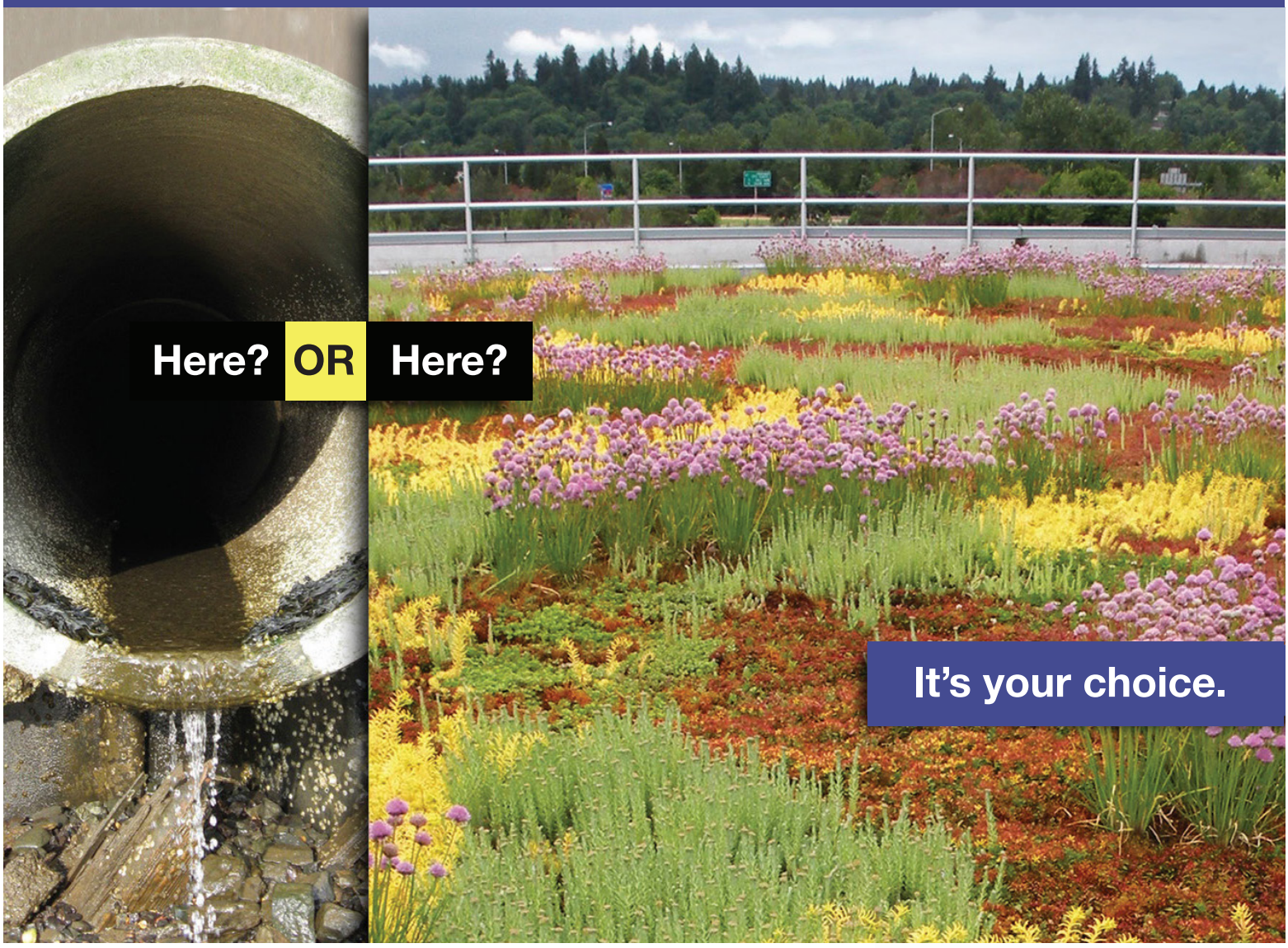
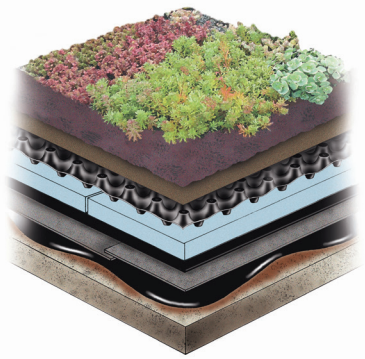
The Garden Roof® Assembly

HYDROTECH®

Beauty Meets Performance™ BMP



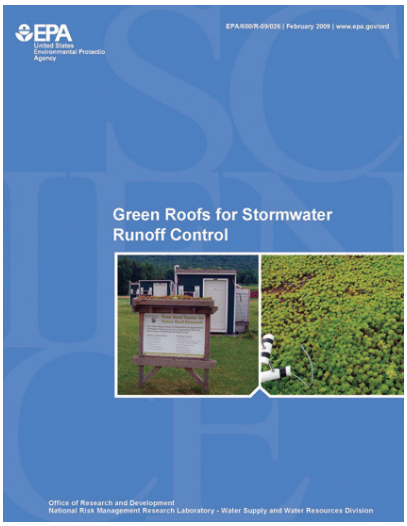
Where would you rather put your stormwater?



Stormwater Management and Vegetated Roofs

When stormwater has no other place to go:

Stormwater and its effects on our infrastructure, environment and budgets continue to be an ongoing issue in the United States. As more natural open land is paved over for roads, buildings and parking lots, there is less area in which rainwater can infiltrate into the ground or traverse safely and effectively to waterways. This increasing level of impervious cover concentrates more rainwater into smaller areas on its way to being stored in pipes, ponds and reservoirs. **In many cities, it is simply not possible to put more water into increasingly fragile and brittle sewer infrastructure systems.**



This is not a new problem; the first major federal laws were enacted in the 1940s to address this issue. In the 1970s those early laws were modified into the Clean Water Act and administered by the then-new Environmental Protection Agency (EPA).

Since that time, the EPA has developed programs and research to address this issue. A number of studies have been commissioned during the past several decades to address stormwater management techniques. Vegetated roofs are a tested and EPA-endorsed and approved best management practice (BMP) for inclusion in a project's stormwater management plan. Vegetated roofs are now becoming a standard BMP in many low impact design/development (LID) projects.

How do vegetated roofs really work?

Properly designed vegetated roof assemblies have the ability to capture all or portions of a typical rainfall event. This rainwater is stored in several areas of the assembly - within the open pore spaces in the growing media and within the drainage/water retention system that underlays the media.

This total assembly handles this stormwater in several ways:

- It ***retains*** a portion of the stormwater until the assembly is completely saturated.
- It ***delays*** the release of excess stormwater from the building roof and into a site stormwater system.
- It ***reduces*** the volume of stormwater runoff and releases some of this rainwater into the atmosphere by evaporation and evapotranspiration through the plantings.
- It ***cleans*** the rainfall of particulate matter and chemicals within acid rain trough the filtering actions of the plant materials, growing media, system filter and drainage layers.

In these ways, vegetated roofs mimic natural hydrology systems like wetlands and similar structures. The complete assembly is simultaneously an engineered and biological system design to manage stormwater.

Vegetated Roofs Mimic Natural Hydrology

Vegetated roof media functions very much like aggregate materials that are used in permeable pavements; the water is stored in the spaces between the coarse and fine aggregates and the organic particles. In addition, water is stored in the cups of the Gardendrain panels. While both permeable pavement systems and vegetated roofs store water, only vegetated roofs have vegetation to help enhance the hydrology of the stormwater BMP.

The media, plants and Gardendrain act very much like a sponge in their function.

Hydrotech's Approach to Stormwater Management

A dry sponge has great potential for absorbing water in the internal pore structure. As water is slowly added, the sponge begins to fill but will not release that water. As more water is added the sponge continues to absorb water until it reaches full capacity (saturation). At that point, water will flow out as more water is added. When no more water is added and no excess water drips out, the soaking wet sponge reaches a state of equilibrium. In soil sciences, this is considered the field capacity of the media and includes a mix of water and air among the matrix of coarse and fine aggregates that make up the media.

A portion of the water is retained by the media and some leaves the media via evaporation and by gravity. In addition, the normal evaporation of moisture from the roof is accelerated by the plant materials as plants release moisture into the air through normal evapotranspiration activities as part of photosynthesis.

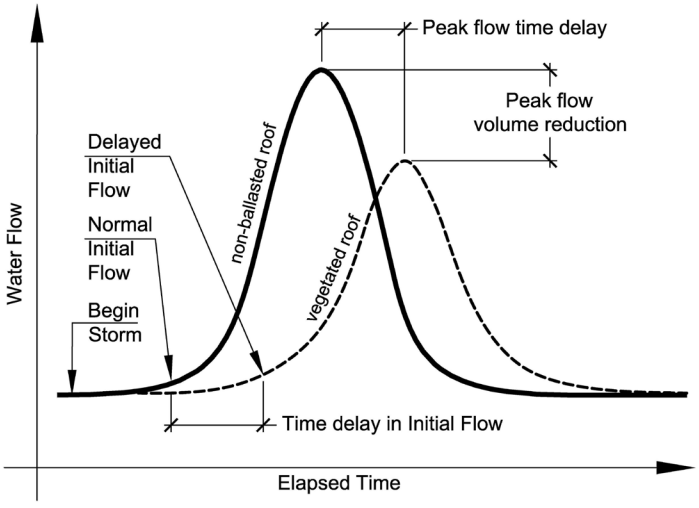
Storm Hydrology

Hydrotech's Garden Roofs make ideal stormwater BMPs because of how well they perform during storm events. In a standard, non-ballasted roof, rain water begins to run off the roof very soon after it lands. In a Garden Roof, there is a delay in the initial run off.

This delay in the initial flow is a very important component in stormwater management. It prevents the water from immediately entering and overwhelming the downstream drainage systems.

The evaporation and evapotranspiration functions in a Garden Roof help to reduce the total volume of water that could enter the stormwater system.

This dual function - **to delay and to reduce** - can be mathematically predicted and illustrated in hydrographs like the ones below:



Civil engineers use hydrographs to predict the performance of stormwater BMPs. Comparing hydrographs from non-vegetated and vegetated roofs can determine the delay in the peak flow and the reduction of the peak volume.

Hydrotech Hydrology Tool

There are many claims in the marketplace regarding the performance of vegetated roofs for stormwater management. Many of these claims have little or no quantified data as backup. In response to these claims, Hydrotech has developed a specialized service for its customers called the **Hydrotech Hydrology Tool - HHT.**

The HHT not a simple calculator that uses simple generalized information to arrive at a generic set of values with no meaning. The HHT is a software tool that predicts how a specific Garden Roof Assembly will perform from a stormwater management perspective. The HHT was developed by Hydrotech and stormwater engineers and provides detail information and data that can be used by the project's design team for:

- The development of stormwater BMPs by incorporating tested component performance data
- Proving compliance with project specific LEED requirements
- Proving Garden Roof Assembly performance by accounting for local climatic and assembly variations
- Balancing the stomwater needs of a site among the other available BMPs like cisterns, bioswales and underground storage

Unlike simple on-line calculators, the HHT uses all of the Garden Roof components in the determination of the amount of stormwater the assembly can store. In addition, the HHT can show how the assembly will perform during a typical rain event. The HHT uses a wide range of variables in its calculations including:

- Site specific climatic data
- Project location historical rainfall data
- Storm event desired for the modeling
- Size of the overall roof
- Size of the vegetated portion of the roof
- LiteTop media performance test data
- LiteTop media depth
- Gardendrain component performance test data
- Plant materials incorporated into the Garden Roof

With this information, the **HHT can generate water storage and storm data** to conduct "what-if" scenarios for consideration by the design team in developing stormwater BMP models and options.

The HHT data has proven to be valuable in assisting design teams, project owners and municipal agenicies in developing comprehensive stormwater management plans for their projects.

Hydrotech Hydrology Tool Benefits

How will the HHT benefit the design team?

The data generated in the HHT analysis can:

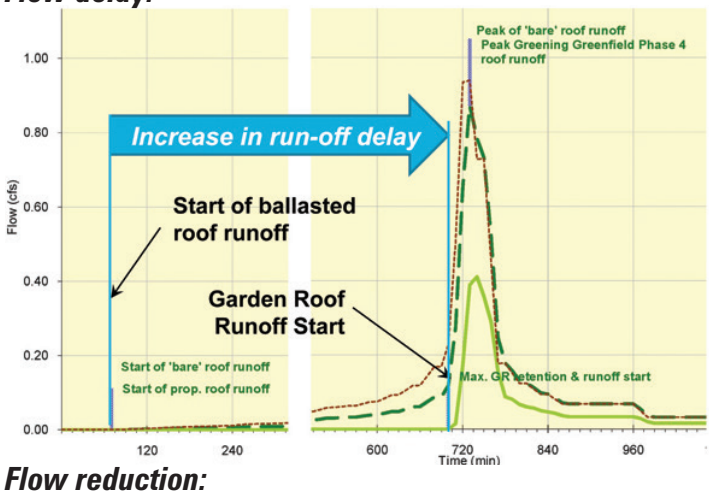
- Help the design team address and meet local and project specific stormwater requirements
- Help with BMP and LID requirements
- Prove compliance with project specific LEED requirements
- Prove Hydrotech's Garden Roof® Assembly performance by accounting for local climatic and assembly variations
- Determine the "real life" retention/detention abilities of the Garden Roof Assembly
- Reduce or eliminate dollars spent on retention/detention ponds, cisterns and bio-swales

How can the HHT meet project specific requirements?

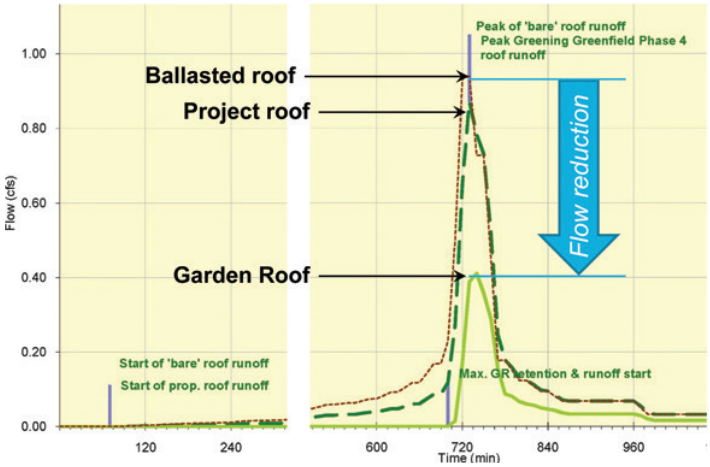
By using established means and methods to meet project specific requirements, the 18+ page HHT analysis can provide the following information:

- **Potential Water Storage Capabilities**
  - — Within the local LiteTop media specifc to your project
  - — Within the Gardendrain components
  - — Options to maximize storage capacities by evaluating various Garden Roof assembly configurations
- **24 hour storm event evaluations (TR55)**
  - — Provides a composite Curve Number for both vegetated and non-vegetated roof surfaces
  - — Predicts retention and runoff volumes
  - — Provides anticipated lag time (the time at which water begins to flow off the roof, compared to a typical "bare" roof)
- **Short Duration storm events (Rational Method)**
  - — Provides a composite C-factor (runoff coefficient) to help size drains/pipes, detention/retention ponds, cisterns, etc.
  - — Predicts peak flows (how fast water is leaving the roof) in cubic feet per second
- **Long term storm evaluations**
  - — Predicts long term and short term retention, run-off and evaporation values
  - — Effectively compares a Garden Roof to a "bare" roof
- **Help to establish LEED Compliance**
  - — LEED Sustainable Sites (SS) credits

Flow delay:



Flow reduction:



For your project specific HHT, contact Hydrotech's Garden Roof Department at 800-877-6125 or gardenroof@hydrotechusa.com

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