

A photograph of a forest with a wooden observation tower in the background. The text is overlaid on the image.

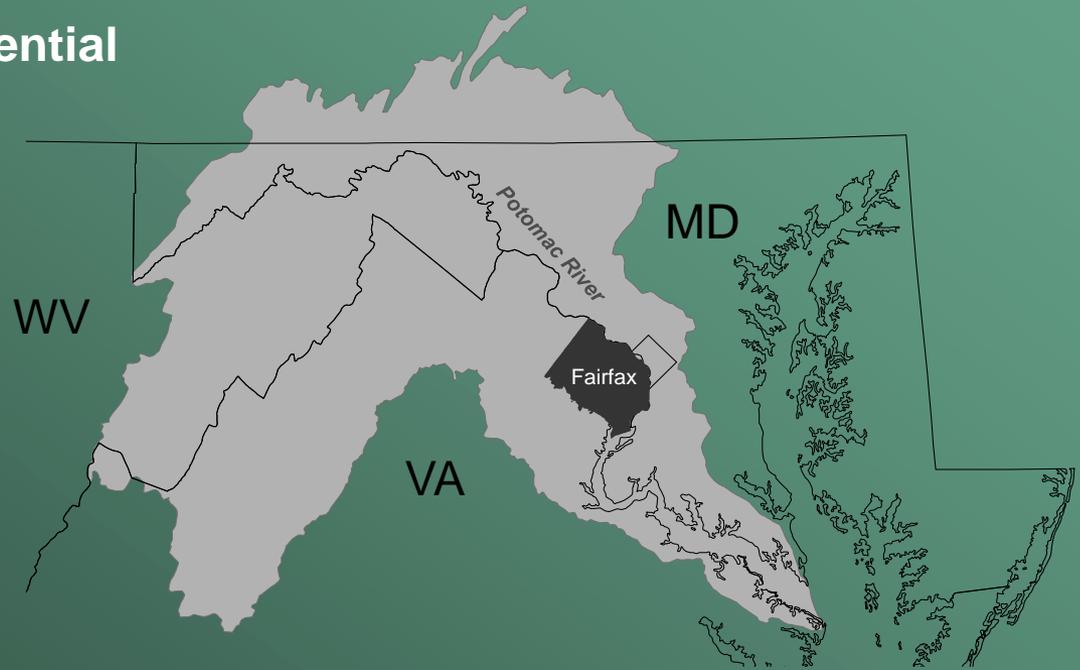
Assessing Watershed Scale Responses to BMP Implementation

John Jastram

USGS VA Water Science Center

Study Area: Fairfax County, VA

- Potomac River Watershed
- Piedmont and Coastal Plain Provinces
- Highly urbanized
 - Medium Density Residential
 - Population \approx 1 million



Watershed Planning in Fairfax Co.

- **FY 2006 - Funding increase for Stormwater Management**
 - 1¢ per \$100 property tax
 - Initiated development of first round of Watershed Master Plans (approx 50% of county)
 - Project types:
 - Riparian plantings/restorations
 - Building and retrofitting STW management facilities
 - LID facilities – rain gardens, bio-retention, infiltration
 - Public involvement, education, outreach materials
 - Flooding abatement (i.e. culvert replacements)
 - Stream stabilizations and restorations

Future Concerns for Stormwater Management

- >200 years to implement watershed plans based on current funding levels.
- Regulatory implications
 - Impaired water bodies
 - TMDLs
 - Compliance/non-compliance with permit
- Continued degradation of systems & response time lag.
- **Quantify effectiveness of newer technologies, older controls & future implementation efforts.**



Study Objectives

- 1. Generate long-term monitoring data to describe:**
 - Current water-quality (sediment and nutrients) and quantity conditions,
 - Trends in water-quality and quantity,
 - Nutrient and Sediment Loads and Yields.
- 2. Evaluate relations between observed conditions/trends and BMP implementation.**
- 3. Transfer the understanding gained to other less-intensively monitored watersheds.**

The Challenges

BMP induced changes are difficult to quantify at the watershed scale:

- Environmental factors cause great variability
 - need to separate signal from noise,
- Lag times may be considerable,



Approach: Intensive Monitoring

- Operate four intensive monitoring stations
- 10+ years of data collection
 - Continuous-record stream gage
 - Continuous water-quality monitor (turbidity, pH, SC, DO, water temp)
 - Nutrients & Sediment Sampling
 - Automated sampler (storm samples)
 - Scheduled monthly sampling
 - Annual benthic monitoring



Approach: BMP Evaluation

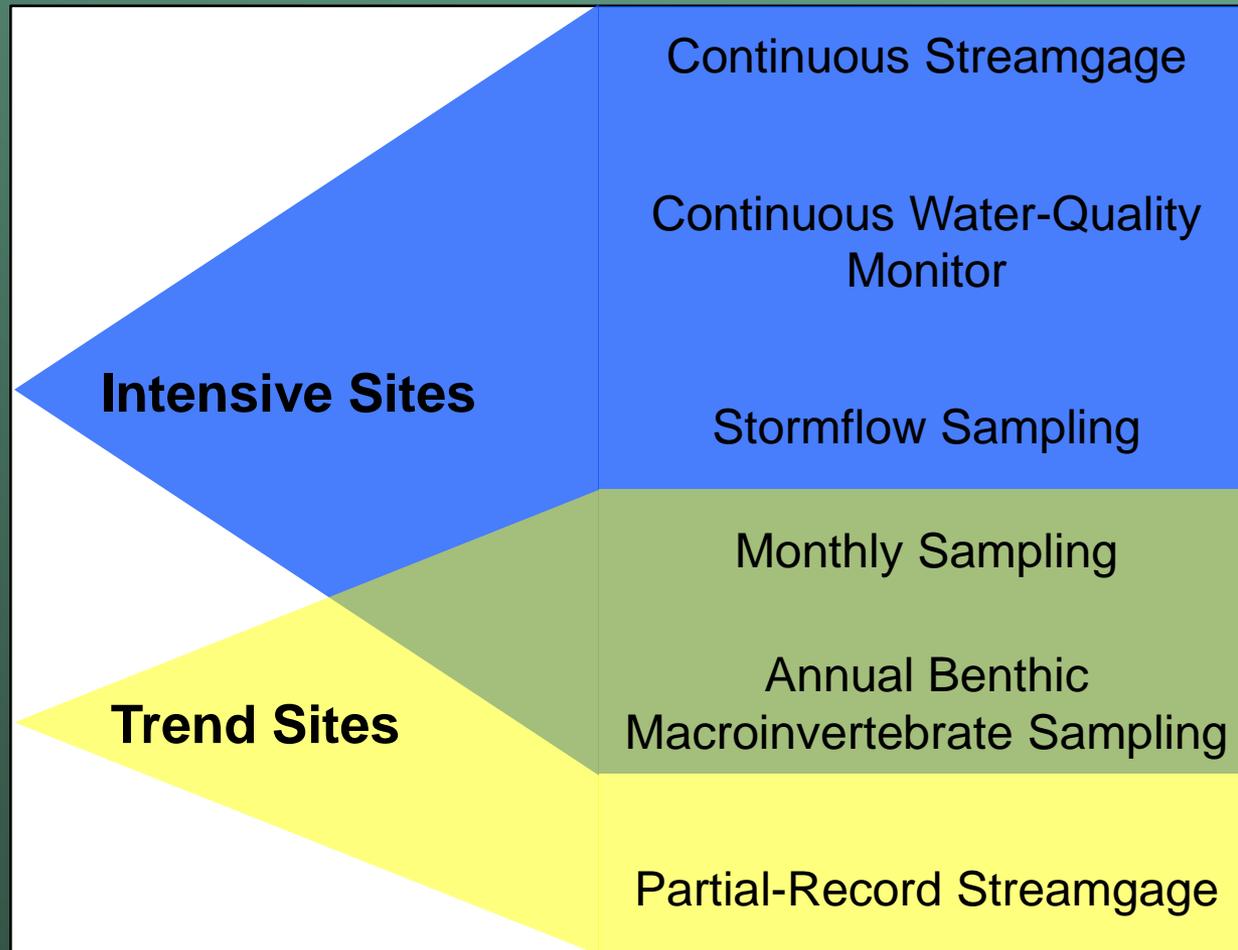
- Assemble BMP implementation dataset for monitored watersheds.
 - Extent of BMP implementation.
 - Types of BMPs installed.
- Evaluate relations between water-quality conditions/trends and BMP activities (after 5+ years of data collection).

Approach: Knowledge Transfer



- Operate 10 trend monitoring stations
 - Partial-record stream gage
 - Nutrient & sediment sampling
 - Scheduled monthly sampling
 - Annual benthic monitoring
- Evaluate relations between trend- and intensive monitoring sites

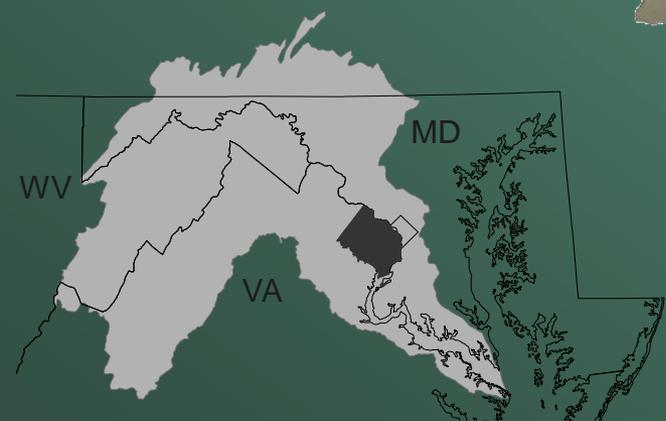
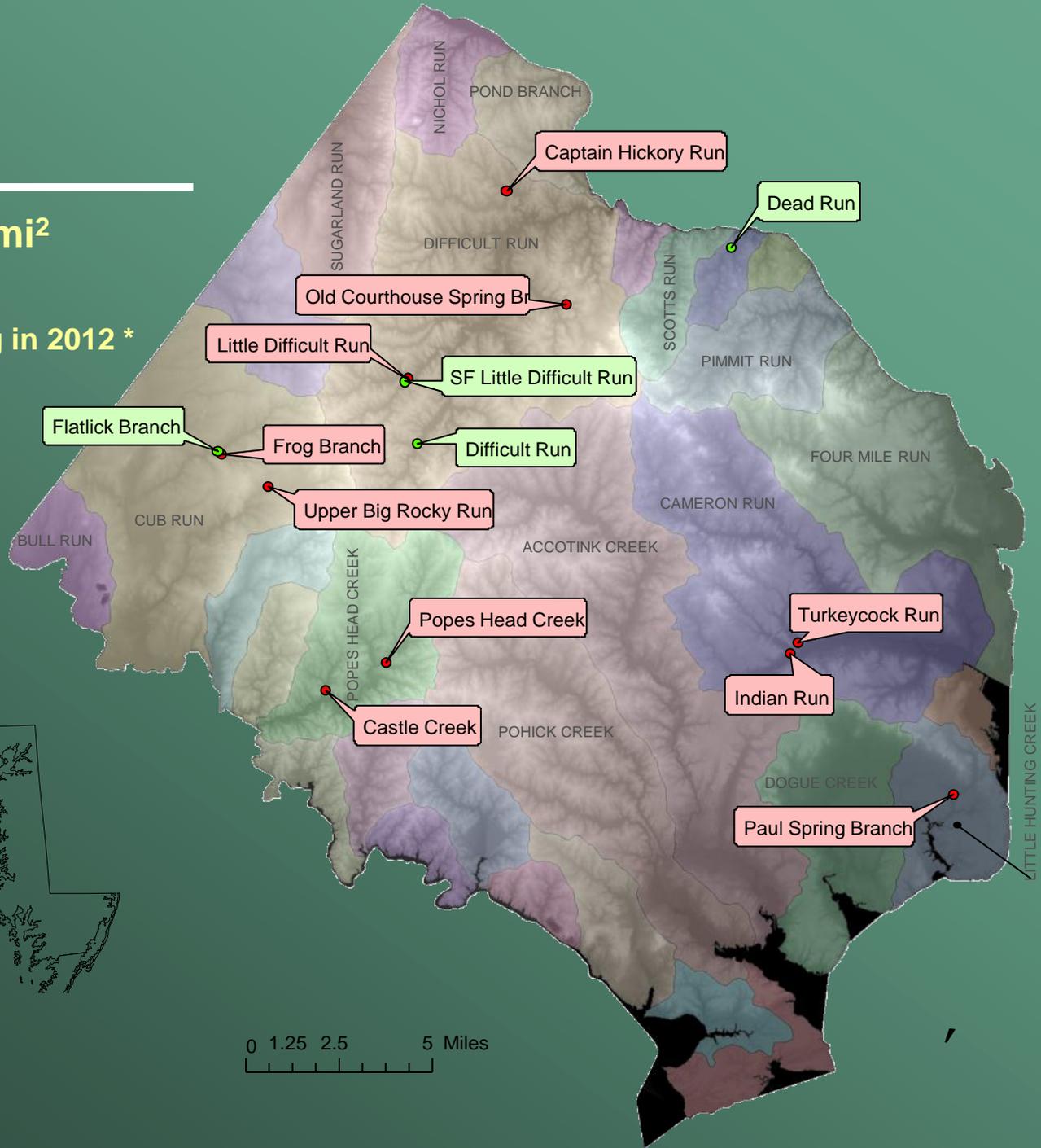
Measurements



Network

Watersheds 1 – 6 mi²

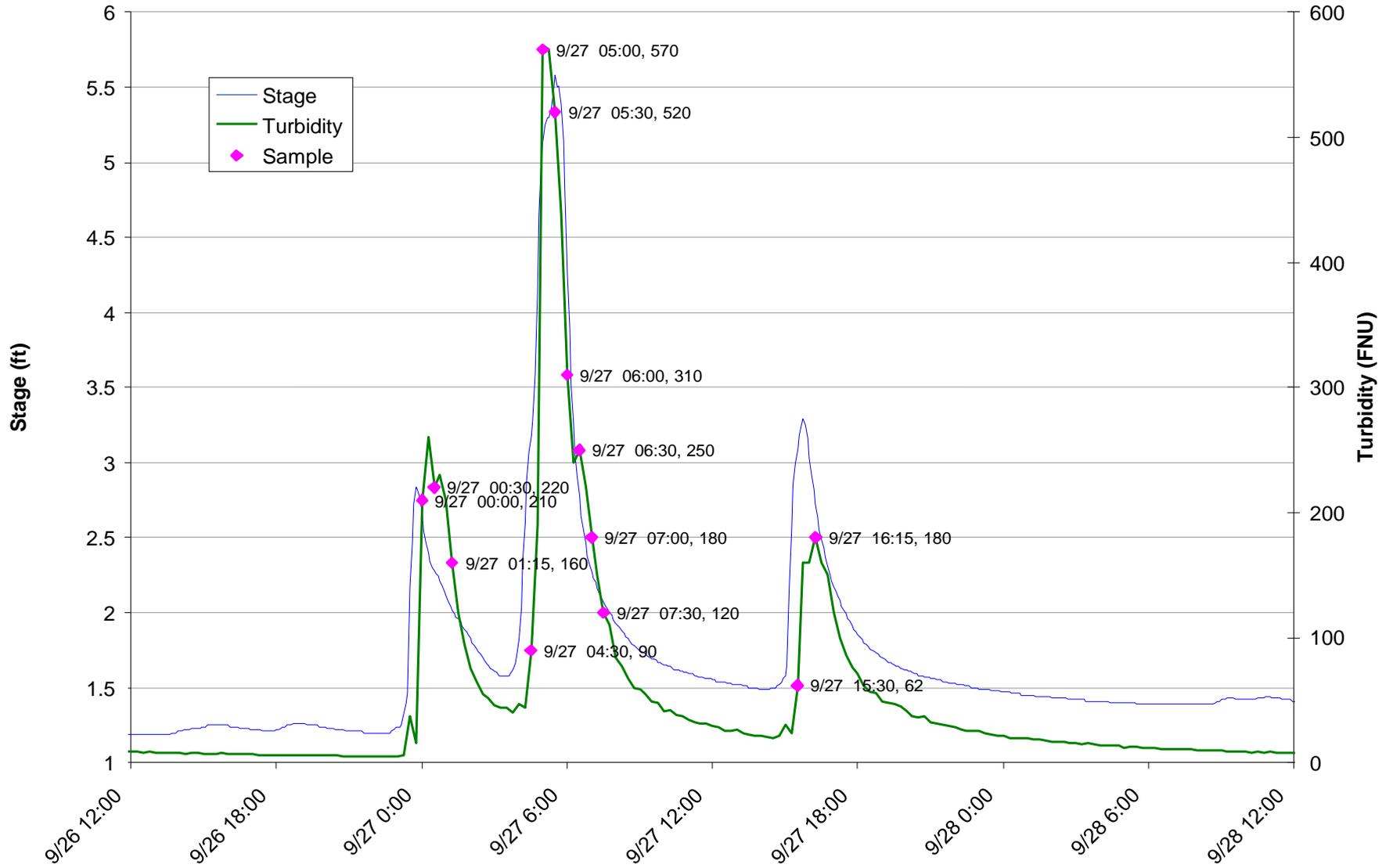
* 7 Site Expansion Coming in 2012 *



Reduction of Uncertainty

- **Data Collection**
 - Temporally dense data collection
 - **Turbidity Threshold Sampling**
 - Integrate continuous sensors with autosampler to optimize storm sample collection

Dead Run



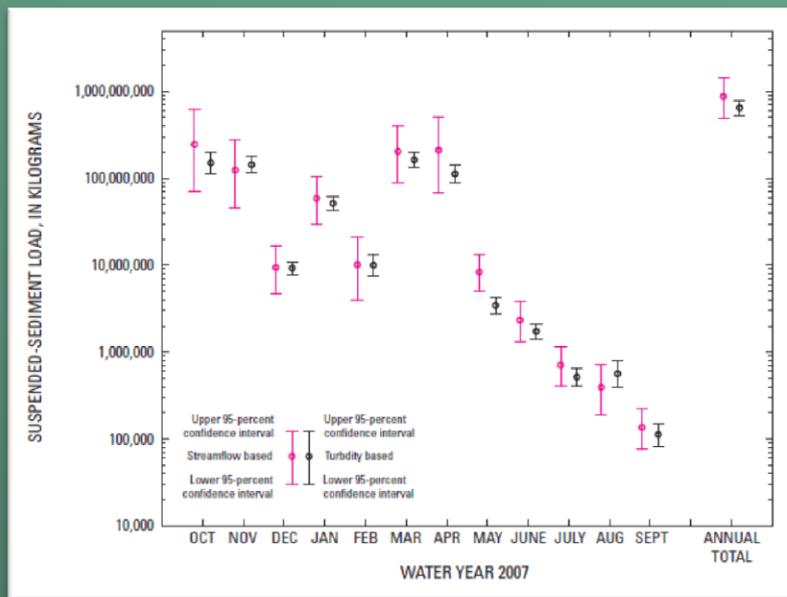
Reduction of Uncertainty

- **Data Collection**
 - Temporally dense data collection
 - Turbidity Threshold Sampling
 - Integrate continuous sensors with autosampler to optimize storm sample collection
- **Data Analysis**
 - Surrogate approaches coupled with continuous water-quality data

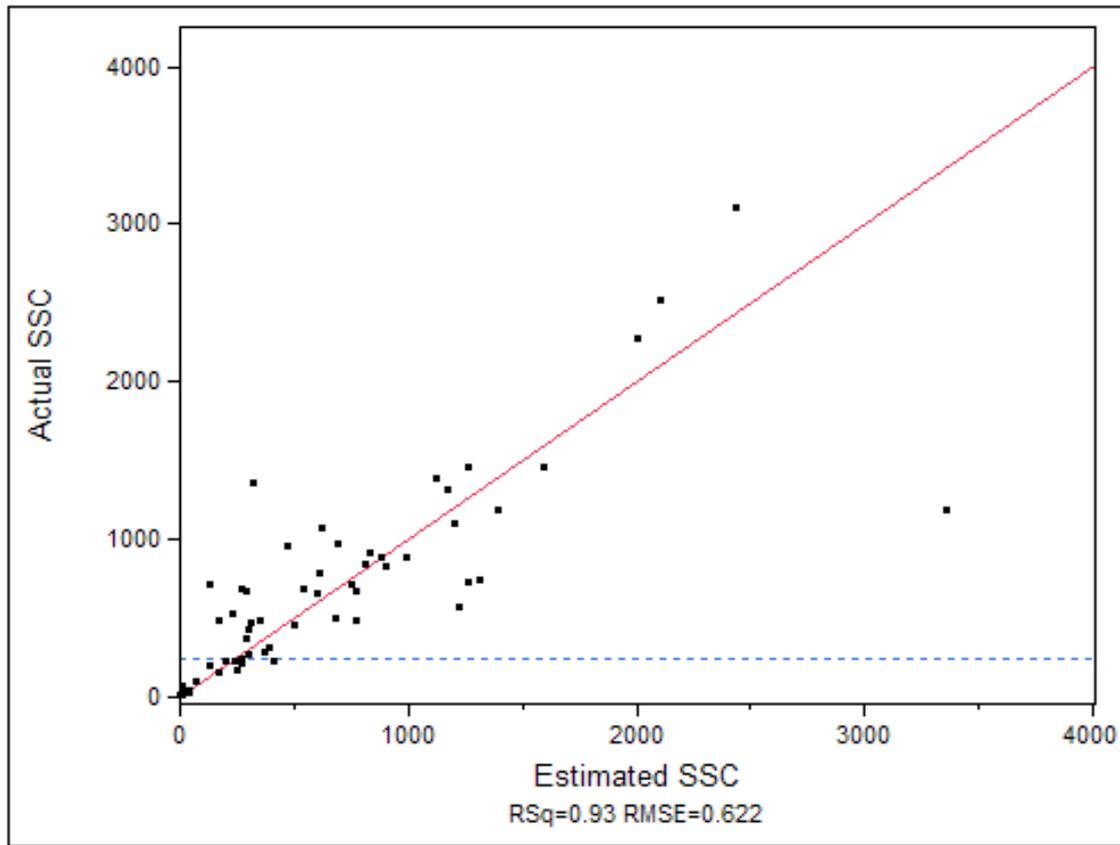
Surrogate Approaches

for continuous concentration and load estimation

- Estimate WQ Data using WQ Data
- Multivariate Regression
- More accurate and precise than flow based approaches
 - USGS Scientific Investigations Report 2009-5165



$$SSC = f^{-1}[\hat{\beta}_0 + \hat{\beta}_1 f(\text{turbidity}) + \hat{\beta}_j f(x_j) \dots \hat{\beta}_k f(x_k) + \varepsilon]$$

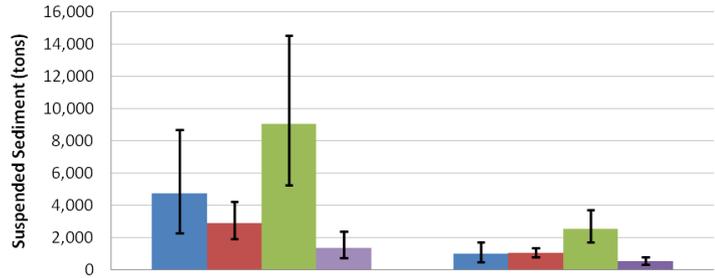


Term	Estimate	Std Error	t Ratio	Prob> t	VIF
Intercept	0.6234086	0.179798	3.47	0.0009	.
Log(Turbidity)	0.7866	0.081047	9.71	<.0001	4.8584813
Log(Q)	0.3725171	0.090522	4.12	0.0001	4.8584813

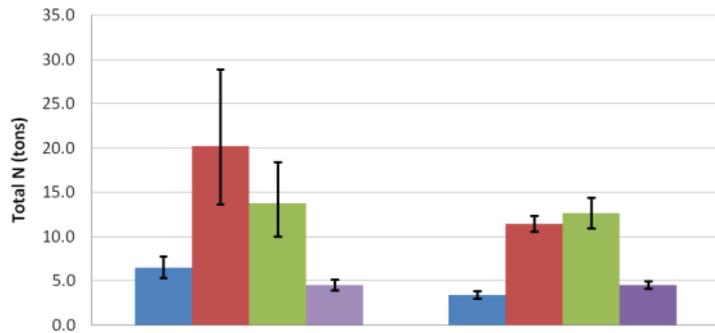
R-square 0.925
R-square Adjusted 0.923
Root Mean Square Error 0.622
Mean of Response 5.492
Observations 74

Annual Loads and Yields

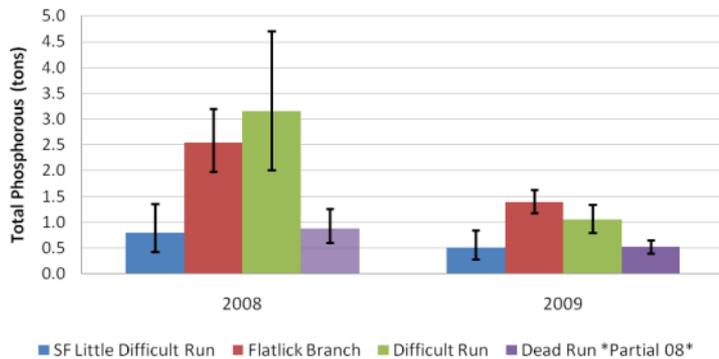
Suspended Sediment LOADS



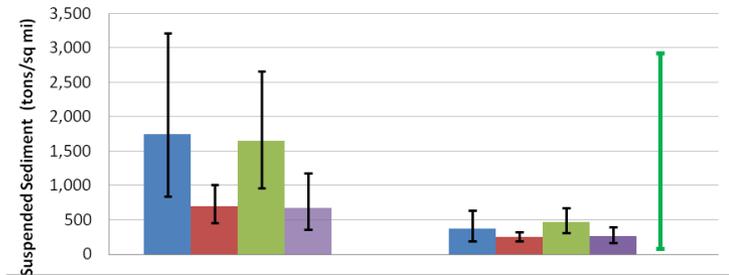
Total N LOADS



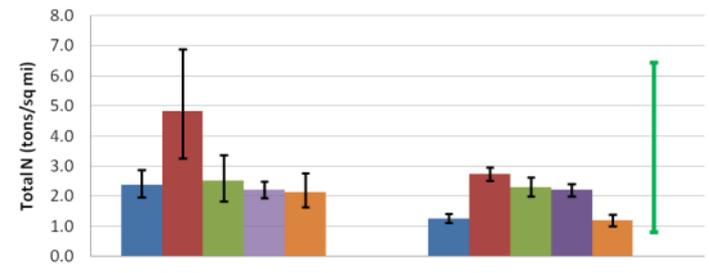
Total P LOADS



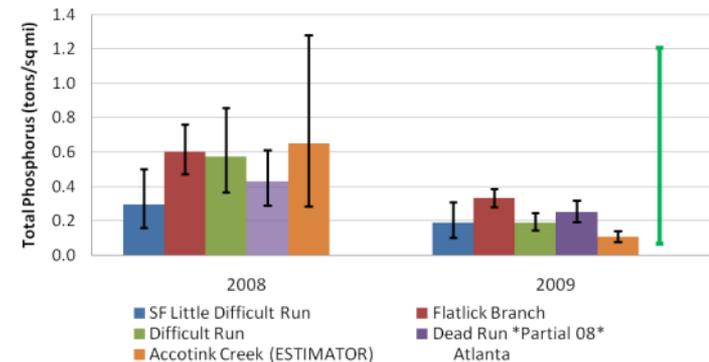
Suspended Sediment YIELDS



Total N YIELDS



Total P YIELDS

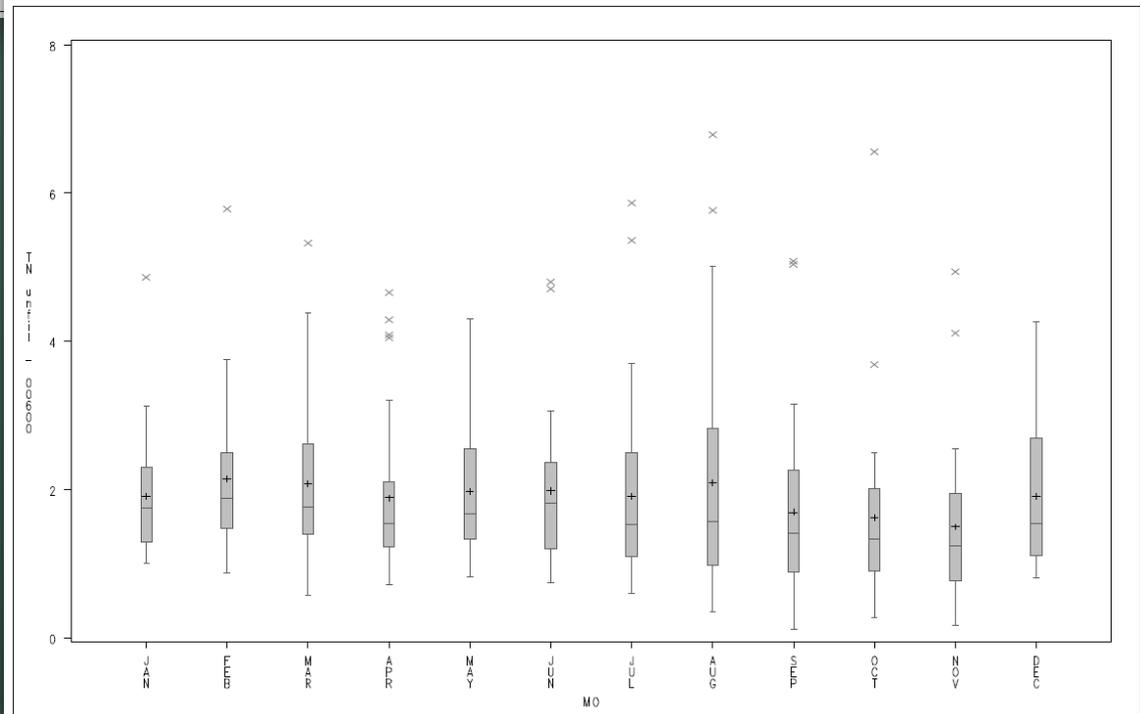
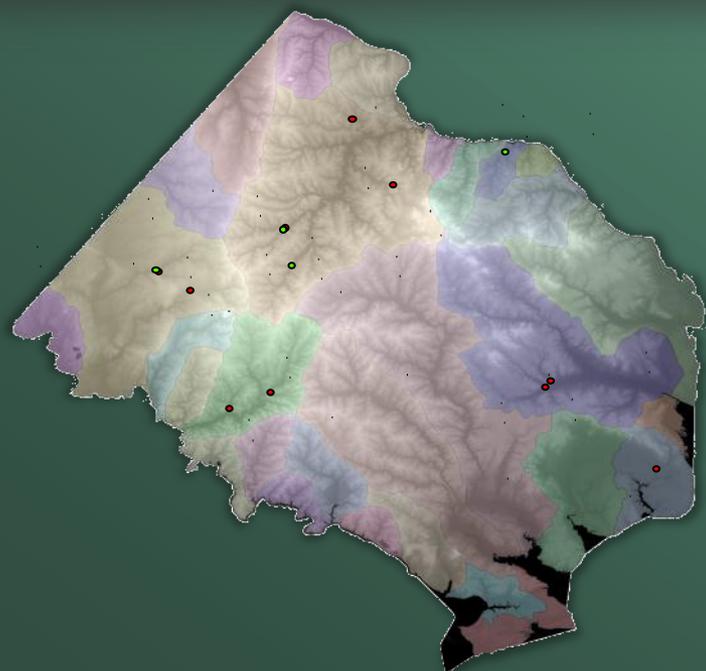
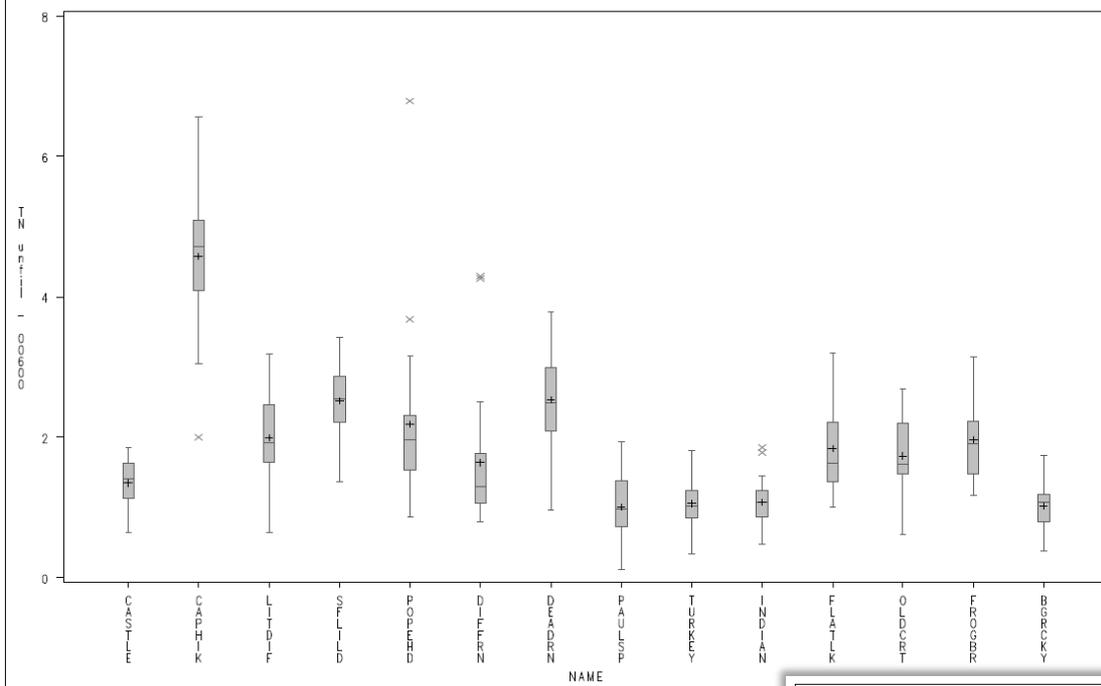


2008

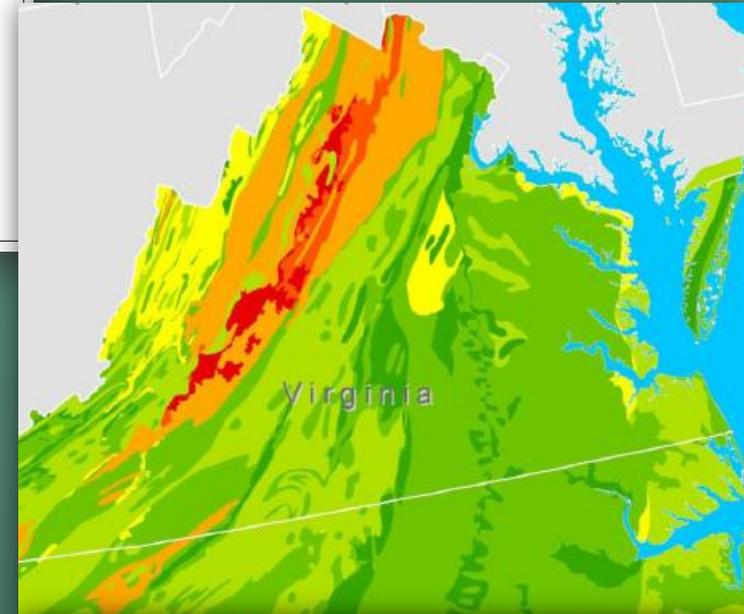
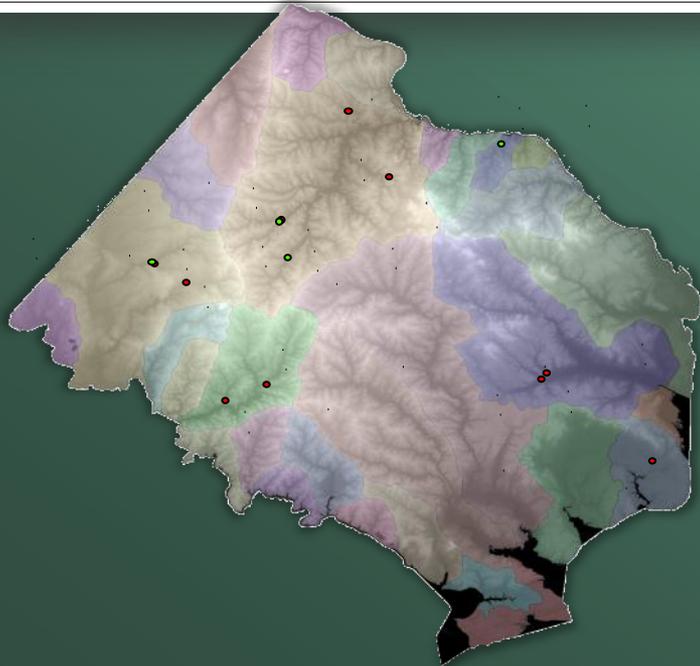
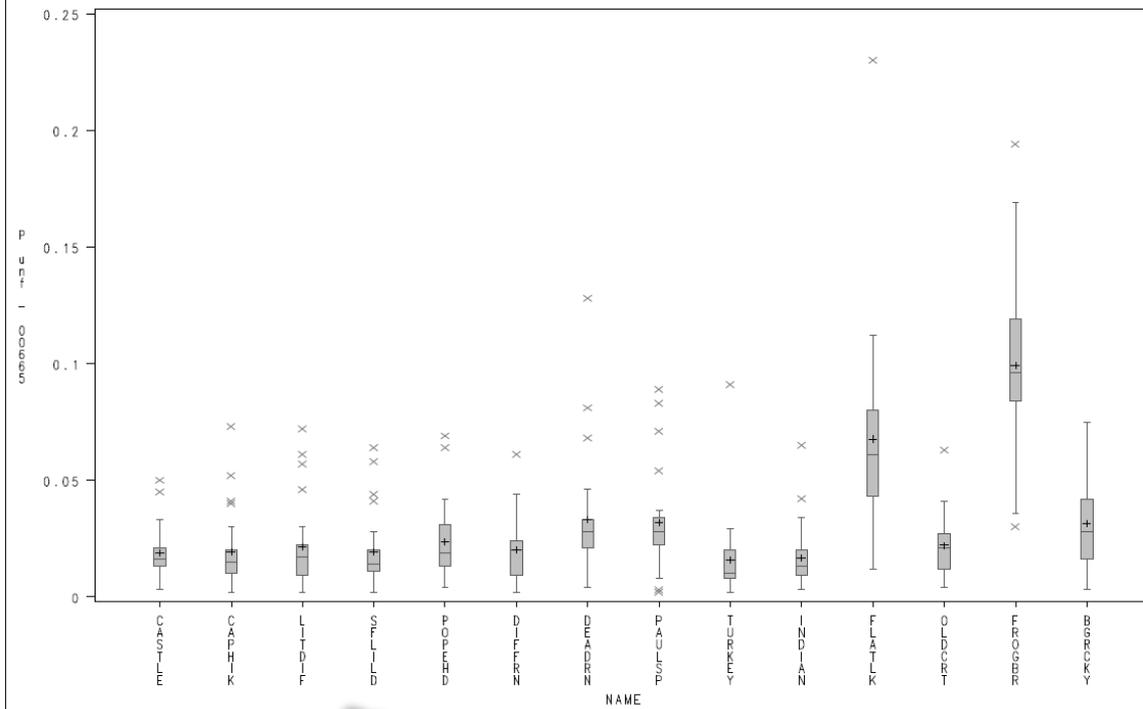
2009

- SF Little Difficult Run
- Flatlick Branch
- Difficult Run
- Dead Run *Partial 08*
- Accotink Creek (ESTIMATOR)
- Atlanta

Total Nitrogen

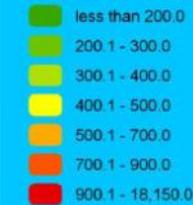


Total Phosphorus



Mean bed-sediment phosphorus concentration, in parts per million

by geologic map unit



Source:
USGS Scientific
Investigations Map 3102

Data Dissemination

- Realtime data and sampling results via Google Map

Water Quality Samples for Virginia

- Additional information:
 - Annual Water Data Reports: [Water Years 2002-09](#)
 - Historical instantaneous flow data for Virginia: [Instantaneous Data Archive - IDA](#)
 - National Weather Service Advanced Hydrologic Prediction Service: [River forecasts](#)

USGS 01646305 DEAD RUN AT WHANN AVENUE NEAR MCLEAN, VA

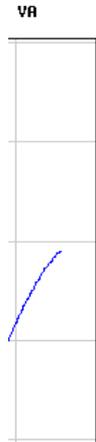
Available data for this site

Fairfax County, Virginia Hydrologic Unit Code 02070008 Latitude 38°57'34.8", Longitude 77°10'33.5" NAD27 Drainage area 2.05 square miles	Output formats
	Parameter Group Period of Record table Inventory of available water-quality data for printing Inventory of water-quality data with retrieval Tab-separated data, one result per row Tab-separated data one sample per row with remark codes combined with values Tab-separated data one sample per row with tab-delimiter for remark codes Reselect output format

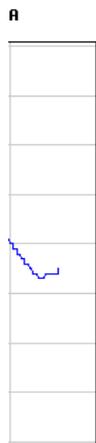
Parameter Code	Count	Begin Date	End Date	Parameter Code Complete Name
00010	26	2008-04-24	2010-04-27	Temperature, water, degrees Celsius
00020	25	2008-04-24	2010-04-27	Temperature, air, degrees Celsius
00025	25	2008-04-24	2010-04-27	Barometric pressure, millimeters of mercury
00061	51	2008-10-22	2009-09-29	Discharge, instantaneous, cubic feet per second
00065	109	2008-04-03	2010-04-27	Gage height, feet
00095	26	2008-04-24	2010-04-27	Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius
00191	26	2008-04-24	2010-04-27	Hydrogen ion, water, unfiltered, calculated, milligrams per liter
00300	26	2008-04-24	2010-04-27	Dissolved oxygen, water, unfiltered, milligrams per liter
00301	24	2008-04-24	2010-04-27	Dissolved oxygen, water, unfiltered, percent of saturation
00400	26	2008-04-24	2010-04-27	pH, water, unfiltered, field, standard units
00600	94	2008-04-24	2010-02-24	Total nitrogen, water, unfiltered, milligrams per liter
00601	94	2008-04-24	2010-02-24	Total nitrogen, suspended sediment, total, milligrams per liter
00602	94	2008-04-24	2010-02-24	Total nitrogen, water, filtered, milligrams per liter
00605	69	2008-08-28	2010-01-25	Organic nitrogen, water, unfiltered, milligrams per liter
00607	69	2008-08-28	2010-01-25	Organic nitrogen, water, filtered, milligrams per liter
00608	94	2008-04-24	2010-02-24	Ammonia, water, filtered, milligrams per liter as nitrogen
00613	94	2008-04-24	2010-02-24	Nitrite, water, filtered, milligrams per liter as nitrogen
00618	94	2008-04-24	2010-02-24	Nitrate, water, filtered, milligrams per liter as nitrogen
00623	94	2008-04-24	2010-02-24	Ammonia plus organic nitrogen, water, filtered, milligrams per liter as nitrogen
00625	94	2008-04-24	2010-02-24	Ammonia plus organic nitrogen, water, unfiltered, milligrams per liter as nitrogen
00631	94	2008-04-24	2010-02-24	Nitrate plus nitrite, water, filtered, milligrams per liter as nitrogen

----- Provisional Data Subject to Revision -----

----- Provisional Data Subject to Revision -----



Jun 16



Jun 16

Gage height, feet
 3
 2
 2
 1
 1
 Location
 Fairfax
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 Period
 to pre:
 -->
 pH, water, unfiltered, field, standard
 units

Virginia Real-Time Water Quality

Home View Data Methods Constituents Models Bibliography Links

NRTWQ Home >> Virginia >> View Data >> 02035000

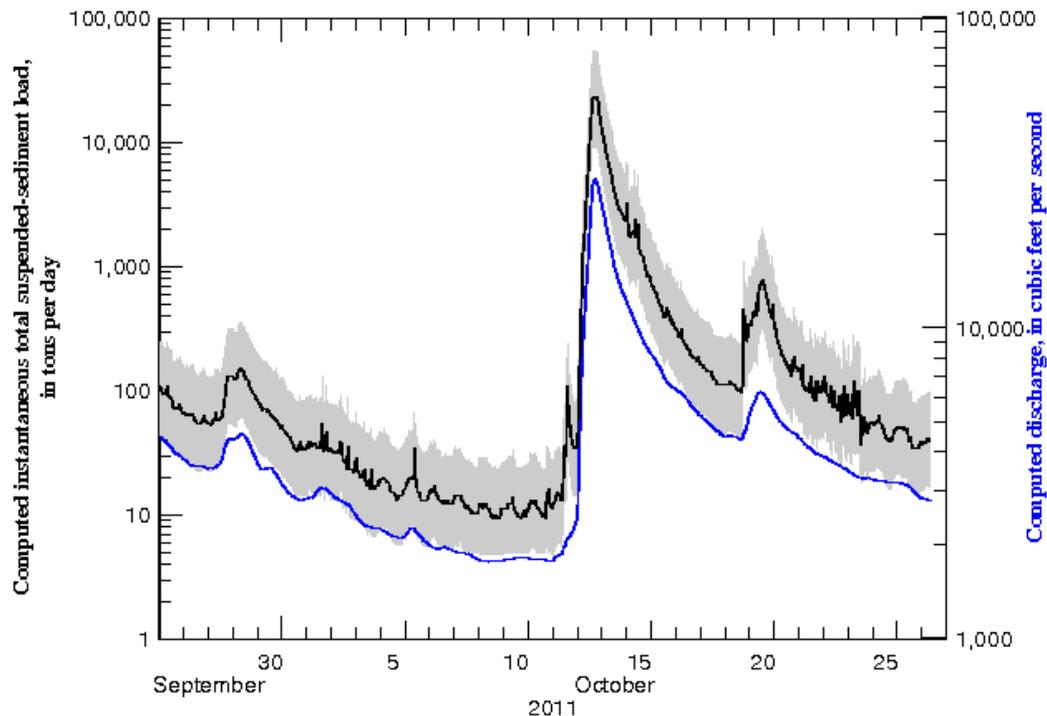
Plot Data Table Statistics Duration Curve Site Info Model Info

USGS station: 02035000 James River at Cartersville, VA [Go to NWSWeb](#)

Constituent: Computed suspended sediment **load** hourly < Go >

Time period: Last 31 days

The data used to produce this plot are **provisional** and have not been reviewed or edited. They may be subject to change.



Computed instantaneous total suspended-sediment load in James River at Cartersville, VA

Generated 10-27-11 9:43

EXPLANATION

- Discharge
- Measured or computed water-quality constituent
- ▒ 90-percent prediction interval for computed value
- Value obtained from discrete sampling and analysis
- Load calculated using laboratory analysis and discharge

Status

- **Continuous water-quality and streamflow data since Fall 2007**
 - 35,000+ measurements per year of 6-7 parameters
 - **Monthly and storm-event sampling since Spring 2008.**
 - Over 1,250 sediment and nutrient samples collected.
 - **Implementation ongoing (although slower than anticipated)**
-

Further Benefits of Monitoring

- Network will replace existing MS4 monitoring program in Fairfax County
 - Generation of load estimates allows verification of allocations and understanding of actual loadings from localities
 - Established monitoring infrastructure promotes collaboration
 - Additional USGS research
 - Field trial of HACH Continuous Nutrient Analyzers (w/ VA DEQ)
 - Field trial of S. Korean Continuous Nutrient Analyzers (w/ U. of Seoul)
-



John Jastram
804-261-2648
jdjastra@usgs.gov

http://va.water.usgs.gov/projects/ffx_co_monitoring.htm