poor site suitability costs are in-line ($24,478 - $34,036) with the Pigtown Jan. 2017 planning level costs for Scott Street ($22,407).

Help

Runoff results are up to date.

Analyze a New Site Save Current Site Exit

SWC Analysis: Scott Street

Annual Maintenance Costs Summary

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

Ignore Consecutive Days

Actions

Refresh Results

Use as Baseline Scenario

Remove Baseline Scenario

Print Results to PDF File

Reports

- Site Description
- Summary Results
- Rainfall / Runoff Events
- Rainfall / Runoff Frequency
- Rainfall Retention Frequency
- Runoff By Rainfall Percentile
- Extreme Event Rainfall / Runoff
- Cost Summary

Help

Estimate of Probable Maintenance Costs (estimates in 2016 US.$)

Capital Costs| Graphical View

	Current Scenario (C)		Baseline Scenario (B)		Difference (C - B)	
Cost By LID Control Type	**Low**	**High**	**Low**	**High**	**Low**	**High**
Disconnection	$0	$0	-	-	-	-
Rainwater Harvesting	$0	$0	-	-	-	-
Rain Gardens	$0	$0	-	-	-	-
Green Roofs	$0	$0	-	-	-	-
Street Planters	$49	$1,169	-	-	-	-
Infiltration Basins	$0	$0	-	-	-	-
Permeable Pavement	$0	$0	-	-	-	-
Total	**$49**	**$1,169**	-	-	-	-

Note: site complexity variables that affect cost shown below:

	Current Scenario	Baseline Scenario
Dev. Type	Re-development	-
Site Suitability	Poor	-
Topography	Mod. Flat (5% Slope)	-
Soil Type	C	-
Cost Region	Washington (40 miles) 0.92	-

Help

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 and construction plans/designs

- Comparing the relative magnitude of planning level costs for different stormwater management solutions
  - —Finding least cost option(s) while meeting performance goals

- Comparisons may be made between national and regional cost estimates:
  - —Using local knowledge in selection of regional BLS cost multipliers
    - Other nearby cities: Philadelphia, etc.

SWC Analysis:
Potential Next Steps (Pigtown – Baltimore, MD)

- Applying for funding
- Construction plans/designs
- Final construction costs
- Construction

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Over $800,000 Announced to Support Local Green Infrastructure Projects to Improve Communities and Provide Jobs

June 29, 2017

Today the Chesapeake Bay Trust in partnership with the U.S. Environmental Protection Agency (EPA), Maryland Department of Natural Resources (DNR), and the City of Baltimore Office of Sustainability announce $843,486 in funding for the Chesapeake Bay Green Streets-Green Jobs-Green Towns Grant Program.

The goal of the grants is to help communities develop and implement plans that reduce stormwater runoff, increase the number and amount of green spaces in urban areas.

http://news.maryland.gov/dnr/2017/06/29/over-800000-announced-to-support-local-green-infrastructure-projects-to-improve-communities-and-provide-jobs/

Climate Resiliency Planning Application: Mount Rainier, MD

U.S. Climate Resilience Toolkit

Steps to Resilience | Case Studies | Tools | Topics | Expertise | Search

Improving Water Quality by Dealing with the First Inch of Rain

The suburban city of Mount Rainier, Maryland, is doing its part to improve the water quality of a polluted river in its region: residents and organizations are using green infrastructure to reduce stormwater runoff.

Taking Action › Improving Water Quality by Dealing with the First Inch of Rain ›

Just outside the northeastern boundary of Washington, D.C., the suburban city of Mount Rainier, Maryland, features affordably priced homes, pedestrian-friendly sidewalks, and a handful of historic buildings. The city—named after the better-known mountain in the Pacific Northwest—expanded in the early 1900s after a streetcar line began offering service in and out of the capital. Since the 1970s, officials in Mount Rainier have made substantial efforts to improve air and water quality for the town's residents, and to become a sustainable "green" community.

Mount Rainier lies within the watershed of the Anacostia River, which flows into the Potomac River. In turn, the Potomac River flows into the ecologically productive Chesapeake Bay. Unfortunately, the Anacostia—sometimes referred to as Washington's "forgotten river"—is severely polluted with toxic sediments, agricultural nutrients, and trash. As climate

Steps to Resilience:

- Step 1: Explore Climate Threats
- Step 2: Assess Vulnerability & Risks
- Step 3: Investigate Options
- Step 4: Prioritize Actions
- Step 5: Take Action

Tools:

National Stormwater Calculator—Climate Assessment Tool ›

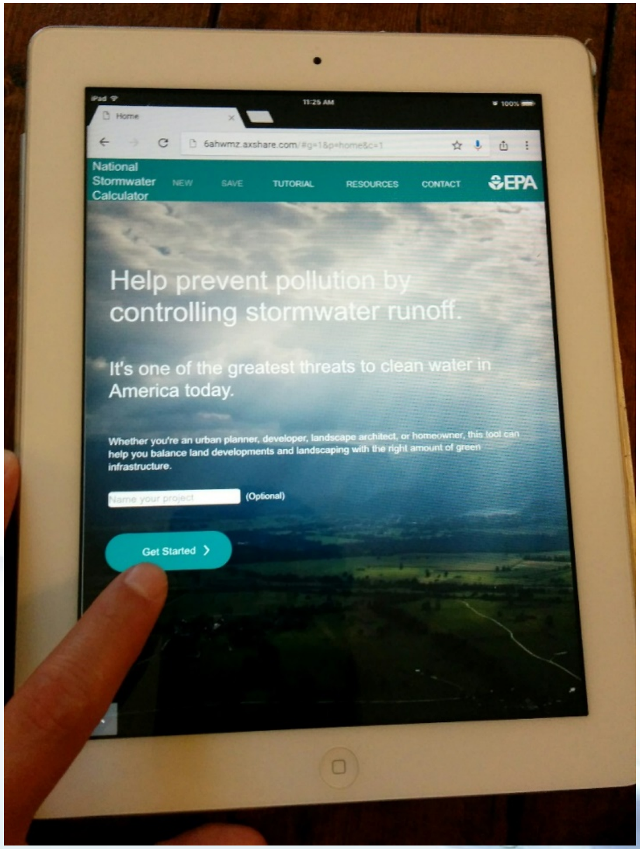
Topic:

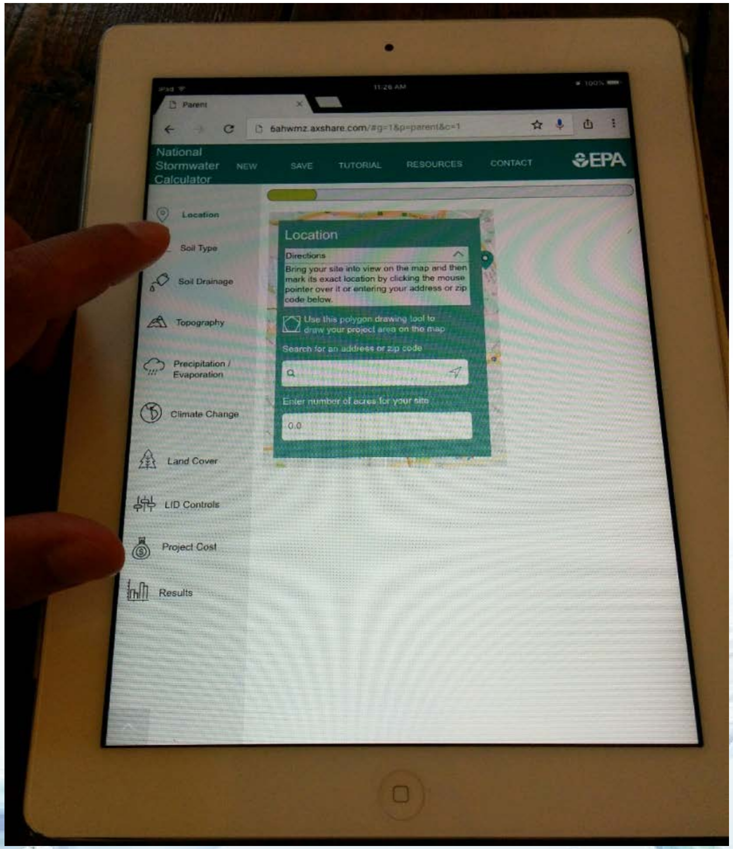
Built Environment › Water and

http://toolkit.climate.gov/case-studies/improving-water-quality-dealing-first-inch-rain

Mobile Web App Development: Public Release Expected in Fall 2017

Live demonstrations at WEFTEC 2017 Stormwater Pavilion, Oct. 2 - 3 (Chicago, IL)





Discussion and Questions

Thank You!

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National Stormwater Calculator Website:
https://www.epa.gov/water-research/national-stormwater-calculator
Contact: SWC@epa.gov