Growing Green Roofs in Denver, Colorado

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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
- Roof Membrane Lifespan
- Energy Efficiency
- Increased biodiversity
Types of Green Roofs

Intensive or Rooftop Garden

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

Extensive

- Shallow (<6”)
- Lightweight
- Retrofit
Colorado Green Roof Research


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 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

<table>
<thead>
<tr>
<th>Gross Floor Area (Size of Building)</th>
<th>Coverage of Roof Space (Size of Green Roof)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25,000 – 49,999 ft²</td>
<td>20%</td>
</tr>
<tr>
<td>50,000 – 99,999 ft²</td>
<td>30%</td>
</tr>
<tr>
<td>100,000 – 149,999 ft²</td>
<td>40%</td>
</tr>
<tr>
<td>150,000 – 199,999 ft²</td>
<td>50%</td>
</tr>
<tr>
<td>200,000 ft² or greater</td>
<td>60%</td>
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</tbody>
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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