

# Integrating LID, Stream Enhancement, and Floodplain Functions in Urban Watersheds

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*Rocky Branch, NC State University*



# Urban Stream Syndrome (USS)

- Response to watershed changes
- Loss of natural functions & values
- Causes problems locally & downstream
- Requires systematic assessment & treatment



# Symptoms of USS

- Erosion & incision
- Water quality decline
- Habitat loss
- Ecosystem degradation
- Flooding
- Land loss
- Infrastructure damage
- Recreation impaired
- Aesthetics impaired
- Economic loss



# Causes of USS

- Watershed impervious
- Channelization
- Impoundments
- Diversions
- Floodplain filling
- Pollution discharges
- Sedimentation
- Stormwater runoff
- Utilities & culverts
- Buffer loss
- *Neglect & Ignorance*



# Green Infrastructure

“integrated system of natural elements and LID practices that provide broad environmental benefits” (USEPA)

***Maintenance Required!***



*Bioretention, Carrboro, NC, Baldwin Park*



*Floodplain Wetland, Auburn, AL, Town Cr Park*

**Low Impact Development:** “natural systems for infiltration, evapotranspiration and harvesting of rainwater... to maintain or restore a watershed's hydrologic and ecological functions” (USEPA)

## Stormwater Control Measures (SCMs):

- Bioretention cells
- Curb and gutter elimination
- Grassed swales
- Green parking design
- Infiltration trenches
- Inlet protection devices
- Permeable pavement
- Permeable pavers
- Rain barrels and cisterns
- Riparian buffers
- Sand and organic filters
- Soil amendments
- Stormwater planters
- Tree box filters
- Vegetated filter strips
- Vegetated roofs



# Stream Enhancement

“implementing certain stream rehabilitation practices in order to improve water quality and/or ecological function” (NCDEQ)



# Floodplains

“area inundated with water during high flows... needed for the watercourse to maintain natural biologic, geomorphic, and hydrologic functions” (*ASFPM*)

- Flood storage & conveyance
- Groundwater recharge & discharge
- Erosion & sediment control
- Pollution control
- Habitats
- Carbon storage
- Micro-climates
- Food production
- Recreation & aesthetics



# Healthy Urban Watersheds (*Systematic Approach*)

- LID: Stormwater Control Measures (retention, treatment)
- Bio-Conveyance (stability, retention, treatment)
- Stream Enhancement (stability, ecology)
- Floodplain Functions (retention, treatment, ecology)



*Rocky  
Branch, 2012  
(6 years after  
restoration)*

# Goals

- Ecological conditions (habitats & water quality)
- Social conditions (recreation & aesthetics)
- Economic conditions (infrastructure & land value)
- Educate citizens & decision-makers



Daphne UT D'Olive Creek



Samford University Shades Creek

# Rocky Branch, NCSU Campus, Raleigh, NC

*(Project Manager: Barbara Doll, PhD, PE, NCSU)*

- SCMs (upland and in floodplain)
- Stream Restoration (5,000 ft perennial channel)
- Floodplain creation (2 to 4 x channel width)
- Riparian Buffer (50 ft native forest)



# Stormwater Control Measures

- Bioretention and Bioconveyance
- Stormwater Wetlands/Ponds
- Outfall Energy Dissipation Basins
- Floodplain Wetlands
- Riparian Buffers



# Stream Enhancement

- Channel Realignment
- Floodplain Excavation (2 to 4 x channel width)
- In-stream Structures (grade control, bank protection, habitat)
- Riparian Buffers



# Rocky Branch Downstream near Pullen Road

Priority 2 (floodplain excavation, C channel replacing F)

Entrenchment Ratio =  $W_{fpa} / W_{bkf} = 80/20 = 4$



**Floodplain flows several times each year**



# NCSU Rocky Branch Downstream at Pullen Road

T.S. Fay 27Aug08

T.S. Alberto 15Jun06



# NCSU Rocky Branch Downstream at Pullen Road

2012



2009



# Stream Daylighting at IM Fields: Facing Downstream in 2008 before construction



# Stream Daylighting at IM Fields:

## Facing Downstream in 2009 during construction



# **Stream Daylighting at IM Fields:**

## **Facing Downstream in 2009 during construction**



# **Stream Daylighting at IM Fields:**

## **Facing Downstream in 2015 after construction**



**Google  
Earth  
Images:**

**2007  
to  
2014**



# Auburn Town Creek Trib (2008)



2007

*Project Mgmt:* Auburn Univ

*Funding:* ADEM 319, USEPA

*Design:* Stantec, Jennings

*Construction:* North State  
Environmental

*Vegetation:* Auburn Univ

2008



$$\text{Entrenchment Ratio} = W_{\text{fpa}} / W_{\text{bkf}} = 180/10 = 18$$



2008

Town Creek Tributary

# Education: Workshops & Tours





2016

Town Creek Tributary

# Auburn Saugahatchee Creek (2008)



*Project Mgmt:* City of Auburn

*Funding:* City of Auburn

*Design:* Bidelspace, Jennings

*Construction:* North State  
Environmental

*Vegetation:* NSE

2007

2008





## Multiple Log Vanes

## Saugahatchee Creek

*2009 January*



*2009 July*

07.14.2009

Photo Credit: Dan Ballard, Town of Auburn

# Multiple Log Vanes: Saugahatchee Creek



**2012 April**

*Photo Credit: Dan Ballard, Town of Auburn*

# Auburn Saugahatchee Trib (2013)



*Project Mgmt:* City of Auburn

*Funding:* City of Auburn

*Design:* Bidelspach, Jennings

*Construction:* North State  
Environmental

*Vegetation:* Auburn University

2013

2016



# Samford University Shades Creek (2011)



2010

*Project Mgmt:* Samford Univ

*Funding:* Samford Univ

*Design:* LBYD, Jennings

*Construction:* North State  
Environmental

*Vegetation:* Auburn Univ, NSE



2011

Priority 3: Excavate narrow floodplain benches  
in confined corridor



$ER = 1.4$   
 $W/d = 15$   
 $K = 1.02$   
 $S = 0.005$

*Construction:*  
*Jan, 2011*



$$\text{Entrenchment Ratio} = W_{\text{fpa}} / W_{\text{bkf}} = 55/40 = 1.4$$



*May 2011*

# Erosion Control: Seed, Straw, Matting, Wood Stakes



# In-Stream Structures (10): Boulder & Log

- Grade Control
- Bank Protection
- Sediment Transport
- Habitat



# Log Vane (Grade Control J-Hook)

- 70-ft long log; 30-inch diameter; root wad attached
- 3 % arm slope; 20 degree angle
- Sealed with woven geotextile & backer log
- Back filled with river cobble, gravel, sand



# Log Vane (Grade Control J-Hook)



***Oct 2012***

# Boulder Cross-Vanes

- 1 to 2 ton boulders; 3 % arm slope; 20 degree angle
- Throat extends through center half of channel
- Boulder footers; Sealed with non-woven geotextile
- Back filled with river cobble, gravel, sand



# Boulder Cross-Vanes



# Shades Creek Flood, March 2011



*March 2011*



*September 2011*

# Vegetation – Streamside Forest

Native plants

Grasses, shrubs, trees

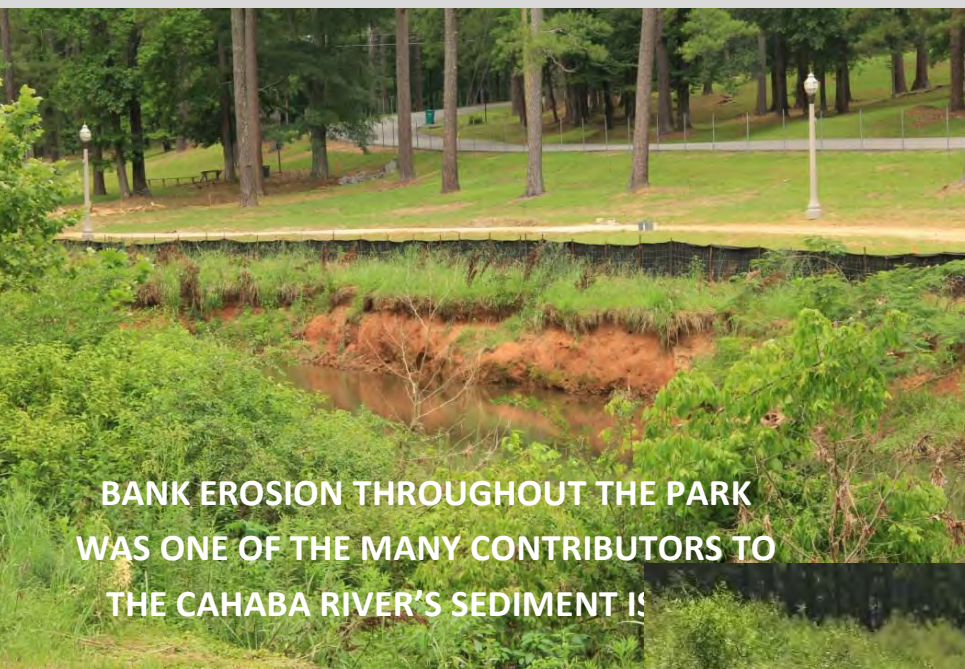
Live stakes, bare roots, containers



# Trussville Cahaba River (2015)

BEFORE

AFTER



BANK EROSION THROUGHOUT THE PARK  
WAS ONE OF THE MANY CONTRIBUTORS TO  
THE CAHABA RIVER'S SEDIMENT IS

**TOUR AGENDA:**

**10:00 am** — Meet City of Trussville at the Seneca Park

**10:15 am** — Walking tour of the ongoing Cahaba River enhancement activities.

**Activities Center**

**Funding:** City of Trussville

**Design:** LBYD, Jennings

**Construction:** Stream Structures (log and boulder vanes, enhanced sifflee, Environmental

**Vegetation:** Erosion and sediment control practices, NSE, Invasive plant management

2014

LBYD , Inc.

North State Environmental  
Jennings Environmental, L

2015



# Trussville Cahaba River (2016)



# D'Olive Creek Watershed Restoration Projects

- Design to reduce erosion and provide ecological values
- Share ideas, techniques, and lessons learned
- Build capacity and understanding for solving problems
- Support sustainable communities

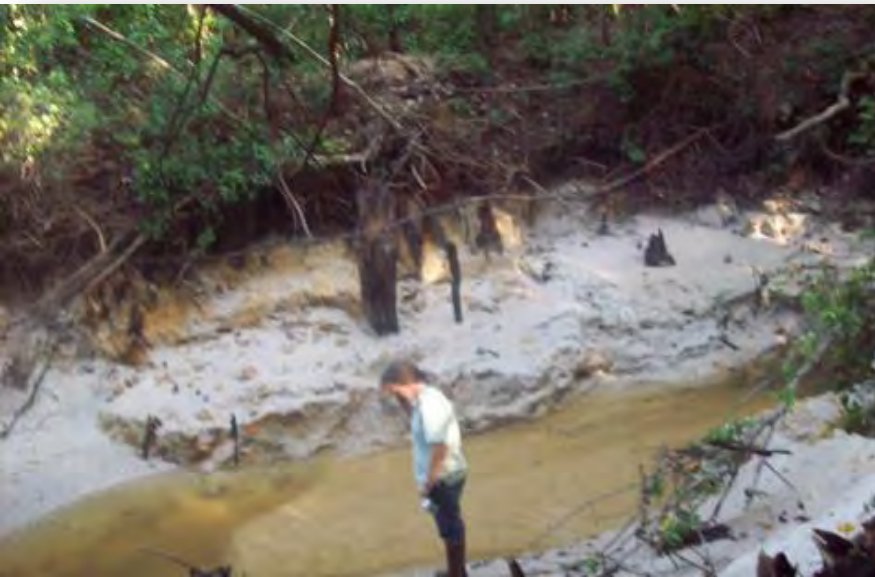


# D'Olive Creek Watershed Restoration

Before 2014: Many projects to protect infrastructure

2014-2018: NFWF funding + other grants for watershed approach to reduce sediment loading to Mobile Bay

2016 into Future: Watershed stewardship to continue reducing stormwater runoff and sediment loading



# Joel Branch (tributary to D'Olive Creek)

Engineer: Thompson Engineering

Contractors: Southern Excavating; North State Environmental



*Sedimentation in wetlands of a tributary to Joe's Branch upstream of Town Center Avenue*

## Joes Branch: JB Step Pool (completed 2012)



# Tiawassee Creek: Reaches TC1, TC2

Engineer: Goodwyn, Mills, Cawood

Contractor: North State Environmental (2016 construction)

***Partnership with City of Daphne, CIAP, ADEM, EPA319, NFWF***





# Tiawassee Creek: Reaches TC1, TC2 (*August, 2016*)



# Tiawasseee Creek: Reaches TC1, TC2 (*August, 2016*)

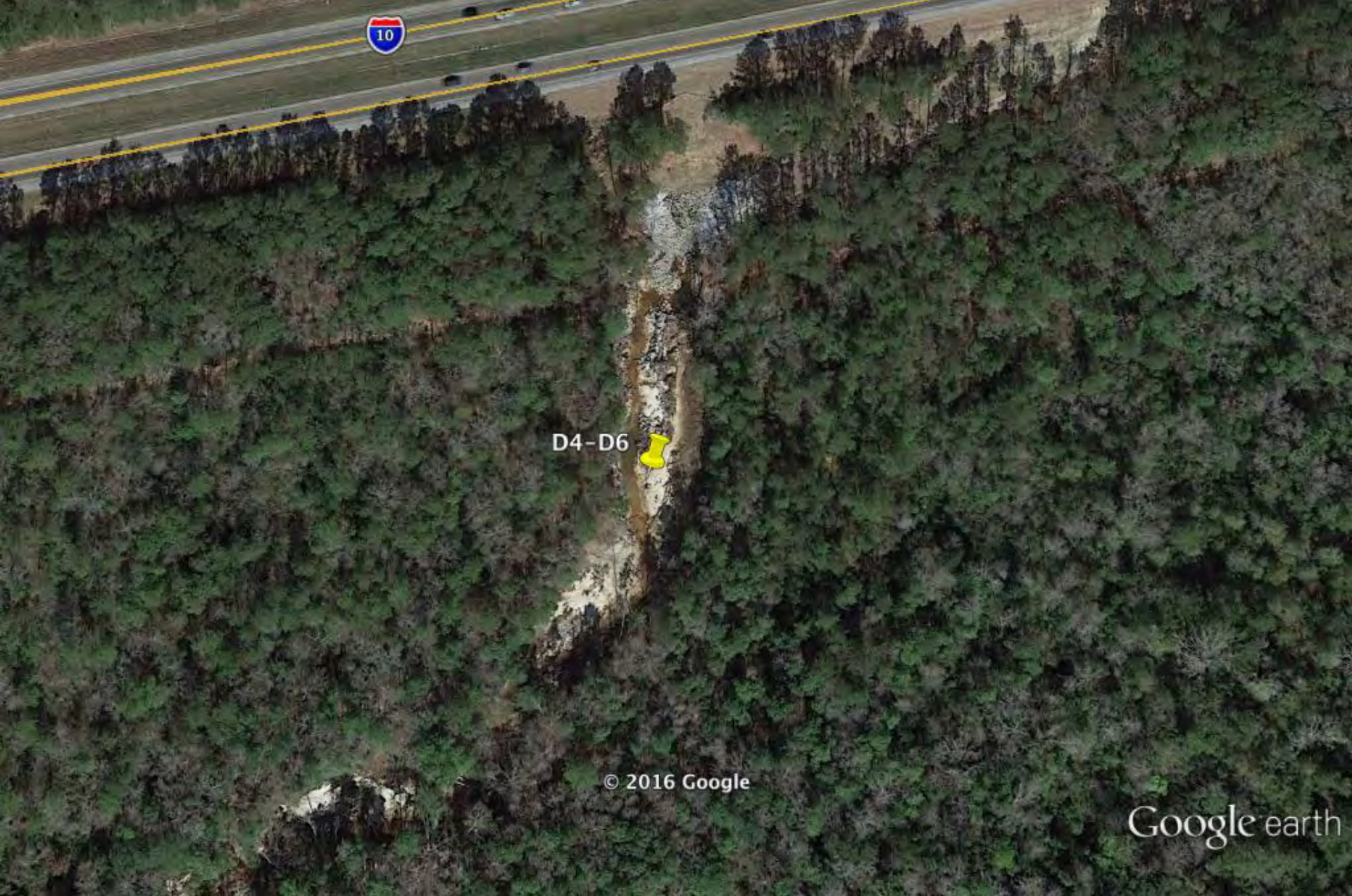


# D'Olive Creek: Reach D4-D6 (I-10 to US90)

Engineer: Goodwyn, Mills, Cawood

Contractor: North State Environmental





***2016 (following 2014 flood of record)***

# D'Olive Creek: Reach D4-D6, I-10 - US90 (May, 2016)



# D'Olive Creek: Reach D4-D6, I-10 - US90 (*Jun, 2016*)



# D'Olive Creek: Reach D4-D6, I-10 - US90 (Aug, 2016)



# Enhancing Urban Watersheds: *Final Thoughts*

- Systematic approach using all Green Infrastructure Tools
- Community Engagement
- Permanent Easements
- Inspection, Maintenance, Adaptive Management

***Thank you,  
Greg Jennings  
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