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

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

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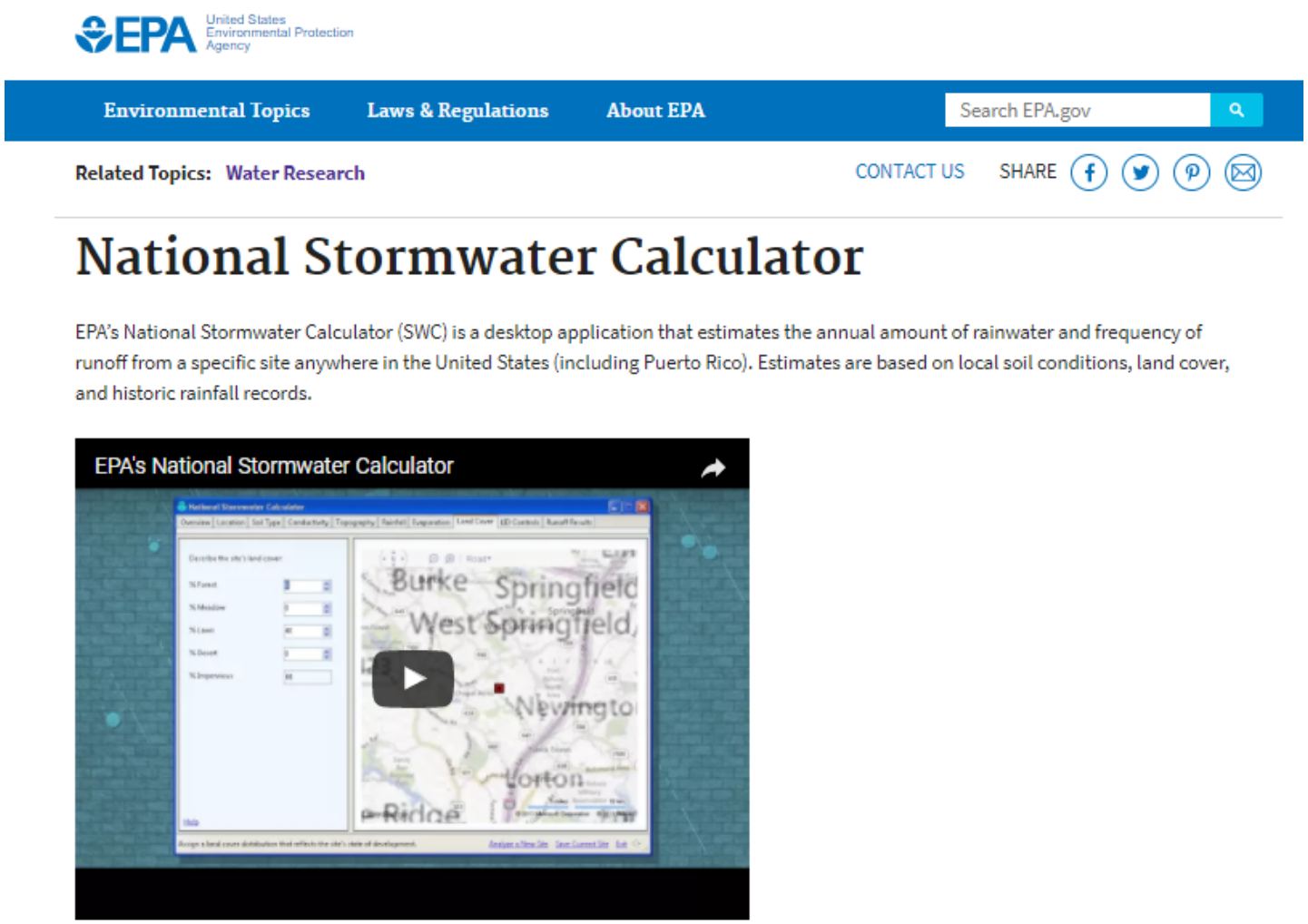
90 WORKSHOPS 90 YEARS

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

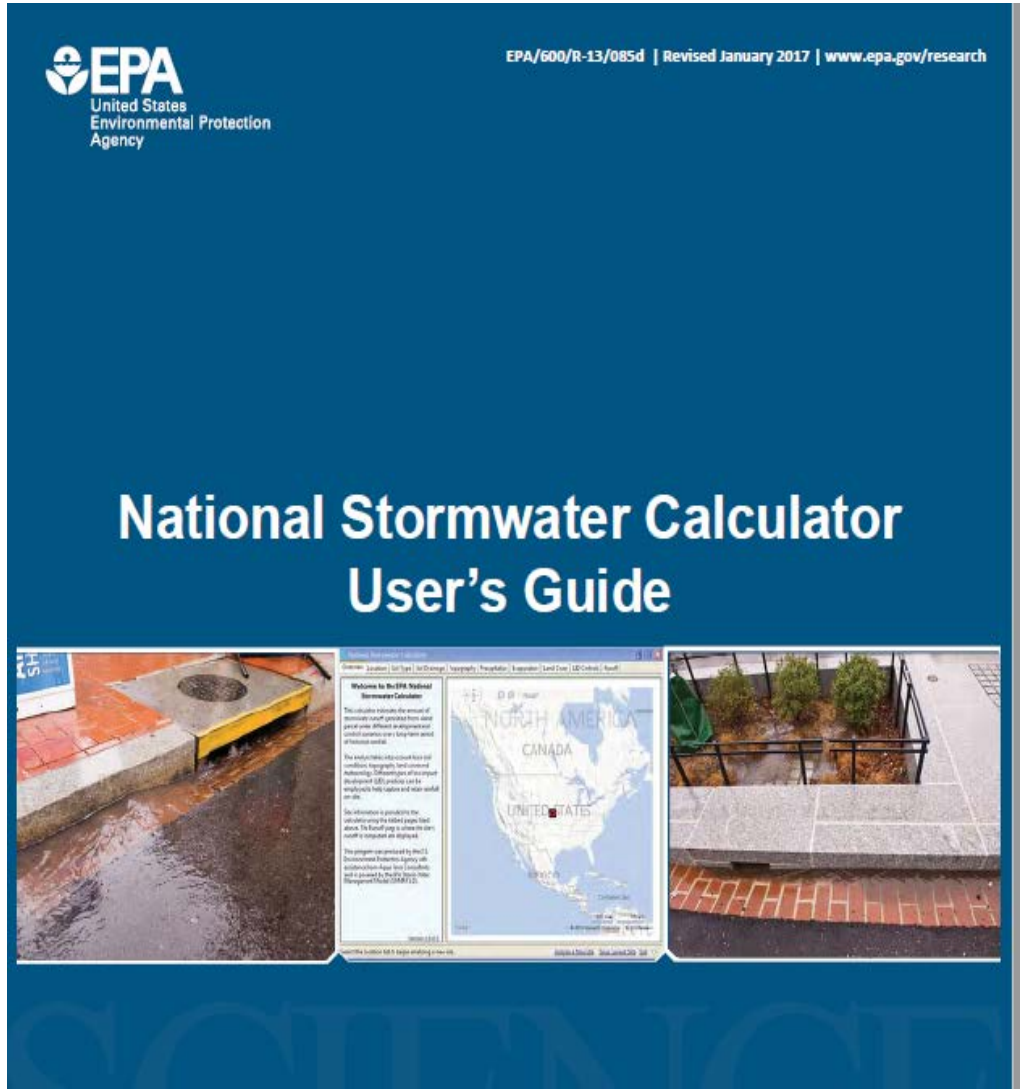
National Stormwater Calculator Website



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



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…

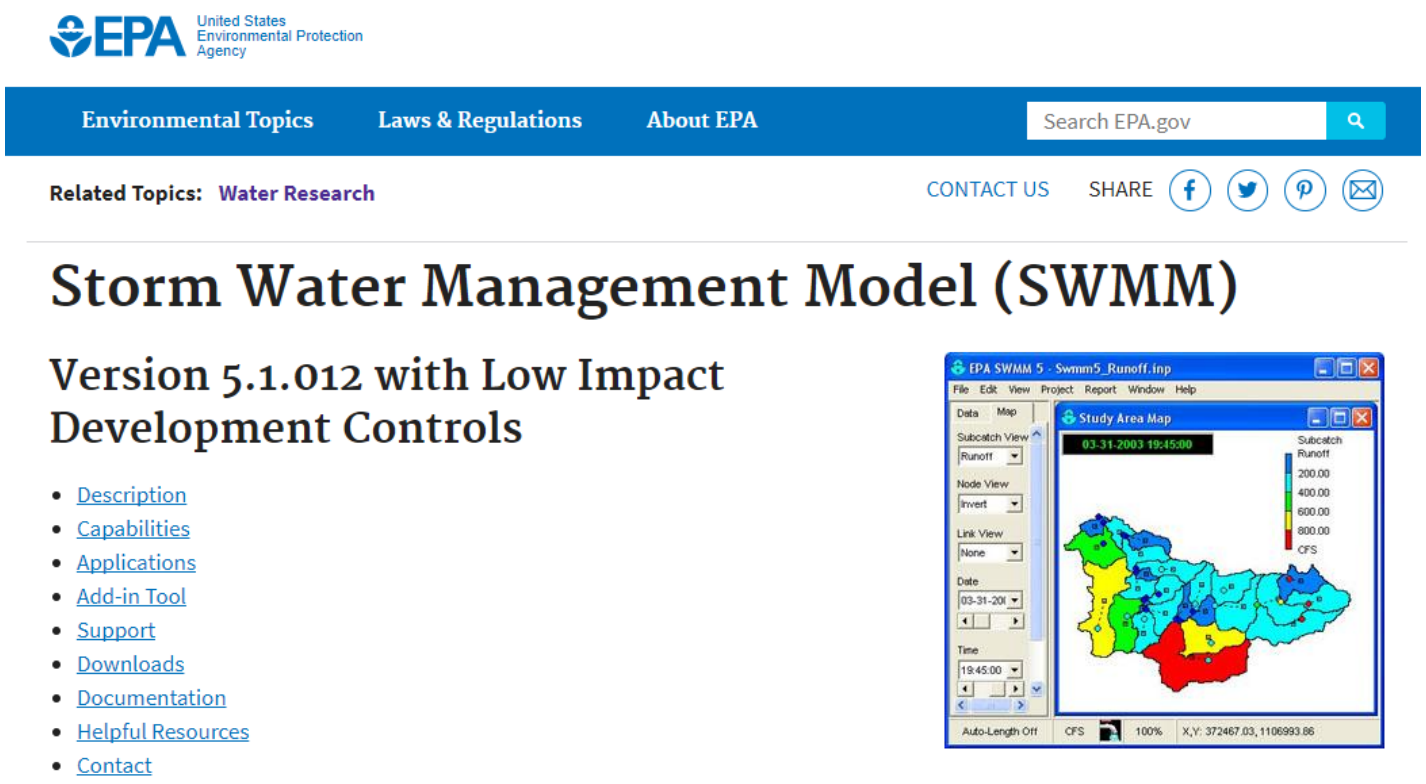
- Local planners
- Land developers
- Landscape architects
- Homeowners, etc.

…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)

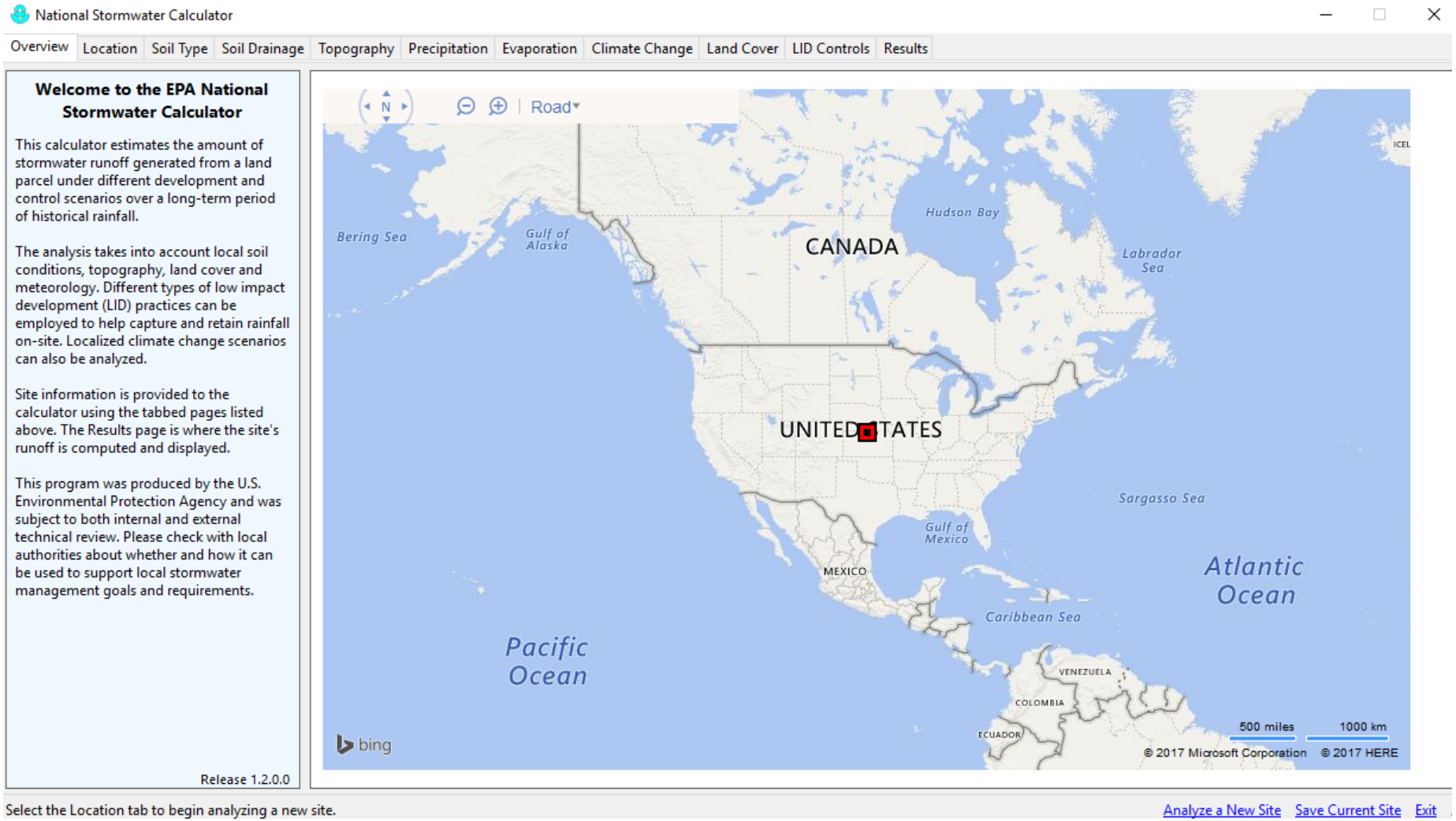


- The calculator is based on SWMM: dynamic rainfall-runoff simulation model for long-term simulation of runoff quantity
- SWMM produces stormwater runoff estimates in the background of the Stormwater Calculator

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



SWC Cost Estimation Module *(Released Spring 2017)*

- Intended Uses:
  - Planning level cost estimates (magnitude of costs between planning scenarios)

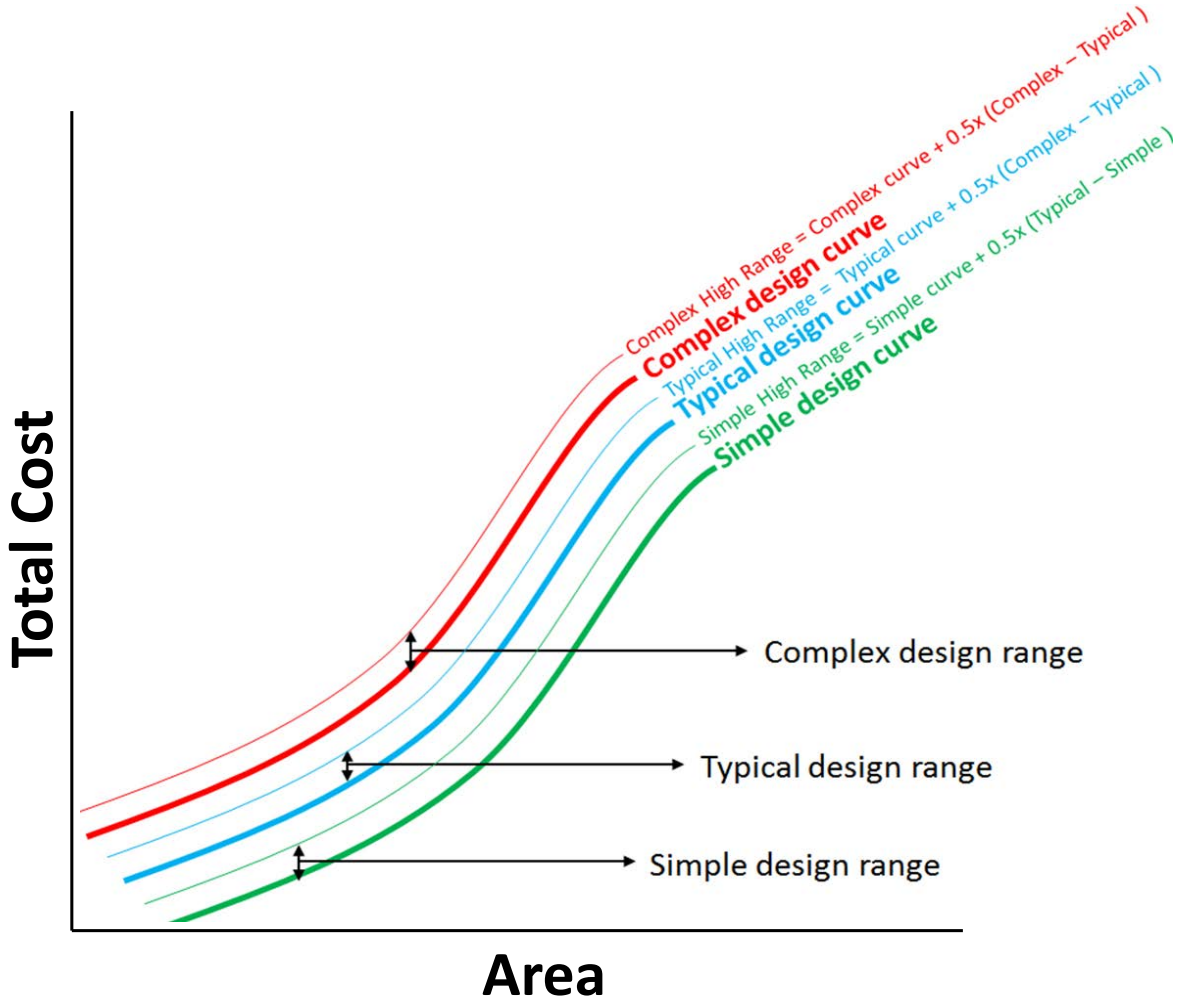
- Limitations:
  - Not final construction/build costs
  - Not lifecycle costs (gives annual O & M costs, not replacement costs)
  - Regional costs not available for all areas of the US (many of the Western states)

- 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
(Pretreatment) 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)

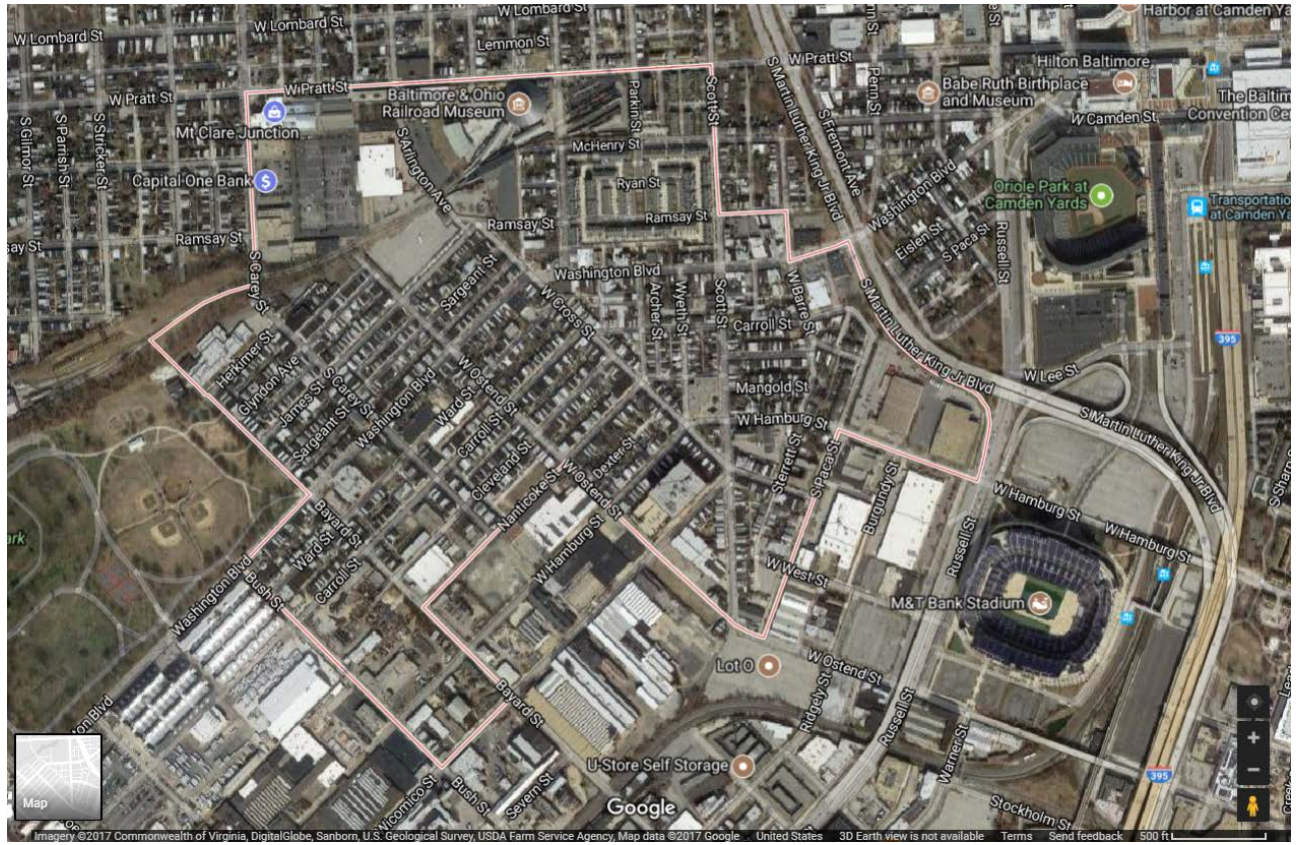
Accounting for Uncertainty with Cost Estimates (Regression Cost Curves)



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

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



- Street planters as part of a complete street

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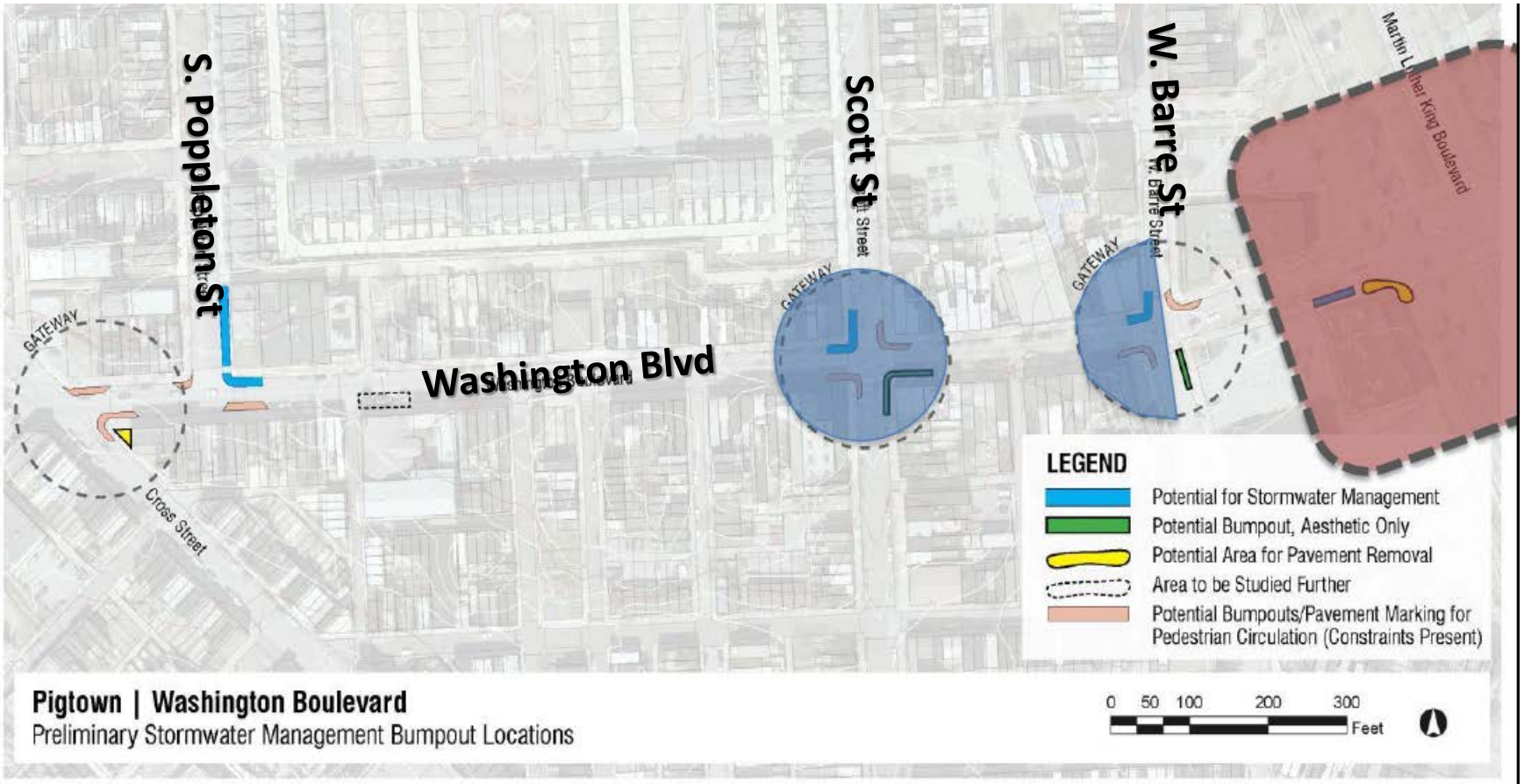

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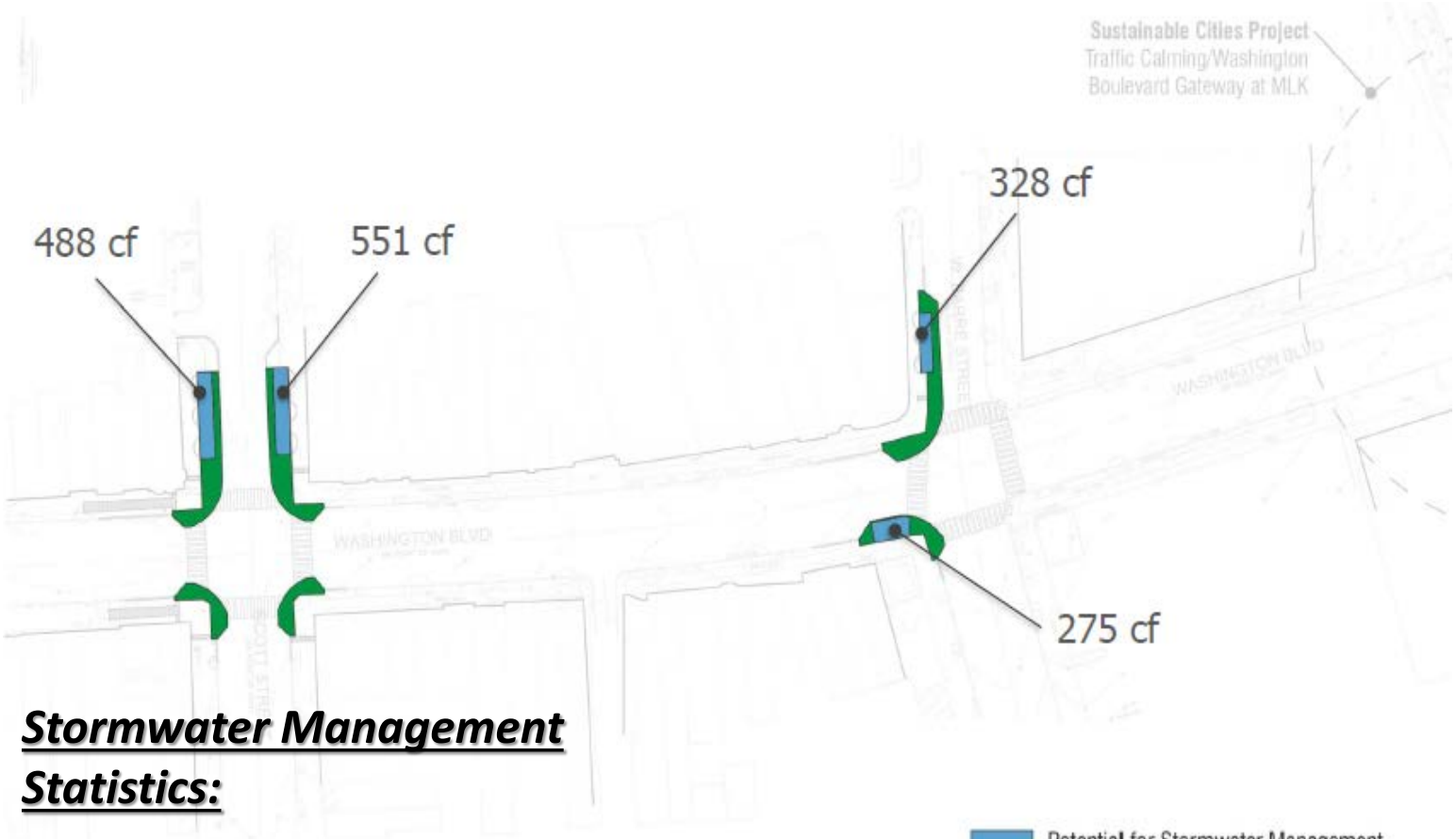


Stormwater Management Statistics:

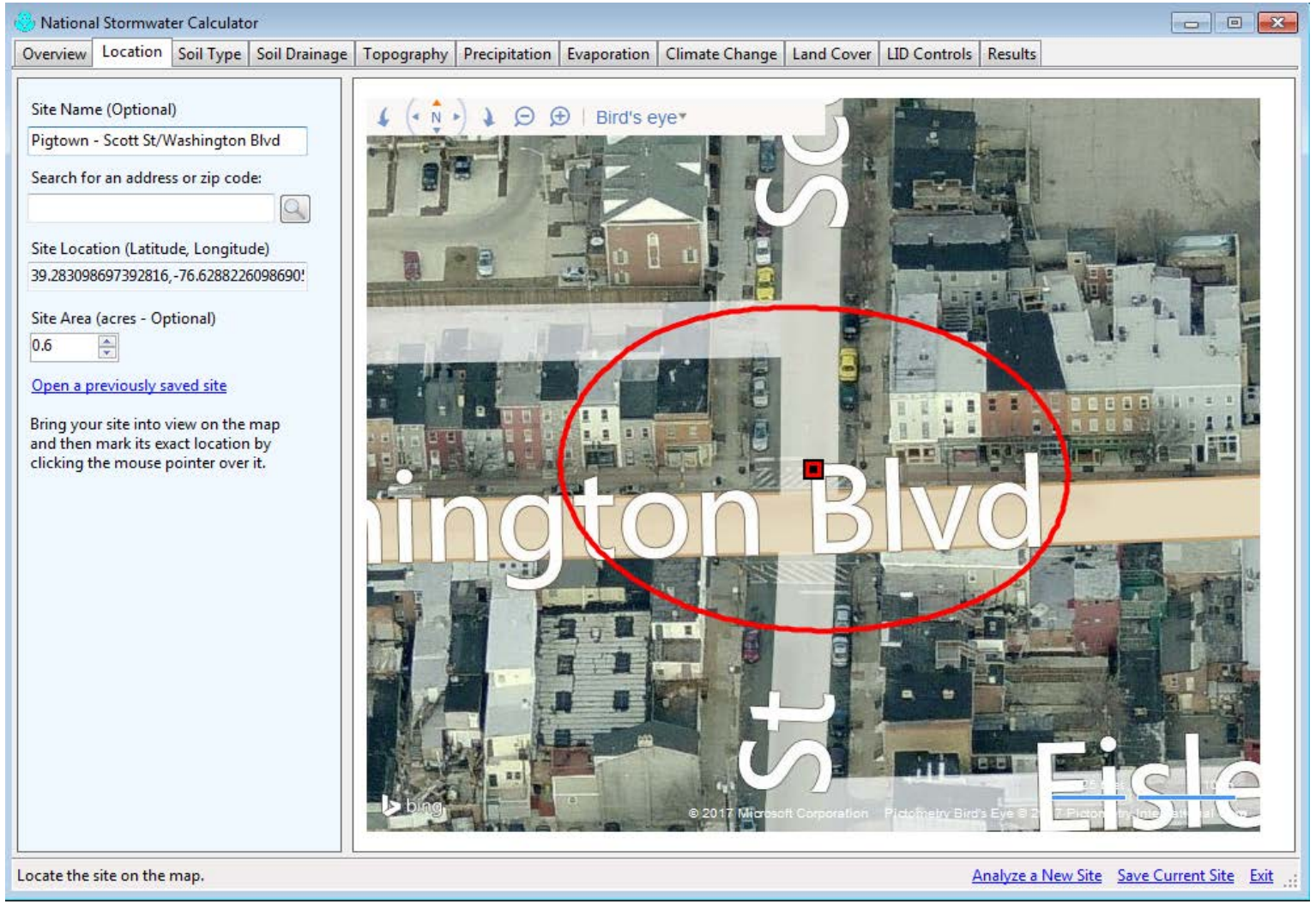
Total Treatment Per Rainfall Event: 1,810 cf
Total Impervious Removal: 2,125 sf (168 cf)
Annual Treatment: 68,418 cf or 512,000 gallons

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

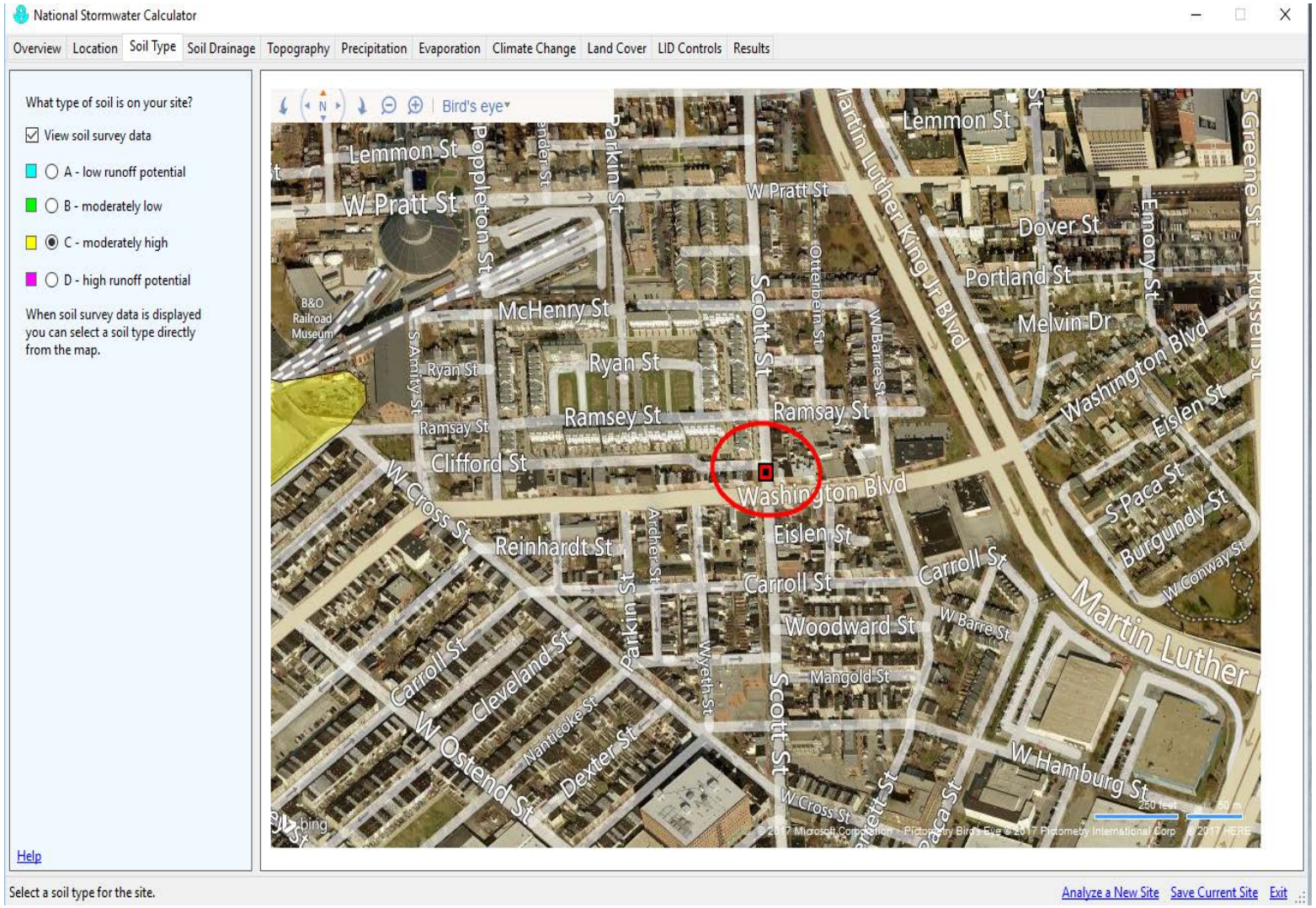
CAT 3 – STORMWATER								
ITEM	QTY (H)		EXCA.	QTY	UNITS	COST	TOTAL COST	NOTES
MICROBIORETENTION AREAS	582	291	1.1	640	SF	$35	$22,407	includes plants

**Costs do not include annual maintenance and operations*

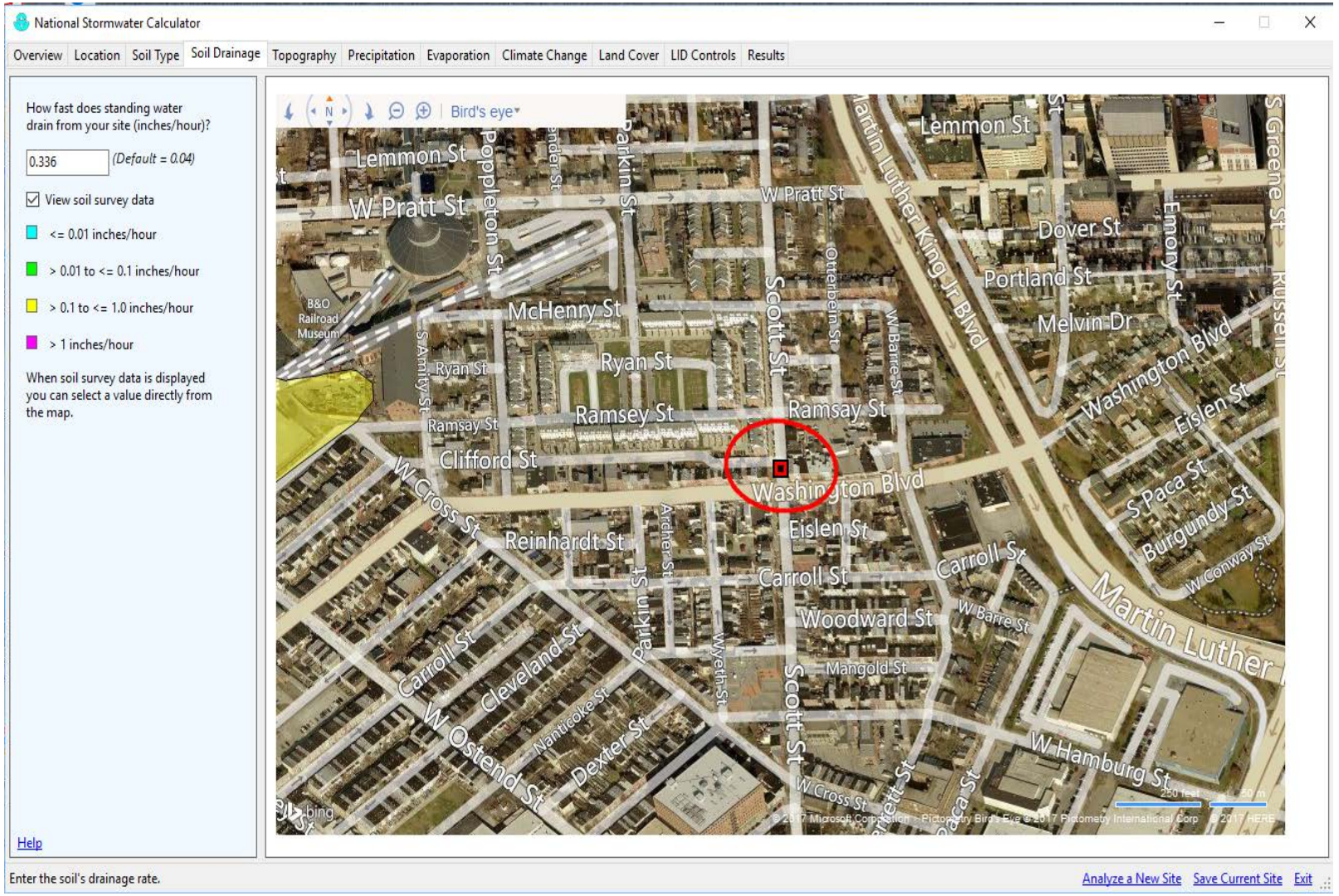
SWC Analysis: Scott Street
Project Location



SWC Analysis: Scott Street
Soil Runoff Potential

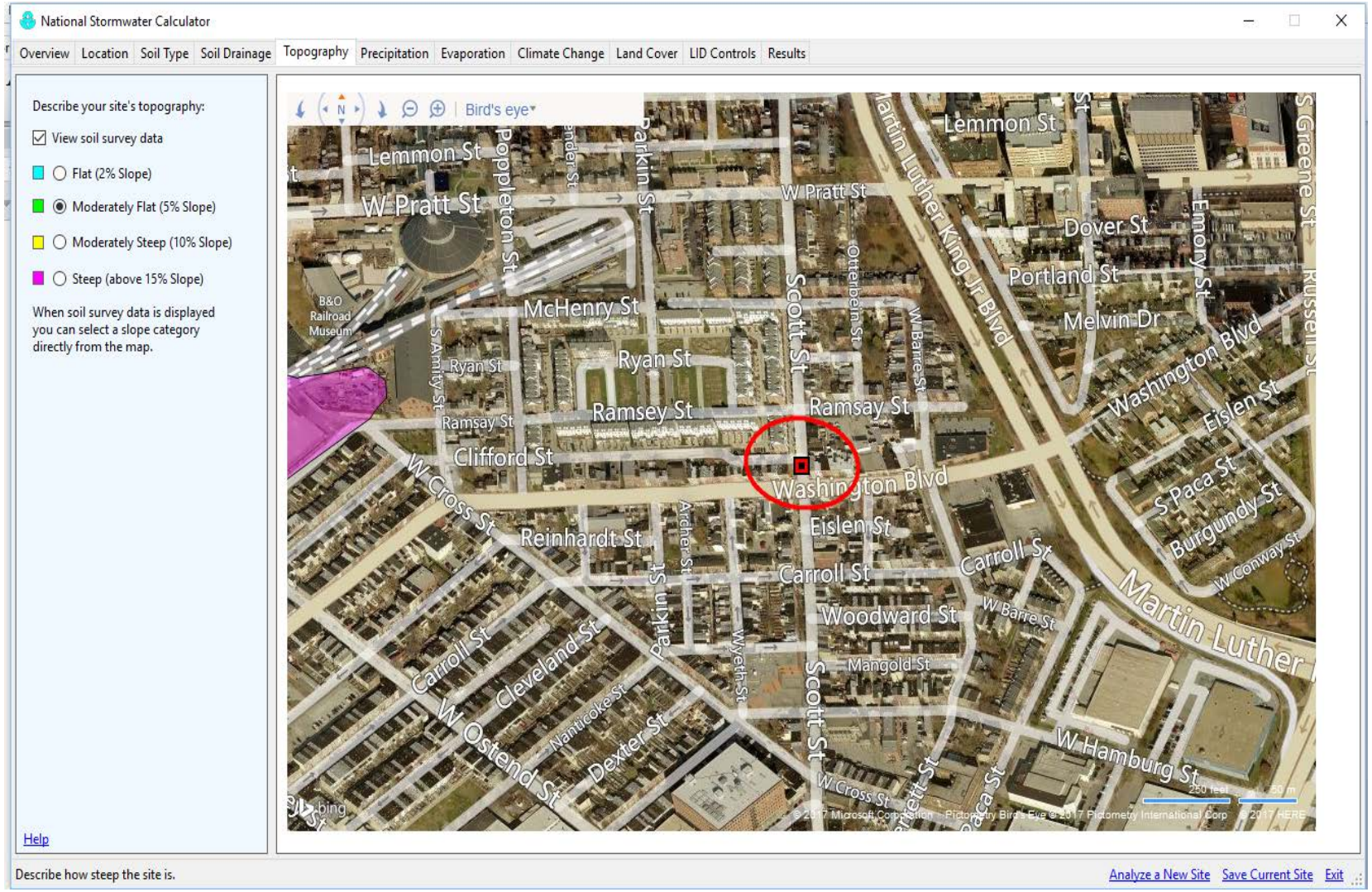


SWC Analysis: Scott Street
Soil Drainage

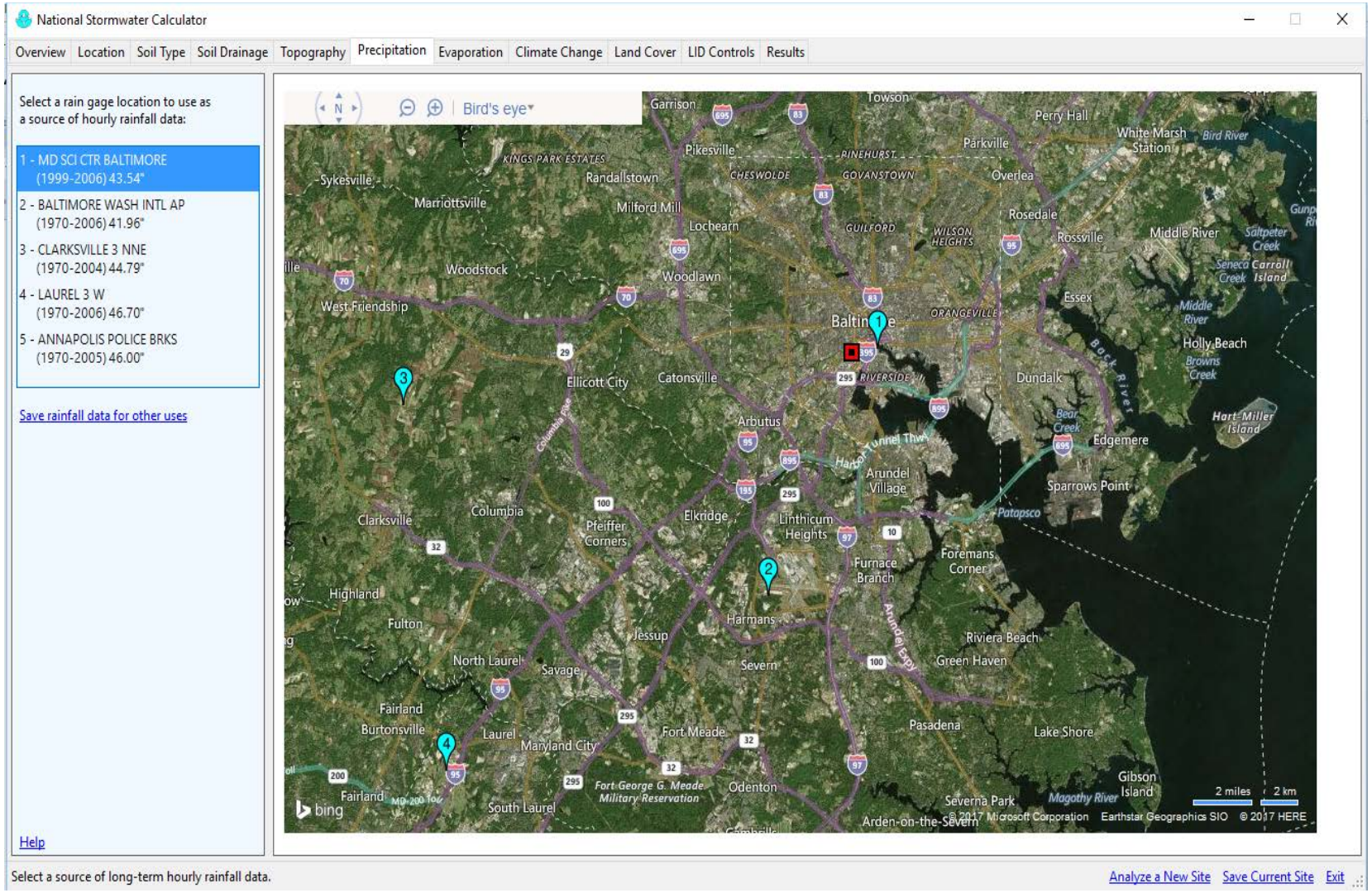


SWC Analysis: Scott Street

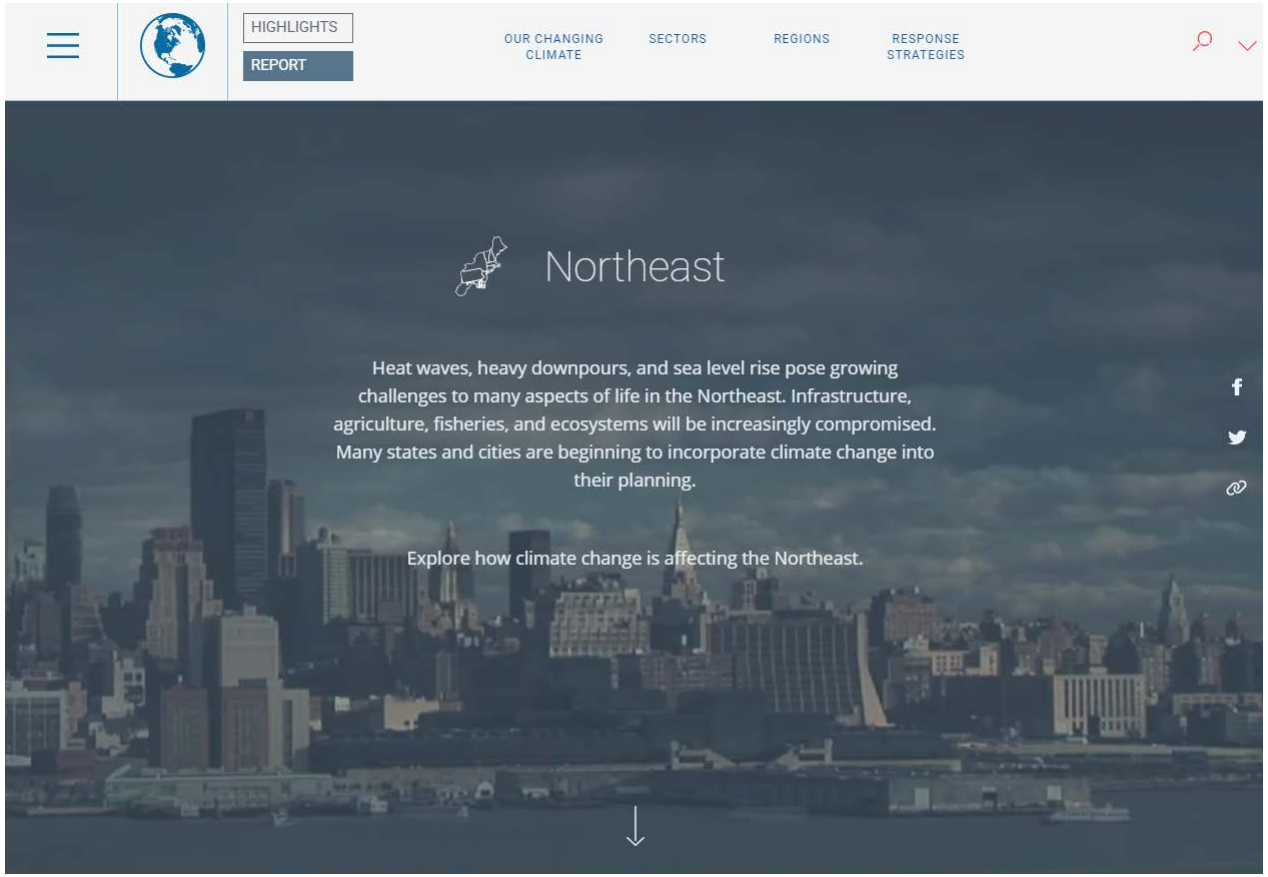
Topography



SWC Analysis: Scott Street
Historical Precipitation



SWC Analysis:
Climate Change Impacts for the Northeast



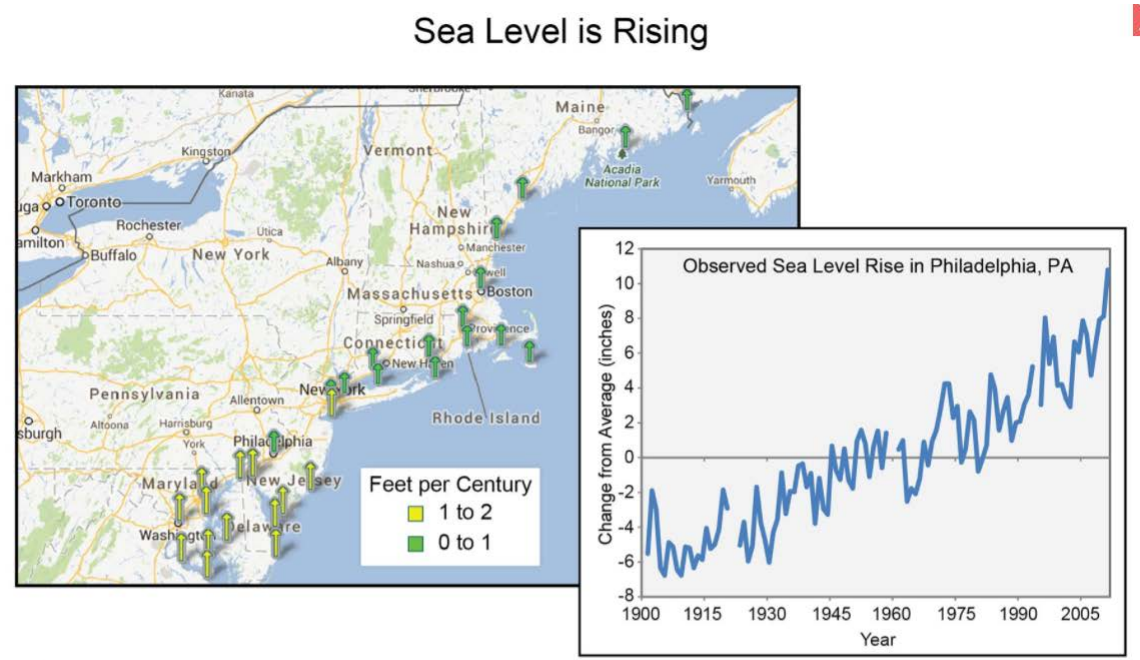
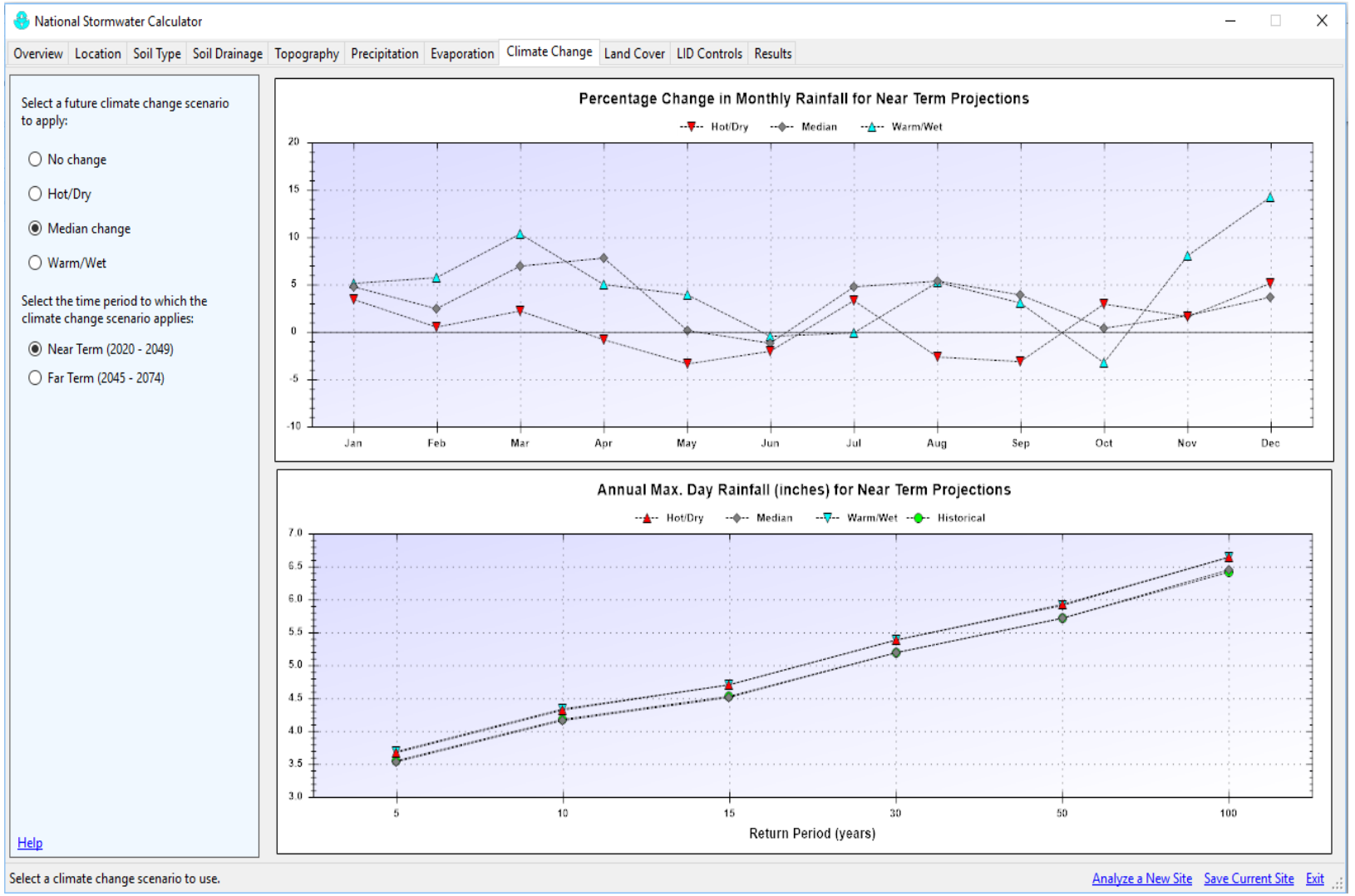


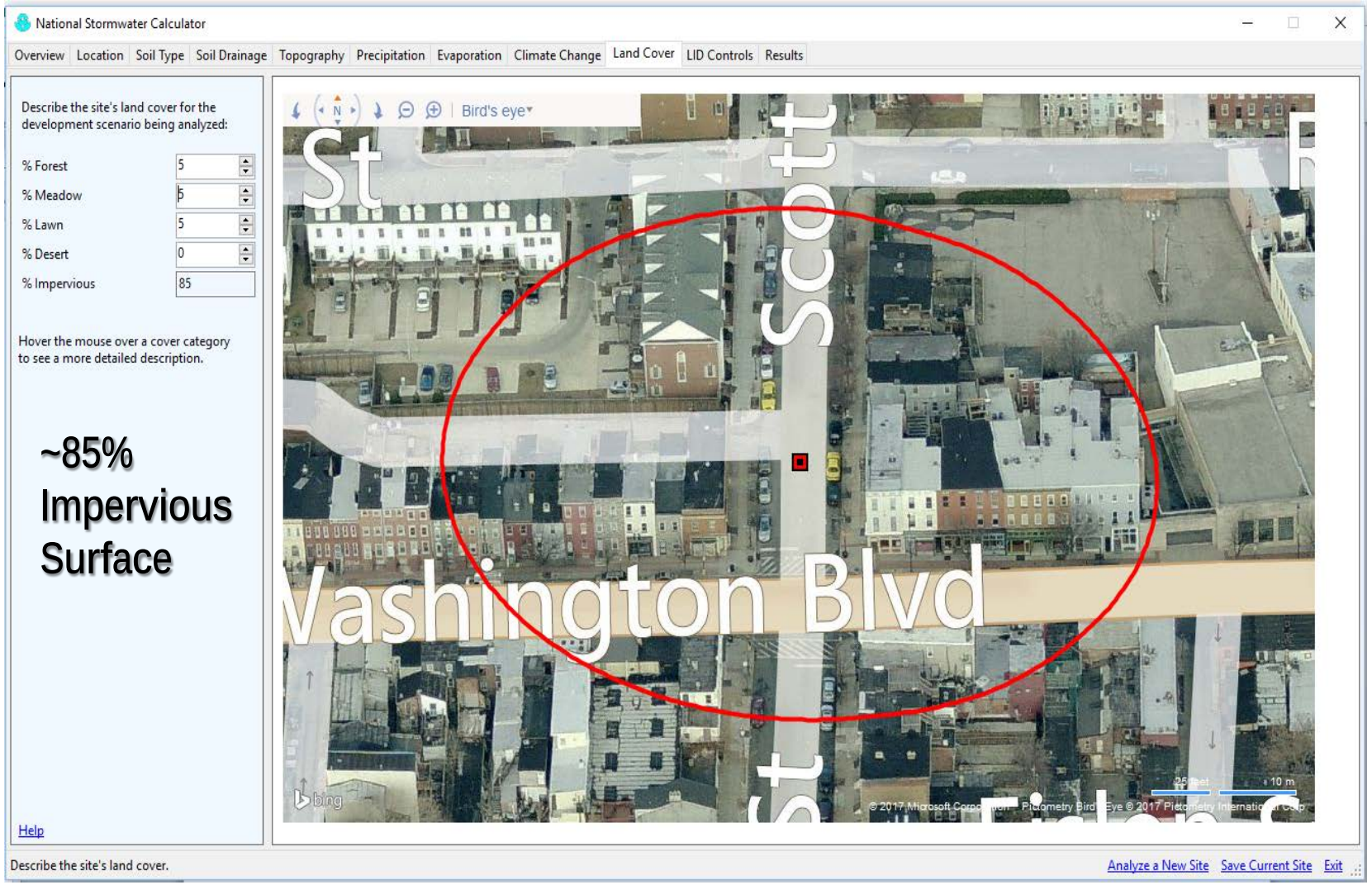
Figure 16.1: (Map) Local sea level trends in the Northeast region. Length of time series for each arrow varies by tide gauge location. (Figure source: NOAA[1]). (Graph) Observed sea level rise in Philadelphia, PA, has significantly exceeded the global average of 8 inches over the past century, increasing the risk of impacts to critical urban infrastructure in low-lying areas. Over 100 years (1901-2012), sea level increased 1.2 feet (Data from Permanent Service for Mean Sea Level).

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

SWC Analysis: Scott Street
Climate Change Scenarios

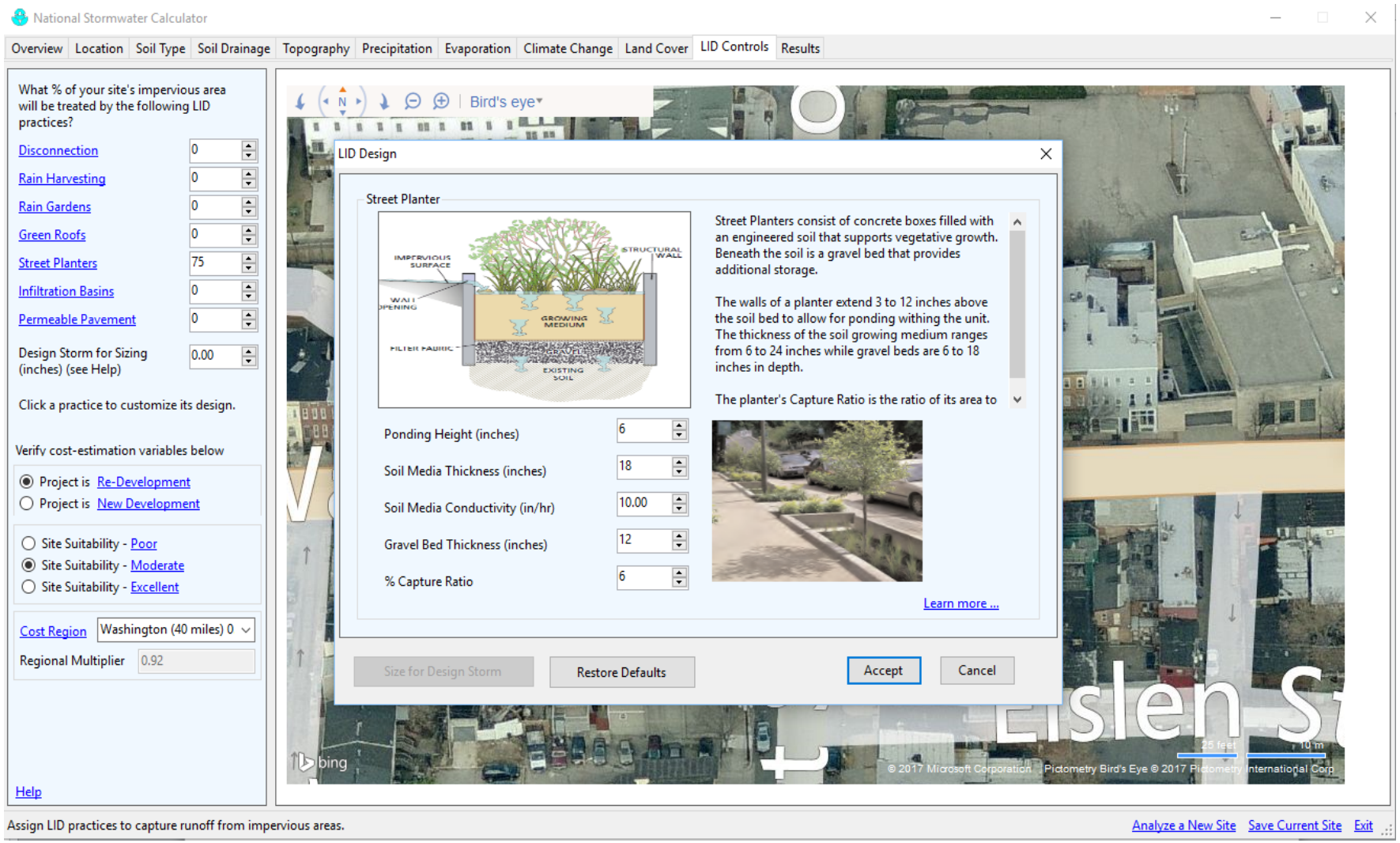


SWC Analysis: Scott Street
Existing Land Cover

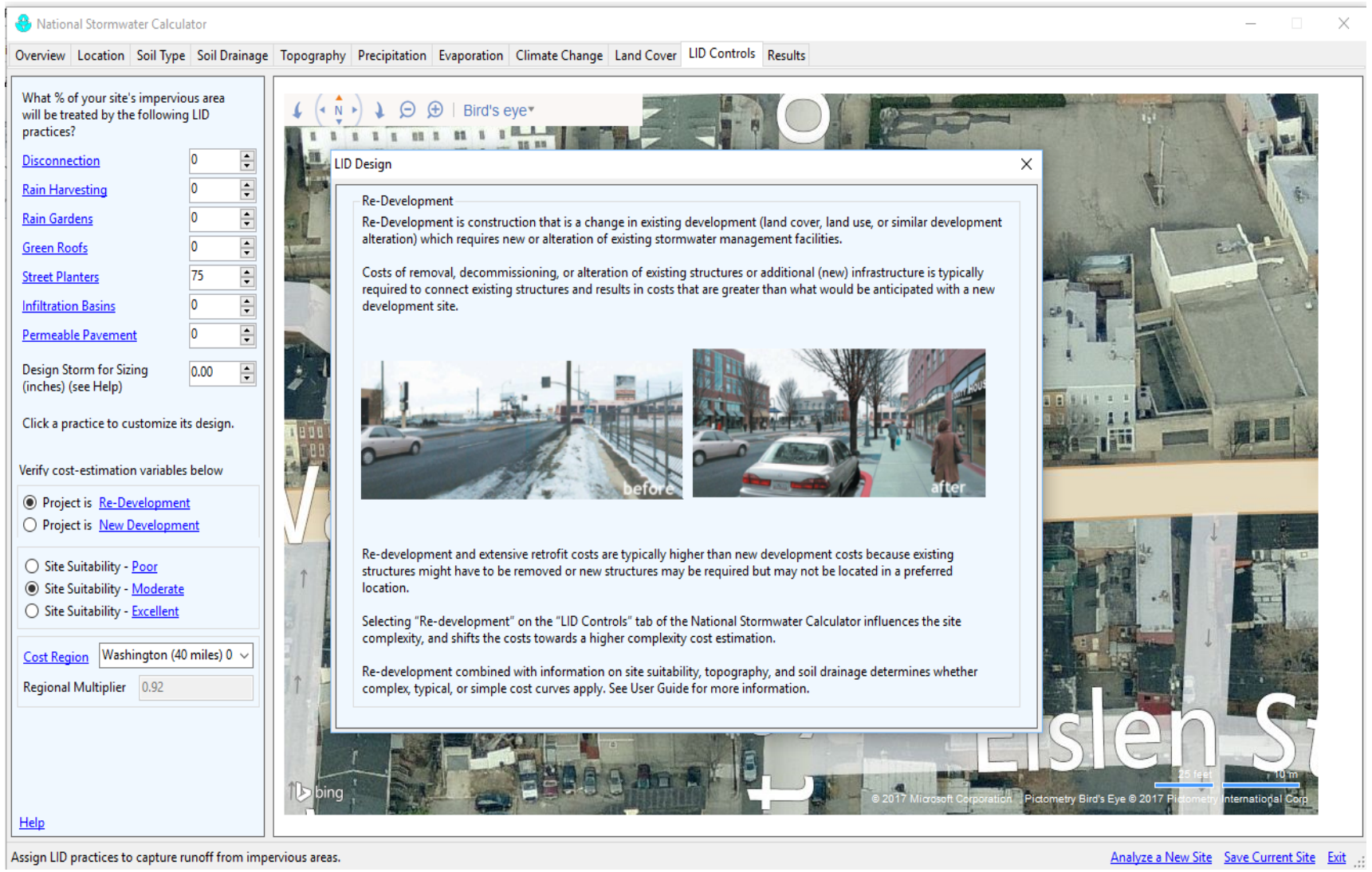


SWC Analysis: Scott Street

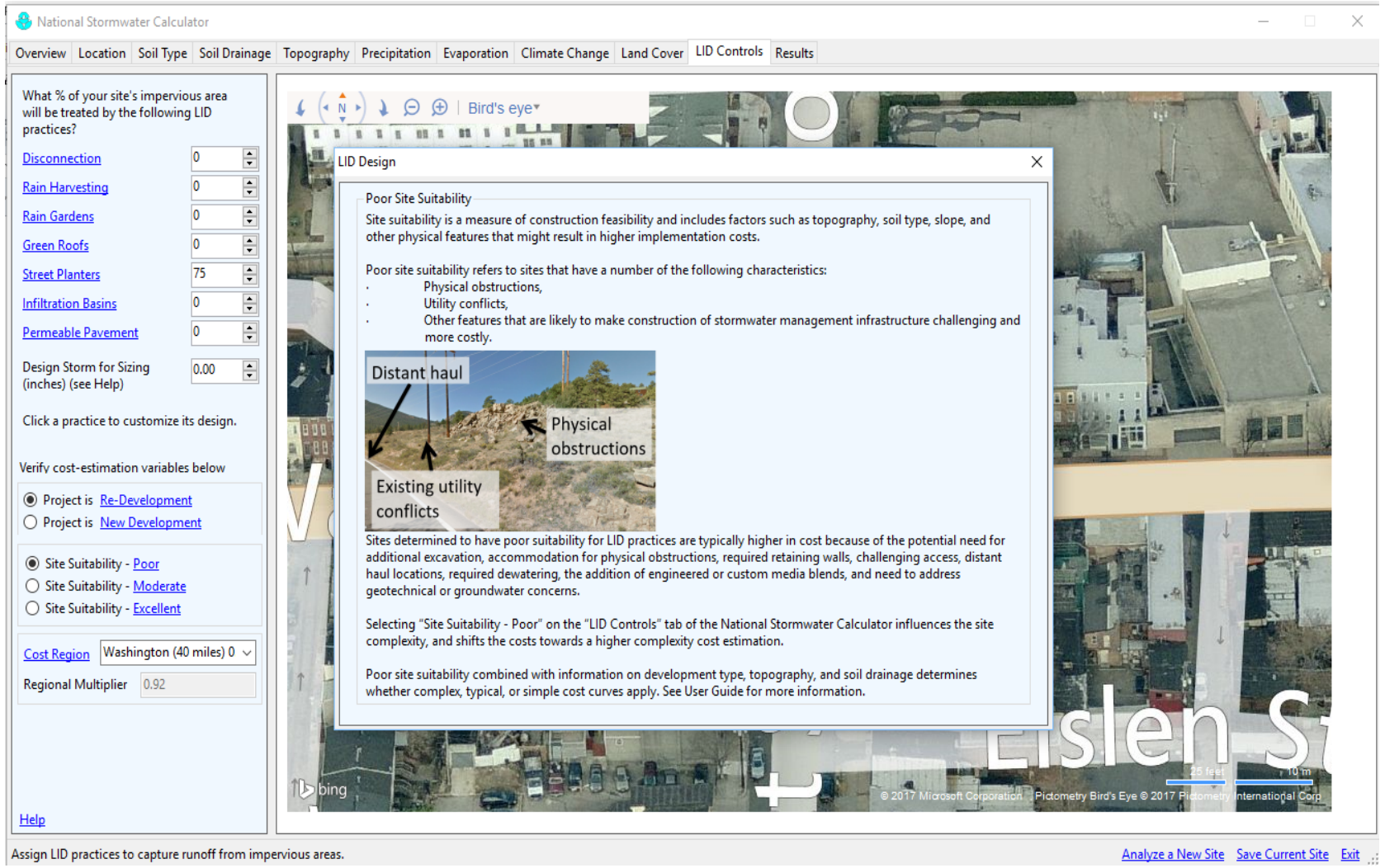
Low Impact Development Controls (LID)



SWC Analysis: Scott Street
LID: Redevelopment Project

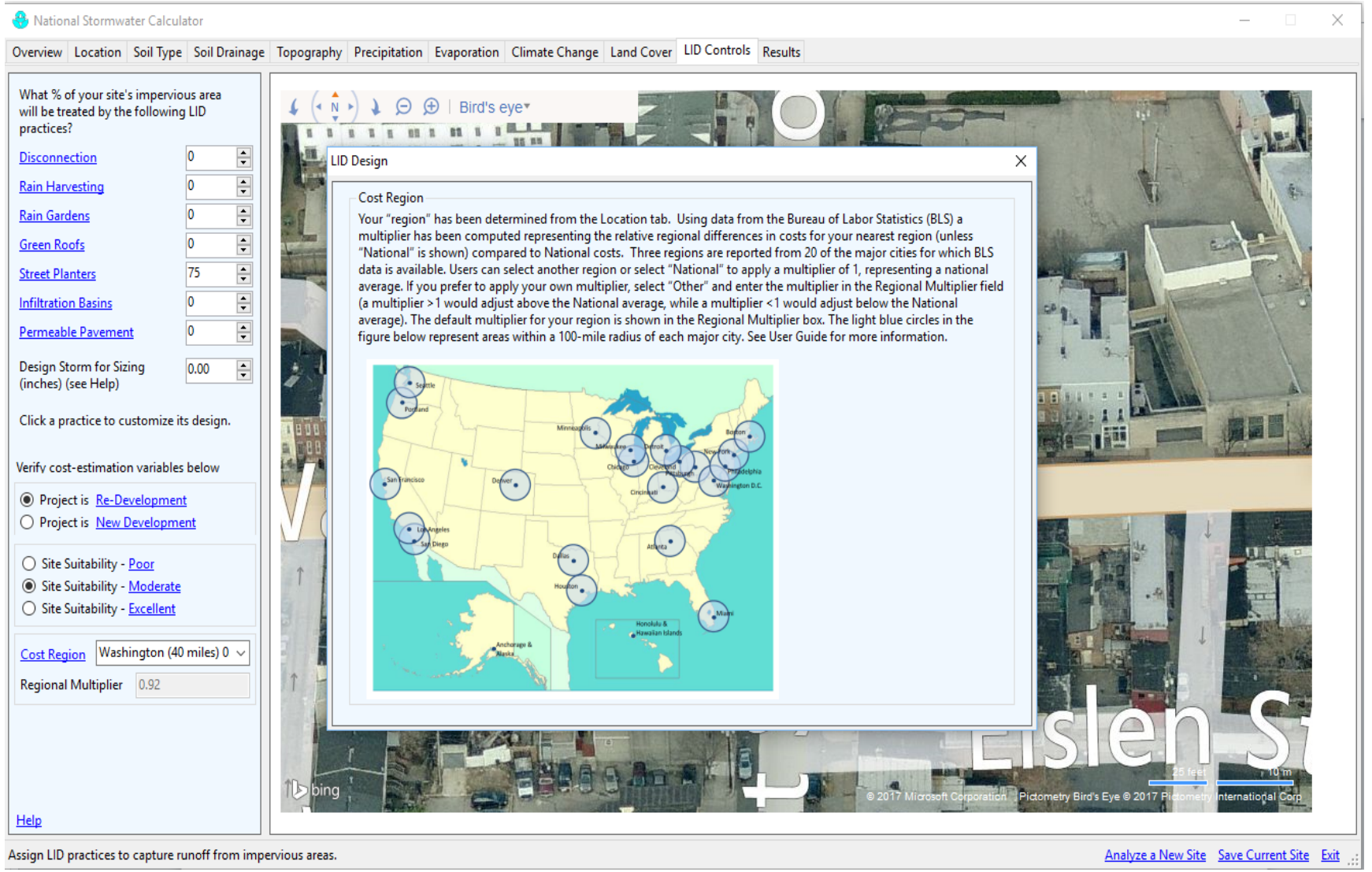


SWC Analysis: Scott Street
LID: Site Suitability (Poor)

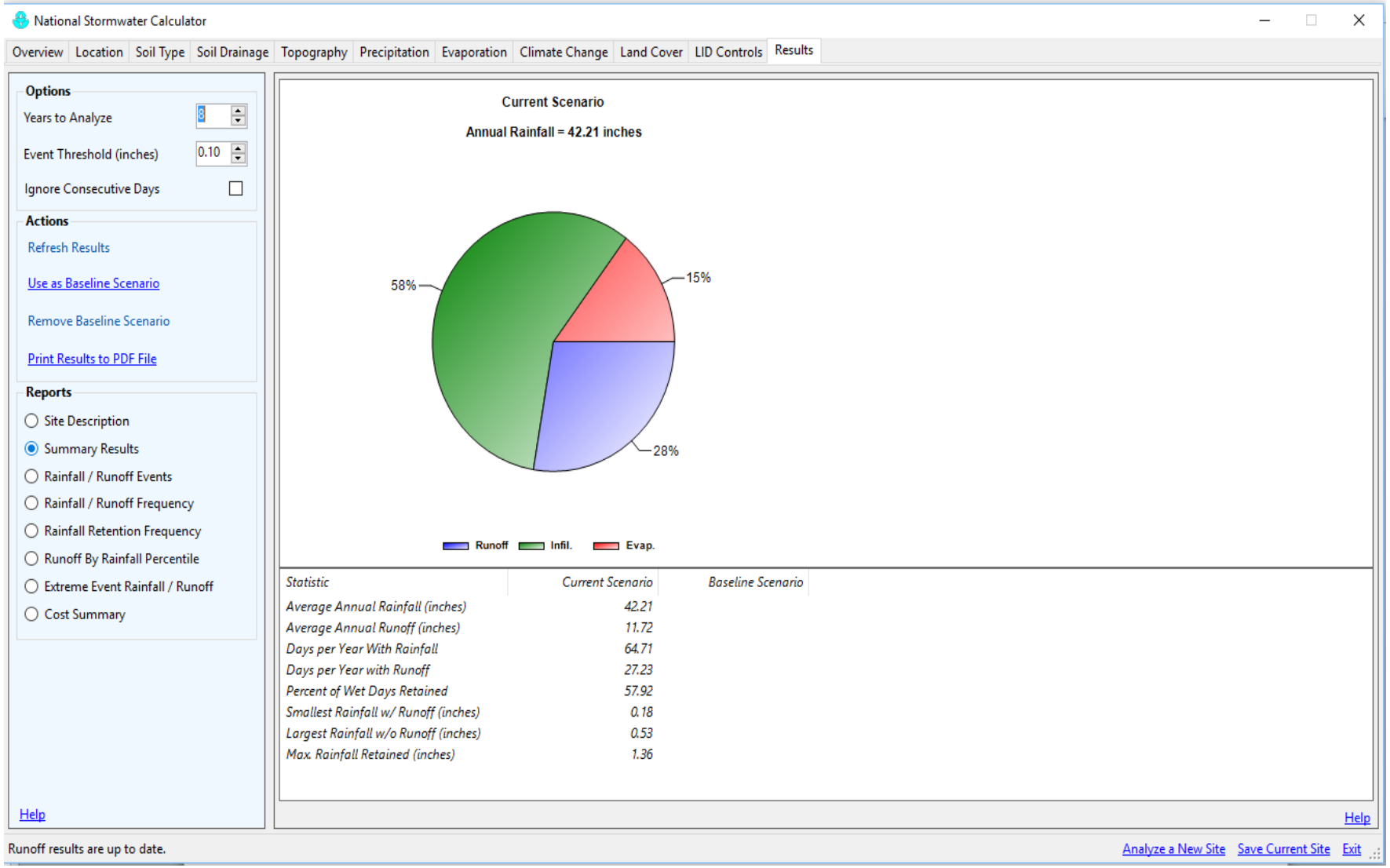


SWC Analysis: Scott Street

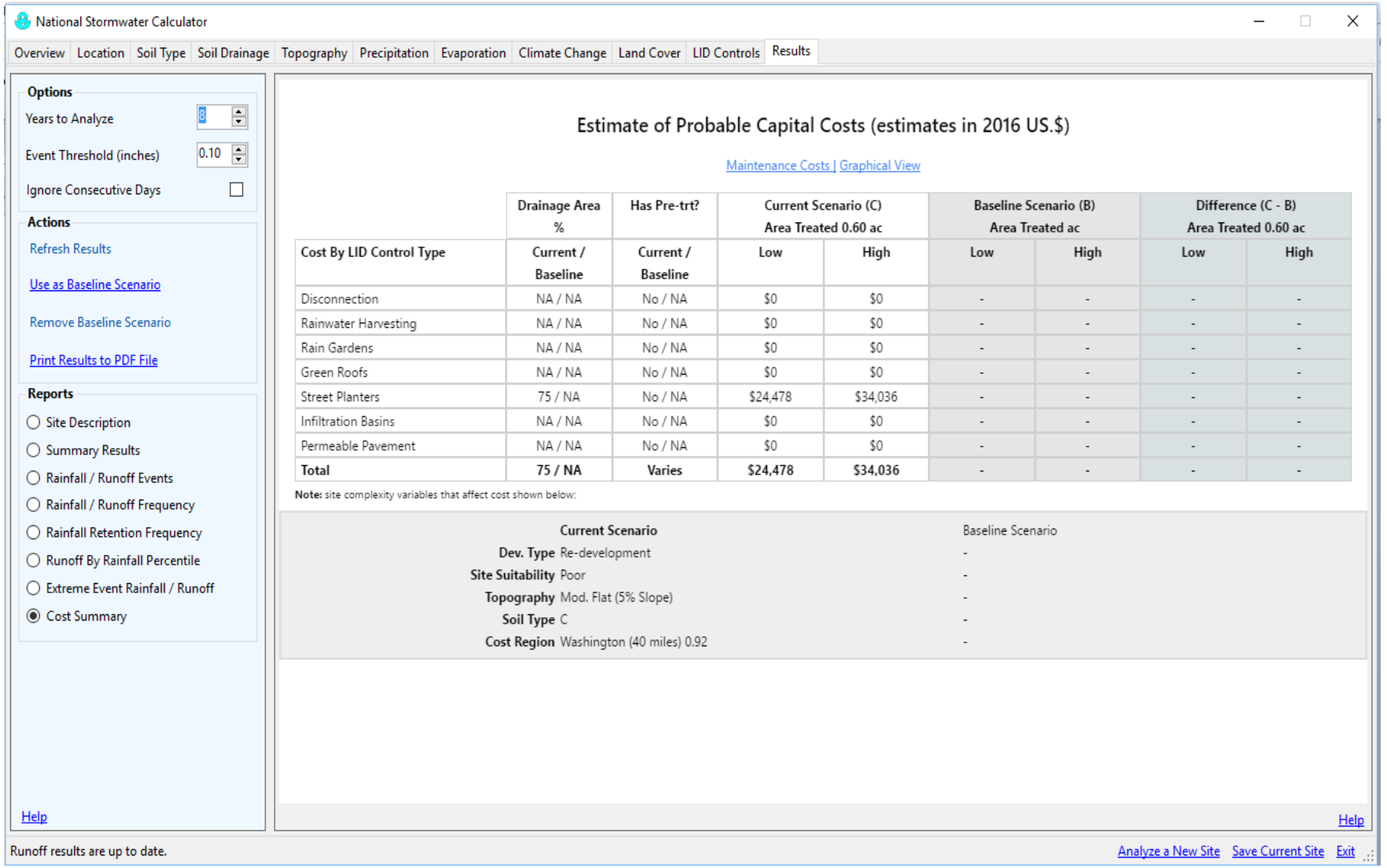
LID: US Bureau of Labor Statistics Regional Cost Centers



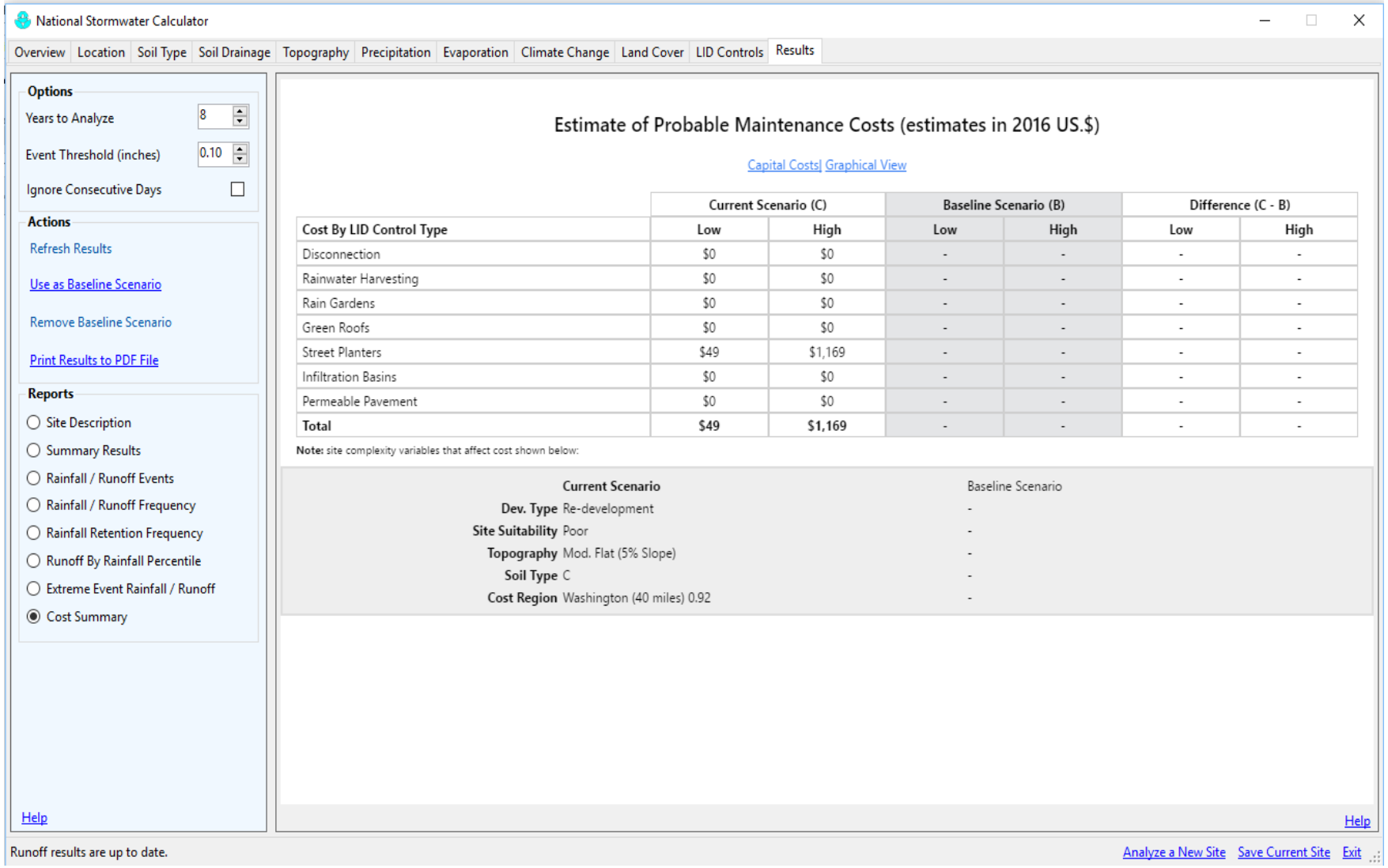
SWC Analysis: Scott Street
Runoff Reduction Results



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



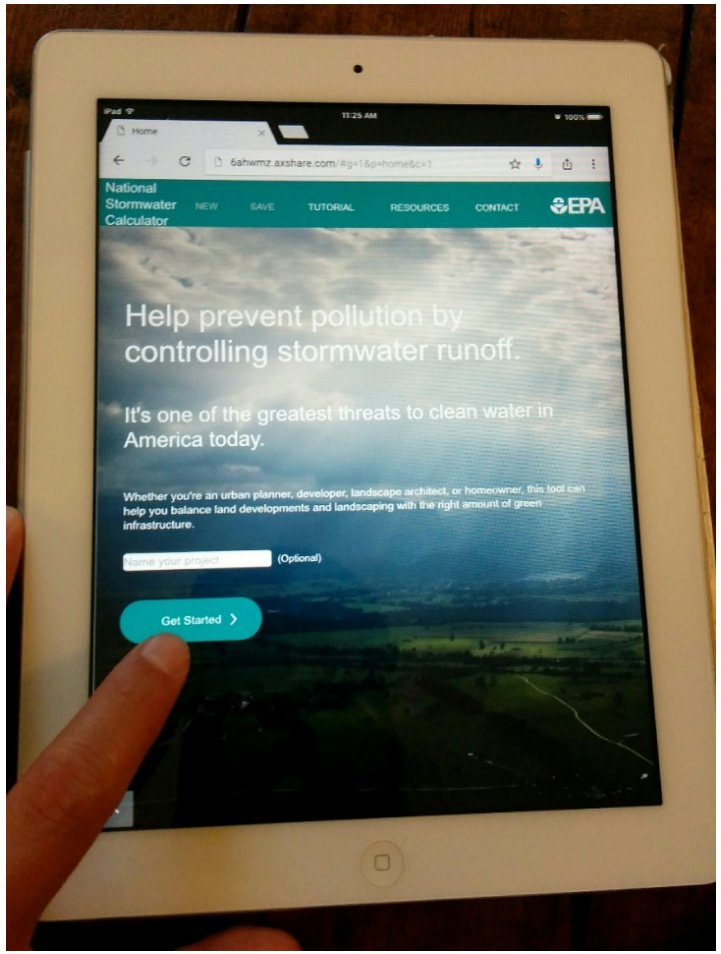
SWC Analysis: Scott Street
Annual Maintenance Costs Summary (Poor Site Suitability)

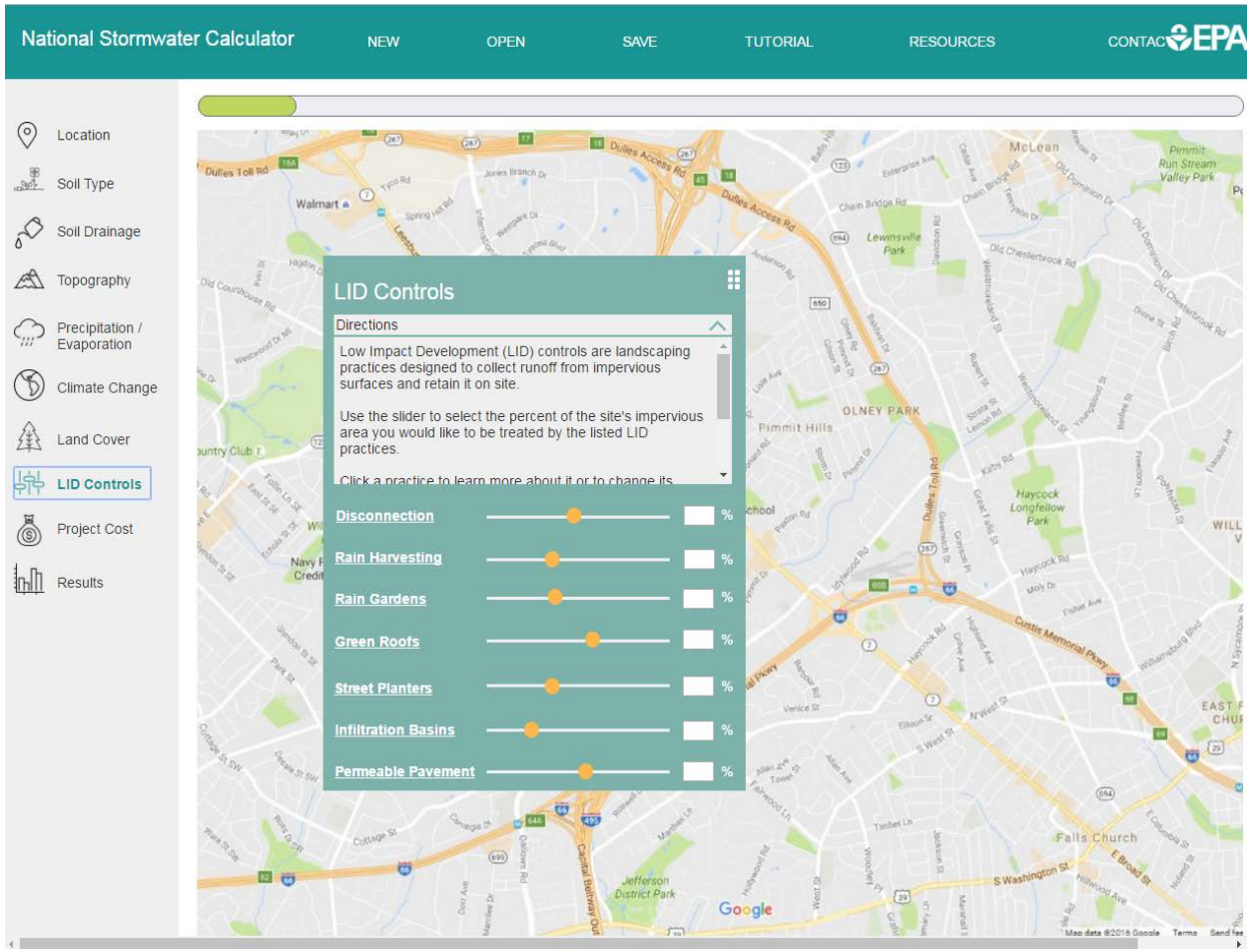


Interpreting the Results

- 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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