The Carleton Green Roof Project

June 20, 2005

Project History:

After taking the "Building the Eco-House class in Spring 2004 David Holman '06 and Jason Lord '06 decided to start an independent study on green roofs with Director of Facilities Richard Strong as their advisor. Jake Gold '07 joined them and they began their independent study over the summer of 2004, beginning in earnest during the fall of 2004. They researched green roofs from a number of different sources and constructed several test modules to measure the insulation value of various soil types. During the winter they planned how and where to build a small test green roof at Carleton to gain knowledge about the building process and demonstrate this technology to the campus and public. Spring term of 2005 the team was joined by Andrew Kaplan '08 and Mandi Fix '08 and they all began working hard to acquire the necessary materials and work out of logistics of building a green roof. Construction began on Friday, May 13,th the roof was finished and planted by Thursday, May 19th.

Press Release:

On May 19th five Carleton College students completed building the first green roof to test 78 varieties of prairie plants native to Minnesota for their viability to the green roofing industry. This 665 sq ft roof on part of the Olin Science Building at Carleton College is also the first student-designed and built green roof in Minnesota. The roof will provide structural, functional, environmental and aesthetic benefits to the building. The project will provide plant growth data, water monitoring and temperature data that will be used for further roof construction at Carleton and by green roof contractors. The roof can be easily viewed from the glass hallway connecting the Olin and Mudd Science Buildings at Carleton College.

The Carleton Green Roof Project was formed last September by **David Holman '06**, **Jason Lord '06**, and **Jake Gold '07** as an independent study at Carleton College in Northfield, MN. The project is advised by green architect and Carleton Director of Facilities **Richard Strong. This** project was inspired by Richard's class, "Building the Eco-House" taught in the spring of 2004. The fall of 2004 was spent studying green roof design and planning where green roofs could be made at Carleton. The team did R-value testing on various soil types during the fall and winter, finding that in our testing,, green roofs did not substantially contribute to a roof's R-value. More in-depth R-value testing and resarchiis planed. Planning to build a small test roof on campus began in the winter of 2005. This spring, **Mandi Fix '08** and **Andrew Kaplan '08** joined the project and we planted our first roof!

The team decided to try testing only prairie plants native to Minnesota. Prairies are typically draught resistant because of extremely deep root systems, we expect many of our species to suffer under the shallow and dry soil conditions of our green roof. The group chose a 665 square foot roof connected to the Olin Science building. This roof is highly visible via an elevated glass walkway on the west side and is one of the strongest roofs on campus. The soil substrate consists of two layers. The bottom layer is a 4" mix of 36.5% Perlite, 36.5% Vermiculite, 12% Clay Particles (A product called Turface), and 15% compost from Carleton's yard waste pile. This bottom layer is designed extremely lightweight, water absorptive, and inorganic. The top layer 2 inches of pure compost which is then slightly mixed into the bottom layer to create a heavier, more organic top layer for seed germination and prevention of soil loss via wind. The 6" mixture weighs 16.1 lbs/sq ft dry and 24.9 lbs/sq ft saturated. This unusually organic soil mixture was used to provide more lush plant growth. 54 species of prairie forbs, 3 types of shrub/vine species, 19 species of grasses, sedges, and rushes, and a cover crop of oats were seeded. This mix was provided by Prairie Moon nurseries of Winona. To provide faster plant establishment for this highly visible roof, 250 root stocks from Prairie Moon of various prairie plants were planted among the seeds.

The drainage layer beneath that soil is a DBR-50 Rootbloc product manufactured and generously donated by American Wick Drain. This drainage layer provides a grid of small plastic cups to retain water while any overflow drains away.Thanks to donation of materials and student labor, the cost of the current project was around $2 per square foot. This season the team will be constructing another test roof which will compare plant growth using three different drainage techniques over two different soil depths. The team will be measuring plant establishment and survival over the next couple years and planning to construct a much larger project that would provide cooling benefits to a dorm. A hydrologist from Carleton will be testing the water runoff quality over time. The team will be publishing all the specifics of our materials, design and research results on our website.

For pictures or more information please contact David Holman (holmand@carleton.edu) 507-646-5479 or Jason Lord (lordj@carleton.edu) 330-285-0699

What is a Green Roof?

A green roof is simply a roof with plants on it. The green roofing industry has historical roots in many different cultures but saw a modern revitalizing beginning in Germany in the 1970's. Today green roofs are most common in Western and Northern Europe but people all over the world are beginning to reawaken to their benefits. There are three distinct kinds of green roofs. **Sod Roofs** are heavy layers of thick soil that were used as effective roofing by many different cultures throughout history. **Intensive Green Roofs** are modern roof gardens that require rich heavy soils and moderate to high levels of maintenance by a gardener. **Extensive Green Roofs** are lightweight, thin, low maintenance roofs that are designed for a lower budget project where function and aesthetics must be closely linked. The we constructed on top of the Olin storage room is an extensive green roof, using between 6 and 2 inches of soil, and draught resistant prairie plants that don't require regular maintenance.

Our Green Roof:

- Before:

- After:

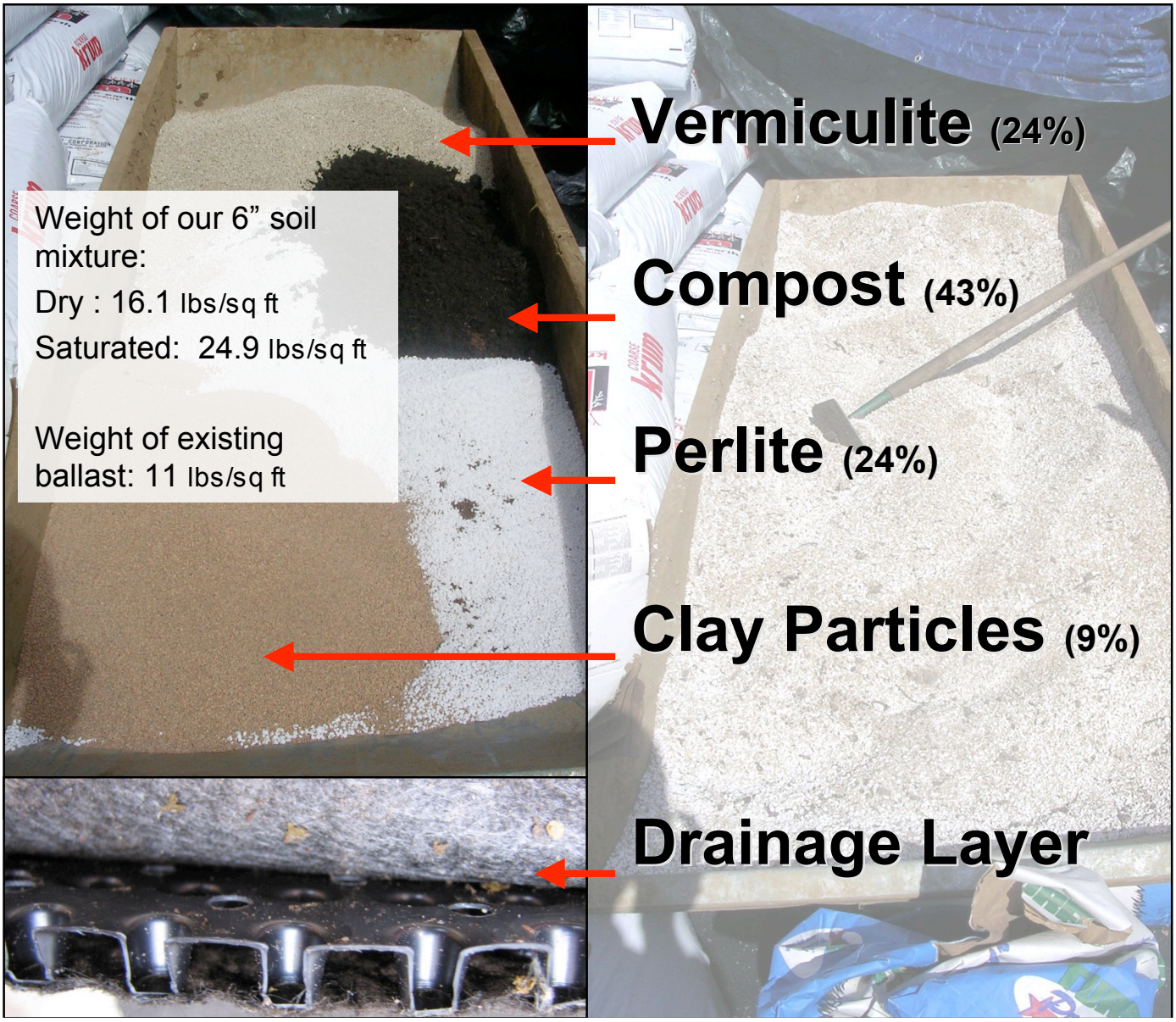
The Cost of Our Green Roof:

(with free labor and drainage layer)

Materials: $2.07/sq ft
Total Roof Area: 666 sq ft
Total Project Cost: $1,375

We would like to thank American Wick Drain for their generous donation of 1000sq ft of their $^1/_2$" drainage layer for this project! We would also like to thank Carleton's facilities and grounds departments for their great support for this project!

The Soil on Our Green Roof:



Plants on Our Green Roof:

Our Goal in this project was to design a green roof using as many native Minnesota prairie plants as possible. We used a large seed mixture of hardy prairie plants from this area. We chose species that we thought would best survive thin the hot, dry and shallow soil environment We planted: 4 species of prairie forbs, 3 types of shrub/vine species, 19 species of grasses, sedges, and rushes, and a cover crop of oats were seeded . We selected our plants with the help of: **Ron Bowen** of Prairie Restorations, **Prairie Moon Nursery & Carleton Biology** and **Arab** faculty**.** To provide faster plant establishment for this highly visible roof, 250 root stocks of various prairie plants were planted among the seeds. We will be monitoring growth rates of our prairie species and publish a list of recommended species from our results.

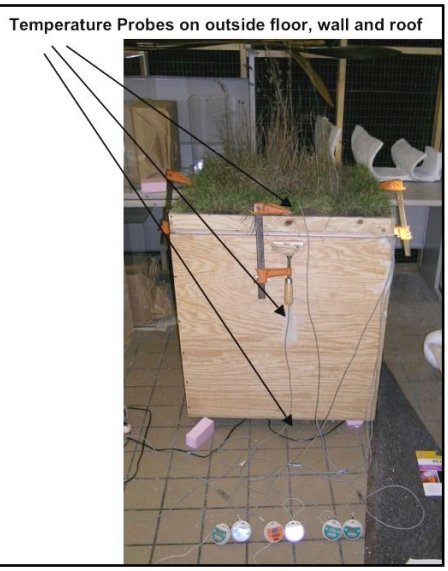
Our Completed Roof:

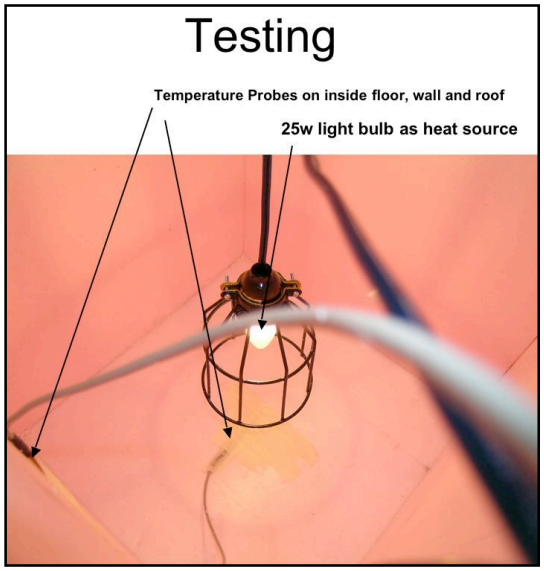
R-Value Testing:

In our independent study, we set out to conduct some of our own research. In our research we found many case studies demonstrating the energy savings green roofs provide in the summer, but no studies demonstrating energy savings in the winter. To determine energy savings, we calculated the additional insulation value (R-value) that a green roof provides to an existing roof. We calculated R-values with our soil mixture saturated and dry. We will continue to do further testing with different soil compositions under different conditions next year.

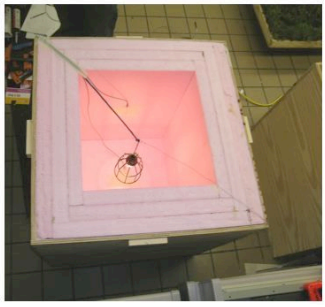
Known Side and floor R-value (R31) of test cube

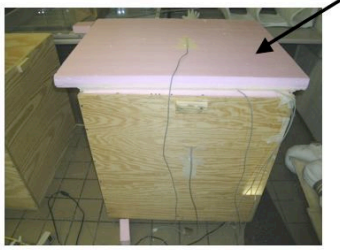
Variable is top R-value





R-Value Calculation





R value =

$\frac{ft^2 \times (\text{inside temp} - \text{outside temp})}{\text{Total Watts (Q)} \times 3.413 \text{ (BTU)/watt}}$

We calibrated our experimental setup with R 10 insulation → R 9.33

6.7 % error

Our 6" Soil: R4

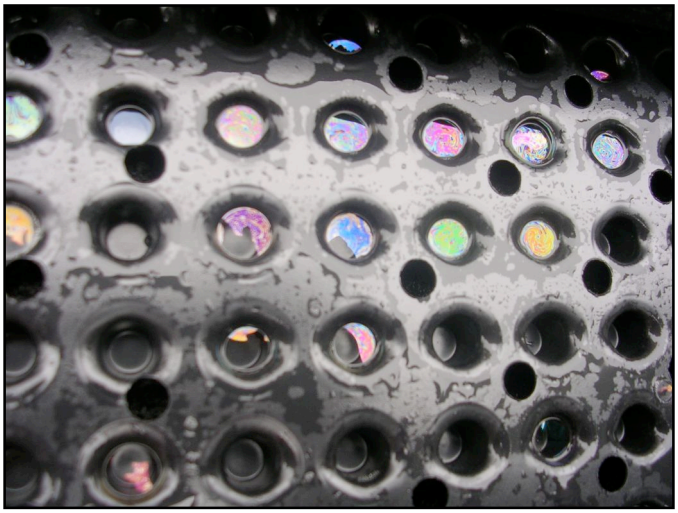
Saturated: R2.5

Current Rock Ballast: R 0

Our Calculated R-values:

- R-value of what is on the roof:
  -Rocks, R=0
- R-value of our soil mixture
  -6" of soil, R=4
- R-value of our soil saturated:
  -6" of saturated, R=2.5

Project Photos:




METRIC