Green Roofs and Walls

Presentation to Landscape Ontario Congress
January 12, 2012

Jordan Richie, GRP
Green Roofs for Healthy Cities
Green Roofs

Millenium Village, Vancouver
2011 Award of Excellence Winner (Intensive Residential)
Green Walls

Phoenix Convention Center
2011 Award of Excellence Winner (Green Wall Design)
Member-based non-profit industry association established in 1999.

Mission:

To increase the awareness of the economic, social and environmental benefits of living architecture through education, advocacy, professional development and celebrations of excellence.

Big Sur Residential
Source: Fred Ballerini
2009 Award of Excellence Winner (Extensive Residential)
Green Roof Professional (GRP) training and accreditation program. Specialized half-day workshops. Online learning via the Living Architecture Academy.
These courses are in the approval process for Landscape Industry Certified Continuing Education Credits.

**Training at Landscape Ontario Congress**

**Advanced Green Roof Maintenance**
1:30 pm – 4:30 pm

**Green Walls 101: Systems Overview and Design**
1:30 pm – 4:30 pm

*These courses are in the approval process for Landscape Industry Certified Continuing Education Credits.*
Upcoming GRP Training in Ontario

• GRP Training Program – Ottawa – Algonquin College
  • Evening sessions every Wednesday from February 8 to March 28

• Toronto Green Roof Boot Camp (all four GRP courses on consecutive days)
  • February 23rd to 26th at Ryerson University and Carrot Common

Register at www.greenroofs.org/education
Green Roof Professional (GRP) Accreditation Program

Industry-driven, exam-based certification.
Launched in June of 2009.
Now over 400 GRPs in the marketplace.

- Enables professionals to differentiate themselves in the marketplace
- Improves multi-disciplinary collaboration
- Increases customer confidence in green roof technology
- Results in better green roof design and installation practices
- Protects the industry from the inevitable failures that result from inappropriate design, installation and maintenance practices
About GRHC – GRP Accreditation
About GRHC – Communications

- Web site: www.greenroofs.org
  - Contains resources and tools like the GreenSave Calculator, Green Roofs Tree of Knowledge, and Living Architecture Toolbox
- Connect with GRPs and our members: designers, product manufacturers, and service providers
  - Annual industry survey
  - Quarterly *Living Architecture Monitor* magazine
- Awards of Excellence program
  - Recognizes outstanding North American green roof and wall projects
- *Green Infrastructure Webinar Series*
About GRHC – Conferences & Symposia

- Policy, Design & Case Studies, and Research tracks
- Trade show
- GRP and specialized half-day training courses
- Awards of Excellence ceremony
- Local green roof and wall tours

Schwab Rehabilitation Hospital. Chicago, IL.
Three types of membership:

**Corporate Membership**
- Green roof and wall product manufacturers, suppliers, or service providers.

**Individual Membership**
- Individuals practicing the art of living architecture.

**Supporter Membership**
- Individuals with a personal or professional interest in living architecture who wish to subscribe to the *Living Architecture Monitor* magazine.
About GRHC - Membership

GRHC Individual Membership by Profession

- 52.6% Other
- 20.3% Roofing Contractor
- 8.8% Architect
- 7.2% Landscape Designer
- 6.0% Landscape Architect
- 5.1% Roofing Consultant
Green Roof Industry Growth

Source: GRHC Industry Survey.
## Industry Growth

### Top Ten Green Roofs Cities – 2010

<table>
<thead>
<tr>
<th>Metropolitan Area</th>
<th>State/Prov</th>
<th>Total Installed (SF)</th>
<th># Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago</td>
<td>IL</td>
<td>539,171</td>
<td>59</td>
</tr>
<tr>
<td>Toronto</td>
<td>ON</td>
<td>439,892</td>
<td>59</td>
</tr>
<tr>
<td>Washington</td>
<td>DC</td>
<td>410,245</td>
<td>46</td>
</tr>
<tr>
<td>New York</td>
<td>NY</td>
<td>233,333</td>
<td>58</td>
</tr>
<tr>
<td>Ottawa</td>
<td>ON</td>
<td>230,686</td>
<td>10</td>
</tr>
<tr>
<td>Vancouver</td>
<td>BC</td>
<td>224,550</td>
<td>4</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>PA</td>
<td>147,592</td>
<td>24</td>
</tr>
<tr>
<td>Norfolk</td>
<td>VA</td>
<td>132,869</td>
<td>9</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>WI</td>
<td>130,132</td>
<td>14</td>
</tr>
<tr>
<td>Baltimore</td>
<td>MD</td>
<td>90,079</td>
<td>14</td>
</tr>
</tbody>
</table>
A green roof is a 'contained' green space on top of a human-made structure below, above, or at grade.

Howard Hughes Medical Institute
Chevy Chase, MD
Source: Sika Sarnafil
Overview of Green Roofs - History

- 600 BC: Ziggurats of Ancient Mesopotamia
- 800-1000 AD: Vikings

Hanging Gardens of Babylon
Mesopotamia

Sod Roof
Restored Viking Settlement
L’ance aux Meadows, Newfoundland

Source: Steven W. Peck
Overview of Green Roofs - History

Residential Development
Germany
Source: Steven W. Peck

Daimler-Chrysler Building
Berlin, Germany
Source: Steven W. Peck
Green Roof Components

Basic Green Roof Assembly

- Vegetation
- Growing Medium
- Drainage Layer and Filter Fabric
- Root Barrier
- Waterproofing Membrane
- Structural Deck
## Green Roof Overview - Categories

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>EXTENSIVE</th>
<th>SEMI-INTENSIVE</th>
<th>INTENSIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growing Medium Depth</td>
<td>6” or less</td>
<td>25% above or below 6”</td>
<td>More than 6”</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Often inaccessible</td>
<td>May be partially accessible</td>
<td>Usually accessible</td>
</tr>
<tr>
<td>Fully Saturated Weight</td>
<td>Low 10-35 lb / ft²</td>
<td>Varies 35-50 lb / ft²</td>
<td>High 50-300 lb / ft²</td>
</tr>
<tr>
<td></td>
<td>(48.8 - 170.9 kg / m²)</td>
<td>(170.9 - 244.1 kg / m²)</td>
<td>(244.1 - 1,464.7 kg / m²)</td>
</tr>
<tr>
<td>Plant diversity</td>
<td>Low</td>
<td>Greater</td>
<td>Greatest</td>
</tr>
<tr>
<td>Cost</td>
<td>Low</td>
<td>Varies</td>
<td>High</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Minimal</td>
<td>Varies</td>
<td>Varies, but is generally high</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXTENSIVE</th>
<th>SEMI-INTENSIVE</th>
<th>INTENSIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightweight</td>
<td>Combines best features of extensive and intensive</td>
<td>Greater diversity of plants</td>
</tr>
<tr>
<td>Suitable for large areas</td>
<td>Utilizes areas with greater loading capacity</td>
<td>Best insulation properties and storm water management</td>
</tr>
<tr>
<td>Low maintenance costs and may be designed for no irrigation</td>
<td>Greater coverage at less cost than intensive</td>
<td>Greater range of design</td>
</tr>
<tr>
<td>More suitable for retrofit projects</td>
<td>Average maintenance</td>
<td>Usually accessible</td>
</tr>
<tr>
<td>Lower capital costs</td>
<td>Greater plant diversity than extensive</td>
<td>Greater variety of human uses</td>
</tr>
<tr>
<td>Easier to replace</td>
<td>Greater opportunities for aesthetic design than extensive</td>
<td>Greater biodiversity potential</td>
</tr>
</tbody>
</table>
Green Roof Systems

Modular Systems

Source: Green Grid

Source: Green Roof Blocks

Source: Eco-Roofs

Source: Mule-Hide Products
Green Roof Systems

Loose Laid Systems

Source: Rooflite

Source: Stancils

Source: American Landscape
Growing medium is made up of four components:

- **Inorganic material** (a.k.a. aggregate)
  - Vermiculite, expanded slate, clay, volcanic rock, coarse sands, pumice stone, scoria, zeolite, diatomaceous earth, perlite, crushed roofing tile, and rock wool.

- **Organic material**
  - Straw, saw dust, wood, grass, leaves, clippings, agricultural waste, worm castings, peat or peat moss, and manures. Bio-solids and Animal carcasses can be used but must be done exercising caution.

- **Water**

- **Air**
Green Roof Growing Media

J.C. Raulston Arboretum
Raleigh, NC
Source: Chuck Friedrich, Carolina Stalite
Properties of Green Roof Growing Media

- Minimal contribution to weight load
- Retention of nutrients/moisture
- Offer a high void (air volume) ratio even when saturated
- Sufficiently porous for internal aeration
- Ability to prevent rotational movement, shrinkage, and compaction
- Resistant to heat and rot
- An ability to anchor plants
- Readily drainable
- Free of material which may degrade, clog, or corrode drainage or waterproofing system
Commonly used plant categories for green roofs include:

- Succulent plants
- Grasses
- Herbaceous plants
- Woody plants
Green Roof Vegetation

Woodlands Assisted Living
New Westminster, BC
Source: Nat’s Nursery

4287 Kingsway
Vancouver, BC
Source: Steven W. Peck

Chicago City Hall
Chicago, Il
Source: City of Chicago
Green Roof Vegetation - Sedums

Delosperma nubigenum ‘Basutoland’

Sedum album

Sedum reflexum

Sedum spurium ‘John Creech’

Source: Ed Snodgrass, Emory Knoll Farms
‘Green wall’ is an all-encompassing term used to refer to various forms of vegetated vertical surfaces.

Green Façades

Living Walls

Source: Jakob

Source: Elevated Landscape Technologies
A ‘Green Façade’ or façade greening, features a training structure that support vines or climbing plants growing upward from the ground away from the building.
A ‘Living Wall’ is part of a building envelope system, comprising pre-vegetated or planted on site panels with plants, growing medium or liquid nutrient installed in or on a frame, secured to a structural wall or free standing.
Green Walls – Living Walls

Urban Food Chain. Green Living Technologies.
Green roof benefits that can accrue to the public include:

- Stormwater Management
- Urban Heat Island Mitigation
- Improved Air Quality
- Aesthetics
- Waste Diversion
- Improved Liveabiltiy
- Green Job Creation – Design, Mfg, Installation and Maintenance
Green Roof Overview – Stormwater Management

Source: US Environmental Protection Agency
Green Roof Overview – Stormwater Management

10th @ Hoyt Apartments
Portland, OR
Award of Excellence 2006

Source: Koch Landscape Architecture
The urban heat island (UHI) effect is the temperature increase in urban areas associated with the replacement of “natural vegetation with pavements, buildings, and other structures necessary to accommodate growing populations” (Wong 2005).
Benefits – Urban Heat Island Mitigation

Causes of Urban Heat Islands

• Replacement of the vegetated landscape with urban structures and materials
  • Properties of urban materials, different thermophysical characteristics
  • Geometry of the Urban Form
• Anthropogenic Heat
Additional public benefits of green roofs include:

• Creation of Amenity Spaces
• Local Job Creation
• Waste Diversion
• Aesthetic Appeal
Green Roofs – Private Benefits

Building-scale benefits that accrue to building owners or occupants include:

- Energy Efficiency
- Increased Membrane Durability
- Noise Reduction
- Increased property values and marketability
Private Benefits – Energy Efficiency

Basic Roof/Surface Energy Balance Model

- Shortwave down (solar + diffuse)
- Shortwave reflected
- Longwave down (the greenhouse effect)
- Longwave up re-emitted
- Latent heat loss
- Sensible heat loss
- Heat conduction into or from room interior

Source: Stuart Gaffin, Center for Climate Systems Research, Columbia University.
Typical sunny day temperatures on roof surfaces:

- Asphalt Roof: 158°F/ 70°C
- White PVC: 101°F/ 38 °C
- Green Roof: 90°F/ 32 °C
Private Benefits – Energy Efficiency

Source: National Research Council, Institute for Research in Construction
Private Benefits – Increased Membrane Durability

- North American roofs have an average lifespan of 10-15 years
  - Average across climates and membrane types
- Waterproofing membranes in green roof assemblies have lasted over 40 years in Germany
Private Benefits – Increased Membrane Durability

Source: National Research Council, Institute for Research in Construction
Private Benefits – Noise Reduction

GAP Headquarters
San Bruno, CA
Award of Excellence 2003
Source: William McDonough + Partners
Private Benefits – Marketability

Green buildings have been identified as facilitating:

• Sales
• Lease outs
• Increased property value due to increase efficiency
• Easier employee recruiting
• Lower employee turnover
Through the process of integrated building design, green roofs may earn LEED® direct credits for:

- Storm water retention
- Reducing heat island effects
- Energy efficiency
- Water use efficiency

Solaire Building
Battery Park City, NY
Award of Excellence 2004
Source: Simon Bird
Private Benefits – Marketability

Exhibition Place
Toronto, ON
Source: Melinda Zytaruk

Old Country Market
Coombs, BC
Source: Steven W. Peck
Additional project specific-benefits of green roofs:

- PV Integration
- Increased Biodiversity
- Improved Health and Well-Being
- Urban Agriculture

Earth Pledge Green Roof
New York, NY
Source: Earth Pledge
Barrier to green roof implementation:

- Higher upfront costs
- Many of the benefits accrue to the public at large, not directly to building owners
- Lack of familiarity with the technology
- Lack of long-term performance data
There are four ways in which this technology can be made more affordable:

- Public incentives at municipal, state/provincial, or federal levels
- Product development and technological innovation
- Integration of green roofs with other building systems or programs
- Market expansion through improved delivery and training

Barriers to Implementation
Toronto Eco-Roof Incentive Program

- Green roof incentive program introduced in 2006
- Installations on existing commercial, industrial or institutional buildings are eligible
- $50/m² up to $100,000
- To date program has supplied over $700,000 in funding
### Public Policies and Incentives

#### Toronto Green Roof Bylaw

<table>
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<tr>
<th>Gross Floor Area (Size of Building)</th>
<th>Green Roof Coverage Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,000 – 4,999 m²</td>
<td>20%</td>
</tr>
<tr>
<td>5,000-9,999 m²</td>
<td>30%</td>
</tr>
<tr>
<td>10,000-14,999 m²</td>
<td>40%</td>
</tr>
<tr>
<td>15,000-19,999 m²</td>
<td>50%</td>
</tr>
<tr>
<td>20,000 m² or greater</td>
<td>60%</td>
</tr>
</tbody>
</table>

Toronto City Hall.
Public Policies and Incentives

Toronto Green Roof Bylaw

• 103 green roofs required under bylaw as of August 2011 (105,000 sq. metres)
• 38 voluntary roof in same period (20,000 sq. metres)
• Prior to bylaw there were estimated to be 133 green roofs (36,517 sq. metres)
Standards and Guidelines:

- 1995: FLL Green Roof Guidelines (Germany)
- 2002: FLL Green Roof Guidelines revised (Germany)
- 2005: Publication of 5 ASTM Standards (Appendix V)
- 2006: Publication of 1 ASTM Guideline
- 2006: FM Global 1-35
- 2010: ANSI/SPRI VF-1 Fire Design Guidelines
- 2010: ANSI/SPRI RP-14 Wind Design Standard
- 2009: City of Toronto Green Roof Construction Standard.
Standards Development

ANSI/SPRI VF-1
External Fire Design Standard for Vegetative Roofs
This standard was developed in cooperation with Green Roofs for Healthy Cities.

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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.

ANSI/SPRI RP-14
Wind Design Standard for Vegetative Roofing Systems
This standard was developed in cooperation with Green Roofs for Healthy Cities.

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Projects – Vancouver Convention Centre

Vancouver Convention Centre Expansion Project, Vancouver, BC.
2010 Award of Excellence Winner. PWL Partnership Landscape Architects Inc.
Projects – Vancouver Convention Centre

Photo credit: PWL Partnership Landscape Architects
Projects – Minneapolis Target Center

Target Center, Minneapolis, MN.
2010 Award of Excellence Winner. The Kestrel Design Group, Inc., and Sika Sarnafil.

Photo courtesy: Sika Sarnafil and Bergerson Photography.
Projects – Minneapolis Target Center

Photo credit: The Kestrel Design Group, Inc.
Projects – California Academy of Sciences

California Academy of Sciences, San Francisco, CA.
2008 Award of Excellence Winner. Rana Creek Living Architecture.
Projects – California Academy of Sciences
Projects – California Academy of Sciences
Projects – Brooklyn Grange
Projects – Brooklyn Grange
Integrated Design

Mountain Equipment Co-op Retail Store
Winnipeg, MB
Source: Richard Kula
Integrated Design

EPA Region 8 Headquarters. Denver, CO.
Final Thoughts
Upcoming GRHC Training in Ontario

- Advanced Green Roof Maintenance (today!)
- Green Walls 101: Systems Overview and Design (today!)
- GRP Training Program – Ottawa – Algonquin College – evening sessions every Wednesday from February 8 to March 28
- Toronto Green Roof Boot Camp (all four GRP courses on consecutive days) – Feb 23rd to 26th

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Living Architecture

“We look at architecture the wrong way: sideways, so what we see is only a thin sliver of the reality around us.”

“To see architecture fully, you must tip it up, stand it on its edge. When you do, you always see dead land on display.”

Malcolm Wells, Rediscovering America