Managing trees to reduce stormwater: i-Tree Hydro can help

Catherine Deininger, Biocenosis LLC
cdeininger@biocenosis.org
www.biocenosis.org

Roadmap

1. Trees as Green Infrastructure
2. i-Tree Hydro
3. Robeson Creek Watershed

It's Raining! What are the Trees doing?

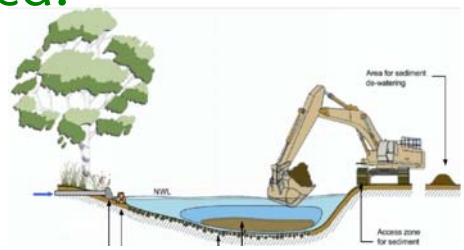
1. Trees Retain rainfall
   - ~20% annual rainfall
   - First 2-4 mm of rainfall
2. Trees Delay Throughfall
   - Depends on crown & storm intensity
   - Delay 10 minutes to > 3hrs
3. Trees Reduce intensity
   - Deciduous canopy 15 – 21%
   - Coniferous canopy 21 – 52%
4. Trees Transpire
   - ~1.5mm/day/m^2 canopy cover
   - 0.3 – 2.6 mm/day/ m^2 leaf area
   - Allows more soil storage capacity

Typical Development

- Remove tree canopy cover
- Remove ground cover
  - Vegetative
  - Detritus (mulch)
- Remove permeable top soil
  - Leaving dense subsoil
- Disturb/compact/pave over remaining soil
- Grass sod over subsoil

Drone image of Briar Chapel, Chatham Co by Peter Theye

How do we usually fix the stormwater runoff problems we have created?

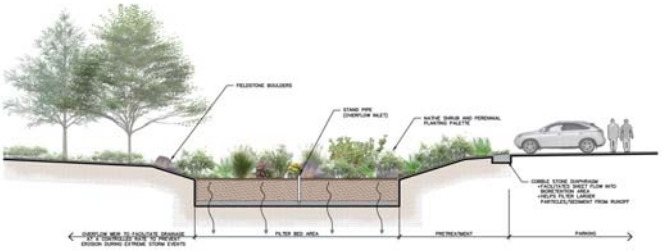


Conventional Infrastructure

- Large end of the pipe structures
- Costly to build, maintain and manage

Green Infrastructure

- Replicate hydrologic cycle
- Multiple smaller, less costly to build, & fits into the landscape.

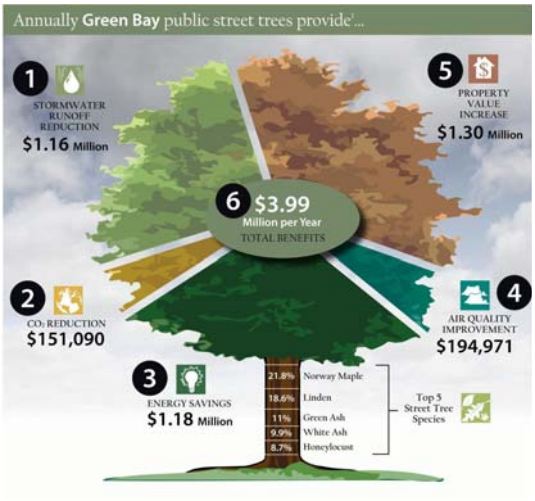


What about the Trees?

1. Retain
2. Delay
3. Reduce Intensity &
4. Increase storage capacity of soil for

STORMWATER

*Our natural **systems** should be included in the conversation as we develop our cities*



Maximize Benefits & Communicate

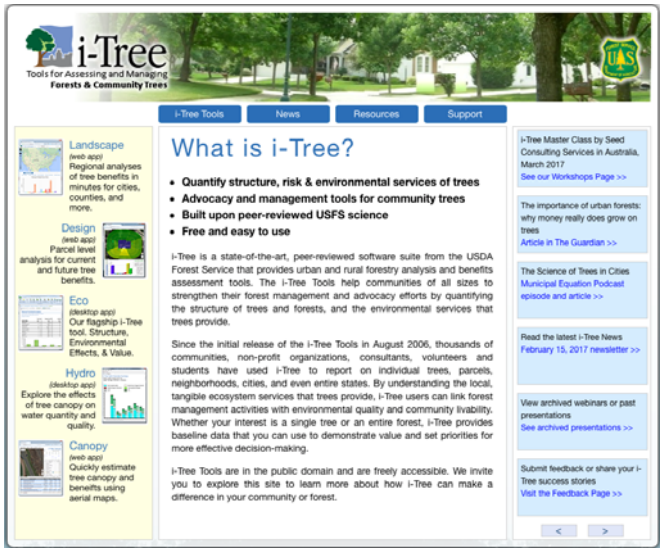
And tools that do this are ….

i-Tree…

"Putting USFS Urban Forest science into the hands of users"

- Public Domain Software
- Based on peer-reviewed research
- Technical support
- Continuously improved

www.itreetools.org



i-Tree is a Cooperative Initiative among these partners

DAVEY

Arbor Day Foundation

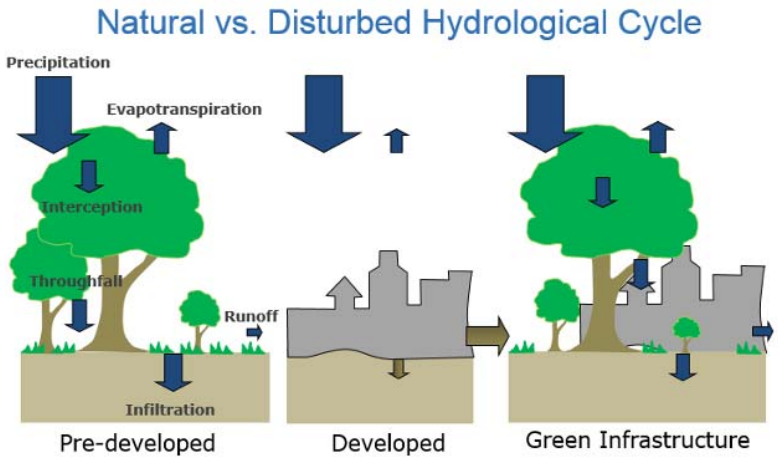
ISA

The 2016 i-Tree Suite of Tools

Web-based

Desktop

i-Tree Hydro



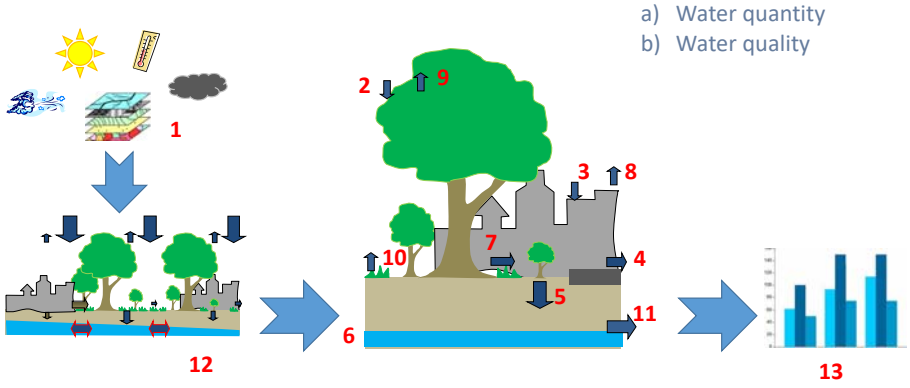
Tree Hydro Model: Conceptual Schematic

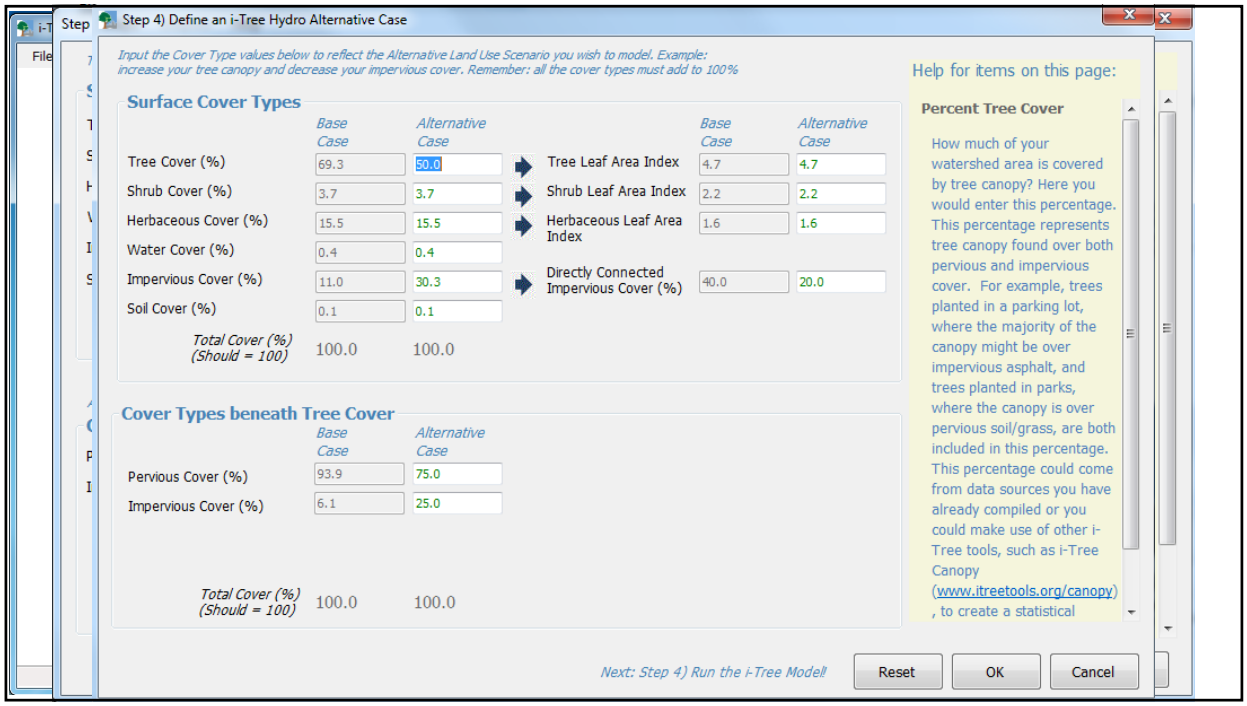
on

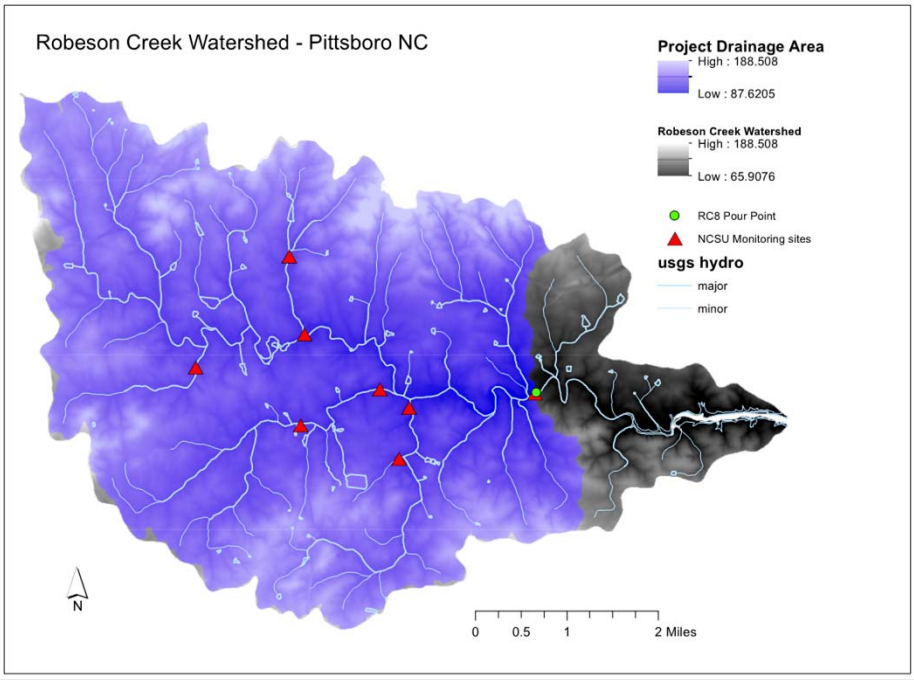
a) Location
b) Weather
c) Land Cover
d) Topography
e) Hydrology & Soil

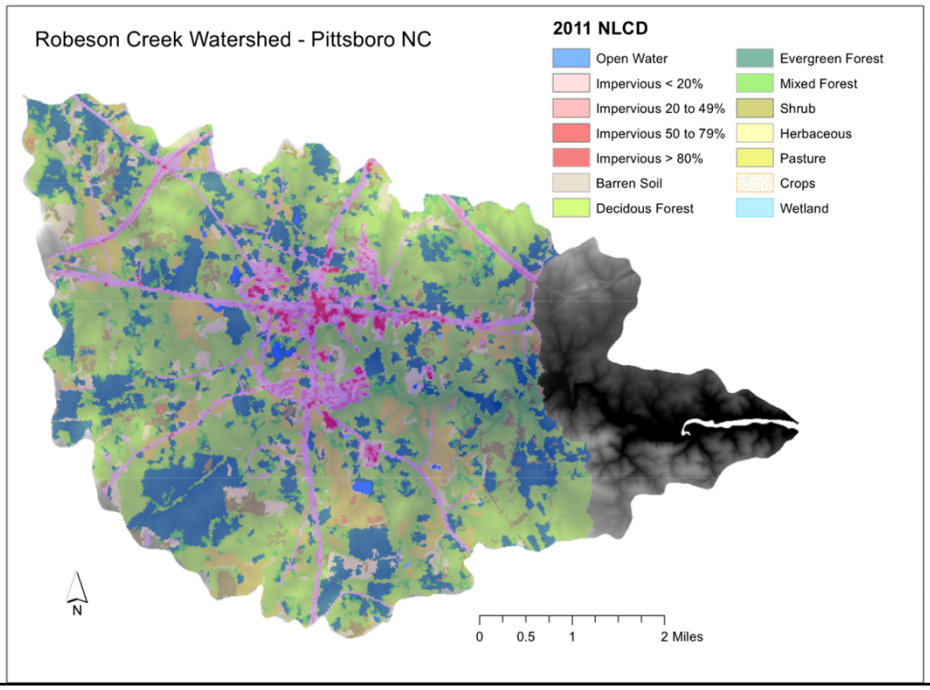
3 Depression Storage
4 Impervious Runoff
5 Infiltration
6 Soil Moisture
7 Pervious Runoff

9 Veg Evaporation
10 Evapo-transpiration
11 Subsurface Runoff
12 Semi-Spatial Distribution
13 Outputs
  a) Water quantity
  b) Water quality






Robeson Creek Watershed - Pittsboro NC
Project Drainage Area
High : 188.508
Low : 87.6205
Robeson Creek Watershed
High : 188.508
Low : 65.9076
RC8 Pour Point
NCSU Monitoring sites
usgs hydro
major
minor
N
0 0.5 1 2 Miles


Robeson Creek Watershed - Pittsboro NC
2011 NLCD
Open Water
Impervious < 20%
Impervious 20 to 49%
Impervious 50 to 79%
Impervious > 80%
Barren Soil
Decidous Forest
Evergreen Forest
Mixed Forest
Shrub
Herbaceous
Pasture
Crops
Wetland
N
0 0.5 1 2 Miles

i-Tree Hydro Executive Summary

Project Location: Pittsboro, North Carolina
Project Time Span: 01/01/2011 - 12/30/2011

Model Parameters

Watershed Area	Rainfall	Total Runoff	Stream Gage	Weather Station
square kilometers	*millimeters*	*cubic meters*		
62.50	910.59	17,912,617.82		

Land Cover	Base	Alternative		Base	Alternative	LC beneath Tree Cover	Base	Alternative
Tree Cover %	69.3	40.0	Tree LAI	4.7	4.7	Soil Cover %	93.9	93.9
Shrub Cover %	3.7	3.7	Shrub LAI	2.2	2.2	Impervious Cover %	6.1	6.1
Herbaceous Cover %	15.5	15.5	Herbaceous LAI	1.6	1.6			
Water Cover %	0.4	0.4						
Impervious Cover %	11.0	40.3	Directly Connected Impervious Cover (%)	40.0	40.0			
Soil Cover %	0.1	0.1						

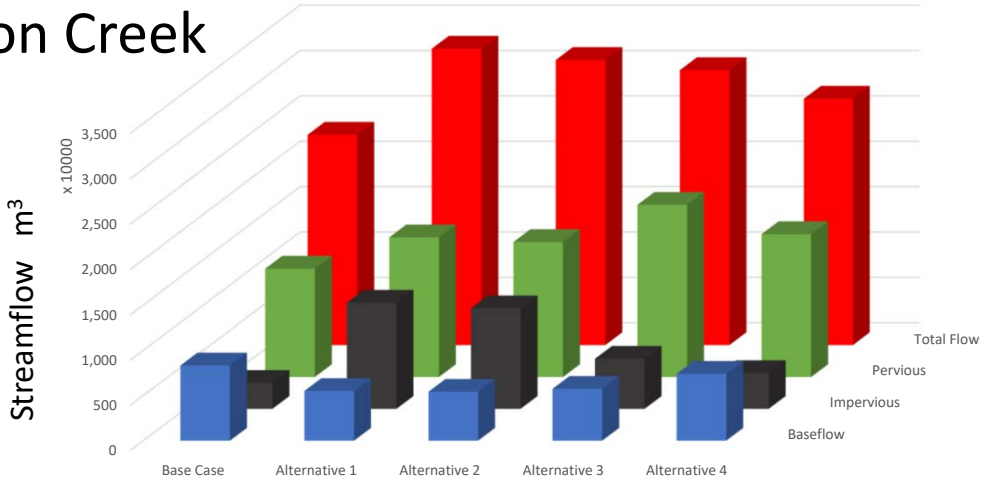
Streamflow Predictions

	Total Runoff		Baseflow		Pervious Flow		Impervious Flow	
	Base	Alternative	Base	Alternative	Base	Alternative	Base	Alternative
Total Flow (cubic meters)	17,912,617.8	20,473,778.6	9,943,846.7	8,177,242.8	6,193,193.2	7,280,793.5	1,775,577.8	5,015,739.5
Highest Flow (cubic meters / hour)	775,425.0	924,443.8	3,374.2	2,288.4	682,012.5	665,893.8	92,866.3	258,145.6
Lowest Flow (cubic meters / hour)	94.6	90.1	94.3	90.0	0.0	0.0	0.0	0.0
Highest Flow Date	05/27/11	05/27/11	12/22/11	09/24/11	05/27/11	05/27/11	05/27/11	05/27/11
Lowest Flow Date	09/06/11	09/06/11	09/06/11	09/06/11	01/01/11	01/01/11	01/01/11	01/01/11
Median Flow (cubic meters / hour)	973.7	934.2	909.6	883.8	0.0	0.0	0.0	0.0
Number of flow events ABOVE median flow	68.0	80.0	7.0	12.0	47.0	47.0	46.0	46.0
Average length of flow events with flow ABOVE median (hours)	39.0	42.1	436.5	302.1	92.9	92.9	95.0	95.0
High Flow: Number of flow events ABOVE 1 standard deviation	24.0	34.0	7.0	9.0	24.0	27.0	44.0	44.0
Average length of flow events ABOVE 1 standard deviation (hours)	107.1	96.9	436.5	369.4	100.6	101.4	96.0	96.0
Number of flow events BELOW median flow	68.0	80.0	7.0	12.0	48.0	48.0	47.0	47.0
Average length of events BELOW median (hours)	64.2	54.6	624.0	364.0	92.7	92.6	94.6	94.6

Robeson Creek Watershed Land Cover

24	sq miles				
		Alternatives Scenarios			
Cover	**Base Case**	**1**	**2**	**3**	**4**
Tree	69.3%	20.0%	50.0%	50.0%	50.0%
Shrub	3.7%	3.7%	3.7%	3.7%	3.7%
Herbaceous	15.5%	15.5%	15.5%	15.5%	15.5%
Water	0.4%	0.4%	0.4%	0.4%	0.4%
Impervious	11.0%	60.3%	30.3%	30.3%	30.3%
Soil	0.1%	0.1%	0.1%	0.1%	0.1%
Total	100%	100.0%	100.0%	100.0%	100.0%
Land Cover Beneath Tree Cover					
Soil / Pervious	93.9%	93.9%	38%	38%	75%
Impervious	6.1%	6.1%	62%	62%	25%
Total	100.0%	100.0%	100.0%	100.0%	100.0%
Direct Connected Impervious Cover	40%	40%	40%	20%	20%

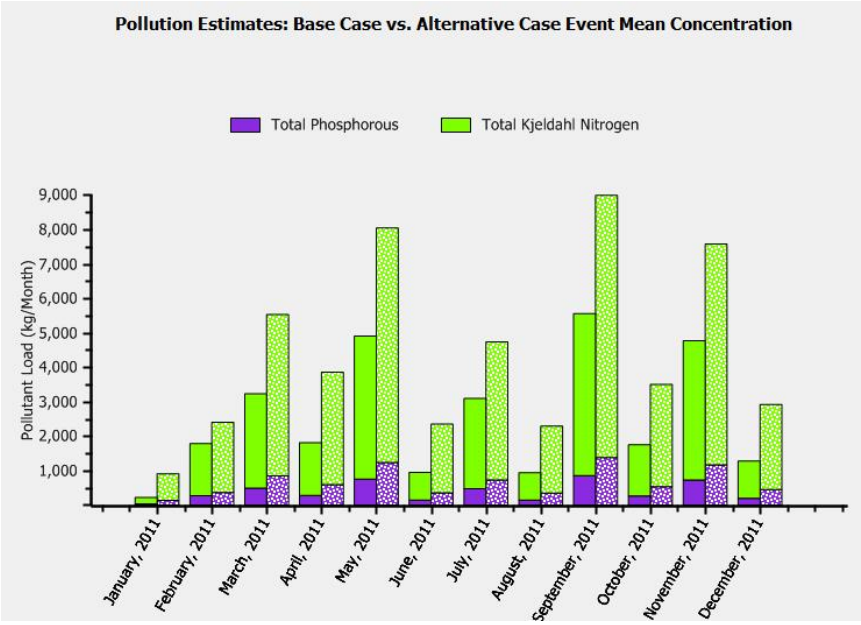
Robeson Creek



Tree Cover	70%	20%	50%	50%	50%
Impervious	11%	60%	30%	30%	30%
Under Tree - Impervious	6%	6%	62%	62%	25%
Storm Drains	40%	40%	40%	20%	20%

Pollutants:

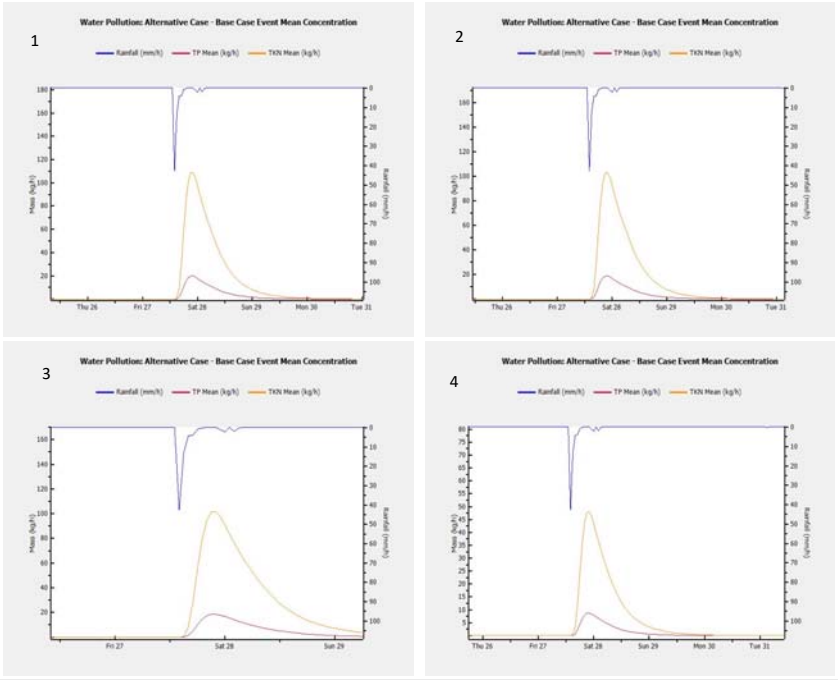
1. Total Suspended Solids
2. Soluble Organic Pollutants
3. Lead
4. Biochemical Oxygen Demand
5. Total Kjeldahl Nitrogen
6. Zinc
7. Chemical Oxygen Demand
8. Nitrogen Dioxide
9. Total Phosphorous
10. Copper



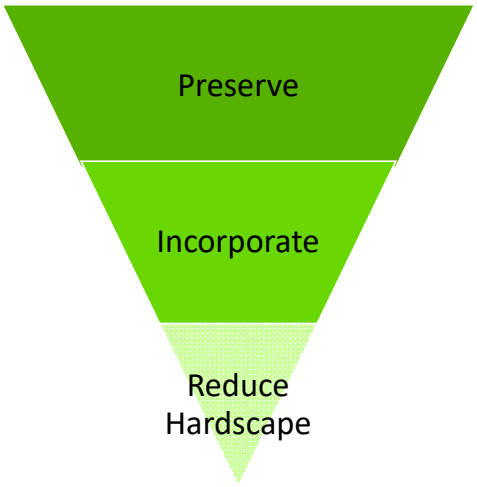
Change in Pollutant Load
Base Case – Alternative Case

Evaluated
¤TP
¤TKN

May 27, 2011
2.5 inches of rain



Managing trees to mitigate stormwater



- Where possible preserve existing tree canopy
- Incorporate trees into BMPs such as bioretention, wetlands, parking gardens, etc
- Reduce or break up paved surfaces

Preserve Tree Canopy

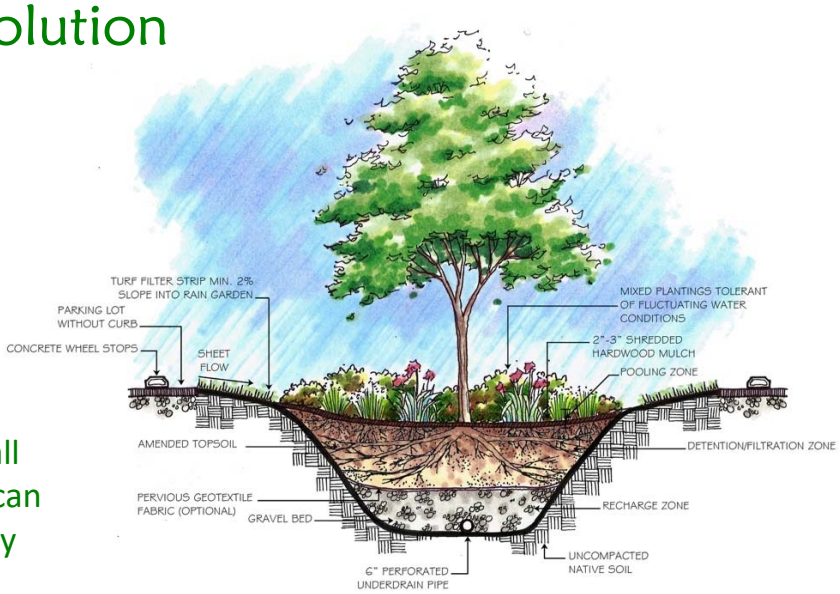
Set tree canopy goals

Drone image of Briar Chapel, Chatham Co by Peter Theye

Additional solution

Incorporate trees into BMPs to help increase infiltration & storage of stormwater

Trees can regulate rainfall so that BMPs can work efficiently



Thank you!

Nancy Stairs, Urban Forestry Program Coordinator, North Carolina Forest Service

Daniel Line, Stormwater Specialist, NCSU Bio. & Ag. Engineering

Robert Coville, Natural Resource Specialist, The Davey Institute

Eric Kuehler Technology Specialist, Forest Service Southern Research Station

www.itreetools.org

Urban Natural Resources Institute

www.unri.org/webcasts/itreeworkshops/

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Dr. Aarin Teague and Erich Kuehler, *Give me the Numbers, How Trees and Urban Forest Systems Really Affect Stromwater Runoff,* Stormwater Magazine (Website: www.foresternetwork.com/stormwater-magazine/sw-water/sw-stormwater/give-me-the-numbers/) October 5, 2016.

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