

# SIUE Green Roof Environmental Evaluation Network

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# Outline

- Overview of G.R.E.E.N.
- Green Wall Maintenance
- Thermal Economic Analyses



# Overview of G.R.E.E.N.

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# Timeline

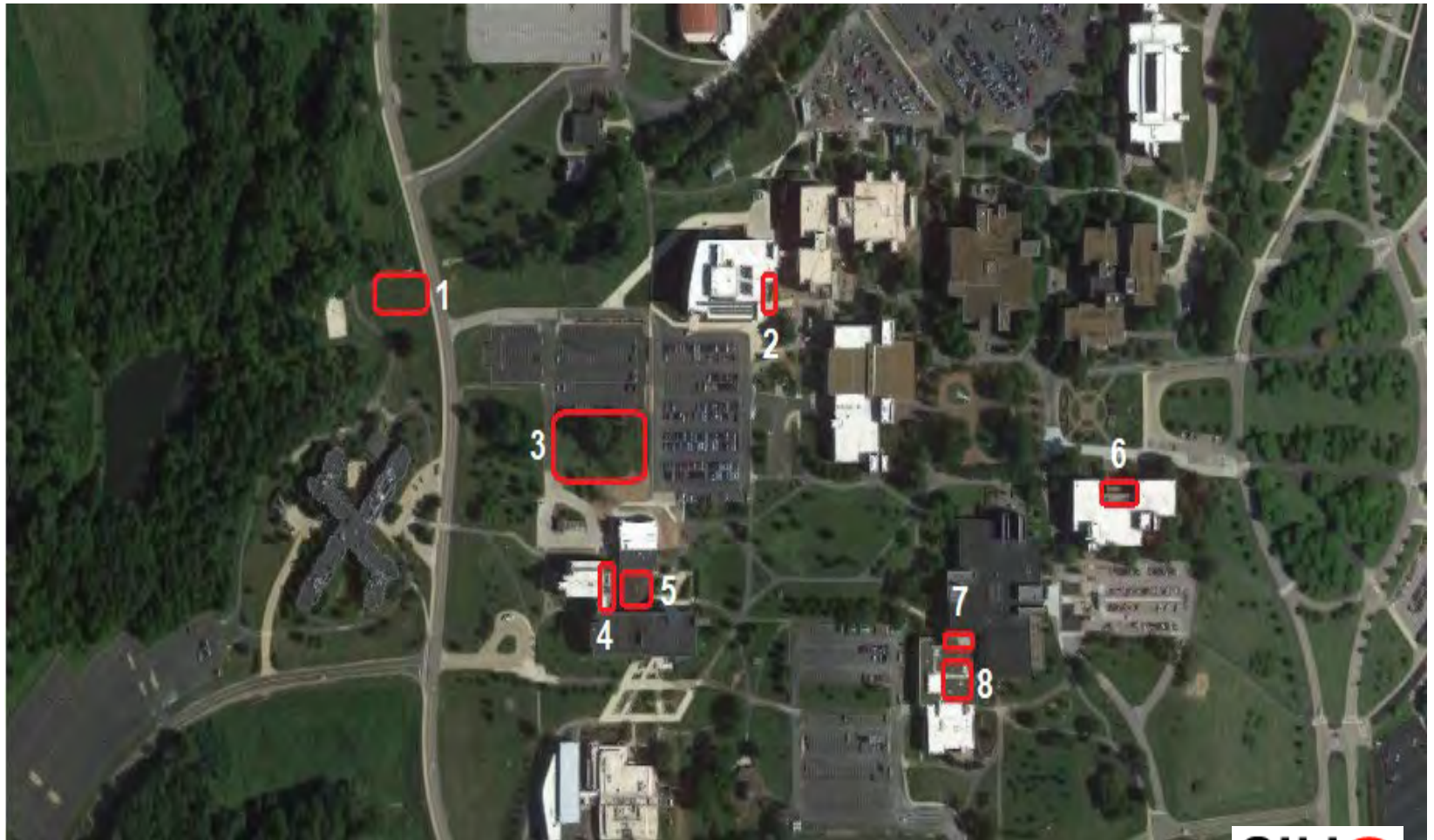
2004

2018



**SIUE**

# SIUE Green Infrastructure Sites





# Engineering Building





# Ground-level Field Site





# Student Success Center





# Types of Research



# Research Results

## Research

Research Sites

Current Research

## Citations of Research

Biodiversity

Maintenance

Plant Performance

Stormwater Quantity & Quality

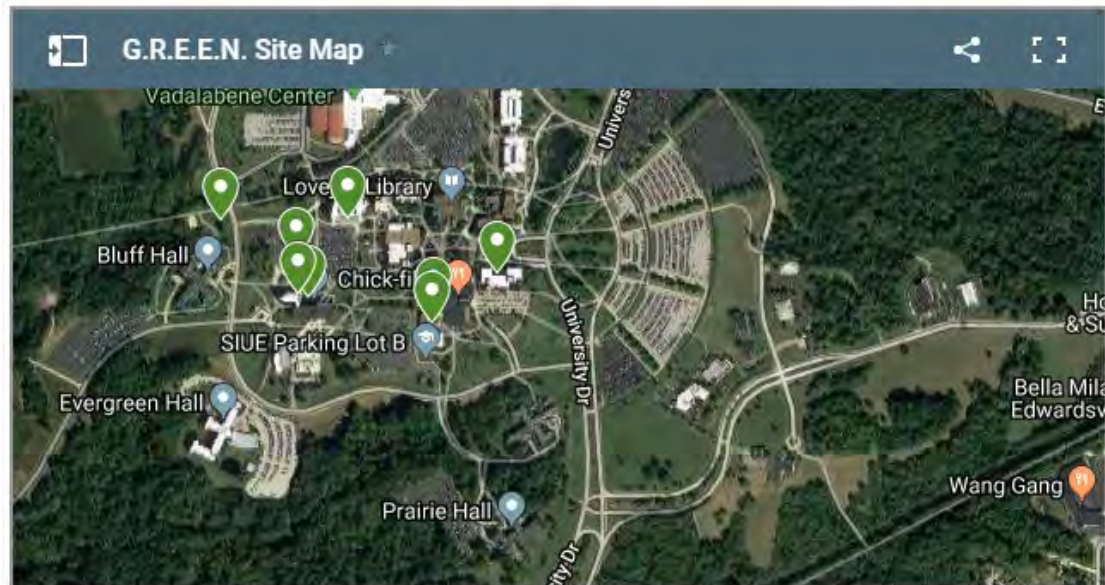
Thermal Performance

Other

## Immersive Sustainable Education

GREEN's efforts have resulted in a significant body of work evaluating living architecture systems in areas such as volume and quality of stormwater runoff, plant performance, maintenance, biodiversity, thermal characteristics, weight loads, wind uplift and new green roof technologies.

SIUE has a variety of research sites and green infrastructure on the main campus, many of which are shown on the following overview map. Research sites include the original research green roof on the Engineering Building laboratory wing, a ground-level field site, and the 16,000-square-foot Student Success Center green roof.



<https://www.siu.edu/green/research/index.shtml>

# Green Wall Maintenance

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# Green Retaining Walls



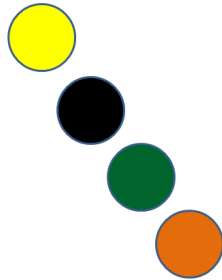
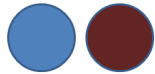
- Living wall that stabilizes a slope.
- Designed to:
  - Prevent erosion
  - Increase stormwater interception, infiltration.
  - Reduce Urban Temperatures
  - Beautify vertical space



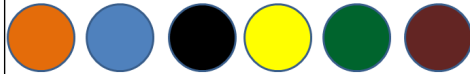




N



Replicate 3



Replicate 2



Replicate 1

- Unplanted Control
- *S. hybridum* 'Immergrauc'
- *S. kamtschaticum*
- *S. (Phedimus) takesimensis*
- *S. spurium*
- Mixed Sedum

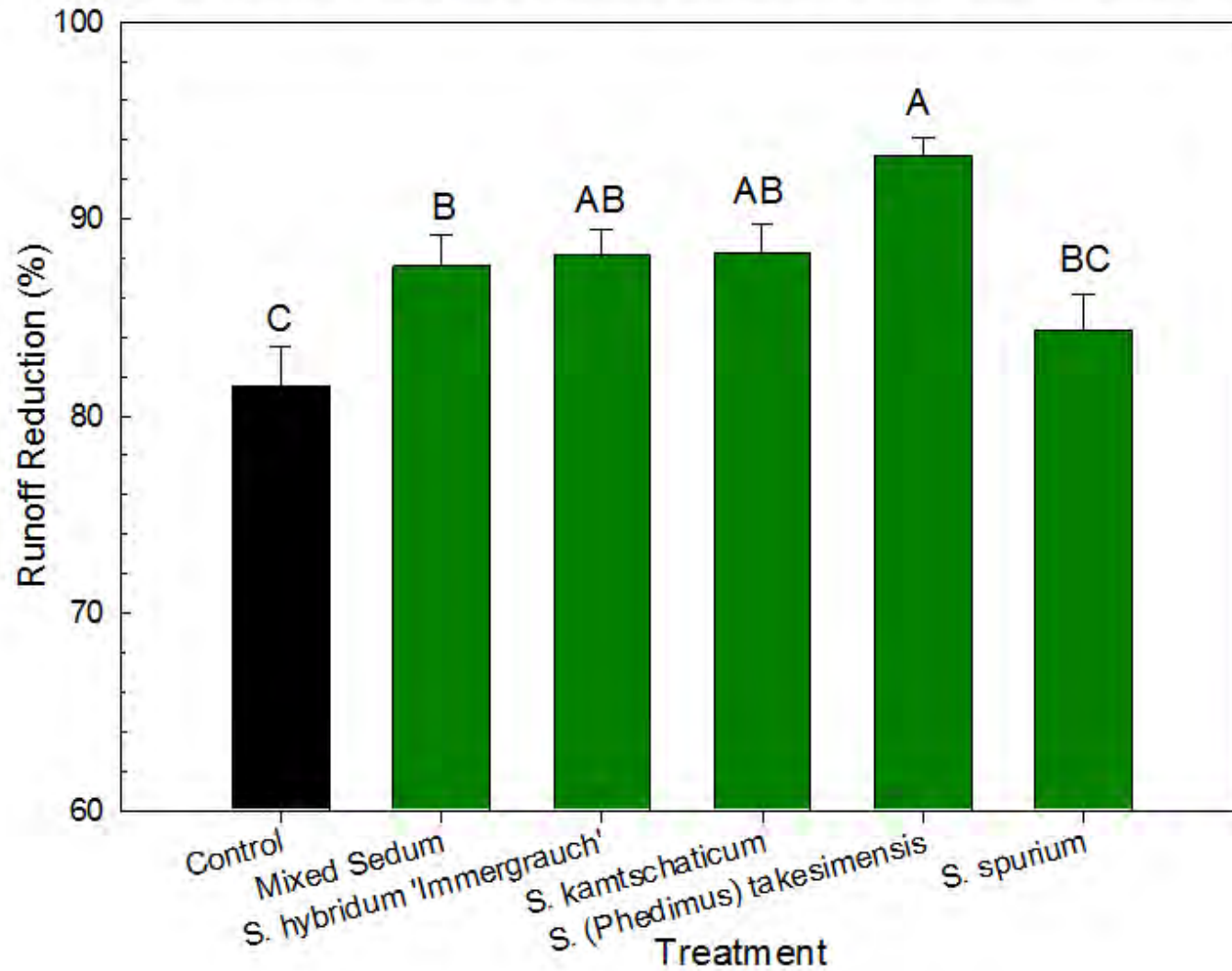




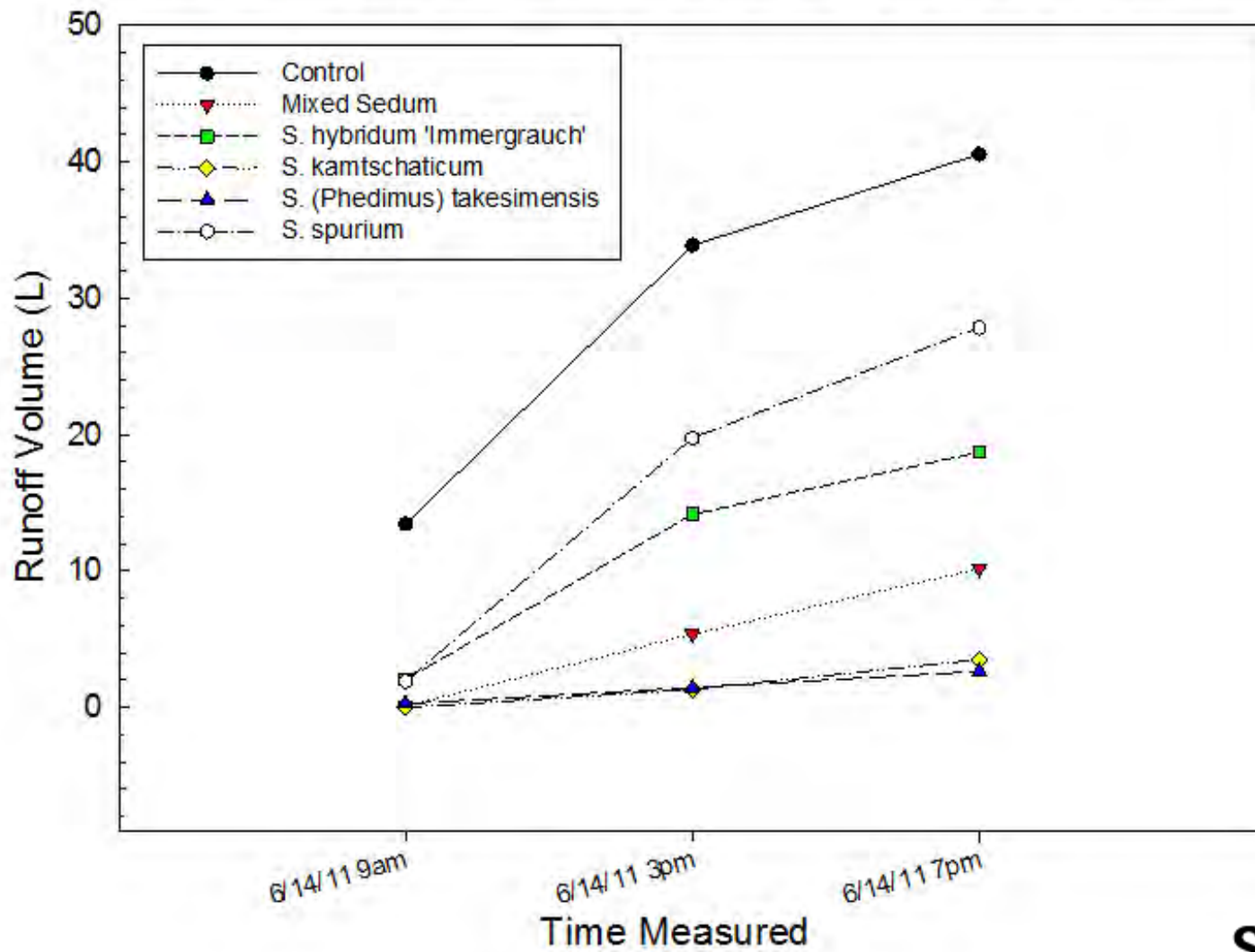
# Stormwater Collection



## Stormwater Runoff Reduction August-October 2010 & March-June 2011



## Cumulative Stormwater Runoff for 6/13/11 Event

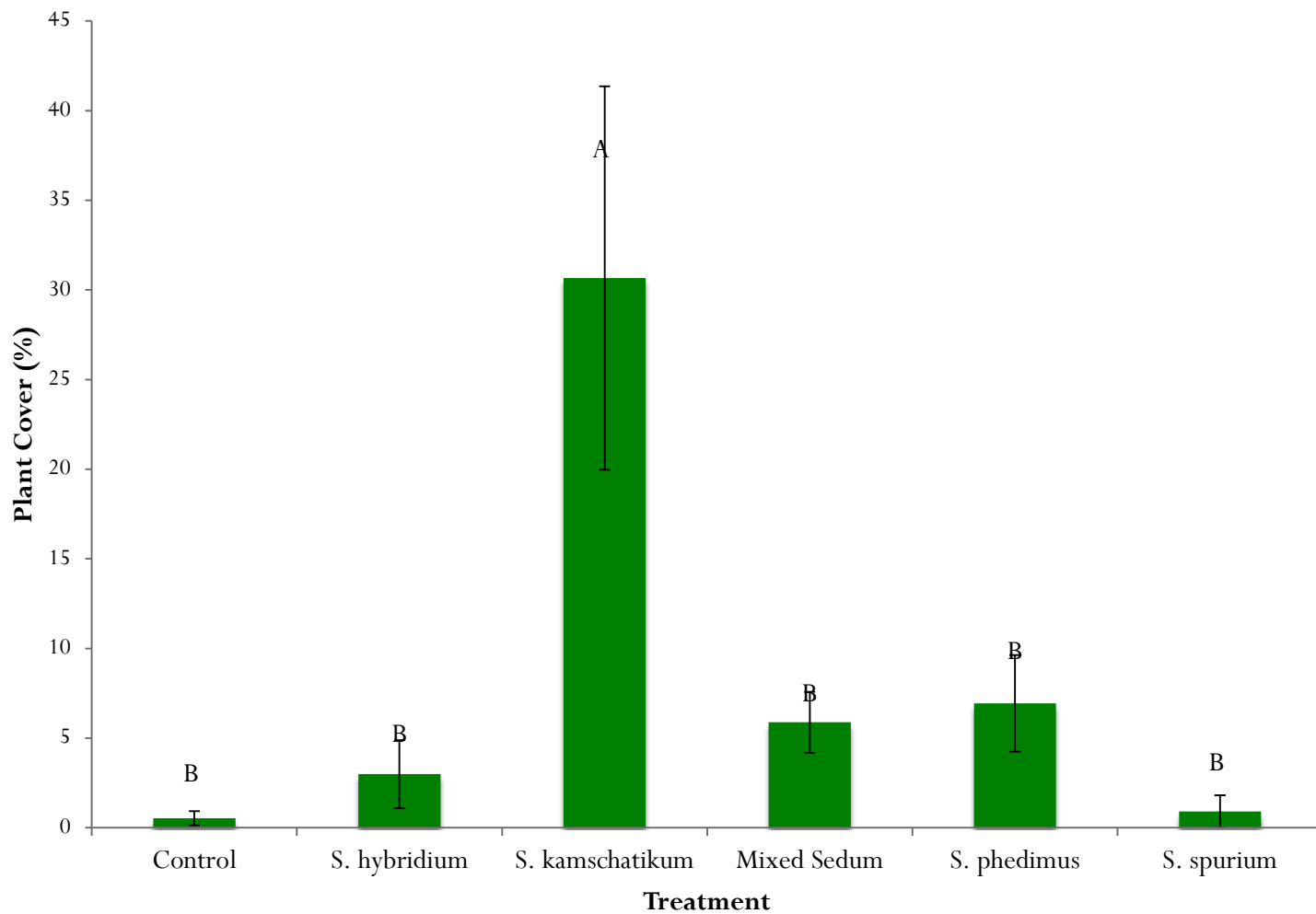






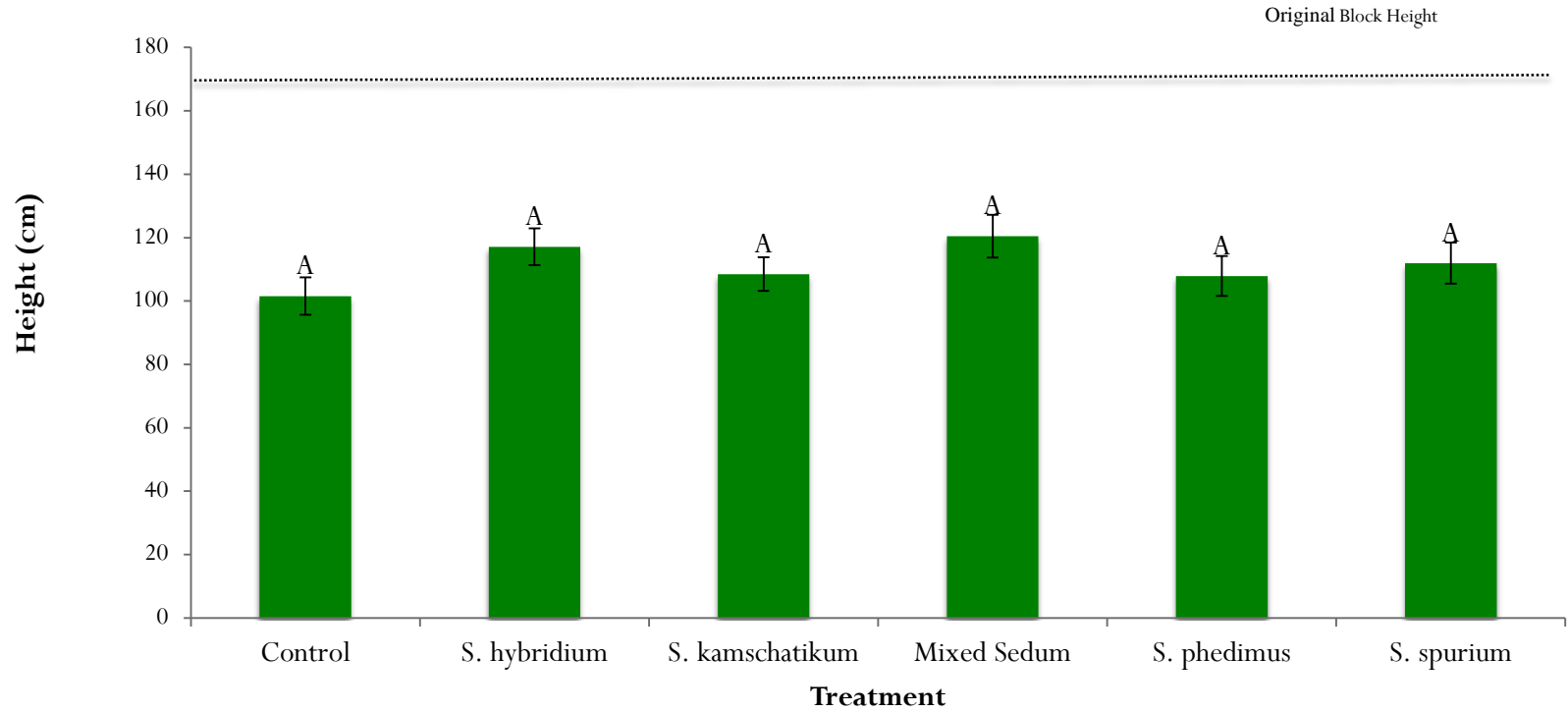


## Mean Plant Coverage by Treatment

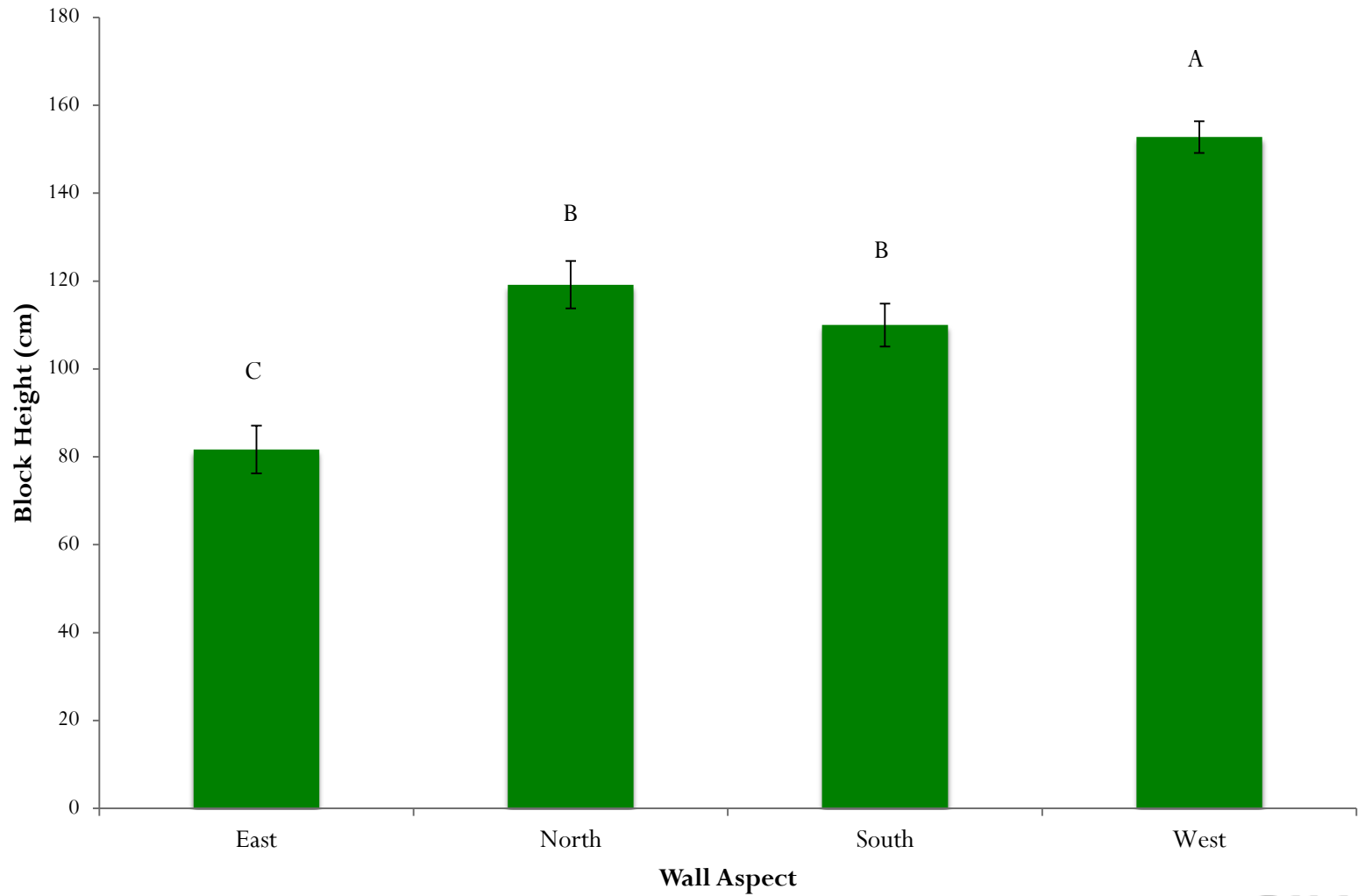




## Mean Block Height by Treatment



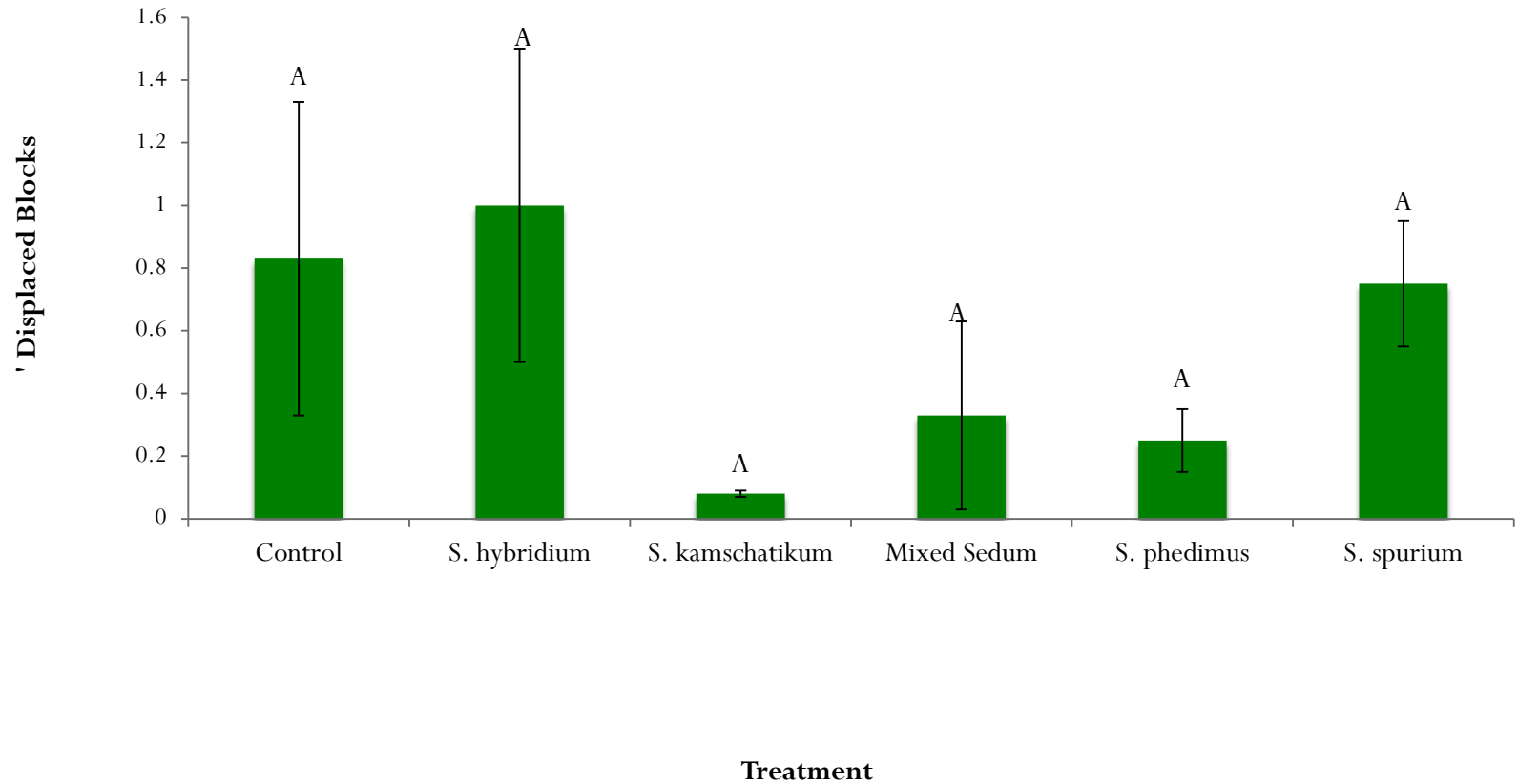
## Mean Block Height by Aspect

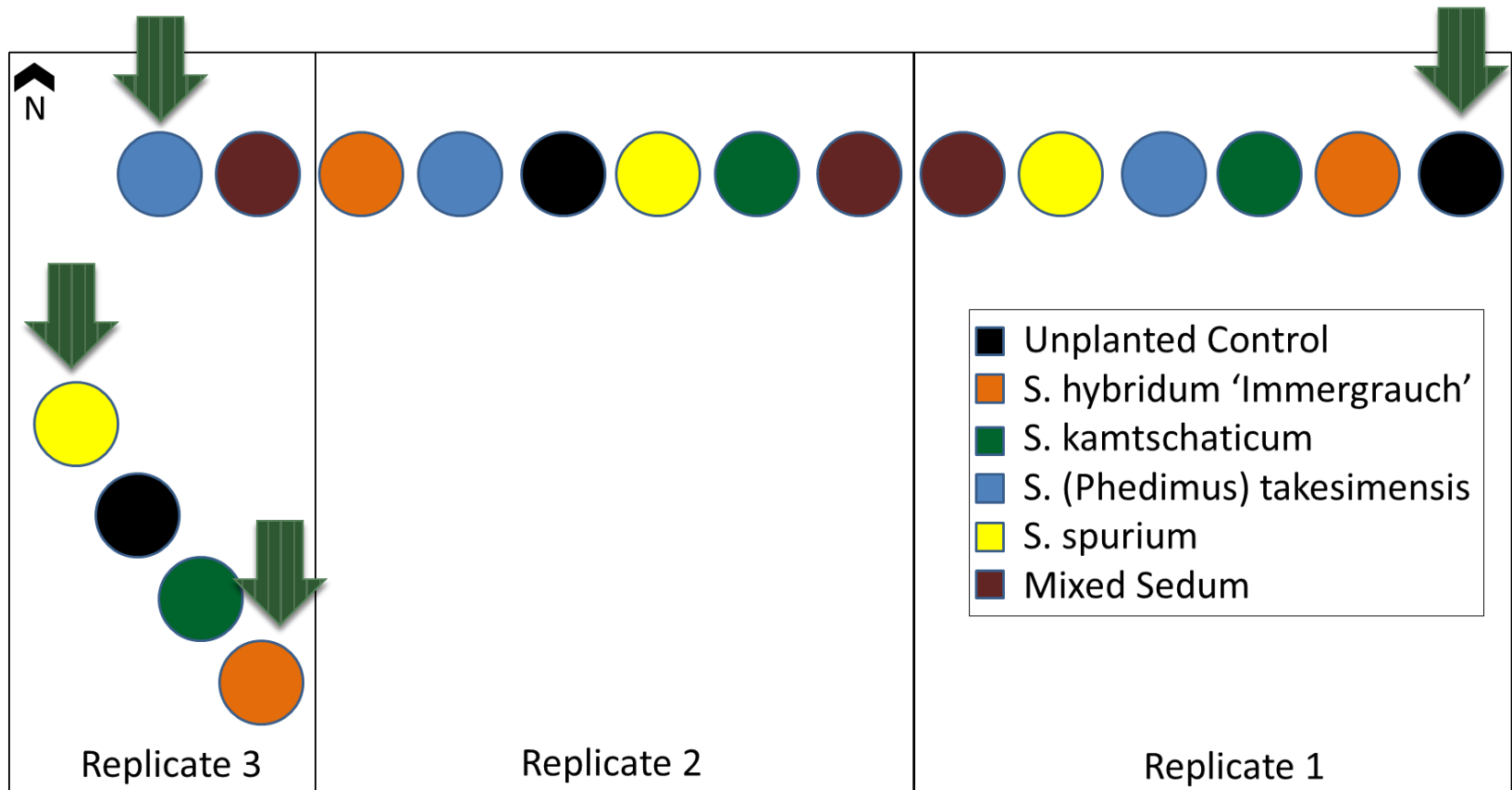






## Mean Number of Displaced Blocks by Treatment





# Long-Term Performance/Maintenance

- There has been some, limited block settling
- 38 of 990 blocks have been displaced (~4%)
- 5 of 990 blocks have been dislocated (<1%)
- Many of the original plants are still covering the wall system















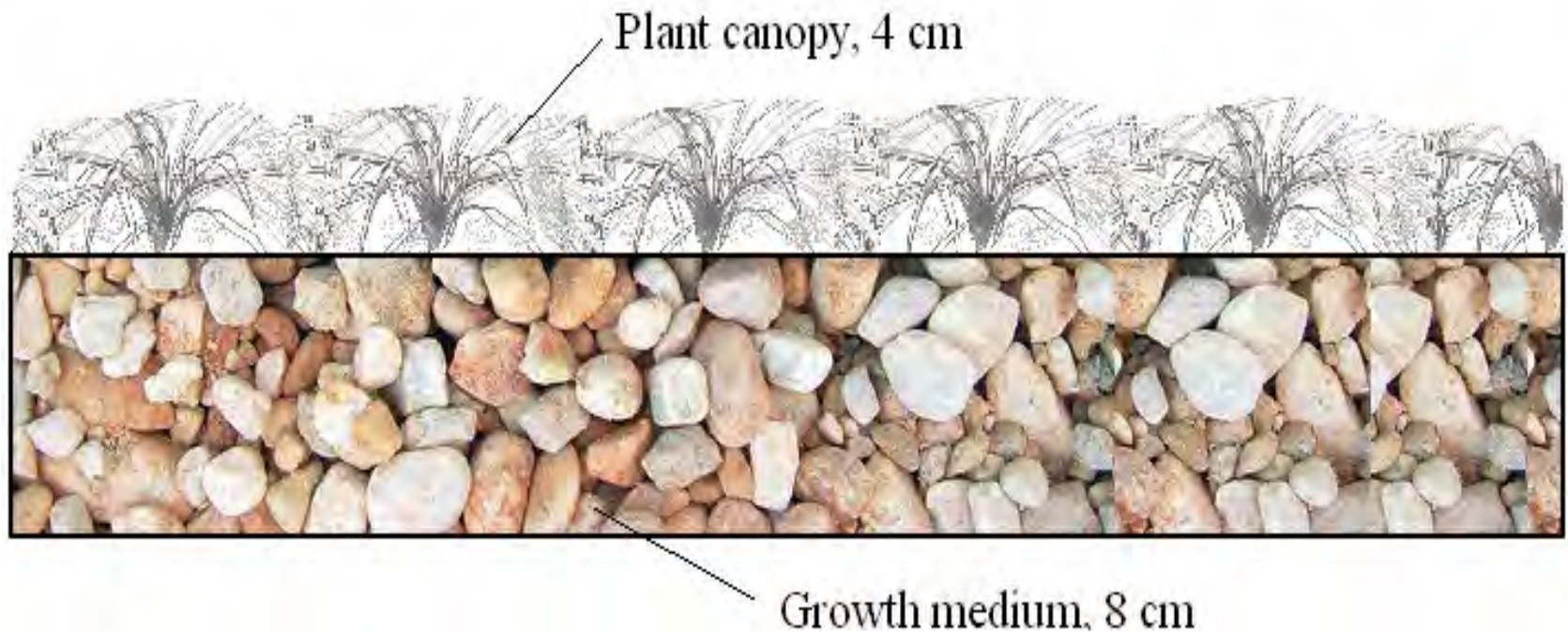


# Thermal Economic Analyses

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# Thermal and Economic Analyses



Coupled green roof model



# Theory

$$q_{\text{radiation}} = \alpha A (G_{ND} + G_d + G_R) - \varepsilon \sigma A (T_s^4 - T_\infty^4)$$

Reflected irradiation

Diffuse irradiation

Normal direct irradiation

$$q_{\text{convection}} = hA(T_s - T_\infty)$$

$$q_{\text{conduction}} = \frac{A(T_s - T_r)}{R_{\text{total}}}$$

Unit thermal resistance  
through all layers

$$R_{\text{total}} = \frac{L_1}{k_1} + \frac{L_2}{k_2} + \frac{L_3}{k_3} + \dots$$

# Vegetation



*S. kamtchaticum*



*S. spurium*



*S. sexangulare*

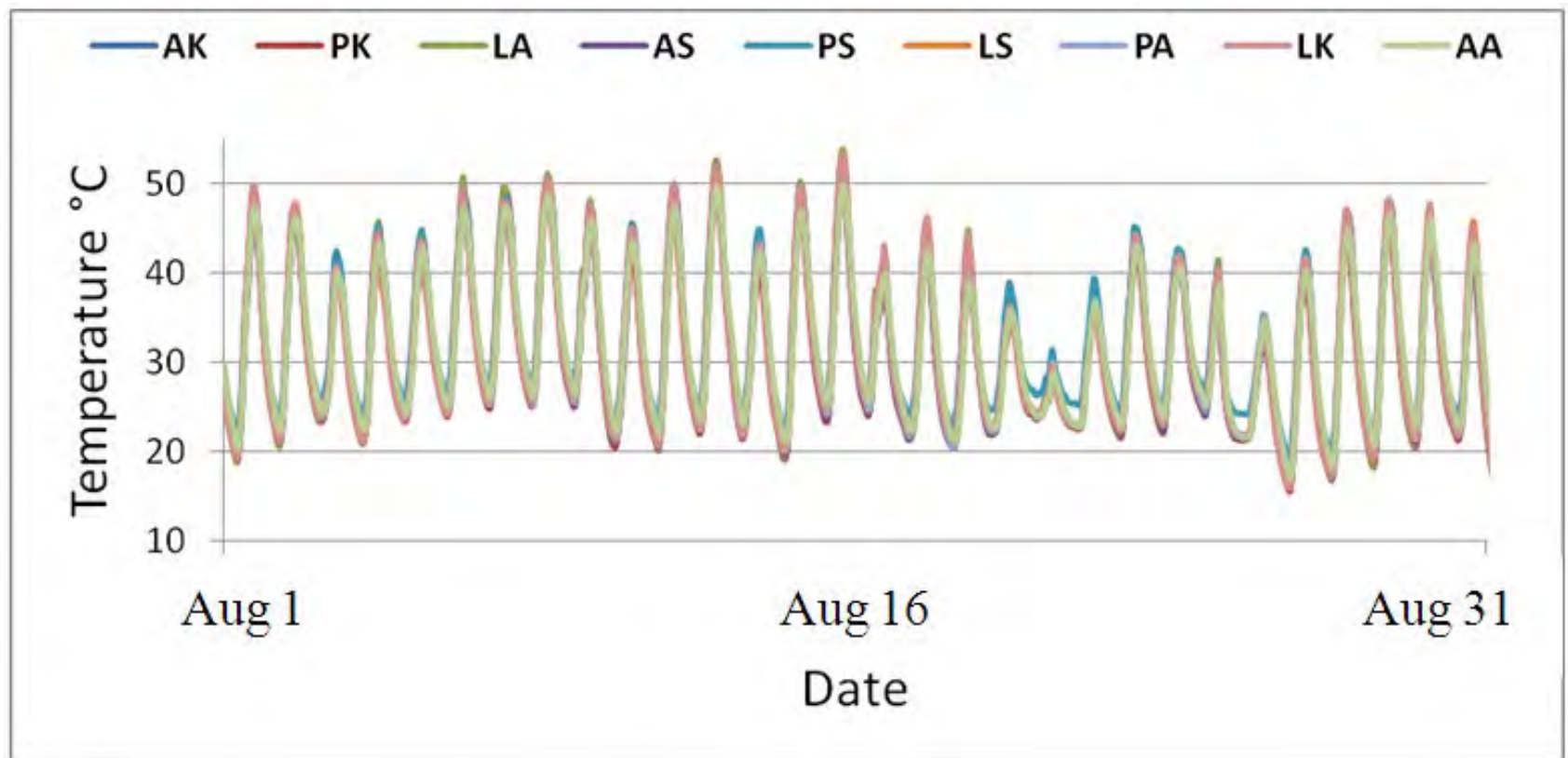
# Growing Media

Media	Description
Arkalyte	Clay heated to 1000 °C
Lava	Volcanic rock
Pumice	Volcanic Rock

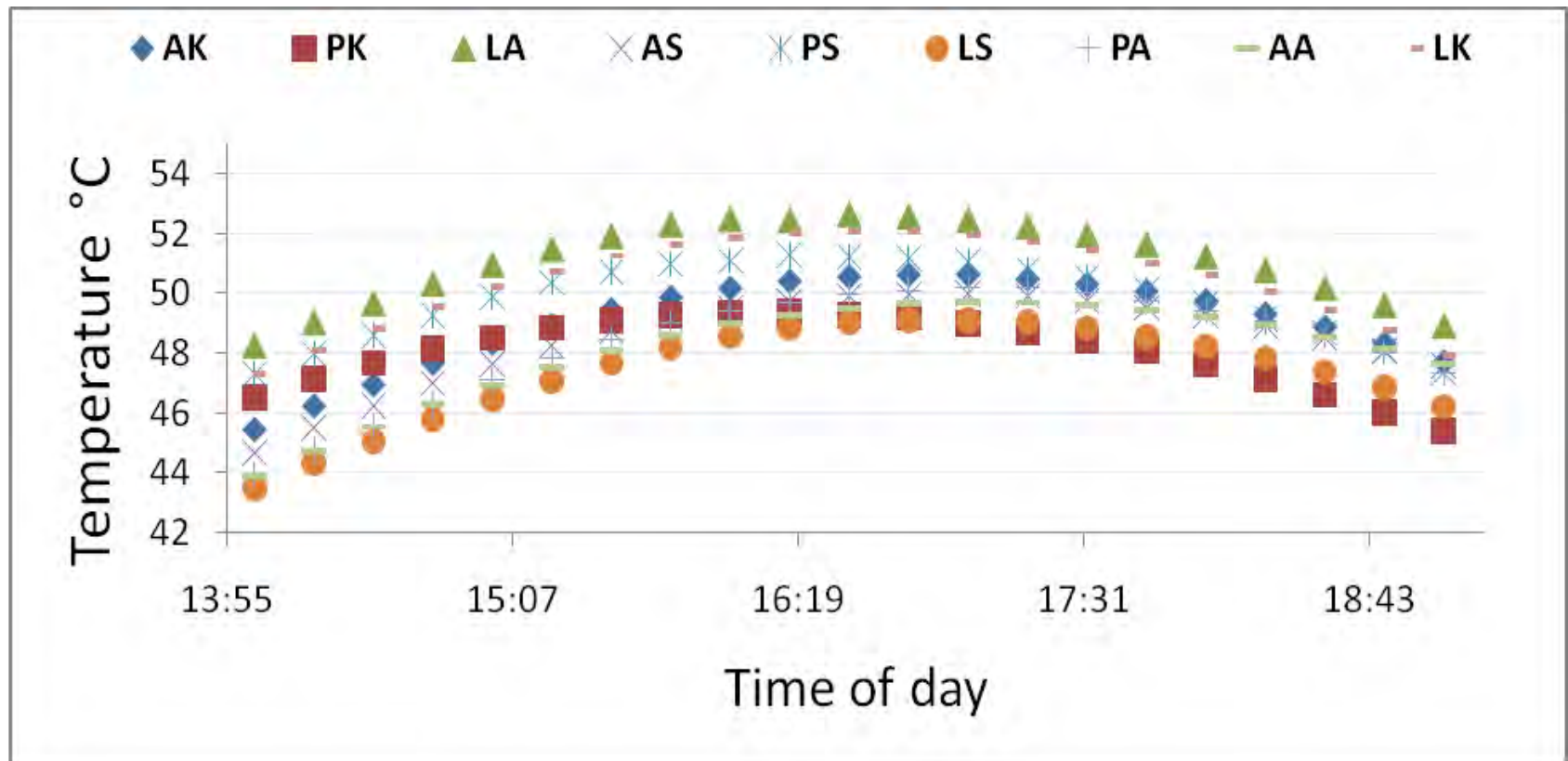




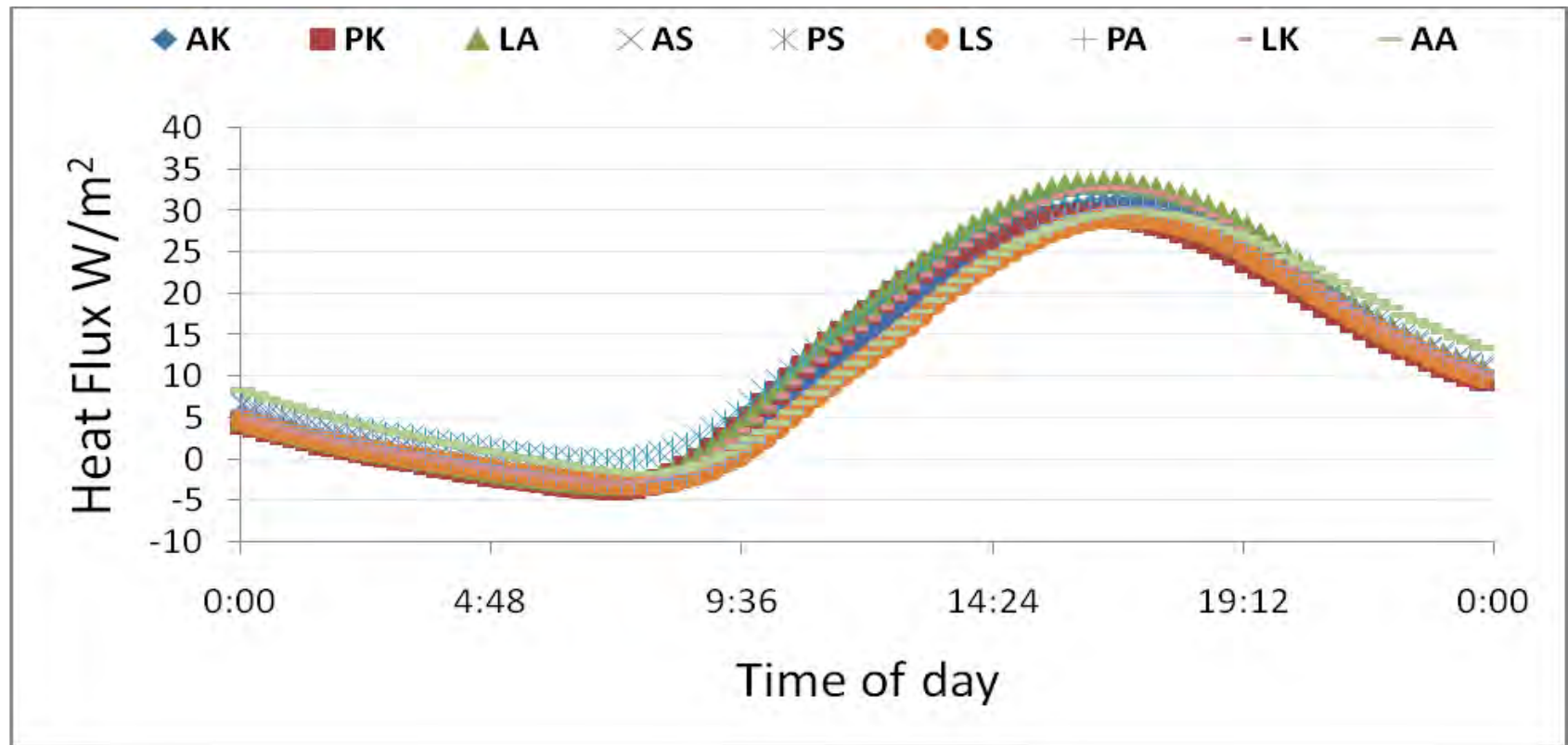
# Temperature Data for All Combinations



# Peak Hours on August 12, 2007

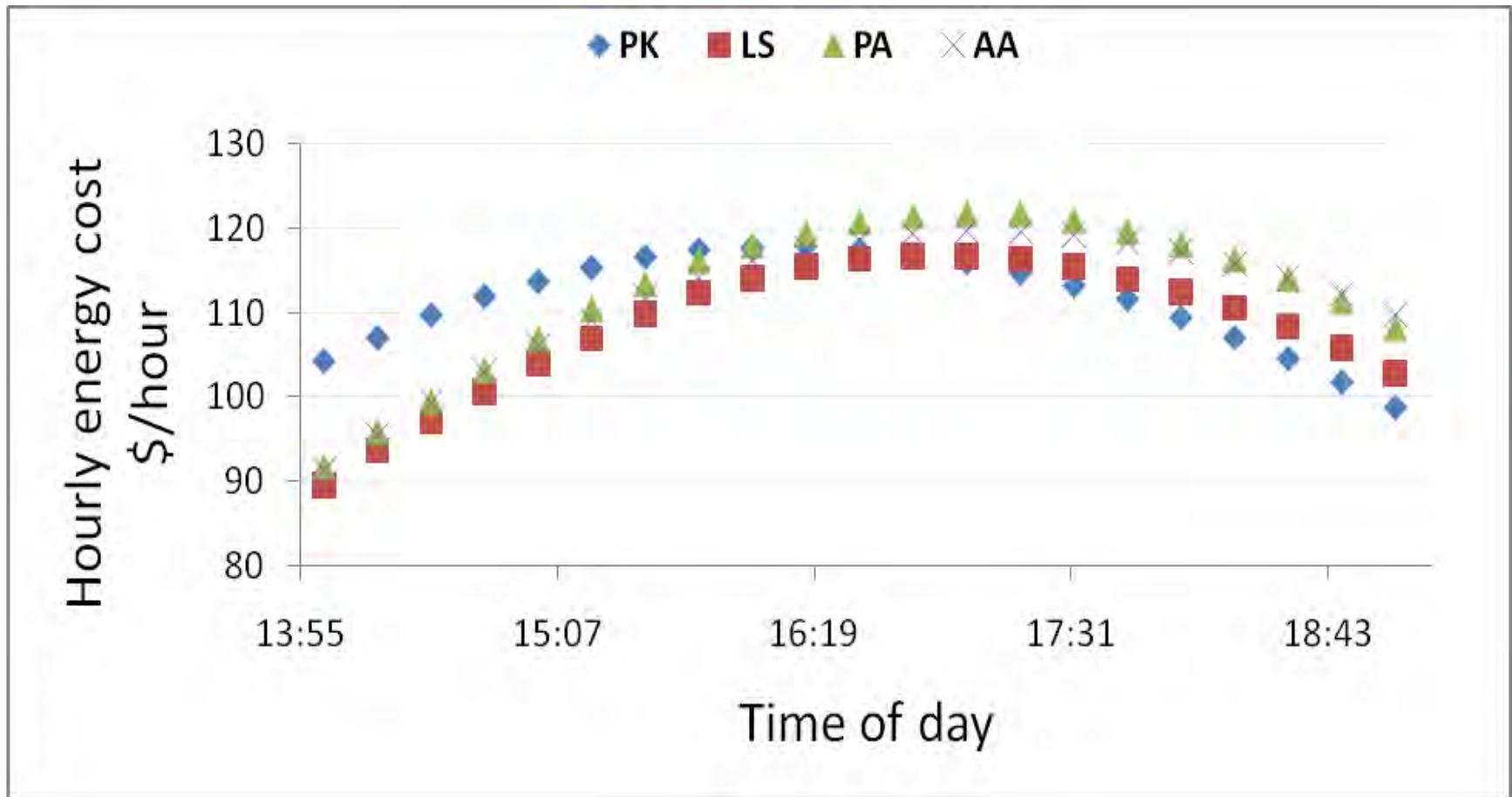


# Heat Flux on August 12, 2007





# Energy Cost of a 50,000 m<sup>2</sup> Roof during Peak Hours



# Summary: Thermal

- The color of the growth media and the vegetation affects the thermal radiation to/from the green roof blocks significantly.
- The porosity of the growth media helps the evaporative cooling of the roof after rain/irrigation events. This is an active cooling process in addition to the added thermal resistance to the roof by the green roof systems.
- The more condensed the leaves are, the better shading effect occurs, resulting in better insulation in air-conditioning seasons. Maintenance helps achieve higher plant coverage and leaf area index, resulting in improved thermal benefits.

# Questions?

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<https://www.siue.edu/green>

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