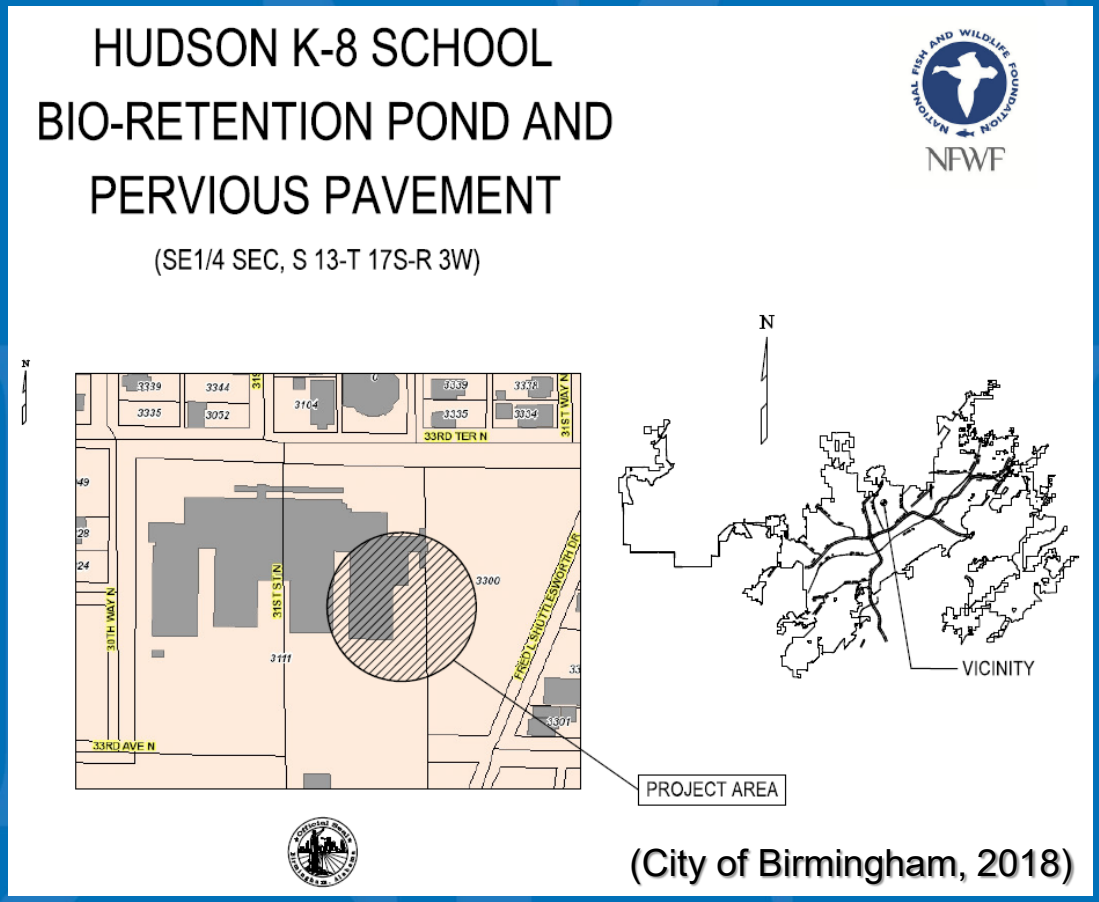
Nov. 1, 2018



U.S. EPA National Stormwater Calculator: City of Birmingham, AL. Demonstration

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

EPA
United States
Environmental Protection
Agency

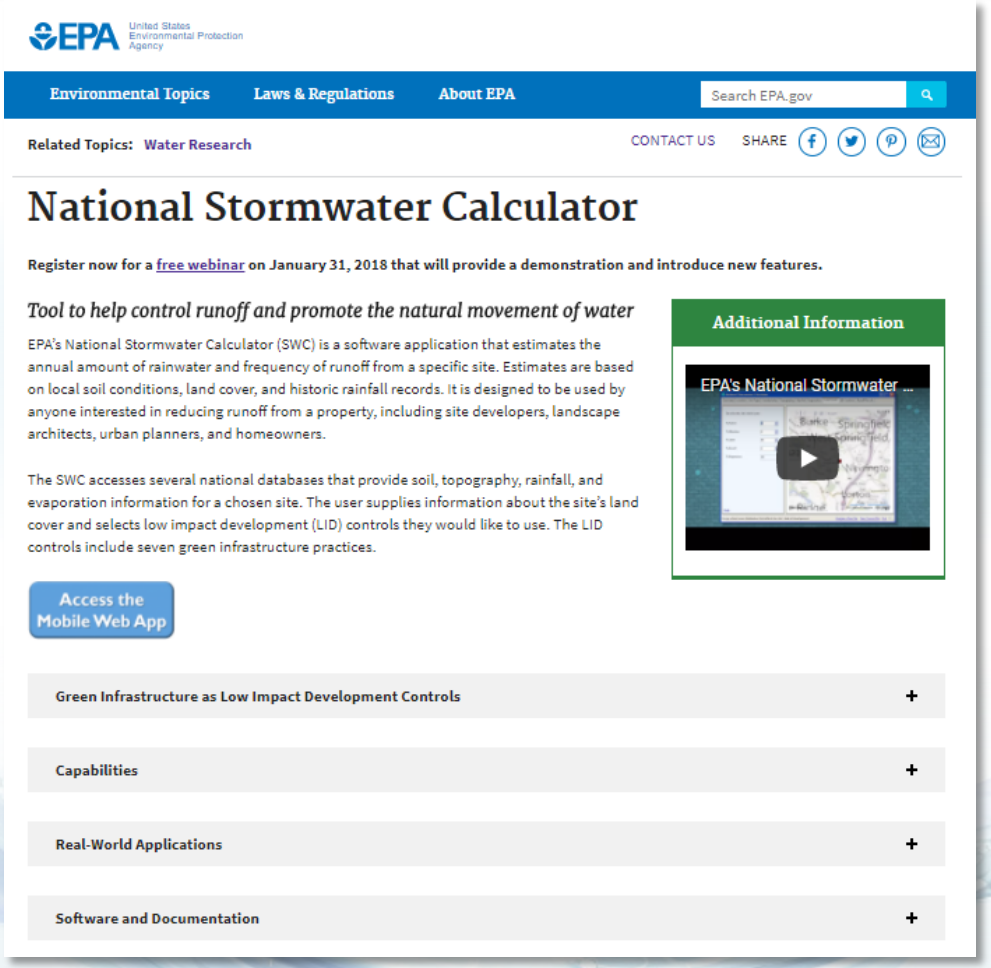
The views expressed in this presentation are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

Outline

U.S. EPA National Stormwater Calculator

- Stormwater Calculator (SWC) Background Information
- Low Impact Development (LID) Cost Estimation Module
- SWC Web Application
- Example Application: Hudson K-8 School, Birmingham, AL.
- Interpreting Results
- Potential Next Steps
- Case Study with Actual Costs: Buckingham Elementary School, Dillwyn, VA
- Discussion & Questions

National Stormwater Calculator Website



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

What We Developed and Why?

A Stormwater Management (Green Infrastructure/LID) Design and Planning Tool

- To estimate post-construction urban stormwater runoff discharges

- Screening-level stormwater runoff reduction and cost analyses of various green infrastructure/LID practices, including:
  - 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
- Climate Resiliency Planning: Rockefeller Foundation's 100 Resilient Cities (extreme storm events)
- Green Building Programs: LEED (U.S. Green Building Council) and Sustainable Sites Initiative stormwater credits

Communities using the SWC

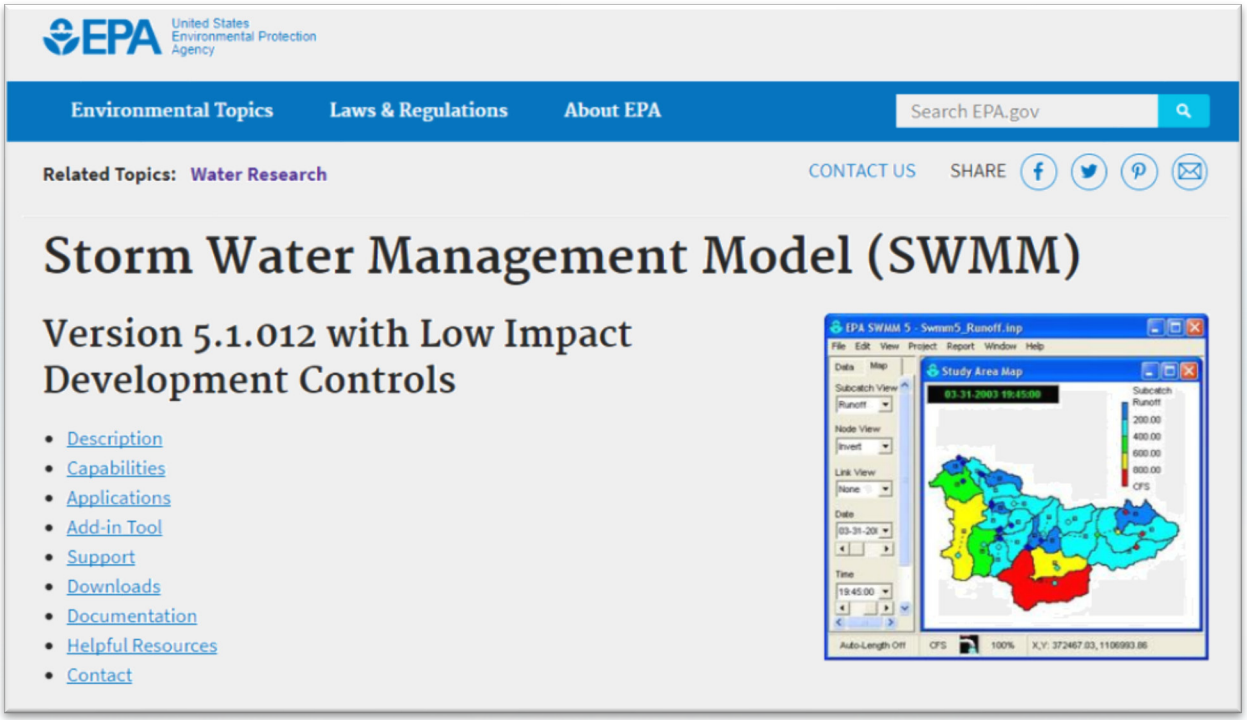
- Northeastern Regional Ohio Sewer District (Cleveland, OH):

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

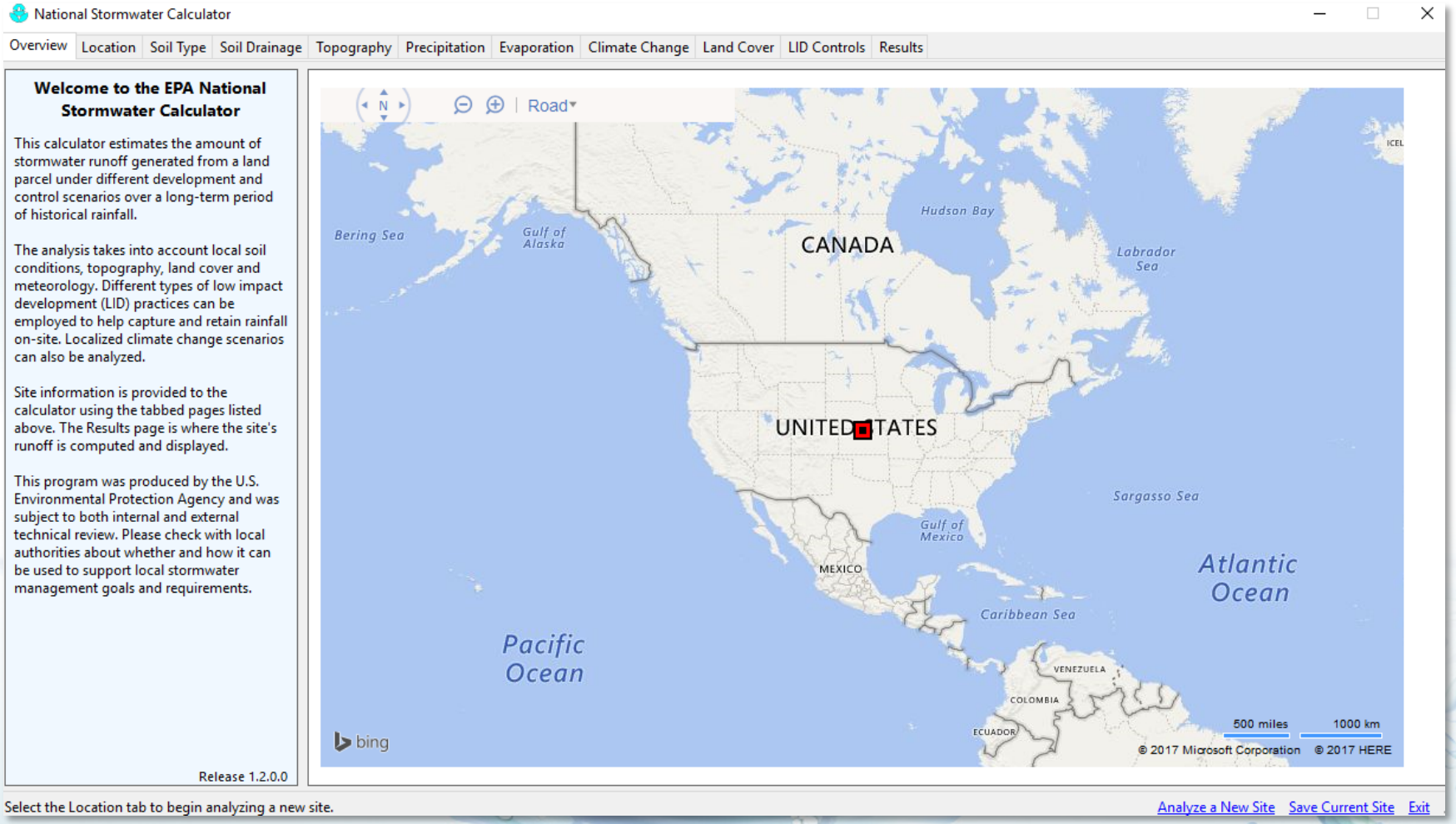
https://www.epa.gov/smartgrowth/building-blocks-sustainable-communities

Storm Water Management Model (SWMM)

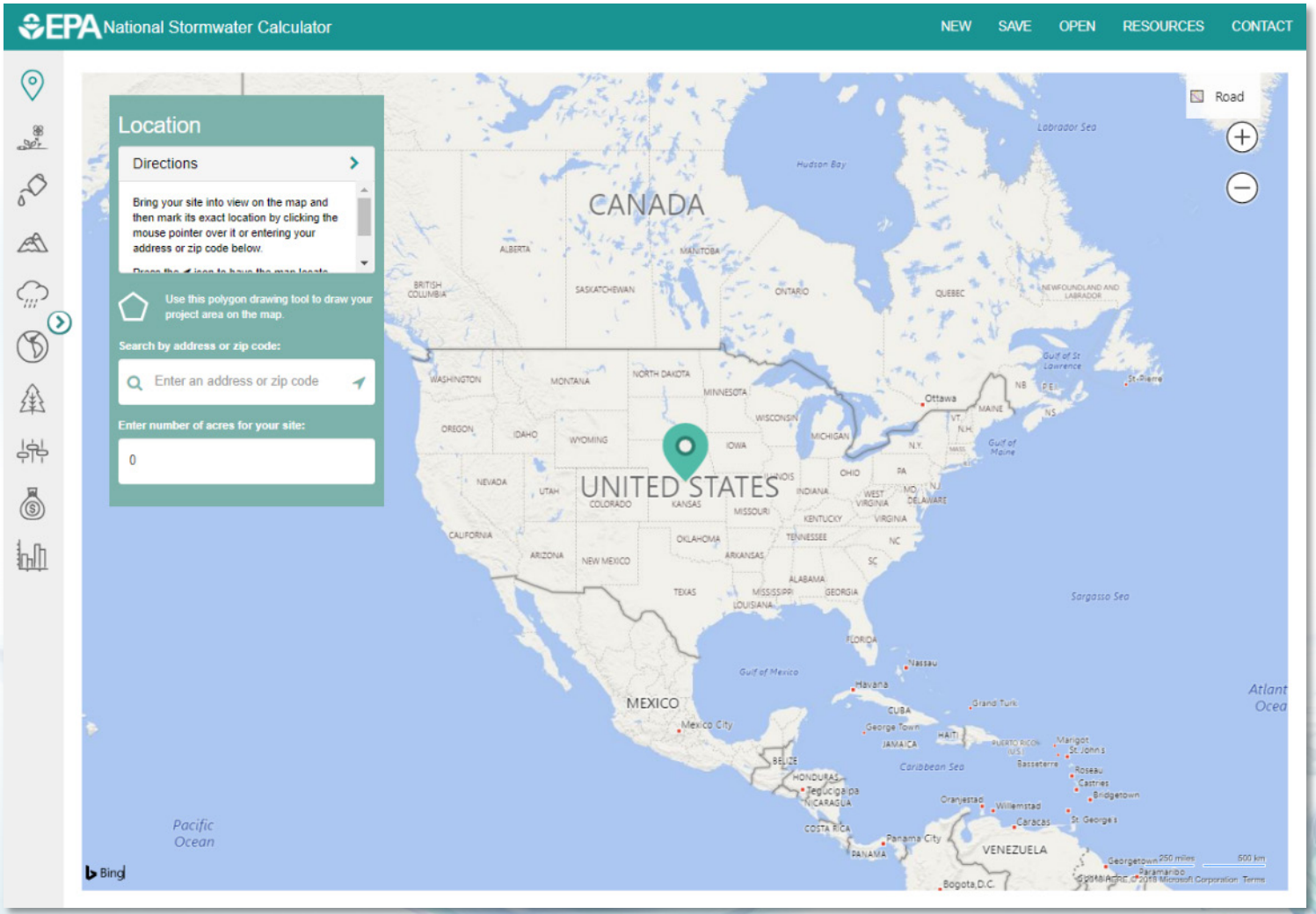


- SWC is based on SWMM: dynamic rainfall-runoff simulation model for long-term simulation of runoff quantity
- SWMM produces stormwater runoff estimates in the background of the SWC

National Stormwater Calculator (SWC) Desktop Application



SWC Mobile Web App



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

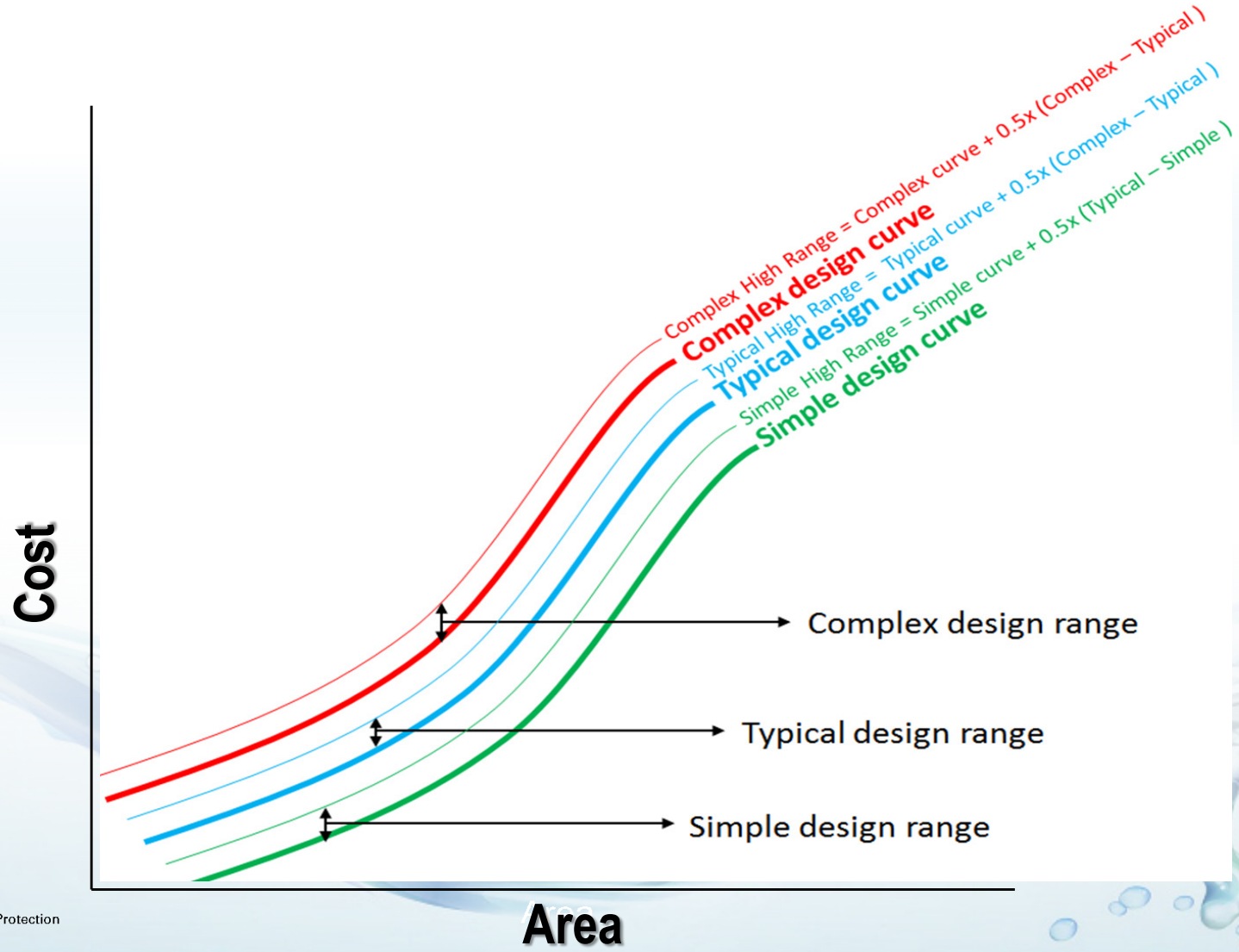
LID Cost Estimation Module (Released May 2017):

- **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 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:

Accounting for Uncertainty with Cost Estimates (Regression Cost Curves)



LID Cost Estimation Module:
Development of Regionalized LID/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 (17 major US cities)
    - Examples include: fuels and utilities, energy, and diesel fuel

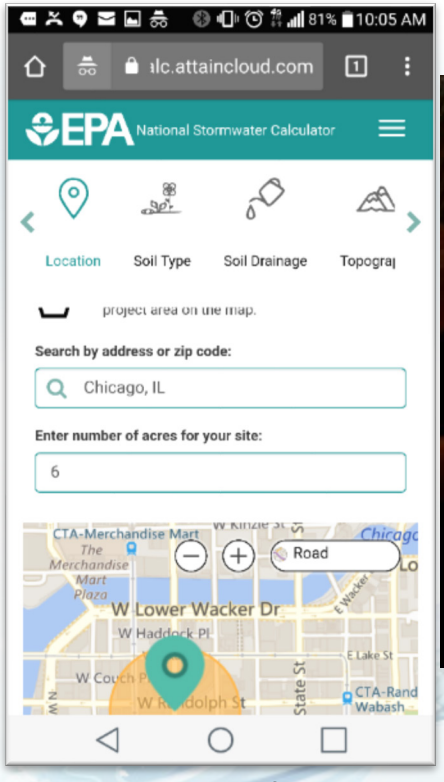
- **Data easily updated and maintained annually by EPA**

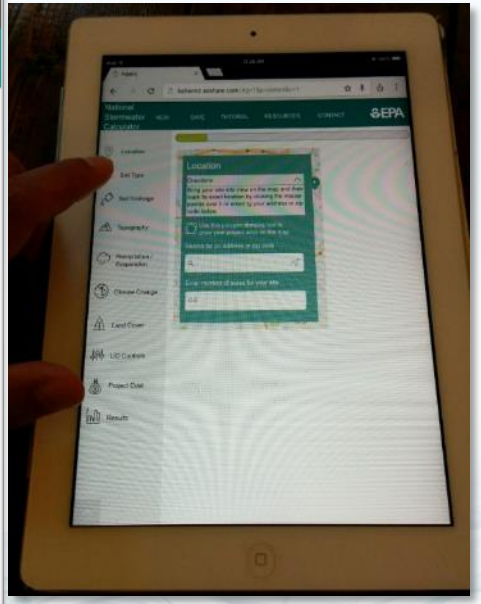
- **Development of regional costs comparable to Engineering News Record (ENR) and RS Means**

Release of SWC Web App
Sept. 2017

***Web app link: https://swcweb.epa.gov/stormwatercalculator/**

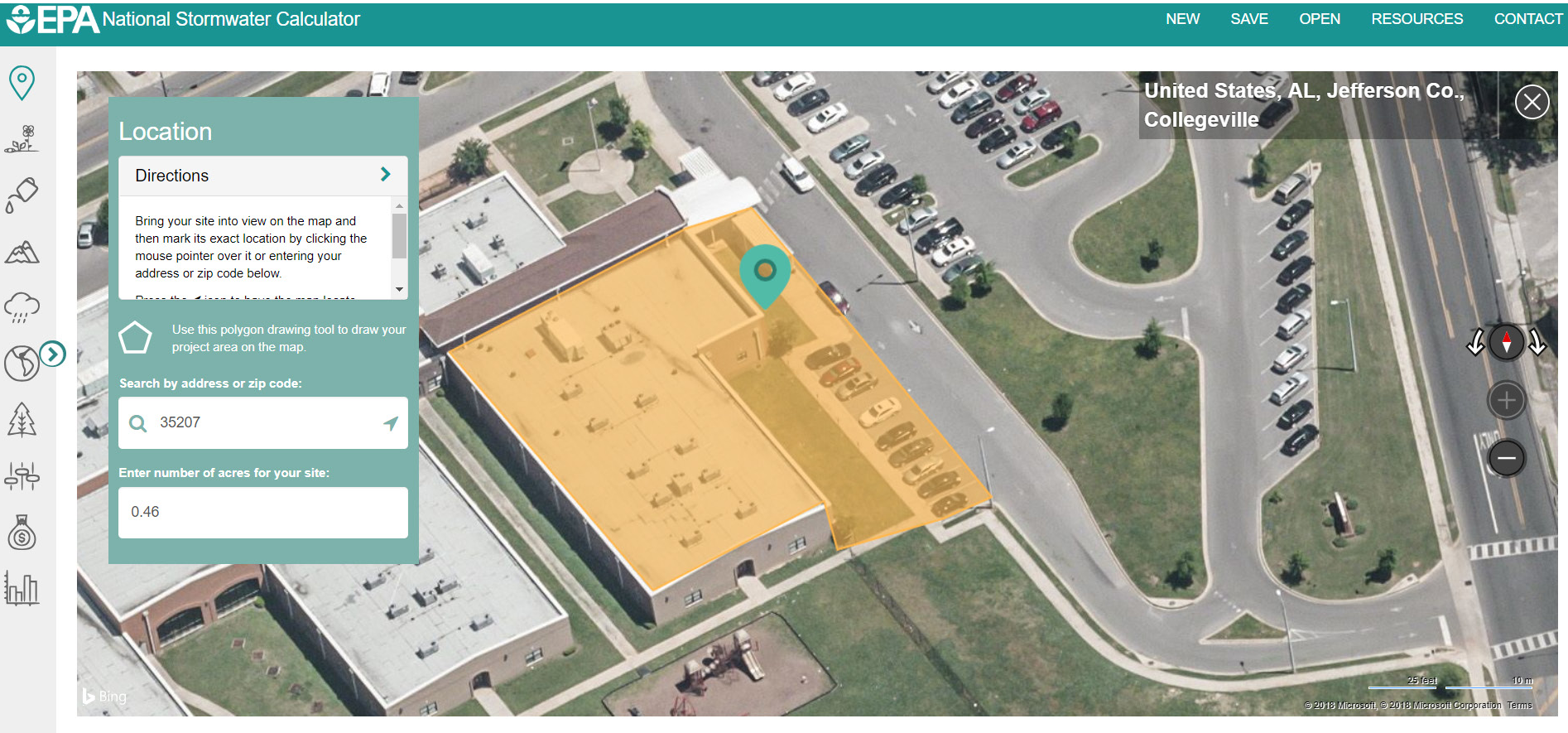
- **Ability to function on any web browser**
- **Mobile friendly design (tablets and smartphones)**
- **Platform neutral: functions on Windows, Apple, and Linux computers**
- **Not found in an "app store" (Google Play or Apple Store)**
  - **Save it as a "favorite" website**
- ***Requires a live Internet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



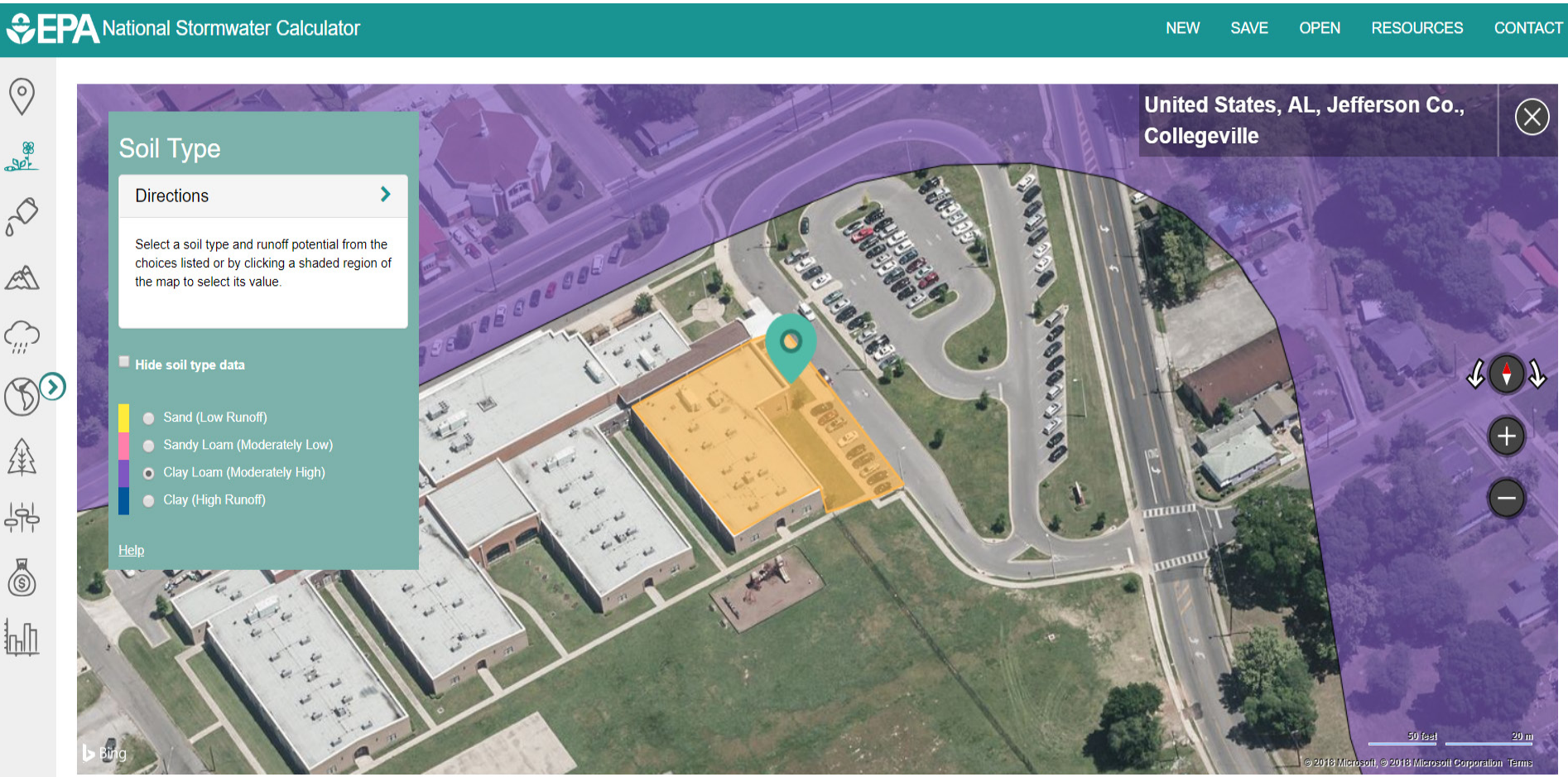


Example views from smartphone and tablet

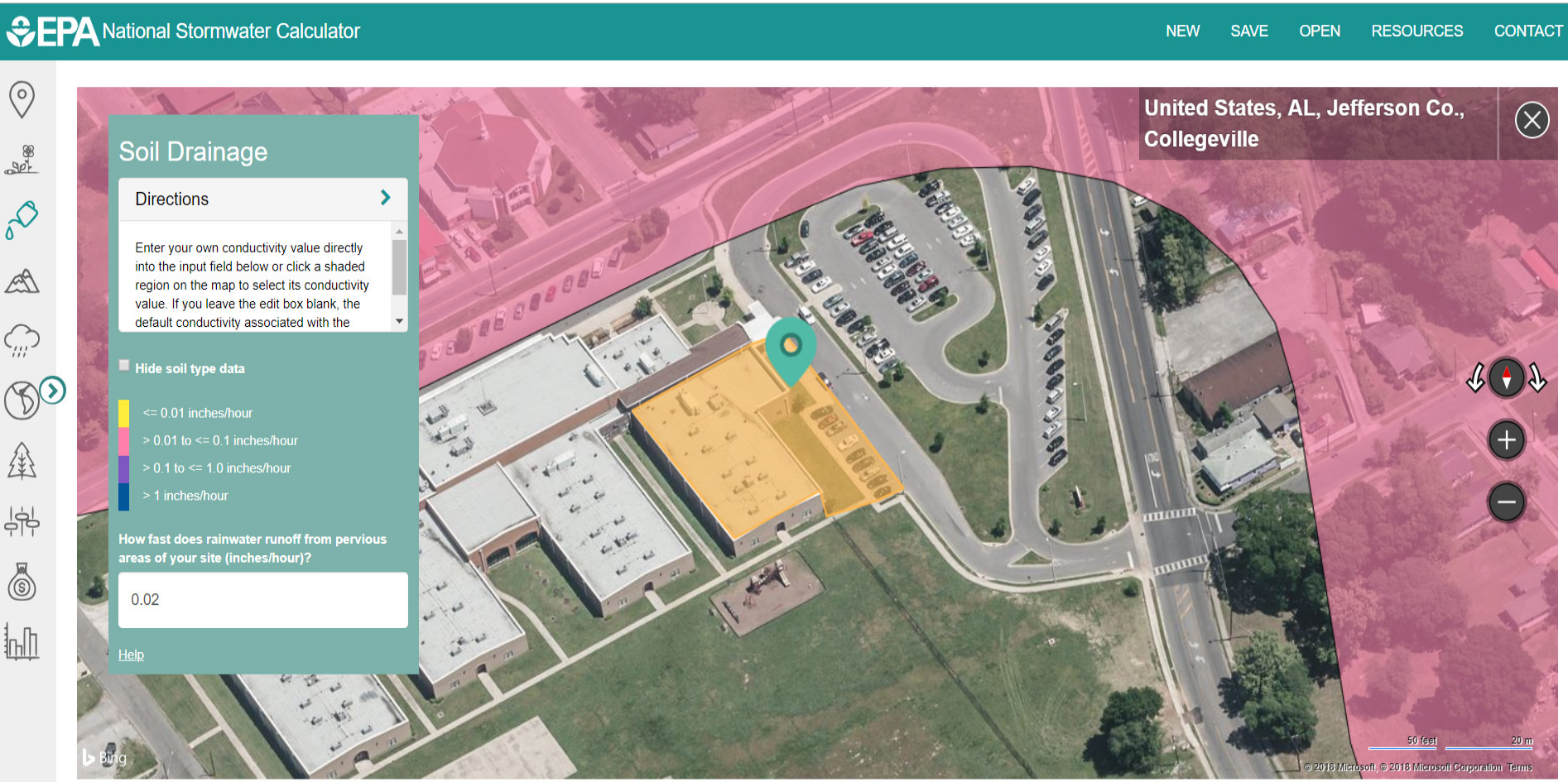
SWC Mobile Web App Application
(Hudson K-8 School, Birmingham, AL)
Location:



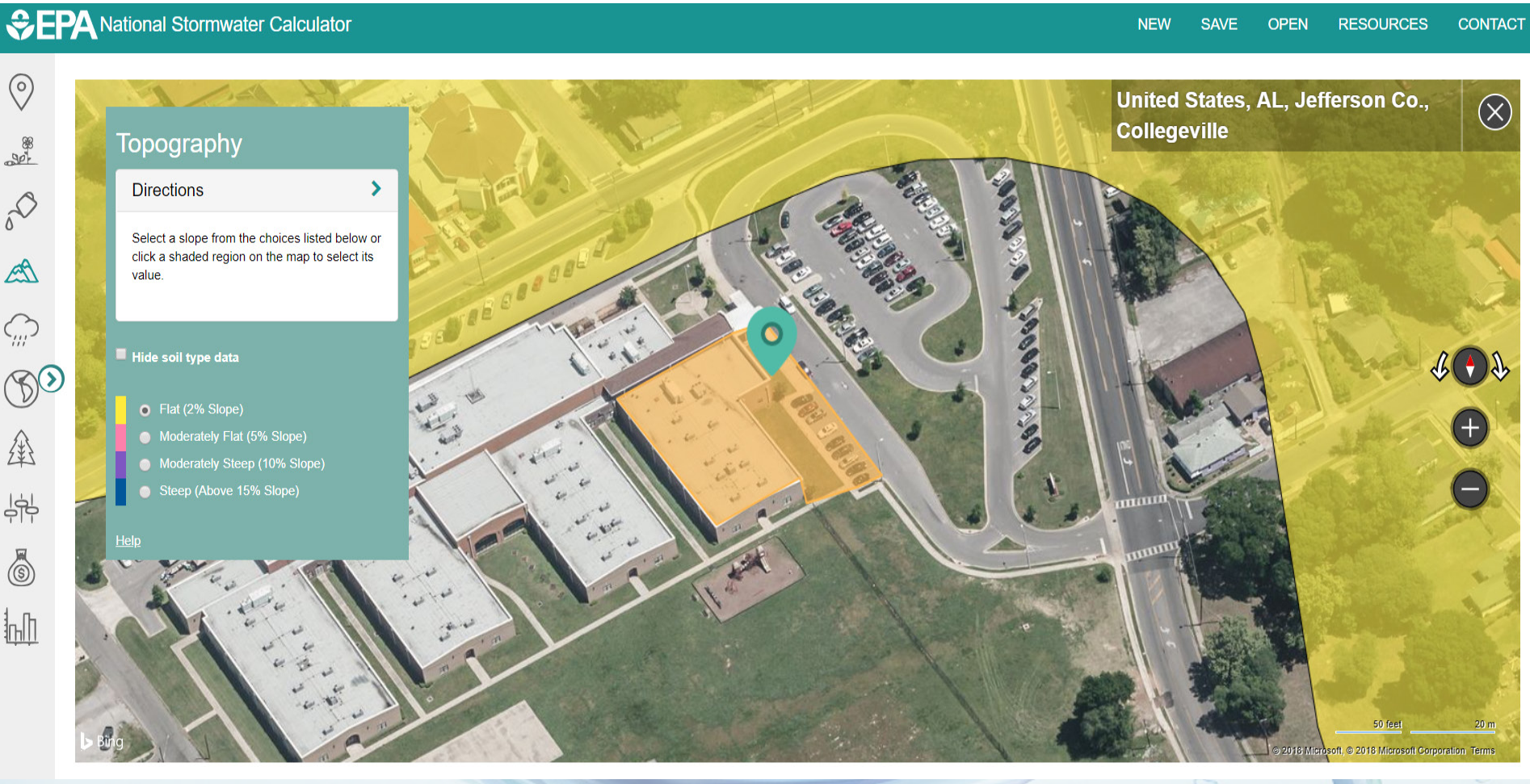
Soil Runoff Potential:



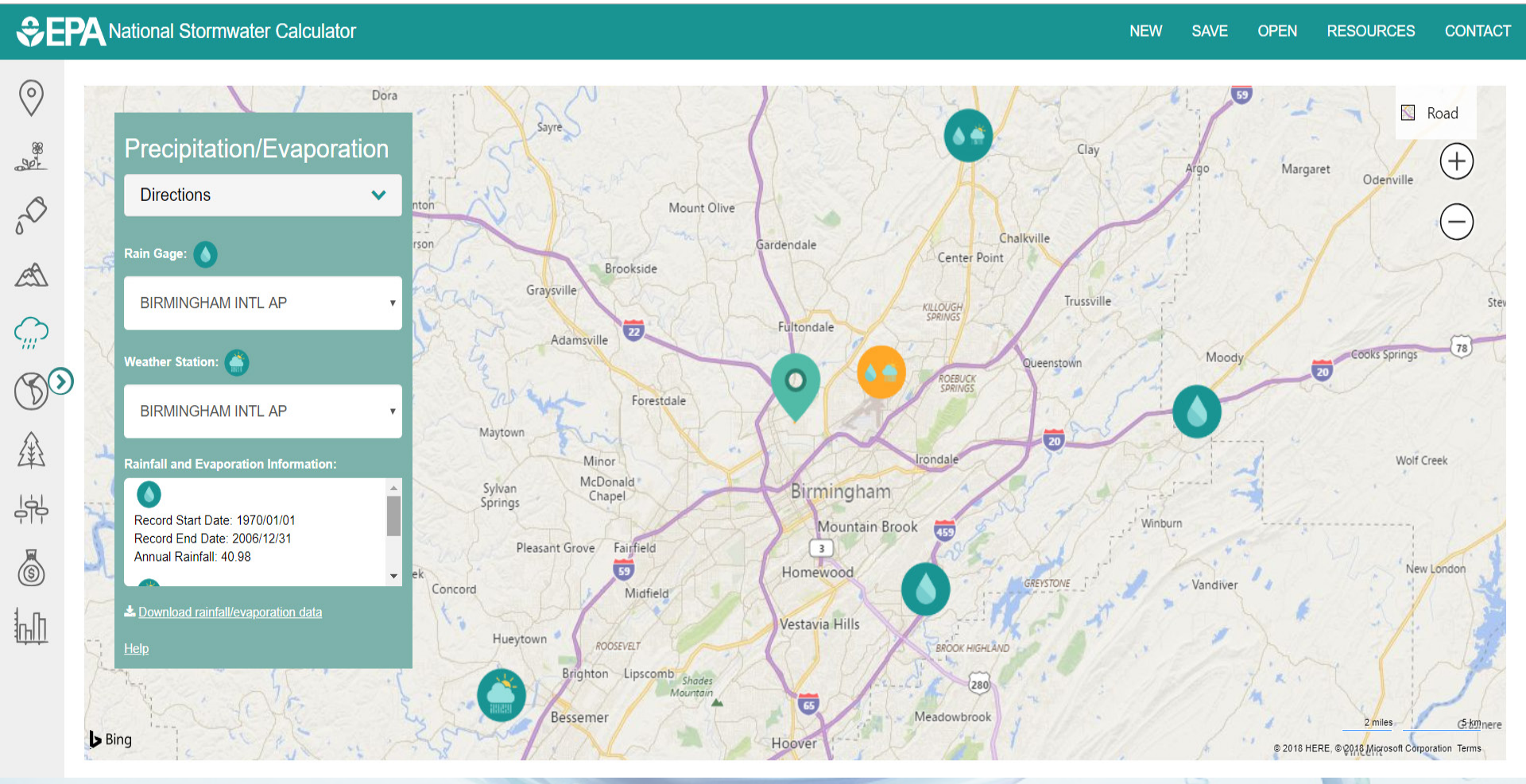
Soil Infiltration Capacity:



Topography/Slope:



Historical Weather (precipitation & evaporation):



Climate Change Scenarios & Extreme Storm Events:

EPA National Stormwater Calculator

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Climate Change

Directions

Helpful Resources

Scenarios for Climate Assessment and Adaptation - Regions

GlobalChange.gov - Regions & Topics

US Environmental Protection Agency - Future of Climate Change

World Climate Research Programme

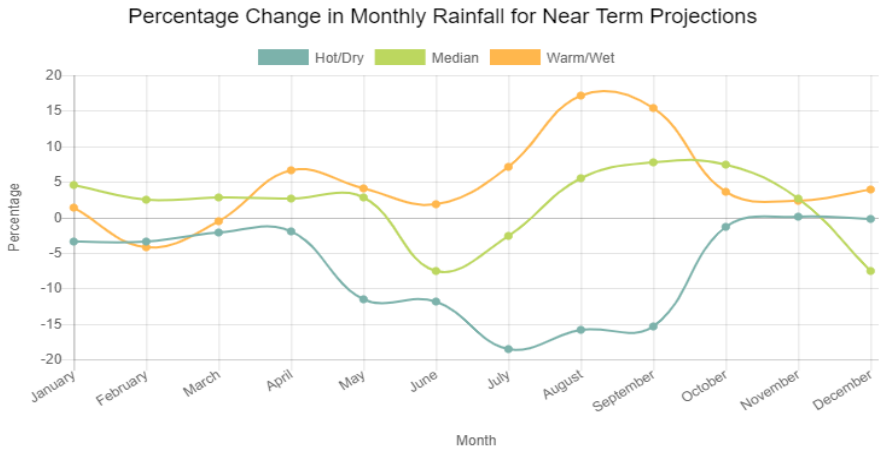
Select a future climate change scenario to apply:

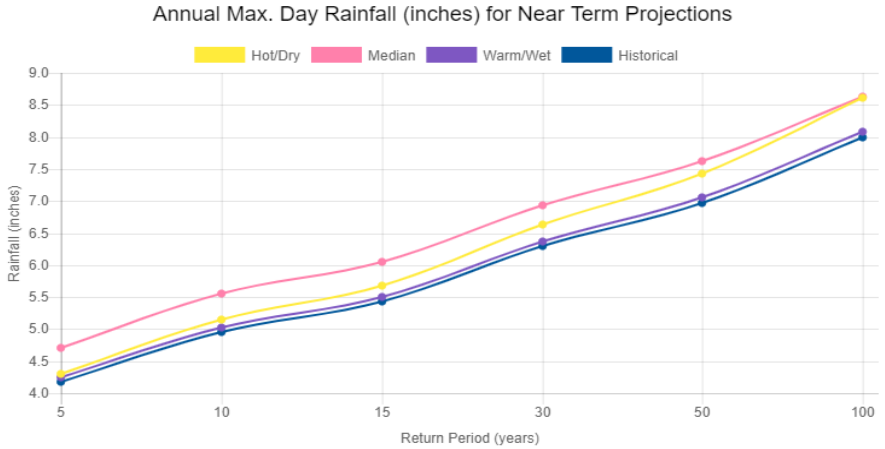
- (•) No Change
- ( ) Hot/Dry
- ( ) Median Change
- ( ) Warm/Wet

Select the time period to which the climate change scenario applies:

- (•) Near Term (2020 - 2049)
- ( ) Far Term (2045 - 2074)

Print Charts to PDF File





Land Cover:


EPA National Stormwater Calculator
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Land Cover
Directions
Describe the site's land cover for the development scenario being analyzed.
Click on a category to see a more detailed description.
Forest: 2 %
Meadow: 0 %
Lawn: 23 %
Desert: 0 %
Impervious: 75 %
Help
United States, AL, Jefferson Co., Collegeville
Bing

LID Controls:

EPA National Stormwater Calculator

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LID Controls

Directions

Enter the percentage of your site's impervious area would like to be treated by the listed LID Controls.

Click a practice to learn more about it or to

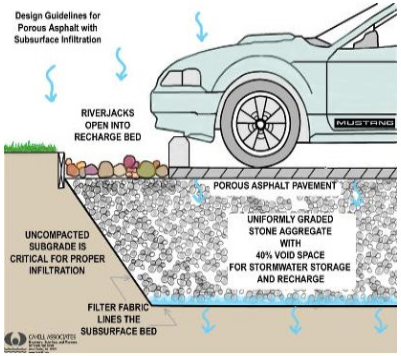
Disconnection:	30 %
Rain Harvesting:	0 %
Rain Gardens:	15 %
Green Roofs:	0 %
Street Planters:	0 %
Infiltration Basins:	0 %
Permeable Pavement:	20 %

Design Storm for Sizing: 0.75 in.

Help

United States, AL, Jefferson Co., Collegeville

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.

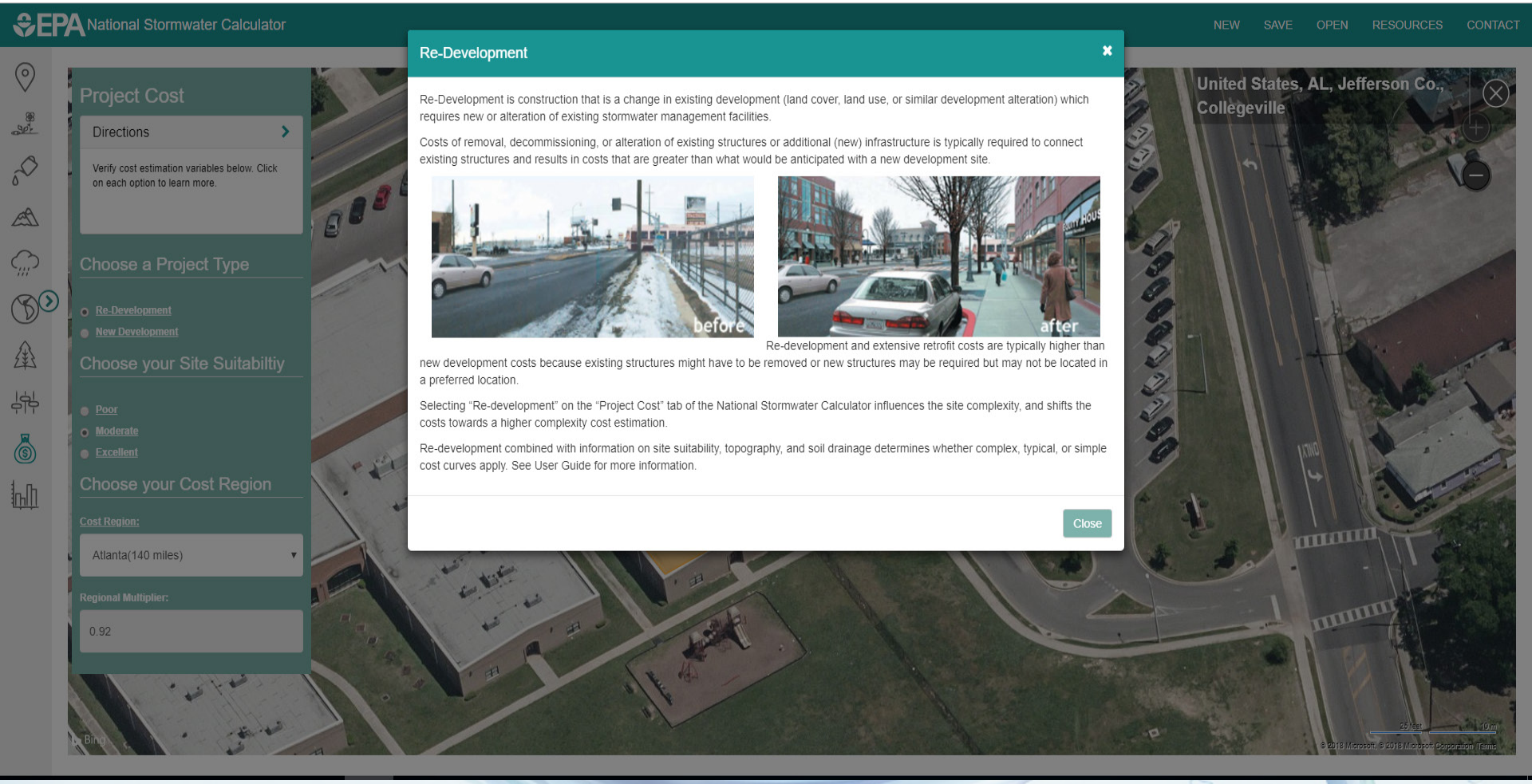
Learn More

Pavement Thickness:	6	in.
Gravel Layer Thickness:	18	in.
% Capture Ratio:	11	%

☑ Pre-Treatment

Size for Design Storm | Save and Return | Restore Defaults

Project Cost (Development Type):



Project Cost (Site Suitability):

EPA 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 Suitabiltiy

- Poor
- Moderate
- Excellent

Choose your Cost Region

Cost Region:

Atlanta(140 miles)

Regional Multiplier:

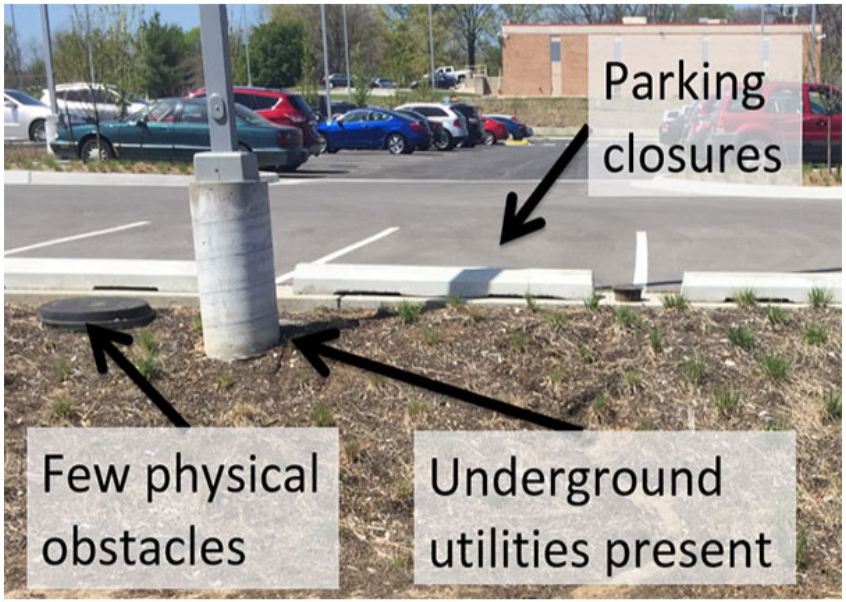
0.92

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.

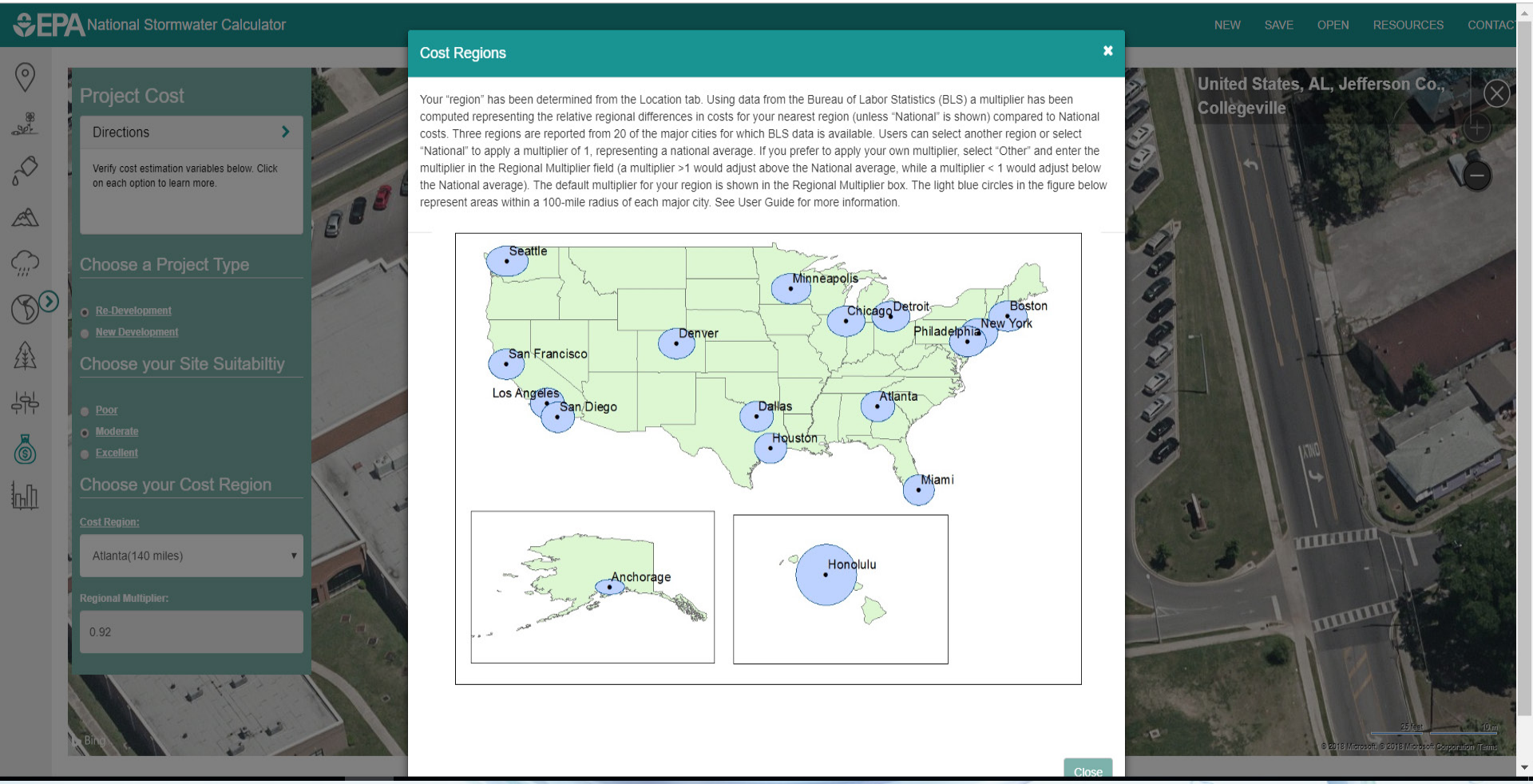


Sites determined to have moderate suitability for LID practices may result in higher costs because of the potential need for additional excavation, accommodation for physical obstructions including utilities, required retaining walls, moderately challenging access, limited dewater, the addition of engineered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

United States, AL, Jefferson Co., Collegeville

Project Cost (Bureau of Labor Statistics Cost Region):

*Regional cost data available from Atlanta; Birmingham within 200 mile radius.



Results (Summary):

EPA National Stormwater Calculator

NEW SAVE OPEN RESOURCES CONTACT

Results

Directions

The Results page is where the site's hydrologic response to a long term period of historical hourly rainfall is computed and reported on. Statistics for both annual and daily rainfall/runoff are presented.

The user controls on this page are grouped together in three sections:

1. Options

The Options section allows you to specify how the rainfall record should be analyzed with respect to:

- The number of most recent years of rainfall record to use,
- The minimum amount of daily rainfall or runoff that will constitute a measurable event,
- Whether subsequent days of back to back daily events should be counted or not.

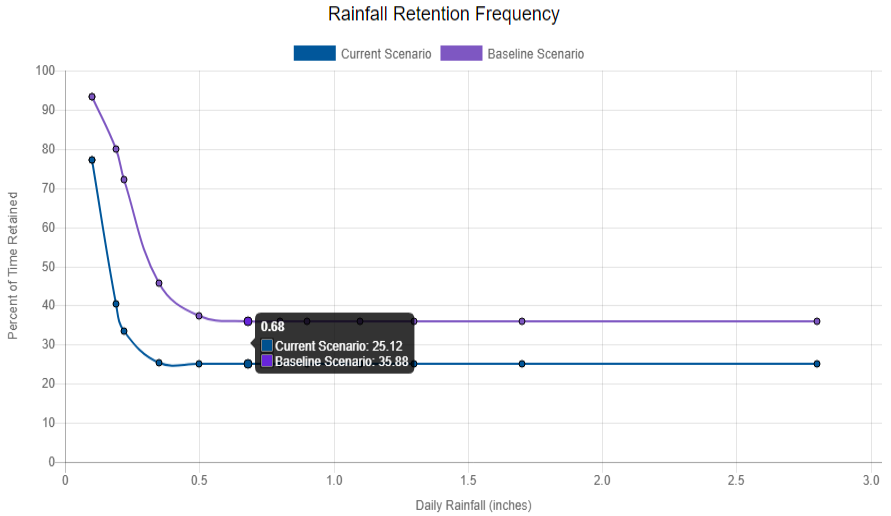
2. Actions

The Actions section contains commands that allow you to:

- Refresh results after site data have changed.
- Use the most current results as a baseline scenario that can be compared with results from subsequent runs.

3. Reports

The Reports section allows you to select how the rainfall/runoff results generated for the site should be displayed.



Options:

Years to Analyze:

20

Event Threshold:

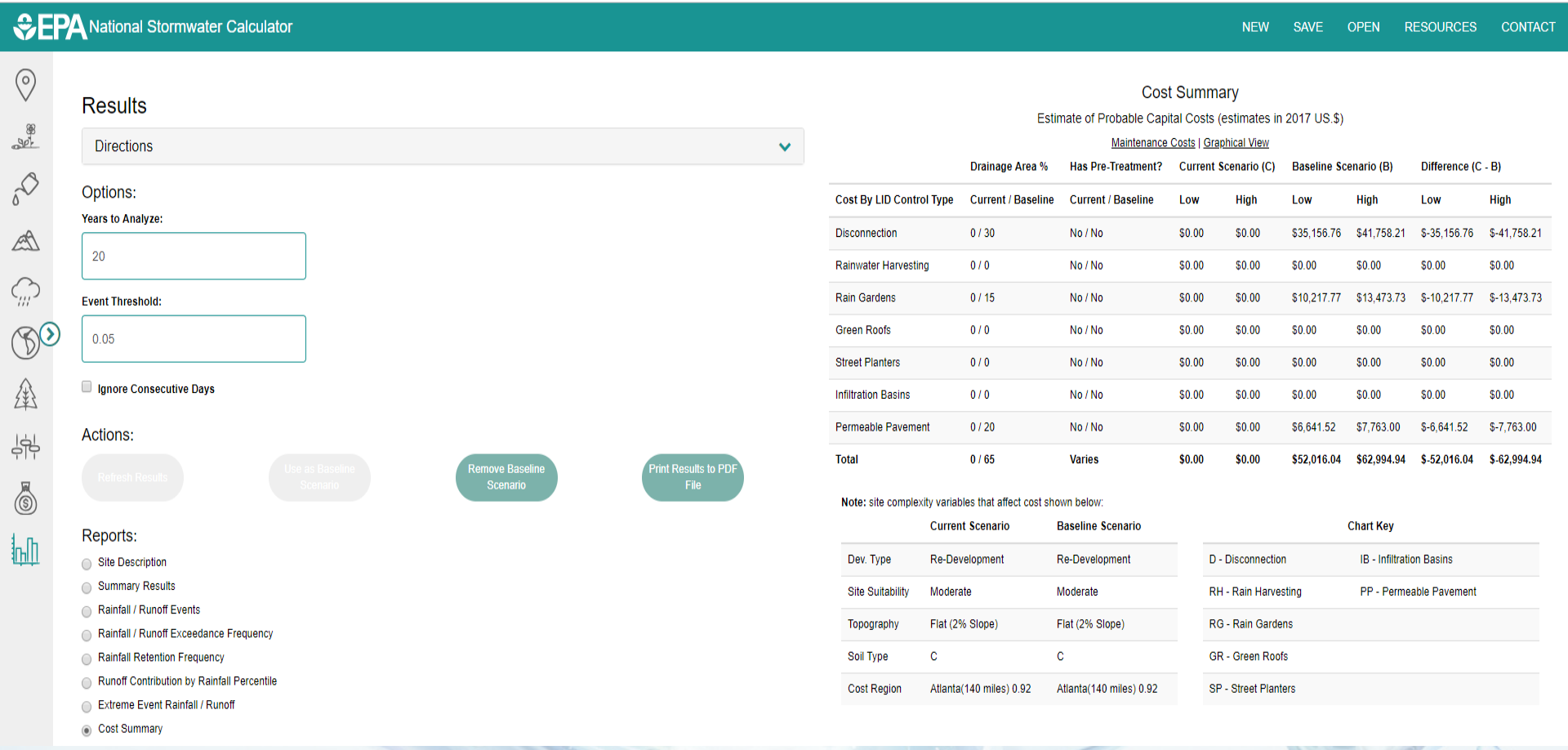
0.05

Ignore Consecutive Days

Actions:

Refresh Results | Use as Baseline Scenario | Remove Baseline Scenario | Print Results to PDF File

Results (Capital Costs):



Cost Summary

Estimate of Probable Capital Costs (estimates in 2017 US.$)

Maintenance Costs | Graphical View

	Drainage Area %	Has Pre-Treatment?	Current Scenario (C)		Baseline Scenario (B)		Difference (C - B)	
Cost By LID Control Type	Current / Baseline	Current / Baseline	Low	High	Low	High	Low	High
Disconnection	0 / 30	No / No	$0.00	$0.00	$35,156.76	$41,758.21	$-35,156.76	$-41,758.21
Rainwater Harvesting	0 / 0	No / No	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Rain Gardens	0 / 15	No / No	$0.00	$0.00	$10,217.77	$13,473.73	$-10,217.77	$-13,473.73
Green Roofs	0 / 0	No / No	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Street Planters	0 / 0	No / No	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Infiltration Basins	0 / 0	No / No	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Permeable Pavement	0 / 20	No / No	$0.00	$0.00	$6,641.52	$7,763.00	$-6,641.52	$-7,763.00
Total	**0 / 65**	**Varies**	**$0.00**	**$0.00**	**$52,016.04**	**$62,994.94**	**$-52,016.04**	**$-62,994.94**

Note: site complexity variables that affect cost shown below:

	Current Scenario	Baseline Scenario
Dev. Type	Re-Development	Re-Development
Site Suitability	Moderate	Moderate
Topography	Flat (2% Slope)	Flat (2% Slope)
Soil Type	C	C
Cost Region	Atlanta(140 miles) 0.92	Atlanta(140 miles) 0.92

Chart Key	
D - Disconnection	IB - Infiltration Basins
RH - Rain Harvesting	PP - Permeable Pavement
RG - Rain Gardens	
GR - Green Roofs	
SP - Street Planters	

*Estimated project cost $85,548 (MS4 2016 Annual Report, City of Birmingham)

Results (Annual Maintenance Costs):

EPA National Stormwater Calculator

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Results

Directions

Options:

Years to Analyze: 20

Event Threshold: 0.05

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

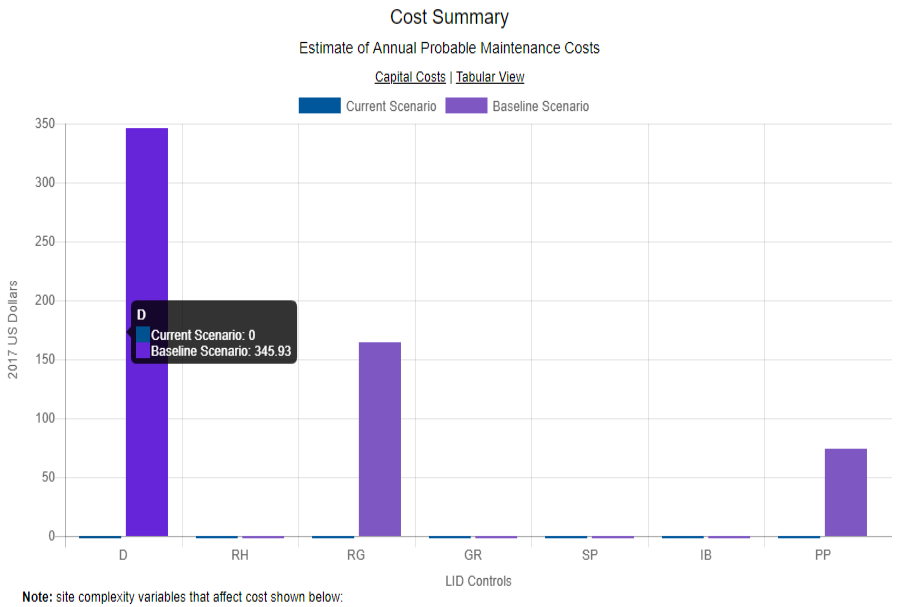

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Chart Key	
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GR - Green Roofs	
SP - Street Planters	

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

SWC Analysis: Potential Next Steps

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

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

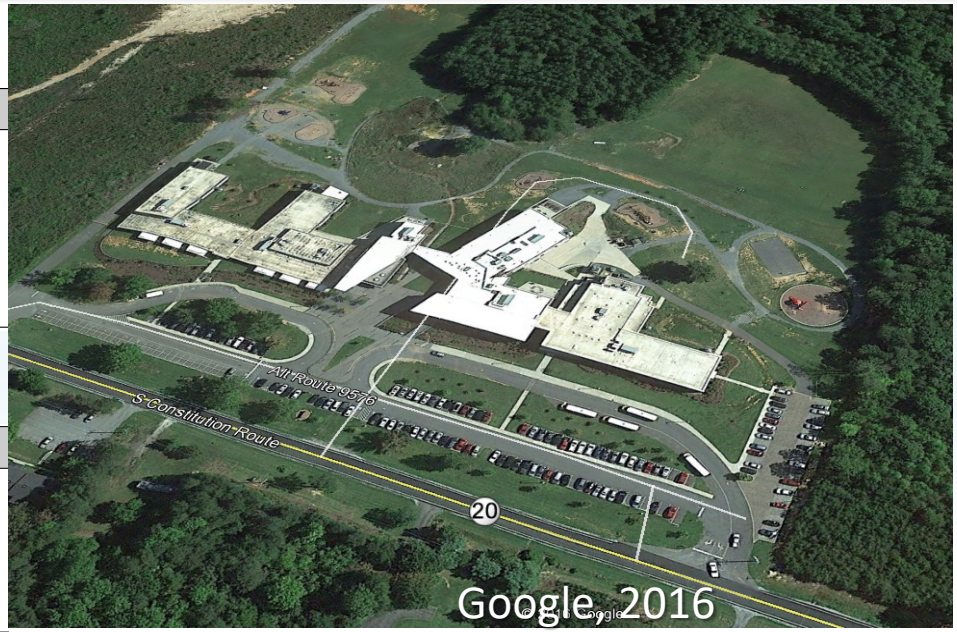
Case Study with Actual Costs:
Buckingham Elementary School, Dillwyn, VA

Site Characteristics:

Variable	Value
Total Area (acres)	10.5
Estimated Imperviousness (%)	31.0
Site Soils	Type C
Soil Drainage (inches/hour)	0.01
Topography	moderately flat

LID Controls:

Practice	Percent of Impervious Area Treated (%)
Disconnection	5
Rainwater harvesting	19
Rain gardens	5
Permeable pavement	5

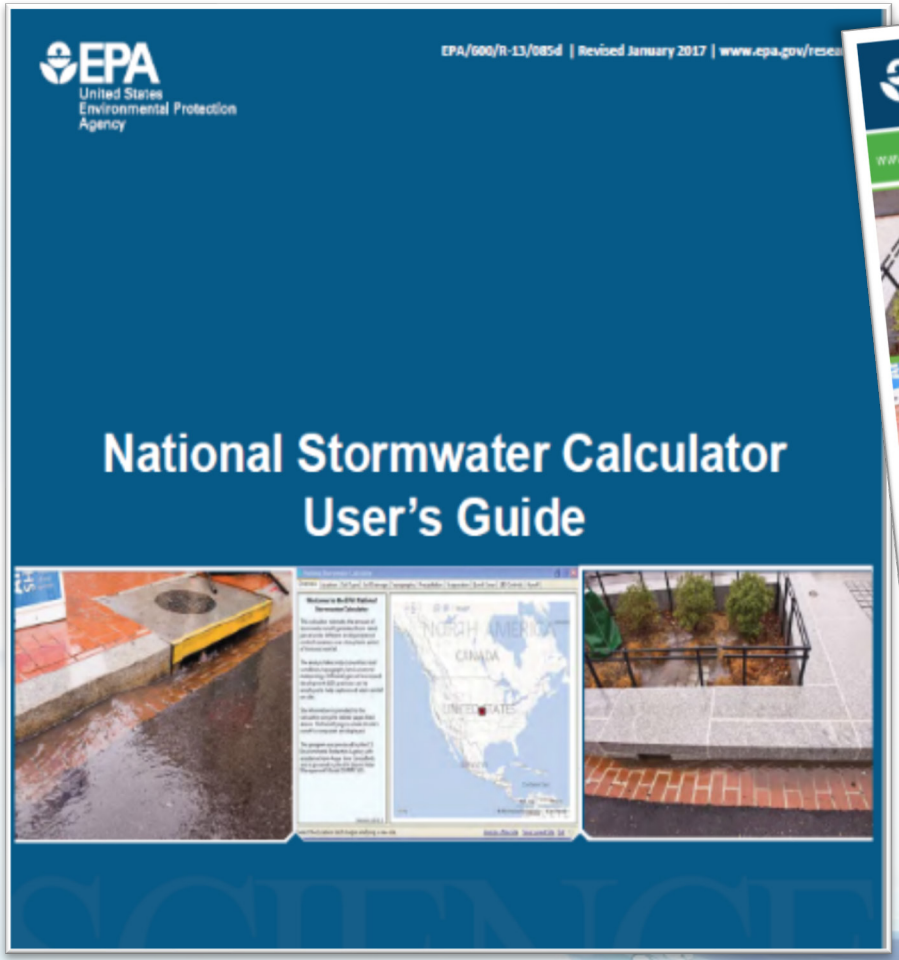


Cost Summary: Estimated VS. Actual:

LID Control	Capital Cost Range	Maintenance Cost Range
Disconnection	$83,500 – 107,600	$1,100 – 1,700
Rain Harvesting	$29,600 – 40,873	$3,400 – 8,200
Rain Gardens	$5,375 – 10,412	$100 – 1,800
Permeable Pavement	$107,300 – 143,400	$1,300 – 6,900
Total Cost (2015 $)	**$225,700 – 302,200**	**$5,900 – 18,500**
Actual Project Cost (2014$)	**$268,662**	**Not Available**

EPA United States Environmental Protection Agency

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



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

Discussion and Questions
Thank You!

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(202) 566-1671
bernagros.jason@epa.gov

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

Contact: SWC@epa.gov

SWC:
Site Parameters and Embedded GIS Data-sets

- **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