



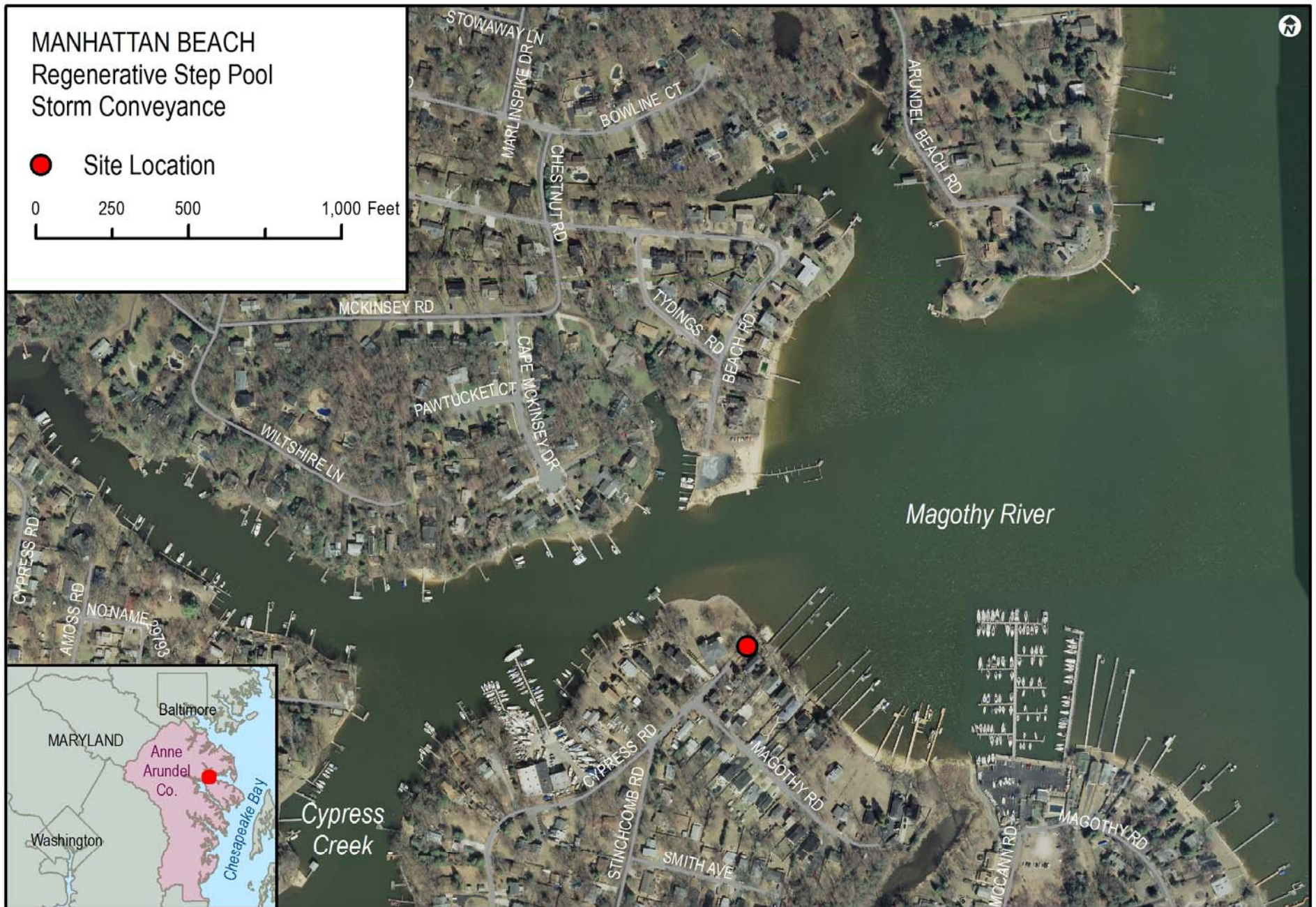
# **Volunteer Post-Construction Monitoring of Stormwater Attenuation in a Regenerative Step Pool Storm Conveyance System Retrofit**

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# Manhattan Beach Civic Association (MBCA)



- Asphalt Ditch Leading to Cypress Beach
- Reached out to community activists and Anne Arundel County DPW

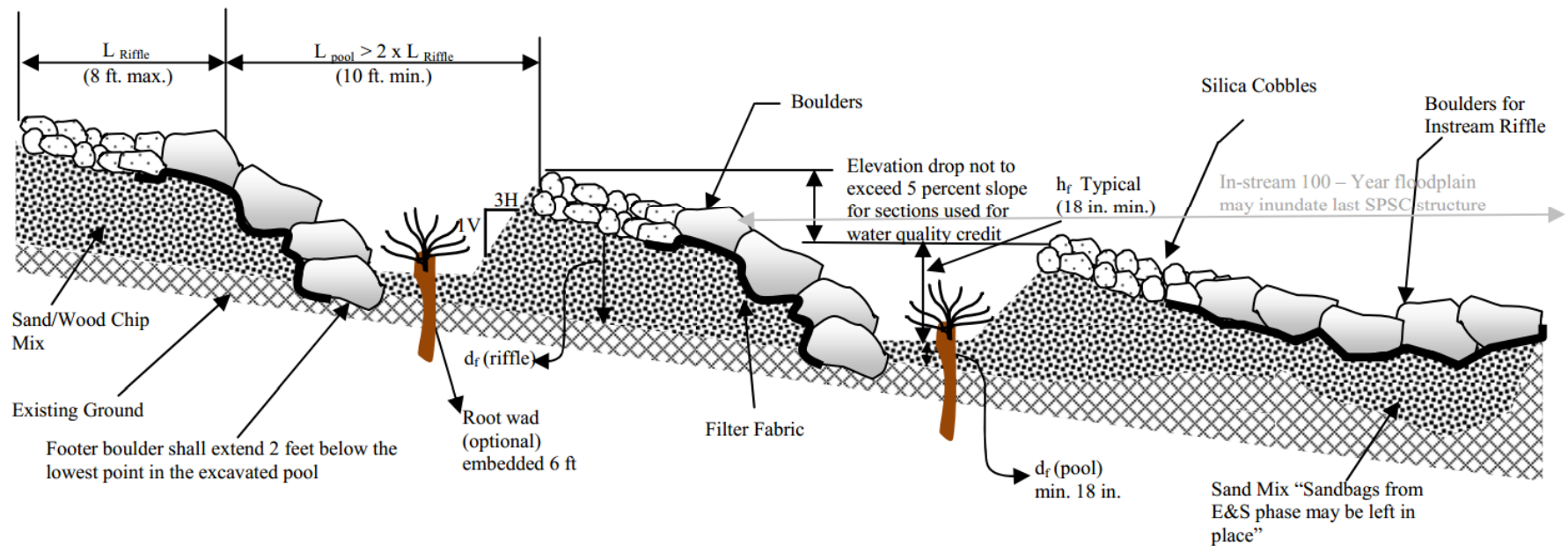
# MBCA & Anne Arundel County

- Motivated Civic Association and County
- Ideal situation to apply a Regenerative Step Pool Storm Conveyance (SPSC) outfall retrofit
- Potential to add to the body of research on the ability of an SPSC to attenuate stormwater

# Regenerative Step Pool Storm Conveyance System (SPSC)

- Maryland Department of Environment (MDE) approved system for stormwater mitigation and stream restoration
- Intended to mimic natural ecosystem systems to the greatest extent possible

# Typical SPSC Profile



**Typical Profile – Alternating Pools and Riffles**

<http://www.aacounty.org/DPW/Watershed/SPSCdesignguidelinesJan2012rev4.pdf>

# SPSC Performance

- Traditional models are not currently set up to model the ability of SPSCs to attenuate stormwater flows
- Anne Arundel County is actively working to collect post-construction data on regenerative SPSC performance

# Who Made The SPSC Retrofit Happen?

- Active volunteers
- Cooperative County DPW
- National Fish and Wildlife Federation Grant
  - \$47,000
  - “In kind” contributions of \$29,062
    - Community Labor
    - Anne Arundel County DPW labor
    - Nursery Stock Donations



# Design & Installation of SPSC

- Work by Underwood & Associates and Anne Arundel County DPW
- Designed to convey the 100 year return period storm
- Provides filter area capable of filtering a volume of water roughly corresponding to 3.2 inches of rainfall in a 24 hr period



# MBCA Cypress Beach SPSC















# Documenting the Process

- A 10 minute summary video was developed to inform others
- Posted on YouTube so everyone can see it

<http://youtu.be/t2f9f7Cfk1c>



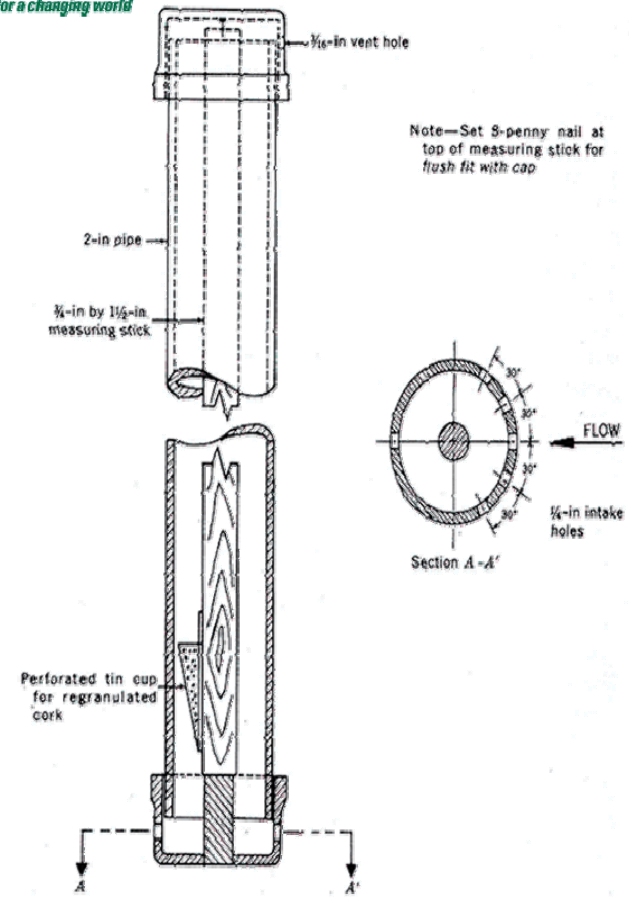
# WATER QUANTITY





# Water Quantity Monitoring

- Completed by volunteers
- Crest Gage Recorder Chosen (Pritchard, 1995; USGS, 2012)
- Recorder built by volunteers























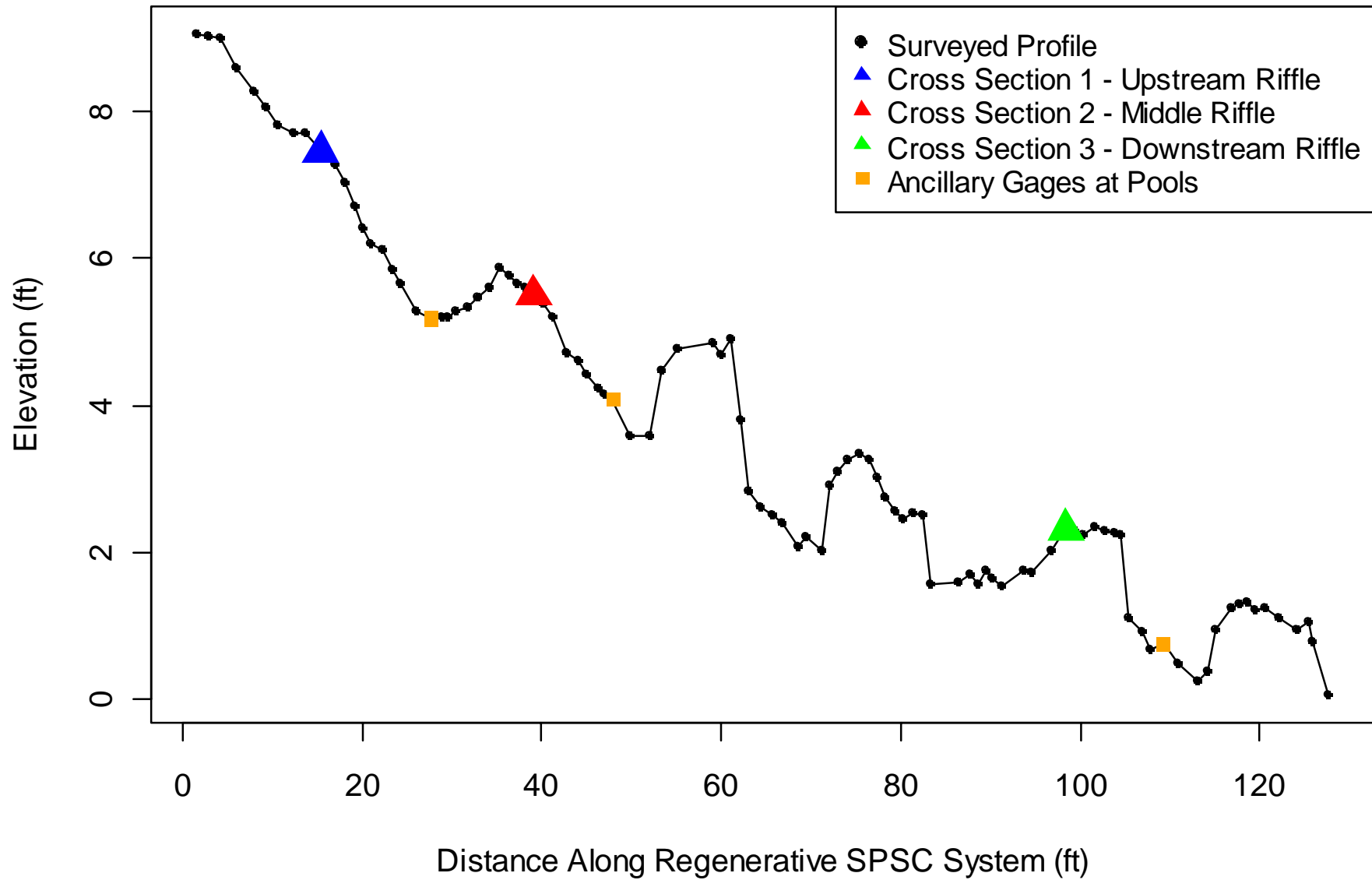






Stormwater 2012







# Monitoring Protocol

- After each rain event
  - Remove the dowel and check the elevation of cork
  - Wipe off the dowel
  - Replace the dowel and cap
  - Check Rain Gage
- Does not require constant monitoring of storm events

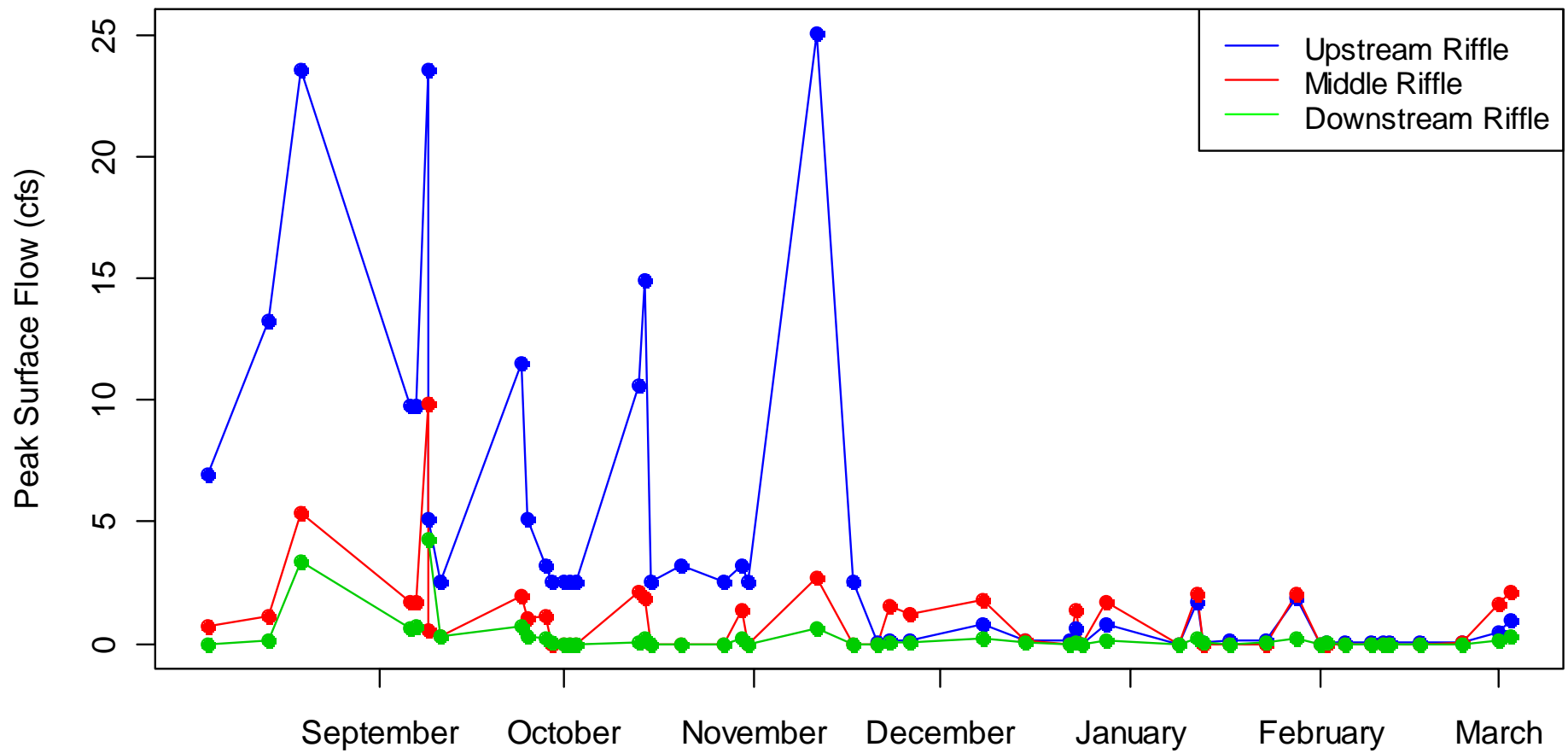
# Conversion of Gage Data To Surface Flows

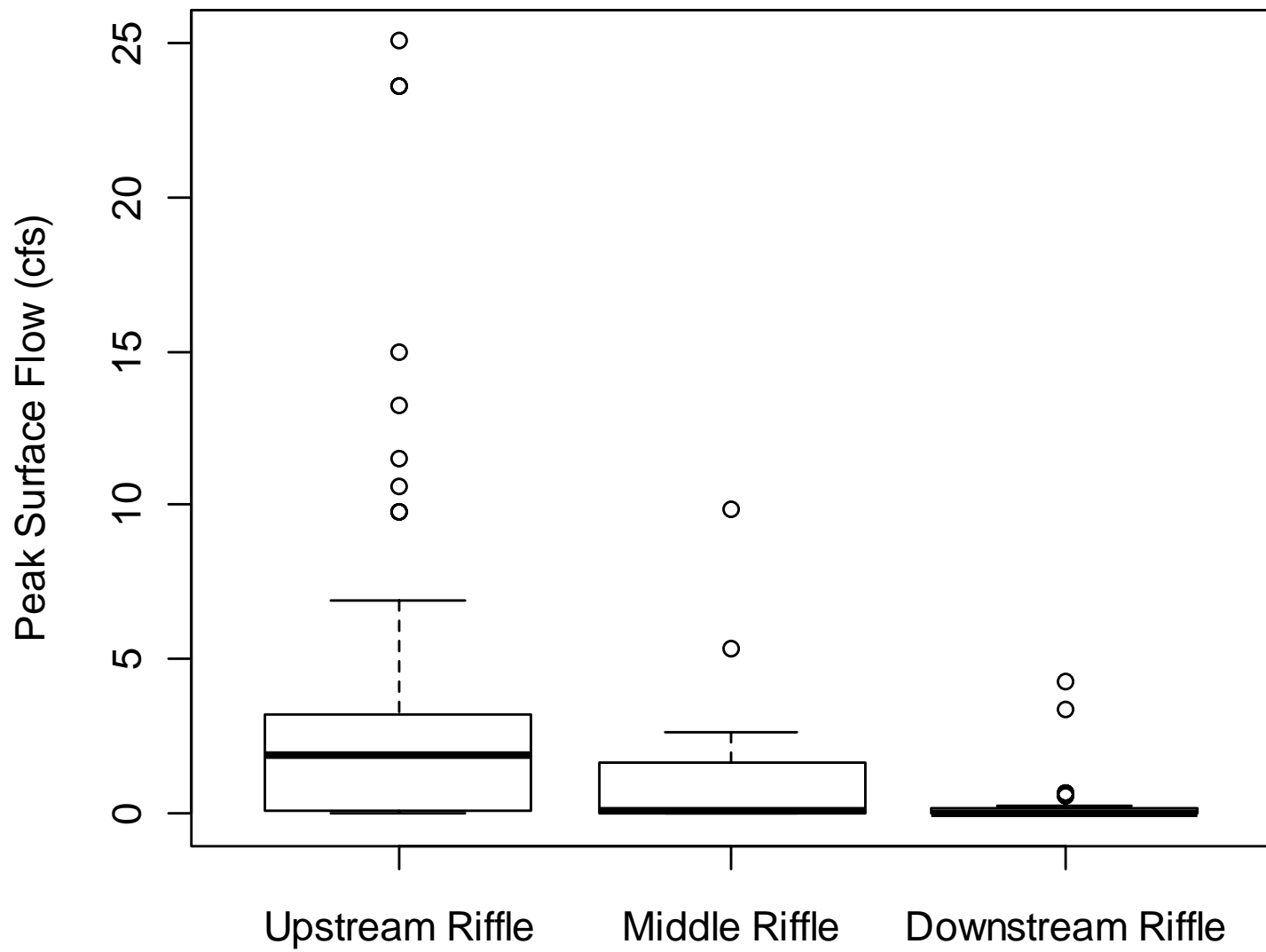
- Longitudinal and Cross Section Surveys of the SPSC and Crest Stage Recorder
- Roughness estimated with Cowan Method



# Water Quantity Results

- 49 Storm Events – *ALL BY VOLUNTEERS*  
– August 2011 to March 2012
- Rainfall event from 0.03 inches to over 4 inches
- Hurricane Irene and Tropical Storm Irene







# Summary of Water Quantity

- Field observations match calculated peak surface flow values
- Stormwater attenuation matches preliminary results from other studies
- Dataset adds to the current body of research



Water Quality



# Water Quality

- Pre-Construction (January 2010 through May 2010)
  - 4 Sampling Events
- Post-Construction (August 2011 through February 2012)
  - 3 Sampling Events
- Collected at inflow and outflow of SPSC and outfall of asphalt ditch
  - Enterococci, Suspended Solids, Total Nitrogen, Total Phosphorus

# Water Quality Timing Issues

- Samples not taken at the time of peak surface flow
  - Can't Calculate Load
- After many storms, no water present at outflow

# Water Quality Results

- Pollutant Concentrations:
  - Typical of Urban Stormwater
- Consider other options in the future

# Recommendations for Other Volunteer Monitoring Projects

- Document the process to keep the community involved
- Crest Gage Recorder is a great option for water quantity studies
- Very volunteer friendly
- Consider other options if Water Quality data are desired





Stormwater 2012



# ACKNOWLEDGEMENTS

- **Anne Pearson** of the Alliance for Sustainability for her assistance in the design and proposal preparation;
- **August Pasquale, MD** for his management of the project from the perspective of the MBCA;
- **Thomas Caperna, Ph.D.** for his assistance in the design and construction of the storm water gages;
- **Keith Underwood** of Keith Underwood and Associates for his assistance in the step pool design and construction;
- **Janis Markusic** and **Chris Victoria** of Anne Arundel County DPW for their assistance in the choice of storm gage monitoring;
- **Ronald Bowen** and **Ginger Ellis** of Anne Arundel County DPW for reviewing the manuscript;
- **Other Anne Arundel County Staff** for their assistance in surveying, analysis, permitting, and construction.



# Citations

- Anne Arundel County. 2012. Regenerative Step Pool Storm Conveyance (SPSC) Design Guidelines.  
<http://www.aacounty.org/DPW/Watershed/SPSCdesignguidelinesJan2012rev4.pdf>. (accessed April 30, 2012).
- Manhattan Beach Civic Association. 2009. Coastal Plain Outfall Informational Video. <http://youtu.be/t2f9f7Cfk1c> (accessed May 8, 2012).
- Pritchard, K. 1995. Combination Staff Gauge/Crest Gauge. *The Volunteer Monitor*, Vol.7 (2).
- United States Geological Survey. Implementation of Rural Small-Stream Crest-Stage Gaging Station Network.  
<http://mo.water.usgs.gov/surfwat/CSGWeb/images/diagram1.htm>  
(accessed April 30, 2012).



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