

Living Systems for Improving Energy & Water Balance of Buildings

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Outline

- Green Roofs
 - Types
 - Benefits
- Green Walls
 - Types
 - Research
 - ◎ Growth
 - ◎ Water
 - ◎ Temperature
 - ◎ Energy Effects
- Integration of Living Systems
 - UMd Solar Decathlon =
WaterShed



Green Roofs



“Intensive Green Roof”



Construction Materials

Vegetation

Growing Medium

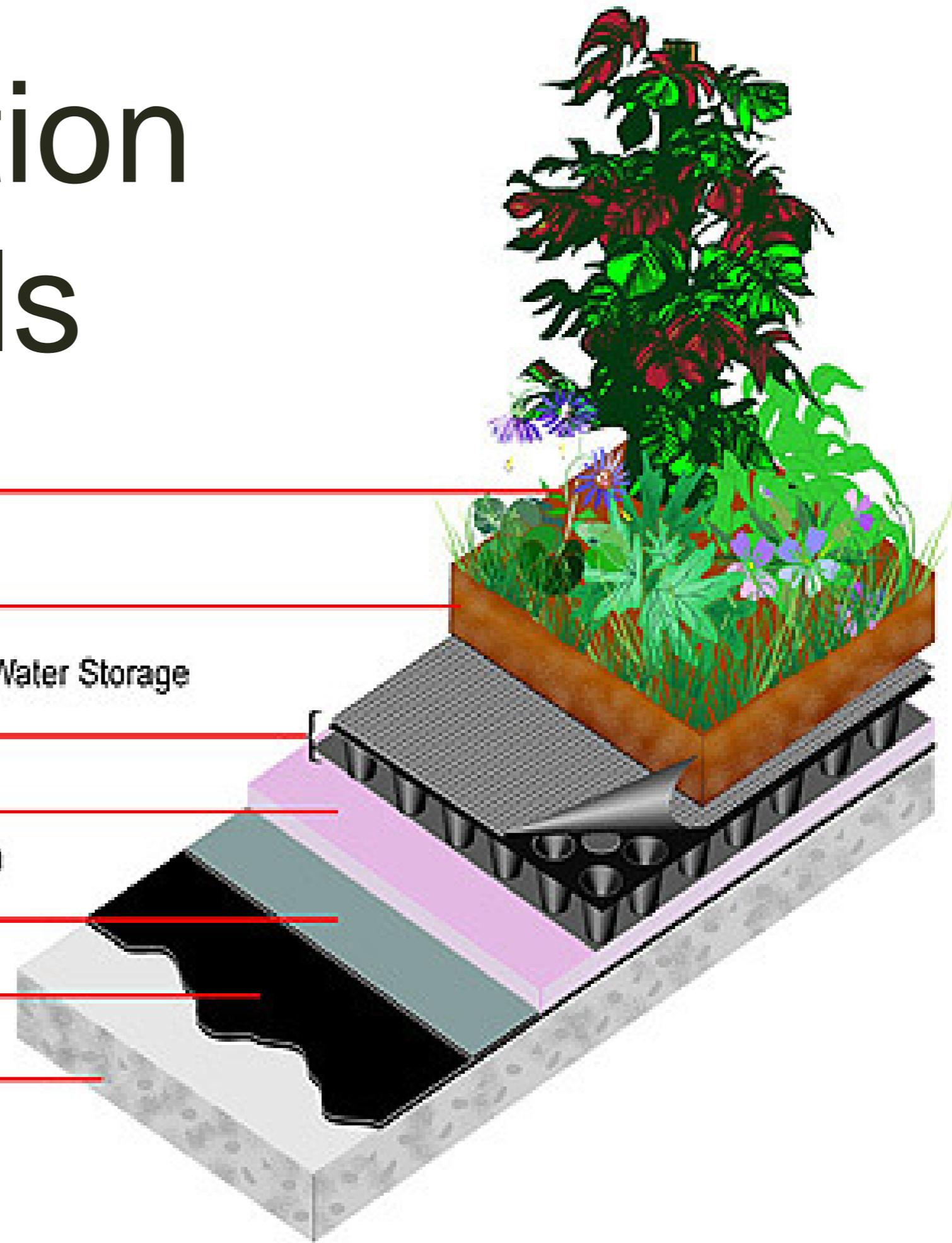
Drainage, Aeration, Water Storage
and Root Barrier

Insulation

Membrane Protection
and Root Barrier

Roofing Membrane

Structural Support



“Extensive” Sedum Green Roof



One Year Later



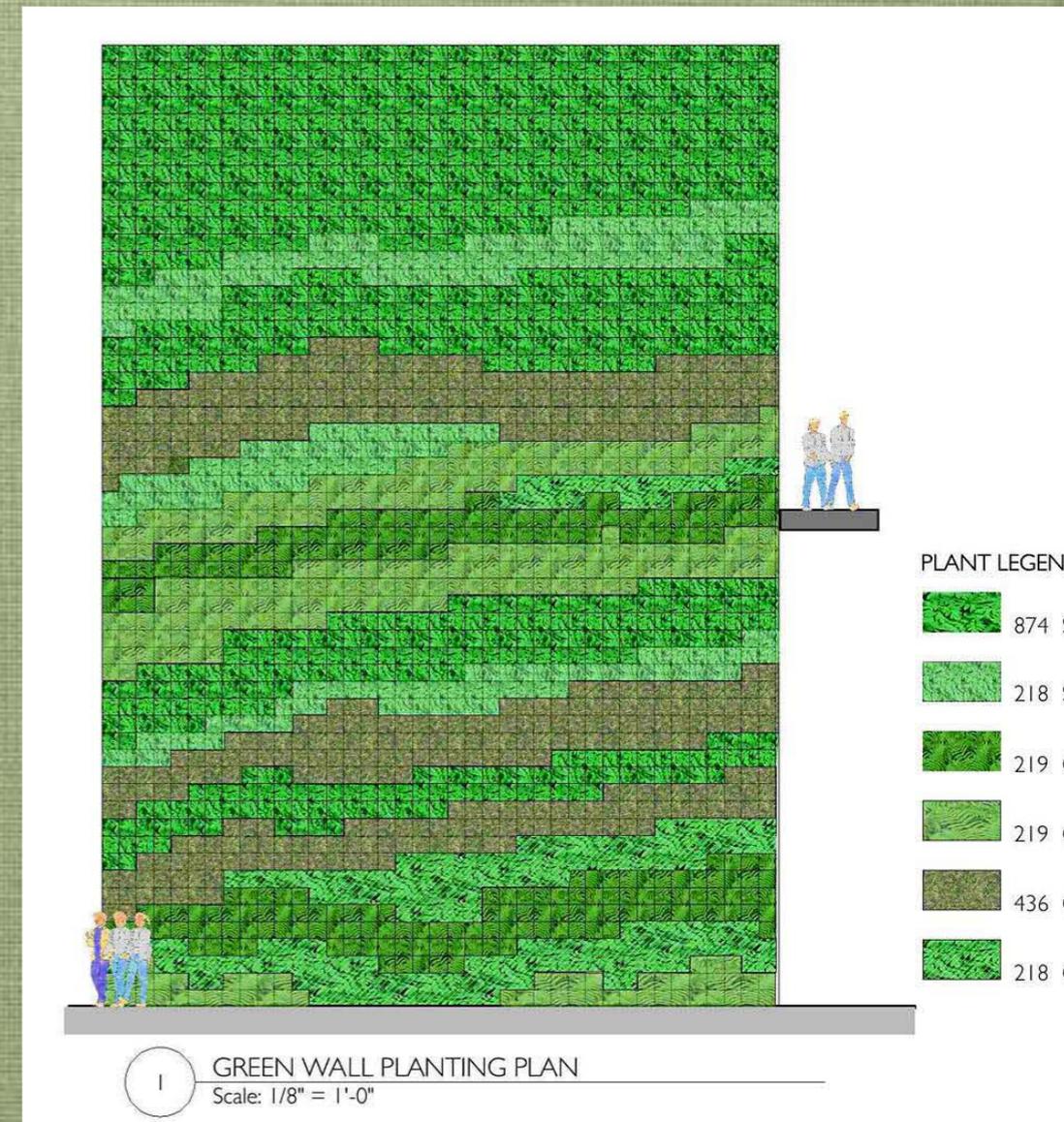
Green Roof Benefits

- Stormwater Management
- Water Quality
- Cool Buildings
- Aesthetics
- "Ecophilia"
- Habitat



Green Walls

VANCOUVER AIRPORT
 Site / transit planning and preliminary design (top)
 Detailed green wall design (right)





modular living wall panels



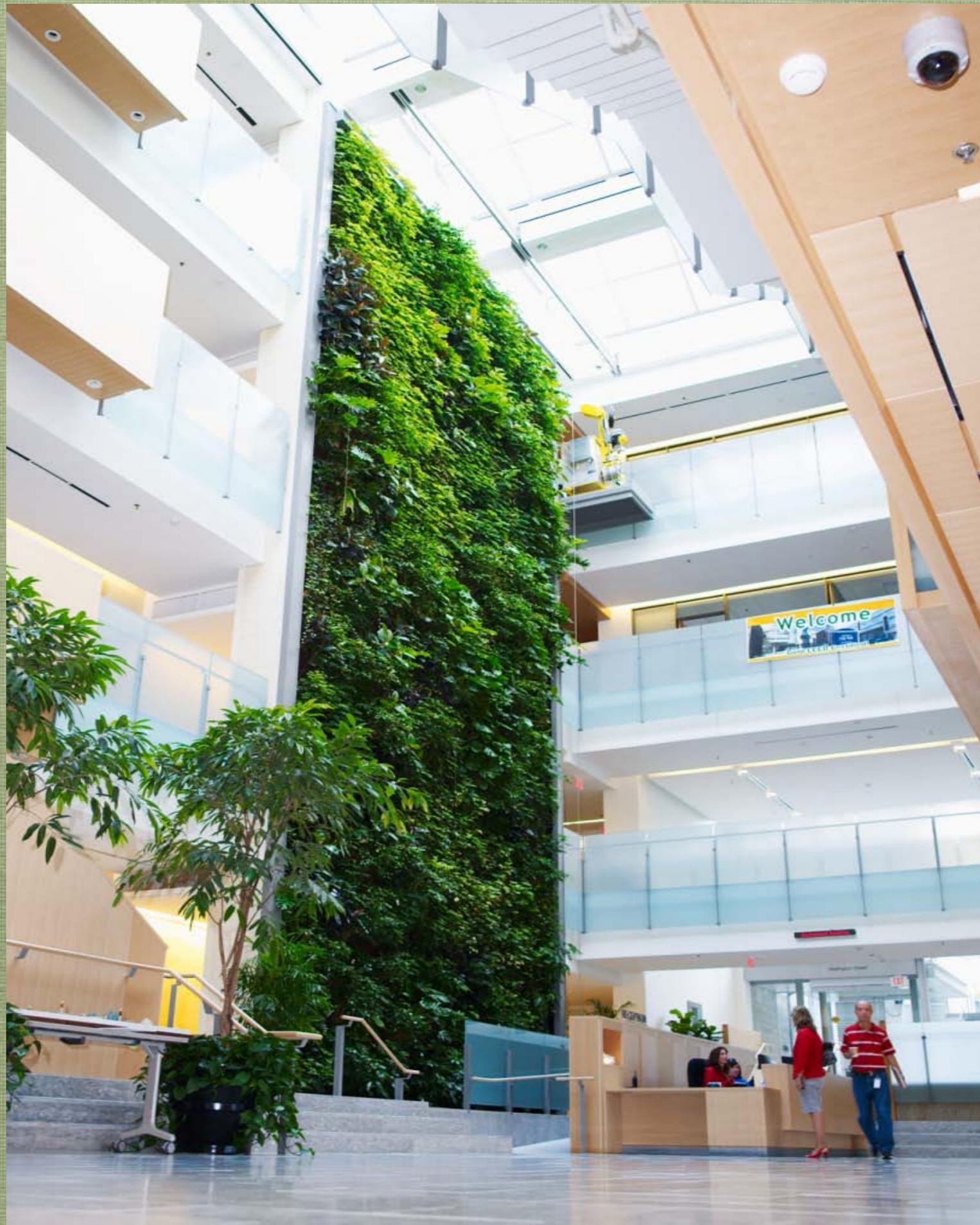
- fabric panels pre-vegetated
- plugs rooted in hydroponic gel
- vertical production in greenhouse



Air Biofiltration with Fabric Hydroponic Wall



Indoor Living Walls as Biofilters of toxic VOCs in air



VINE + TRELLIS SYSTEMS









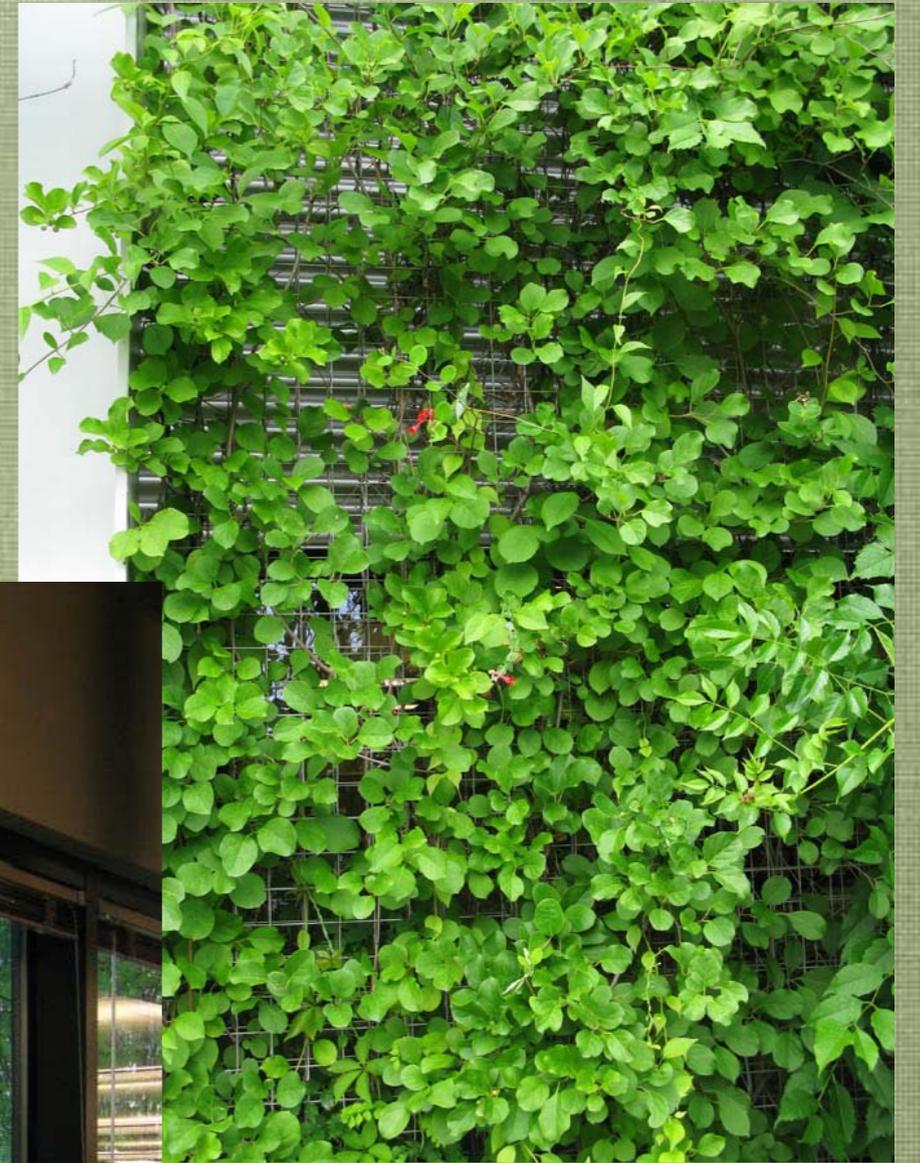




**Eastern Village Co-Housing,
Silver Spring, MD**

**National Wildlife Federation,
Reston, VA**





VINE SPECIES TO AVOID







Maryland Greenwall Experiment

2009 - 2011

University of Maryland

College of Agriculture & Natural Resources
Ecosystem Engineering Design Lab

Green Roofs for Healthy Cities
Greenwalls Research Group



Maryland Greenwall Experiment

CONTROL
BUILDINGS

GREENWALL
BUILDINGS



On Building Walls

4.5 Months (June 7th, 2010)

Building #1



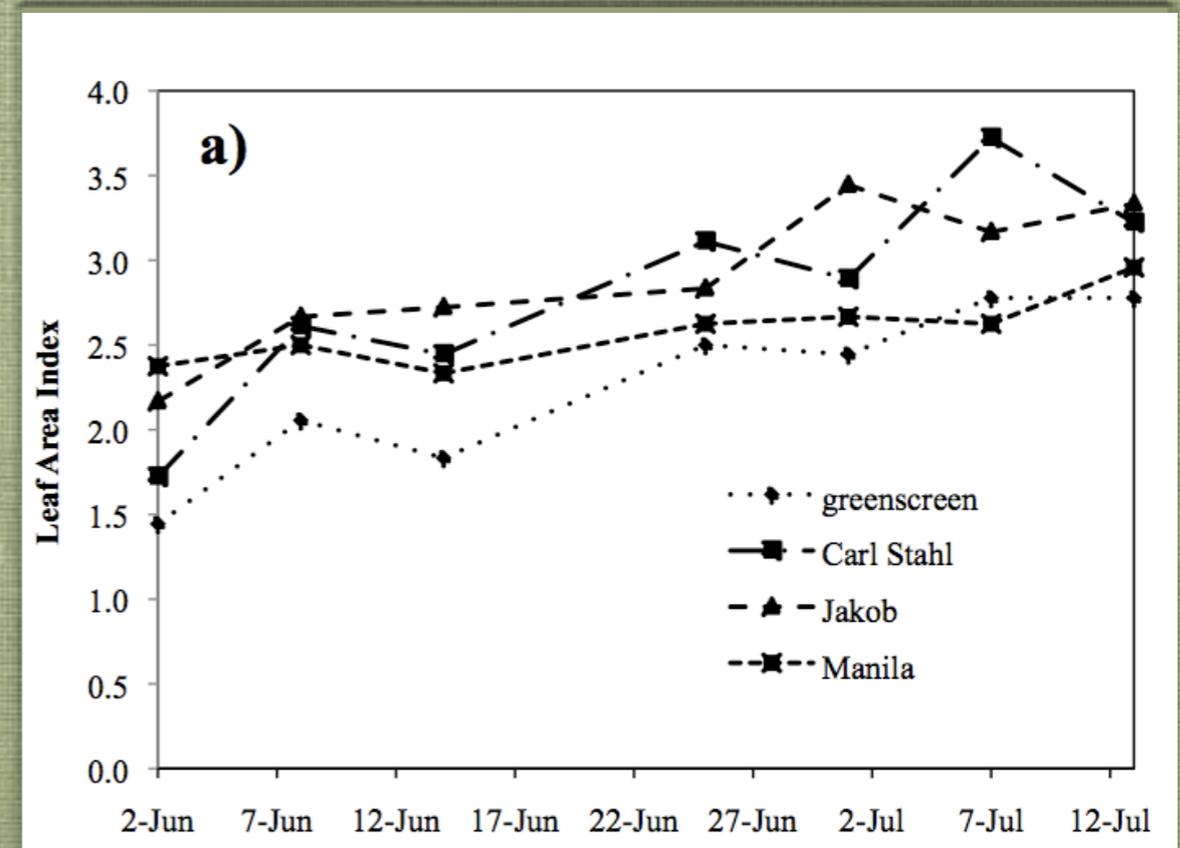
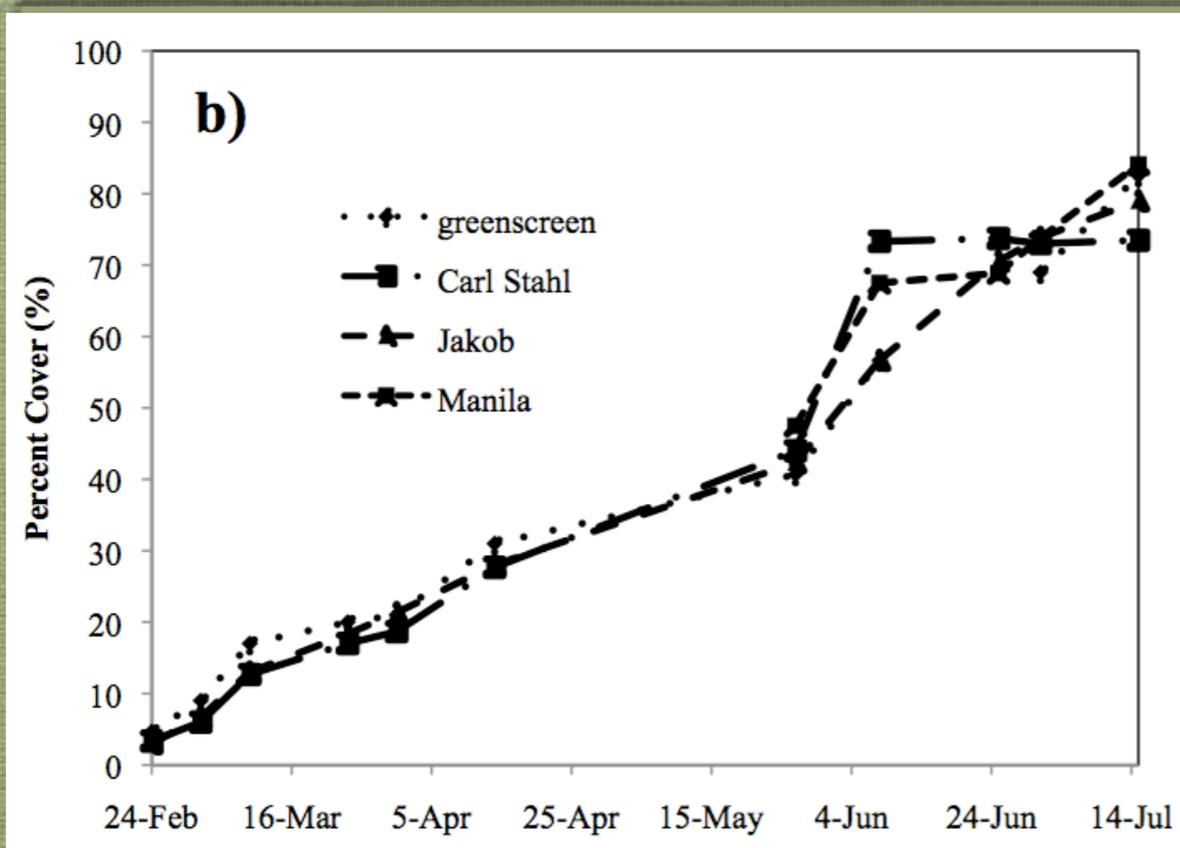
Building #2



Vegetation Growth

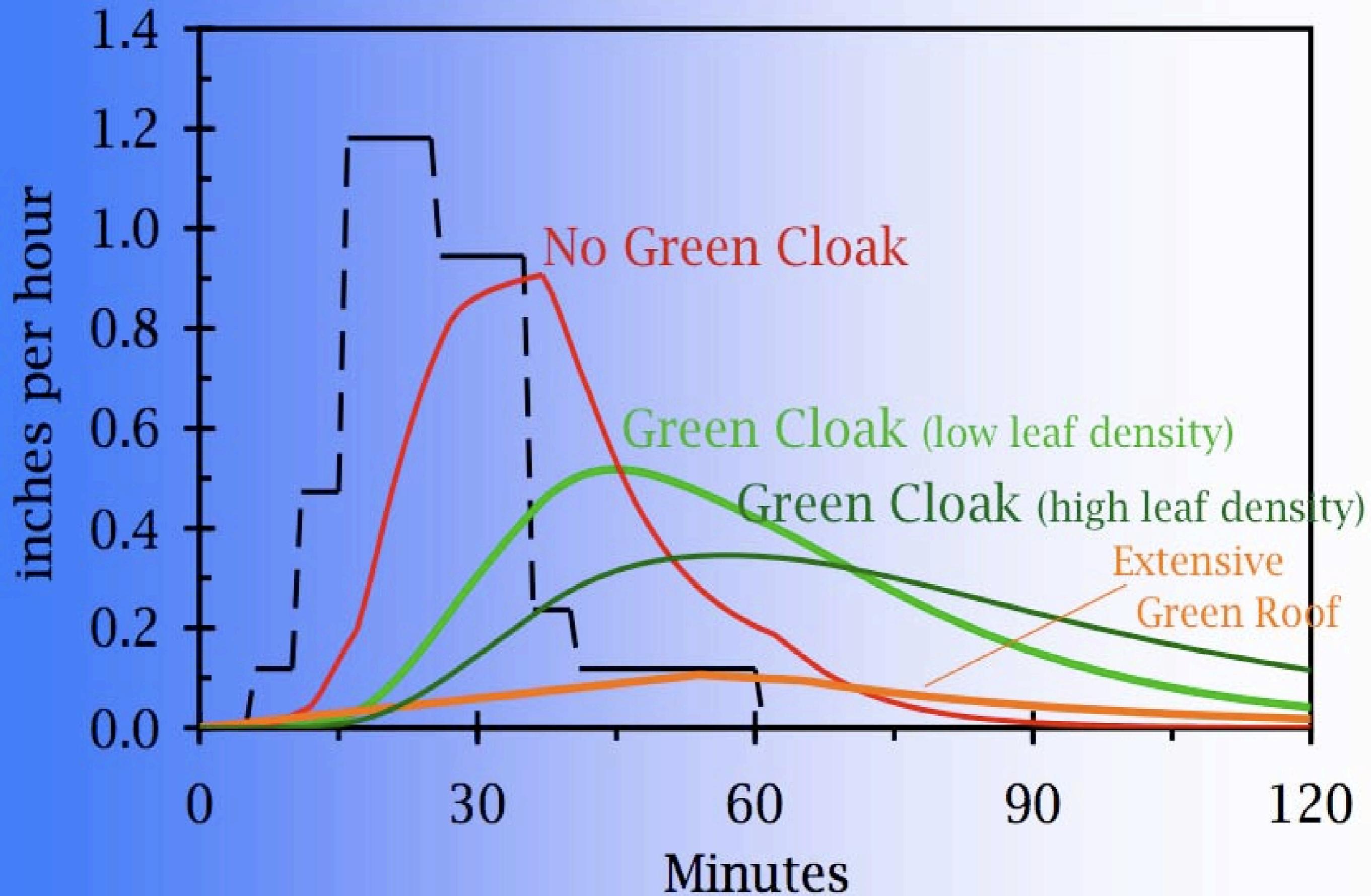
Percent Cover

Leaf Area Index



Water Use & Stormwater Retention

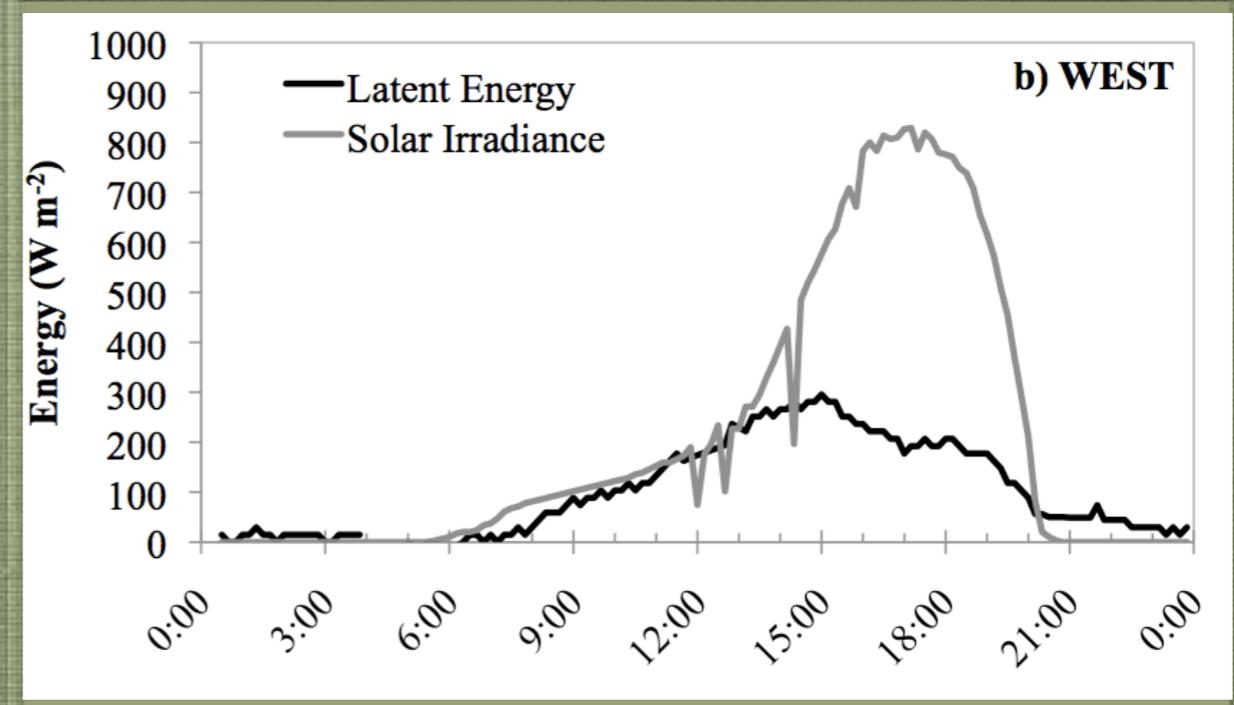
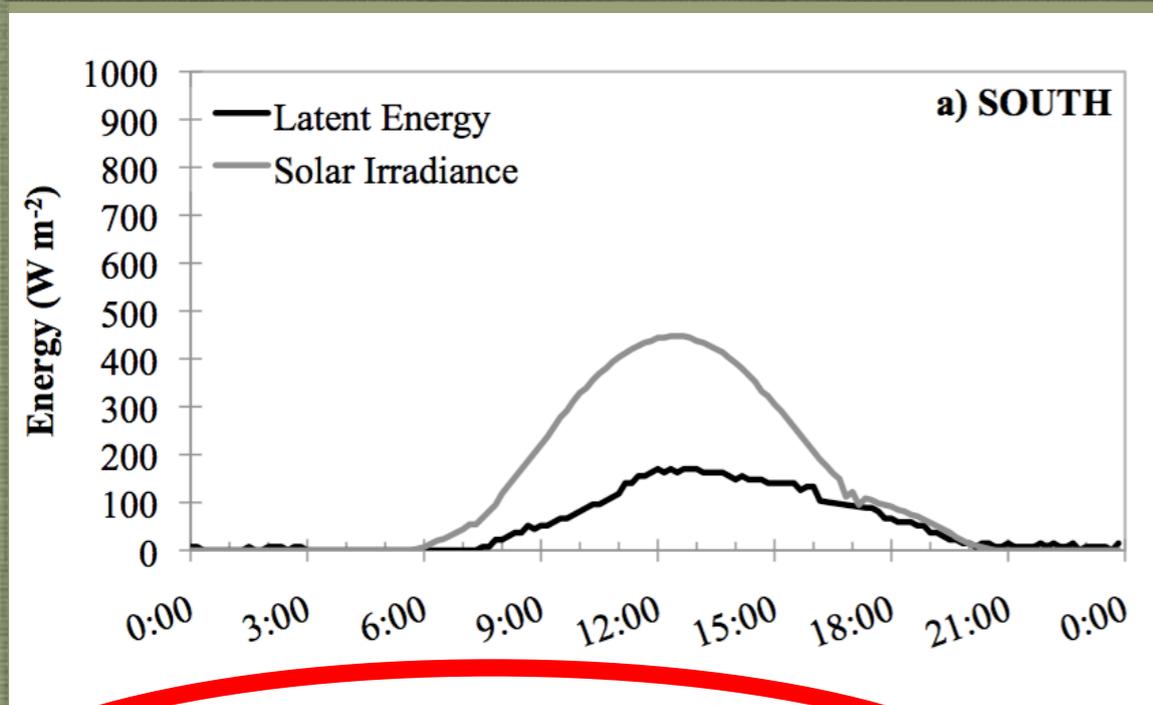
Storm Hydrograph for Green Cloak



Plant Water Use

South-facing

West-facing



Evapotranspiration

Liters/m²/day

2.8

5.2

Watts/m²

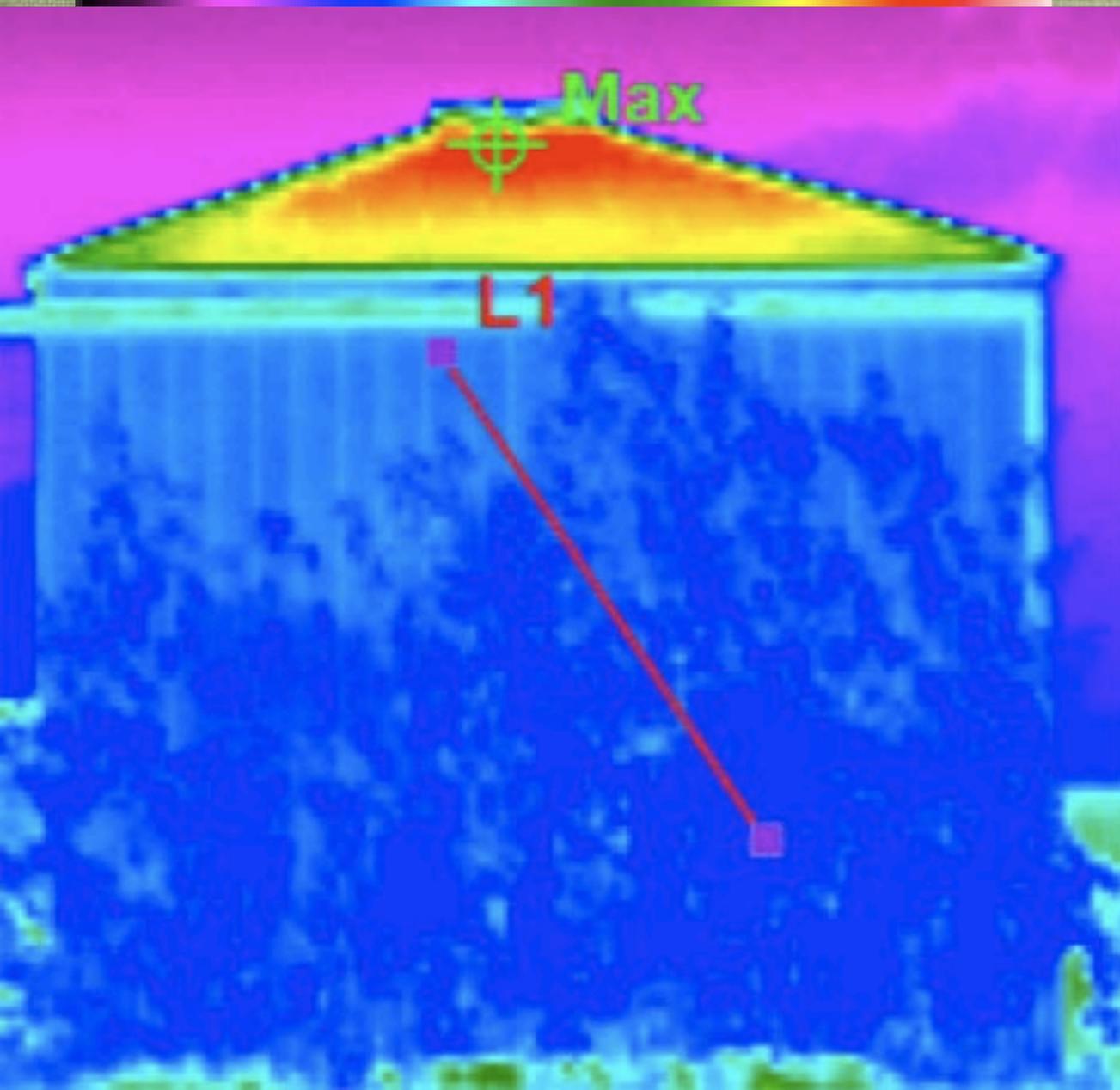
72

133

Temperature Effects

Cooling Effect: Thermal Imagery Grape Green Wall (2009)

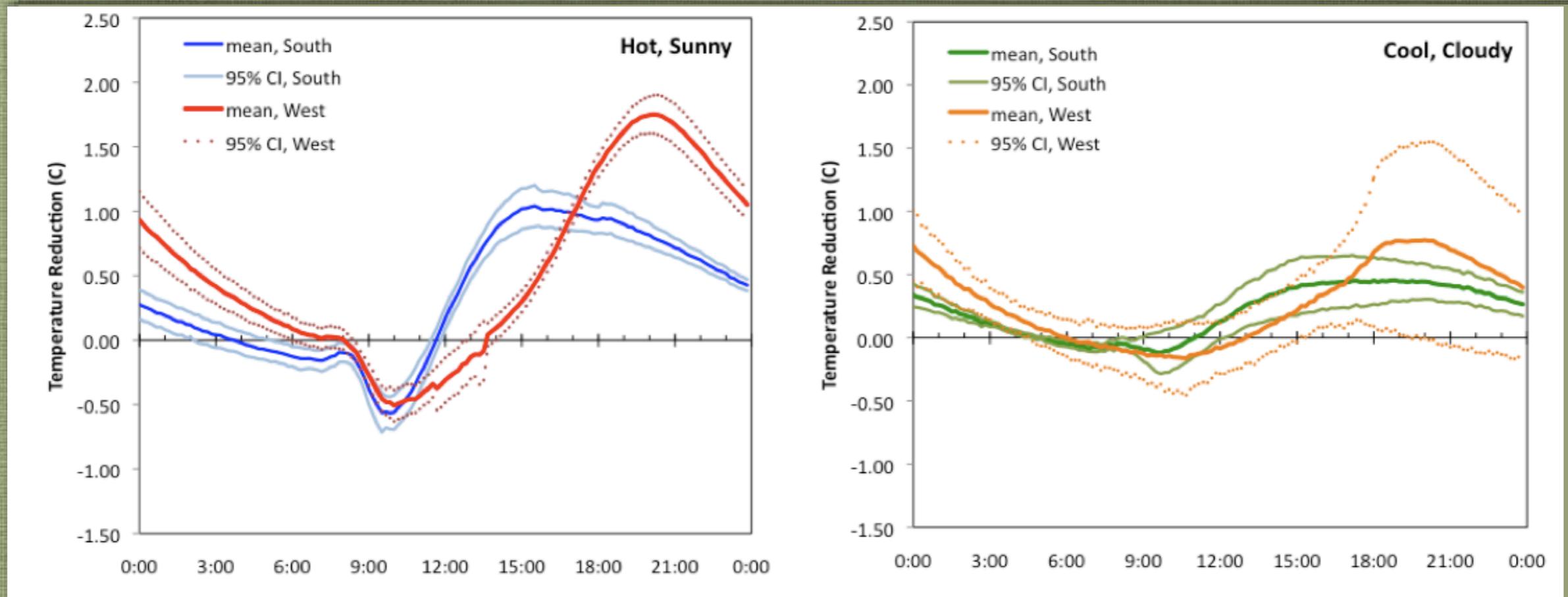
20 30 40 50 60 °C



Interior Air Temperature Reduction

Hot, Sunny

Cool, Cloudy



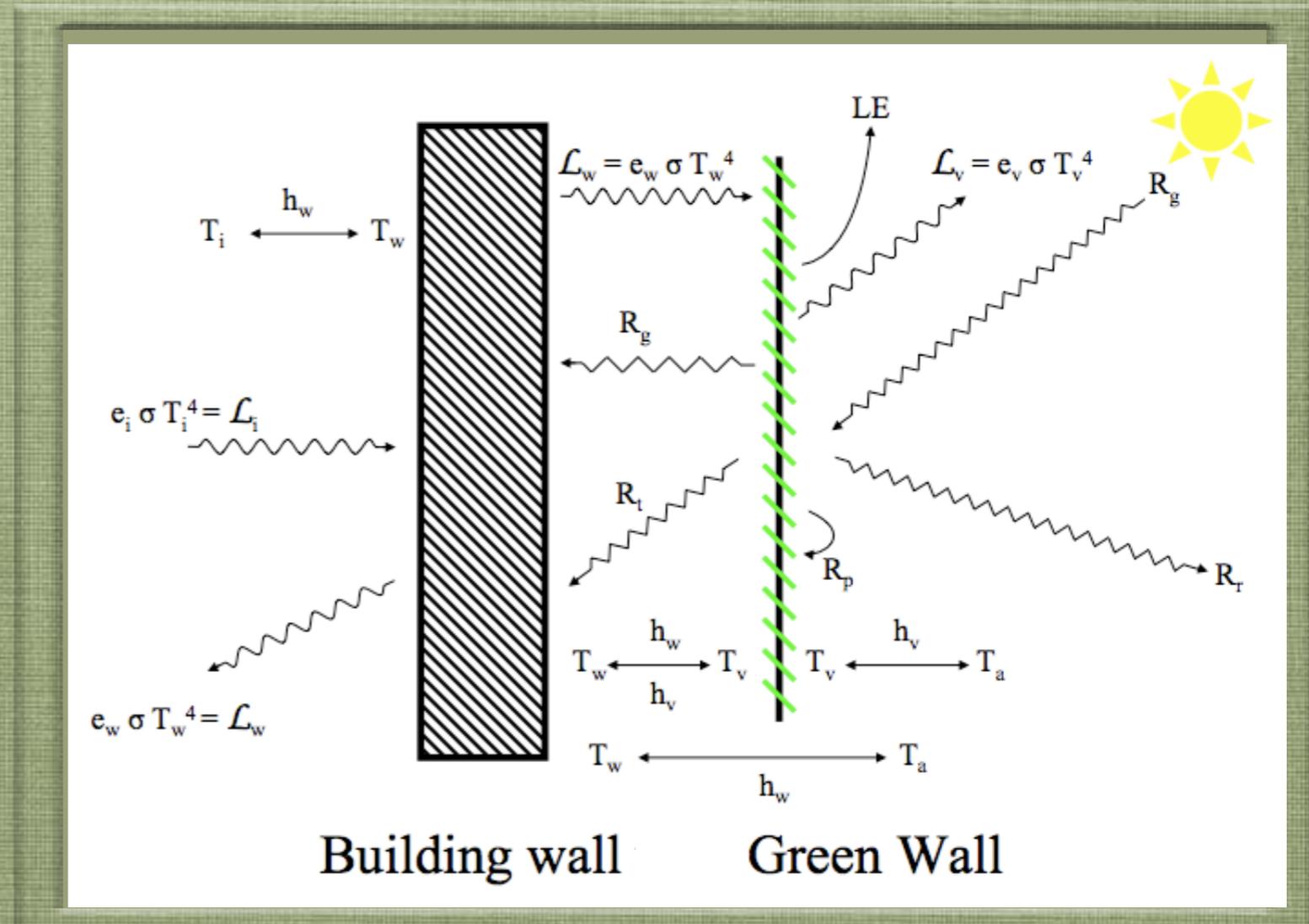
Heat Flux Effects

Energy Balance

GAINS: solar radiation, thermal radiation, convection

LOSSES: reflectance, photosynthesis, transmittance, thermal radiation, convection, evapotranspiration

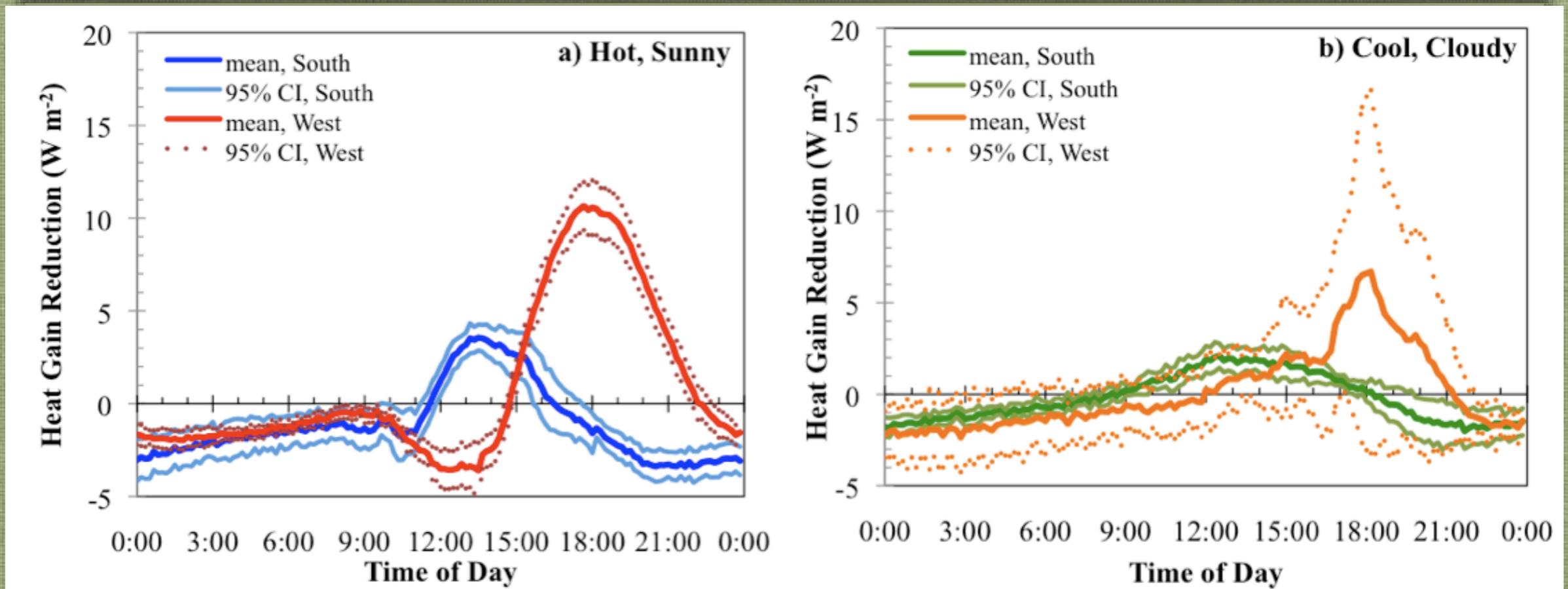
$$R_g = R_r + R_p + R_t + \varepsilon\sigma(T_v^4 - T_a^4) + h_v(T_v - T_a) + \lambda E$$



Heat Flux Reduction to Interior Air

Hot, Sunny

Cool, Cloudy



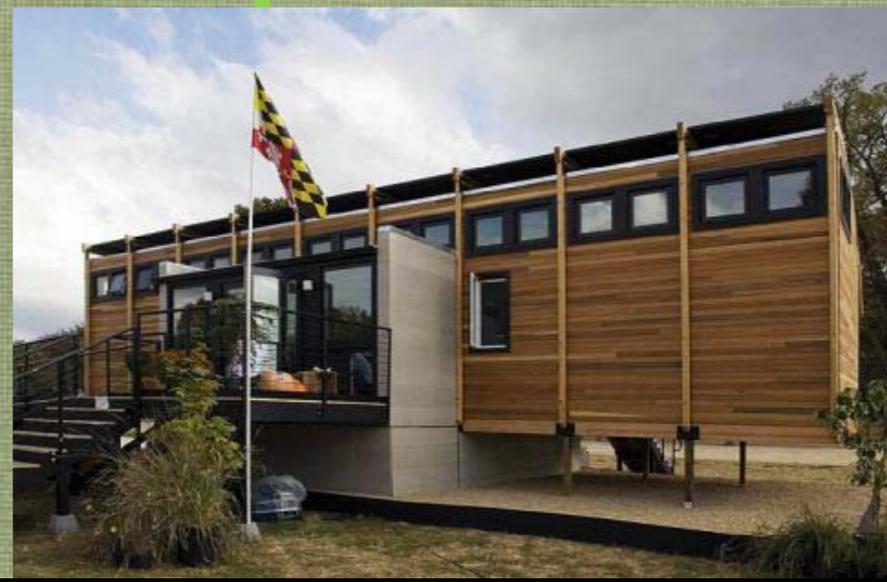
INTEGRATION OF LIVING SYSTEMS INTO BUILDINGS!



Solar Decathlon: Evolution

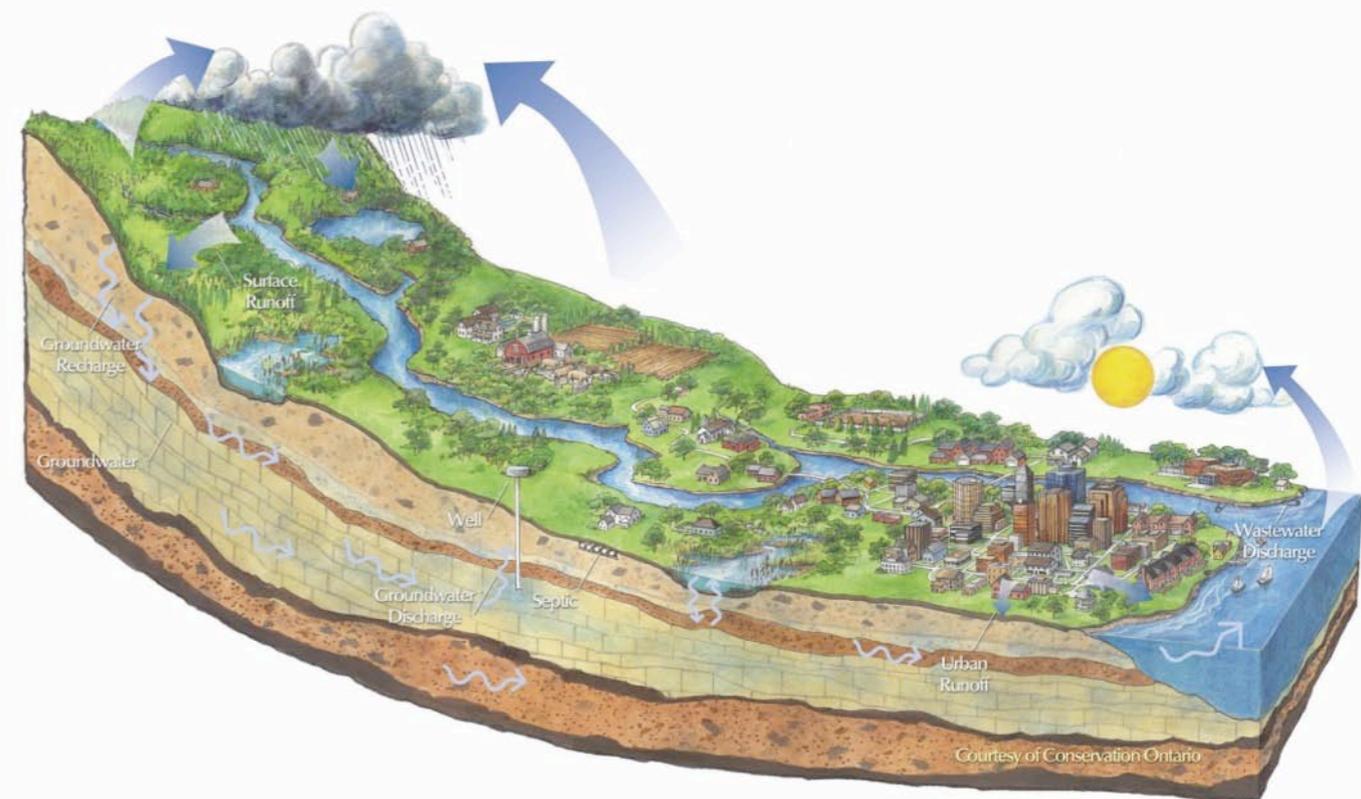
- 2002
 - 4th place overall
- 2005
 - 8th place overall
 - People's Choice Award
 - BP Solar Innovation Award
- 2007
 - 2nd place overall
 - People's Choice Award
 - BP Solar Innovation Award
 - NAHB Curb Appeal
- 2011
 - **WATERSHED**

WATERSHED



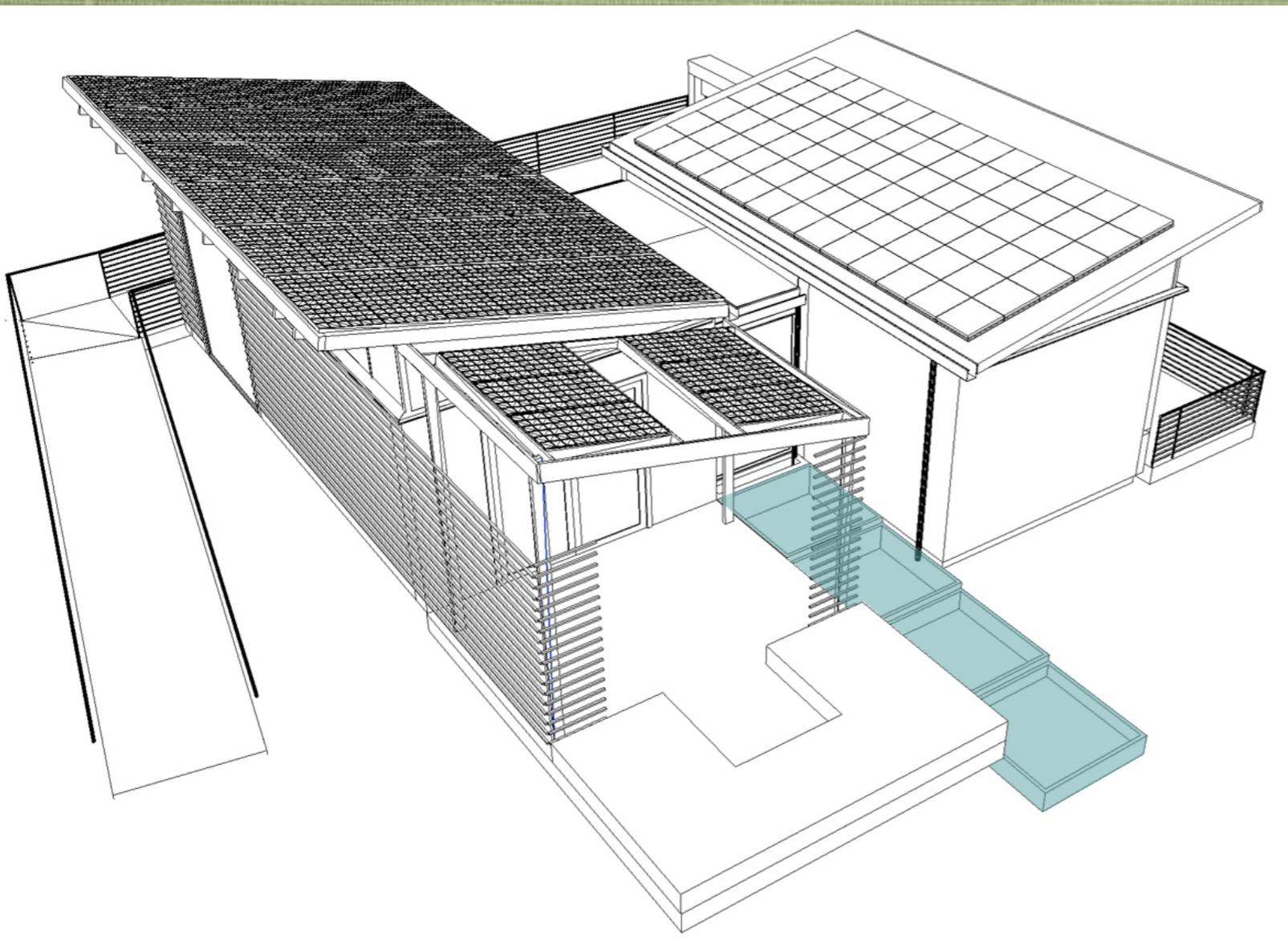
WaterShed: Living Systems

- Living Systems Goals and Objectives
 - Ecosystem design
 - Connections between systems
- Resources leave the site cleaner than they arrived



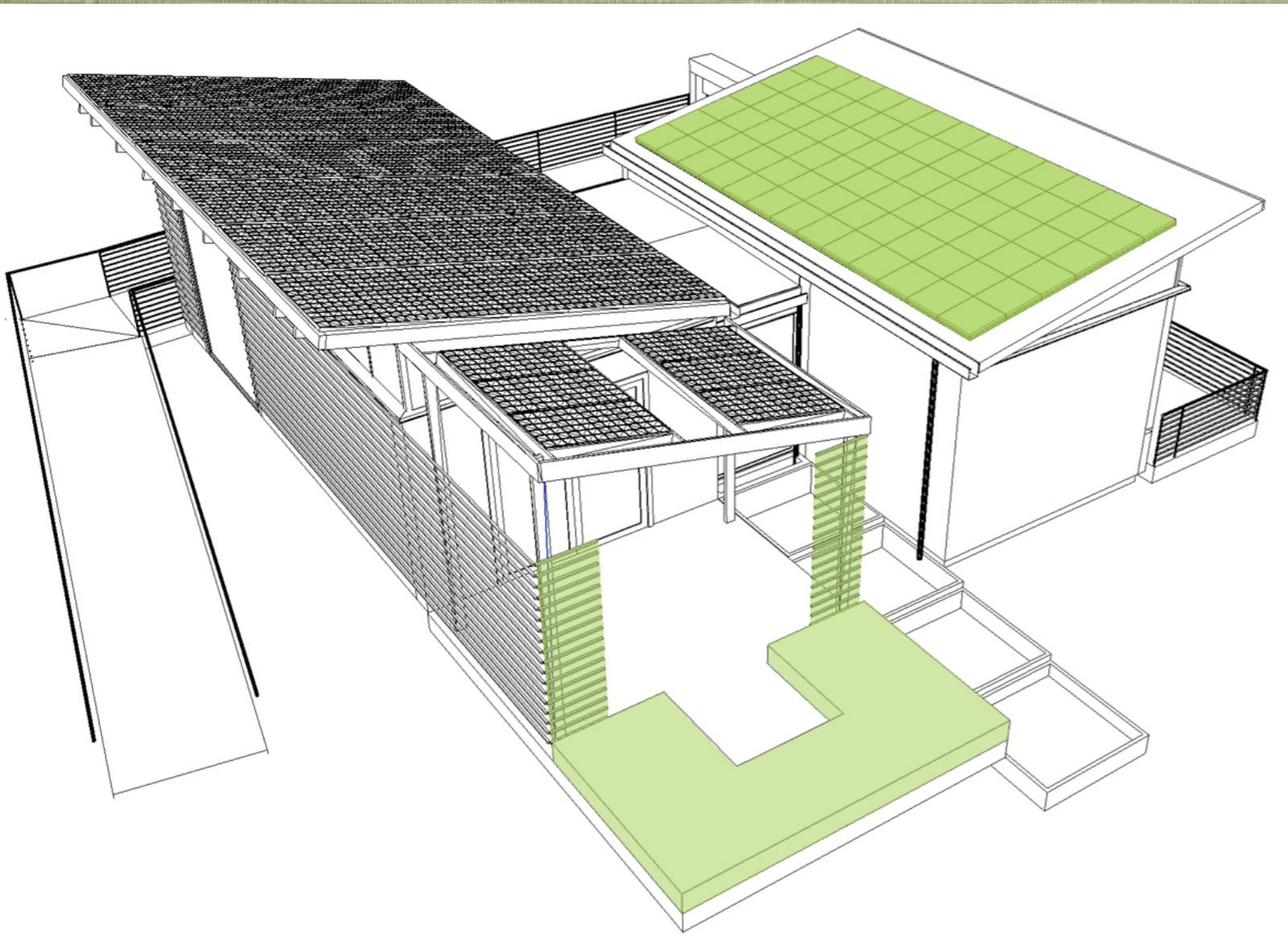
WaterShed: Living Systems

- Constructed Wetlands
- Grey-water treatment, mimic wetlands



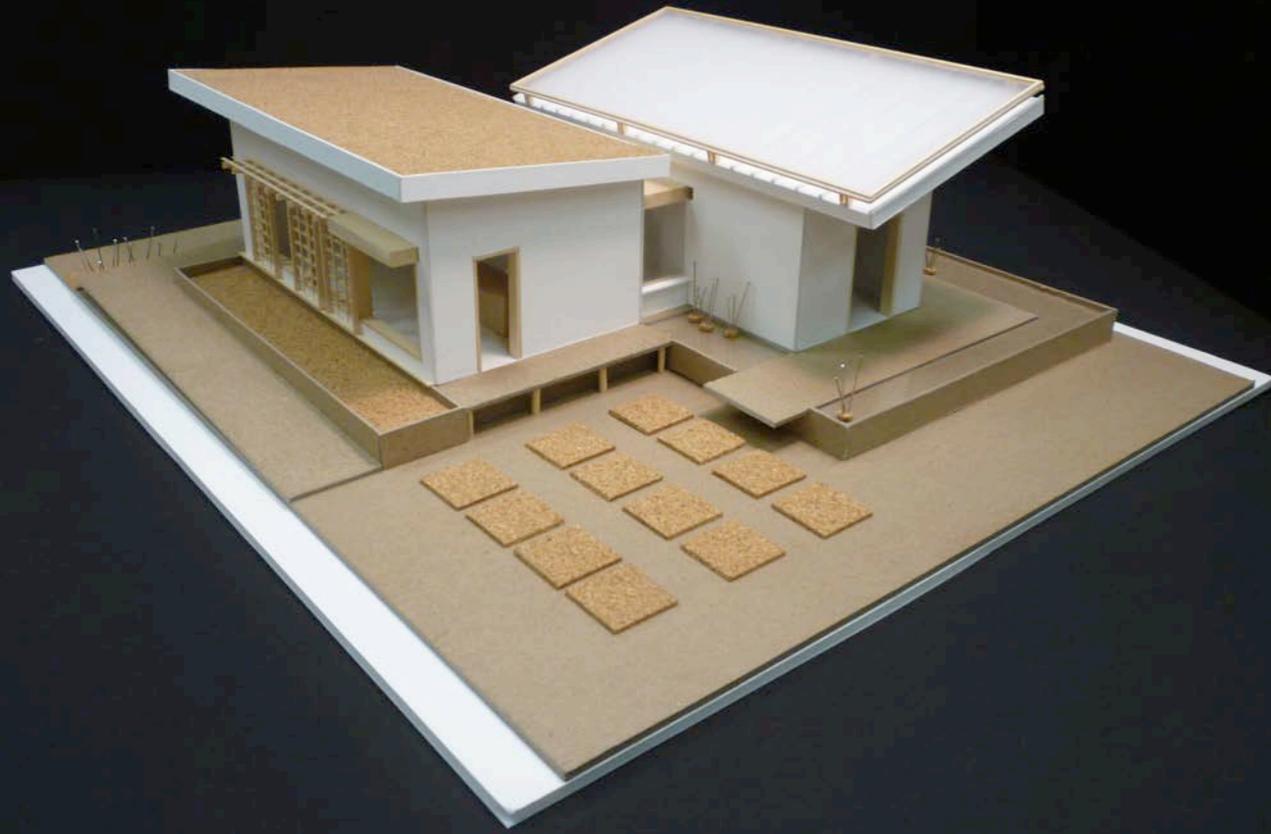
WaterShed: Living Systems

- Green Roofs
 - Storm water management
 - Reduce "Heat Island" effect
- Green Walls
 - Food Production
 - Eating Local, composting



WaterShed

Solar Decathlon 2011
National Mall Sept.



Questions?

