



Office of Research and Development

Monthly Water Research Webinar Series

SAFE AND SUSTAINABLE WATER RESOURCES RESEARCH PROGRAM



October 26, 2016

**TODAY'S TOPIC:**

# Toolkit of Available EPA Green Infrastructure Modeling Software

**Watch as  
you wait**

**Watch the Toolkit video:**

<https://www.epa.gov/water-research/green-infrastructure-modeling-toolkit>

**Webinar Support Phone Number:** 1-800-263-6317

**Audio Controls:** Your audio is muted by the organizer

**To Ask a Question:** Type in the "Questions" box in the lower section of your screen

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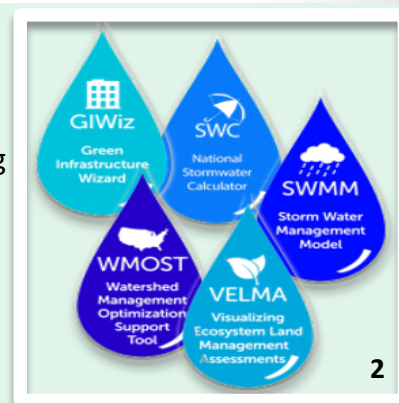
**Need for Water Runoff Control:** Stormwater discharges continue to cause impairment of our Nation's waterbodies. Conventional stormwater infrastructure, or gray infrastructure, is largely designed to move stormwater away from urban areas through pipes and conduit. Runoff from these surfaces can overwhelm sewer systems and end up contaminating local waterways. When stormwater runs off impervious streets, parking lots, sidewalks, and rooftops, it carries pollutants, such as motor oil, lawn chemicals, sediments, and pet waste to streams, rivers, and lakes. Runoff flows can also cause erosion and flooding that can damage property, infrastructure, and wildlife habitat. In addition to runoff problems, impervious surfaces also prevent water from penetrating the soil and recharging groundwater supplies.



**Green Infrastructure:** Green infrastructure, such as rain gardens, green roofs, porous pavement, cisterns, and constructed wetlands, is becoming an increasingly attractive way to recharge aquifers and reduce the amount of stormwater runoff that flows into wastewater treatment plants or into waterbodies untreated. It provides many environmental, social, and economic benefits that promote urban livability, such as improved surface water quality, water conservation, and improved aesthetics and property values. Green infrastructure is also incorporated into municipal separate storm sewer system (MS4) and National Pollutant Discharge Elimination System (NPDES) stormwater permits for retention requirements for various states across the Nation.

**Green Infrastructure Modeling Toolkit:** Researchers in EPA's Office of Research and Development (ORD) have been studying green infrastructure practices and developing models and tools to help communities manage their stormwater runoff and address nutrient impairment. This webinar will present a toolkit consisting of five EPA green infrastructure models and tools, along with communication material, that can be used as a teaching tool and as a quick reference resource for use by planners and developers when making green infrastructure implementation decisions, and can also be used for low impact development design competitions. The models and tools included in the toolkit will be presented during this webinar.

The toolkit is available on EPA's website: [epa.gov/water-research/green-infrastructure-modeling-toolkit](https://epa.gov/water-research/green-infrastructure-modeling-toolkit)





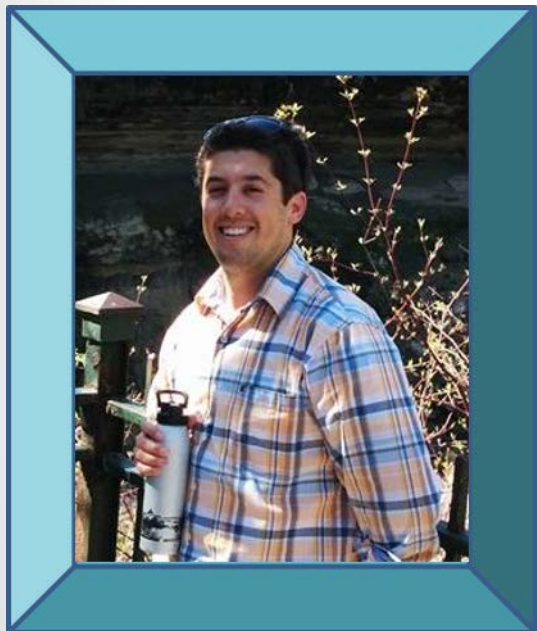
## **Disclaimer**

The views expressed in this presentation are those of the author and do not necessarily reflect the views of the U.S.

Environmental Protection Agency. Any mention of trade names or commercial products does not constitute Agency endorsement or recommendation for use.



**National Stormwater Calculator (SWC):** SWC is a desktop application that estimates the annual amount of stormwater runoff from a specific location in the United States (including Puerto Rico), based on local soil conditions, land cover, and historic rainfall records. It is used to inform site developers on how well they can meet a desired stormwater retention target with and without the use of green infrastructure. It also allows users to consider how runoff may vary based both on historical weather and potential future climate. SWC was mentioned in President Obama's Climate Action Plan and is now a resource for LEED Project Credit 16 (Rainwater Management) certification by the U.S. Green Building Council for projects that are designed to reduce runoff volume and improve water quality of a site.



### Jason Bernagros

Jason Bernagros is trained as a landscape architect and has been with EPA for over nine years. He has worked in EPA's Region 2 and Office of Water, and is currently working as a biologist in ORD. His research focuses on the application of green infrastructure planning tools, urban planning and design, community capacity building with municipalities and utilities, and supporting innovative water technologies. Jason has a Master of Landscape Architecture and a B.S. in Environmental Sciences from the University of Illinois at Urbana-Champaign.

**Contact:** [bernagros.jason@epa.gov](mailto:bernagros.jason@epa.gov)


# U.S. EPA National Stormwater Calculator (SWC)

- Stormwater Calculator Background Information
- Low Impact Development (LID) Cost Estimation Module
- SWC Web Application
- Example Application: Northport, MI





# Website

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## National Stormwater Calculator

Register now for a [free webinar](#) on January 31, 2018 that will provide a demonstration and introduce new features.

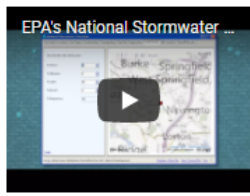
*Tool to help control runoff and promote the natural movement of water*

EPA's National Stormwater Calculator (SWC) is a software application that estimates the annual amount of rainwater and frequency of runoff from a specific site. Estimates are based on local soil conditions, land cover, and historic rainfall records. It is designed to be used by anyone interested in reducing runoff from a property, including site developers, landscape architects, urban planners, and homeowners.

The SWC accesses several national databases that provide soil, topography, rainfall, and evaporation information for a chosen site. The user supplies information about the site's land cover and selects low impact development (LID) controls they would like to use. The LID controls include seven green infrastructure practices.

Access the  
Mobile Web App

Additional Information



Green Infrastructure as Low Impact Development Controls

+

Capabilities

+

Real-World Applications

+

Software and Documentation

+

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



# What Have We Created and Why?

## Stormwater Management (Green Infrastructure/Low Impact Development) Design and Planning Tool

- **Model pre- and post-construction stormwater runoff discharges**
- **Allow for screening-level analysis of various green infrastructure practices (green roofs, rain gardens, cisterns, etc.) throughout the U.S.**
- **Allow non-modelers to conduct screening level stormwater runoff analyses for small to medium sized (less than 1 acre to 12 acres) urban development 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 (US Green Building Council) and Sustainable Sites Initiative stormwater credits, Rockefeller Foundation's 100 Resilient Cities
- Climate Resiliency Planning
- LID/Green Infrastructure Design Competitions: Campus RainWorks Challenge, DC Water Green Infrastructure Challenge, etc.



- Northeastern Regional Ohio Sewer District (Cleveland, OH):

[Home](#) > [Stormwater](#) > [Green Infrastructure Grant Program](#)

## ***Green Infrastructure Grant Program***



<https://www.neorsd.org/stormwater-2/green-infrastructure-grant-program>

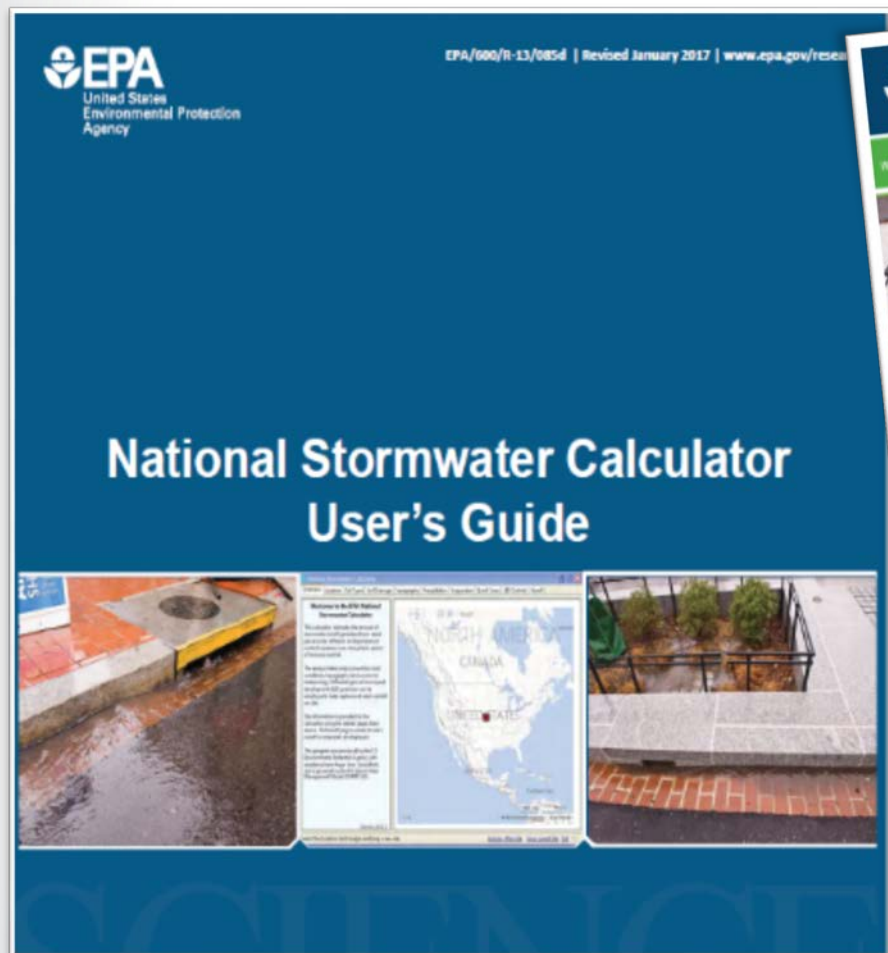
- EPA's Green & Complete Streets Building Blocks Program Recipients (2016- 2017):
  - Manatee County, FL
  - Baltimore, MD
  - Central Falls, RI




<https://www.epa.gov/smartgrowth/building-blocks-sustainable-communities>



# Training and Outreach Materials: User's Manual and Fact Sheet



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


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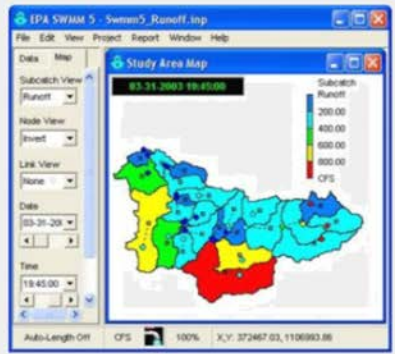
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## Storm Water Management Model (SWMM)

Version 5.1.012 with Low Impact Development Controls

- [Description](#)
- [Capabilities](#)
- [Applications](#)
- [Add-in Tool](#)
- [Support](#)
- [Downloads](#)
- [Documentation](#)
- [Helpful Resources](#)
- [Contact](#)



- Calculator is based on SWMM: dynamic rainfall-runoff simulation model for long-term simulation of runoff quantity
- SWMM runs in background of Stormwater Calculator





# Desktop Application

 National Stormwater Calculator

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

**Welcome to the EPA National Stormwater Calculator**

This calculator estimates the amount of stormwater runoff generated from a land parcel under different development and control scenarios over a long-term period of historical rainfall.

The analysis takes into account local soil conditions, topography, land cover and meteorology. Different types of low impact development (LID) practices can be employed to help capture and retain rainfall on-site. Localized climate change scenarios can also be analyzed.

Site information is provided to the calculator using the tabbed pages listed above. The Results page is where the site's runoff is computed and displayed.

This program was produced by the U.S. Environmental Protection Agency and was subject to both internal and external technical review. Please check with local authorities about whether and how it can be used to support local stormwater management goals and requirements.

Release 1.1.0.0

  | Road▼



bing

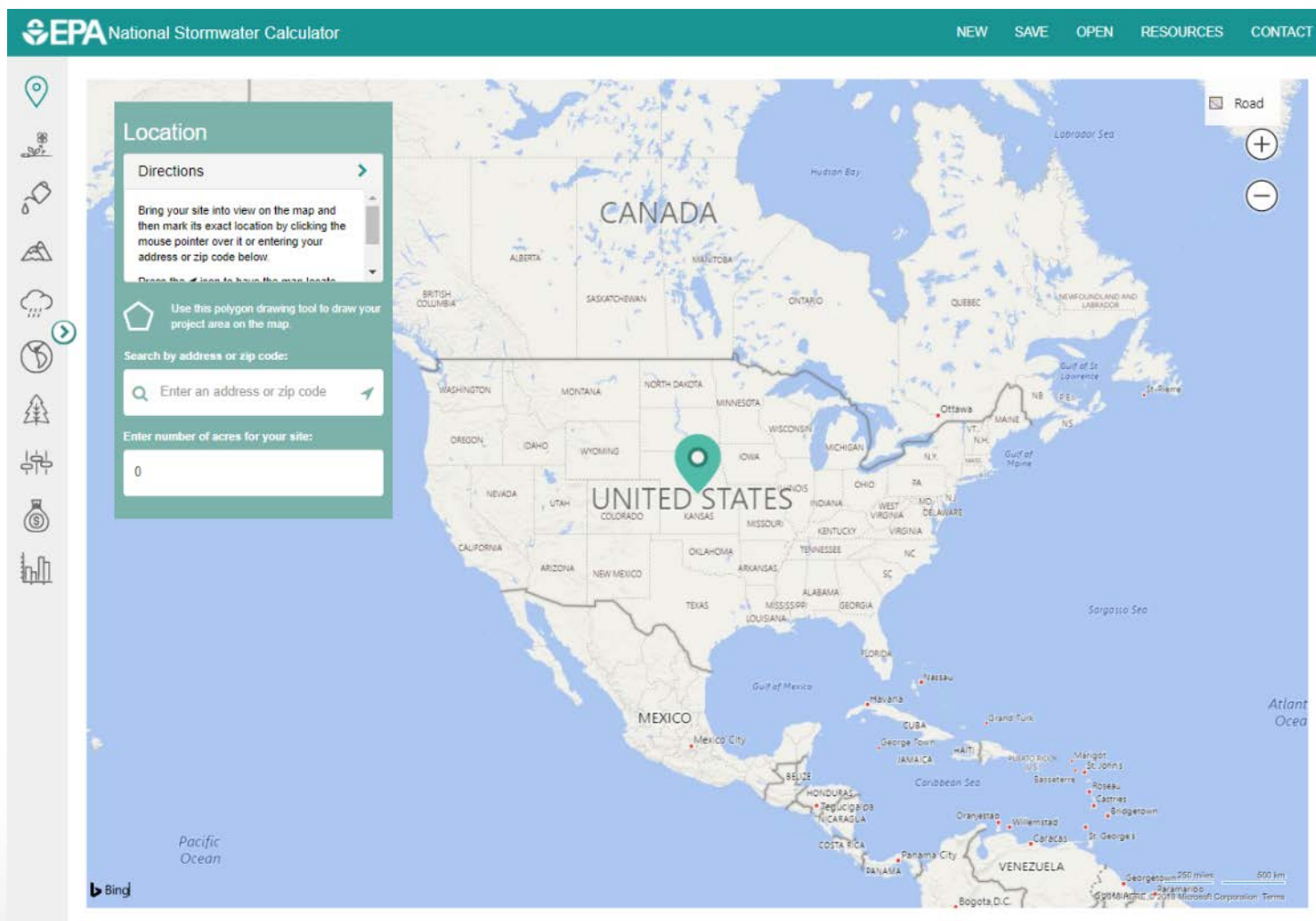
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Select the Location tab to begin analyzing a new site.

[Analyze a New Site](#) [Save Current Site](#) [Exit](#)



# Web Application



Web App Link: <https://swcweb.epa.gov/stormwatercalculator>

- **Intended Uses:**
  - Planning level cost estimates (magnitude of costs between planning scenarios)
- **Limitations:**
  - Doesn't provide final construction/build costs
  - Doesn't provide lifecycle costs (gives annual operation and maintenance (O & M) costs, not replacement costs)
  - Regional costs not available for all areas of the US (many of the Western states)





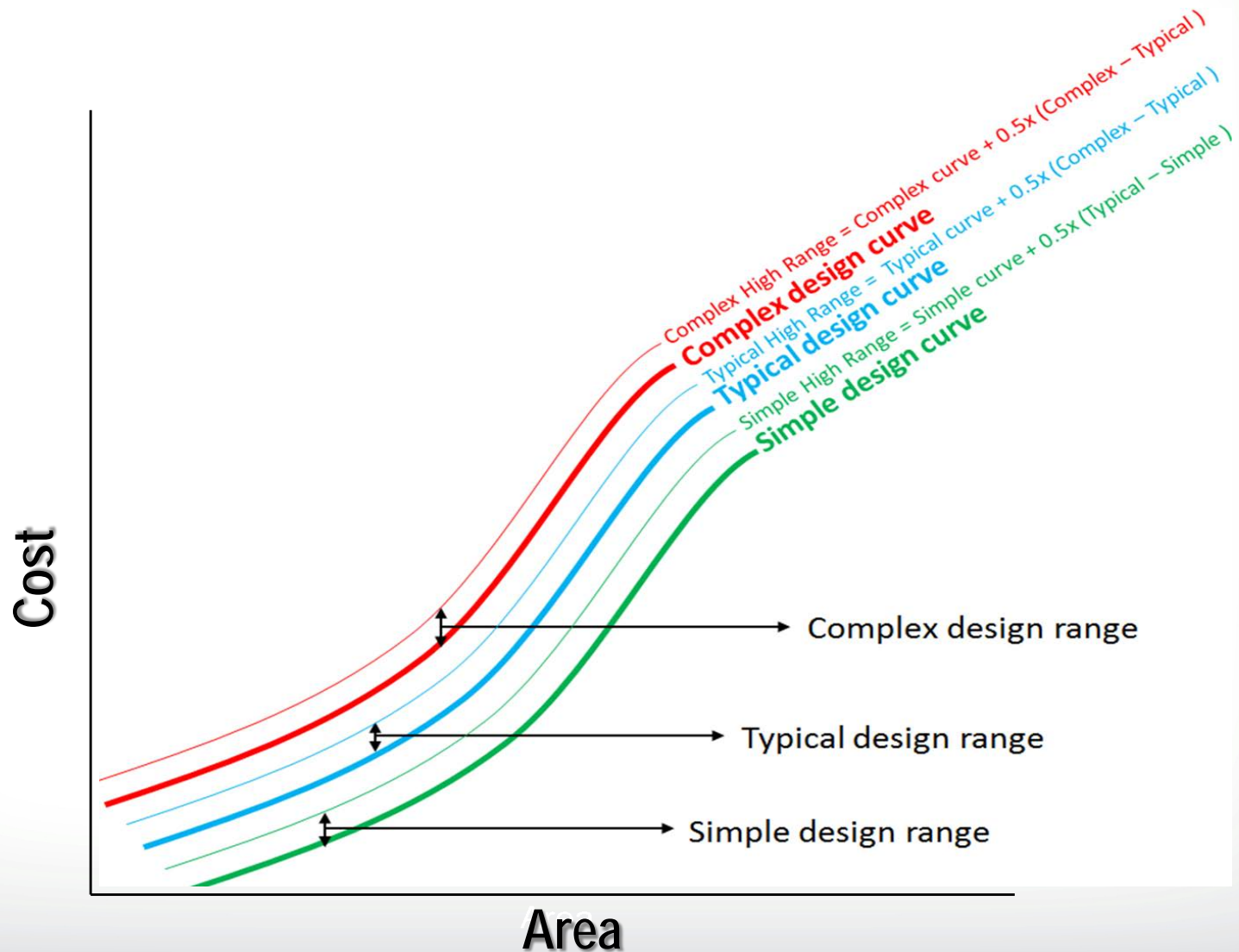


## LID Cost Estimation Module: Site Complexity Effects on Costs

Criteria	Degree of Complexity		
	Simple	Typical	Complex
<b>New vs. existing development</b>	New	Existing	Existing
<b>(Pretreatment) Outflow and overflow discharge safety constraints</b>	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
<b>Equipment accessibility</b>	Easy access	Fairly easy	Difficult access
<b>Slope for LID control placement</b>	Flat to moderately flat (0 – 4%)	Moderately flat (4 – 7%)	Steeper slope (greater than 7%)
<b>Soil infiltration rate</b>	High infiltration (HSG: A)	Moderate infiltration (HSG: B)	Low infiltration (HSG: C and D)



## LID Cost Estimation Module: Accounting For Uncertainty (Regression Cost Curves)





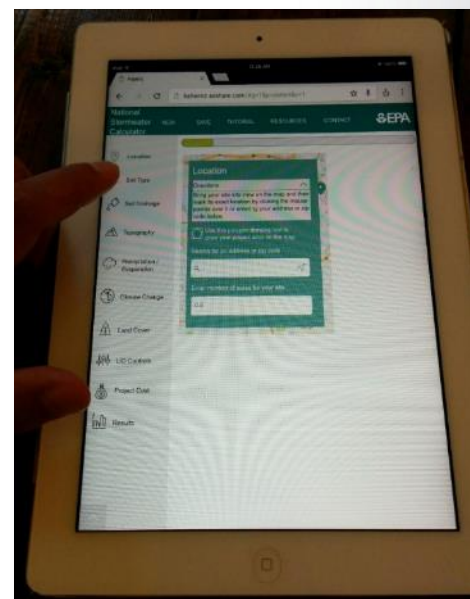
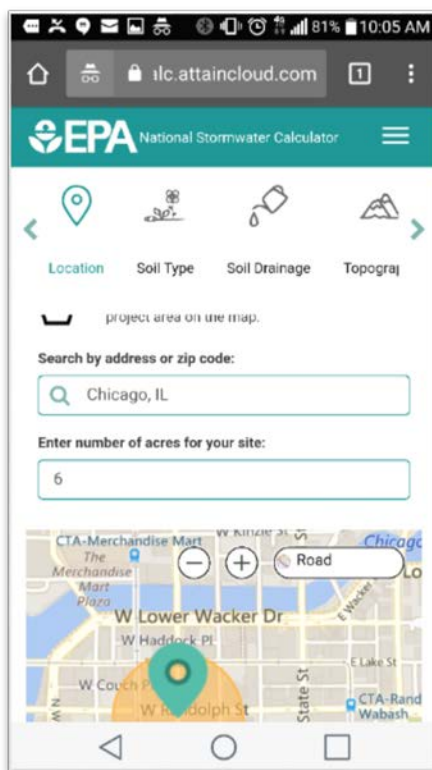
## LID Cost Estimation Module: Development of Regionalized Costs

- **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**



# New SWC Web App

- Ability to function on any web browser
- Mobile friendly design (tablets and smartphones)
- Platform neutral: functions on Windows, Apple, and Linux computers
- Not found in an “app store” (Google Play or Apple Store)
  - Save it as a “favorite” website
- Requires a live Internet connection



*Example views from smartphone and tablet*

- **Location:** Bing Maps
- **Soils:** NRCS SSURGO (*web service*)
- **Slope:** NRCS SSURGO
- **Hydraulic Conductivity:** NRCS SSURGO
- **Precipitation and Temperature:** National Climate Center (NCDC)-NOAA (*EPA's BASINS Model*)
- **Evaporation:** Calculation based on meteorological data
- **Climate Change Future Scenarios:** Precipitation & evaporation (*EPA's CREAT 2.0*)
- **Land-Cover/Use:** User provided
- **LID Practices (\*new costing module available\*):** User provided





# SWC Web App Application: Northport, MI

**EPA National Stormwater Calculator**

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**Location**

Directions >

Use this polygon drawing tool to draw your project area on the map.

Search by address or zip code

Nahonaba, Northport, MI

Enter number of acres for your site

1.9036617766219754

Map showing Nahonaba, Northport, MI, with a highlighted orange polygon area. The map includes street names (E 3rd St, E 2nd St, E Main St, W Main St, Waukazoo St, Bay St, Rose St, N Mills St), a marina, and Grand Traverse Bay. A scale bar indicates 100 feet and 25 meters. Copyright information: © 2017 HERE © 2017 Microsoft Corporation Available Exclusively by DigitalGlobe.

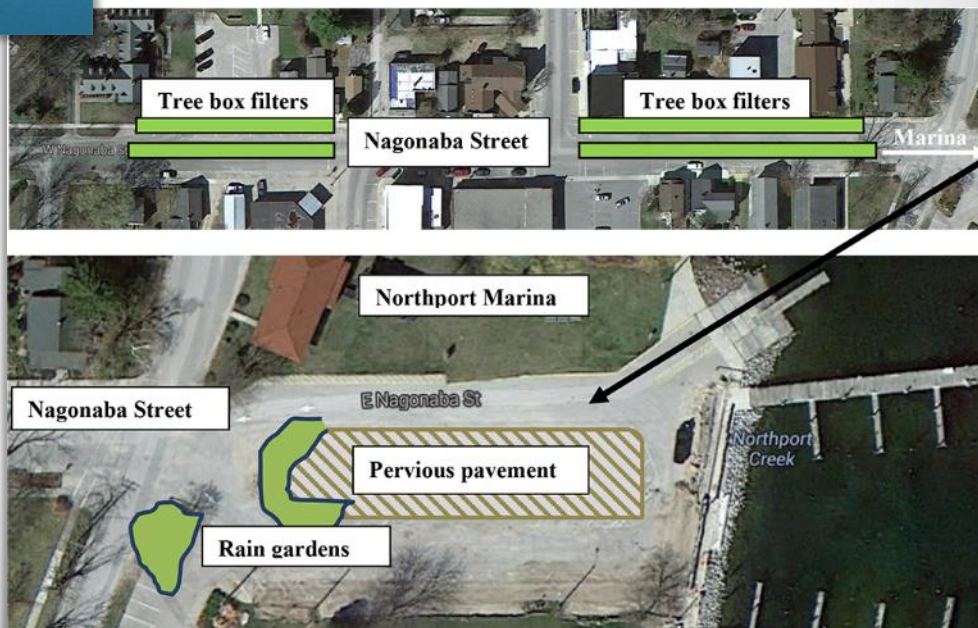




# SWC Web App Application: Northport, MI

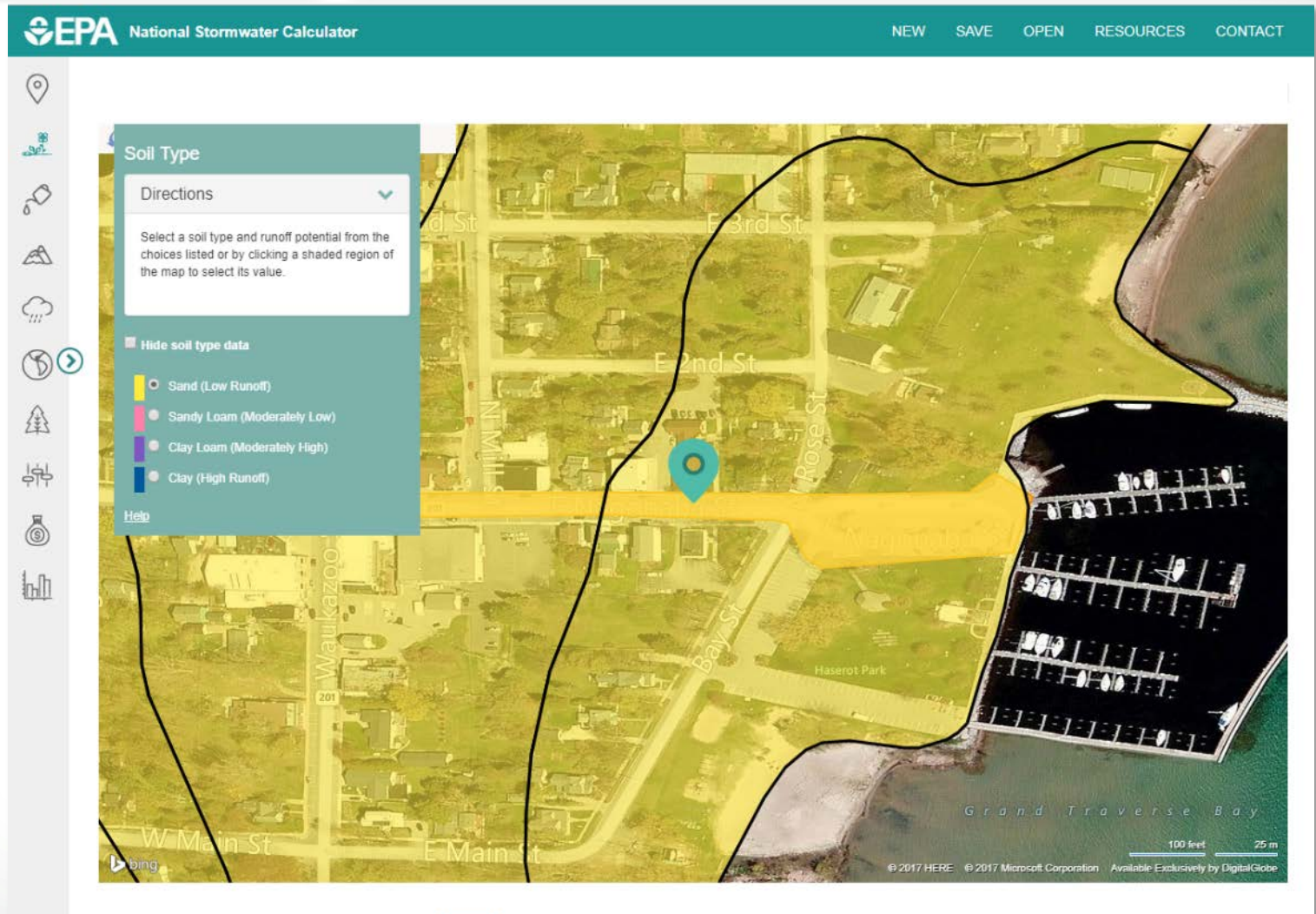


The Watershed Center Grand Traverse Bay (2016)





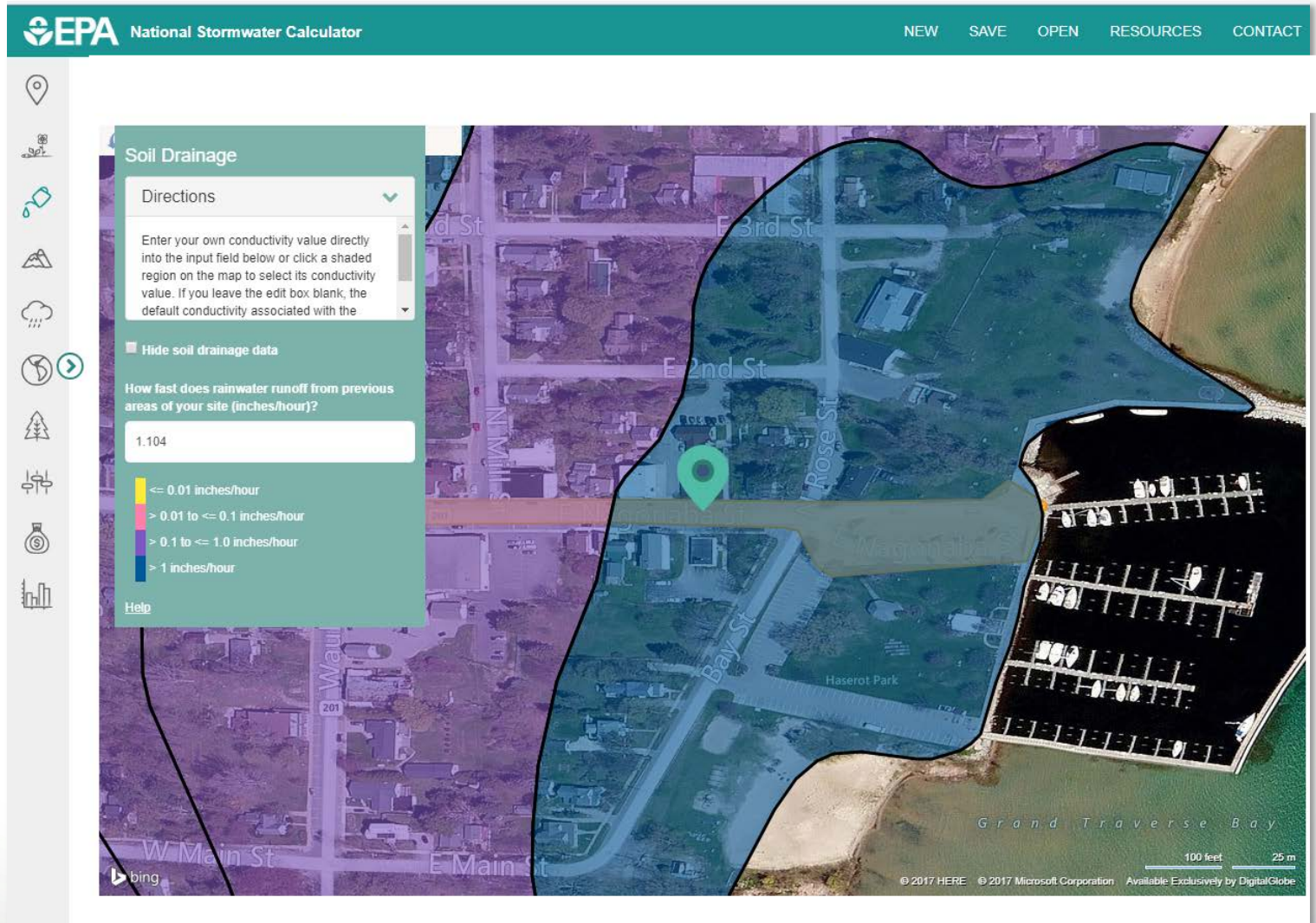
# Soil Runoff Potential





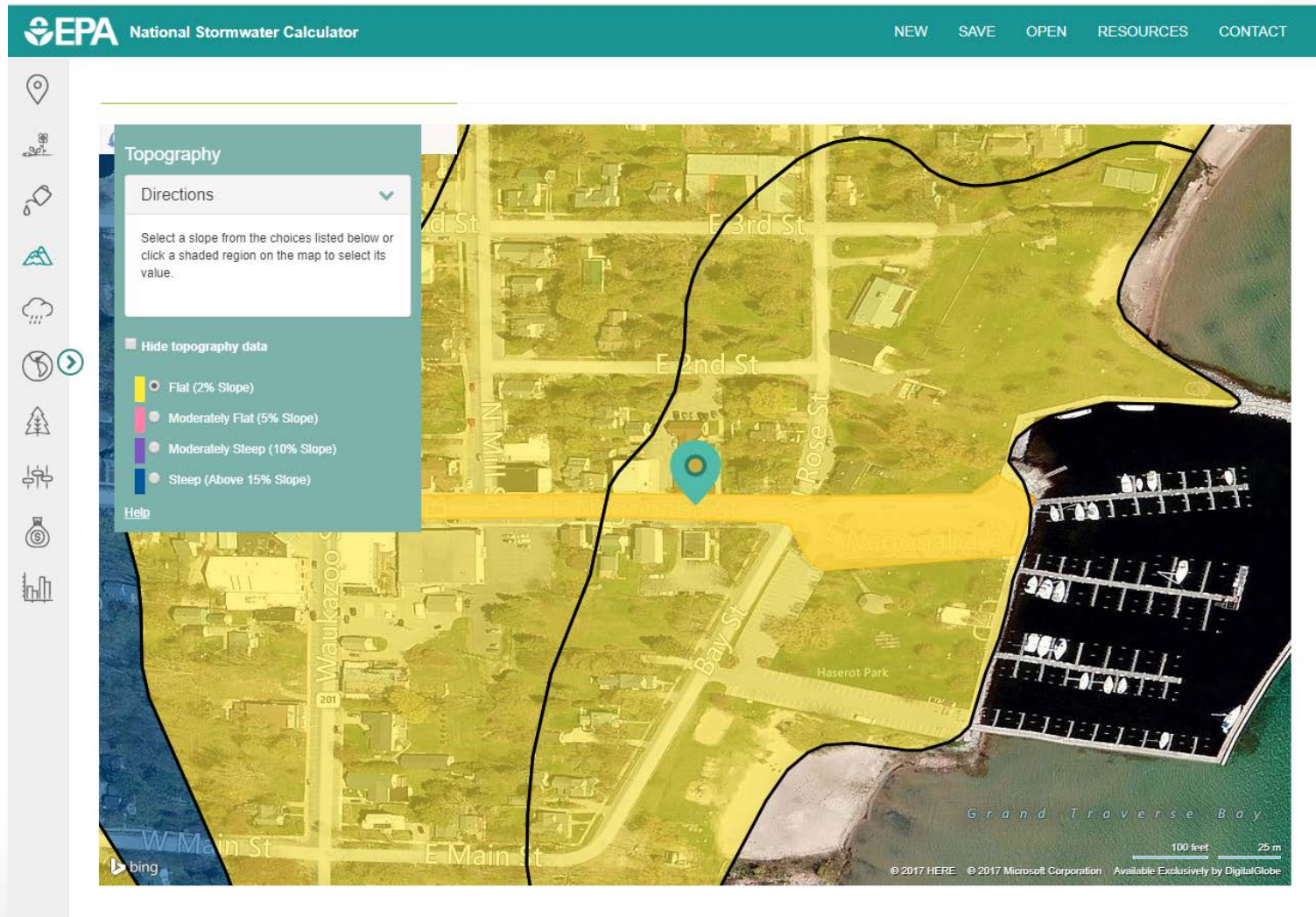


# Soil Infiltration Capacity





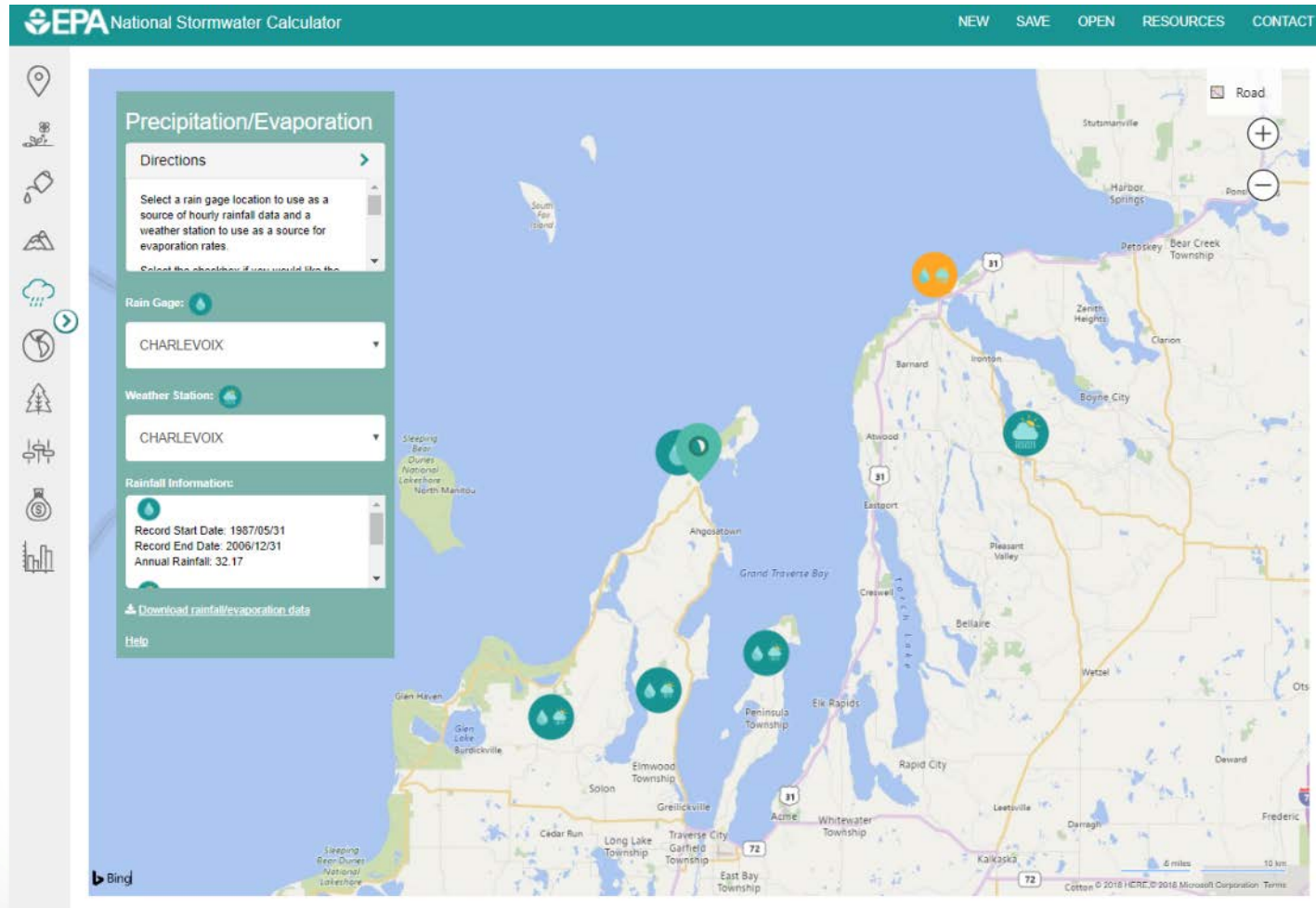
# Topography/Slope







# Historical Weather (Precipitation & Evaporation)





# Climate Change Scenarios & Extreme Storm Events

Midwest

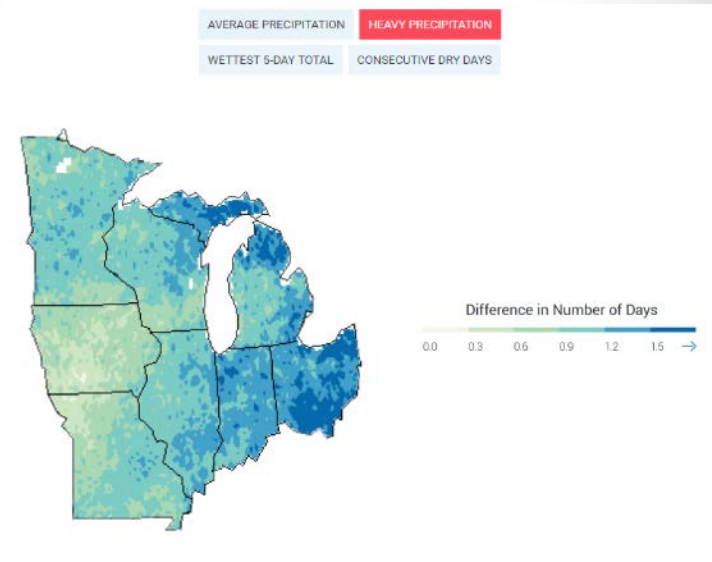
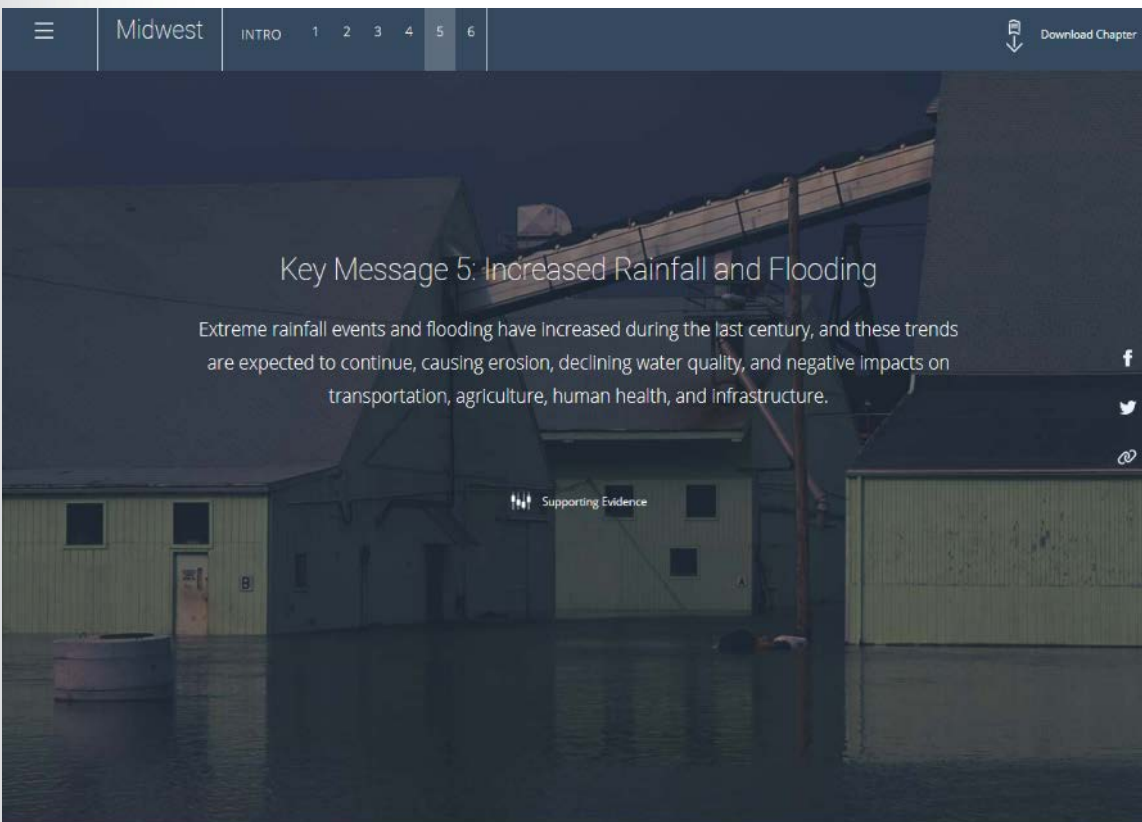
INTRO 1 2 3 4 5 6

Download Chapter

## Key Message 5: Increased Rainfall and Flooding

Extreme rainfall events and flooding have increased during the last century, and these trends are expected to continue, causing erosion, declining water quality, and negative impacts on transportation, agriculture, human health, and infrastructure.

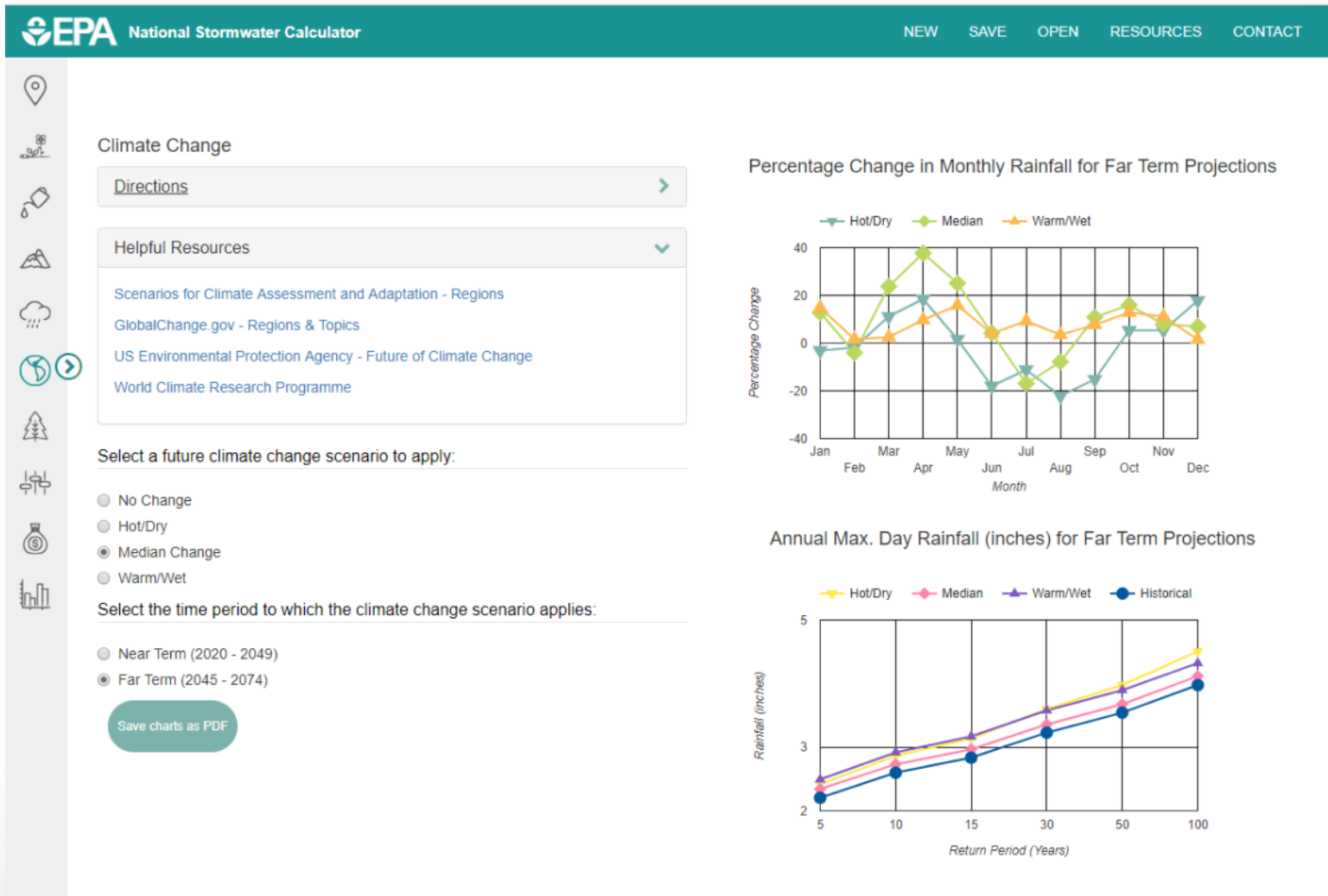
Supporting Evidence





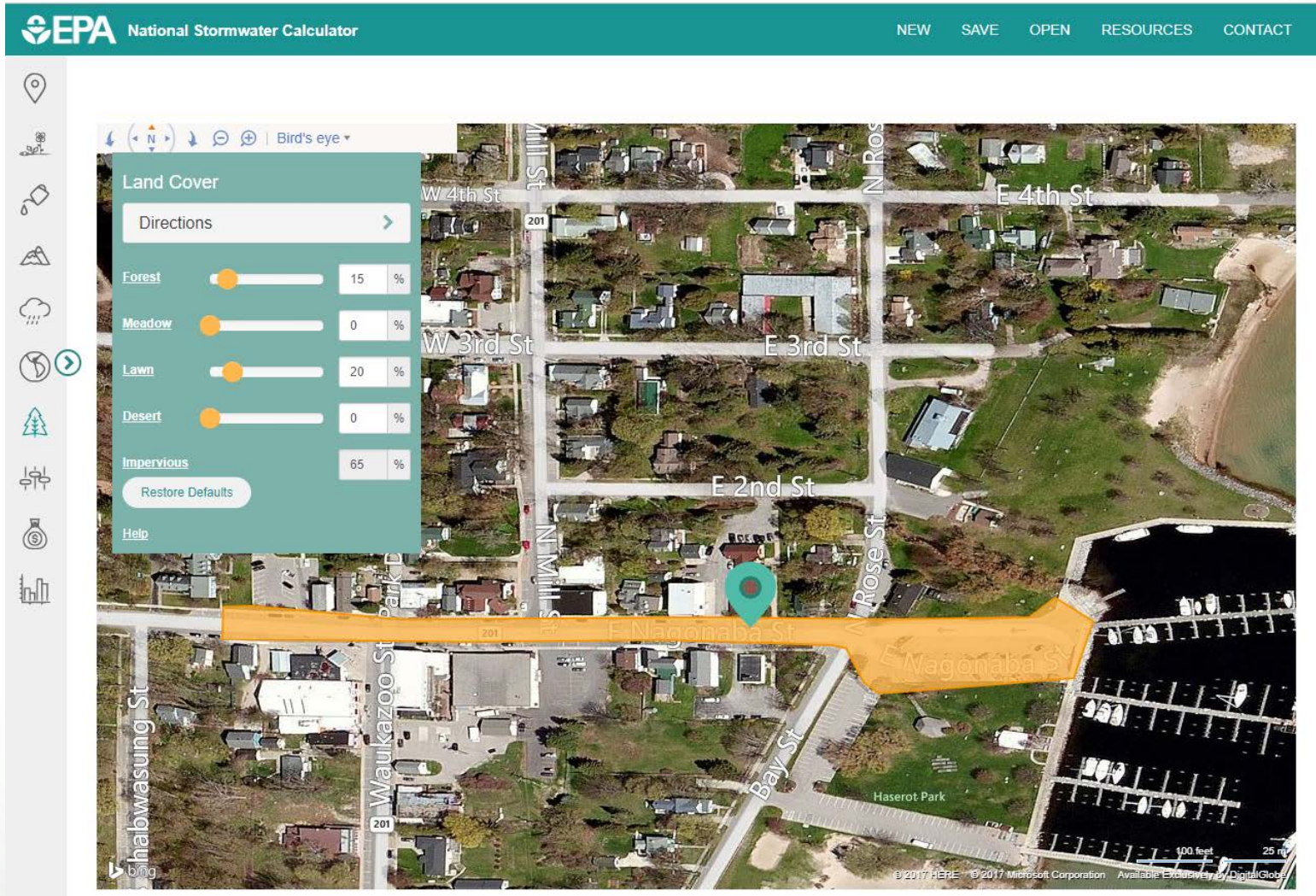


# Climate Change Scenarios & Extreme Storm Events






# Land Cover

















# LID Controls

 **National Stormwater Calculator**

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### LID Controls

Directions >

Disconnection

0 %

Rain Harvesting

0 %

Rain Gardens

10 %

Green Roofs

0 %

Street Planters

55 %

Infiltration Basins

0 %

Permeable Pavement

20 %

Design Storm for Sizing 1.0 in.

Restore Defaults

Help

### Permeable Pavement


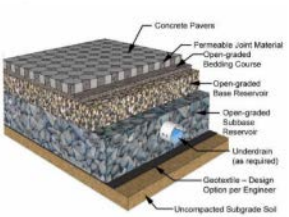
Continuous Permeable Pavement systems are excavated areas filled with gravel and paved over with a porous concrete or asphalt mix. Modular block systems are similar except that permeable block pavers are used instead.

Normally all rainfall will immediately pass through the pavement into the gravel storage layer below it where it can infiltrate at natural rates into the site's native soil.

Pavement layers are usually 4 to 6 inches in height while the gravel storage layer is typically 6 to 18 inches high.

The Capture Ratio is the percent of the treated area (street or parking lot) that is replaced with permeable pavement.

[Learn More](#)



Pavement Thickness  6 in

Gravel Layer Thickness  18 in


% Capture Ratio  14 %

☒ Pre-Treatment

Size for Design Storm

Save and Return

Restore Defaults



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# Project Costs: Development Type

The screenshot displays the EPA National Stormwater Calculator interface. On the left, a sidebar titled 'Project Cost' contains the following sections:

- Directions:** A dropdown menu with a green arrow icon. Below it, text reads: 'Verify cost estimation variables below. Click on each option to learn more.'
- Choose a Project Type:** Two radio button options:   
☒ Re-Development  
☐ New Development
- Choose your Site Suitability:** Three radio button options:   
☐ Poor  
☒ Moderate  
☐ Excellent
- Choose your Cost Region:** A dropdown menu showing 'Milwaukee(190.0 miles)'.
- Regional Multiplier:** A text input field with the value '1'.

On the right, a modal window titled 'Re-Development' is open. It contains the following text:

**Re-Development**

Re-Development is construction that is a change in existing development (land cover, land use, or similar development alteration) which requires new or alteration of existing stormwater management facilities.

Costs of removal, decommissioning, or alteration of existing structures or additional (new) infrastructure is typically required to connect existing structures and results in costs that are greater than what would be anticipated with a new development site.

Below the text are two side-by-side images: 'Before' (a street view) and 'After' (a street view with a car). Below the images, text reads: 'Re-development and extensive retrofit costs are typically higher than new development costs because existing structures might have to be removed or new structures may be required but may not be located in a preferred location.'

Further down, text reads: 'Selecting "Re-development" on the "Project Cost" tab of the National Stormwater Calculator influences the site complexity, and shifts the costs towards a higher complexity cost estimation.'

At the bottom, text reads: 'Re-development combined with information on site suitability, topography, and soil drainage determines whether complex, typical, or simple cost curves apply. See User Guide for more information.'


A 'Close' button is located at the bottom right of the modal window.

The background of the calculator interface shows an aerial map of a residential area with streets labeled 'Waukegan', 'Waukegan St', 'Bay St', and 'E 4th St'. A yellow highlighted area is visible on the map. The bottom right corner of the map shows a scale bar for 100 feet and 25 meters, and copyright information: '© 2017 HERE © 2017 Microsoft Corporation Available Exclusively by DigitalGlobe'.
















# Project Costs: Site Suitability

 **National Stormwater Calculator**

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### Project Cost

Directions 

Verify cost estimation variables below. Click on each option to learn more.

#### Choose a Project Type

- ☒ Re-Development
- ☐ New Development

#### Choose your Site Suitability

- ☐ Poor
- ☒ Moderate
- ☐ Excellent

#### Choose your Cost Region

Cost Region

Milwaukee(190.0 miles)

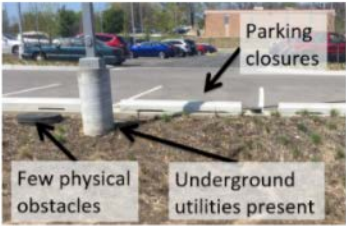
Regional Multiplier

### Moderate Site Suitability

Site suitability is a measure of construction feasibility and includes factors such as topography, soil type, slope, and other physical features that might result in higher implementation costs.

Moderate site suitability refers to sites that have several of the following characteristics:

- Few physical obstructions,
- Few utility conflicts,
- Other features that may make construction of stormwater management infrastructure challenging and likely more costly, but less than a site with poor site suitability.



Sites determined to have moderate suitability for LID practices may result in higher costs because of the potential need for additional excavation, accommodation for physical obstructions including utilities, required retaining walls, moderately challenging access, limited dewater, the addition of engineered or custom media blends, or need to address geotechnical or groundwater concerns.

Selecting "Site Suitability - Moderate" on the "LID Controls" tab of the National Stormwater Calculator influences the site complexity, and may shift the costs towards a higher complexity cost estimation compared to.

Moderate site suitability combined with information on development type, topography, and soil drainage determines whether complex, typical, or simple cost curves apply. See User Guide for more information.

Close

habwasunc

Wauke

201

4th St


100 feet

25 ft










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# Project Costs: Bureau of Labor Statistics Cost Region

 **National Stormwater Calculator**

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Project Cost

Directions

Verify cost estimation variables below. Click on each option to learn more.

Choose a Project Type

☐ Re-Development

☐ New Development

Choose your Site Suitability

☐ Poor

☐ Moderate

☐ Excellent

Choose your Cost Region

Cost Region

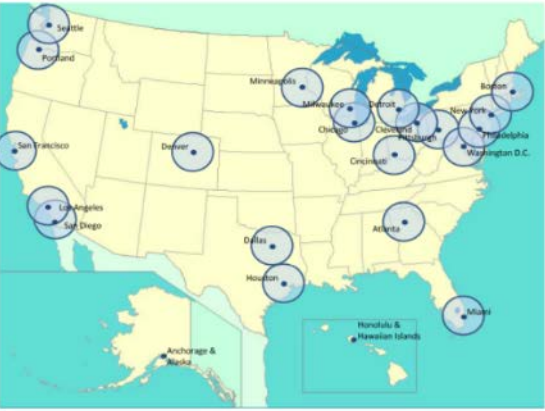
Milwaukee(190.0 miles)

Regional Multiplier

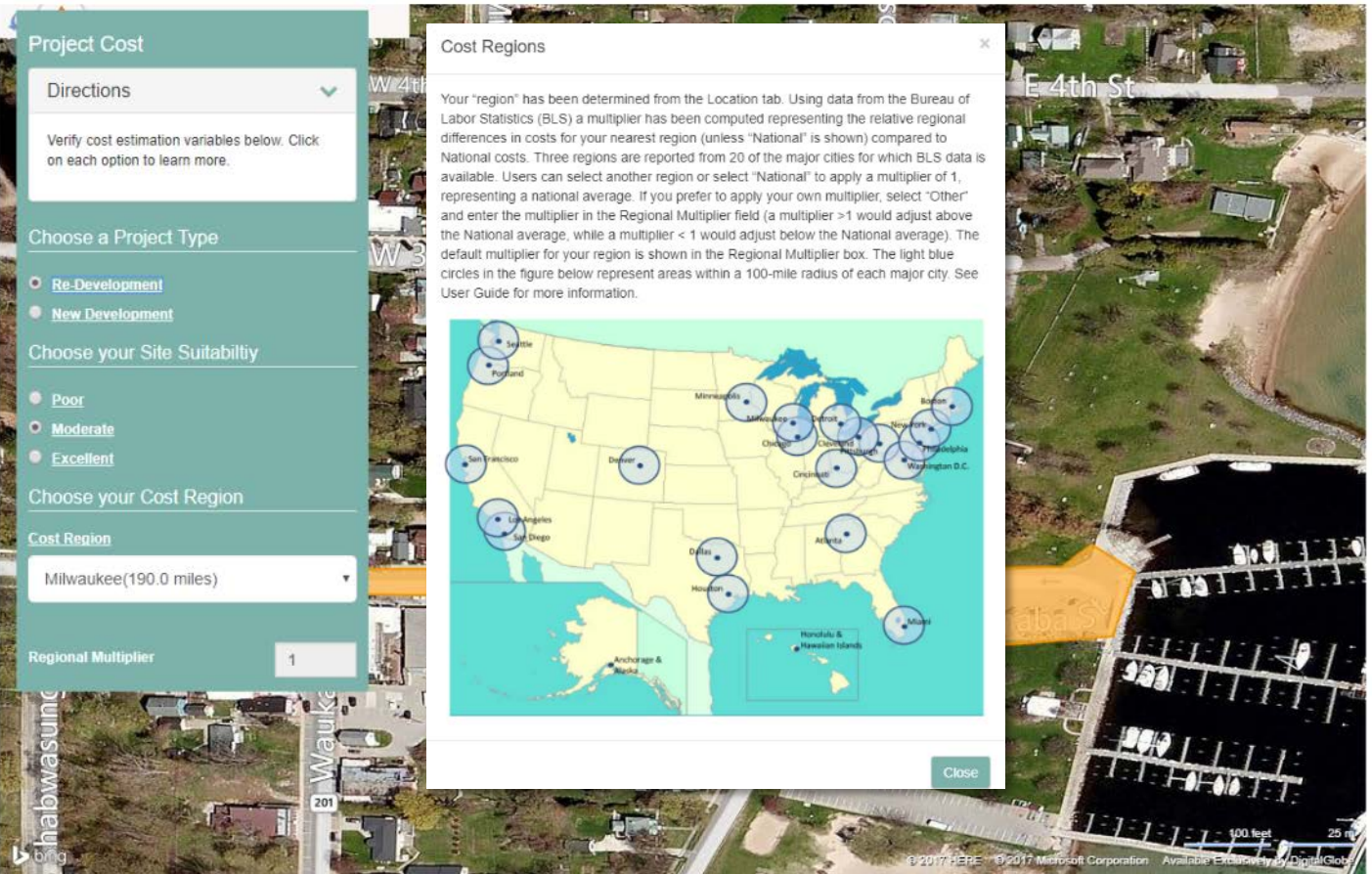
1

Cost Regions

Your "region" has been determined from the Location tab. Using data from the Bureau of Labor Statistics (BLS) a multiplier has been computed representing the relative regional differences in costs for your nearest region (unless "National" is shown) compared to National costs. Three regions are reported from 20 of the major cities for which BLS data is available. Users can select another region or select "National" to apply a multiplier of 1, representing a national average. If you prefer to apply your own multiplier, select "Other" and enter the multiplier in the Regional Multiplier field (a multiplier >1 would adjust above the National average, while a multiplier < 1 would adjust below the National average). The default multiplier for your region is shown in the Regional Multiplier box. The light blue circles in the figure below represent areas within a 100-mile radius of each major city. See User Guide for more information.



Close

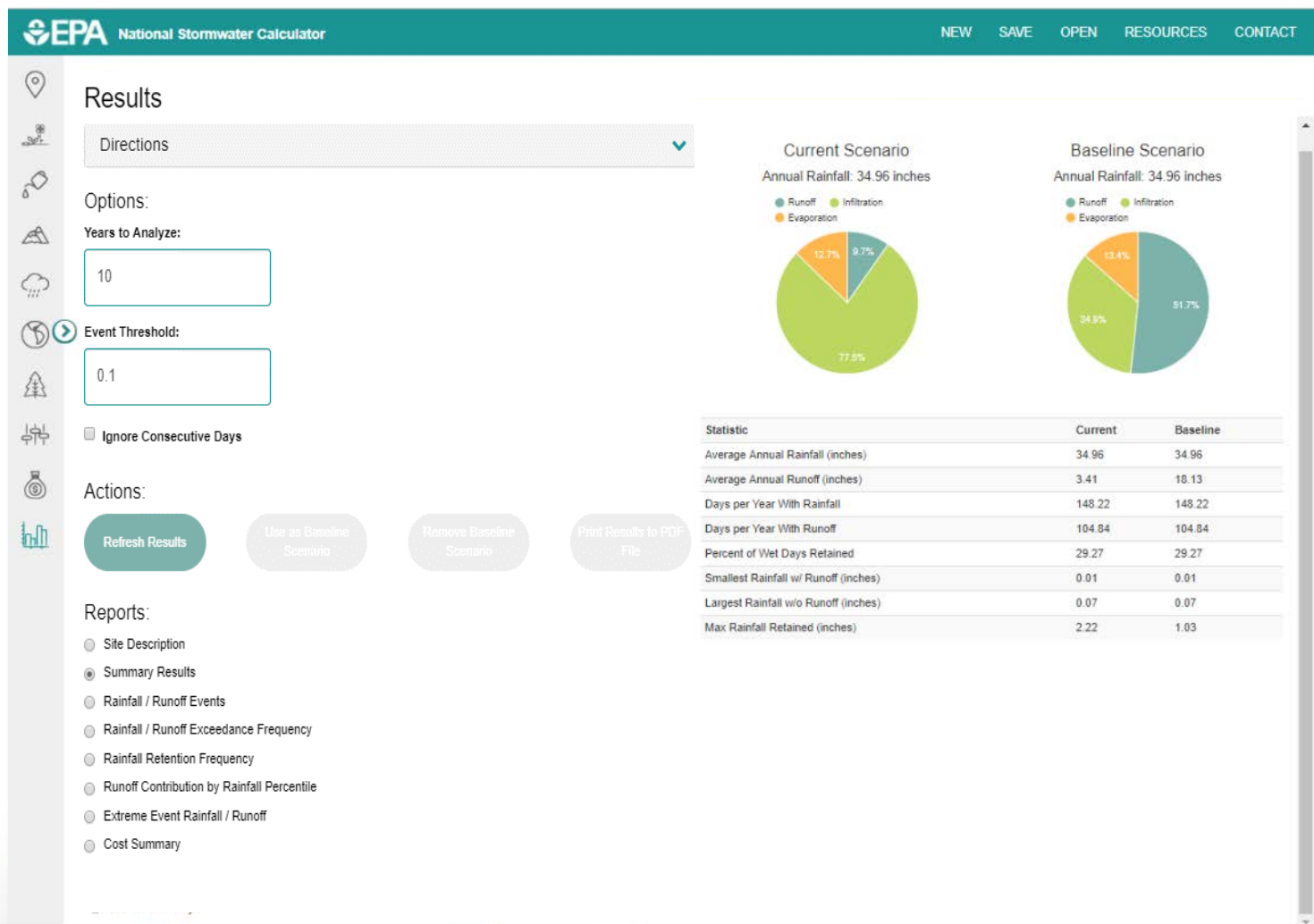


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# Results Summary





# Results: Costs Summary

Directions

Options:  
Years to analyze:  
10  
Event threshold (inches):  
0.00  
☐ 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 Exceedance Frequency  
☐ Rainfall Retention Frequency  
☐ Runoff Contribution by Rainfall Percentile  
☐ Extreme Event Rainfall / Runoff  
☒ Cost Summary

NEW SAVE OPEN RESOURCES CONTACT

Cost Summary  
[Tabular View](#) | [Graphical View](#)

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

LID Control Type	Drainage Area %		Has Pre-Treatment?		Current Scenario (C)		Baseline Scenario (B)		Difference (C - B)	
	Current	Baseline	Current	Baseline	Low	High	Low	High	Low	High
Disconnection	0	0	No	No	\$0	\$0	\$0	\$0	\$0	\$0
Rainwater Harvesting	0	0	No	No	\$0	\$0	\$0	\$0	\$0	\$0
Rain Gardens	10	0	Yes	No	\$4,867	\$9,329	\$0	\$0	\$4,867	\$9,329
Green Roofs	0	0	No	No	\$0	\$0	\$0	\$0	\$0	\$0
Street Planters	55	0	No	No	\$8,766	\$23,274	\$0	\$0	\$8,766	\$23,274
Infiltration Basins	0	0	No	No	\$0	\$0	\$0	\$0	\$0	\$0
Permeable Pavement	20	0	Yes	No	\$12,761	\$17,391	\$0	\$0	\$12,761	\$17,391
Total	85%	0%			\$26,394	\$49,994	\$0	\$0	\$26,394	\$49,994

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

LID Control Type	Current Scenario (C)		Baseline Scenario (B)		Difference (C - B)	
	Low	High	Low	High	Low	High
Disconnection	\$0	\$0	\$0	\$0	\$0	\$0
Rainwater Harvesting	\$0	\$0	\$0	\$0	\$0	\$0
Rain Gardens	\$50	\$1,218	\$0	\$0	\$50	\$1,218
Green Roofs	\$0	\$0	\$0	\$0	\$0	\$0
Street Planters	\$103	\$2,439	\$0	\$0	\$103	\$2,439
Infiltration Basins	\$0	\$0	\$0	\$0	\$0	\$0
Permeable Pavement	\$131	\$714	\$0	\$0	\$131	\$714
Total	\$284	\$4,371	\$0	\$0	\$284	\$4,371

Note: Site complexity variables that affect cost shown below:



# Potential Next Steps After Using the SWC

- Sharing planning results with decision-makers
- Applying for funding
- Developing construction plans/designs
- Construction

The screenshot shows the Maryland Department of Natural Resources (DNR) website. The header includes the Maryland state logo and ".gov" on the left, and "DEPARTMENT OF NATURAL RESOURCES" in the center. A search bar is on the right. Below the header is a green navigation bar with links: HOME, LANDS, WATERS, PARKS, FISHING, HUNTING, BOATING, WILDLIFE, and TREES. The main content area features a "News" section on the left with a list of topics: Boating, Education, Fishing, Forestry, Hunting, Lands, Parks, Police, Waters, Wildlife, and Events. The featured news article is titled "Over \$800,000 Announced to Support Local Green Infrastructure Projects to Improve Communities and Provide Jobs" and is dated June 29, 2017. The article text states that the Chesapeake Bay Trust, in partnership with the U.S. Environmental Protection Agency (EPA), the Maryland Department of Natural Resources (DNR), and the City of Baltimore Office of Sustainability, announced \$843,486 in funding for the Chesapeake Bay Green Streets-Green Jobs-Green Towns Grant Program. A photograph on the right shows a group of people standing in front of a large pink pig sculpture. The article's goal is to help communities develop and implement plans that reduce stormwater runoff, increase the number and amount of green spaces in urban areas.

**News**

- › Boating
- › Education
- › Fishing
- › Forestry
- › Hunting
- › Lands
- › Parks
- › Police
- › Waters
- › Wildlife
- › Events

**Media Tools**

- › Press Releases & News

### 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/>



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National Stormwater Calculator Website:  
[epa.gov/water-research/national-stormwater-calculator](http://epa.gov/water-research/national-stormwater-calculator)



Office of Research and Development

## SAFE AND SUSTAINABLE WATER RESOURCES RESEARCH PROGRAM



## Questions and Answers Session