

The U.S. EPA's National Stormwater Calculator



Achieving LEED BD+C V4 Homes and New Construction Sustainable Sites Rain Water Management
Green Home Institute Presentation

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Disclaimer:

The views expressed in this presentation are those of the author(s) and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

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1. Review the U.S. EPA's National Stormwater Calculator (SWC)
2. Learn how it can assist you in achieving LEED BD+C V4 Homes and New Construction Sustainable Sites Rain Water Management
3. Summarize the conceptual methods used by SWC
4. Learn how it assists in achieving LEED BD+C V4 Homes and New Construction SS Rain Water Management

Using EPA's SWC to assist in achieving LEED BD+C V4 Homes and New Construction SS Rain Water Management

1. Run the calculator to quantify stormwater reductions
2. Interpret the SWC results and applying low impact development (LID) controls

Summary



Introduction

LEED BD+C V4 Homes and New Construction Sustainable Site Rain Water Management

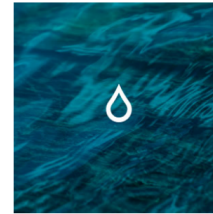
Priorities

LEED-certified buildings are proven to save money, improve efficiency, lower carbon emissions and create healthier places for people. They are critical to addressing the climate crisis, meeting ESG goals, enhancing resilience, and supporting more equitable communities.

- Some of the requirements
 - Percentile of rainfall events
 - managing on site runoff from the developed site for a given percentile (different for different conditions and points) with low impact development (LID) and green infrastructure

Calculators

LEED v4 Rainfall Events Calculator



LEED version: v4

Download

Format: [Excel Doc](#)



Use the Rainfall Events Calculator to calculate the percentile of storm events and list low impact development strategies for LEED v4 BD+C SS Credit Rainwater Management and LEED v4 O+M SS Credit Rainwater Management. Use the summary tab in the calculator to complete the form in LEED Online.

<https://www.usgbc.org/resources/leed-v4-rainfall-events-calculator>

Introduction

U.S. EPA's National Stormwater Calculator (SWC) Overview

- Description
 - Planning-level tool that estimates changes in stormwater runoff given site characteristics and low impact development (LID) practices at a location
- Details
 - Provides access to national datasets
 - Uses EPA's Stormwater Management Model as its hydrologic model
 - Includes
 - Hydrology analysis for a site under different development and LID controls
 - Cost module
 - Green infrastructure as LID controls
 - Climate scenarios



Introduction

SWC Components

Soil (data layer available from SURGO soil survey)

- Type
- Drainage

Topography

Precipitation and temperature (recently updated historical precipitation, temperature, and evaporation data)

- From NOAA, LDAS

Climate

- Accounts for changes in monthly average precip., temperature, and extreme events based on global climate models using the Climate Resilience Evaluation and Analysis Tool
- <https://www.epa.gov/crwu/climate-resilience-evaluation-and-awareness-tool-creat-risk-assessment-application-water>

Land Cover

- Forest
- Meadow
- Lawn
- Desert
- Impervious

Low Impact Development Controls



Location



Soil Type



Soil Drainage



Topography



Precipitation/Temperature



Climate Change



Land Cover

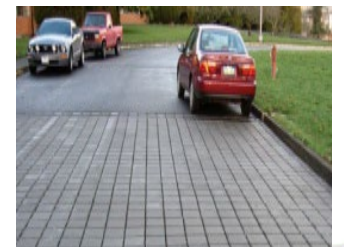


LID Controls

Introduction

SWC Low Impact Development (LID) controls

- Green Infrastructure, Green-blue Infrastructure-
 - a subset of sustainable and resilient infrastructure
 - designed to address urban and climatic issues
- **Low impact development**
 - Low Impact Development (LID) controls are green infrastructure and landscaping practices designed to collect runoff from impervious surfaces and retain it on site
 - Examples
 - Disconnection
 - Rain Harvesting
 - Rain Gardens
 - Green Roofs
 - Street Planters
 - Infiltration Basins



Introduction

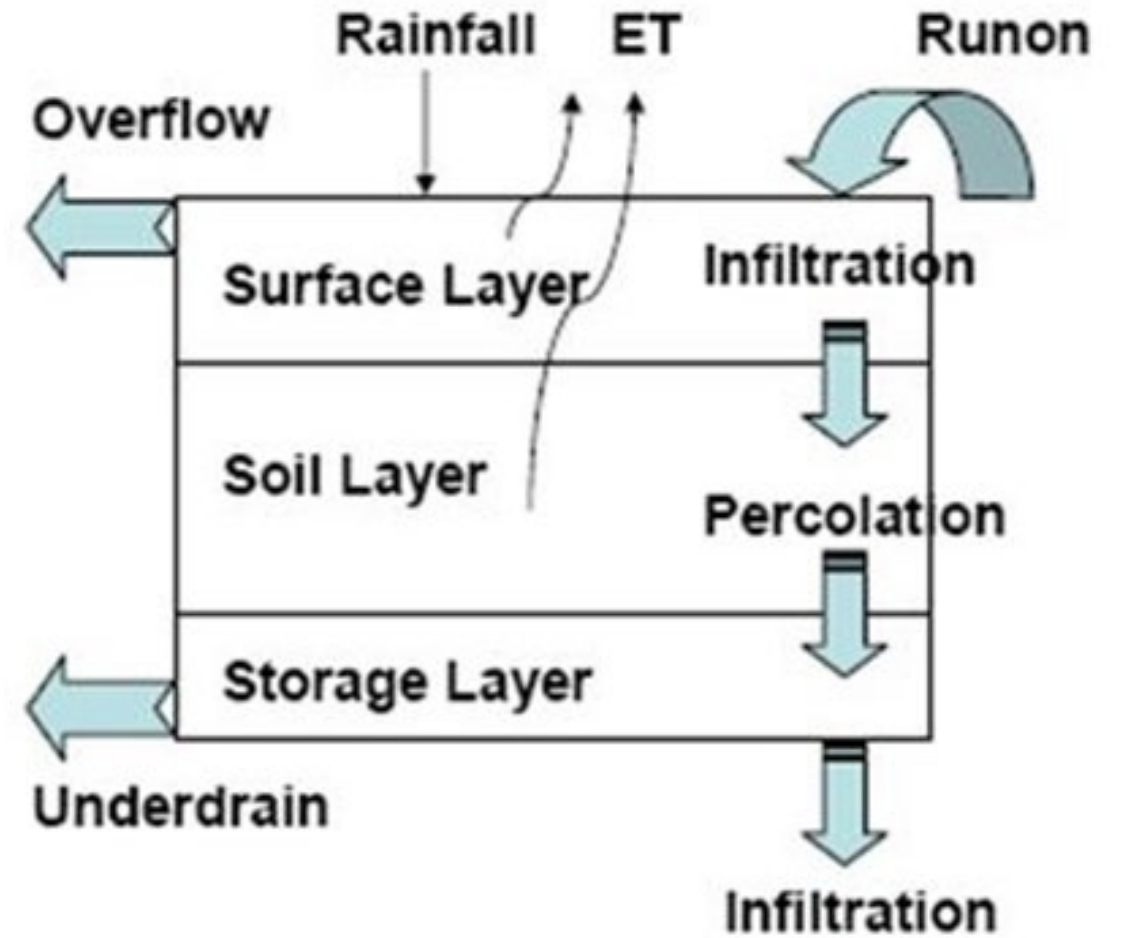
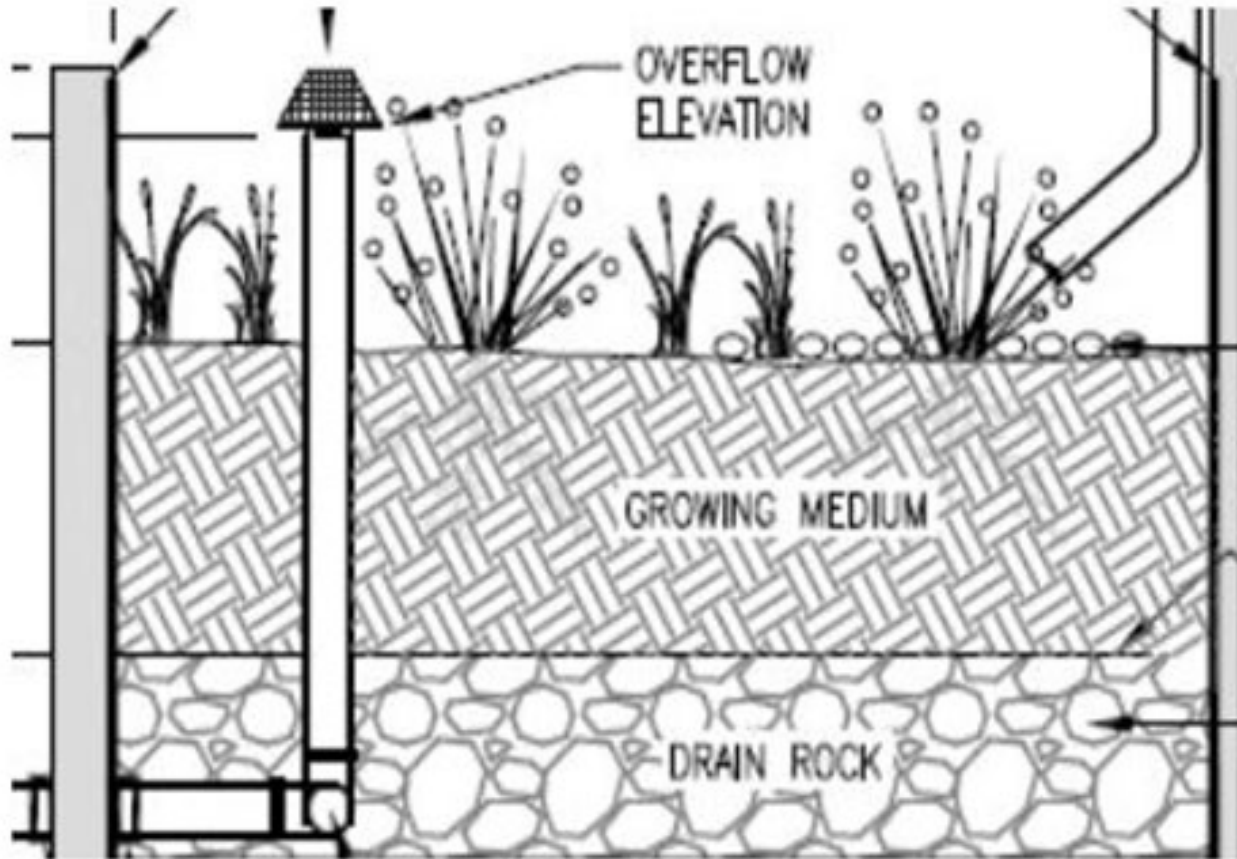
Understanding how the SWC works

- Uses SWMM 5 (EPA, 2010) as its computational engine
- SWMM 5 Addresses
 - Surface runoff
 - Infiltration
 - Groundwater
 - Snowmelt
 - Stormwater detention
 - Full dynamic wave flow routing with any configuration of open and closed channels
- SWC only carries out its hydrology calculations from runoff, infiltration, and LID sub-models
 - Other parameter values: site area, width of the outflow face, slope, percent impervious, depression storage depth (varies by land cover), roughness coefficient (varies by land cover), Percent of Impervious Area without Depression Storage



Introduction

Consider a street planter (i.e., a kind of bio-retention cell)



Introduction

Underlying model to assist in achieving LEED BD+C V4 Homes
and New Construction SS Rain Water Management

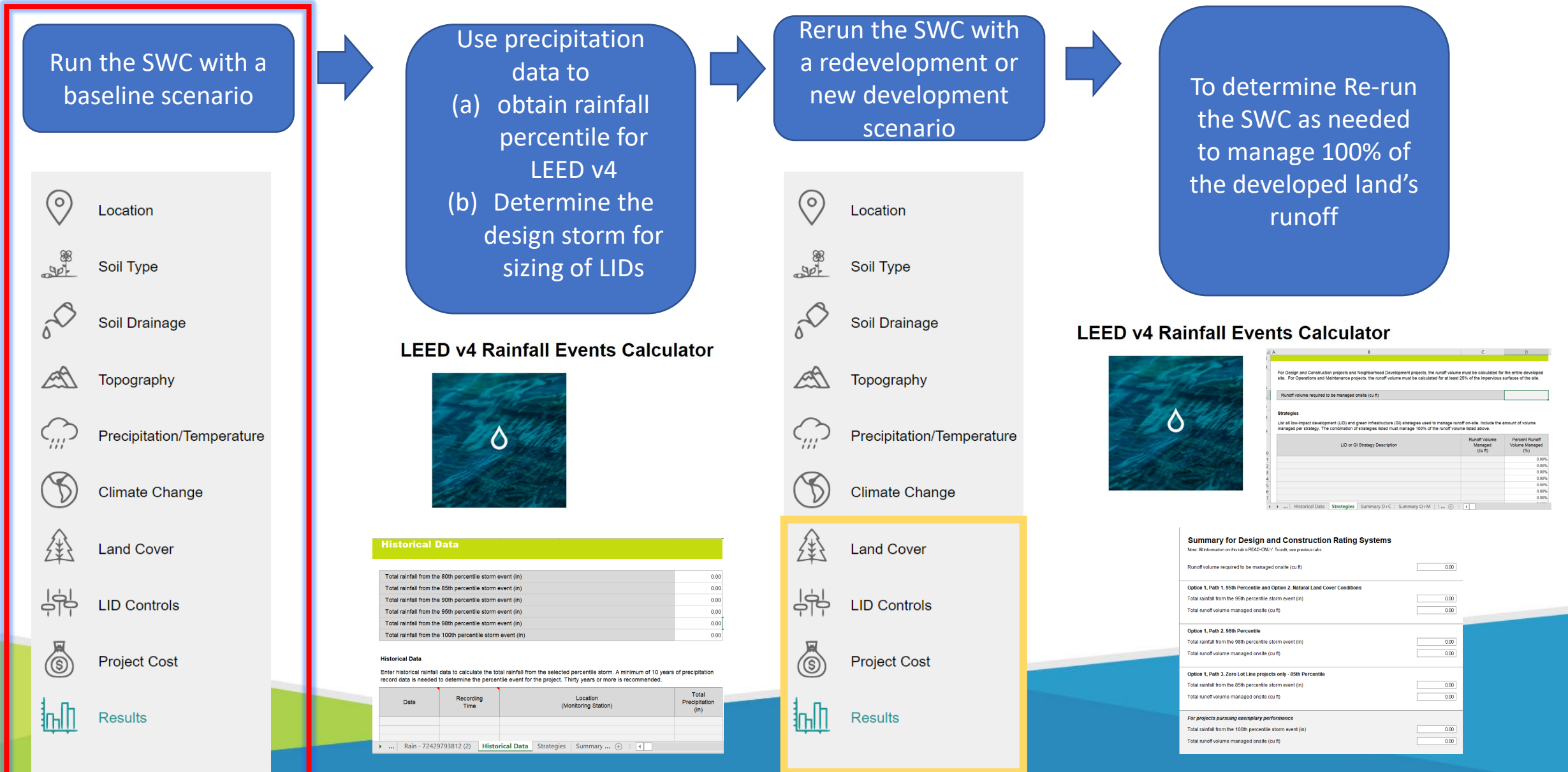
Main points:

- 1) The way that rain water is managed depends on site characteristics
- 2) SWMM can process site characteristics and using knowledge of physical processes, predict how runoff will change from applying LID controls



Using the SWC to assist with LEED v4

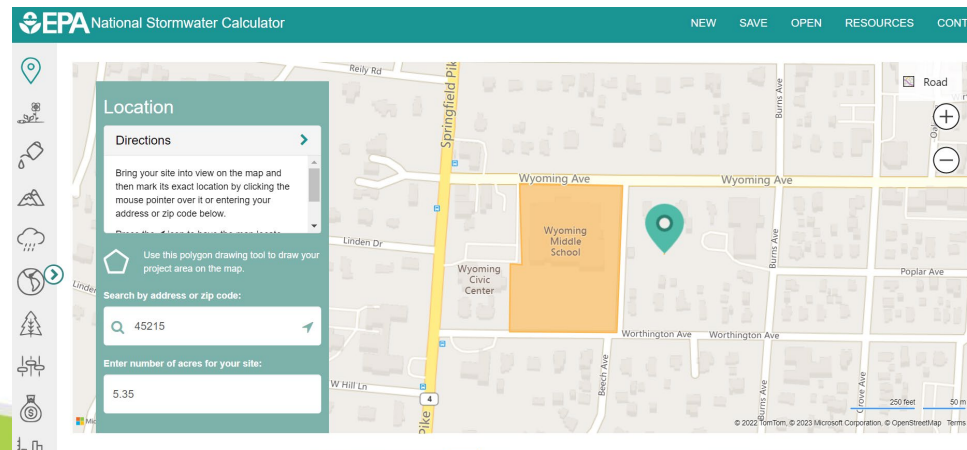
Summary



Using the SWC to assist with LEED v4

Getting started with the SWC going through the tabs

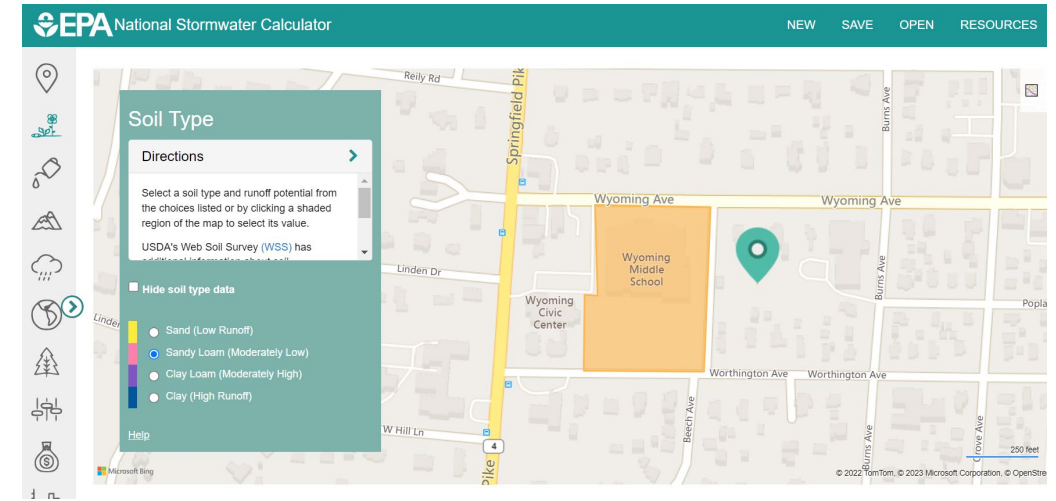
1. Navigate to <https://swcweb.epa.gov/stormwatercalculator/>
2. Name your site
3. Enter in an address or zip code and press enter
4. Locate your site on the map and use the polygon drawing tool to draw your project area



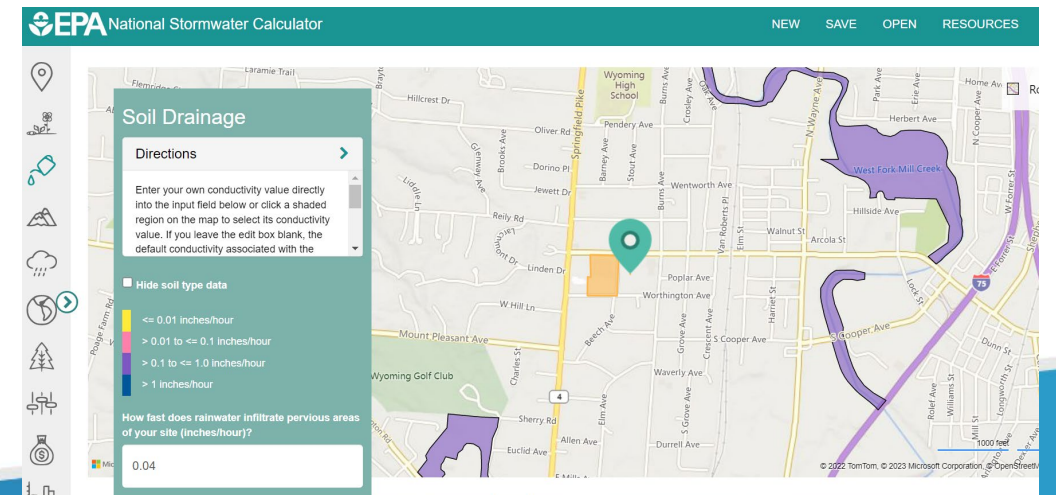
Using the SWC to assist with LEED v4



5. Enter your site's soil type



6. Enter your site's soil drainage

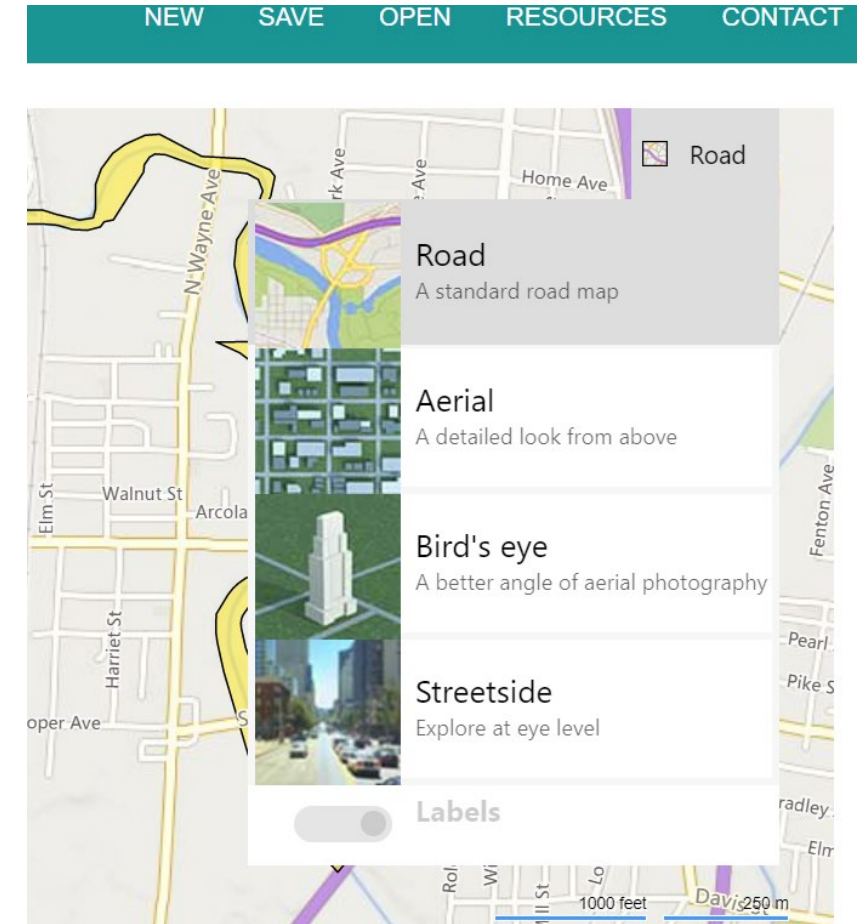
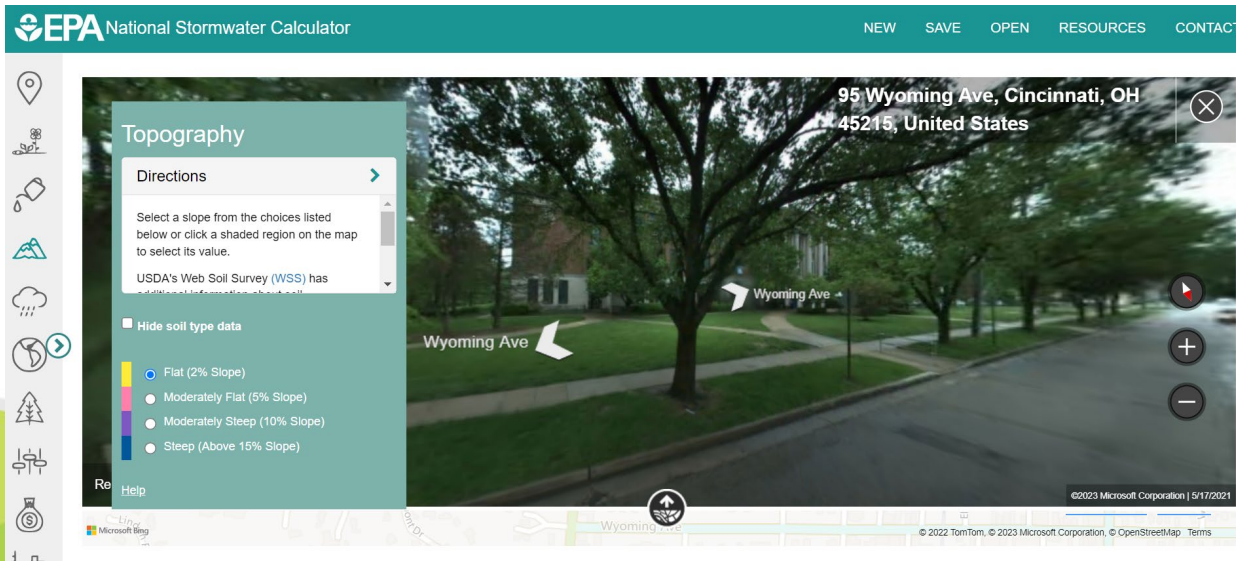


Using the SWC to assist with LEED v4



7. Enter in the topography

It may be helpful to use street, bird's eye, or aerial view.



Using the SWC to assist with LEED v4



Precipitation and temperature data

8. Select a weather station for precipitation and temperature data

The screenshot displays the EPA National Stormwater Calculator interface. The top navigation bar includes links for NEW, SAVE, OPEN, RESOURCES, and CONTACT. The left sidebar contains icons for various input types: location, land use, impervious area, and precipitation/temperature data. The main panel shows the following configuration:

- source of hourly precipitation data and a weather station to use as a source for daily minimum and maximum temperature (used to calculate evaporation):** A dropdown menu.
- Rain Gage:** A dropdown menu with the selected option "CINA MUNI APT/LUKN FD APT".
- Weather Station:** A dropdown menu with the selected option "CINA MUNI APT/LUKN FD APT".
- Precipitation and Temperature Information:**
 - Record Start Date: 1990/01/01
 - Record End Date: 2019/12/31
 - Annual Precipitation: 39.67
 - Buttons: Download precipitation data, Download temperature data
 - Help link

The right side of the interface features a map of the Springfield, MA area, with several weather station icons (teal and orange) overlaid. A scale bar indicates 5 miles and 10 km. The bottom right corner includes copyright information: © 2022 TomTom, Earthstar Geographics SIO, © 2023 Microsoft Corporation Terms.

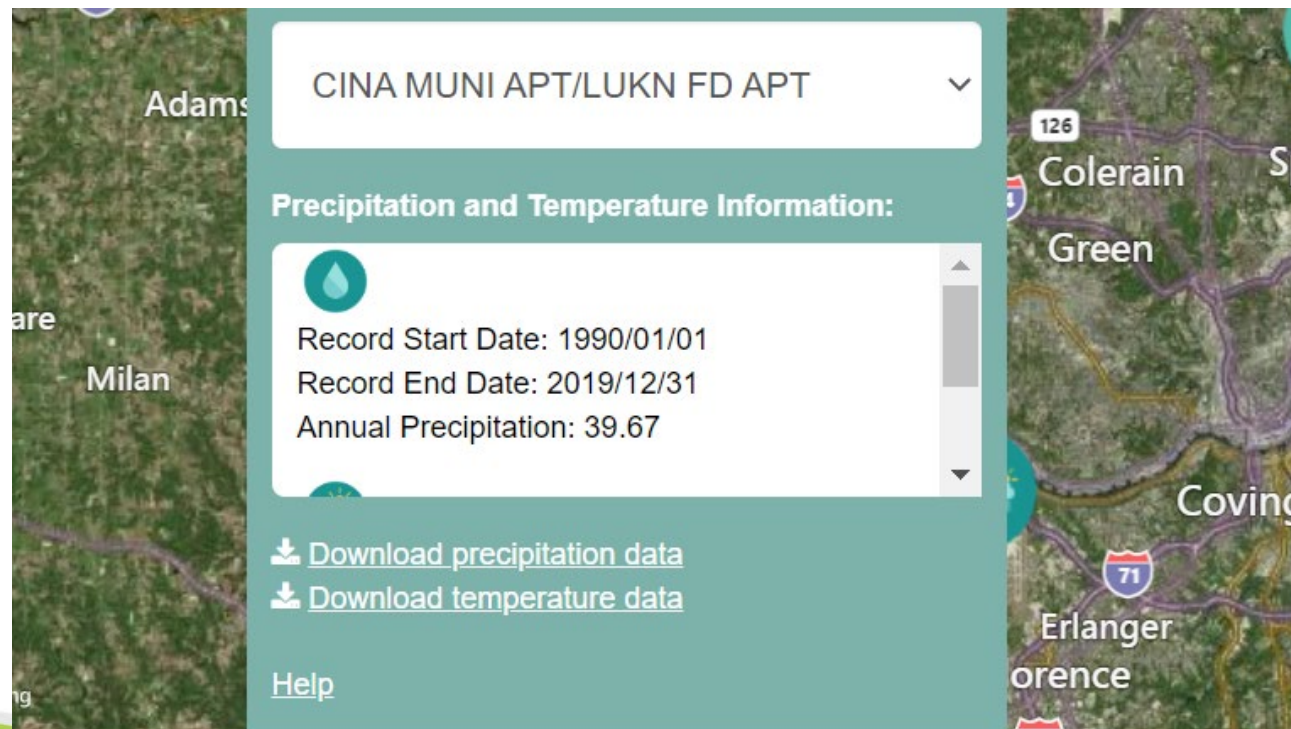
Using the SWC to assist with LEED v4



Obtaining precipitation data to calculate percentile rain events for LEED v4 rain management

9. Download the precipitation data (it is a .dat file)

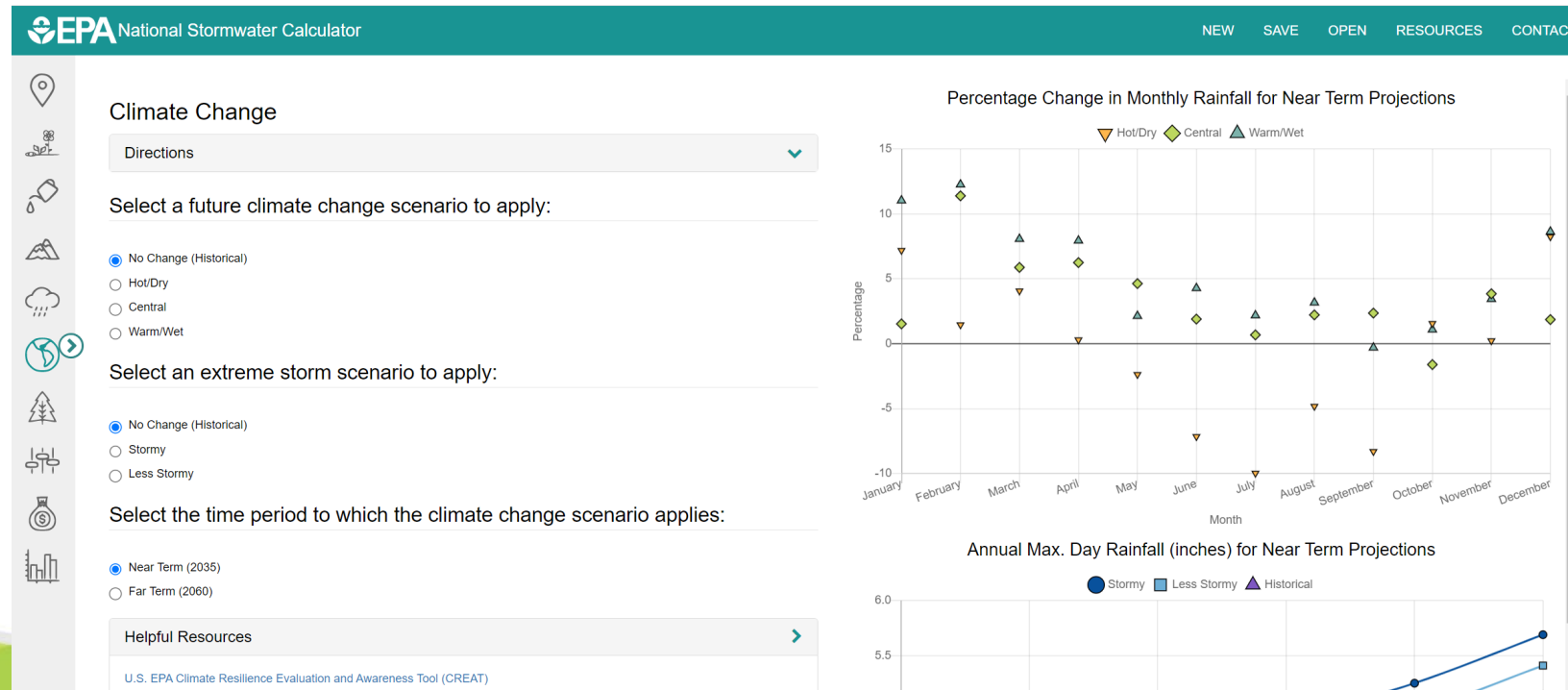
This will be needed to determine the LEED v4 rainfall percentile to which the LID needs to be designed



Using the SWC to assist with LEED v4



10. For the climate change scenarios tab, select “No Change (Historical)”



Using the SWC to assist with LEED v4



11. Describe the land cover on your site

EPA National Stormwater Calculator NEW SAVE OPEN RESOURCES CONTACT

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:	<input type="range"/>	2	%
Meadow:	<input type="range"/>	0	%
Lawn:	<input type="range"/>	40	%
Desert:	<input type="range"/>	0	%
Impervious:		58	%

[Help](#)

Using the SWC to assist with LEED v4



12. Describe baseline LID controls (what percent of the impervious area is treated by each type of control)

The screenshot displays the EPA National Stormwater Calculator interface. The 'LID Controls' section is active, showing a list of controls with sliders and percentage inputs. The 'Directions' box at the top explains the input requirements. The controls listed are Disconnection, Rain Harvesting, Rain Gardens, Green Roofs, Street Planters, Infiltration Basins, and Permeable Pavement. The 'Design Storm for Sizing' is set to 0 in. The background shows a satellite view of a street labeled 'Springfield Pike'.

EPA National Stormwater Calculator

LID Controls

Directions

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

Click a practice to learn more about it or to

Disconnection: 20 %

Rain Harvesting: 0 %

Rain Gardens: 0 %

Green Roofs: 0 %

Street Planters: 0 %

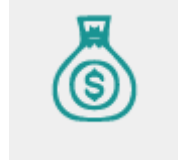
Infiltration Basins: 0 %

Permeable Pavement: 0 %

Design Storm for Sizing: 0 in.

[Help](#)

Using the SWC to assist with LEED v4



13. Skip the cost module for now.

Using the SWC to assist with LEED v4



14. In the options, set the years to analyze to 30, noting that this may take some time to run.
15. Define the event threshold. This will not affect the calculation of rainfall or runoff. It will go into the number of days with rainfall and number of days with retained rainfall.
16. Click “Refresh Results”
17. Click “Use as baseline scenario”

EPA National Stormwater Calculator

should be displayed.

Options:

Years to Analyze:
30

Event Threshold:
0.1

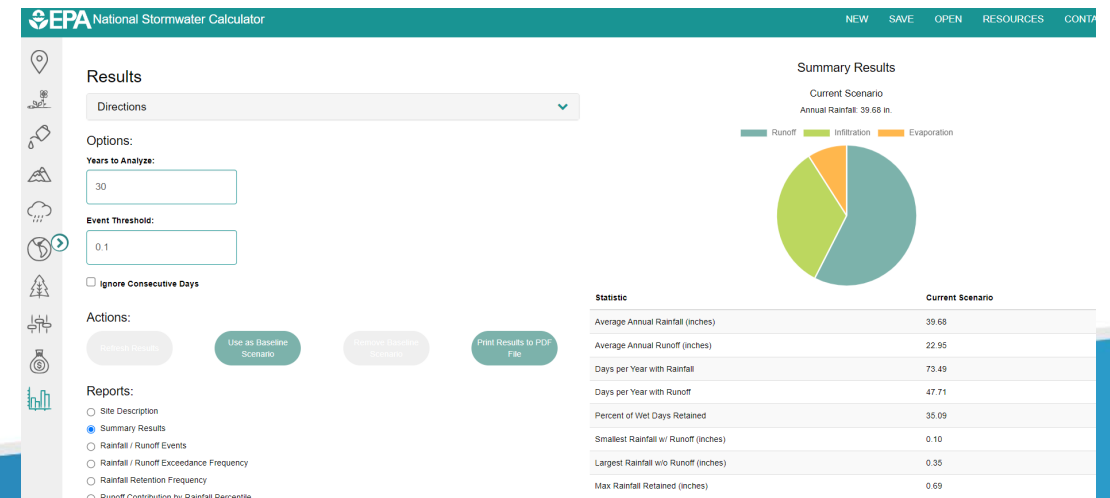
☐ Ignore Consecutive Days

Actions:

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

Reports:

☐ Site Description
☒ Summary Results



Using the SWC to assist with LEED v4

Summary

Run the SWC with a baseline scenario (50% of the work!)



Use precipitation data to

- (a) obtain rainfall percentile for LEED v4
- (b) Determine the design storm for sizing of LIDs

LEED v4 Rainfall Events Calculator

Historical Data	
Total rainfall from the 80th percentile storm event (in)	0.00
Total rainfall from the 85th percentile storm event (in)	0.00
Total rainfall from the 90th percentile storm event (in)	0.00
Total rainfall from the 95th percentile storm event (in)	0.00
Total rainfall from the 98th percentile storm event (in)	0.00
Total rainfall from the 100th percentile storm event (in)	0.00

Historical Data

Enter historical rainfall data to calculate the total rainfall from the selected percentile storm. A minimum of 10 years of precipitation records is needed to determine the percentile event for the project. Thirty years or more is recommended.

Date	Recording Time	Location (Monitoring Station)	Total Precipitation (in)

Rain - 72429793812 (2) | Historical Data | Strategies | Summary ...

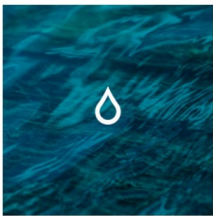


Rerun the SWC with a redevelopment or new development scenario



Use information from SWC to fill out fields in LEED v4 Rainfall Events Calculator

LEED v4 Rainfall Events Calculator



LEED v4 Rainfall Events Calculator		
For Design and Construction projects and Neighborhood Development projects, the runoff volume must be calculated for the entire developed site. For Operations and Maintenance projects, the runoff volume must be calculated for at least 25% of the impervious surfaces of the site.		
Runoff volume required to be managed onsite (cu ft)		
Strategies		
List all low-impact development (LID) and green infrastructure (GI) strategies used to manage runoff on-site. Include the amount of volume managed per strategy. The combination of strategies listed must manage 100% of the runoff volume listed above.		
LID or GI Strategy Description	Runoff Volume Managed (cu ft)	Percent Runoff Volume Managed (%)
1		0.00%
2		0.00%
3		0.00%
4		0.00%
5		0.00%
6		0.00%
7		0.00%

Land Cover

LID Controls

Project Cost

Results

Summary for Design and Construction Rating Systems

Note: All information on this tab is READ-ONLY. To edit, see previous tabs.

Runoff volume required to be managed onsite (cu ft)

Option 1, Path 1, 95th Percentile and Option 2, Natural Land Cover Conditions

Total rainfall from the 95th percentile storm event (in)

Total runoff volume managed onsite (cu ft)

Option 1, Path 2, 98th Percentile

Total rainfall from the 98th percentile storm event (in)

Total runoff volume managed onsite (cu ft)

Option 1, Path 3, Zero Lot Line projects only - 85th Percentile

Total rainfall from the 85th percentile storm event (in)

Total runoff volume managed onsite (cu ft)

For projects pursuing exemplary performance

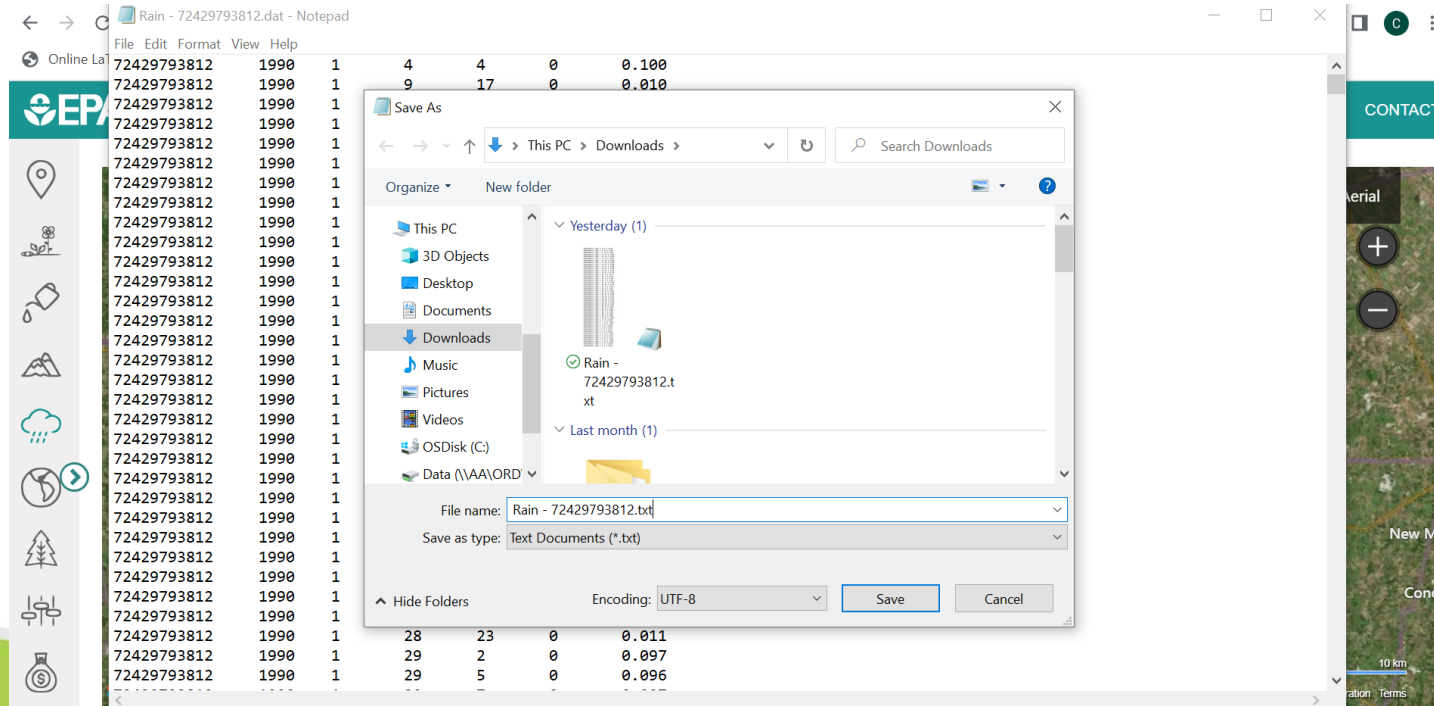
Total rainfall from the 100th percentile storm event (in)

Total runoff volume managed onsite (cu ft)

Using the SWC to assist with LEED v4

Obtaining precipitation data to calculate percentile rain events for LEED v4 rain management

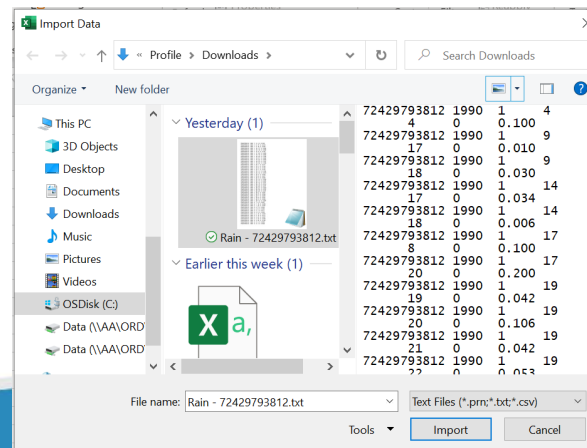
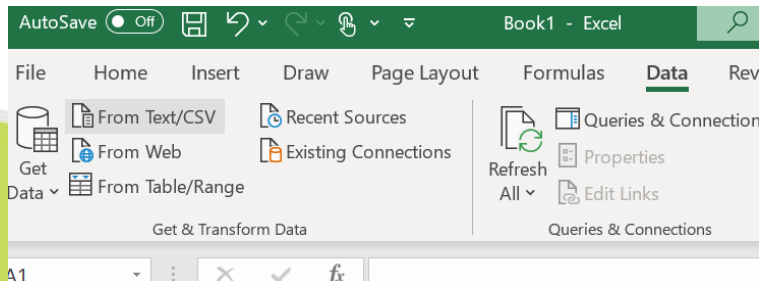
1. Open the file you obtained from the SWC for precipitation (rain_#####...#.dat) and save as a .txt (rain_#####...#.txt)



Using the SWC to assist with LEED v4

Obtaining precipitation data to calculate percentile rain events for LEED v4 rain management

2. Open the v4_Rainfall Events Calculator_v02_0.xlsm
3. Open a new tab at the bottom
4. Import data from Text/CSV (the columns are: Station ID, Year, Month, Day, Hour, Minute, Non-Zero Precipitation reading in *inches*)
5. Can import directly by clicking “Load”
6. Create new column that is the date
`=DATE([@Column2],[@Column3],[@Column4]))`



Column1	Column2	Column3	Column4	Column5	Column6	Column7
72429793812	1990	1	4	4	0	0.1
72429793812	1990	1	9	17	0	0.01
72429793812	1990	1	9	18	0	0.03
72429793812	1990	1	14	17	0	0.034
72429793812	1990	1	14	18	0	0.006
72429793812	1990	1	17	8	0	0.1
72429793812	1990	1	17	20	0	0.2
72429793812	1990	1	19	19	0	0.042
72429793812	1990	1	19	20	0	0.106
72429793812	1990	1	19	21	0	0.042
72429793812	1990	1	19	22	0	0.053
72429793812	1990	1	19	23	0	0.127
72429793812	1990	1	19	24	0	0.106
72429793812	1990	1	20	1	0	0.211
72429793812	1990	1	20	3	0	0.106
72429793812	1990	1	20	5	0	0.106
72429793812	1990	1	20	7	0	0.105
72429793812	1990	1	20	11	0	0.106
72429793812	1990	1	23	14	0	0.01
72429793812	1990	1	25	5	0	0.006

Using the SWC to assist with LEED v4

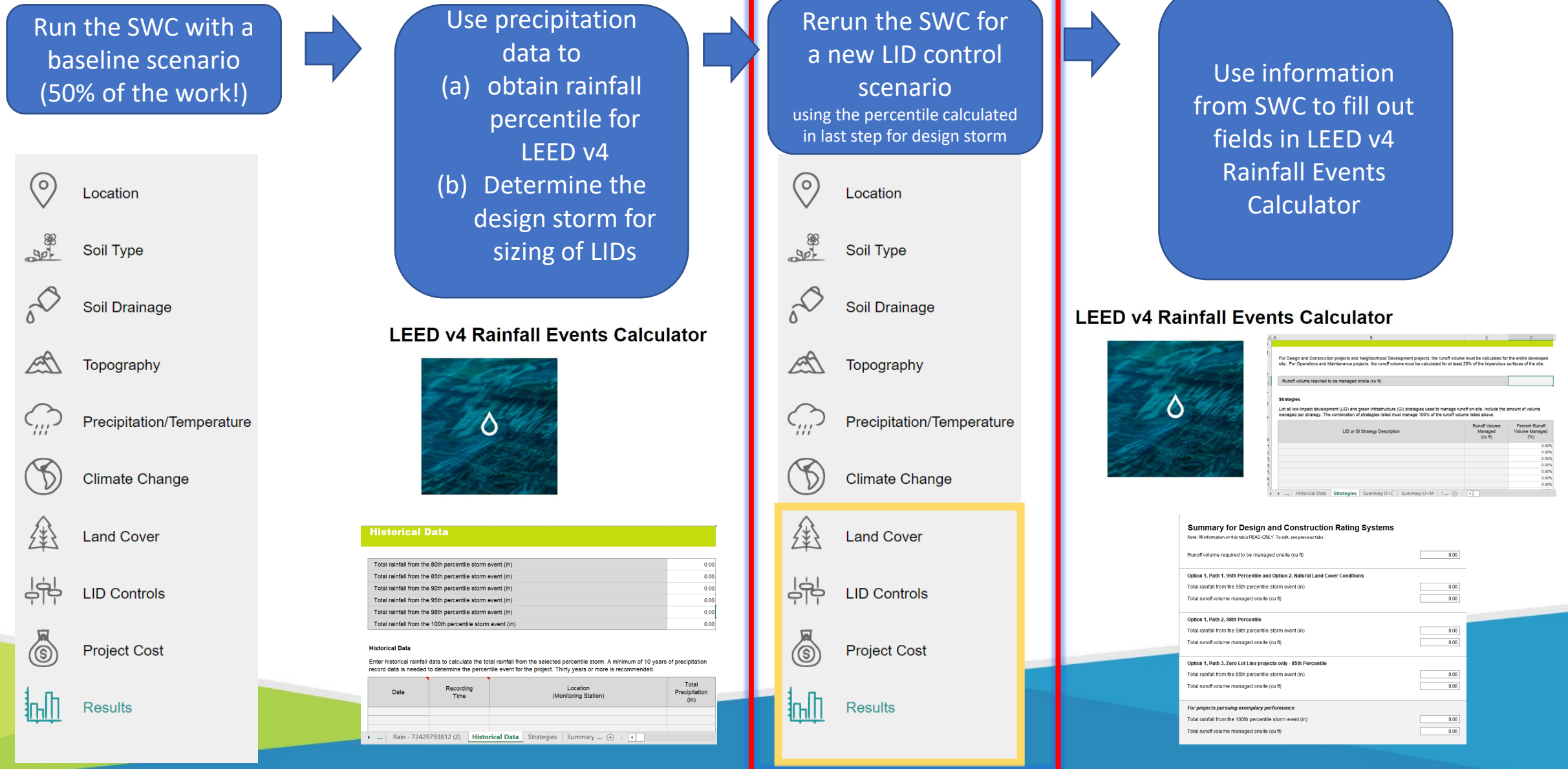
Obtaining precipitation data to calculate percentile rain events for LEED v4 rain management

7. Calculate percentile relevant to your Rainwater management option 1 path (95th, 98th, or 85th) with Excel's PERCENTILE function

The screenshot displays the Microsoft Excel interface. The ribbon at the top includes File, Home, Insert, Draw, Page Layout, Formulas, Data, Review, View, Help, and Table Design. The Home ribbon is active, showing options for Clipboard, Font, Alignment, Number, Styles, Cells, Editing, and Sensitivity. The formula bar shows the formula `=DATE([@Column2],[@Column3],[@Column4])` in cell H3. The data table below has columns A through H, with headers Column1 through Column8. The data rows show a sequence of values for each column, including dates in the final column. On the right side, the Queries & Connections pane is open, showing two queries: 'Rain - 72429793812' and 'Rain - 72429793812 (2)'. The second query is highlighted in green and shows '15,281 rows loaded'.

	Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8
1	72429793812	1990	1	4	4	0	0.1	1/4/1990
2	72429793812	1990	1	9	17	0	0.01	1/9/1990
3	72429793812	1990	1	9	18	0	0.03	1/9/1990
4	72429793812	1990	1	14	17	0	0.034	1/14/1990
5	72429793812	1990	1	14	18	0	0.006	1/14/1990
6	72429793812	1990	1	17	8	0	0.1	1/17/1990
7	72429793812	1990	1	17	20	0	0.2	1/17/1990
8	72429793812	1990	1	19	19	0	0.042	1/19/1990
9	72429793812	1990	1	19	20	0	0.106	1/19/1990
10	72429793812	1990	1	19	21	0	0.042	1/19/1990
11	72429793812	1990	1	19	22	0	0.053	1/19/1990
12	72429793812	1990	1	19	23	0	0.127	1/19/1990
13	72429793812	1990	1	19	24	0	0.106	1/19/1990
14	72429793812	1990	1	20	1	0	0.211	1/20/1990
15	72429793812	1990	1	20	3	0	0.106	1/20/1990
16	72429793812	1990	1	20	5	0	0.106	1/20/1990
17	72429793812	1990	1	20	7	0	0.105	1/20/1990
18	72429793812	1990	1	20	11	0	0.106	1/20/1990
19	72429793812	1990	1	23	14	0	0.01	1/23/1990
20	72429793812	1990	1	25	5	0	0.006	1/25/1990

Using the SWC to assist with LEED v4 Summary



Using the SWC to assist with LEED v4



1. Without reloading the page or anything, return to the “Land Cover Tab” and if your land cover has changed after development or redevelopment, describe the land cover on your site

The screenshot displays the EPA National Stormwater Calculator interface. The top navigation bar includes links for NEW, SAVE, OPEN, RESOURCES, and CONTACT. The left sidebar contains icons for various site features. The main panel is titled "Land Cover" and includes a "Directions" section with instructions. Below this, there are sliders and input fields for different land cover categories:

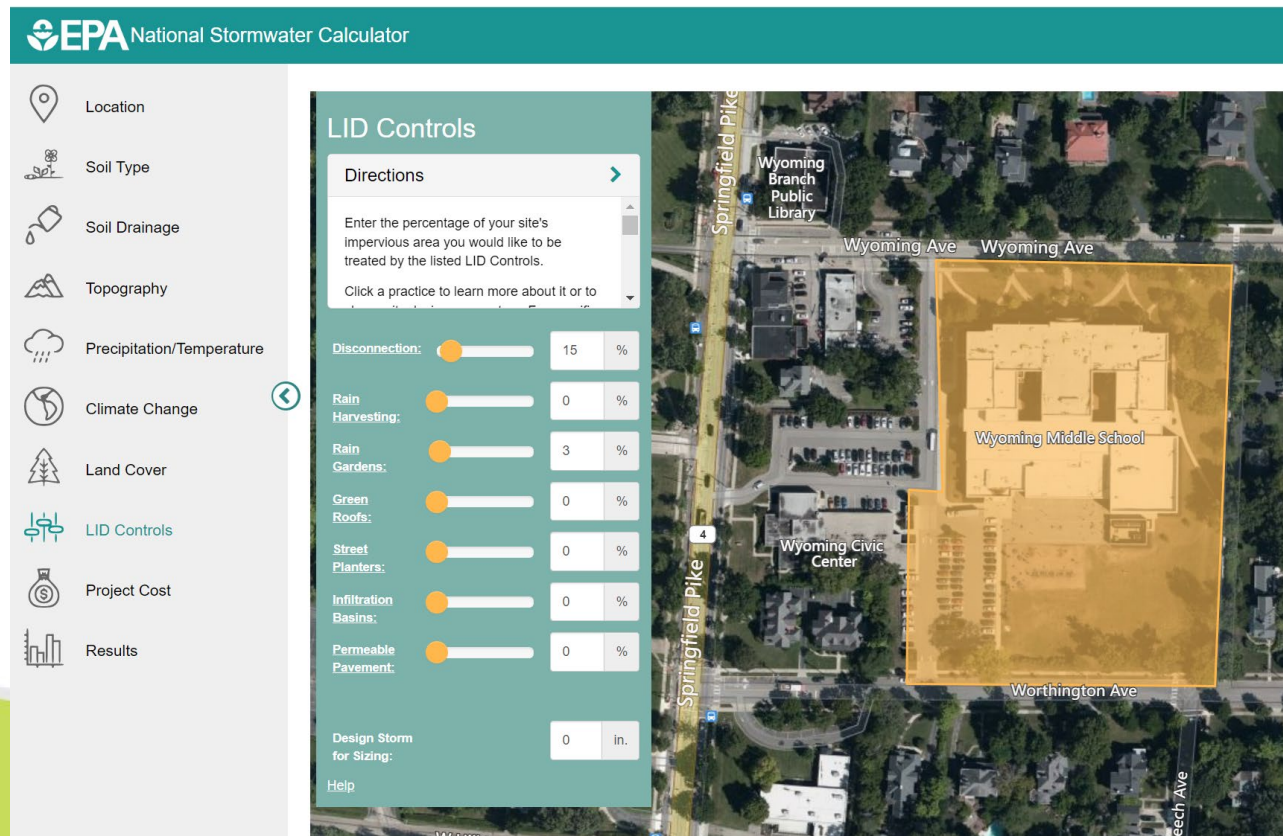
Category	Value	Unit
Forest:	2	%
Meadow:	0	%
Lawn:	40	%
Desert:	0	%
Impervious:	58	%

The background of the interface shows an aerial map of a residential area. A large yellow rectangular area highlights a building labeled "Wyoming Middle School". Other labels on the map include "Wyoming Branch Public Library", "Wyoming Civic Center", "Wyoming Presbyterian Church", and "Worthington Ave". A teal location pin is placed on the map near the school. The map also shows streets like Springfield Pike, Burns Ave, and Grove Ave.

Using the SWC to assist with LEED v4



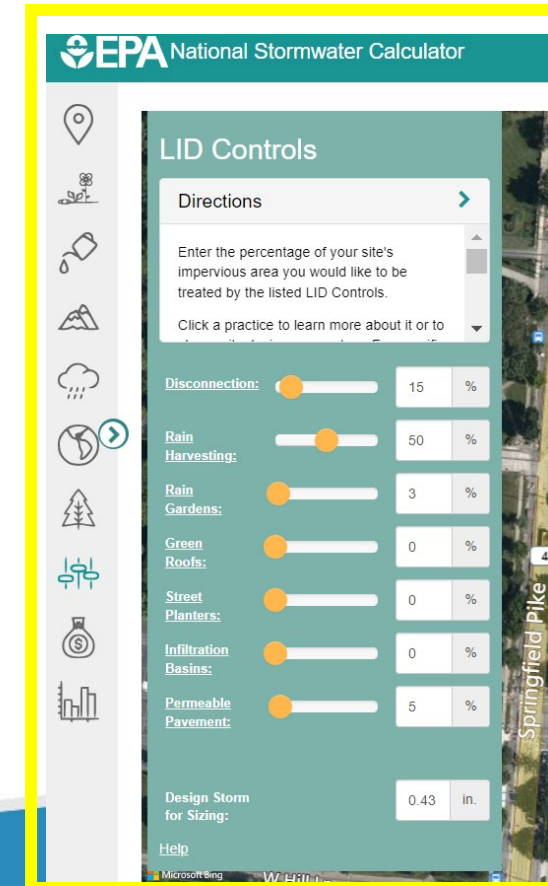
- Describe the LID controls (what percent of the impervious area is treated by each type of control) keeping the baseline and expanding LID



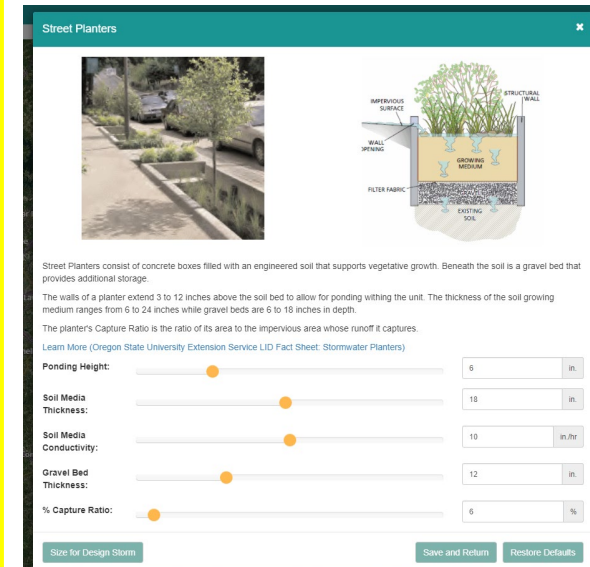
The screenshot shows the EPA National Stormwater Calculator interface. The left sidebar contains navigation icons for Location, Soil Type, Soil Drainage, Topography, Precipitation/Temperature, Climate Change, Land Cover, LID Controls (highlighted), Project Cost, and Results. The main panel displays the 'LID Controls' section with a 'Directions' box and a list of controls with sliders and percentage values:

Control	Value	Unit
Disconnection	15	%
Rain Harvesting	0	%
Rain Gardens	3	%
Green Roofs	0	%
Street Planters	0	%
Infiltration Basins	0	%
Permeable Pavement	0	%

The 'Design Storm for Sizing' is set to 0 in. The background shows an aerial view of a site with labels for Wyoming Branch Public Library, Wyoming Middle School, Wyoming Civic Center, and Springfield Pike.



This screenshot is identical to the one on the left, showing the EPA National Stormwater Calculator interface with the 'LID Controls' section. The 'Design Storm for Sizing' is set to 0.43 in. The background shows an aerial view of a site with labels for Wyoming Branch Public Library, Wyoming Middle School, Wyoming Civic Center, and Springfield Pike.



The screenshot shows the 'Street Planters' section of the EPA National Stormwater Calculator. It includes a diagram of a street planter and a table of settings:

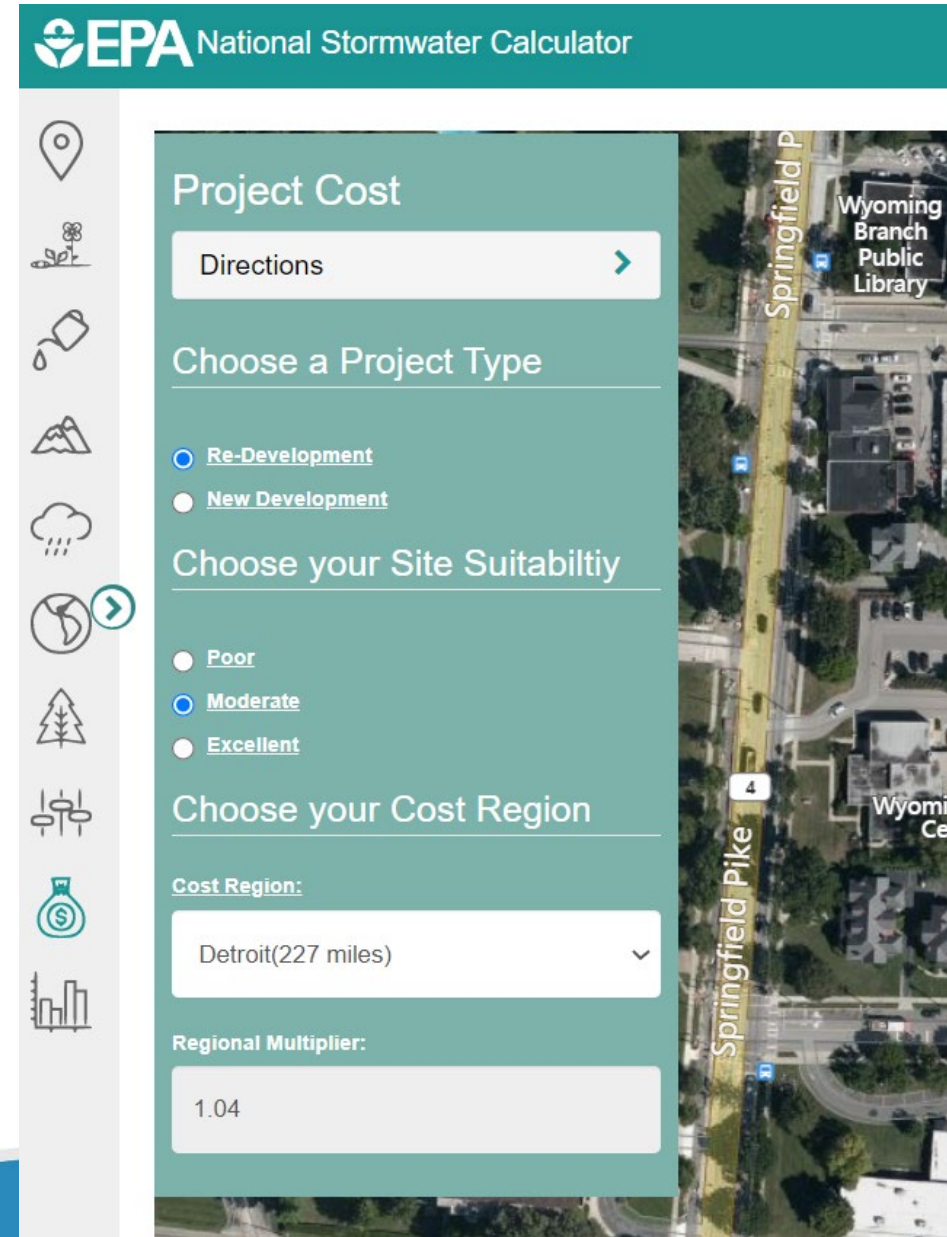
Parameter	Value	Unit
Ponding Height	6	in.
Soil Media Thickness	18	in.
Soil Media Conductivity	10	in./hr.
Gravel Bed Thickness	12	in.
% Capture Ratio	6	%

Buttons for 'Size for Design Storm', 'Save and Return', and 'Restore Defaults' are visible at the bottom.

Using the SWC to assist with LEED v4



3. In the cost module, select your project type and site suitability.
4. Select the cost region.



The screenshot displays the EPA National Stormwater Calculator interface. The header features the EPA logo and the title "National Stormwater Calculator". A vertical sidebar on the left contains icons for various project types: a location pin, a flower, a water drop, a mountain, a cloud with rain, a circular arrow (highlighted with a green circle and arrow), a tree, a power plug, a money bag (highlighted with a green circle and arrow), and a bar chart. The main content area is titled "Project Cost" and includes a "Directions" button with a right arrow. Below this, the "Choose a Project Type" section has two radio buttons: "Re-Development" (selected) and "New Development". The "Choose your Site Suitability" section has three radio buttons: "Poor", "Moderate" (selected), and "Excellent". The "Choose your Cost Region" section includes a "Cost Region:" dropdown menu showing "Detroit(227 miles)" and a "Regional Multiplier:" input field with the value "1.04". The background of the interface shows an aerial view of a city street, with labels for "Springfield Pike" and "Wyoming Branch Public Library".

Using the SWC to assist with LEED v4



14. You will see a message that the inputs have changed and the results need to be refreshed, click the X and proceed.

15. Click “Refresh Results”

16. Many options from here:

- Save (top right of the page) the file by emailing results:
- Print results to pdf
- View different reports

Please enter your email address

Email Address

Send SWC XML File

EPA National Stormwater Calculator

Results

Directions

Options:

Years to Analyze: 30

Event Threshold: 0.1

☐ 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 Duration

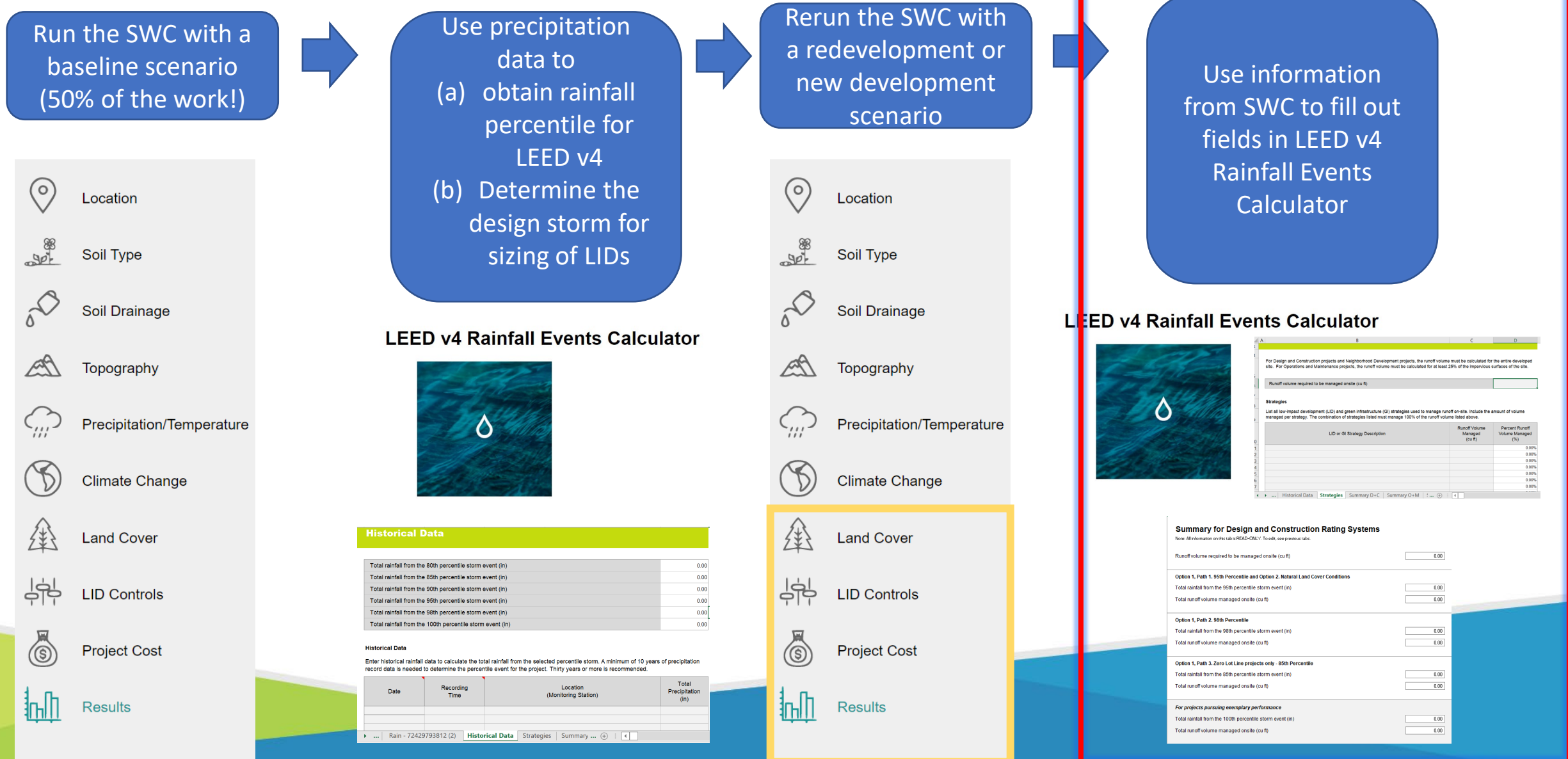
Statistic

- Average Annual Rainfall (inches)
- Average Annual Runoff (inches)
- Days per Year with Rainfall
- Days per Year with Runoff
- Percent of Wet Days Retained
- Smallest Rainfall w/ Runoff (inches)
- Largest Rainfall w/o Runoff (inches)
- Max Rainfall Retained (inches)



Using the SWC to assist with LEED v4

Summary



Using the SWC to assist with LEED v4

Getting the inputs to calculate percent runoff volume managed

- As you adjust the LID controls in the SWC and refresh your results, you can compare to your baseline scenario.
- Look for the value, “Average Annual Runoff (inches)”
- Some conversions needed to input into LEED v4 rainfall events calculator



Using the SWC to assist with LEED v4

Important information

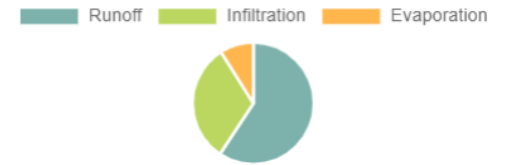
- SWC does not calculate runoff reductions attributable to each individual LID control.
- Find a mix of LID controls that will approach LEED v4 specifications by toggling LID controls and comparing average annual runoff from a non-developed baseline

Summary Results

Current Scenario
Annual Rainfall: 39.67 in.

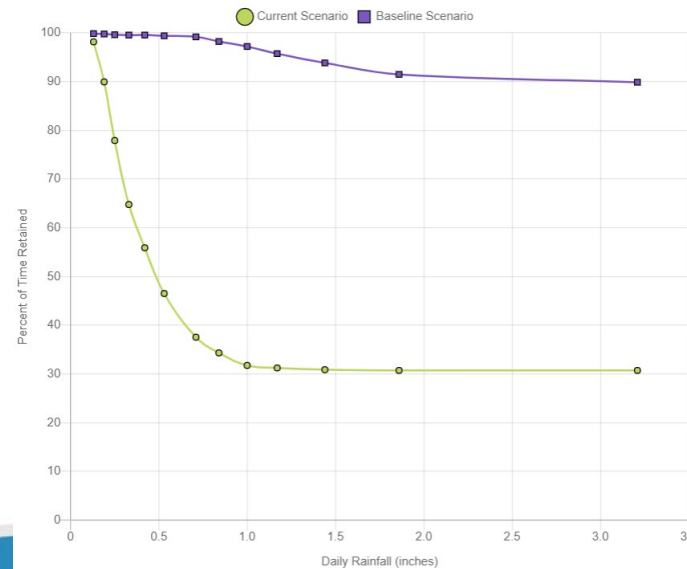


Baseline Scenario
Annual Rainfall: 39.67 in.

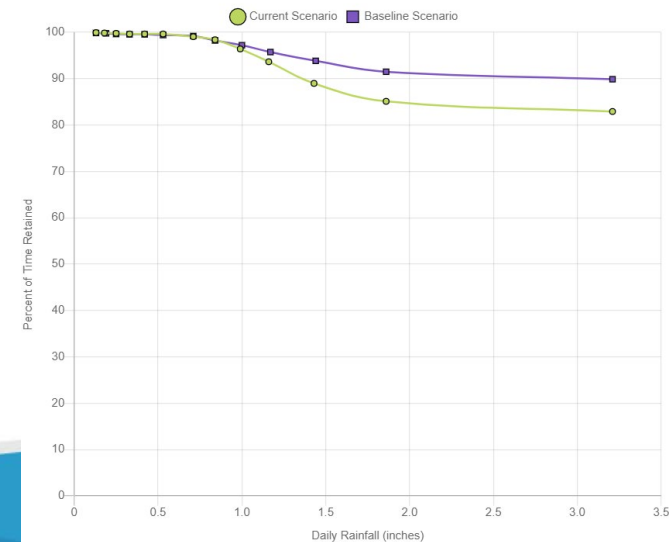


Statistic	Current Scenario	Baseline Scenario
Average Annual Rainfall (inches)	39.67	39.67
Average Annual Runoff (inches)	16.31	23.65
Days per Year with Rainfall	72.06	72.06
Days per Year with Runoff	34.58	50.34
Percent of Wet Days Retained	52.01	30.14
Smallest Rainfall w/ Runoff (inches)	0.11	0.11

Rainfall Retention Frequency



Rainfall Retention Frequency



Summary

- EPA's National Stormwater Calculator (SWC) and LEED v4 D+C
 - SWC is a valuable tool that can be used for obtaining precipitation data to calculate percentile rain events for LEED v4 rain management credits
 - Can help to understand how combinations of LID controls can influence runoff
 - Can help to screen for estimated costs of LID controls can be used to help determine the inputs for the LEED v4 Rainfall Events calculator
- SWC can help to determine how future climate scenarios may affect runoff given development and LID controls
- SWC provides
 - Educational information material and links for land cover, LID controls, and more.
 - sizing information for LID controls based on the "*size for design storm*" feature

Questions?

- If you require technical support in using EPA's National Stormwater calculator you can email SWC@epa.gov

