Final Presentation
Green Roofs

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Motivation/Background

- Green roof benefits:
  - Increase recreational green space in cities
  - Reduce urban heat island effect
  - Increase building energy efficiency
- Difficult to start and to maintain
  - Identifying the right kinds of plant species
  - Proper irrigation systems
  - 21% total failure per year, 37% partial failure
- Many opportunities for installation at Duke, in Durham, and in other cities

Website Goal

- Our website aims to **inform** potential green roof owners of **common issues** and **best practices** to **maximize the longevity of green roofs** constructed across **North Carolina**

Visit Our Website

sites.duke.edu/ncgreenroofs

Website Topics

- Green Roof Structuring
- NC Department of Environmental Quality (NCDEQ) Guidelines
- Irrigation Tips
- Native Plants
- Local Examples
- Green Roof Experiences

Website Technical Design

- Website hosted via Sites@Duke and Wordpress
  - Used base theme *Lovecraft* and modified for our needs
- Opted to use pages instead of posts since our information is not in a necessarily chronological order
- Main modifications:
  - Six primary pages
  - Full-width template
  - Image resizing
  - Color theme, website logo, and cover photos

Beta Testing*

- 50.0% of of beta testers were extremely likely to share the website with a friend
- 55.6% of beta testers found the website extremely helpful
- 88.9% of beta testers found the website extremely easy to navigate
- 61.1% of beta testers definitely liked the interface and design of the website
- 72.2% of beta testers definitely felt better informed

“I want a green roof now”
“Green roofs are cool!”

“More photos would be great”

*18 respondents

Native Plants

- Why chose native grass species?
  - Adapted to the native climates with less need for fertilization and weeding
  - Support other native ecosystems (pollinators, birds, etc.)
  - Support biodiversity, rarely invasive
  - Diverse green roofs have better disease resilience

Smaller grasses:

- Sideoats grama, *Boutelous curtipendula*
- Purpletop, *Tridens flavus*
- Lovegrass, *Eragrostis sp.*

Mid-size grasses:

- Broomsedge bluestem, *Andropogen virginicus*
- Little bluestem, *Schizachyrium scoparium*

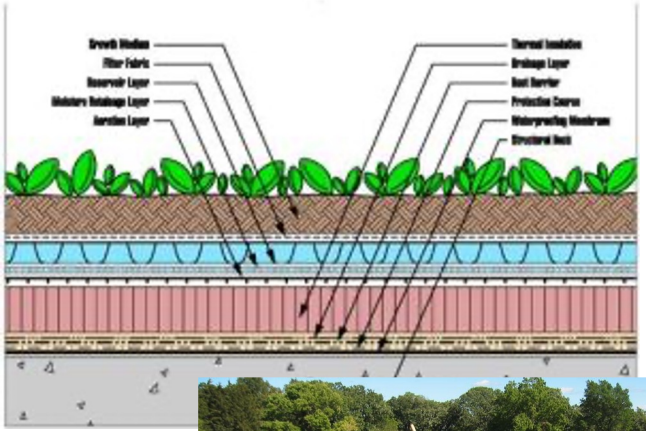
Larger grasses:

- Big bluestem, *Andropogon gerardi*
- Eastern gamagrass, *Tripsacum dactyloides*
- Indiangrass, *Sorghastrum nutans*

Stormwater Design (NCDEQ Guidelines)

- Design considerations by NCDEQ
  - NCDEQ Stormwater design manual
    - One of the main benefits of green roofs is storm water treatment
  - Growth media, volume, slope, safety, drainage, waterproof membrane, stormwater design
  - Vegetation success to maximize cooling effects
    - installing photovoltaic cells or solar panels to reduce sun exposure and intensity
    - place walls around vegetation to reduce wind exposure
    - create non-vegetated paths to reduce water evaporation

Waterproofing



- Applied at a gentle positive slope to aid with drainage (minimum of ¼ inch per foot).
- EPDM membrane is common due to durability and versatility
- Internal drainage systems should be prioritized in place of edge draining

Structural Considerations

- Pitch
  - Minimal pitch of 2% (~1 degree, or one inch elevation per run of foot)
  - Designed for drain excess rain and prevent moisture buildup
- Trays
  - Prefabricated for optimal design
  - 4 month grow time prior to installation
- Installation
  - Trays snap together
  - Aluminum edges provide extra integrity

Irrigation and Hydroponics

- Green roof soil vs. regular soil – uneven rainfall distribution
- Irrigation system options and how to choose
  - Drip vs. spray
- Quantity and frequency of irrigation
- Feedback: more images and charts

Watering System	Drip	Spray
Flow rate	1	3
Watering duration	3	1
Aesthetic result	Slow-acting effect	Fast-acting effect
Area	All Unusually-shaped areas	Large
Maintenance	3	1
Appearance	Barely visible after growth	Very discreet from installation
Implementation	3	2
Example at install		

Note: Contrary to popular belief, the drip solution does not consume less water.

Benefits Vary by Location

City	Gas (kWh)		Electricity (kWh)		Difference in predicted total savings	
	Eplus	ESP-r	EPlus	ESP-r	(kWh)	(%)
Atlanta, GA	182	-320	6291	7574	781	11
Chicago, IL	1393	1379	6179	4982	-1211	-17
Denver, CO	518	427	9069	7552	-1608	-18
Detroit, MI	1402	1440	5045	5265	258	4
Houston, TX	78	-33	5284	7142	1747	28
Memphis, TN	223	-220	5739	7283	1101	17

Green Roofs in Durham

- On-campus
  - Grainger Hall and Smart Home
- Off-campus
  - Xero Flor America HQ
  - Durham County Main Library
- Outside Organizations
  - Green Roofs for Healthy Cities
  - Living Roofs

Green Roof Experiences

- Smart Home
  - Team met with lead gardener at Smart Home
  - Maintenance issues
  - Difficult to access by foot
  - Lack of knowledge transferred between years of students at Smart Home
  - Planted sedum originally - mostly weeds today
- Grainger Hall
  - Team met with GROW club officer
  - Maintenance issues over the summer and high club turnover
  - Crops being planted this year
  - Importance of a key person pioneering the club

Feedback from Showcase

Questions raised by showcase visitors:

- “Isn’t it more energy efficient to paint a roof white?”
- “So are green roofs really only for school or government buildings that have a lot of space?”

Solutions:

- Including resources for buildings that won’t support a green roof
- Acknowledging non-energy benefits of green roofs

Next (and Last!) Steps

✅ Poster for Bass Connections Showcase

- Revising and Editing Content on Website Pages
- Finish Final Report