



Growing Green Roofs in Denver, Colorado

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Common Southwestern Native Plants



Common Southwestern Native Plants

AN IDENTIFICATION GUIDE

THIRD EDITION
REVISED AND EXPANDED

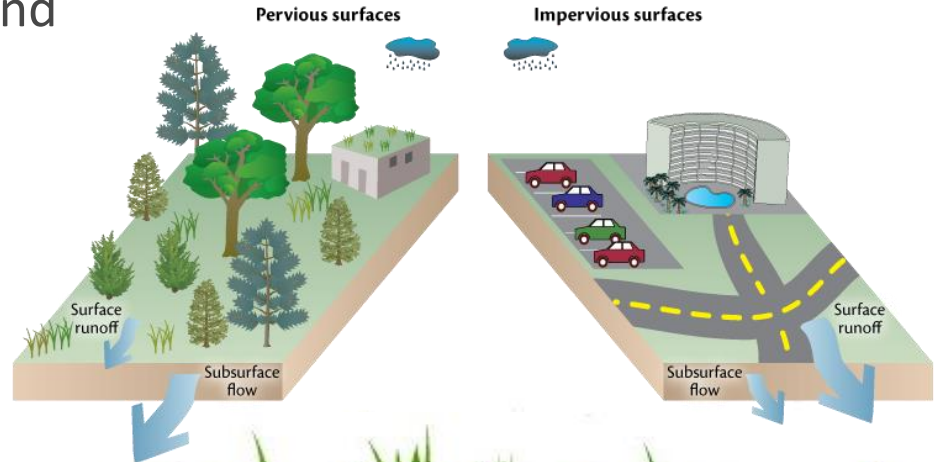
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Green Roof Rational

- As urbanization consumes land, impervious surfaces increase
- Issues emerge which *were* insignificant
 - The need to manage stormwater,
 - The urban heat island effect, and
 - Loss of arable land
- Mitigation?
- Vegetation



Green Roof Benefits

- Carbon Sequestration
- Energy Efficiency
- Roof Membrane Lifespan
- Increased biodiversity



Types of Green Roofs

Intensive or Rooftop Garden

- Deep substrate (>6")
- More like raised beds
- Diverse



Extensive

- Shallow (<6")
- Lightweight
- Retrofit



Colorado State University



EPA Region 8 Headquarters CSU Research Site



Colorado Green Roof Research

Bousselot, J., J. Klett, + R. Koski. 2010. *Extensive green roof species evaluations using digital image analysis*. HortScience: 45(8).

Plant Species

Bousselot, J., J. Klett, + R. Koski. 2011. *Moisture content of extensive green roof substrate and growth response of 15 temperate plant species during dry down*. HortScience: 46(3).

Dry Down/Water

Slabe, T., O'Connor, T., Loder, A., Dakin, K., Creath, A. and Fusco, M. 2011. *Thermal characteristics of an extensive green roof in high elevation, semi-arid, temperate Denver, CO*. CititesAlive.

Urban Heat Island

Bousselot, J., J. Klett, + R. Koski. 2012. *Evaluating a natural zeolite as an amendment for extensive green roof substrate*. J. Env. Hort., 30(4).

Substrates

Schneider, A., Fusco, M., + Bousselot, J.M. 2014. *Observations on the survival of 112 plant taxa on a green roof in a semi-arid climate*. J. of Living Arch. 1(5).

Diversity + Time

Bousselot, J., T. Slabe, J. Klett, + R. Koski. (in press) *Photovoltaic array influences the growth of green roof plants*. J. of Living Arch.

+ Solar

Introduction

- Moisture Content of Extensive Green Roof Substrate and Growth Response of Fifteen Temperate Plant Species During Dry Down
 - Elucidate dry down characteristics by plant type
 - Versus non-vegetated control



Greenhouse Trials



Conclusions

- Herbaceous dried out faster than succulents
- Succulents had viable foliage for over five times longer than the herbaceous
- Succulents were nearly twice as likely to revive as herbaceous



Denver Botanic Gardens Café Garden



Denver Botanic Gardens Children's Garden

A photograph of the Denver Botanic Gardens Children's Garden. A wooden boardwalk with rope railings winds through a lush garden filled with various plants and flowers. In the background, there is a large, rocky structure and a wooden pergola.

© Michael Guidi

Denver Green Roof Ordinance

- Denver Green Roof Initiated Ordinance 300
 - Ballot issue on November 2017 Denver election
- The ordinance was based on Toronto's policy
 - But added existing buildings at expansion/reroof



Gross Floor Area
(Size of Building)

Coverage of Roof Space
(Size of Green Roof)

25,000 – 49,999 ft²

20%

50,000 – 99,999 ft²

30%

100,000 – 149,999 ft²

40%

150,000 – 199,999 ft²

50%

200,000 ft² or greater

60%

Green Roofs and Water

- Denver Water on the Denver Green Roof Task Force
 - Primary concern was potable water use on green roofs
- Denver Water ran an in depth independent analysis
 - Using irrigation data from CSU/EPA research
 - Assumed 1,000 acres of new green roofs
 - Assumed 95% succulents/natives, 5% turf/ag
- Only increased water use by 1.15% at peak season!



Denver Green Roof Task Force Final Products

New Buildings

Cool roof + 1 of 8 options

- Green roof or green space
- Finance off-site green space
- Combo green space + solar
- Combo green space + energy efficiency
- A solar array on 70% of roof
- 12% more efficient than code
- LEED Gold
- Enterprise Green Communities Certification

Existing Buildings

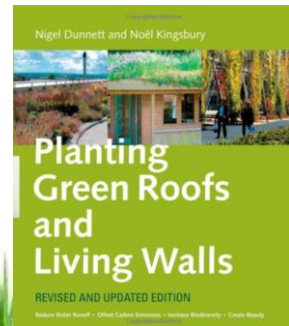
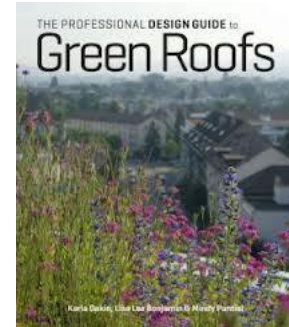
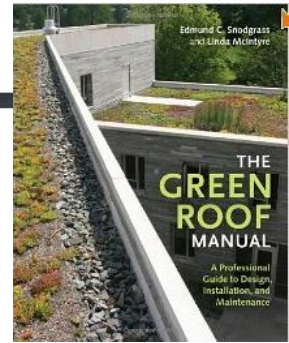
Cool roof + 1 of 5 options


- Small green roof or green space on site
- On-site solar
- LEED Silver certification
- Finance off-site green space
- Enrollment in a flexible Energy Program



Green Roof References

- Green Roofs for Healthy Cities greenroofs.org
- greenroofs.com
- *The Green Roof Manual* by Snodgrass & McIntyre
- *The Professional Design Guide to Green Roofs* by Dakin, Benjamin, and Pantiel
- *Planting Green Roofs and Living Walls* by Dunnett & Kingsbury



A photograph of a rooftop garden. The garden is composed of several wooden planters filled with a variety of plants, including tall grasses, low-lying green shrubs, and small purple flowers. The planters are arranged in a grid-like pattern on a flat roof. In the background, a dark shingled roof of a house is visible. To the left, a street with a white car and some trees can be seen. The overall scene is a well-maintained urban garden.

Questions? Thank You.