A new stormwater treatment technique-regenerative stormwater conveyances

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Ecological Restoration:

…the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.
(Society for Ecological Restoration)

Ecological Engineering:

…integrating ecology and engineering… design and construction of sustainable ecosystems… to integrate society with the natural environment for the benefit of both . (Howard Odum)

Novel Ecosystem:

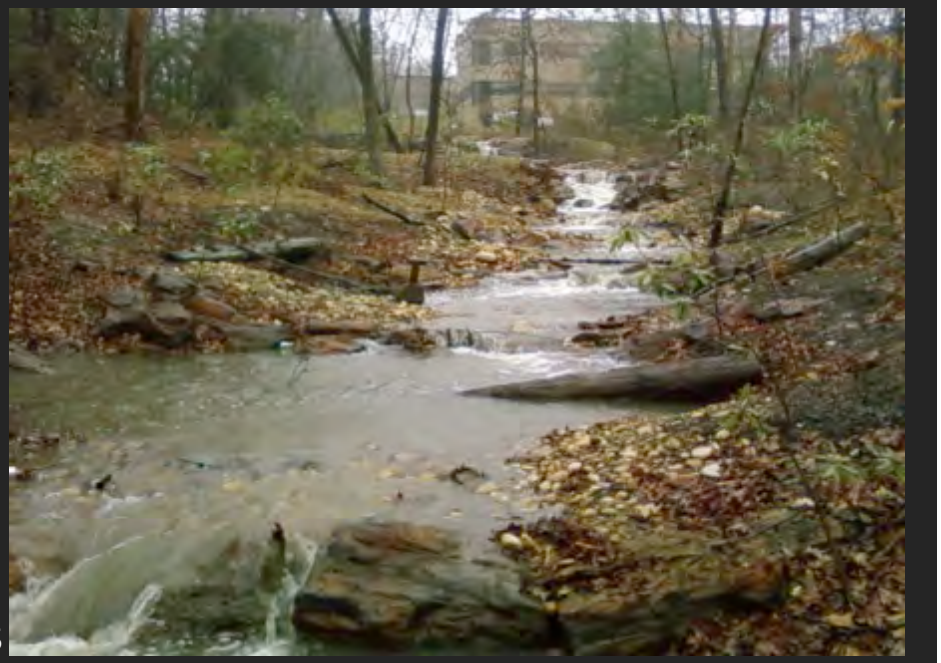
…ecosystem that has been heavily influenced by humans but is not under human management.

Nature (2009) 460: 450-453

Regenerative Stormwater Conveyances (RSCs)

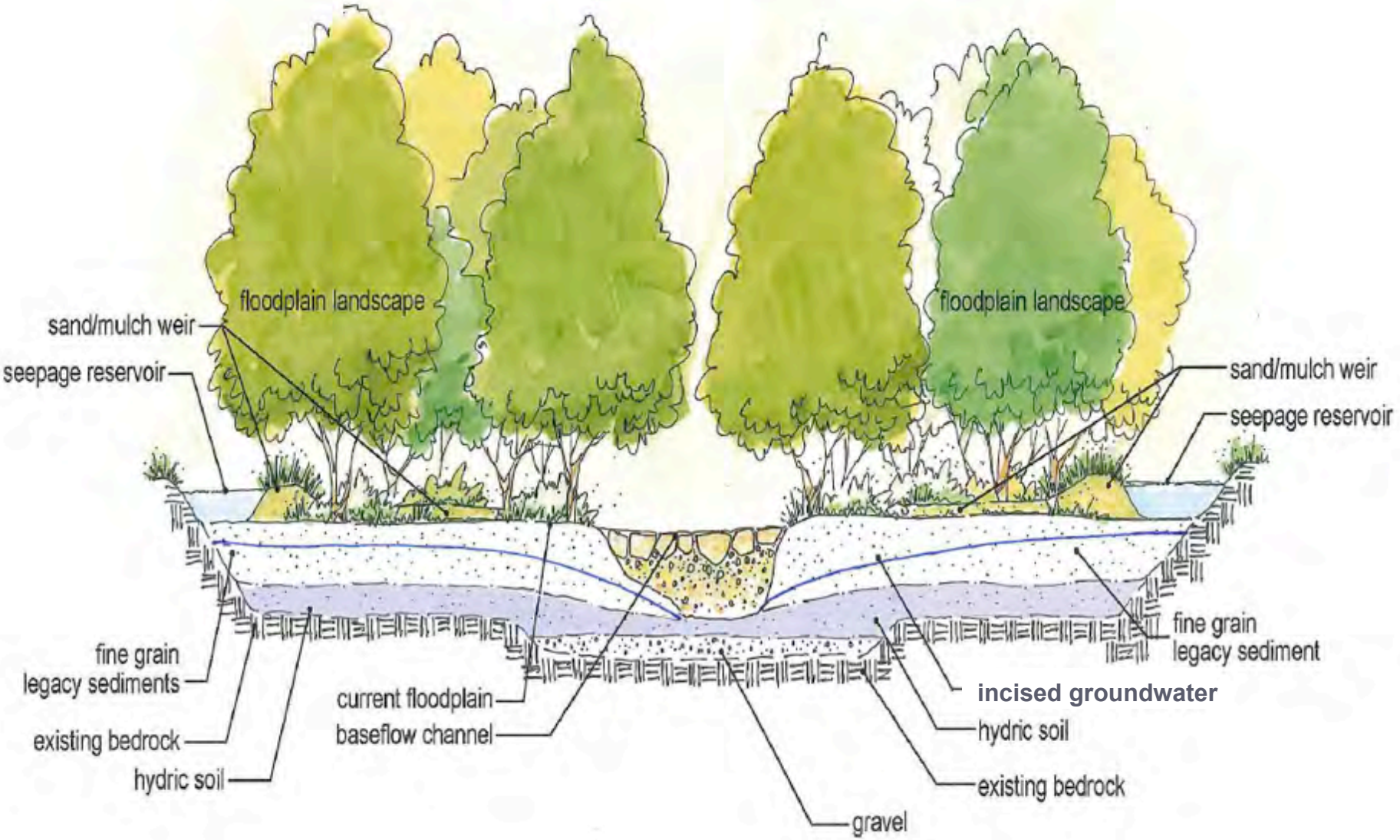
-----Utilize a series of shallow aquatic pools, riffle/grade controls , native vegetation , and an underlying sand/wood chip substrate (ecological restoration and ecological engineering)

-----intercept stormwater, and filter pollutants from the flow of stormwater in channels that are often degraded by urban runoff (novel ecosystems).



Source of Photos: Underwood & Associates

Groundwater Restoration



Preliminary RSC Monitoring Data – Emerging Trends/Benefits:

- **Reduction of peak discharge and extension of the time of concentration of stormwater flows**
- **Reduction of nitrogen loads**
- **Reduction of phosphorus loads**
- **Reduction of TSS loads**
- **Reduction in stream temperature**
- **Extension of downstream baseflow periods**

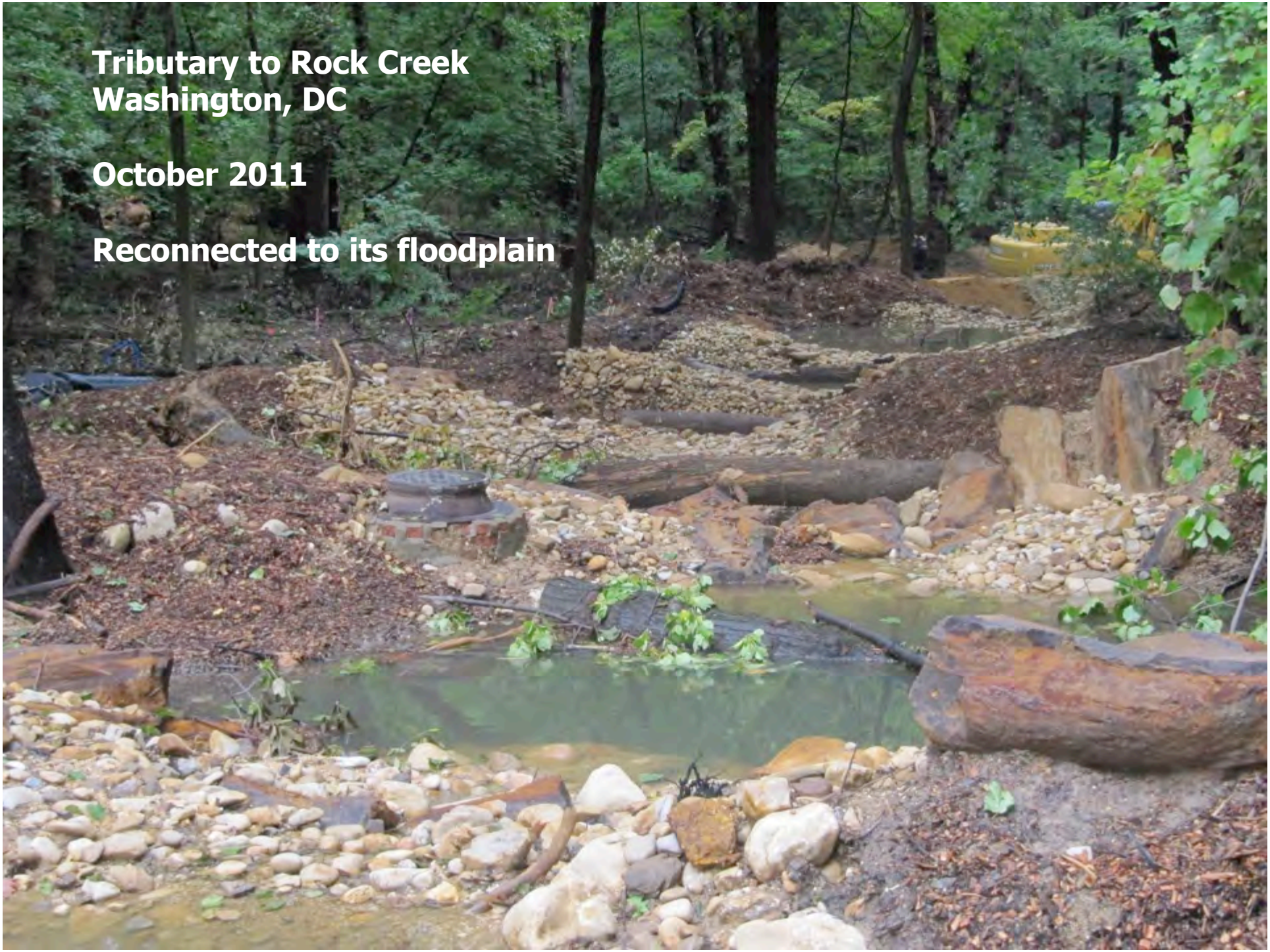

Set riffle elevations to retain water on landscape

There is a somewhat analogous / reference system -- beaver dams

Tributary to Rock Creek
Washington, DC

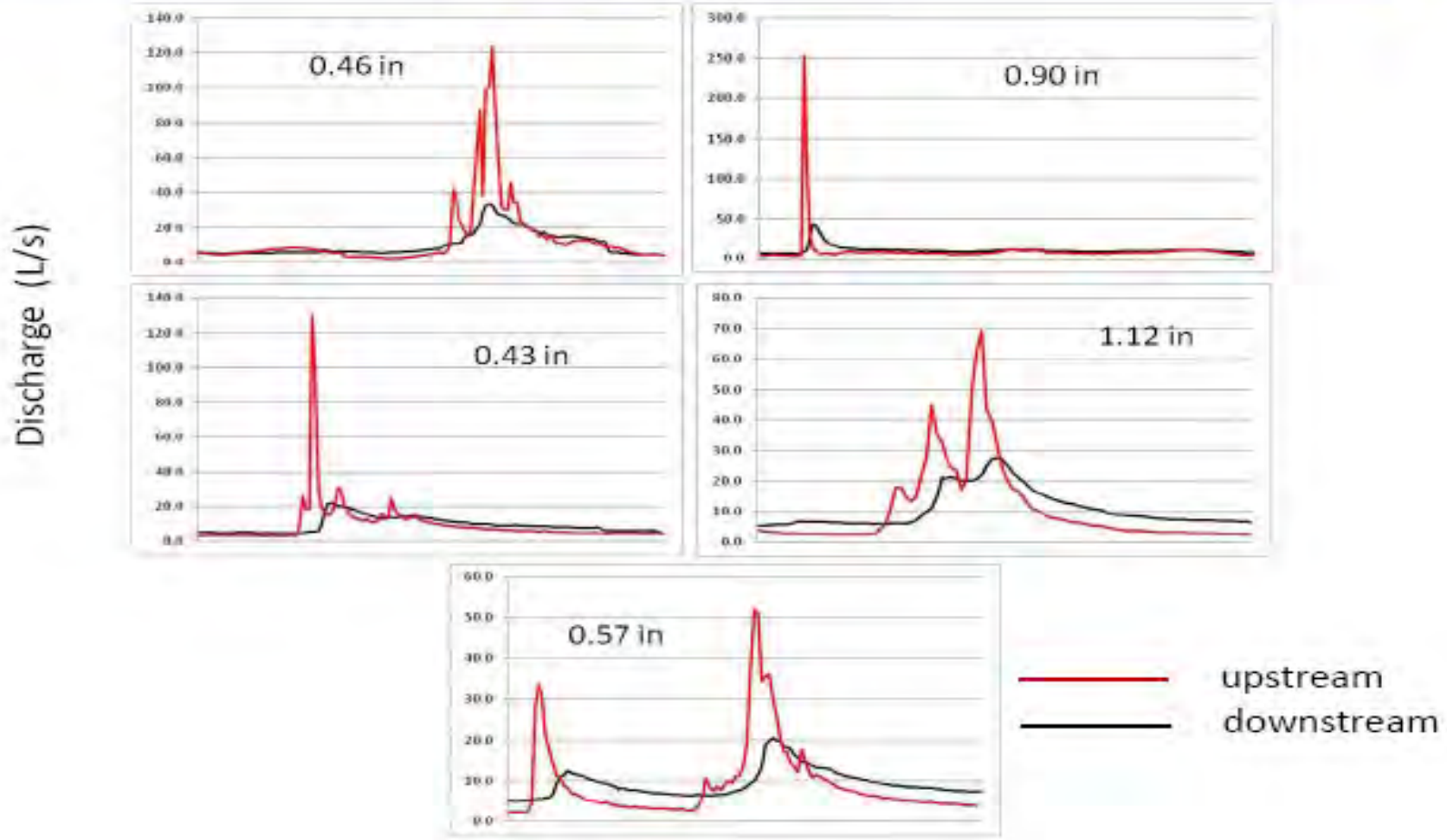
February 2011

~10 ft Incised


Tributary to Rock Creek
Washington, DC
October 2011
Reconnected to its floodplain

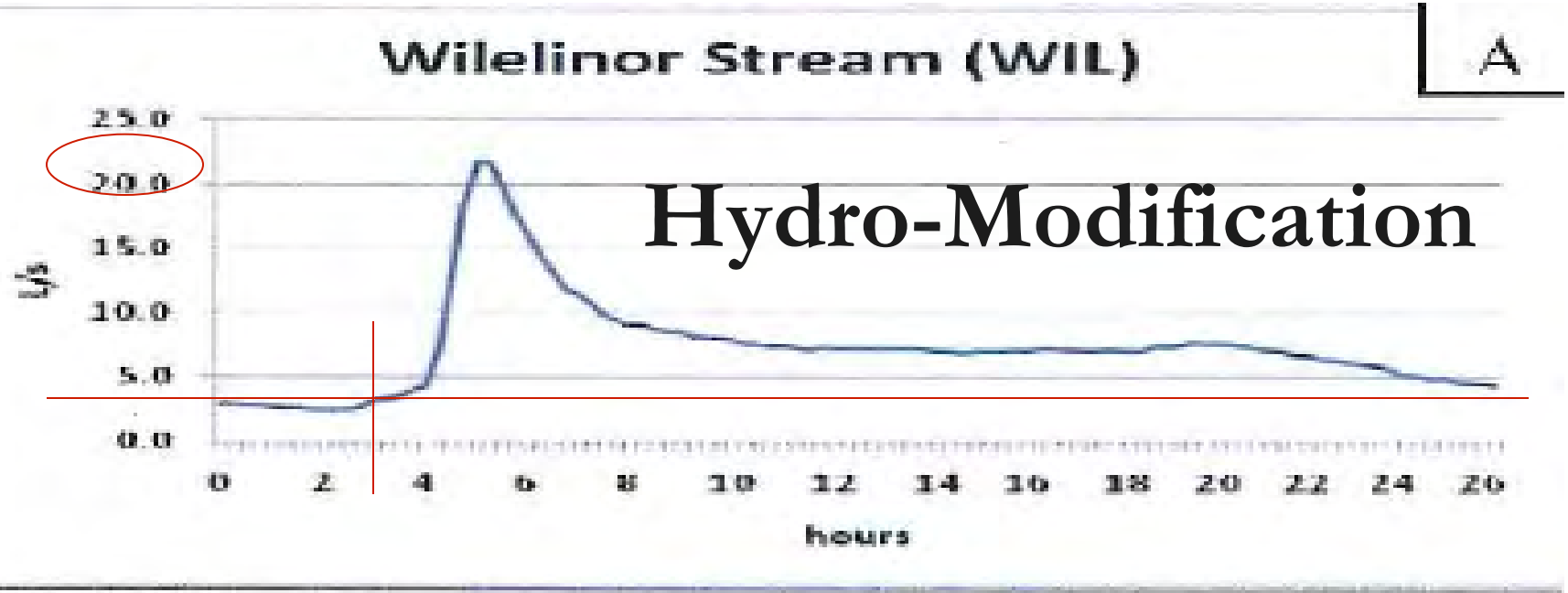

Wilelinor

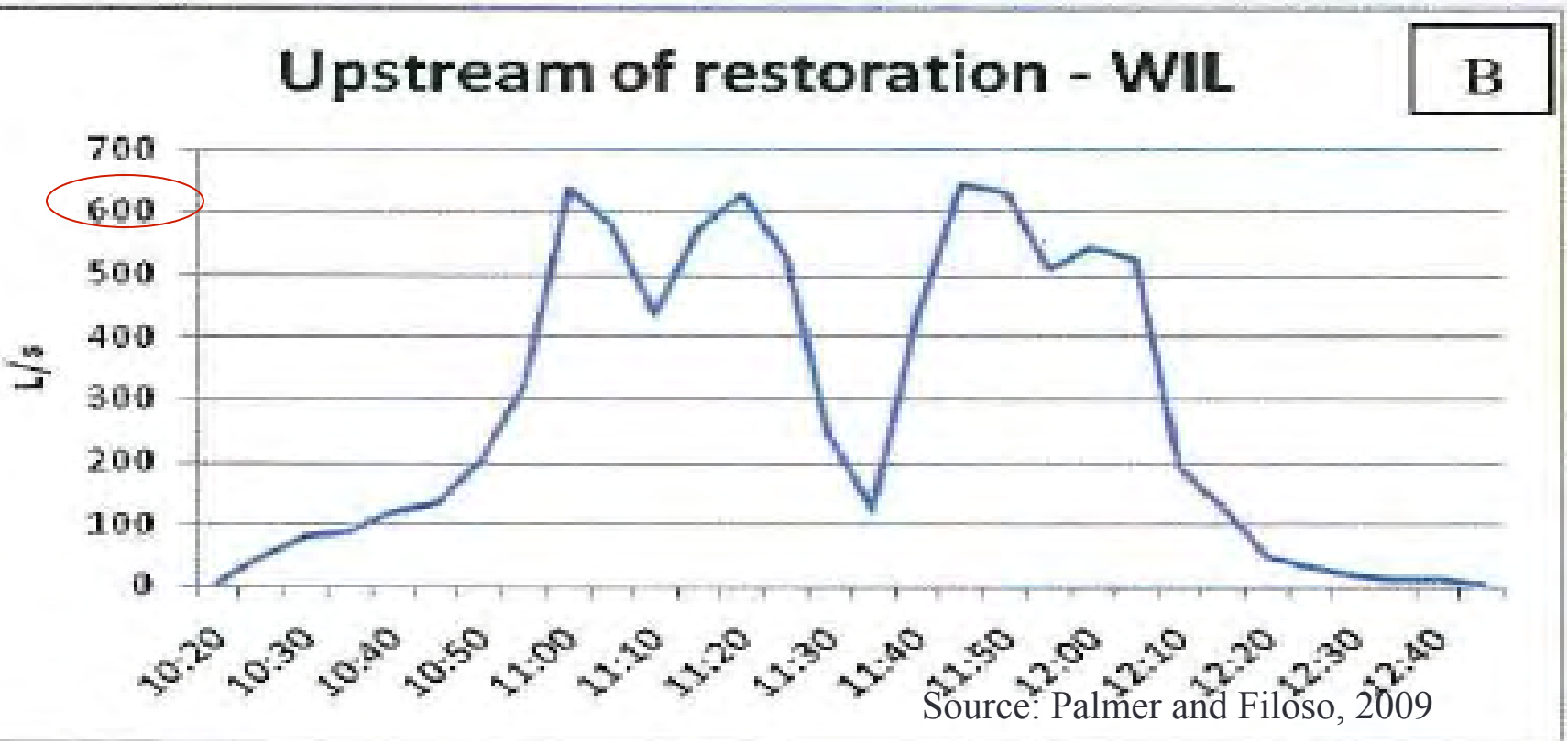
Hydrographs during individual storms WILELINOR



Source: Solange Filoso, University of Maryland

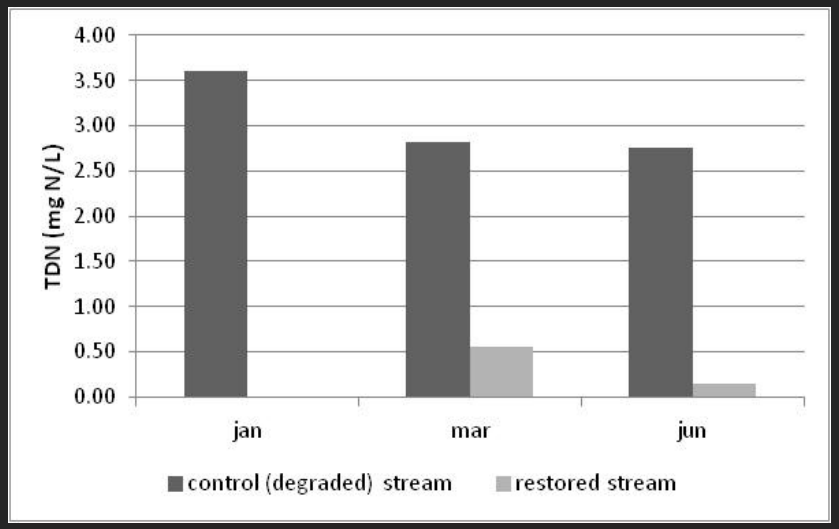
Hydro-Modification

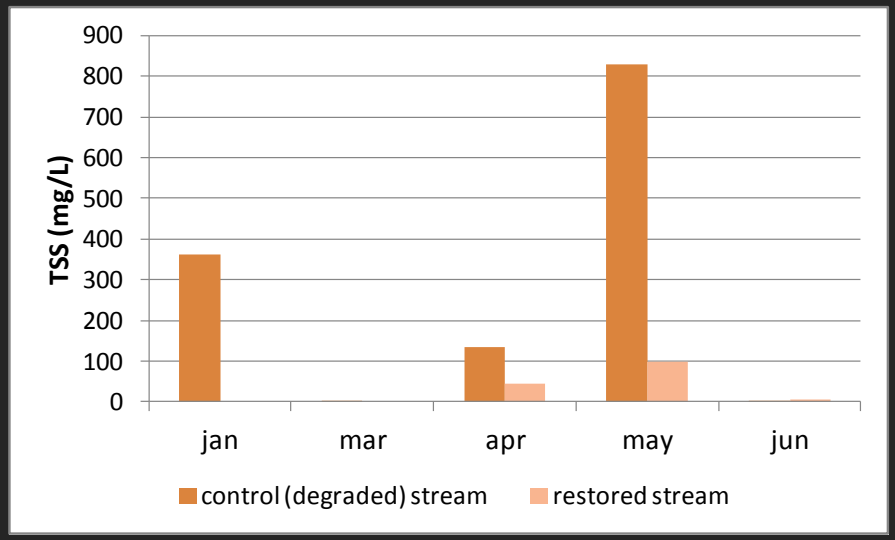


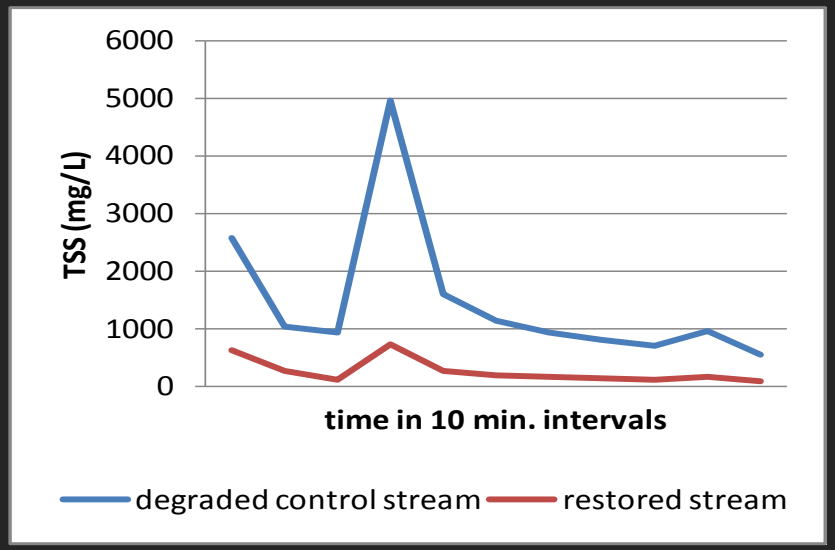


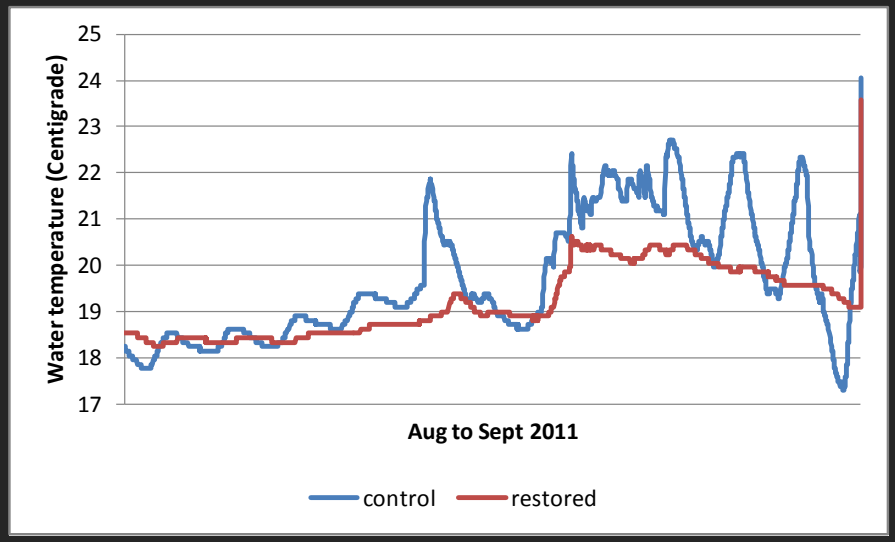
Source: Palmer and Filoso, 2009

Carriage Hills









Carriage Hills,
Source: Solange Filoso, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory

Reconnect Stream – PB-1

Raising groundwater elevation to near top of bank would store
8.5 ac-ft of water

Estimated to extend baseflow by 19 days

Significant benefits to
Stream hydrograph, shear s, instream-habitat, adjacent wetland hydrology, etc.

ACCOUNTING FOR STORMWATER WASTELOAD ALLOCAT AND IMPERVIOUS ACRES TRI

GUIDANCE FOR NATIONAL POLLUTANT DISCHARGE ELIMINAT STORMWATER PERMITS

JUNE (DRAFT) 2011

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Table 4. Structural BMP Retrofit Matrix

BMP Practice	TN	TP	TSS
CBP Structural BMPs			
Dry Detention Ponds	5%	10%	10%
Hydrodynamic Structures	5%	10%	10%
Dry Extended Detention Ponds	20%	20%	60%
Wet Ponds and Wetlands	20%	45%	60%
Infiltration Practices	80%	85%	95%
Filtering Practices	40%	60%	80%
Vegetated Open Channels	45%	45%	70%
Erosion and Sediment Control	25%	40%	40%
Stormwater Management by Era			
Development Between 1985 - 2002	17%	30%	40%
Urban BMP Retrofit	25%	35%	65%
Development Between 2002 and 2010	30%	40%	80%
Development After 2010	50%	60%	90%
ESD to the MEP from the *Manual*			
Green Roofs	50%	60%	90%
Permeable Pavements	50%	60%	90%
Reinforced Turf	50%	60%	90%
Disconnection of Rooftop Runoff	50%	60%	90%
Disconnection of Non-Rooftop Runoff	50%	60%	90%
Sheetflow to Conservation Areas	50%	60%	90%
Rainwater Harvesting	50%	60%	90%
Submerged Gravel Wetlands	50%	60%	90%
Landscape Infiltration	50%	60%	90%
Infiltration Berms	50%	60%	90%
Dry Wells	50%	60%	90%
Micro-Bioretention	50%	60%	90%
Rain Gardens	50%	60%	90%
Grass, Wet, or Bio-Swale	50%	60%	90%
Enhanced Filters	50%	60%	90%
Additional Structural BMP Guidance			
Redevelopment (MDE)	50%	60%	90%
Existing Roadway Disconnect (MDE)	50%	60%	90%
Step Pool Storm Conveyance (MDE)	50%	60%	90%

NC STATE UNIVERSITY

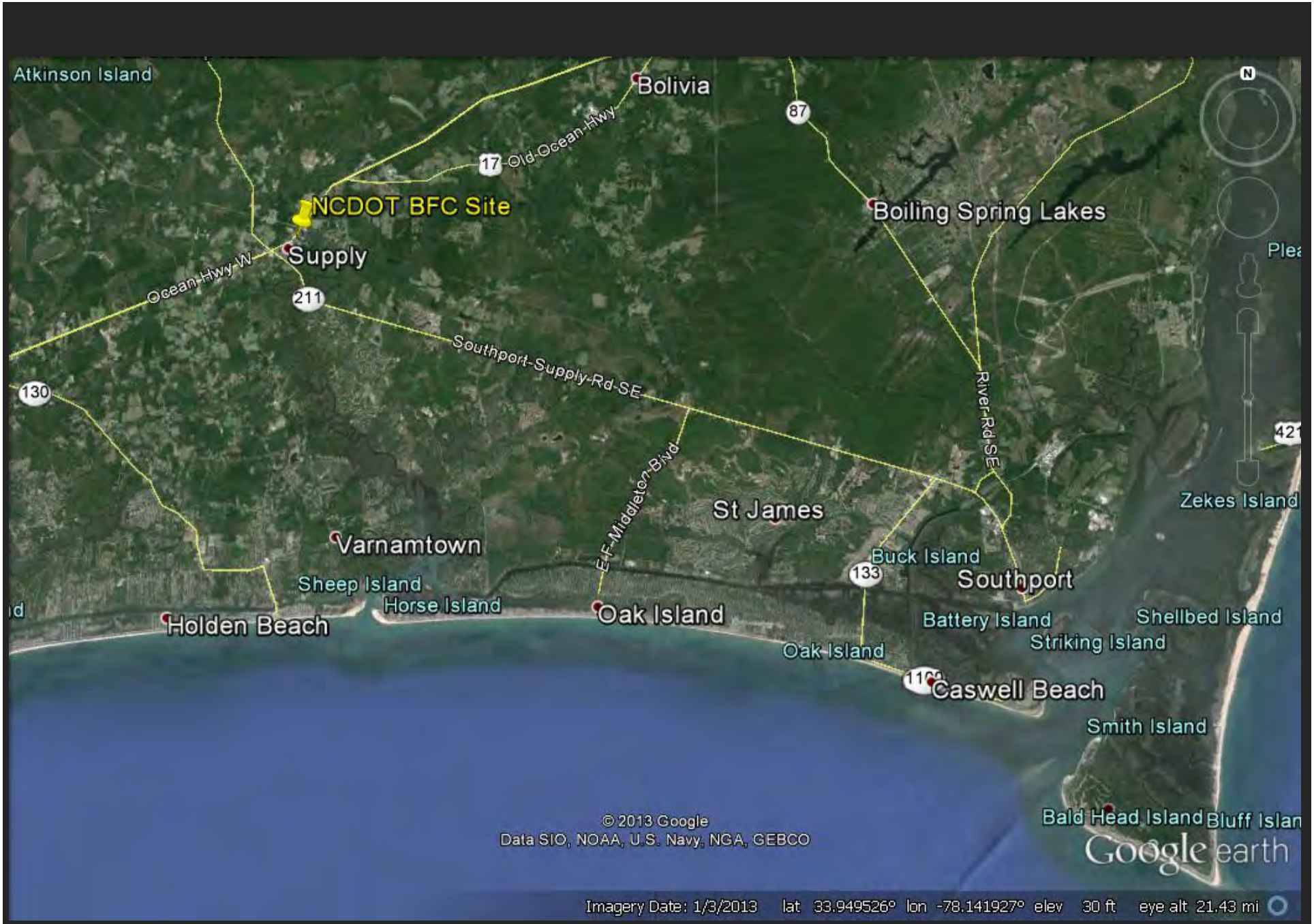
Brunswick County BFC Hydraulic Performance

Adrienne Cizek

December 2013

NC STATE UNIVERSITY
Bio&Ag ENGINEERING

www.bae.ncsu.edu/stormwater

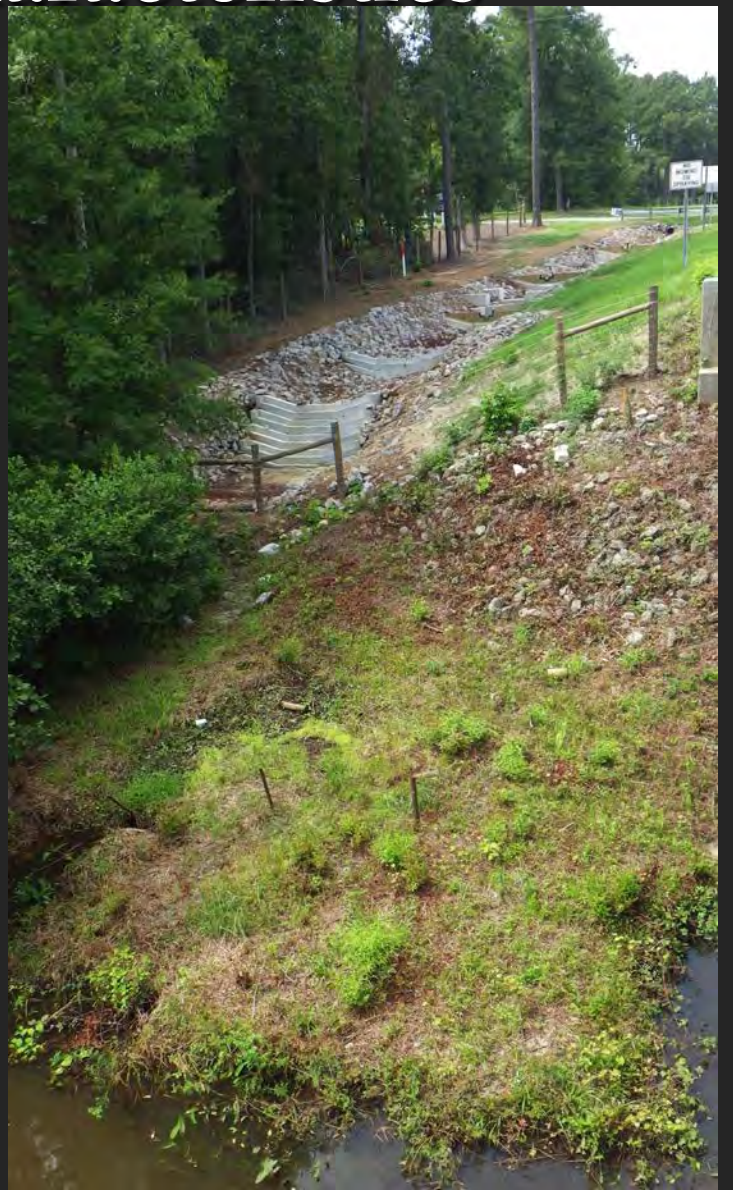

Atkinson Island
Bolivia
87
17
Old Ocean Hwy
NCDOT BFC Site
Supply
Boiling Spring Lakes
Ocean Hwy W
211
Southport-Supply-Rd-SE
130
River Rd SE
E F Middleton Blvd
St James
Zekes Island
Varnamtown
Buck Island
133
Southport
Sheep Island
Horse Island
Oak Island
Holden Beach
Battery Island
Shellbed Island
Striking Island
Oak Island
Caswell Beach
Smith Island
Bald Head Island
© 2013 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth
Imagery Date: 1/3/2013 lat 33.949526° lon -78.141927° elev 30 ft eye alt 21.43 mi

Brunswick County, NC

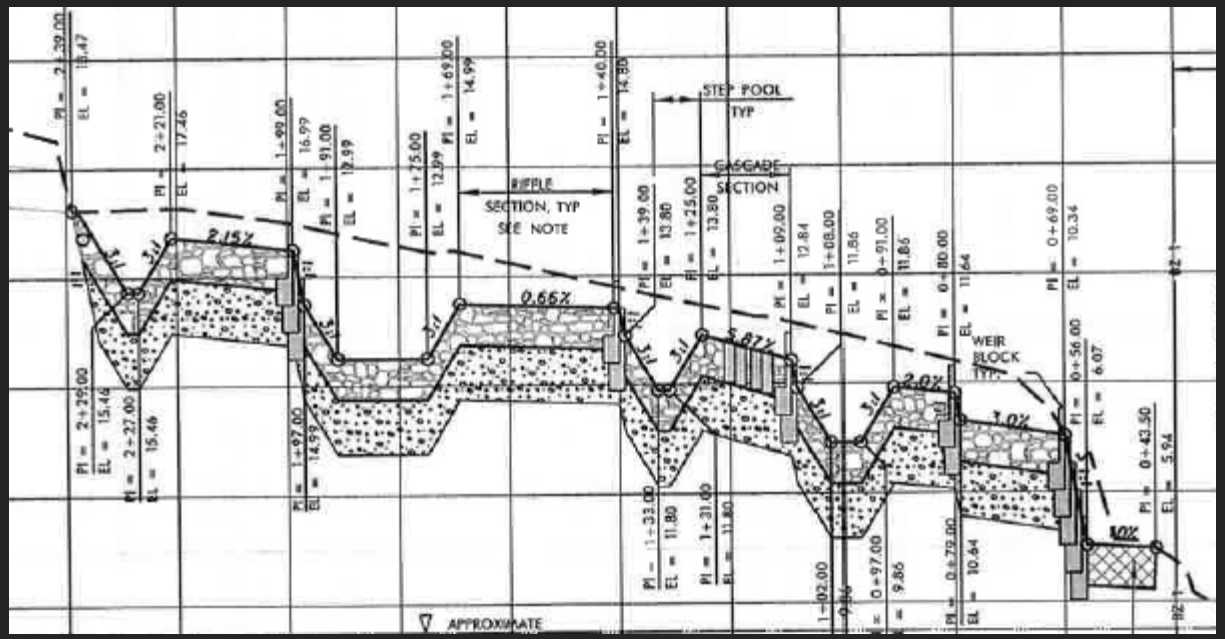
- Severely eroded "ditch"
- Entering Lockwood Folly stream/wetland complex
- **Goal: Hydraulically manage stormwater runoff**

Watershed Characteristics

- Coastal Plain in Brunswick Co, NC
  - HSG A
- 12 ac mostly pervious land uses
  - Also treats runoff from Hwy 17
- Retrofit eroding swale into Lockwood Folly



Biofiltration Conveyance Retrofit (BFC)



Storm Stats

- Monitoring Period 1/13 to 8/13
  - 20 inflow producing rainfall events
    - Max Rainfall Depth = 1.5 in
    - Max Inflow Volume = 2683 cf
    - Max Peak Flow = 1.3 cfs
  - 1 produced surface outflow
    - Max Outflow Volume = 44 cf
    - Max Outflow Rate = 0.04 cfs

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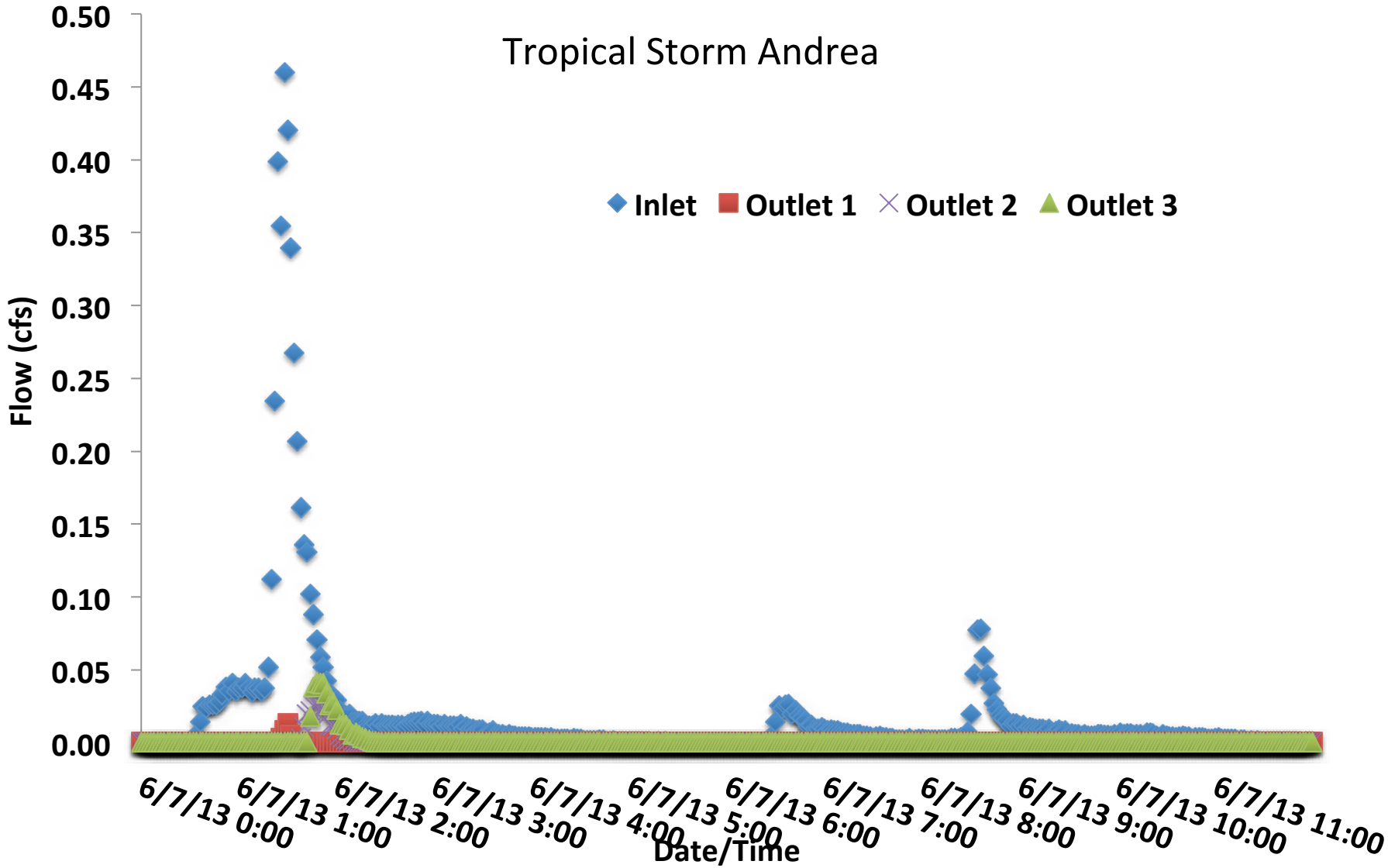
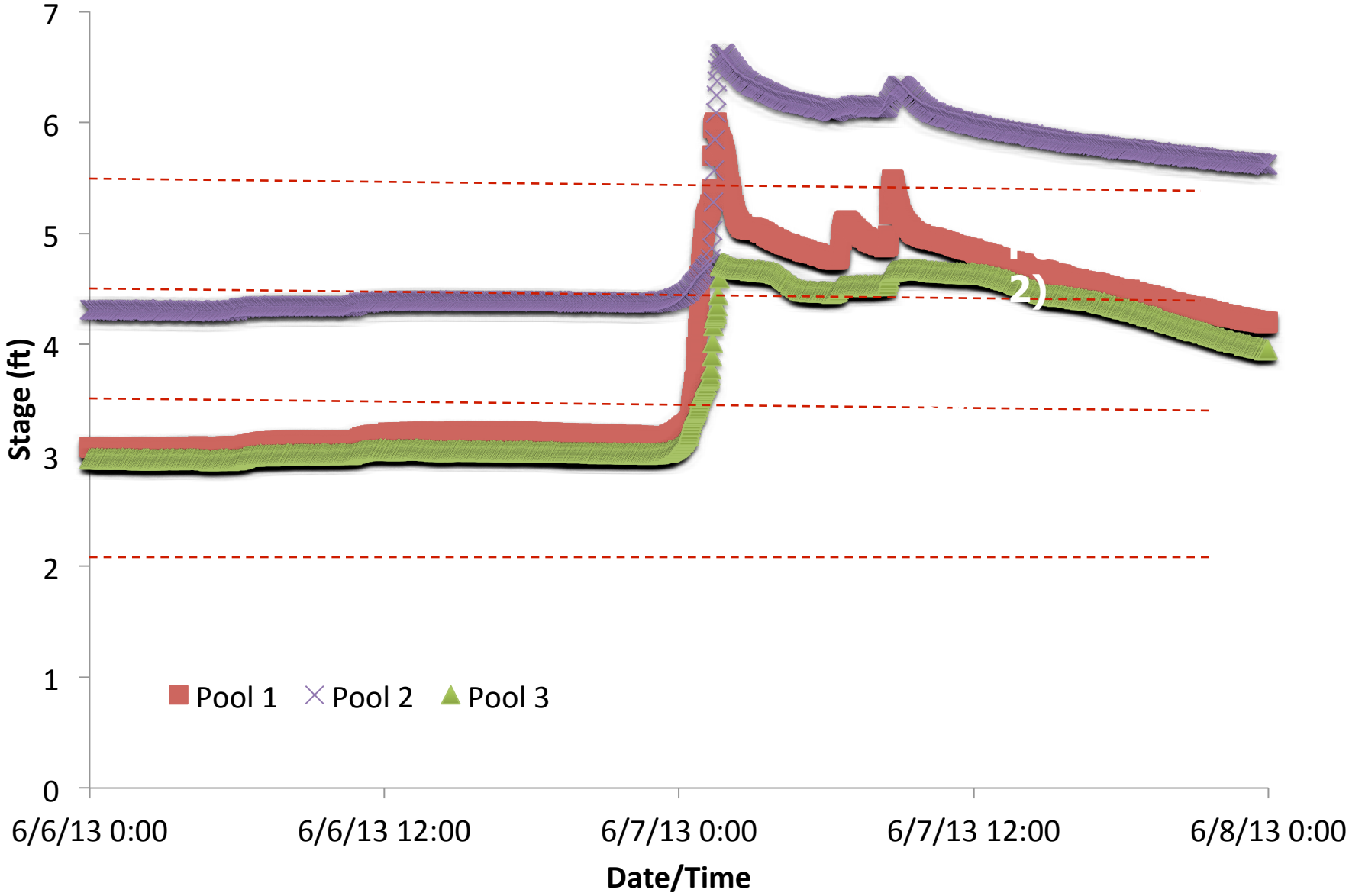
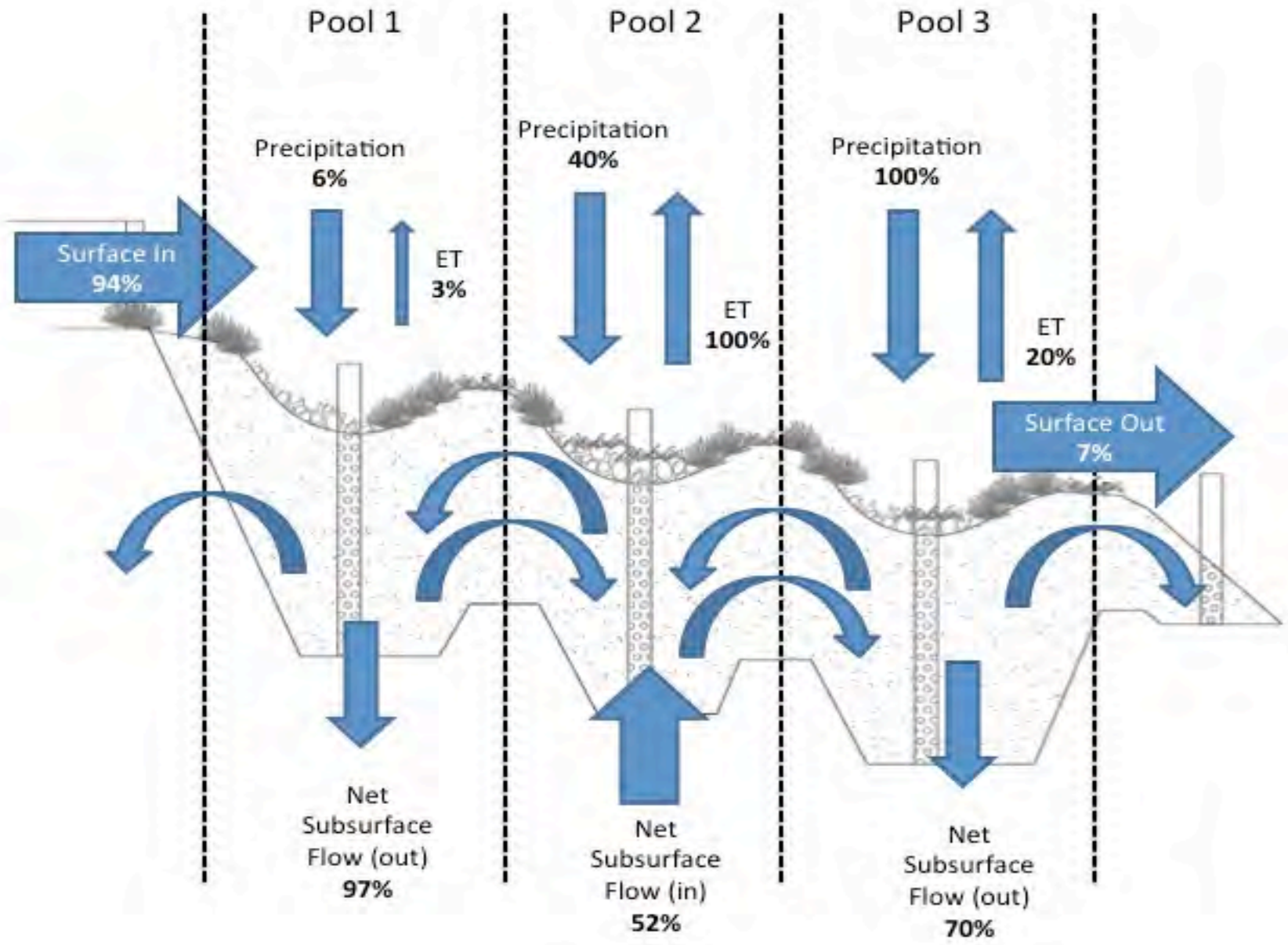
Outflow Producing Event 6-7-13



Stage in Pools: 6-6-13



Overall Water Balance



Next Steps…

- Discretite subsurface flows
  - Groundwater
  - Seepage from pool to pool
- Data collection through Spring 2014


Questions?