

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



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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/m² canopy cover
- 0.3 – 2.6 mm/day/ m² 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

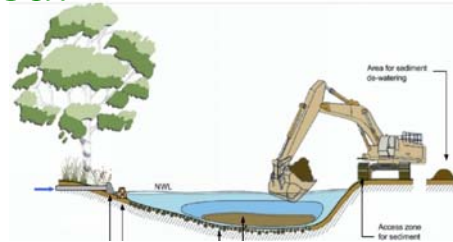


Drone image of Briar Chapel, Chatham Co by Peter Theye

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

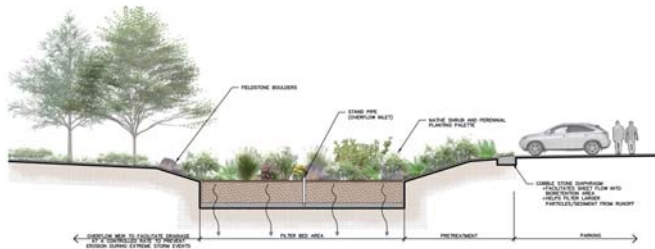
Conventional Infrastructure

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



Green Infrastructure

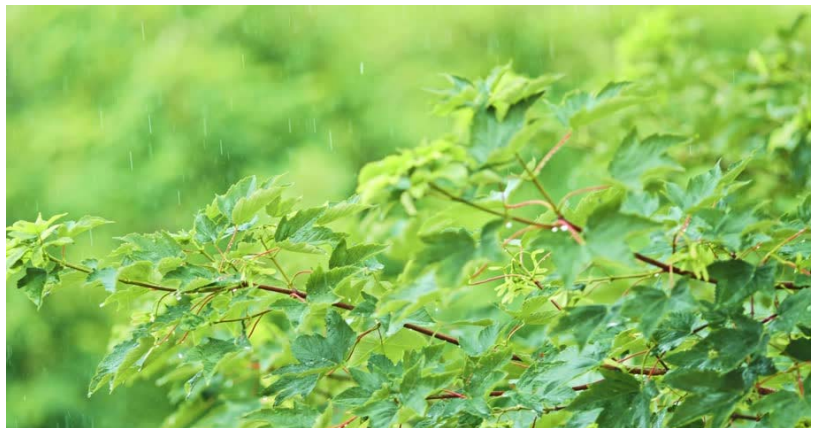
- Replicate hydrologic cycle
- Multiple smaller, less costly to build, & fits into the landscape.



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*



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

What is i-Tree?

- Quantify structure, risk & environmental services of trees
- Advocacy and management tools for community trees
- Built upon peer-reviewed USFS science
- Free and easy to use

i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools. The i-Tree Tools help communities of all sizes to strengthen their forest management and advocacy efforts by quantifying the structure of trees and forests, and the environmental services that trees provide.

Since the initial release of the i-Tree Tools in August 2006, thousands of communities, non-profit organizations, consultants, volunteers and students have used i-Tree to report on individual trees, parcels, neighborhoods, cities, and even entire states. By understanding the local, tangible ecosystem services that trees provide, i-Tree users can link forest management activities with environmental quality and community livability. Whether your interest is a single tree or an entire forest, i-Tree provides baseline data that you can use to demonstrate value and set priorities for more effective decision-making.

i-Tree Tools are in the public domain and are freely accessible. We invite you to explore this site to learn more about how i-Tree can make a difference in your community or forest.

The 2016 i-Tree Suite of Tools

Web-based

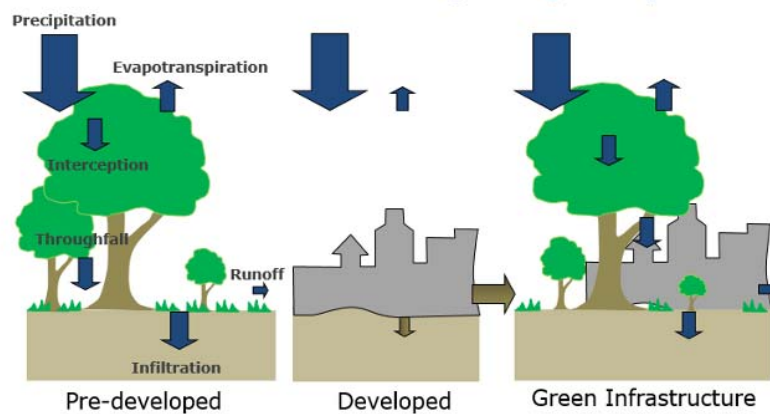


Desktop



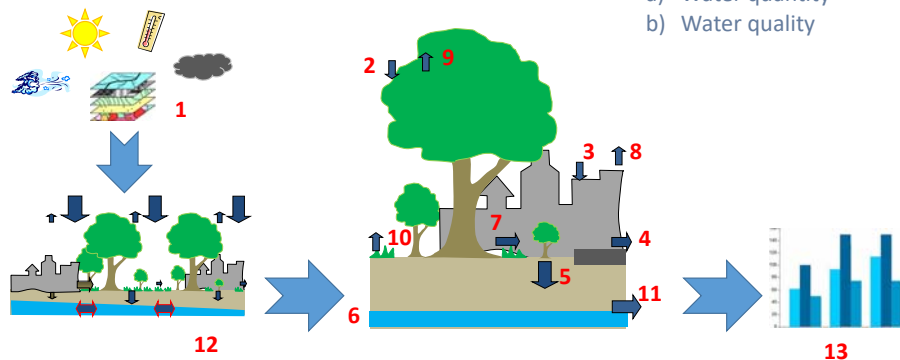
i-Tree Hydro

Natural vs. Disturbed Hydrological Cycle



Tree Hydro Model: Conceptual Schematic

- 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



Step 4) Define an i-Tree Hydro Alternative Case

Input the Cover Type values below to reflect the Alternative Land Use Scenario you wish to model. Example: increase your tree canopy and decrease your impervious cover. Remember: all the cover types must add to 100%

Surface Cover Types	Base Case	Alternative Case	Tree Leaf Area Index	Base Case	Alternative Case
Tree Cover (%)	69.3	50.0	Tree Leaf Area Index	4.7	4.7
Shrub Cover (%)	3.7	3.7	Shrub Leaf Area Index	2.2	2.2
Herbaceous Cover (%)	15.5	15.5	Herbaceous Leaf Area Index	1.6	1.6
Water Cover (%)	0.4	0.4	Directly Connected Impervious Cover (%)	40.0	20.0
Impervious Cover (%)	11.0	30.3			
Soil Cover (%)	0.1	0.1			
Total Cover (%) (Should = 100)	100.0	100.0			

Cover Types beneath Tree Cover	Base Case	Alternative Case
Pervious Cover (%)	93.9	75.0
Impervious Cover (%)	6.1	25.0
Total Cover (%) (Should = 100)	100.0	100.0

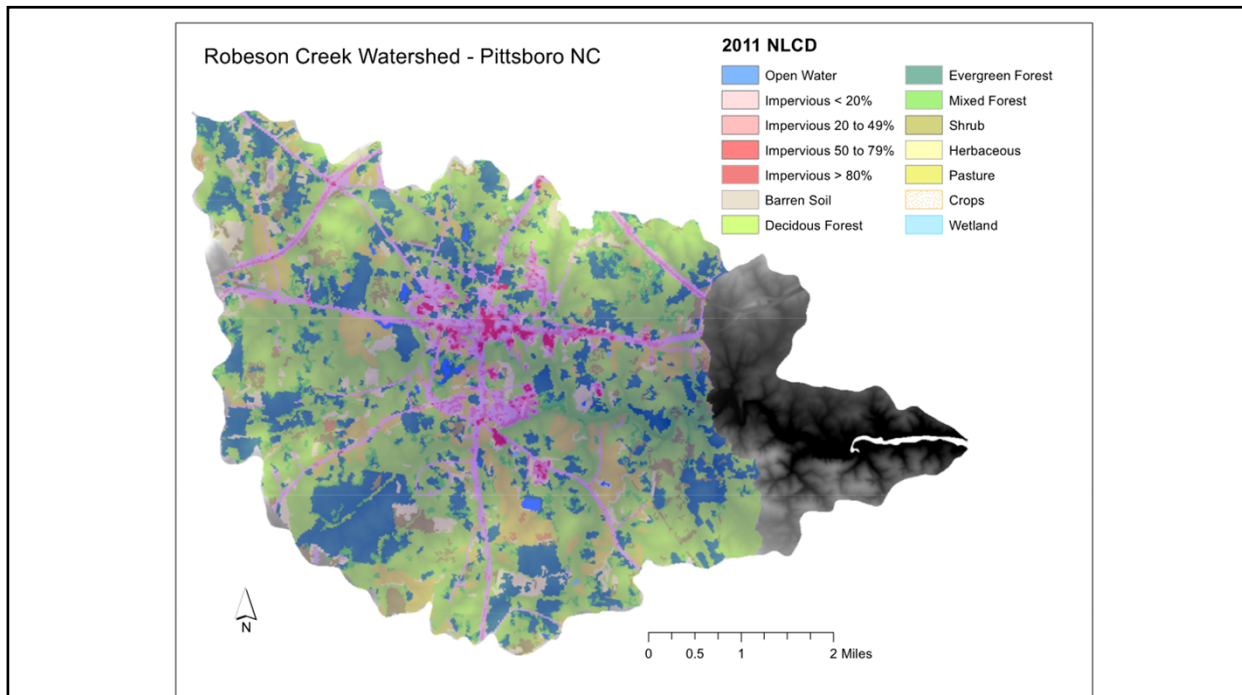
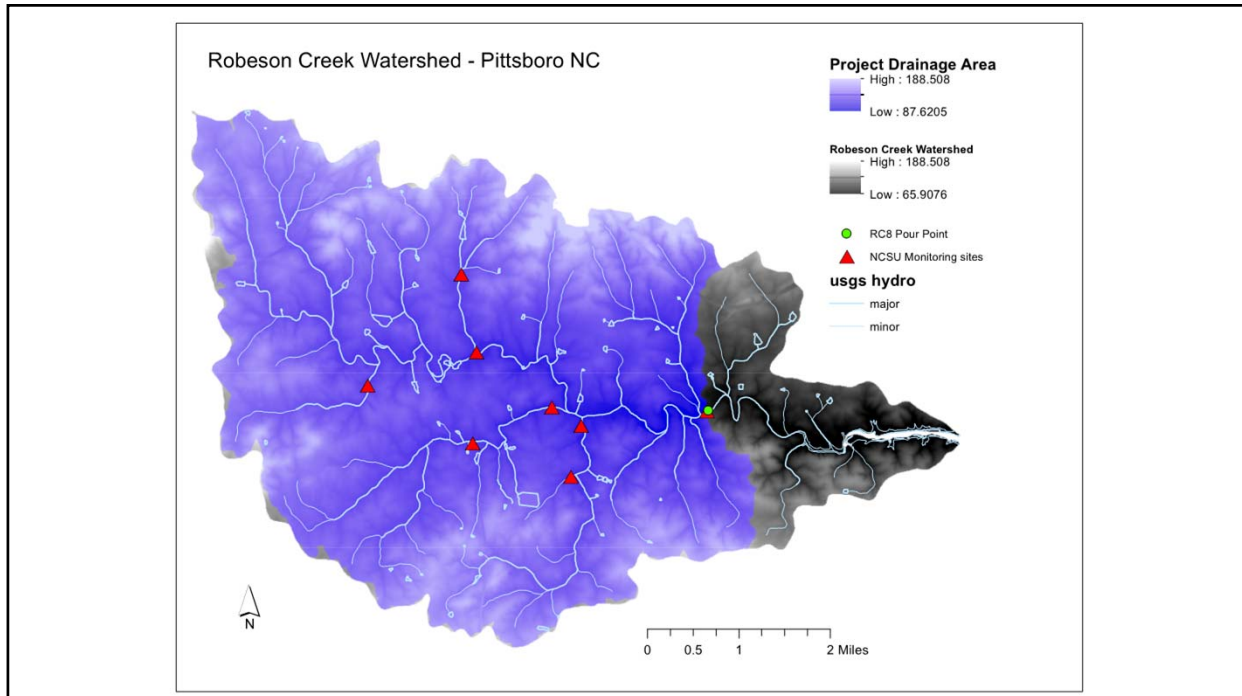
Help for items on this page:

Percent Tree Cover


How much of your watershed area is covered by tree canopy? Here you would enter this percentage. This percentage represents tree canopy found over both pervious and impervious cover. For example, trees planted in a parking lot, where the majority of the canopy might be over impervious asphalt, and trees planted in parks, where the canopy is over pervious soil/grass, are both included in this percentage. This percentage could come from data sources you have already compiled or you could make use of other i-Tree tools, such as i-Tree Canopy (www.itreetools.org/canopy), to create a statistical

Next: Step 4) Run the i-Tree Model

Reset OK Cancel



i-Tree Hydro Executive Summary
 Project Location: Pittsboro, North Carolina
 Project Time Span: 01/01/2011 - 12/30/2011



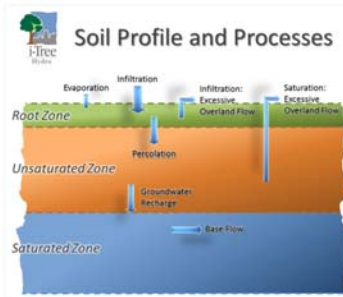
Model Parameters

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

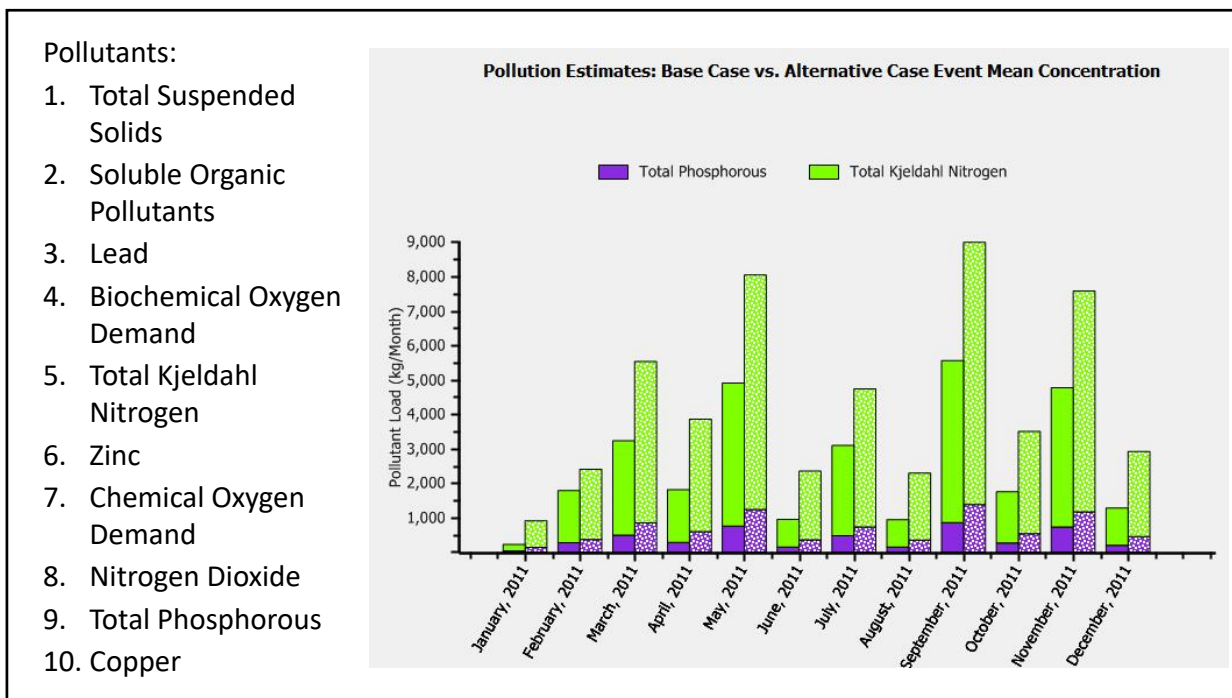
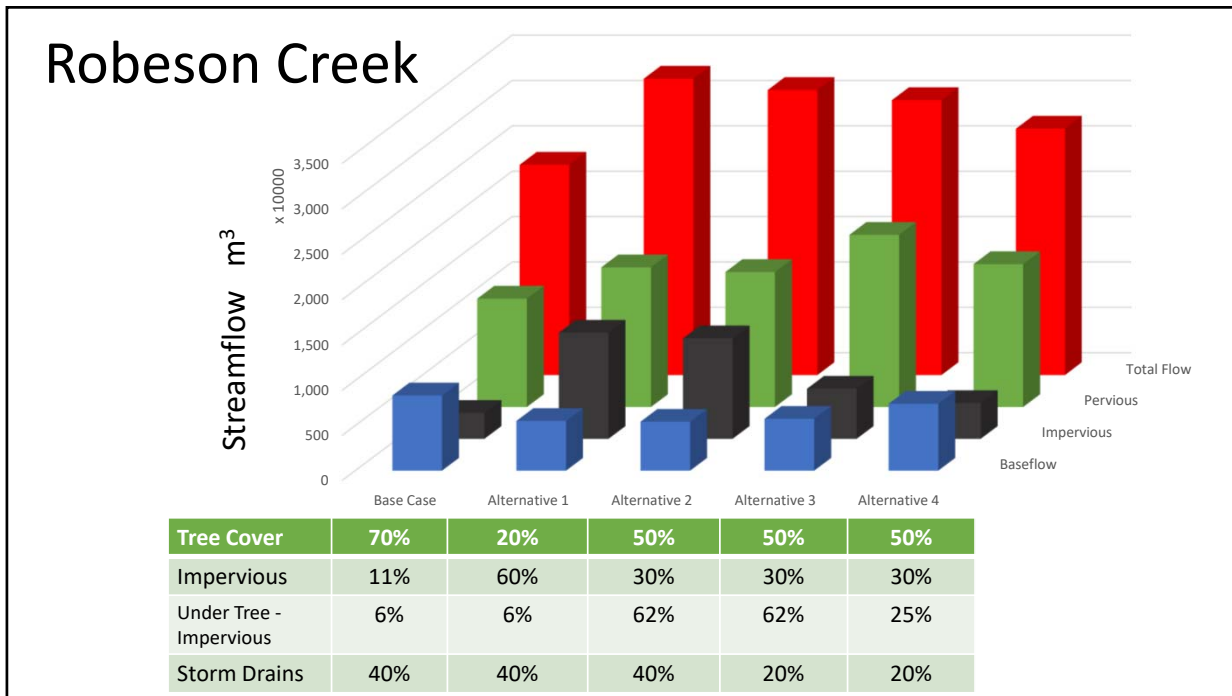
Land Cover	Base		Alternative		LC beneath Tree Cover		Base		Alternative	
Tree Cover %	69.3	40.0	Tree LAI	4.7	4.7	Soil Cover %	93.9	93.9		
Shrub Cover %	3.7	3.7	Shrub LAI	2.2	2.2	Impervious Cover %	6.1	6.1		
Herbaceous Cover %	15.5	15.5	Herbaceous LAI	1.6	1.6					
Water Cover %	0.4	0.4								
Impervious 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



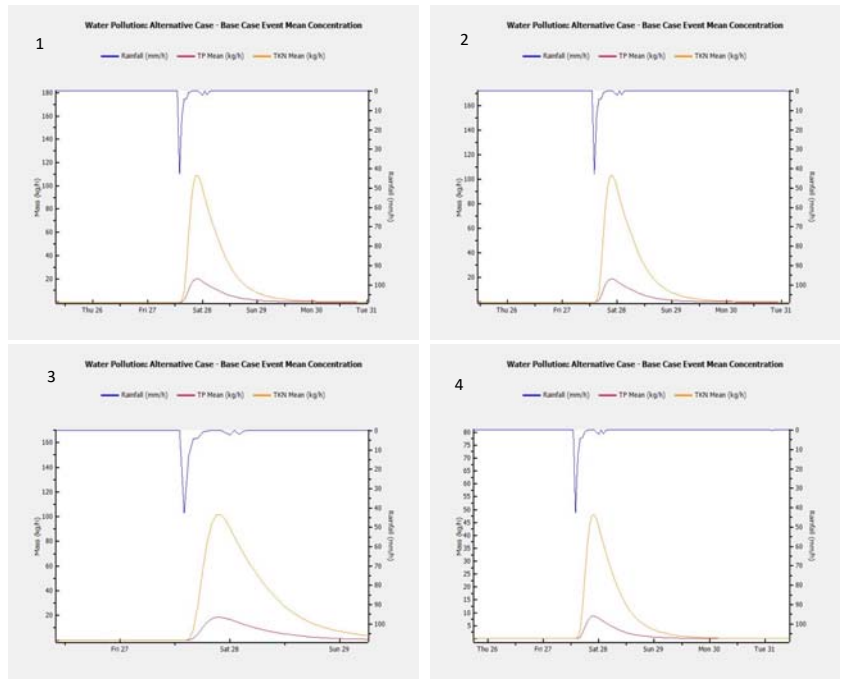
Robeson Creek Watershed Land Cover					
24	sq miles	Alternatives Scenarios			
Cover	Base Case	1	2	3	4
Tree	69.3%	20.0%	50.0%	50.0%	50.0%
Shrub	3.7%	3.7%	3.7%	3.7%	3.7%
Herbaceous	15.5%	15.5%	15.5%	15.5%	15.5%
Water	0.4%	0.4%	0.4%	0.4%	0.4%
Impervious	11.0%	60.3%	30.3%	30.3%	30.3%
Soil	0.1%	0.1%	0.1%	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%



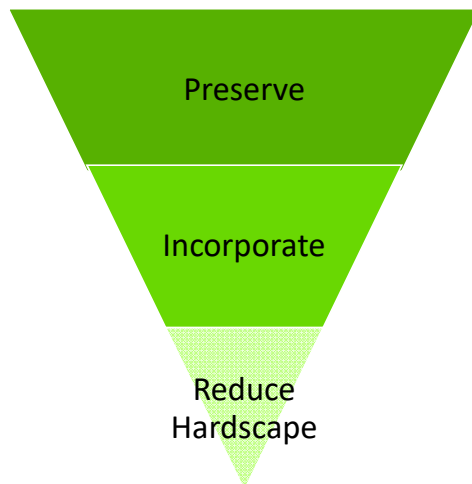
Change in Pollutant Load
Base Case – Alternative Case

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

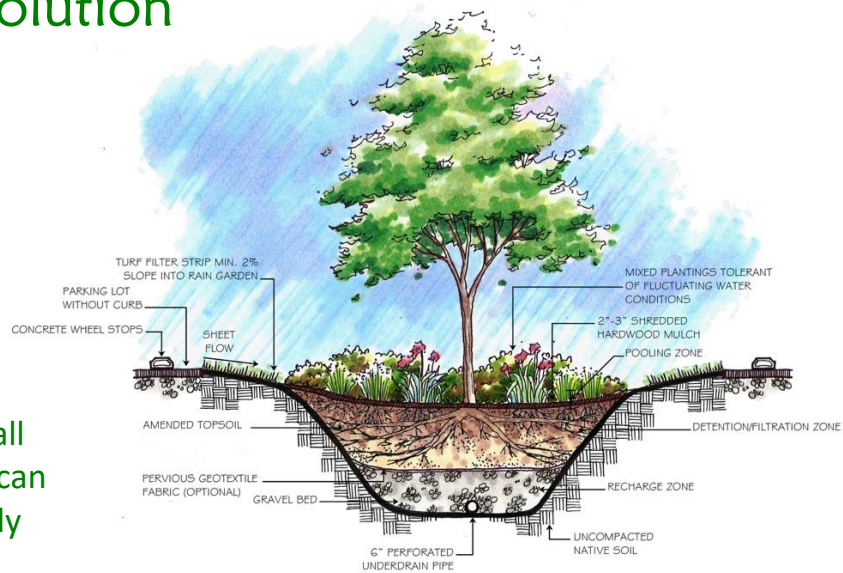
Set tree canopy goals



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!

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www.itreetools.org

Urban Natural Resources Institute

www.unri.org/webcasts/itreeworkshops/



References

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

Jun Wang, Theodore Endreny, and David Nowak, *Mechanistic Simulation of Tree Effects in an Urban Water Balance Model*, *Journal of the American Water Resources Association*, February 2008.

i-Tree Hydro Manual, version 5.1 (Website: www.itreetools.org) October 28, 2016.