Green Roofs as an Urban Stormwater BMP for Water Quantity and Quality in the Subtropics and Mid-Atlantic

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Source: Mike Perry
Building Logics, Inc.

What is a Green Roof?

Source: Dr. Wanielista, UCF Stormwater Academy

Modern day green roofs: Extensive vs. Intensive

EXTENSIVE GREEN ROOFS
- shallow growing media (2-4" deep)
- low-growing drought, inundation and frost tolerant plants such as Sedum spp
- Low maintenance:
  - no irrigation
  - no fertilization
- 11-15 lbs/sq. ft.
- Typically: Temperate Climates

INTENSIVE GREEN ROOFS
- Soil depths---0.5 m to >1m
- Sustain small trees and large shrubs.
- Typical in Tropical Climates

Components of an Extensive Green Roof

- Vegetation: Sedums, Delosperma
- 2-4" growing media:
  - Expanded slate, Perlite, Sphagnum
- Filter Fabric
- Drainage Layer:
  - corrugated egg-carton like layer
  - or gravel in drainage pipes
- Membrane Protection Layer
- Waterproof membrane:
  - Hot applied, cold applied or textile

Source: Hydrotech

Above: Convention Center of the Church of Jesus Christ of the Latter Day Saints

Right: Intensive green roof atop a commercial building in Singapore. Wong et al 2005
Green Roofs in Florida--UCF

- UCF– Student Union
- 1600 sq ft.
- Native plants
- Perforated pipe drainage
- 6-10” growing media
- 50 lbs/ sq. ft.
- Cisterns/irrigation

March 2005

Green Roofs in Florida--UCF

- Drainage media over protection fabric

March 2005

Benefits—

- Reduction in Energy Consumption
- Aesthetics—increase property value
- Increases lifetime of the roof
  - Absorption of UV rays—prevents cracking
  - Reduces ponding and bellying of roof
- Water Quality—total load reduction
- Stormwater retention and detention

Challenges

Tri-Scale Study

1. Paired Roof Study
   Yorktowne Square Condominiums, VA
2. FL GR Monitoring
3. FL GR Platform Study
   Charles R. Perry Construction Yard
YSC--Installation

- Green roof installed in 2002 by Building Logics
- 1968 Retrofit
- Construction: Base sheet of tar,
  - 2-ply membrane, with copper foil root barrier
  - Filter cloth
  - 2.5” growing media
- 8,400 plugs— *Sedum album*, *S. sexangular* and *S. reflexum*
Paired Roof Study-Monitoring

- Two 500 gallon cisterns
- Two Global Water WL15 Level Loggers
- RainLoader 2.1
- WQ: 18± 5 storms
  - 12 samples/storm:± 5 samples x 2 roofs
  - Flow weighted
  - Parameters: NO3/NO2, TP, OP, metals (Cu, Fe, Cd, and TSS, TDS)

Challenges

- WQ sampling—light winter rains
- Freezing temperatures—pressure transducer and WQ sampling
- Distance from site—maintenance

Runoff from Green Roof vs. Conventional Roof July-Aug 2006

2. Monitoring an FL Green Roof--Charles R. Perry Construction Yard
Monitoring

- WQ:
  - Flow weighted
  - Parameters: NO3/NO2, TP, OP, metals (Cu, Fe, Cd), and TSS, TDS
  - Compare WQ with Rain
  - Harvested water from Energy Star Roof
  - Irrigation w/ gr harvested Water (reclaimed back up)

Sizing of Cisterns

- 2600 sq. ft. roof—will need ½" water 1 to 2x week
- expected drought of 3 weeks
- Total: max. 3" water applied to 2600 sq ft.
- Rule of thumb: 1" rain on 1000sq.ft. = ~600 gal.
- So for each inch of rain:
  2600 sq.ft. x 600 gal. / 1000 sq.ft. = 1560 gal.

1560 gallons x 3" = **4680 gallons of cistern**
Hastings Platform Study

Soil Column, container flats and platform study:
1. Container flats leachate study—NOW
   • Establishment 6 weeks w/ regular irrigation
   • April-leachate sampling during simulated rain events
2. Column studies—timing TBD
3. Platforms—May 1-07 to April 30-08, in Hastings, FL

P1: Succulent plants- Low ET, -
Similar in structure to N. Green Roof Plants

P2: Native Dune Habitat Plants:
Low, Med ET
Alkali conditions
Low heat
Low irrigation

P3: Perennial Peanut:
• Med ET
• Low growing
• Low maintenance
• Low irrigation

P4: Ornamental:
• High ET
• Necessary irrigation
• Maintenance req.

COST:
Seed vs. Cutting vs. Plugs

WATER EFFICIENCY:
Usage and ET

GROWTH:
Lateral growth rate

NATIVENESS & AESTHETICS:
Hardiness and Survivability in Climate vs. Perception of Beauty
Response Variables:
- Hydrology—Q, timing
- Moisture release curve
- WQ—(TN, TP, OP, TSS, TDS, NH4)
- Plant Growth:
  - Lateral growth rate
  - Chlorophyll, root depth, root rot
  - Height, width

Plant
- Group 1
- Group 2
- Group 3
- Group 4

Growing Media
- Media 1
- Media 2
- Media 3
- Media 4

X 3 replicates

Optimal Soil Depth/Irrigation Study
- Irrigation
- No Irrigation

Irrigation
- 0%
- 10%
- 20%
- 30%

Repeat for other 3 top Soil/Plant selections from Study 1
Note—I may use 4.5", 6" and 8", depending on results of previous experiment

Green Roof Platform Study—Climate Change
- Pick the 2 Plant/Soil that produced healthy plants on min. depth and irrigation
- Establish 18 green roof platforms based on these 2 depth/soil/plant combos

For example:

- S2/P2—8” depth and S3/P4—6” depth
- Control
  - Treatment 1
  - Treatment 2
- Drought
  - Rep 2
  - Rep 3
- NOx
  - Rep 1