

Blue Roof technologies - an old design with a new twist?



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**Strategic
Initiatives &
Alliances**

**Tremco Roofing and Building
Maintenance
Beachwood, OH**

Learning Objectives

- Definitions of “Blue Roof”
 - Desired outcome of design
- In situ issues
 - Health & Safety of buildings’ population and community
 - Conflicts with International Building Code
 - Structural stress/failure modes
 - Disease
 - Leaks & Liability
 - Installation & maintenance
- Pilot Programs (NYC)
- Codified Design (National Institute of Health, NIH)

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- In the roofing industry, a common saying is “*Out of Sight, Out of Mind*”. This reflects the generally observed neglect that prevails on most low slope, commercial, institutional and public owners’ roofing systems.
- With the needs of balancing Combined Sewer Overflows from the surfaces of structures to the Building Code mandated requirements of constructing and enforcing laws related to the Health and Safety of the building’s occupants and processes, the concept of “Blue Roofs” raises many issues that must be analyzed and addressed.
- This presentation will explore the options for policy decisions related to harvesting rainwater from roof surfaces and the challenges to municipalities, the design community, facilities management & legal groups if this concept is considered and employed.

The Old . . . *Double Pour*

- In built-up roofing, two separate applications of a top coating of bitumen and surfacing; esp. used on level roofs designed to hold water.

McGraw-Hill Dictionary of Architecture and Construction. Copyright © 2003 by McGraw-Hill Companies, Inc.

- Additional weight of the second bitumen and aggregate surfacing layer, special consideration should be given to the structural design of the roof deck and potential for bitumen migration or slippage
- Commonly used Coal Tar Pitch bitumen-now declared a **carcinogen!**

The New . . . Definitions

- **A blue roof slows or stores storm-water runoff but it accomplishes this by using various kinds of flow controls that regulate, block, or store water.**
 - Water can be *temporarily* stored or *harvested* for non-potable uses on-site, and used or reused for landscape or garden irrigation
 - Or . . .direct groundwater recharge via methods like downspout disconnections and infiltration systems
 - Or discharged directly into sewer systems at a reduced flow rate or after peak flow from storms.

Other definitions

The Value of Green Infrastructure for Urban Climate Adaptation

Water can be temporarily stored or harvested for non-potable uses on-site, and used or reused for landscape or garden irrigation, direct groundwater recharge via methods like downspout disconnections and infiltration systems, or discharged directly into sewer systems at a reduced flow rate or after peak flow from storms. The captured water can also be sprayed directly on the roof to increase the evaporative cooling effect for the building.

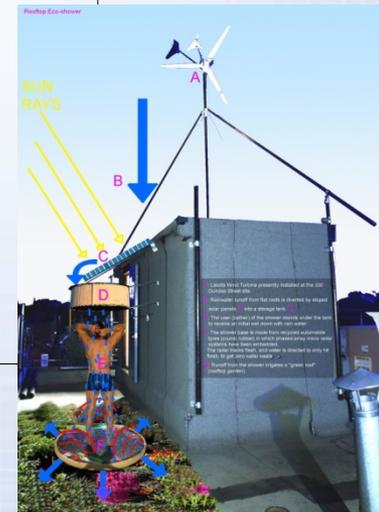
(Presenter's query . . . HOW and metrics????)

The goal is to mimic preconstruction runoff rates at the site primarily to reduce overloads on inadequate or aging local storm-water infrastructure and prevent localized flooding, potential flood damage, and CSOs.

Blue roofs can also help to attain Low Impact Development (LID) standards, with infiltration systems earning 1 LEED credit and mechanisms to store water for reuse earning 3-4 LEED credits under the "Water Efficiency" guidelines.⁴¹
Authored by The Center for Clean Air Policy

Other Definitions (cont'd)

- **Recreational blue roofs integrate rooftop waterplay areas that can also be used to irrigate a green roof**
 - or to cool the roof of a building on hot days, in order to eliminate or at least reduce the HVAC load placed on mechanical refrigeration equipment.
 - Some recreational blue roof designs include such features as an ecoshower, waterplay sculpture, misting spray, etc.



The Code is the Law!

- **International Building Code**

- **1503.4 Roof drainage.**

- “Design and installation of roof drainage systems shall comply with Section 1503 of this code and Sections 1106 and 1108, as applicable, of and the *International Plumbing Code*.”

- Rainfall rates, in inches per hour, are based on a storm of 1-hour duration and a 100-year return period. {Cincinnati 2.9 in/hr}

- *Hypothetically for a medium sized roof of 20,000 sq. ft., this is an impact of 301,600 pounds of additional load (150.8 tons)*

- Requirements for Roof Coverings states all membrane roof covering systems except coal-tar built-up roofs have a design slope minimum of one-fourth unit vertical in 12 units horizontal (2 percent slope) for drainage. Previous IBC editions have the same requirement.

There is no reference in the building codes to use the roof for harvested rain water or storage.

Roof Drainage

Not my problem ... Maybe

- “Many structural engineers are surprised to learn that the *International Building Code* (IBC, 2009) requires the roof structure to be engineered for standing water weight in the vicinity of the drains and scuppers regardless of roof slope.
- In addition, some low-slope roofs also require special attention for water weight and stiffness for safety against ponding failures or protection against accelerated roofing deterioration.
- With a mixture of overlapping design disciplines between the architect, plumbing consultant and structural engineer, proper roof drainage is often not fully addressed in building design and can lead to catastrophic collapse.”

John Lawson, SE, Assistant Professor

California Polytechnic State University San Luis Obispo, CA

International Plumbing Code

Section 1106

- Flow rates depend on pitch (slope) of roof
- Smaller roof drain systems become pressurized
 - Plumbing system “blows out”!
 - Extensive interior damage
 - Additional engineering analysis required in ponded areas around drains
- New requirements
 - Drains, drainpipe sizing, vertical & horizontal leaders

“Slope-To-Drain”

“Positive slope is also required in the new International Building Code, Such unanimity among manufacturers, contractors, designers, and, at long last building officials is rare in the roofing industry”

Richard Fricklas, Co-author, *Manual of Low-Slope Roofing Systems*, 4th Edition, pg. 26

“If several inches of water is going to be retained on the roof, it is essential that an engineer verify the building can safely handle the environmental load. Water weighs 5.2 pounds per inch per square foot, and that is not insignificant.”

(Fricklas’ email to presenter dated 11/16/2012)

Litigation, Losses & Cost

- As reported by Patterson & Mehta, roofing issues at one time or another have been
 - #1 source of litigation in construction
 - #1 source of litigation for architects
 - #1 source of insurance losses
 - #1 source of building maintenance cost

Patterson & Mehta are authors of **Roofing Design & Practice**, a text used in A&E curriculums

The calm (?) Before the Next storm



Added Weight {tons}



The Reason for Codes!



The roof of 315 S. Main, La Feast restaurant, collapsed Saturday morning shortly after 10:00 AM. This was apparently caused by water buildup on the roof that wasn't able to drain.



One Roof, Two Roofs, Green Roofs, Blue Roofs

“Contemporary designers continue to explore new ways that the forgotten wilderness of the roofscape can be utilized as usable space with a greater purpose.”

“The concept itself seems a bit half-baked. For an architect, the idea of having standing water on a roof is usually something we try to avoid rather than encourage. After enough time, water has a way of finding its way into just about everything.”

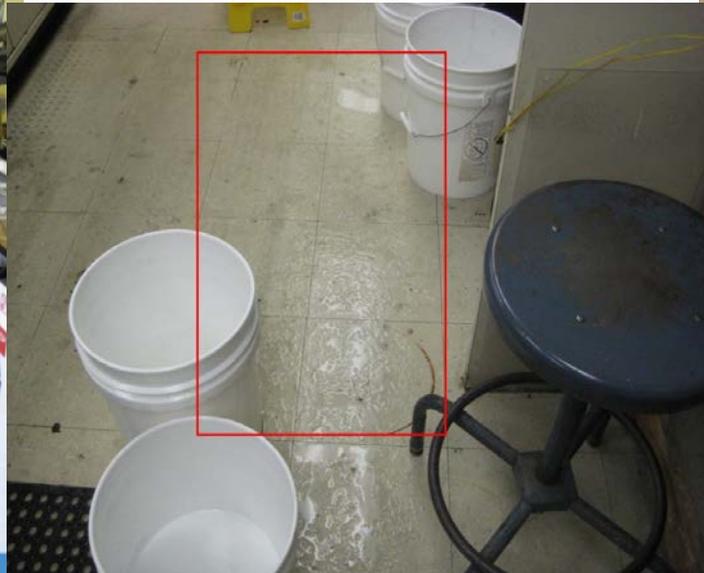
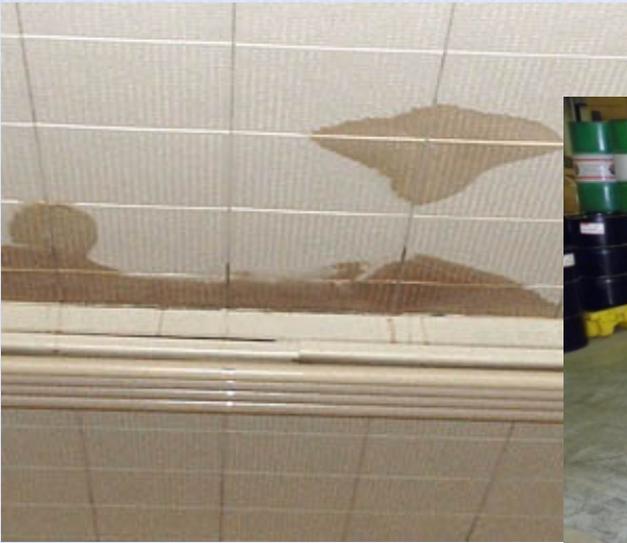
T. Cane from INTERCON Blog

October 4, 2010

Water is called the "universal solvent" because it dissolves more substances than any other liquid. U.S. Geological Survey



Leaks?



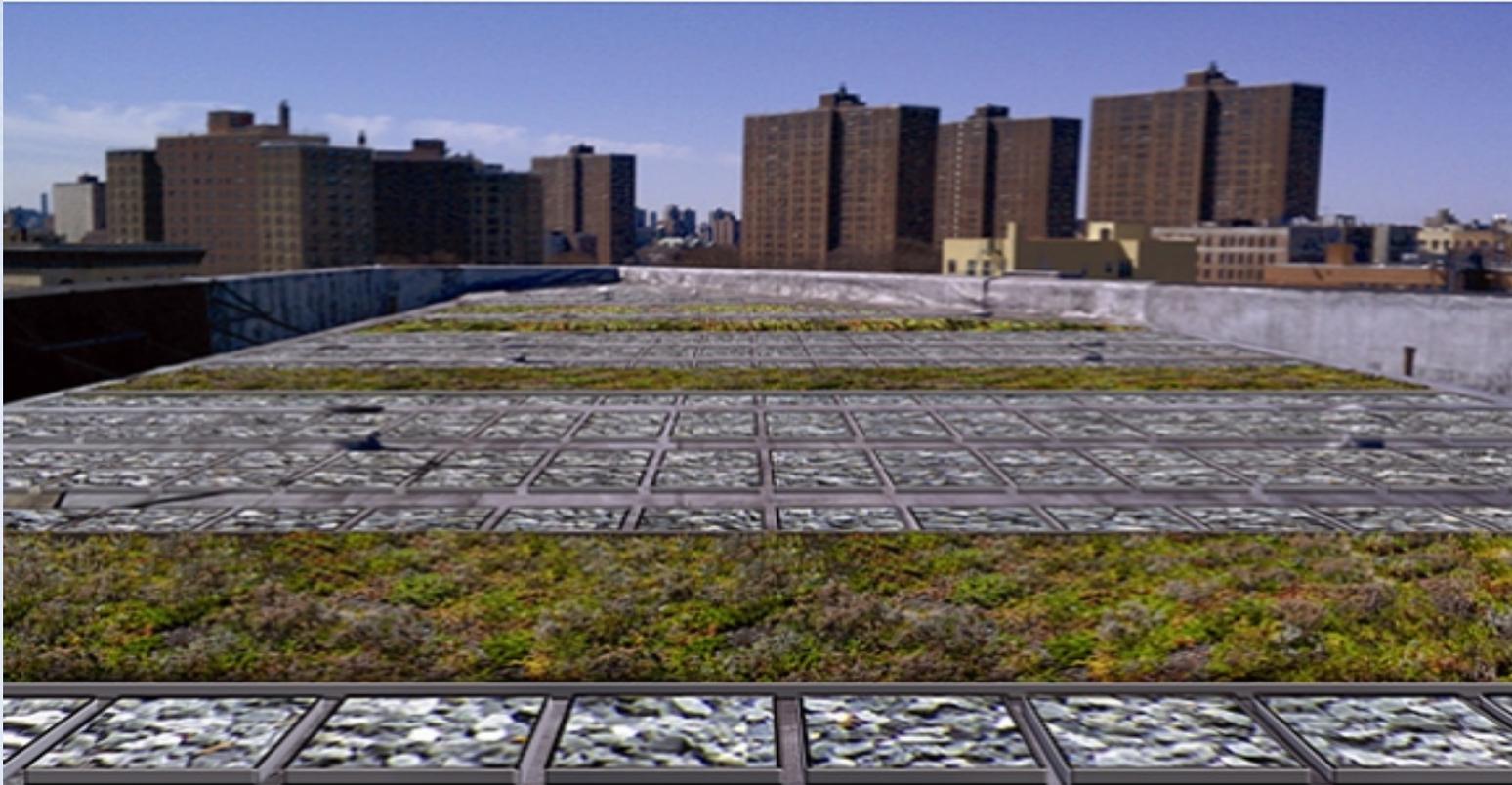
Law of Unintended Consequences

- **West Nile Virus**
 - The West Nile Virus (WNV) is a mosquito-borne virus that can cause a mild fever to encephalitis (swelling of the brain) or meningitis (swelling of the membranes surrounding the brain and spinal cord) in humans and other mammals.
- **Legionnaires' disease**
 - Infection normally occurs after inhaling an aerosol (fine airborne particles) containing *Legionella* bacteria. Such particles could originate from any infected water source.
- **Mold (U.S. EPA Mold & Moisture)**
 - Moisture control is the key to mold control. Molds need both food and water to survive; since molds can digest most things, water is the factor that limits mold growth. Molds will often grow in damp or wet areas indoors. Common sites for indoor mold growth include bathroom tile, basement walls, areas around windows where moisture condenses, and near leaky water fountains or sinks.
 - Common sources or causes of water or moisture problems include roof leaks, deferred maintenance, condensation associated with high humidity or cold spots in the building, localized flooding due to plumbing failures or heavy rains, slow leaks in plumbing fixtures, and malfunction or poor design of humidification systems. Uncontrolled humidity can also be a source of moisture leading to mold growth, particularly in hot, humid climates.

Manufacturer's Warranties?

- **Major Single Ply Roofing Manufacturer**
 - Not included within the scope of the Roofing System Warranty
 - Drainage Requirement -Keep the roof surface clean at drain areas to avoid clogging. Check that ponding water is drained from the roof within 48 hours following rain.
- **Major Built-Up Roofing Manufacturer**
 - Guarantee does not obligate manufacturer to repair or replace the Roofing System, or any part of the Roofing System, for leaks or appearance issues resulting, in whole or in part, from one or more of the following: (e) failure of the Building substrate (mechanical, structural, or otherwise and whether resulting from Building movement, design defects or other causes) or **improper drainage**;
- **Major Modified Bitumen Roofing Manufacturer(s)**
 - **EXCLUSIONS FROM COVERAGE**
 - Conditions that prevent positive drainage or result from ponding water.
 - Lack of positive, proper, or adequate drainage resulting in ponding water on the roof.

The Big Apple's Plans



The Osborne Association project (with design partner Hazen and Sawyer) will feature an alternating blue roof and green roof system on its building in the Bronx. This project will manage over 240,000 gallons of stormwater per year and will reduce CSOs to the East River.

Blue roof installation at a DEP Pilot Project at the Bronx River Houses.



Pilot Programs

- The NYC DEP (Department of Environmental Protection) is testing two alternatives to conventional rooftop surfaces side by side- Blue Roofs and Green Roofs, on the roof of PS 118 in Queens.
- Blue roofs are non-vegetated source controls that detain stormwater.
- Weirs (a small overflow dam) at the roof drain inlets and along the roof can create temporary ponding and gradual release of stormwater. Blue roofs are less costly than green roofs. Coupled with light colored roofing material they can provide sustainability benefits through rooftop cooling.



Monitoring Site Summary NYC EPA	
Metric	Site Data
Impervious Area Managed (ft ²)	Green roof:3,500 Blue roof (check dams):3,500
DA:GI Footprint	1:1
# of Storms	22
Storm Depth (in)	0.19-6.63
Peak Intensity (in/hr)	0.24-3.60
Storm Duration (hrs)	0.5-60

If drains become inoperable,
 6.63" of storm water x 3,500 sq/ft
 x 5.2 lbs/in = 114,660 lbs or
 57.330 tons of water.
 (100 yr rainfall/hour 2.75"-3.0")
 [Hurricane Sandy 3.42" total/hr
 Total rainfall >7"]



Special Requirements in NYC

- Good Design Practices compliant w/ Code
 - Will ensure Optimal Performance
- Rooftop detention requires a secondary waterproofing membrane
- Water depth should not exceed 2"-4"
 - Storage not longer than 24 hours
- Unrestricted overflows
- Load Bearing Capacity (rainfall & snowpack) may require additional structural supports

Is Blue the new “Green?”

Blue Roofs Gaining Ground

“For most designers, contractors, and owners, holding standing water and on a roof is usually something to be avoided rather than encouraged. So, the concept of intentionally encouraging roof-top water retention is bound to give a lot of those same folks pause.

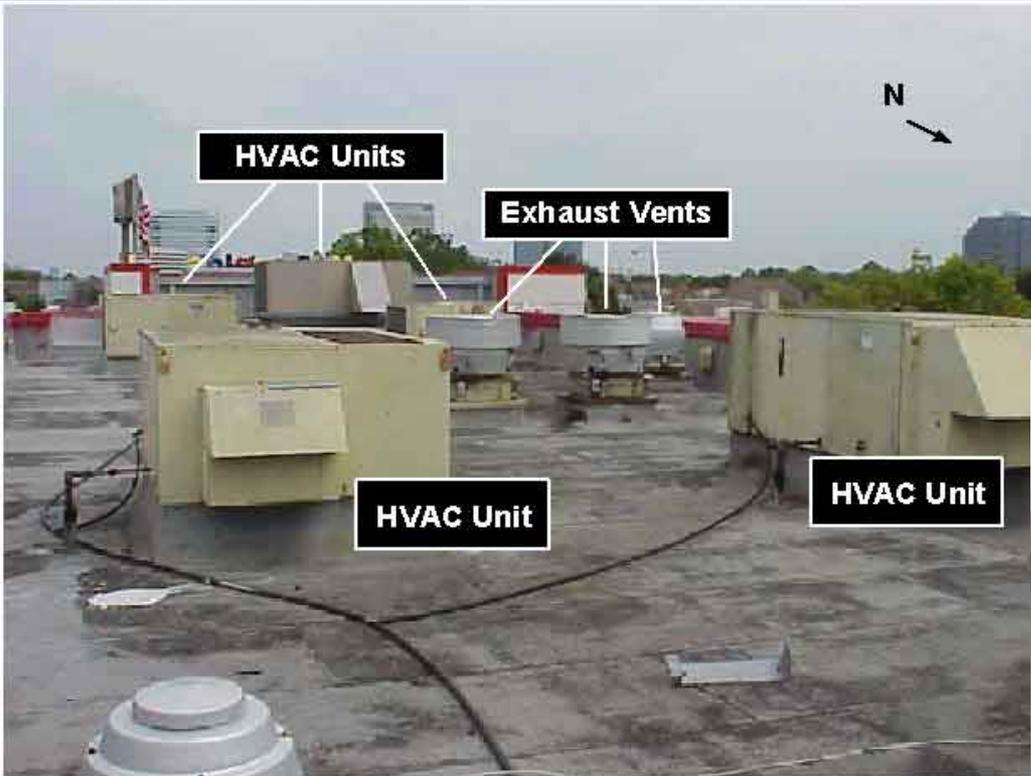
In a “new construction” setting, the design, installation – and all important assignment of liability **should these systems fail** – should be relatively easy to manage.

However, where these systems are proposed for retrofit of existing buildings to help meet new stormwater regulations (think, for example, redevelopment of the myriad of largely vacant shopping centers and office buildings smattering the landscape), designers, contractors, and owners would be advised to tread carefully and purposefully, lest they find themselves on the wrong end of this tidal wave.”

- **Amee S. Farrell, Esq. is a member of the Land Use, Zoning & Development group of Kaplin Stewart in Blue Bell, PA.**



Servicing Equipment Safely?





Stormwater Retention for a Modular Green Roof Using Energy Balance Data

January 2011

“Also in PlaNYC 2008 *detained* water for blue roofs was given equal weight as retained water. But green roofs are also detaining water and probably more effectively than blue roofs, given the area and volume of medium that the rainwater is percolating through before it reaches the drains. “

How Do We get to the well-intentioned "*End In Mind*"?

Section 8-7: Building Storm Drainage Systems (National Institute of Health, NIH Bethesda, MD)

- A separate drainage system shall be provided for stormwater from roof areas and to receive non-contaminated clear water atmospheric condensate.

The building storm drain shall extend outside the building and connect to the campus storm sewer system. Storm drainage systems shall be conventional atmospheric pressure gravity drainage type that does not rely on storage of water on the roof, special drain weirs, or non-conventional system components.

- **Any required storm water retention shall occur outside and downstream of the building in such a manner as to not allow water accumulation on the structure.**

Discussion

The Primary Purpose of a roof system is to protect the occupants & contents from the exterior environment.

- Questions?
- Clarification?

Thank You

Photographic Credits

- Ari Burling Photography (Brooklyn, NY)
- Hazen and Sawyer, P.C. (NYC)
 - Environmental Engineers & Scientists
- Paul Mitchell, RRC, RRO, CDT

Other Credits

- Columbia University
 - Stormwater Retention for a Modular
 - Green Roof Using Energy Balance data
- NASA/NOAA (Rainfall Statistics)
- NYC DEP
 - **NYC Green Infrastructure Plan:**
 - 2011 Preliminary Pilot Monitoring Results
 - UPDATE SUPPLEMENT

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