Assessing Watershed Scale Responses to BMP Implementation in Urban Watersheds

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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.**

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,

Collect numerous samples and continuous data at multiple sites over extended periods of time.

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Study Objectives

1. **Generate <u>long-term</u> 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.**
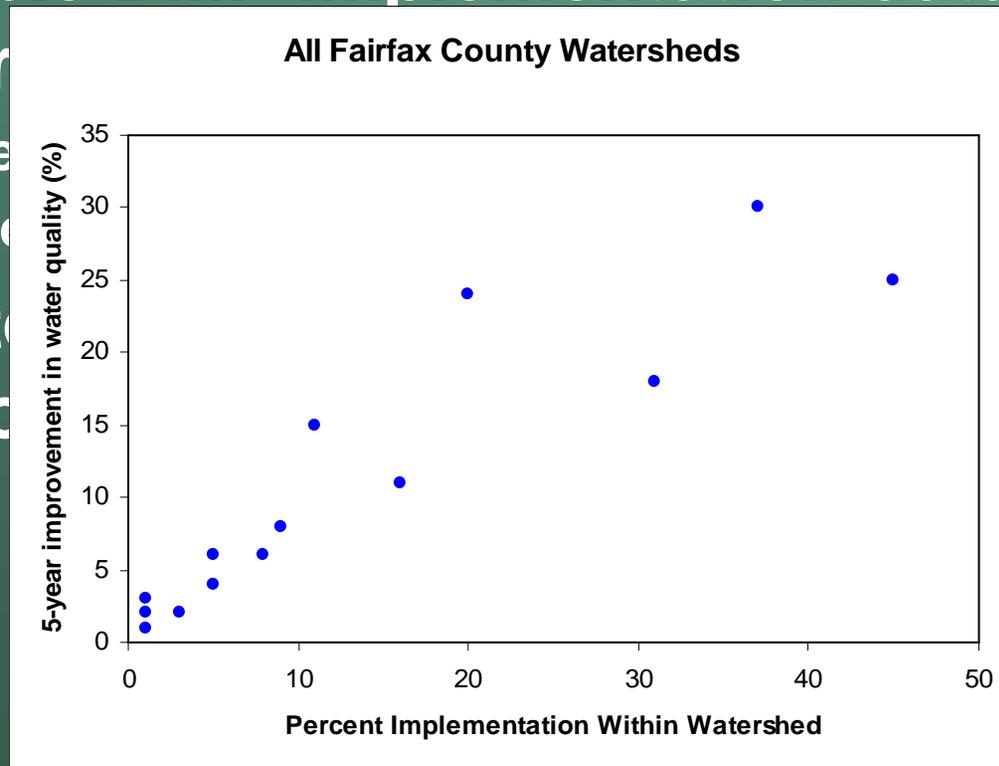
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Approach: Intensive Monitoring

- **Operate four intensive monitoring stations**
- **5 – 10 years of data collection**
    - **Continuous-record stream gage**
    - **Continuous water-quality monitor (turbidity, pH, SC, water temp)**
    - **Automated stream sampler (storm samples)**
        - **Nutrients & Sediment**
    - **Scheduled monthly sampling**
        - **Nutrients & Sediment**
    - **Annual benthic monitoring**
- **Evaluate trends and loads.**

Approach: BMP Evaluation

- **Assemble BMP implementation dataset for monitor...**
  - **Exte...**
  - **Typ...**
- **Evaluat... ...uality conditio... ...s.**

All Fairfax County Watersheds

5-year improvement in water quality (%)

Percent Implementation Within Watershed

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# Approach: Knowledge Transfer

- **Operate 10 trend monitoring stations.**
  - Partial-record stream gage
  - Scheduled monthly sampling
    - Nutrients & Sediment
  - Annual benthic monitoring
- **Evaluate trends in water-quality and quantity.**
- **Evaluate relations between trend- and intensive monitoring sites.**

Site Selection Approach

- **Applied cluster analysis to classify sites based on watershed characteristics.**
  - **Land use and age of development.**
  - **Existing water-quality and benthic macro-invertebrate data.**
  - **Presence/amount of BMPs currently in watershed.**
  - **Percent imperviousness.**

- **All basins < 6 mi^2.**

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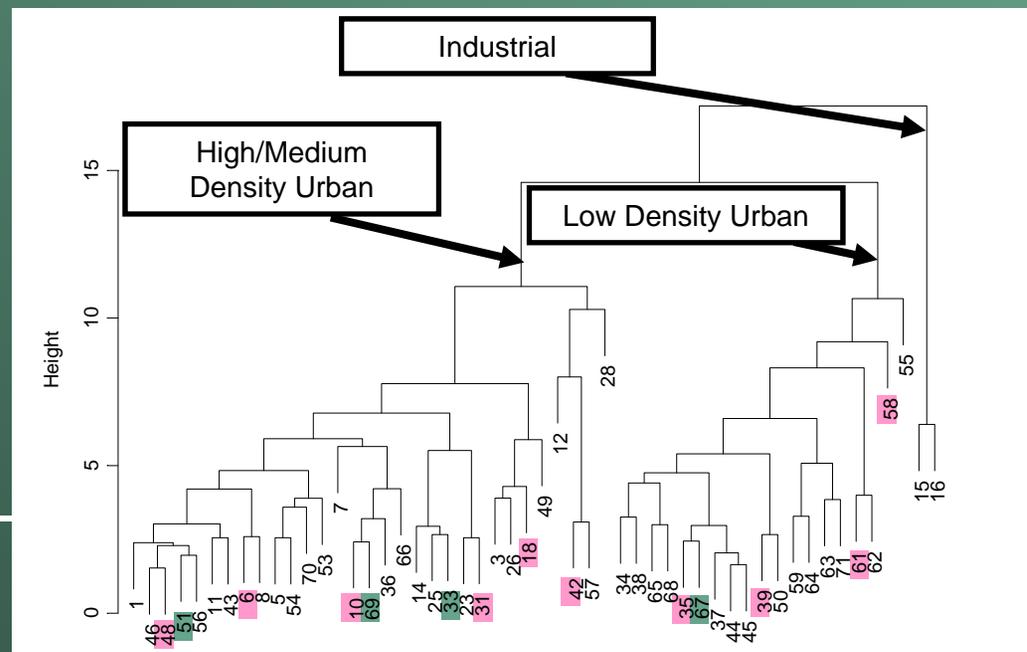
Distribution of Basin Characteristics
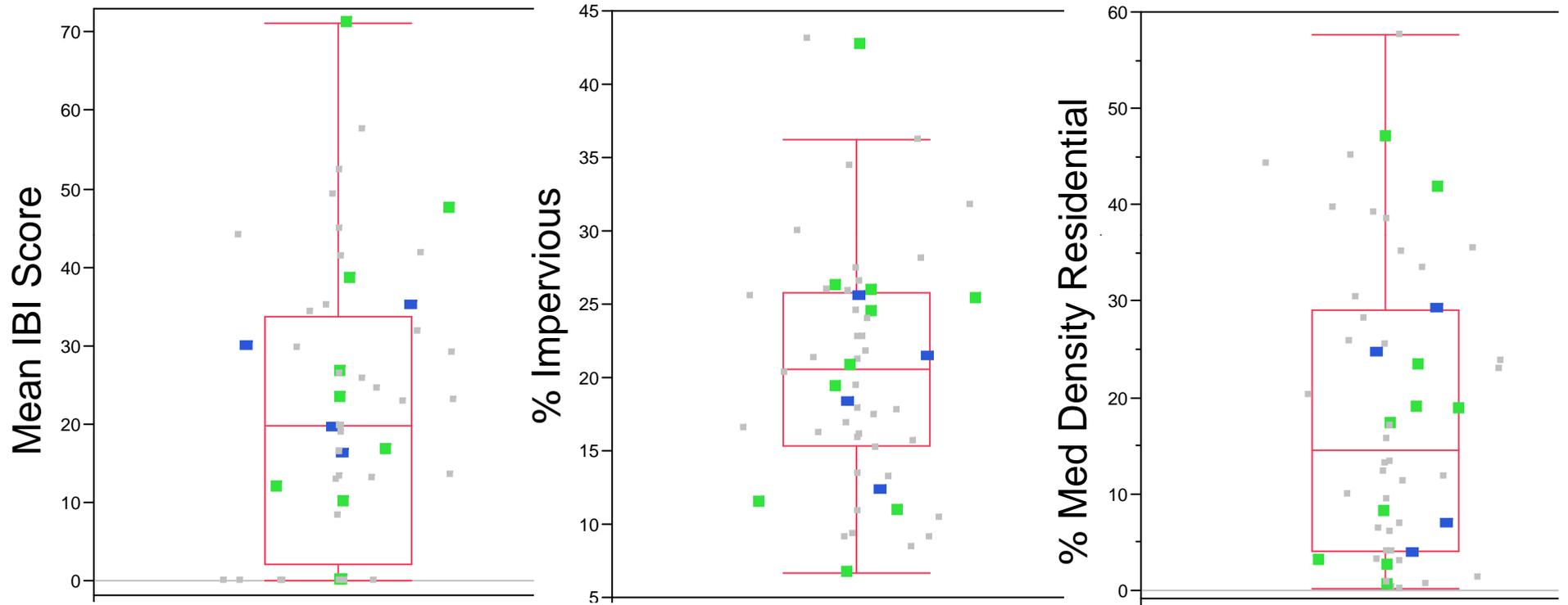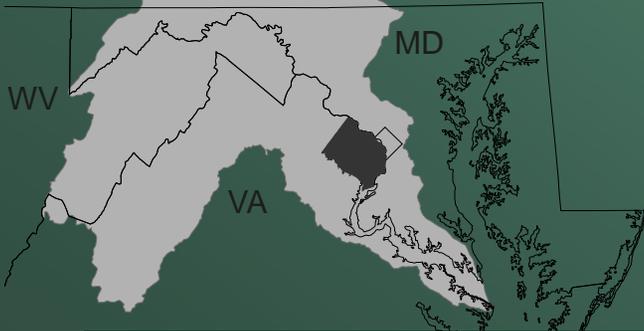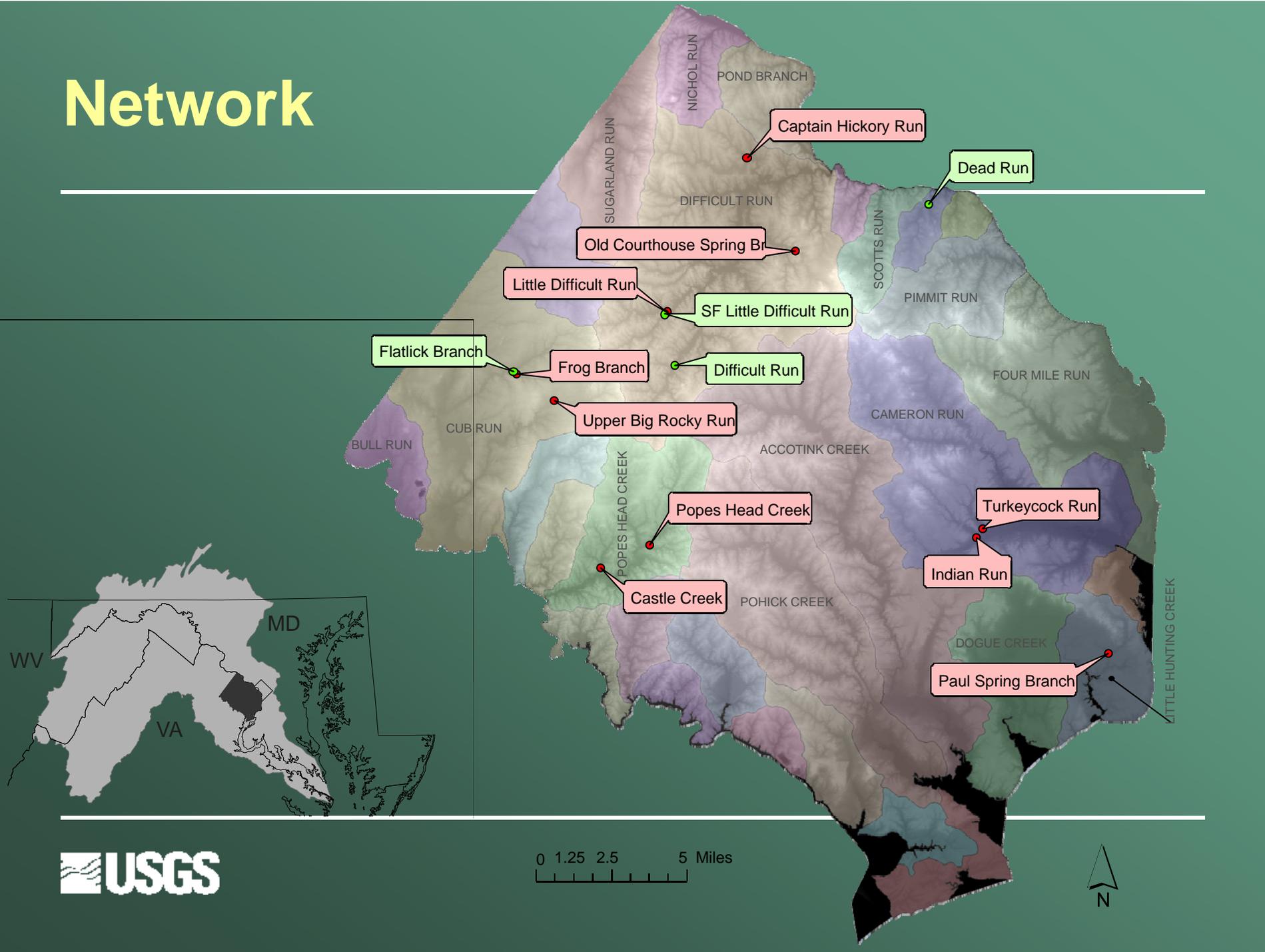
Methods

- **Turbidity Threshold Sampling**
  - **Autosamplers triggered by algor[ithm] realtime sensor data**
    - **Turbidity, flow, time**
- **Surrog[ate]**
  - **Conti[nuous] contin[uous]**
- **LOADE[ST]**
  - **Sedim[ent] sing surrog[ate]**
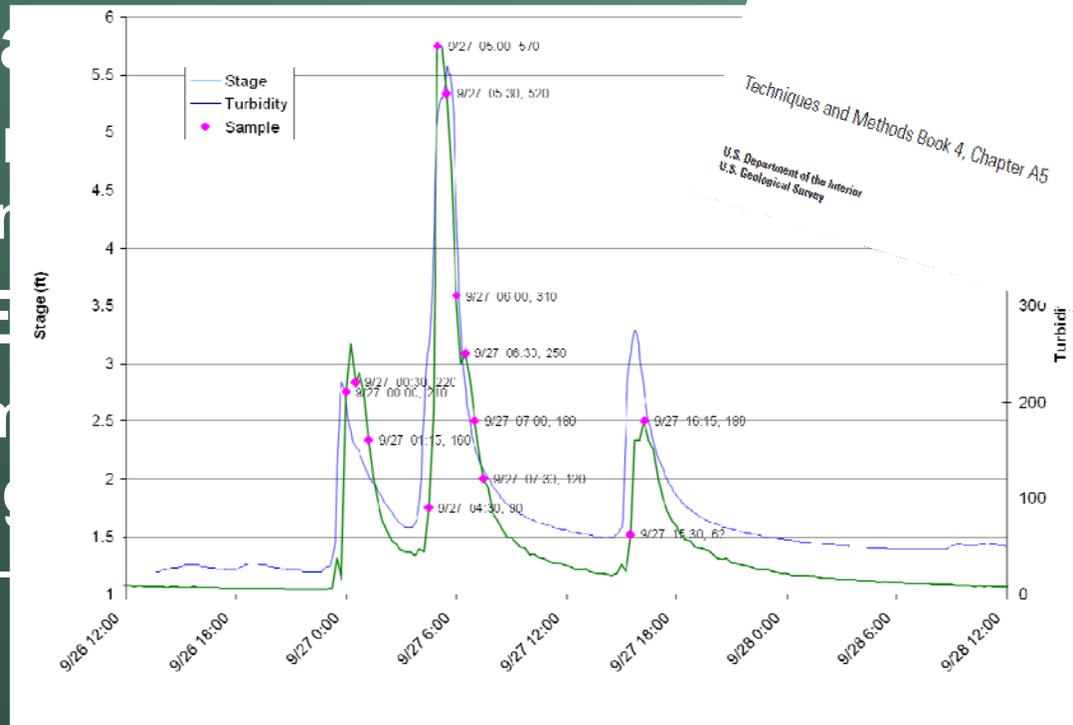
Status

- **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 750 suspended sediment samples collected.**
  - **Over 650 nutrient samples collected.**

- **Preliminary data analysis….**

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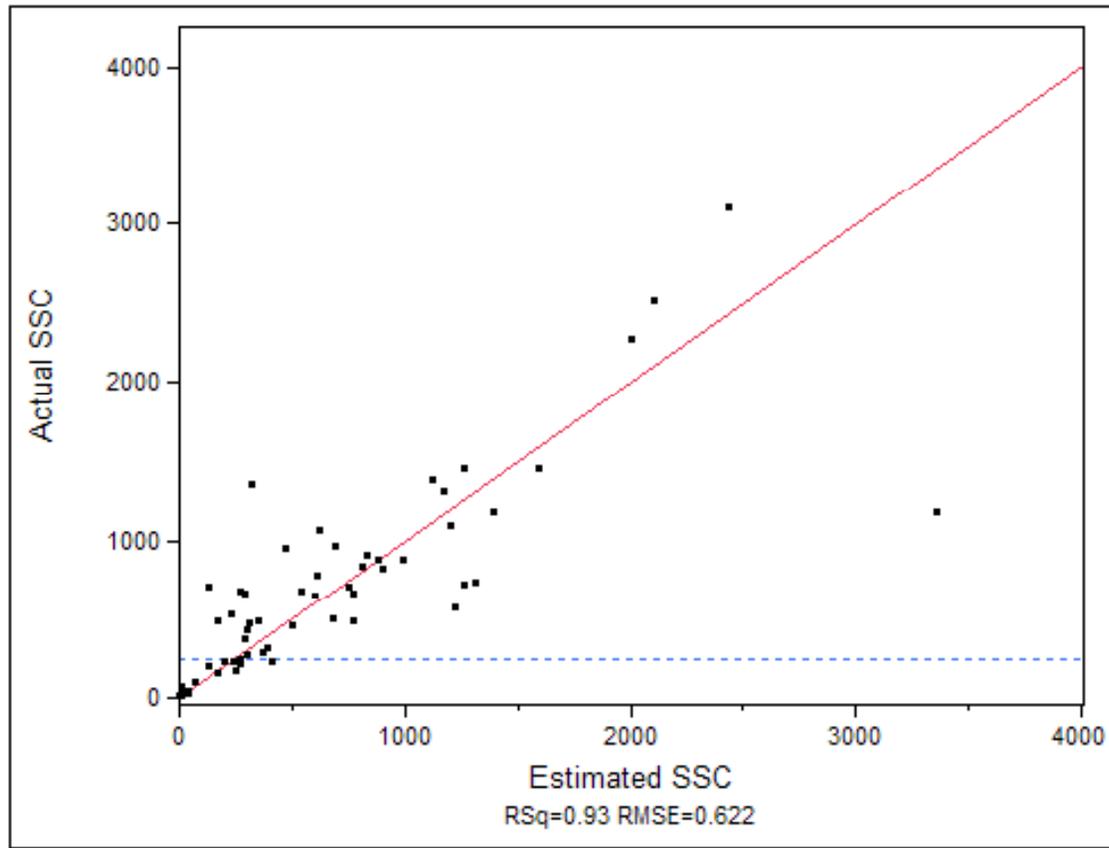
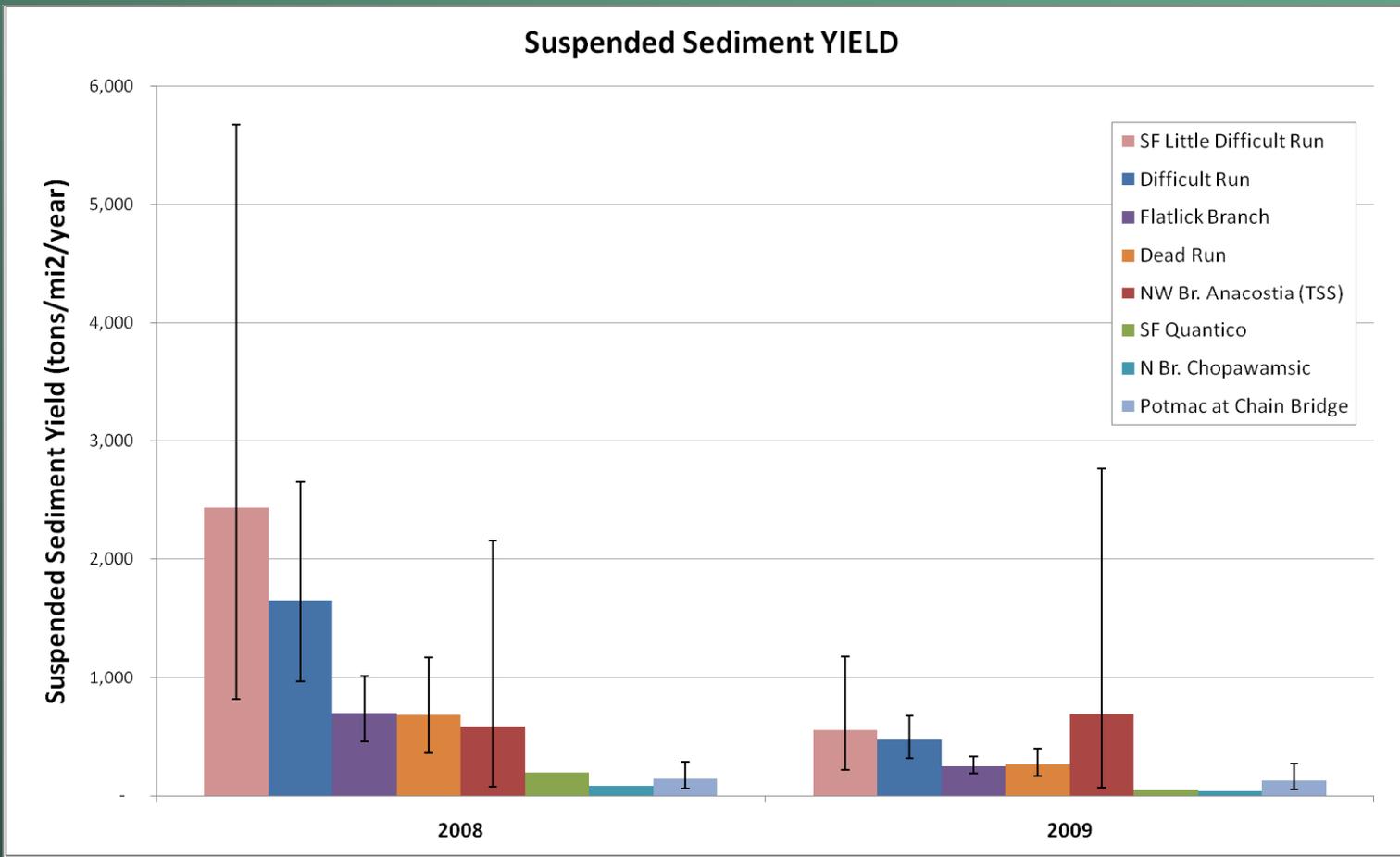| Term	Estimate	Std Error	t Ratio	Prob>|t|	VIF
Intercept	0.6234086	0.179798	3.47	0.0009	.
Log(Turbidity)	0.7866	0.081047	9.71	<.0001	4.8584813
Log(Q)	0.3725171	0.090522	4.12	0.0001	4.8584813

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

Suspended Sediment Yields
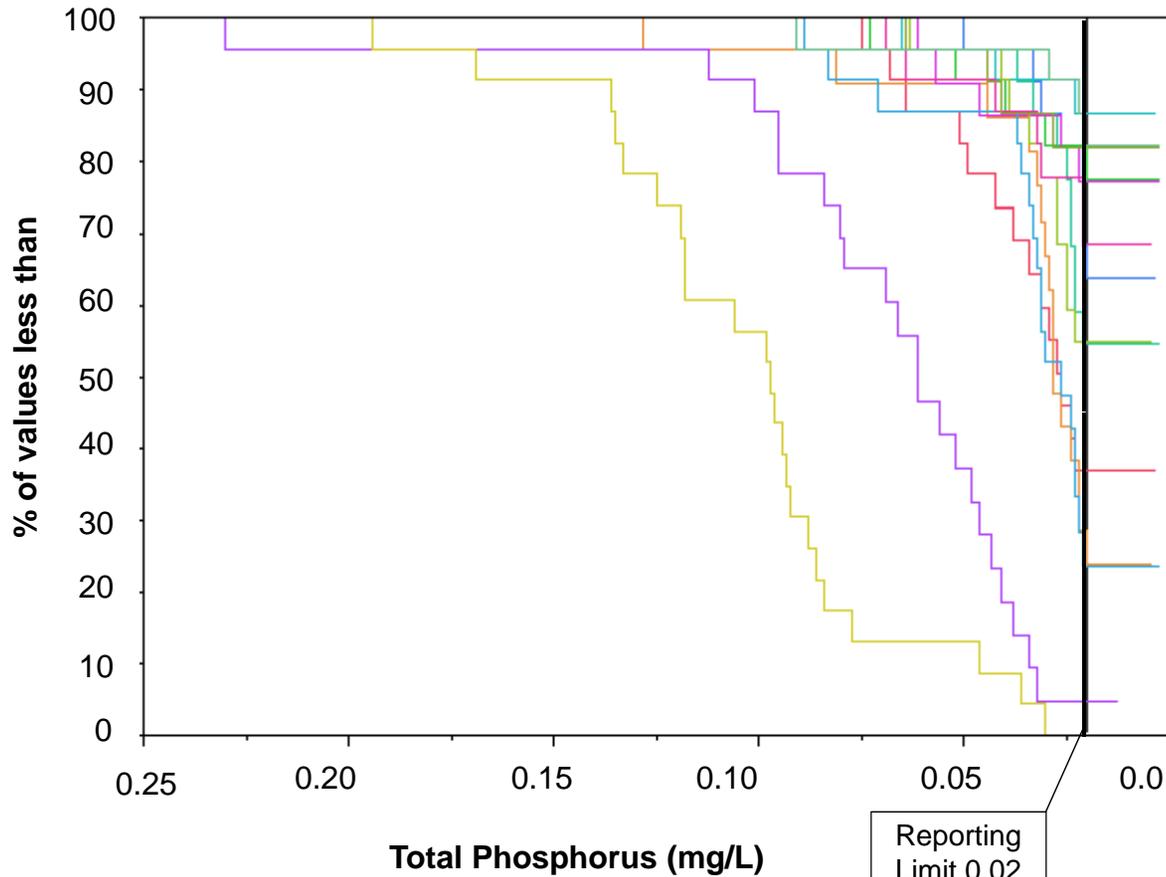

Suspended Sediment YIELD

Nitrogen – Monthly Samples
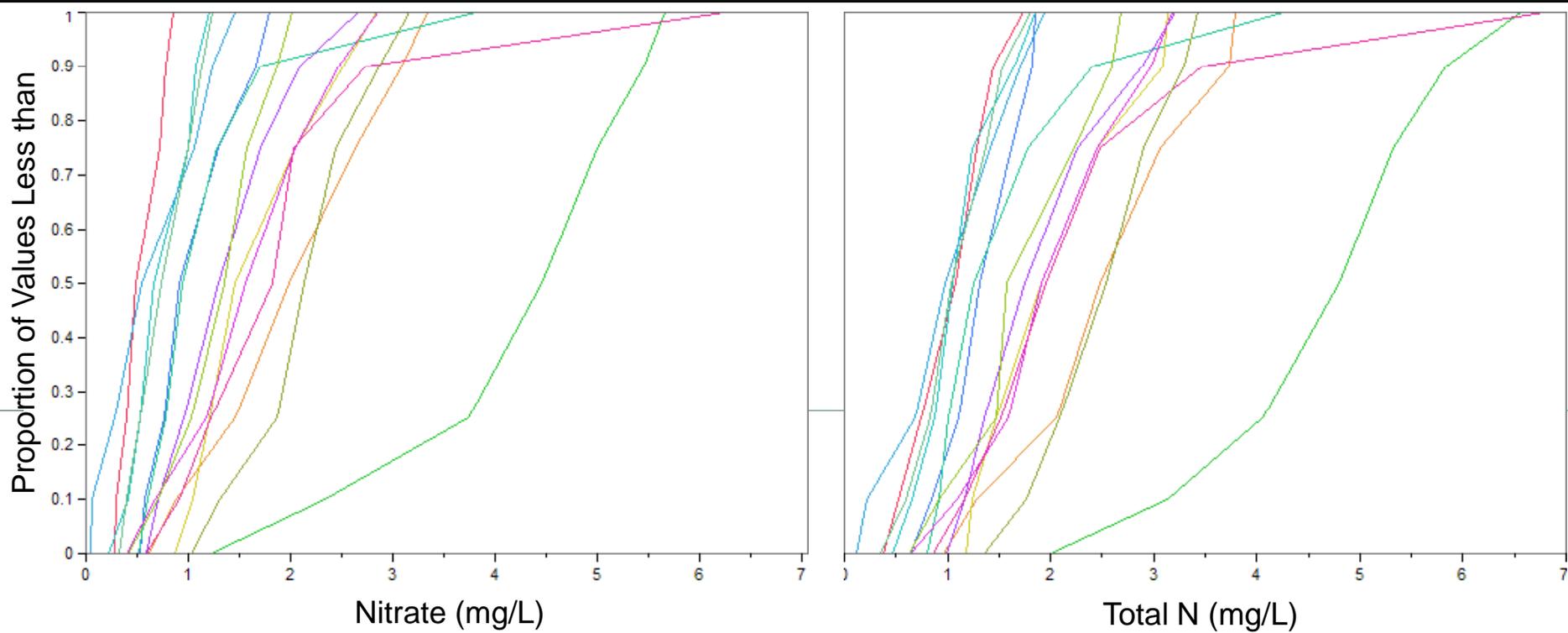
Groups

× — BIG ROCKY RUN AT STRINGFELLOW RD NR CHANTILLY, VA
□ — CAPTAIN HICKORY RUN AT RT 681 NEAR GREAT FALLS, VA
◇ — CASTLE CREEK AT NEWMAN ROAD AT CLIFTON, VA
△ — DEAD RUN AT WHANN AVENUE NEAR MCLEAN, VA
Y — DIFFICULT RUN ABOVE FOX LAKE NEAR FAIRFAX, VA
z — FLATLICK BRANCH ABOVE FROG BRANCH AT CHANTILLY, VA
○ — FROG BRANCH ABOVE FLATLICK BRANCH AT CHANTILLY, VA
□ — INDIAN RUN AT BREN MAR DRIVE AT ALEXANDRIA, VA
□ — LITTLE DIFFICULT RUN NEAR VIENNA, VA
✳ — OLD COURTHOUSE SPRING BRANCH NEAR VIENNA, VA
● — PAUL SPRING BR AB NORTH BRANCH NR GUM SPRINGS, VA
■ — POPES HEAD CREEK TRIB NEAR FAIRFAX STATION, VA
■ — S F LITTLE DIFFICULT RUN ABOVE MOUTH NR VIENNA, VA
■ — TURKEYCOCK RUN AT EDSALL RD AT ALEXANDRIA, VA

Total Phosphorus – Monthly Samples

Reporting Limit 0.02

BIG ROCKY RUN AT STRINGFELLOW RD NR CHANTILLY, VA
CAPTAIN HICKORY RUN AT RT 681 NEAR GREAT FALLS, VA
CASTLE CREEK AT NEWMAN ROAD AT CLIFTON, VA
DEAD RUN AT WHANN AVENUE NEAR MCLEAN, VA
DIFFICULT RUN ABOVE FOX LAKE NEAR FAIRFAX, VA
FLATLICK BRANCH ABOVE FROG BRANCH AT CHANTILLY, VA
FROG BRANCH ABOVE FLATLICK BRANCH AT CHANTILLY, VA
INDIAN RUN AT BREN MAR DRIVE AT ALEXANDRIA, VA
LITTLE DIFFICULT RUN NEAR VIENNA, VA
OLD COURTHOUSE SPRING BRANCH NEAR VIENNA, VA
PAUL SPRING BR AB NORTH BRANCH NR GUM SPRINGS, VA
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S F LITTLE DIFFICULT RUN ABOVE MOUTH NR VIENNA, VA
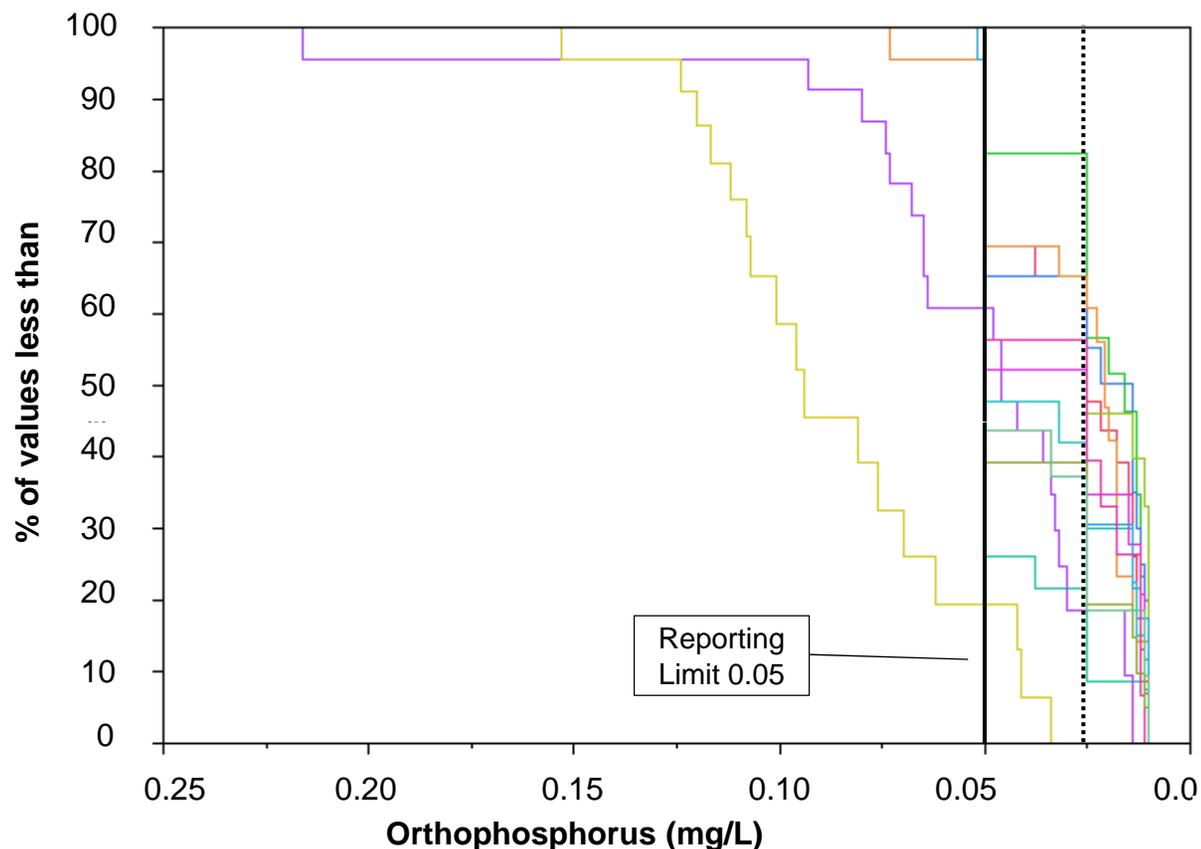TURKEYCOCK RUN AT EDSALL RD AT ALEXANDRIA, VA

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Orthophosphorus – Monthly Samples

% of values less than (y-axis)

Orthophosphorus (mg/L) (x-axis): 0.25, 0.20, 0.15, 0.10, 0.05, 0.0

Reporting Limit 0.05

BIG ROCKY RUN AT STRINGFELLOW RD NR CHANTILLY, VA
CAPTAIN HICKORY RUN AT RT 681 NEAR GREAT FALLS, VA
CASTLE CREEK AT NEWMAN ROAD AT CLIFTON, VA
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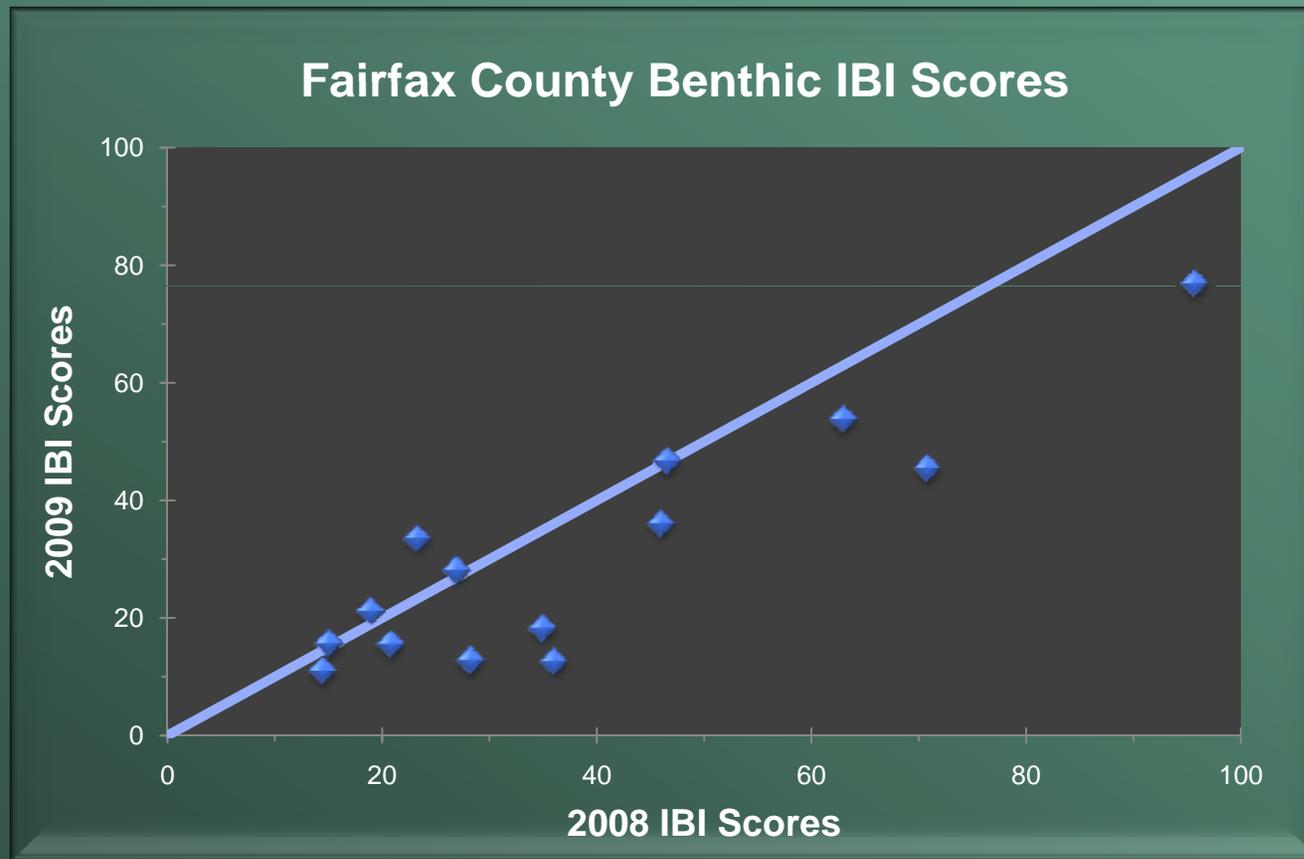TURKEYCOCK RUN AT EDSALL RD AT ALEXANDRIA, VA

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Benthic Macroinvertebrate Data

Fairfax County Benthic IBI Scores

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   Water-Quality: Field/Lab samples ▾   GO

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

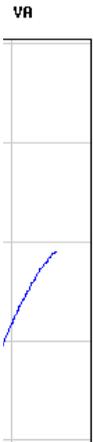| Parameter Code	Count	Begin Date	End Date	Parameter Code Complete Name
00010	26	2008-04-24	2010-04-27	Temperature, water, degrees Celsius
00020	25	2008-04-24	2010-04-27	Temperature, air, degrees Celsius
00025	25	2008-04-24	2010-04-27	Barometric pressure, millimeters of mercury
00061	51	2008-10-22	2009-09-29	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

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science for a changing world

Real-Time Water Quality for Maryland

| Home | View Data | Methods | Constituents | Models | Bibliography | Links |

| Plot | Data Table | Statistics | Duration Curve | Site Info | Model Info |

USGS station: 01651000 Northwest Branch Anacostia River near Hyattsville, MD ⬙ Go to NWISWeb

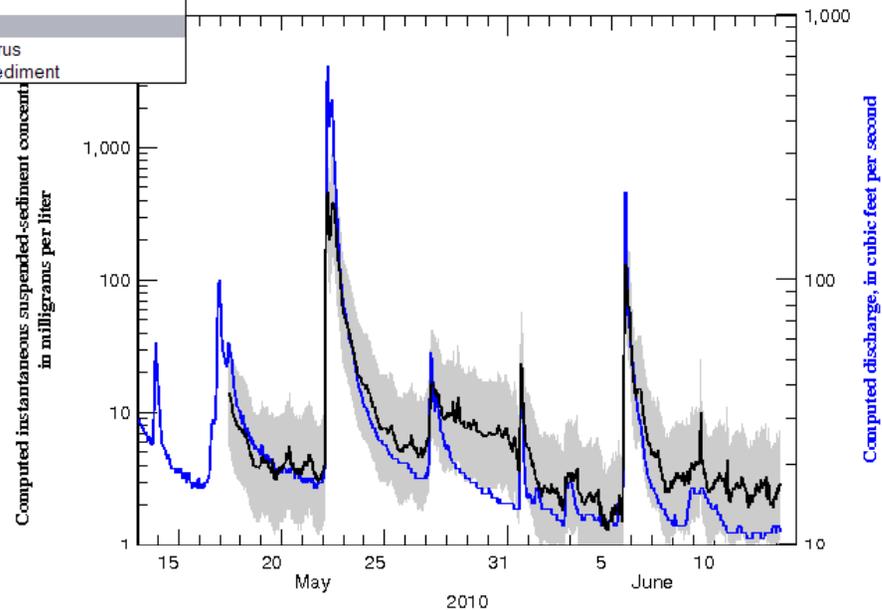**Constituent:** Computed suspended sediment ▾ concentration ▾ hourly ▾ < Go >

concentration
load

Time period:

Computed discharge
Specific conductance at 25 degrees Celsius
pH
Water temperature
Turbidity
Diss. oxygen
Computed total nitrogen
Computed total phosphorus
Computed suspended sediment

this plot are provisional and have not been reviewed or edited. They may be subject to change.

Computed instantaneous suspended-sediment concentration
in Northwest Branch Anacostia River near Hyattsville, MD

Generated 6-14-10 7:22

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
⋯⋯ Water-quality criteria

Notes

UPDATES – Proposed MS4 Permit

- **Fairfax County MS4 Permit Monitoring**
    - **Proposed permit would utilize this study to satisfy monitoring requirements**
    - **Legal requirement to continue monitoring ensures long-term support of study**

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UPDATES – Proposed Additions

- **Chesapeake Bay Executive Order**
  - **Focal Watersheds – Difficult Run**
  - **Proposed Study**
    - **Process level evaluation of nutrient and sediment transport**
      - **2 additional intensive monitoring stations – mouth and mid-basin**
      - **Nutrient Source Identification**
        - **Nutrient Isotopes**
      - **Hydrograph separations**
        - **Geochemical tracers & isotopes**
      - **Improved sediment source and fate understanding**
        - **Sediment fingerprinting**
        - **Bank erosion/floodplain deposition**
  - ➡ **Some portion of this work is expected to be funded in FY 2011**

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UPDATES – Recent Developments

- **HACH Instrumentation Field Trial**
  - **HACH, VA DEQ, USGS**
  - **Homeland Security technology adapted for environmental applications**
    - **Continuous/Realtime Nutrients and field parameters**
    - **Flatlick Branch or Accotink Creek**

Updates – Additional USGS Work

- **USGS National Research Program - Reston**
  - **Process level research on source, transport, and fate of nutrients and sediment in Difficult Run (Noe)**
    - **Trapping and fate of nutrients and sediment in floodplains**
    - **Erosion from streambanks**
    - **Identification of sediment sources**
  - **Development of numerical models to evaluate how different restoration designs impact stream metabolism over a range of flow conditions (Larsen)**
    - **Evaluating linkages between flow, sediment and organic matter transport, stream morphology, and the resulting production and respiration of organic matter in restored and unrestored stream segments (Accotink and Difficult)**

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Study Highlights

- **Intensive Monitoring**
    - **As many as 500 samples/year across 14 sites**
    - **Continuous Water Quality at 4 sites (35,000+ measurements of 4+ parameters per year)**
    - **Use of surrogate relations to generate continuous estimates of SSC and nutrients**
- **Small Urban/Suburban Watersheds**
    - **1-6 square miles**
    - **Varied watershed characteristics**
- **Long Term**
    - **5-10 years of data collection**
- **Many opportunities for add-on research**

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