New Ideas for Nebraska Green Roof Ecosystems

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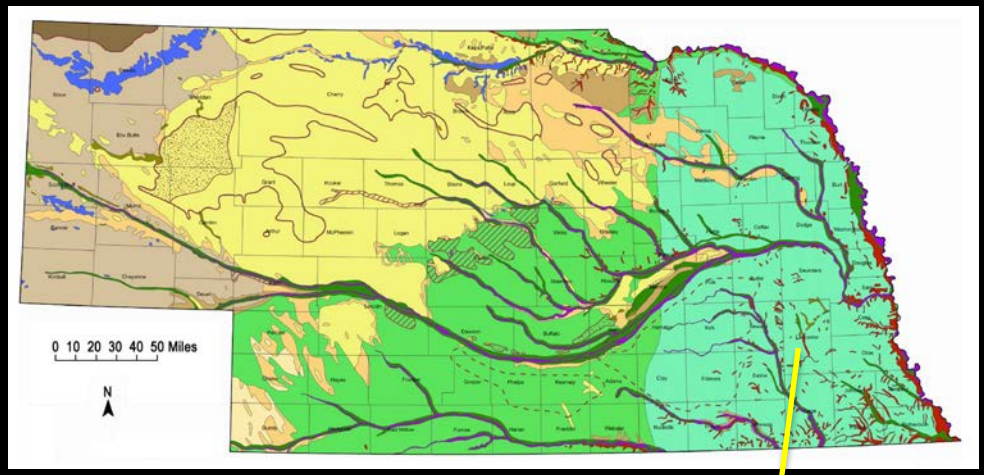
The Program in Landscape Architecture

A green roof should not be thought of as a flower bed in the sky, but an anthropogenic ecosystem of balanced, but reduced inputs and outputs.

- Use native plants from a stressed community template
  - What templates?
  - What plants?
  - How implemented?

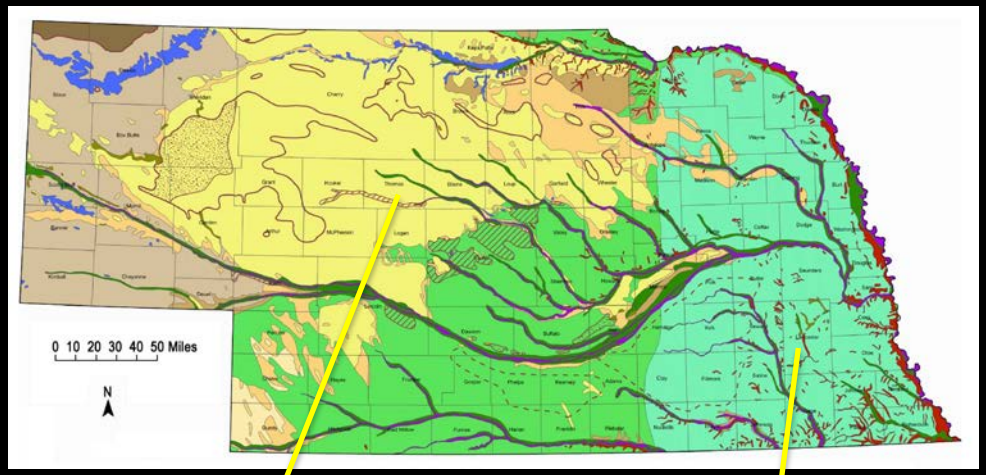
(Sutton et al. 2011. PRAIRIE-BASED GREEN ROOFS: LITERATURE, TEMPLATES, AND ANALOGS. Journal of Green Building Winter 2012, Vol. 7, No. 1, pp. 143-172)

- Glades with shallow soil



Lancaster Co., Ne
Sandstone Prairie

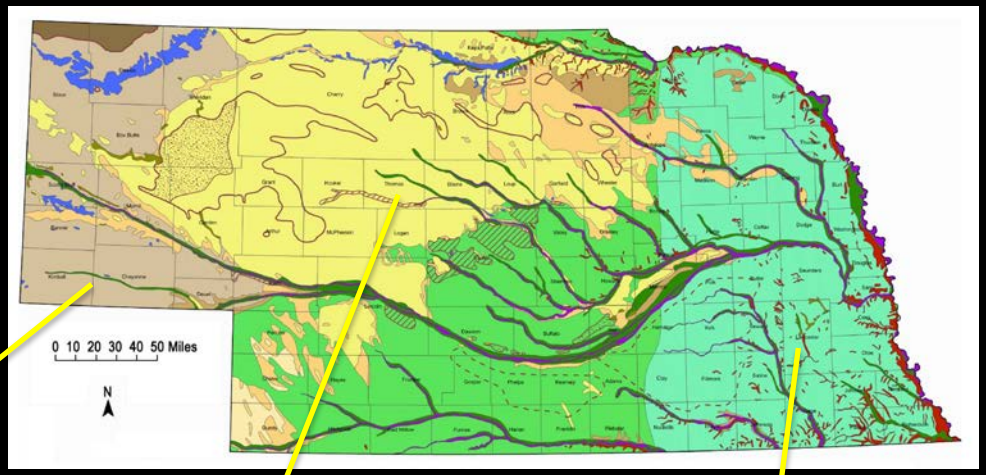
- Glades with shallow soil
- Sand prairies



Thomas Co., NE
Sandhills Blowout

Lancaster Co., Ne
Sandstone Prairie

- Glades with shallow soil
- Sand prairies
- Shortgrass prairies



Kimball Co., NE
Shortgrass Prairie

Thomas Co., NE
Sandhills Blowout

Lancaster Co., Ne
Sandstone Prairie

Glade Template

Functionally shallow soils due to:

Underlying Dakota Sandstone

Sandhills Prairie Template

Droughty & sandy soils

Wind abrasion

Shortgrass Prairie Template

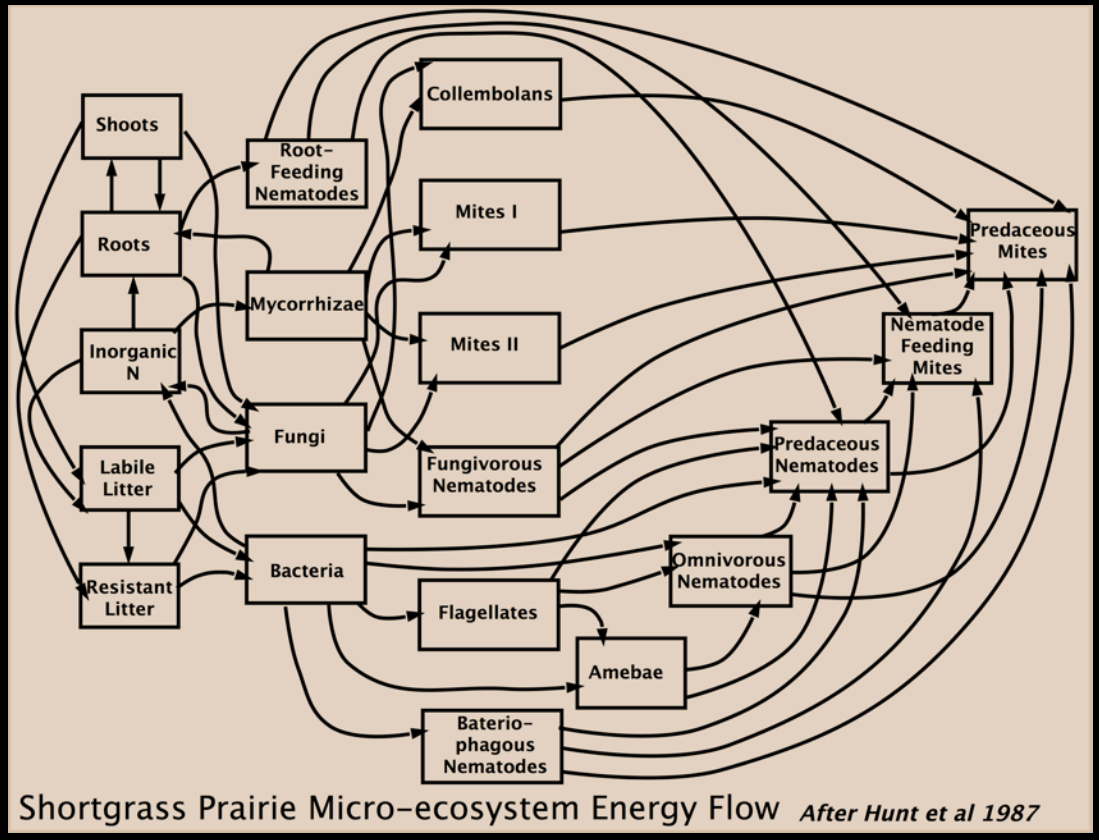
Functionally shallow soils due to:

√ Low rainfall < 400 mm (17 inches)

√ High PET >1300 mm (55 inches)

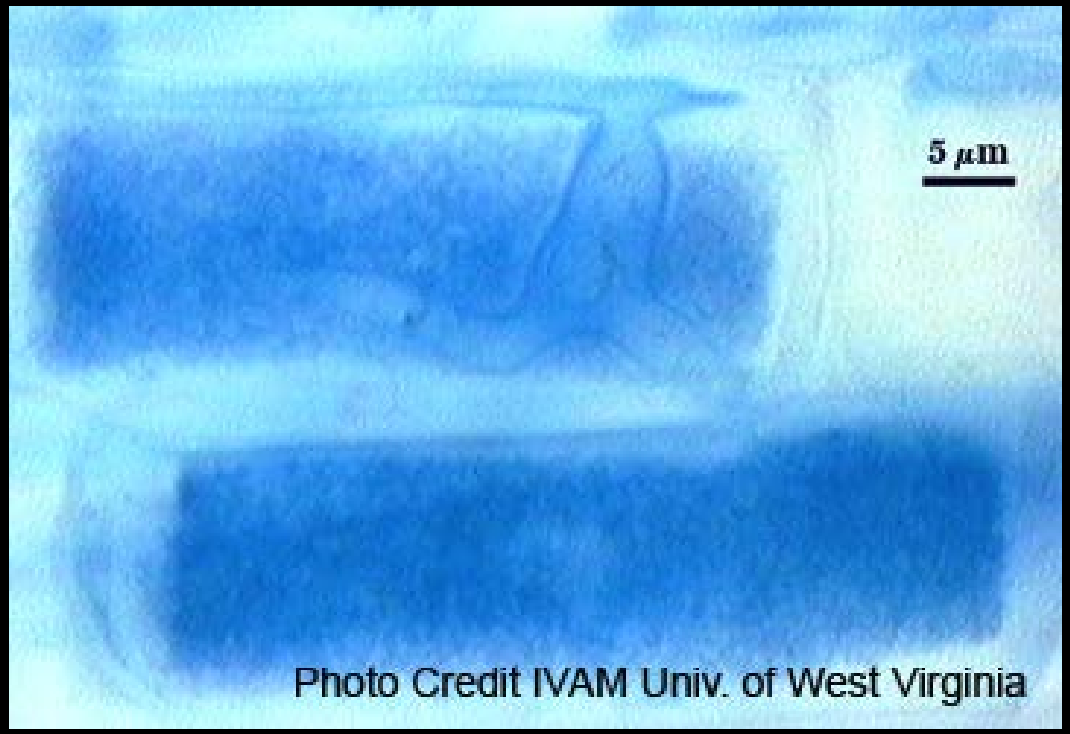
Shortgrass Prairie Template

- After water, nitrogen becomes the next limiting factor.
- Soil microbial pathways aid turnover of nitrogen & other minerals.



Shortgrass Prairie Template

- Bacteria represent key trophic pathways
- Mycorrhizal fungi utilize root's sugars & increase access to moisture & nutrients



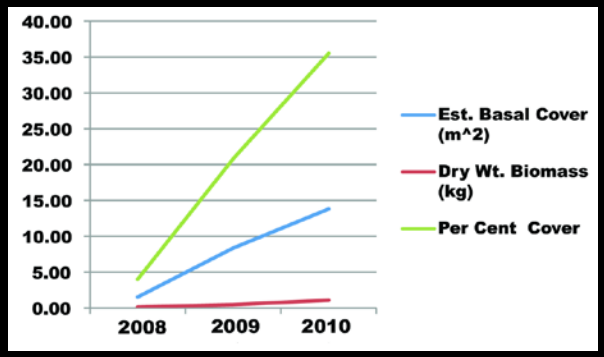
Investigating the Green Roof Ecosystem Concept: Cooperating Green Roof Research Venues

2007-2013

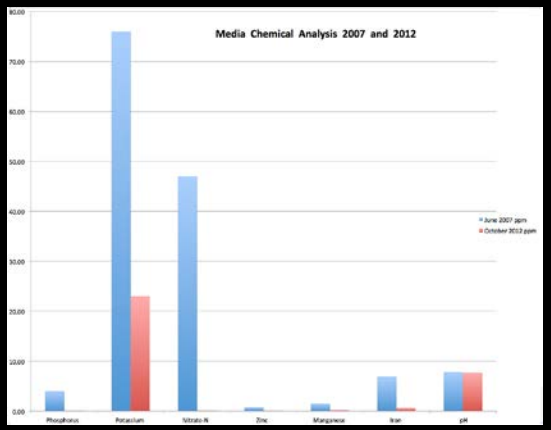
Pioneers Park Nature Center Green Roof

Cooperative Test Plot 2007, Lincoln, NE

- Extensive (3” to 3-1/2”)
- 800 sf :
- Biomass/cover



- Long-term fertility




March 4, 2008


June 13, 2008


July 27, 2008


Sept 2, 2008


Oct 10, 2008


May 16, 2009


June 10, 2009


July 16, 2009


August 1, 2009


Sept 18, 2009


April 19, 2010


May 9, 2010


June 29, 2010

Dynamic growth and visual interest in two and one-half growing seasons at PPNC green rooof planted June 2007-- never fertilized

Dr. Richard Sutton, FASLA, GRP

Nebraska Lincoln

Arbor Day Foundation Green Roof

Cooperative Test Plot 2010, Lincoln, NE

- Ultra- extensive (1-1/2 to 2”)
- 400 sf plot
- Side-by-side w/ Sedum
- Seeded (fall & spring); plugged 72’s

Arbor Day Foundation Green Roof

Cooperative Test Plot 2010, Lincoln, NE

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Sandhills Publishing Green Roof
Cooperative Test Plot 2011, Lincoln, NE

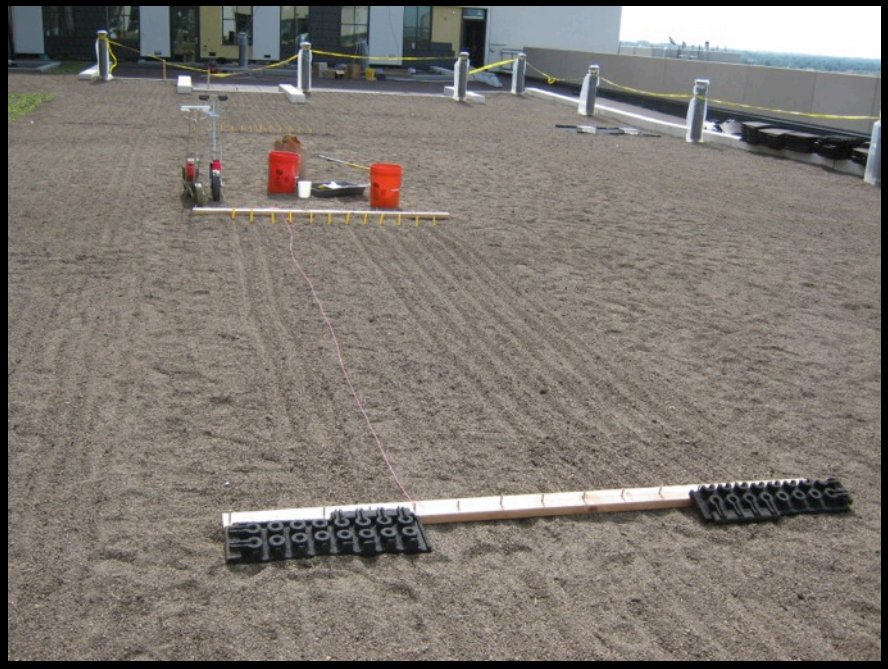
- Semi- extensive (5”-6”)

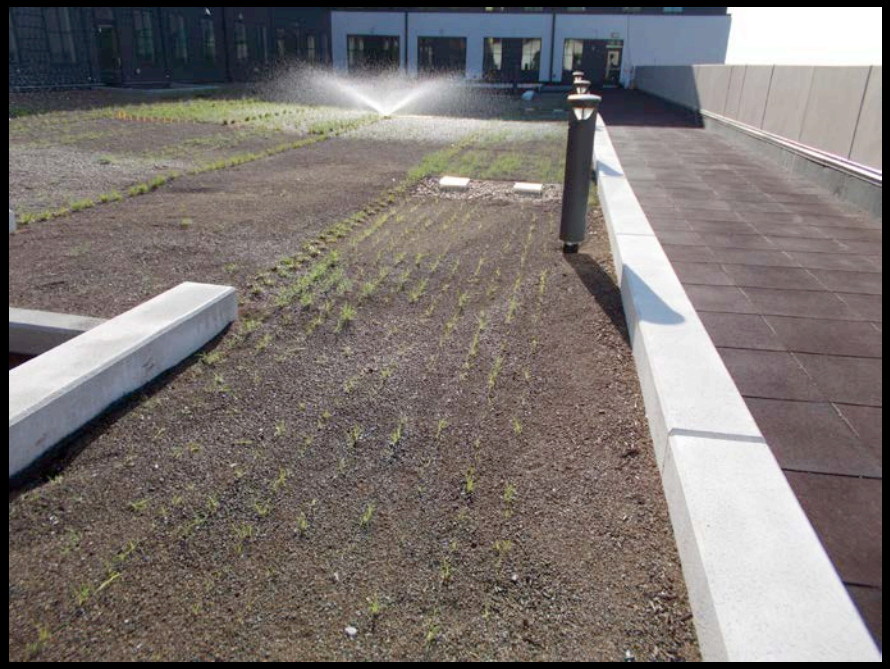
- 2000 sf plot testing:
  Seeding methods & rates
  Adapted & native perennials trials

- Potential germplasm specifically for green roof use:
  - Blue grama — USDA/Ag Research Service
  - Sun sedge — South Dakota State University
  - Hairy grama — UNL

Larson Building/Parkhaus Green Roof
Cooperative Test Plot 2012, Lincoln, NE

- Semi- extensive (4”-8”)
- 6000 sf plot testing:
  - Seeding methods & rates
  - Installation costs
  - Maintenance protocols





Prevailing Wisdom

√ Shallow substrate may not be suitable for many prairie plants

√ Impossible to recreate microbial and nutrient balance for native plants

√ Fire impractical to use on green roofs for removing excess biomass

--*Green Roof Plants* -- Snodgrass and Snodgrass 2006

√ Shallow substrate may not be suitable for many prairie plants

√ Impossible to recreate microbial and nutrient balance for native plants

√ Fire impractical to use on green roofs for removing excess biomass

--*Green Roof Plants* -- Snodgrass and Snodgrass 2006

Conclusion from 2007-2013 Studies:

Carefully selected native plants work perfectly well on extensive and semi-extensive green roof ecosystems.

Reducing Green Roof Plant and Planting Costs

“To become more widely used green roofs must become a commodity, not an oddity” — Peter MacDonagh

Landscape Architect & Director of Design

Kestrel Design Group

Green Roof Costs

$20/ sf ?

Green Roof Costs

~~$20/ sf~~

$10/ sf ?

Green Roof Costs

~~$20/ sf~~

~~$10/ sf~~

$6 / sf ?

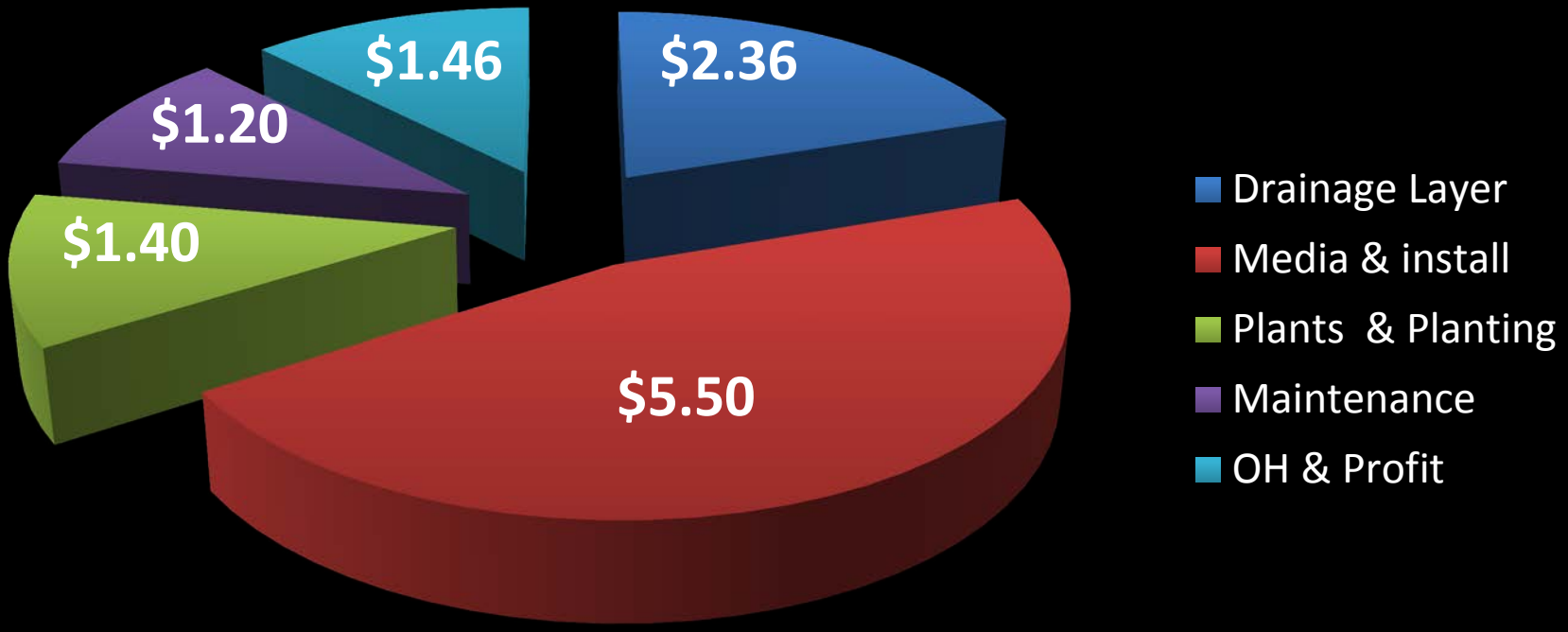
Green Roof Costs

~~$20/ sf~~

~~$10/ sf~~

$6 / sf ? Attaining this in Portland

Example Estimated Per Square Foot Green Roof Cost



Total Square Foot Costs $11.92

How to get to $5.00 / sf installation cost and reduce maintenance costs?

1) Using monolithic media layer (i.e., no trays)
Depths should be around 6-9 inches

Rule of thumb:
Saturated media loading
Weighs about 7+ lbs/sf for each 1” of media depth

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Saturated media loading
Weighs about 7+ lbs/sf for each 1” of media depth

* 6 to 9 inch depth = 45 to 75 lbs/sf loading

2) Seeding native grasses versus planting sedum

May 25, 2011

Slow, backbreaking work to plant raw, native grass seeds by hand but . . .

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Slow, backbreaking work to plant raw, native grass seeds by hand but . . .

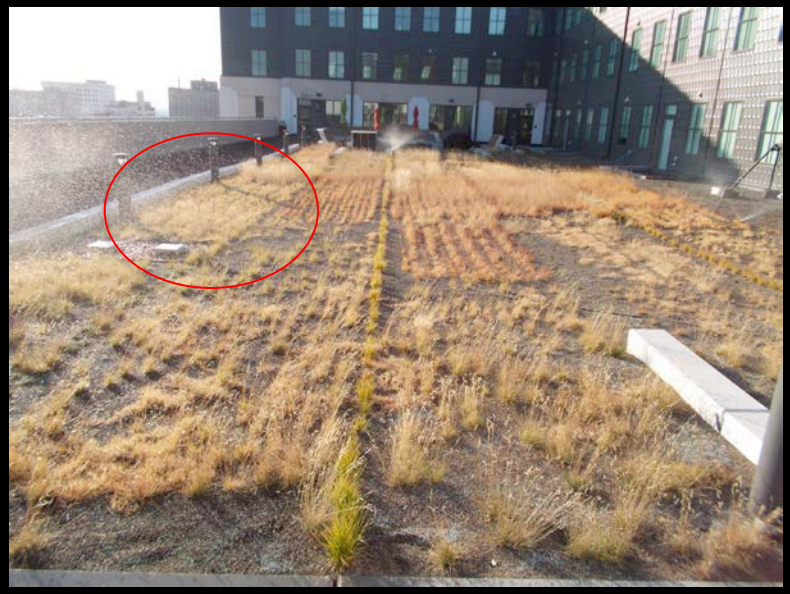
May 25, 2011

Seed to seed in one growing season

September 8, 2011

Reduce costs by increasing ease of seed handling :

Small, hirsute seeds → encrusted or pelletized → spreader



Traditional, dense lawn seeding techniques bring severe competition and require plant fertilization.

Seeding pelletized native grasses with precision spacing using a simple garden seeder

Cost Comparisons

Example: Planting sedum versus seeding native grasses

Timed Production Rate:

1-person-hour 468.5 sf

Sedum:

Plant 1000 sf with 72 plugs at 6” OC

Labor + burden $30/hr = $0.07/hr/sf

Material $5.00/sf

Total $5.07/SF

Seeding native grasses versus planting sedum

Timed Production Rate:

1-person-hour 780 sf

Pelletized native grass seed:

Seed 1000 sf with pellets in 6” rows

Labor + burden $30/hr = $0.04 /hr/sf

Pelletized seed $0.75/sf

Total $0.79/SF

About 6 times <u>less</u> than plugging sedum !!

Green Roof Ecosysystem Pitfalls:

Erosion and Grow-in

Maintenance

- Irrigation
- Weeding
- Fertility
- Fire

3) Erosion control accomplished with PAM

Linear polyacrylamides (WSPAMs)

When wet, these polymers are "watered out" of the granule to help stabilize surrounding soil and Help bind soil particles. They reduce wind erosion and transport by surface water.

Grow-in to meet the 80% cover and no gaps > 5”

July 6, 2013

August 9, 2013

September 9, 2013

October 12, 2013

October 12, 2013

Irrigation protocols honed at PPNC from 2007-2010

Based on 4” depth, high inorganic media

1st Year Establishment Phase
Apply 1/4”-1/2”of water every 7 days
Rainfall not taken into account

Second Year Establishment Phase
Apply 1/4”-1/2”of water every 7 days
Only if no rain greater than 1/4”-inches during that period

Third Year Establishment Phase
Apply 1/4”-1/2”of water every 10 days
Only if no rain greater than 1/4”-inches during that period

Irrigation protocols honed at PPNC from 2007-2010

<u>Year 4 Onward: Maintenance Phase</u>
Apply 1/4”-1/2” of water every 10 days April 1 to October 15.
Only if no rain greater than 1/4”-inches during that period.

Irrigation protocols honed at PPNC from 2007-2010

<u>Year 4 Onward: Maintenance Phase</u>
Apply 1/4”-1/2” of water every 10 days April 1 to October 15.
Only if no rain greater than 1/4”-inches during that period.

AND

For every daytime with a maximum temperature above 99° F, or night-time with a minimum above 77° F, subtract one day from the cycle.

Irrigation protocols honed at PPNC from 2007-2010

Year 4 Onward: Maintenance Phase

Apply 1/4”-1/2” of water every 10 days April 1 to October 15.

Only if no rain greater than 1/4”-inches during that period.

AND

For every daytime with a maximum temperature above 99° F, or night-time with a minimum above 77° F, subtract one day from the cycle.

AND

For each inch of media depth below 4” subtract 1 day from the cycle.

Irrigation protocols honed at PPNC from 2007-2010

During heat and drought periods:

At least every other day visual and physical inspection of the green roof planting and media dryness.

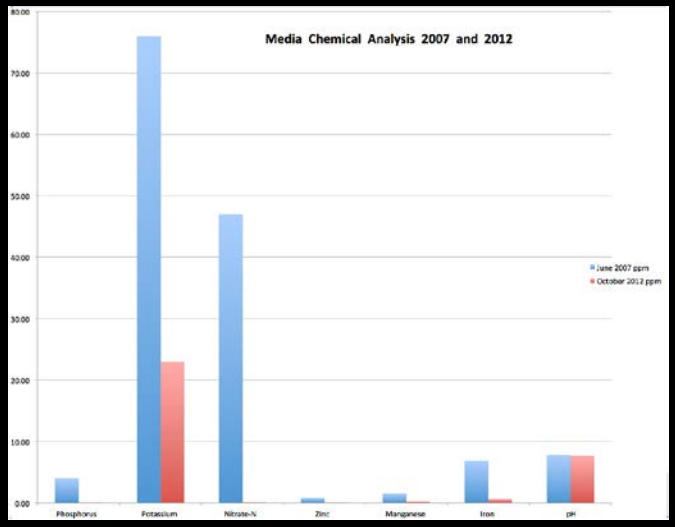
Always check the moistness of the substrate at several locations before irrigating.

Weeding

- Begins with weed free media.
- Look for weed germination 6-10 days after media placement.
- Continually check any live plant balls for weeds.
- Check entire media area for weeds insects and disease every week to week and a half during growing season
- Never let weeds go to seed ! !
- Estimate $0.50/sf/year for first 2 years

Fertility

- Fertilizing a must with Sedum to keep healthy and blooming
- Perform a media test and then only use slow release fertilizer
- Not so necessary with non-accessible roofs planted to native grasses and forbs.
- Perhaps lightly top-dress with compost every 5-6 years



Fire and Biomass Removal

- ANSI VF-1 fire standards
- Must remove dead biomass
- Must keep plantings healthy

Approved American National Standard ANSI

SPRI
Single Ply Roofing Industry

GREEN ROOFS
FOR HEALTHY CITIES
www.greenroofs.org

ANSI/SPRI VF-1
External Fire Design Standard for Vegetative Roofs

This standard was developed in cooperation with Green Roofs for Healthy Cities.

Approved January 29, 2010

Table of Contents

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Waltham, MA 02452
www.spri.org.

Disclaimer
This standard is for use by architects, engineers, roofing contractors and owners of low slope roofing systems. SPRI, its members and employees do not warrant that this standard is proper and applicable under all conditions.

Fire and Biomass Removal

- Media actually protects roof membrane from fire

Future Research

- Can we reduce the cost of green roofs by using local recycled media ingredients

Crushed, recycled brick

Municipal compost

Thanks to:

PPNC, City of Lincoln Parks and Recreation
Architectural Partnership
Arbor Day Foundation
Sinclair-Hille
Sandhills Publishing
Studio 951
Parkhaus, City of Lincoln Park and Go
Lower Platte South NRD
Woodbury-Scott-Wiegert
Kamterter Products
AAA Roofing
UNL Flemming Horticulture Research Grant
UNL UCARE Program & 3 UCARE students