Watershed, Land Use, and Stormwater Influence on Tidal Creeks

Dan Hitchcock, Ph.D., P.E.
with A. D. Jayakaran, T. H. Epps,
T. M. Williams, B. Song, and W. H. Conner
Baruch Institute, Clemson University, Georgetown, SC

Tidal Creek Summit
Charleston, SC USA – December 6, 2011

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- *Tim Callahan, Vijay Vulava and Michael Griffin* - College of Charleston
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- *Ken W. Krauss* - National Wetlands Research Center, USGS
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- *April Turner* – S.C. Sea Grant Extension Program
- *Jeff Vernon* – Clemson – Baruch Institute
- *Dawn White* – Clemson's EPA Center for Watershed Excellence
- *Katie Giacalone* – Clemson's Carolina Clear program

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Where are we located?

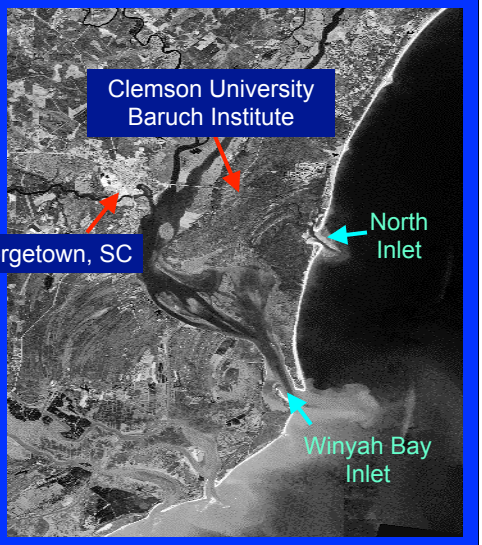

Photo: North Inlet – Winyah Bay NERR

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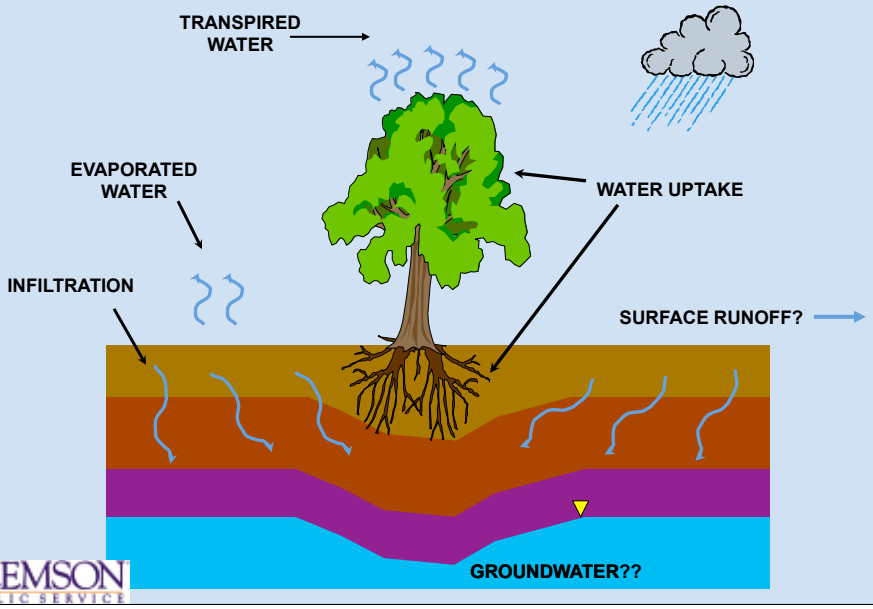
Forest Water Budget – Typical Scenario



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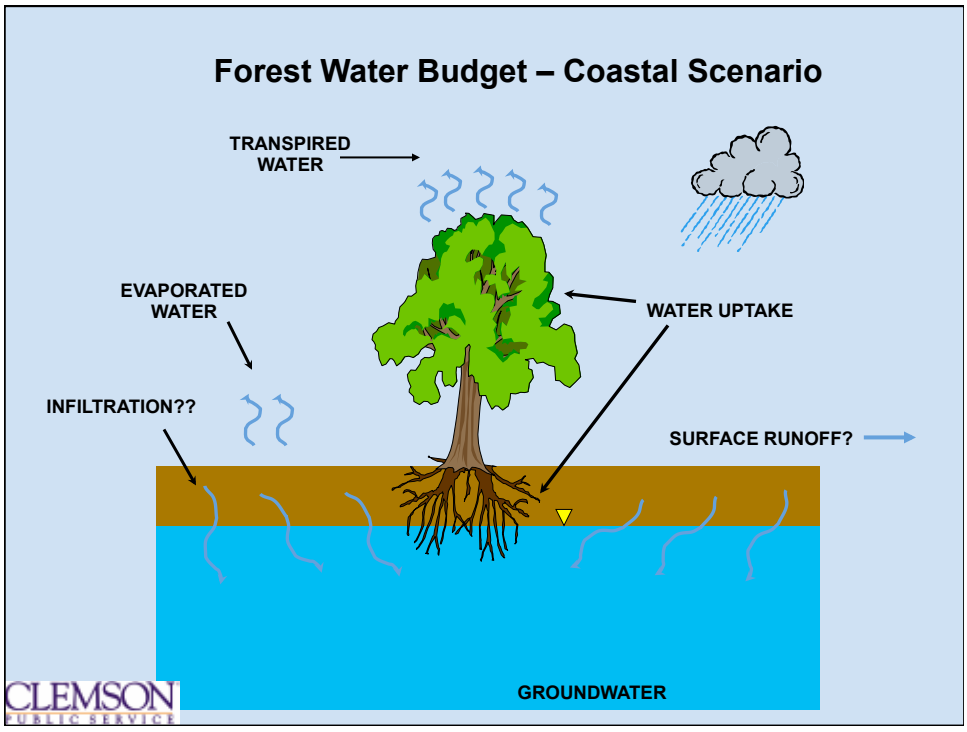
Forest Water Budget – Coastal Scenario
TRANSPIRED WATER
EVAPORATED WATER
WATER UPTAKE
INFILTRATION??
SURFACE RUNOFF?
GROUNDWATER
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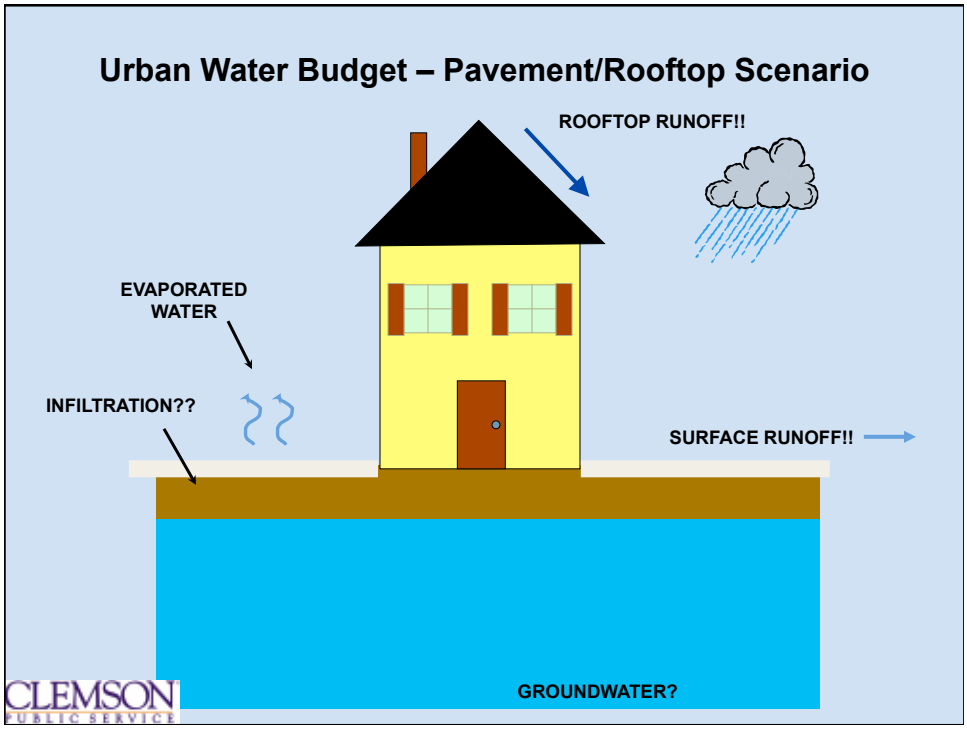
Urban Water Budget – Pavement/Rooftop Scenario
ROOFTOP RUNOFF!!
EVAPORATED WATER
INFILTRATION??
SURFACE RUNOFF!!
GROUNDWATER?
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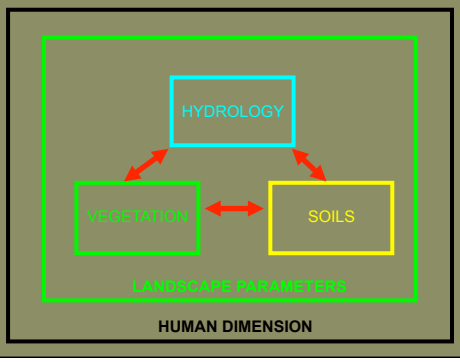
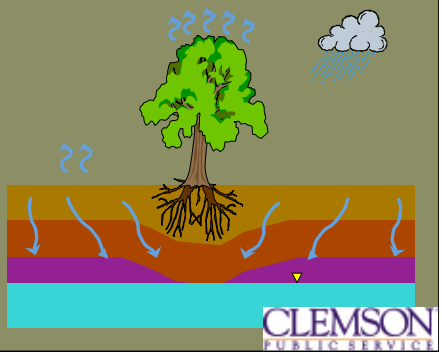
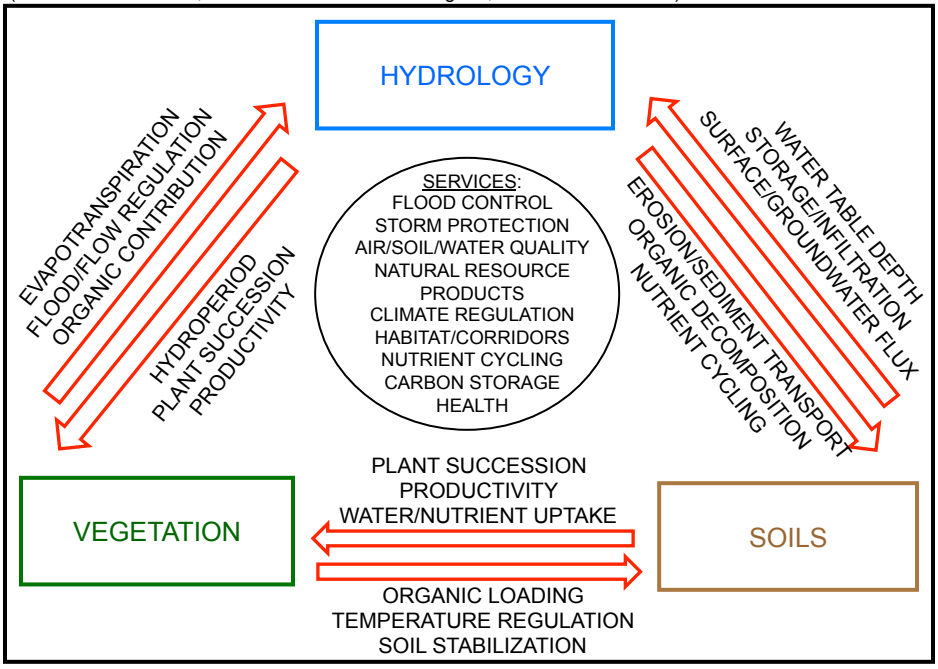
Scales for Decision-Making

- Watershed-scale and geopolitical boundaries
- Development land tract
- Individual management practice (BMP)





Landscape parameters, their interactive complex processes, and ecosystem services.
(Modified from Ge Sun, Southern Global Climate Program, USDA Forest Service)



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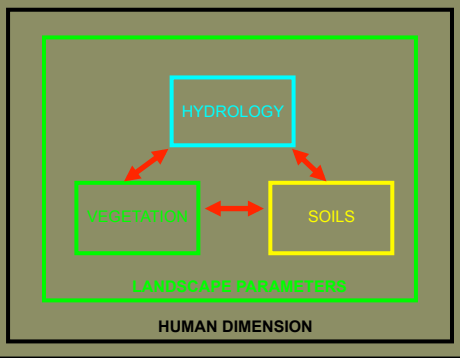

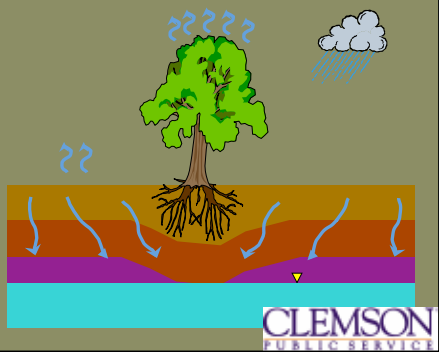

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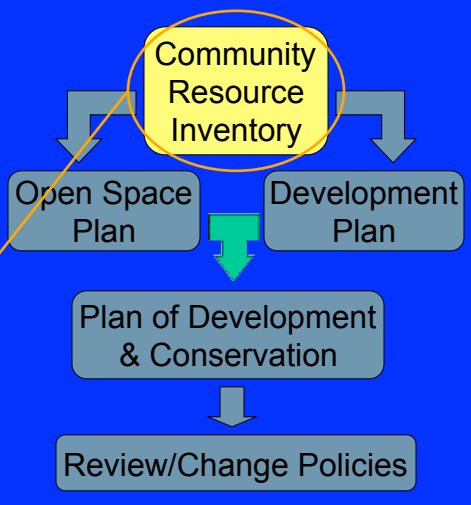
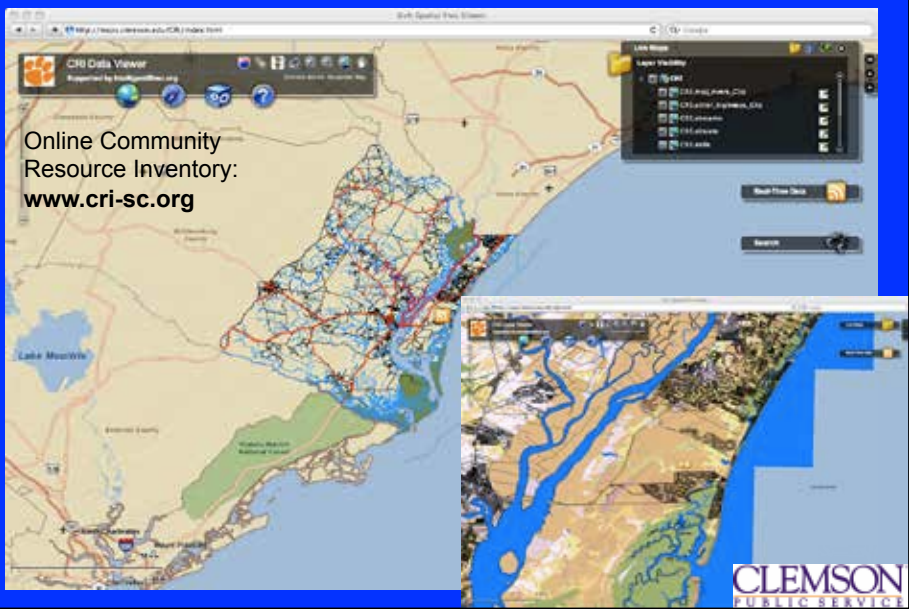
Components of Natural Resource Based Planning

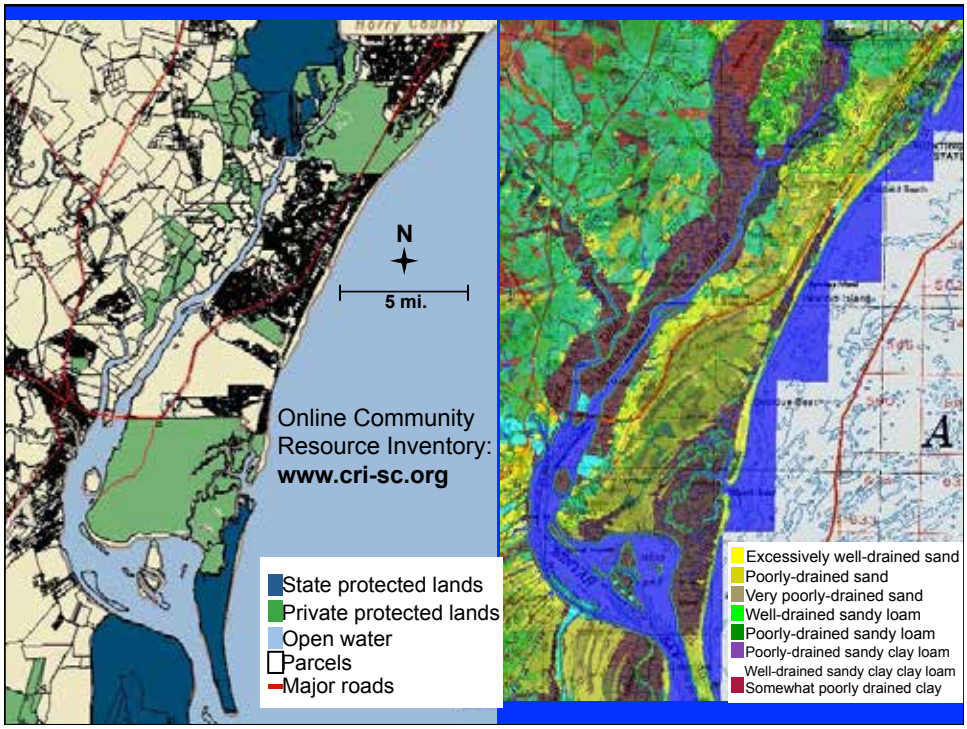
Wetlands
Steep slopes / topography
Water supply areas
Aquifer recharge areas
Wildlife habitat
Endangered species
Productive farmland
Productive forest land
Recreation areas
Viewsheds
Floodplains
Historic/cultural sites
Existing infrastructure
Many more!!



Visit http://nemo.uconn.edu/tools/cri

Online Community Resource Inventory (CRI)





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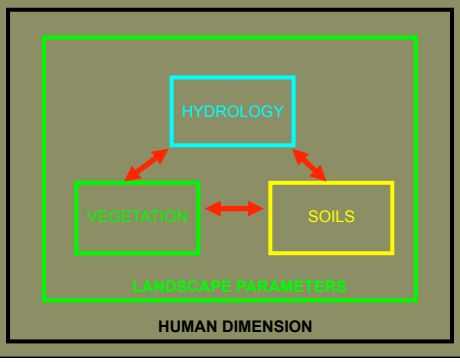

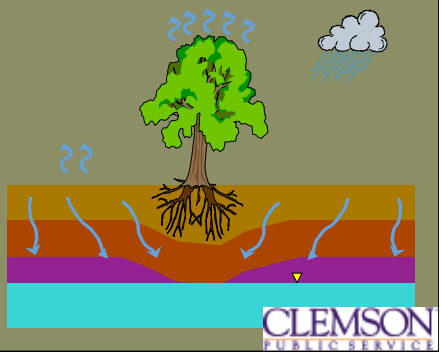

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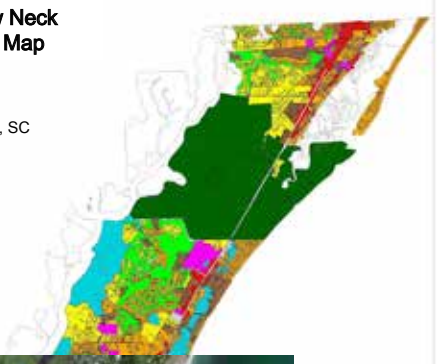
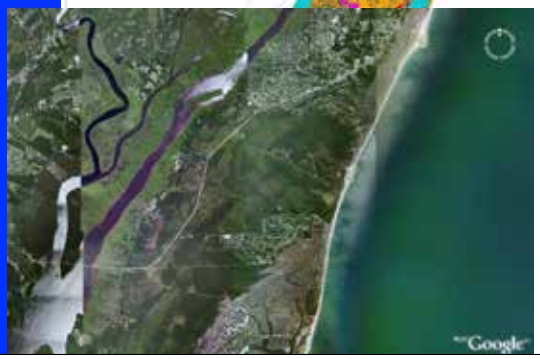
Zoning for Future Land Uses?

- Commercial
- Conservation
- Public/Semi-public
- Private Recreational
- Public Recreational
- High Density Residential
- Low Density Residential
- Medium Density Residential

Waccamaw Neck Land Use Map

Map courtesy of Georgetown County, SC





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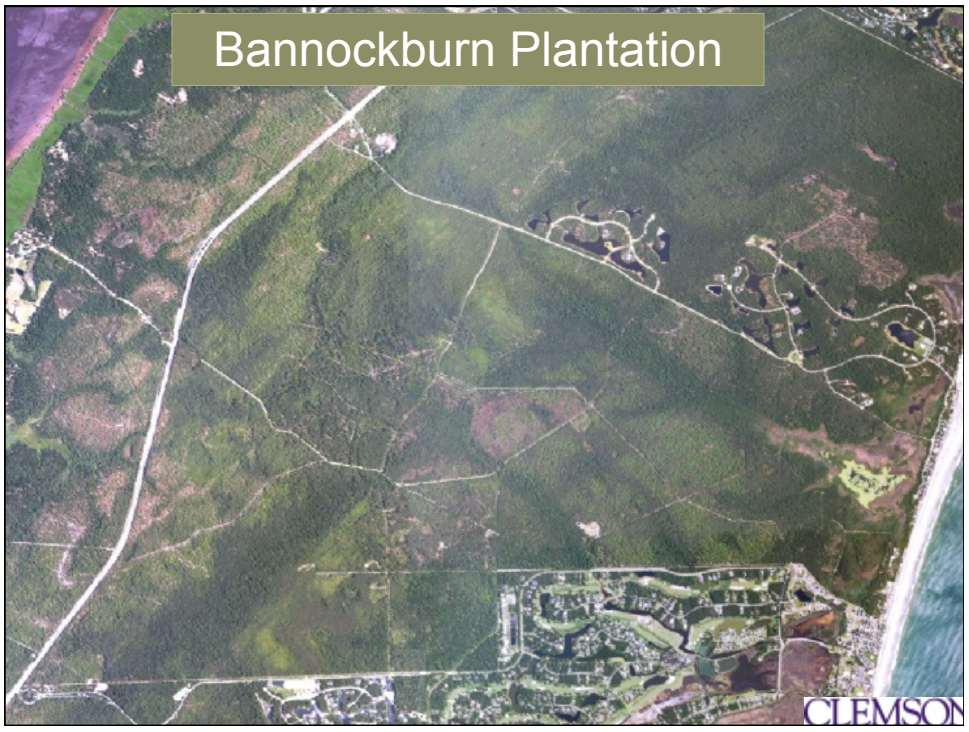
Bannockburn Plantation
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Original Development Plan
Arcadia East Plantation
Conceptual Master Plan
Legend
Proposed plan has been modified and development has been delayed…
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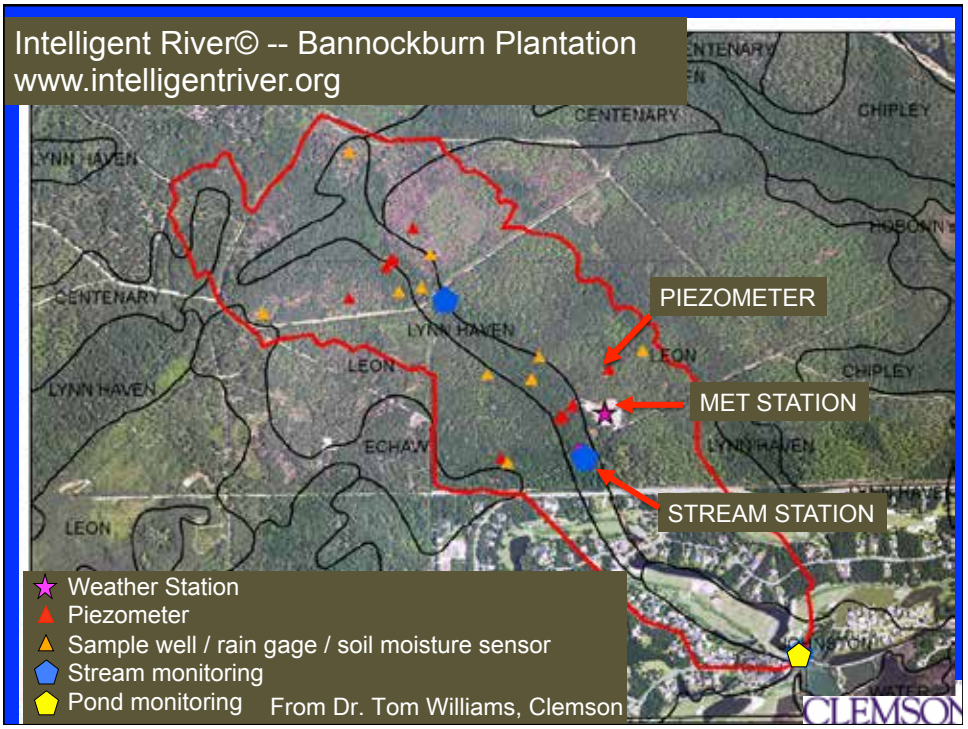
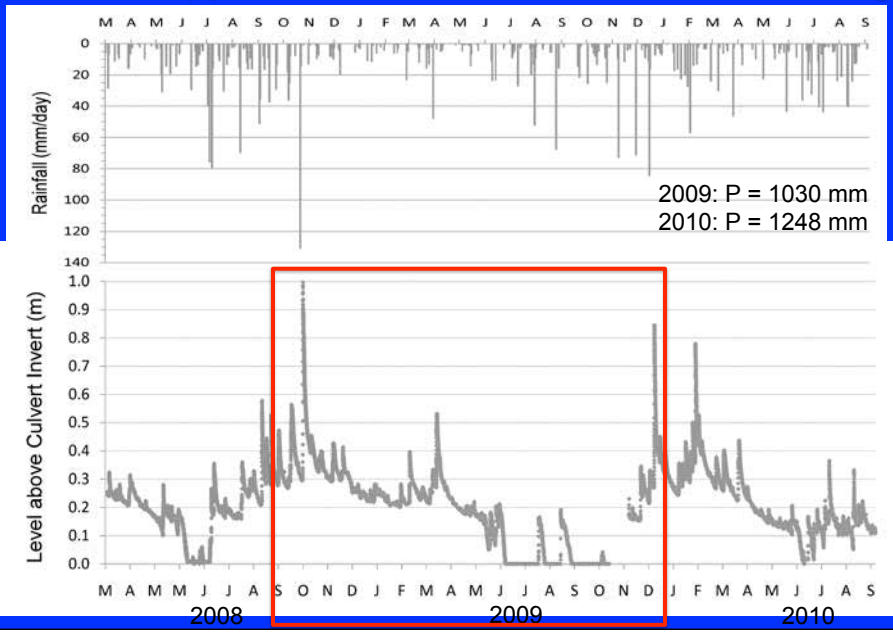
Surface and Groundwater Interaction

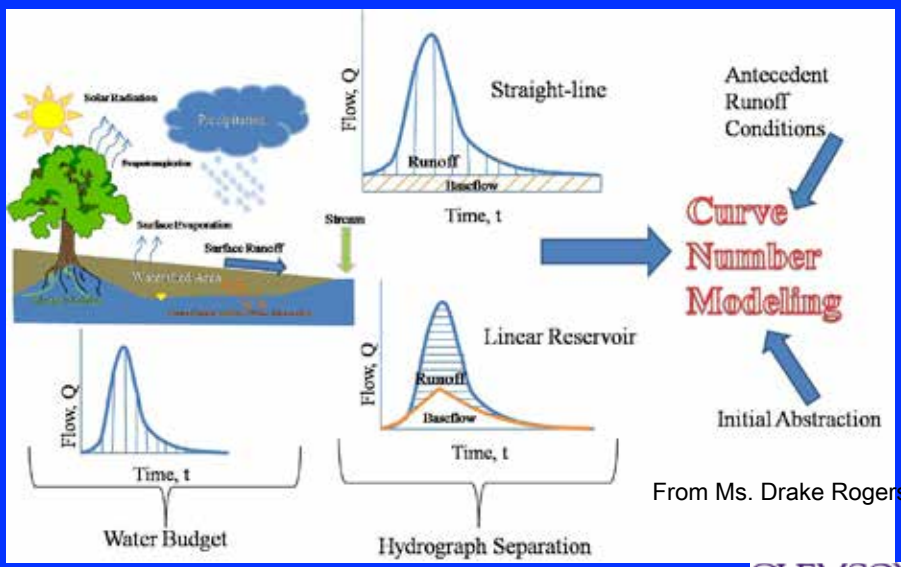
Intelligent River© -- Bannockburn Plantation
www.intelligentriver.org



Upper Debidue Creek – Rainfall and Stage



Curve Number versus Water Budget Approach



From Ms. Drake Rogers

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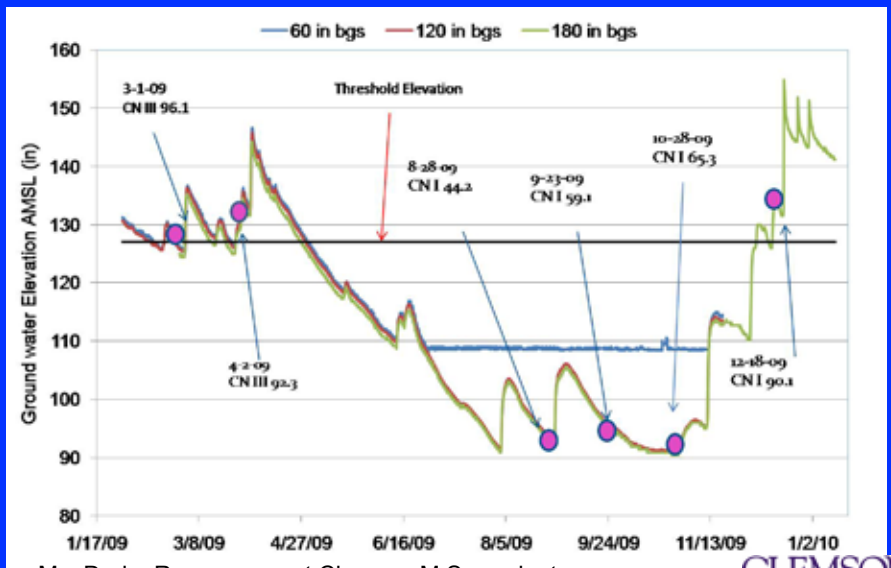
Runoff:Rainfall Relationships

Date	Rainfall (in)	Ratio
9/5/2008	3.4	0.14
9/11/2008	1.0	0.26
9/16/2008	1.9	0.31
9/25/2008	1.7	0.23
10/24/2008	5.7	0.44
3/1/2009	1.6	0.08
4/2/2009	2.0	0.19
11/10/2009	3.1	0.03
1/16/2010	0.9	0.11
1/25/2010	0.9	0.24
2/2/2010	1.1	0.25
2/5/2010	2.3	0.40
3/2/2010	1.0	0.32
9/29/2010	3.2	0.37
6/29/2011	0.8	0.01
8/6/2011	3.2	0.04

Rainfall – Groundwater - Streamflow Relationships

Surface elevation = 169 in. AMSL



From Ms. Drake Rogers, recent Clemson M.S. graduate

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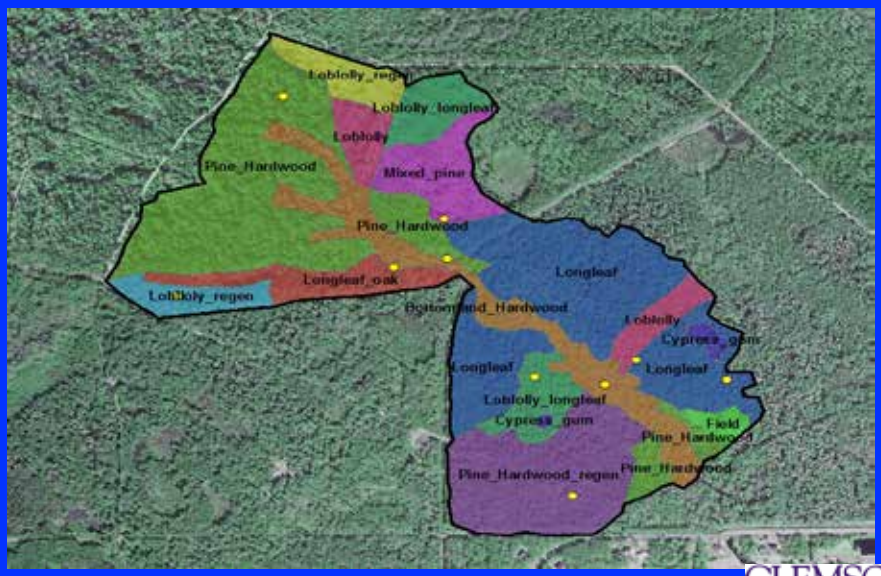
Upper Debidue Creek – Tree Survey



From Dr. Tom Williams and Thom Epps, Clemson

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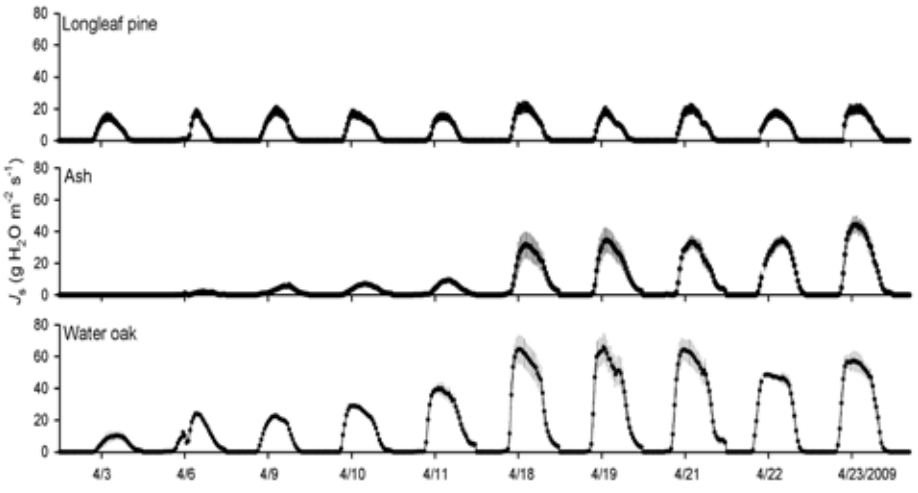
Forest Stand – Water Table Relationships



From Dr. Ken Krauss, USGS

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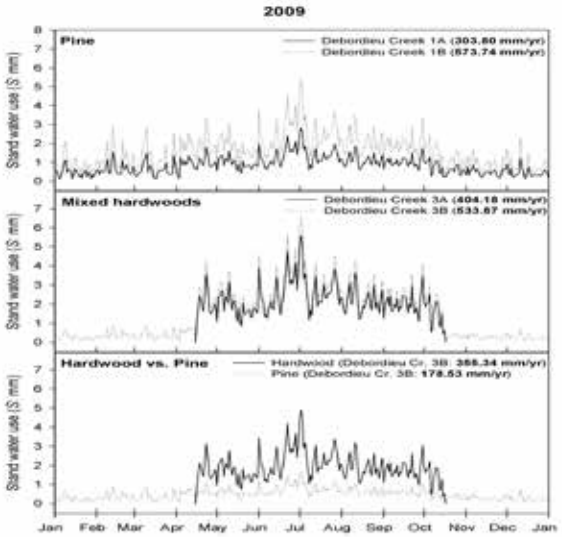
Forest Stand – Water Table Relationships

2009: PET = 928 mm



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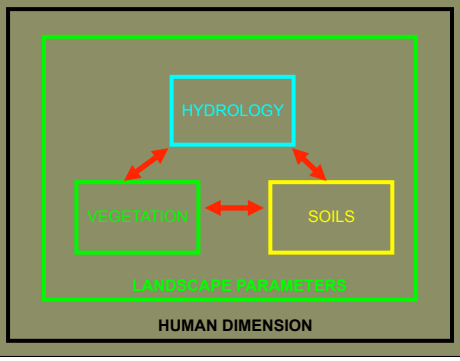

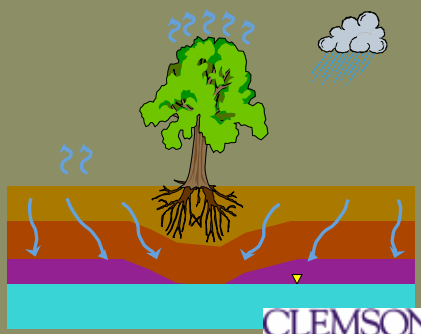

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Low Impact Development (LID)

- Rain barrels/cisterns
- Rain gardens
- Pervious materials
- Vegetative buffers
- Backyard wetlands
- Maintenance!!!






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Rain Barrels

- Rainwater collection and storage = “harvesting”
- Not unlike the old “cistern”
- Barrels come in all shapes and sizes
- Can be used for water reuse such as for irrigation




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Rain gardens –an attractive idea…

- Appealing landscape ideas for homeowners and HOAs
- Allows collection of stormwater and infiltration
- Plants and microbes do the work of pollutant removal
- Can be attractor for wildlife such as birds and butterflies
- A natural way to irrigate

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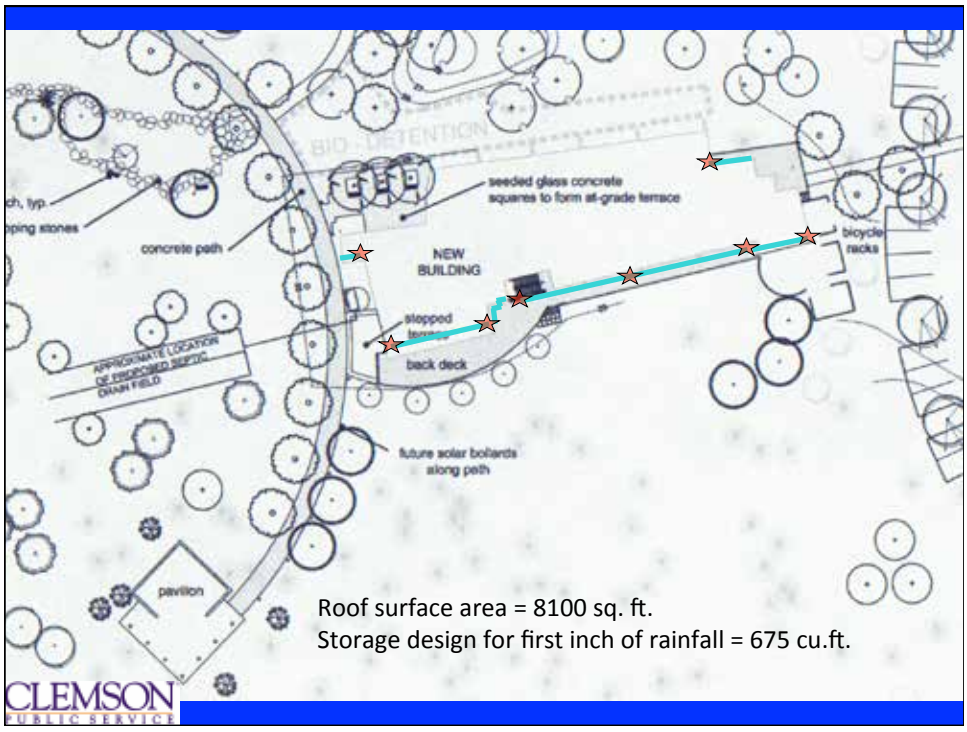
seeded glass concrete squares to form at-grade terrace
concrete path
NEW BUILDING
bicycle racks
stepped
back deck
future solar bollards along path
pavilion
Roof surface area = 8100 sq. ft.
Storage design for first inch of rainfall = 675 cu.ft.
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Planting Day!
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BEFORE… **…AFTER**

Jan. 16, 2008 **Sept. 25, 2009**

From Dan Hitchcock, Ph.D., P.E., Clemson University

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Monitoring

- Weather parameters:
  - Rainfall
  - Barometric pressure
  - Temperature
  - Relative Humidity
  - Solar radiation
  - Potential evapotranspiration
- Soil water parameters:
  - Soil moisture
  - Water table depth
- Surface water level
- Inflows

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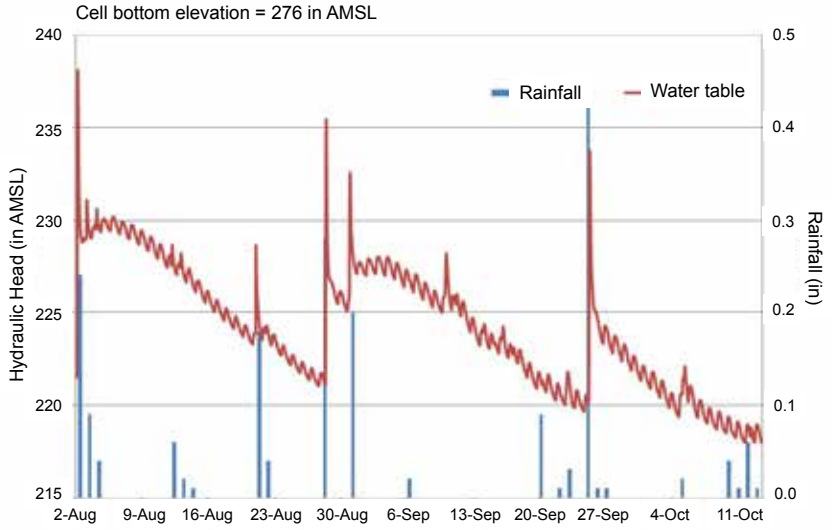
Water Table Response to Rainfall



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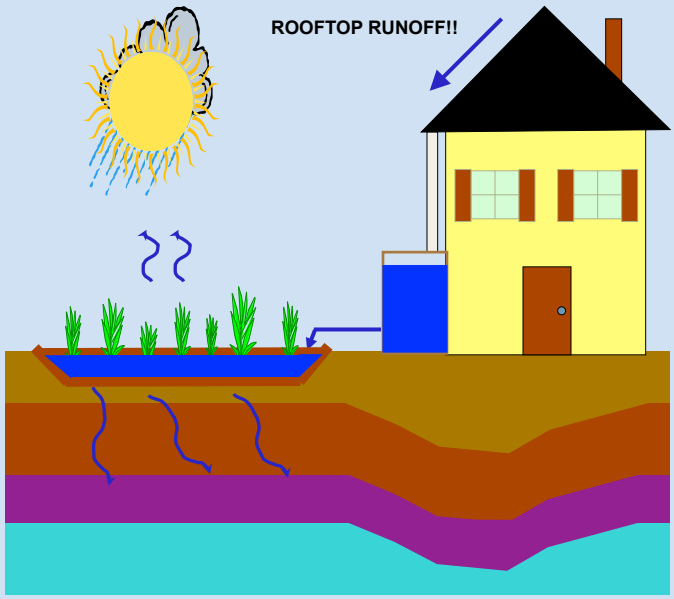
Rainwater Harvesting – Barrels and Gardens



Pervious Materials, Pavers and Concrete

Alternatives to conventional surface materials

Increases chances for infiltration

Can be used in combinations

Pavers can be expensive

Maintenance….

Weeds and clogging

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S.C. SEA GRANT EXTENSION PROGRAM

Landscaping With Pervious Surfaces

Gravel Paths, Vegetated Buffers, and Mulched Areas

Old Brick Pavers for Sidewalks

Block Pavers for Curved Sidewalks

Driveway Grass or Turf Strips

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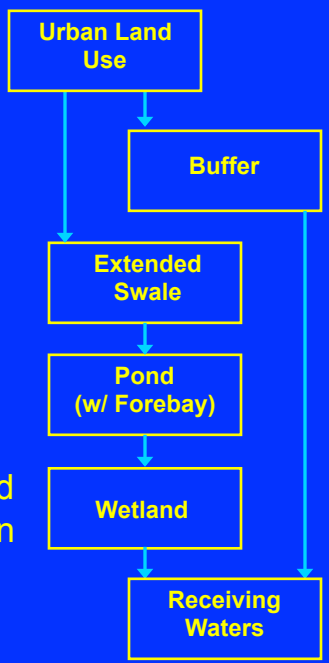
BMPs in Series or "Treatment Train"

- Some BMPs are better than others for certain pollutants
- Consider the connectivity of BMPs
- Front-end sediment collection; i.e., forebays or traps
- Vegetated BMPs can be overloaded so should be toward the end of train



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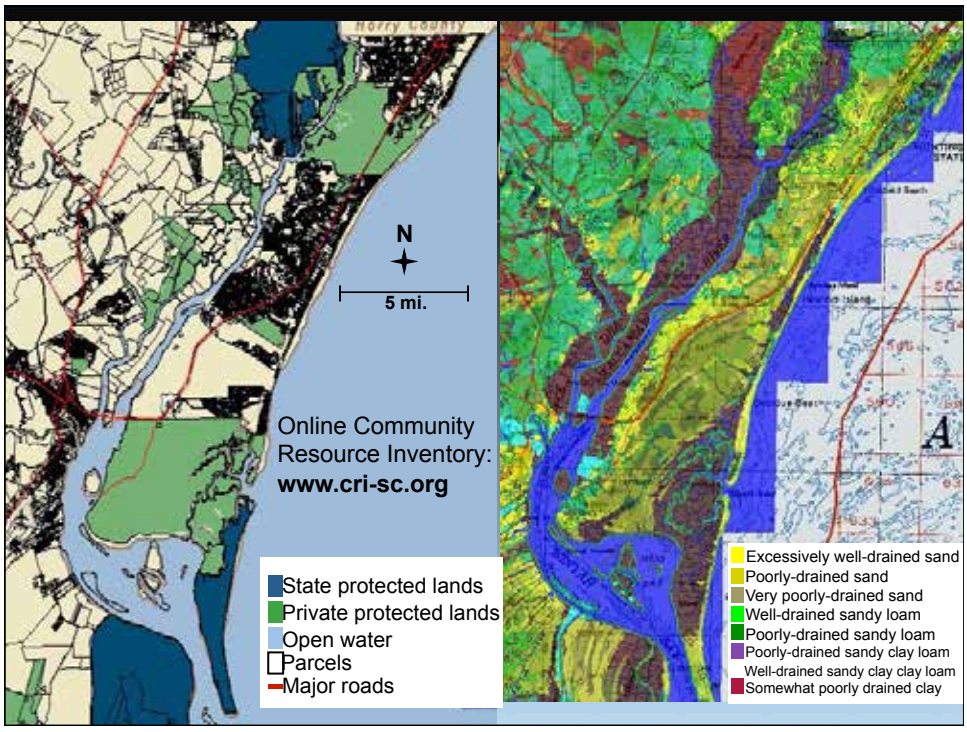

Stormwater Management Strategies
The "M" word = *MAINTENANCE!*

- The critical way to ensure stormwater mgmt success
- Must have a plan!! Who, what, when, where, how, how often?

- Many maintenances practices from which to choose
- Education and outreach programs available

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Sponsors

- Coastal watershed hydrology - South Carolina Sea Grant Consortium pursuant to National Oceanic and Atmospheric Administration Award No. NA06OAR4170015
- Baruch rain garden monitoring and education – USDA Renewable Resources Extension Act (RREA)
- Online Community Resource Inventory – CICEET funds to U.Conn. and NEMO, administered by SC Sea Grant
- This work is also related to the Intelligent River™ project sponsored by Clemson Public Service Activities (PSA) and the EPA Center for Watershed Excellence

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