

BEYOND

SMART CITIES

SUSTAINABLE SITES - GREEN BUILDING TECHNOLOGY

TRAINING PROGRAM

FOR GREEN BUILDING AND SUSTAINABILITY SPECIALISTS

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GREEN BUILDING SPECIALIST CURRICULUM

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RAINWATER MANAGEMENT - CREDIT

FOR GREEN BUILDING AND SUSTAINABILITY SPECIALIST

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LEARNING OBJECTIVES

Intent of Rainwater Management - Credit

Behind the intent

Step by Step Guidance

Requirements

Required Documentation

Connection to Ongoing Performance

Terms and Definitions



BEHIND THE INTENT

Conventional site development disrupts natural hydrological systems and watersheds through impervious surfaces, soil compaction, loss of vegetation, and loss of natural drainage patterns. The cumulative effect of these changes is disruptive to the natural water balance and a loss of water resources. Typically, a conventional site's rainwater management technique is to address runoff as a byproduct to be disposed of by piping and conveying it as quickly as possible into centralized, large facilities at the base of drainage areas. However, such a strategy, although intended to prevent flooding and promote efficient drainage, can harm watersheds: it increases the volume, temperature, peak flow, and duration of runoff, ending streams reducing groundwater recharge and stream baseflow, and increasing the amount and types of pollutants discharged to surface waters.

The v.s credit addresses the management of both the quantity and quality of rainwater runoff. This is done through the required use of green infrastructure (GI) and low-impact development (LID) strategies, which improve upon the conventional approach by mimicking a site's natural hydrology and managing water as close to the source as possible. Rainwater is treated as a resource rather than a waste product. The approaches and techniques in this credit involve minimizing disturbed areas on the project site, limiting the amount of impervious cover on a site, and then infiltrating, filtering, storing and retaining, evaporating, or detaining rainwater runoff as close to its source. The approaches also focus on restoring or designing landscapes to function hydrologically more like the natural, undisturbed landscape of a given location.

This credit's process is iterative in nature, which means that the project will need to conceptualize, calculate, and refine the design until the requirements are achieved to ensure that both the intent of the credit and the project's goals are met. As such, the Step-by-Step Guidance is intended to be a guide only. The steps may need to be repeated or revisited throughout the design process. The rainwater management professional(s) may also have other steps that they typically follow to achieve the requirements.

✓Updates clarify requirements about the percentage of outdoor space and vegetated space to qualify as open space. Projects must provide outdoor space greater than or equal to 30% of the total site area. Of the total outdoor open space calculated, a minimum of 25% must be vegetated or have overhead vegetated canopy. Minimal changes to verbiage regarding vegetation have also been made to clarify types of vegetation that meet the requirements.

SS- CR(1 - 3) - DESIGN

INTENT

To reduce runoff volume and improve water quality by replicating the natural hydrology and water balance of the site, based on historical conditions and undeveloped ecosystems in the region to avoid contributing to flooding downstream in frontline communities.

POTENTIAL TECHNOLOGIES & STRATEGIES

- ✓Design the project site to maintain natural stormwater flows by promoting infiltration.
- ✓Specify vegetated roofs, pervious paving, and other measures to minimize impervious surfaces.
- ✓Reuse stormwater for non-potable uses such as landscape irrigation, toilet and urinal flushing and custodial uses.

RAINWATER MANAGEMENT

REQUIREMENTS

Option 1. Percentile of Rainfall Events (1-3 points except Healthcare, 1-2 points Healthcare) In a manner best replicating natural site hydrology processes, retain on site the runoff from the associated percentile of regional or local rainfall events. The percentile event volume must be retained (i.e. infiltrated, evapotranspirated, or collected and reused) using low-impact development (LID) and green infrastructure (GI) practices. GI and LID strategies can be either structural or non-structural. Points are awarded according to Table 1.

All Projects	Zero lot line Projects	Points	Points Healthcare
80 th Percentile	70 th Percentile	1	1
80 th Percentile	70 th Percentile	2	2
90 th Percentile	80 th Percentile	3	3

Option 2. Natural land cover conditions (3 points except Healthcare, 2 points Healthcare) Calculate the difference between the projected runoff volume under the proposed design conditions and the runoff volume under natural land cover conditions that existed prior to any disturbance. Retain (i.e. infiltrate, evapotranspirate, or collect and reuse) on site the increase in runoff volume using LID and GI practices.

IMPLEMENTATION

REQUIRED DOCUMENTATION

Documentation	Required	Score (0-1)	Notes
Documentation of site hydrology and water balance	1		
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STEP-BY-STEP GUIDANCE

Select the appropriate option and path (if applicable) for the project. First investigate data sources for natural land cover conditions, and choose Option 1 if information is not available.

- Option 1a for projects that elect to manage runoff on their project site such that there is no immediate surface discharge after development for all rainfall events of a given depth. The specific rainfall depth is based on a statistical analysis of rainfall records for that project location. If the project is zero lot line and meets the credit's required density, Path 3 can be selected. Otherwise, it is recommended that the rainfall values for both the 95th and 98th percentile events are calculated to determine whether Path 1 or Path 2 is more appropriate for the project.
- Option 2a for projects that elect to evaluate the site hydrologic response based on both natural, undisturbed (i.e. pre-settlement) conditions, and proposed developed conditions. The proposed rainwater management design will implement measures that replicate the natural, undisturbed hydrology for the full range of hydrologic events. This will require hydrologic analysis and comparison of the site under both natural and proposed conditions, using representative rainfall data such as an analysis of all rainfall events during a statistically representative period of time.

Option 1. Percentile of Rainfall Events

STEP 1. DETERMINE IF PROJECT QUALIFIES FOR ZERO LOT LINE PATH (PATH 3)

- If the project does not qualify for Path 3, move directly to Step 2.
- Determine if the project meets the definition of "zero lot line." If the project does not exactly meet this definition, but the project team feels that it should be considered zero lot line, provide justification for why it qualifies for this path.
- Calculate the average density of the area within a 1/4-mile (400-meter) radius of the project building. If the density, expressed in terms of floor-area ratio (FAR), is less than 1.5, the project is ineligible for the zero lot line path.

STEP-BY-STEP GUIDANCE +

STEP 2. OBTAIN RAINFALL DATA FOR PROJECT LOCATION

Obtain at least 10 years of historical rainfall data, as a minimum, representative of the project climate conditions based on proximity to site, elevation, region, etc. If the team admits less than 10 years' worth of information, explain why additional historical data are not available.

- The rainfall record should be substantially complete, meaning that it is not missing data for extensive periods of time.
- For projects in the U.S., long-term rainfall data for many locations are available through the National Climatic Data Center. Use this database or another source to identify the reference location closest to the project site when similar precipitation patterns are expected (see Further Explanation, Percentile of Rainfall Events).
- For project locations outside the U.S. or other locations not covered by the National Climatic Data Center, obtain information from local airports, universities, water treatment plants, or other facilities that maintain long-term precipitation records (see Further Explanation, Interviewer Tips).
- Data must include the location of the monitoring station, the recording time (usually daily 24-hour time periods), and the total precipitation depth during the time span.

STEP 3. DETERMINE VALUE FOR CHOSEN PERCENTILE OF RAINFALL EVENTS

Using the historical rainfall data collected, calculate the rainfall value for the 50th, 95th, or 98th percentile (in inches or millimeters). This is the precipitation amount that is either not 50 percent, or 95 percent, or 98 percent of all rainfall events for the period of record not exceed and will be represented by a rainfall depth (see Further Explanation, Percentile of Rainfall Events).

- Only calculate the 95th percentile if the project meets the criteria in Path 1.
- If the project does not meet the criteria in Path 2, choose which percentile either the 95th or the 98th is most appropriate for the project.



STEP 4. ANALYZE EXISTING SITE PERFORMANCE

Prior to calculating the runoff volume from the proposed site design, analyze how the current site is performing relative to the management of precipitation.

- A reduction in the volume of runoff can be achieved by protecting existing natural resources that serve to reduce the generation of runoff.
- The site analysis may reveal existing areas that, with no or minimal alterations, could contribute to the management of rainwater runoff.
- Examples of areas to preserve include healthy uncompact soils, riparian buffers, tree canopy, etc.
- These areas must be protected from disturbance during the construction period. If protected from disturbance during construction, these natural areas may be excluded from the project area and hence excluded from runoff volume management.

STEP 5. DESIGN THE SITE

Conceptually design the site, including rainwater management strategies, using the site performance analysis to inform the design. Include any preserved site features that could contribute to a reduction in, or the management of, runoff volume.

- Roughly locate, layout, and size rainwater management features in relation to the buildings, topography, soils, and other site features and the overall site program.
- It is recommended that a conceptual design be developed first, as projects frequently change and refine the design later when calculating runoff in order to manage the required volume.

STEP 6. CALCULATE RUNOFF VOLUME TO BE MANAGED ON SITE

Use the conceptual design to calculate the total volume of runoff (in cubic feet or cubic meters) corresponding to the chosen percentile of rainfall events for the site in its developed condition. This is the amount of precipitation that the project will need to manage entirely on site through green infrastructure and low-impact development techniques.

- Different methods can be used to calculate the runoff volume. The land use runoff coefficients for small rainfall depths, as developed by Dr. Robert Fierl in Table 5 of Small Storm Hydrology Method, are recommended.
- Runoff volume should be calculated by land use type and depends on the specific developed site conditions of the project, such as amount of paving, permeability of different surfaces, roof area, and vegetated areas (see Further Explanation, Calculations and Further Explanation, Examples).

STEP-BY-STEP GUIDANCE +

STEP 7. MANAGE RUNOFF VOLUME ON SITE

Incorporate green infrastructure and low-impact development strategies into the site design to manage, on site, 100% of the total volume of runoff calculated for the chosen percentile rainfall event and the project's developed condition (the proposed design).

- Work with the project's civil engineer, landscape architect, or other qualified professionals to choose and size the design strategies (see Further Explanation, Green Infrastructure and Low-Impact Development Strategies).
- The chosen GI and LD measures should completely manage the required runoff volume for the chosen rainfall percentile.
- Calculations must account for the site-specific soil characteristics, the soil infiltration rate, and the storage capacity of GI and LD measures.
- For projects following Path 1, green roofs and rainwater harvesting approaches are the most likely GI and LD strategies to help pay for the projects meet the credit requirements. Roofs can be either extensive or intensive systems. Maintenance will be needed to keep plants healthy and the structure in good condition. Extensive roofs are an excellent strategy for vegetated roofs. In some cases, zero lot lot projects can also use infiltration structures, porous pavement, and tree boxes.
- For projects that are part of a multifaceted complex, see Further Explanation, Project Type Variations.

Option 2. Natural Land Cover Conditions

STEP 1. OBTAIN INFORMATION ABOUT NATURAL CONDITIONS

Obtain information about how the site (or the site's immediate region) functioned prior to any alteration or human activity. A range of the natural conditions can be deduced through an analysis of land cover and general hydrologic function.

- Natural land cover conditions refer to the vegetation and soil conditions that existed in the area prior to development activities.
- Natural hydrology refers to the partitioning of rainfall into components of infiltration, evapotranspiration, and runoff in amounts and patterns that replicate the natural hydrology.
- Examples of alterations, development, and human activities include large-scale tree clearing and grading, industry, agriculture, mining, construction, municipal development, commercial development, and residential development.
- Natural vegetation maps, soil maps, or a description of typical land cover conditions in the project's region may be helpful to evaluate. Determination of the natural land cover conditions can also be based on the historical context of the site (e.g., forested, grassland) and an assessment of the soil conditions.
- For the purposes of this Option, an estimate of the natural conditions is acceptable.
- Sources of information include local governments and state environmental agencies, conservation or water resource organizations, historical societies or historic preservation groups, libraries, colleges and universities, private historical mapping companies, and (in the U.S.) EPA, Department of the Interior, U.S. Geological Survey, Oak Ridge National Laboratory (ORNL), National Center for Atmospheric Research, and Department of Agriculture.



STEP 8. ANALYZE AND REFINE PROPOSED SITE DESIGN

Refine the site design using the calculated runoff and proposed management strategies from the conceptual design. Determine if the proposed design is performing sufficiently enough to manage the required volume of runoff events using GI and LD strategies. Continue to tweak and refine the design to meet goals 1, 2, and 3 as many times as necessary in order to achieve the credit requirements and meet project goals.

- Rainwater management design is an iterative process that involves analyzing schematic designs, roughly calculating runoff volumes managed, and revising the layout and sizing of management strategies multiple times before finalizing the overall site design.
- See Further Explanation, Examples for an example of this process.

STEP-BY-STEP GUIDANCE +

STEP 2. CALCULATE NATURAL CONDITIONS

Evaluate the full range of hydrologic rainfall events over a 10-year time period. Alternatively, an "average" representative rainfall year may be developed (continuous modeling simulation is required).

- The goal of this step is to determine the pattern and distribution of natural conditions in order to understand how the site functioned and thus what amount of runoff needs to be managed on site.
- In other words, to understand hypothetically how the site has performed over a period of record.
- All variables needed to complete this step are estimated based on the historical land cover conditions. For example, runoff curve numbers for the site are estimated based on the historical vegetation cover and soil conditions.

STEP 3. CALCULATE RUNOFF VOLUME TO BE MANAGED ON SITE

Calculate the runoff volume under the developed (proposed design) conditions, and compare it to the runoff volume under the natural conditions. If there is an increase in runoff volume between natural and developed conditions over the time period evaluated, manage the difference on site.

- In rare cases, the natural land cover conditions would manage less than the 95th percentile. In this case, the project is only required to manage the runoff volume that the natural land cover conditions would manage.

STEP 4. MANAGE RUNOFF VOLUME ON SITE

Similar to Option 1, incorporate green infrastructure and low-impact development strategies into the site design to manage, on site, the required volume of runoff.

- Portions of the site that are natural or close to natural may mitigate rainwater runoff and supplement other best management practices to achieve the goal of natural hydrologic performance.
- Work with the project's civil engineer, landscape architect, or other qualified professionals to choose and size the design strategies (see Further Explanation, Green Infrastructure and Low-Impact Development Strategies).
- Confirm that the chosen GI and LD measures will completely manage the required runoff volume.
- For projects that are part of a multifaceted complex, see Further Explanation, Project Type Variations.



STEP 5. DESIGN THE SITE

Conceptually design the site, including rainwater management strategies, using the site performance analysis to inform the design. Include any preserved site features that could contribute to a reduction in, or the management of, runoff volume.

- Roughly locate, layout, and size rainwater management features in relation to the buildings, topography, soils, and other site features and the overall site program.
- It is recommended that a conceptual design be developed first, as projects frequently change and refine the design later when calculating runoff in order to manage the required volume.

STEP 6. CALCULATE RUNOFF VOLUME TO BE MANAGED ON SITE

Use the conceptual design to calculate the total volume of runoff (in cubic feet or cubic meters) corresponding to the chosen percentile of rainfall events for the site in its developed condition. This is the amount of precipitation that the project will need to manage entirely on site through green infrastructure and low-impact development techniques.

- Different methods can be used to calculate the runoff volume. The land use runoff coefficients for small rainfall depths, as developed by Dr. Robert Fierl in Table 5 of Small Storm Hydrology Method, are recommended.
- Runoff volume should be calculated by land use type and depends on the specific developed site conditions of the project, such as amount of paving, permeability of different surfaces, roof area, and vegetated areas (see Further Explanation, Calculations and Further Explanation, Examples).

REQUIREMENTS

Option 1. Percentile of Rainfall Events (1-3 points except Healthcare, 1-2 points Healthcare)

In a manner best replicating *natural site hydrology* processes, retain on site the runoff from the associated percentile of regional or local rainfall events. The percentile event volume must be retained (i.e. infiltrated, evapotranspired, or collected and reused) using *low-impact development (LID)* and *green infrastructure (GI) practices*. GI and LID strategies can be either structural or non-structural. Points are awarded according to Table 1.

Table 1. Points for percentile of rainfall retained

All Projects	Zero lot line Projects	Points	Points Healthcare
80 th Percentile	70 th Percentile	1	1
85 th Percentile	75 th Percentile	2	2
90 th Percentile	80 th Percentile	3	-

OR

Option 2. Natural land cover conditions (3 points except Healthcare, 2 points Healthcare)

Calculate the difference between the projected runoff volume under the proposed design conditions and the runoff volume under natural land cover conditions that existed prior to any disturbance. Retain (i.e. infiltrate, evapotranspire, or collect and reuse) on site the increase in runoff volume using LID and GI practices.

CONNECTION TO ONGOING PERFORMANCE

LEED O+M WE credit Water Performance: LID and GI measures that harvest and reuse rainwater may help reduce potable water demand. Thus, these measures help ensure that projects will use less water throughout the building life cycle, which may help improve a project's water performance score. Tracking water consumption on a regular basis through metering supports effective water management and provides performance data to help verify that building systems are operating as designed.

LEED O+M SS credit Heat Island Reduction : Vegetated roofs installed for achievement of this credit will also qualify for the related, performance-based credit.

REQUIRED DOCUMENTATION

Documentation	All Projects	Option 1, Path 3	Option 2
Rainfall data	X		
Rainfall events calculator or calculations for the chosen percentile storm	X		
Runoff volume calculations	X		
Plans, details, or cross sections depicting site conditions and GI or LID strategies, highlighting topography, soil qualities, direction of water flow, and area of site that each facility addresses	X		
Narrative confirming measures qualifies GI or LID	X		
Calculations for volume of rainwater managed by GI or LID strategies	X		
Explanation for why 10 years of historic rainfall data are not available for the project location (if applicable)	X		
Description of conditions that make the project zero lot line		X	
Floor area ratio		X	
Documents illustrating natural land cover conditions			X
Multitenant complex projects only summary of centralized approach and associated distributed techniques	X		

EXEMPLARY PERFORMANCE

Option 1. Percentile of rainfall events

All Projects	Zero lot line Projects
98 th Percentile	95 th Percentile

Option 2. Natural land cover conditions

Retain on site an additional 20% in runoff volume to address future precipitation rates (1.2 * [difference in annual runoff volume from the natural landcover to the post-developed condition]) using LID and GI practices.

REFERENCED STANDARDS

✓EPA's LID website: <https://www.epa.gov/nps/lid>

✓Georgetown Climate Centre's Green Infrastructure Toolkit: <http://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/green-infrastructure-strategies-and-techniques.html>

TERMS AND DEFINITIONS

Retain (rainwater) on site to capture and reserve a specified volume of rainfall to mimic natural hydrologic function. Retention is a function of rainwater management that includes strategies involving evapotranspiration, infiltration, and capture and reuse.

Green infrastructure is a soil- and vegetation-based approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure management approaches and technologies infiltrate, evapotranspire, capture, and reuse stormwater to maintain or restore natural hydrologies. (Adapted from the U.S. Environmental Protection Agency)

Manage (rainwater) on site to capture and retain a specified volume of rainfall to mimic natural hydrologic function. Examples of rainwater management include strategies that involve evapotranspiration, infiltration, and capture and reuse.


