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Comprehensive Monitoring in Red Hill Branch Subwatershed, Howard County, Maryland

Our Best Chance to Show Restoration Success

Mid-Atlantic Stream Restoration Conference
November 16, 2011

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VERSAR

HC

MARYLAND

Agenda

- Project Team
- Project Background
- Study Area
- Monitoring Strategy / Sampling Design
- Example Results

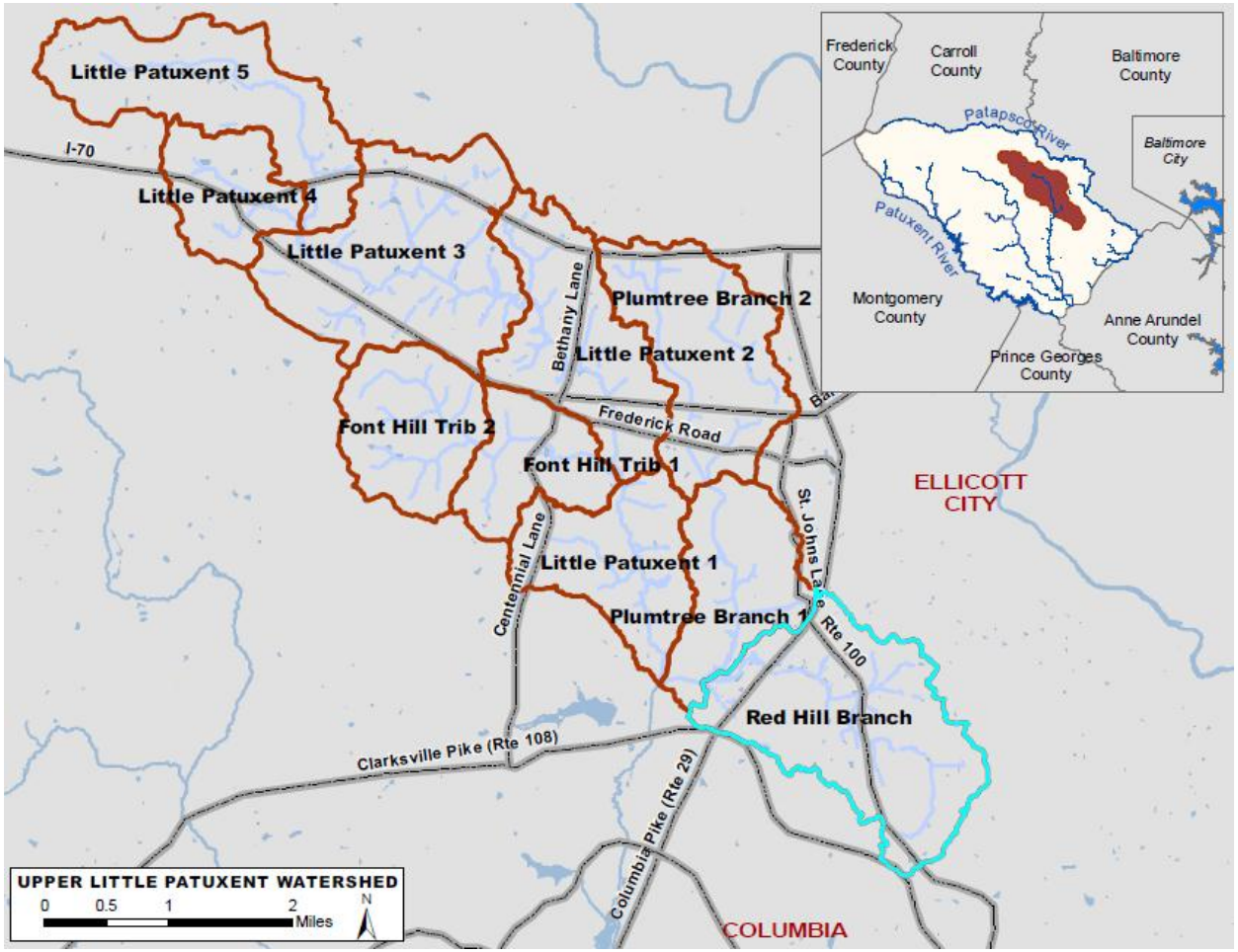
Project Team

- **Howard County DPW**
  - Mark Richmond, Howard Saltzman, Angela Morales
- **KCI Technologies, Inc.**
  - Mike Pieper, Colin Hill, Megan Crunkleton, Susanna Brellis
- **Versar, Inc.**
  - Beth Franks, Mark Southerland, Tom Jones

- **Chesapeake Environmental Management**
- **Maryland Department of Natural Resources**
- **Analytical Laboratories**
- **Environmental Services and Consulting**

Project Background

- **Upper Little Patuxent Watershed**



Project Background

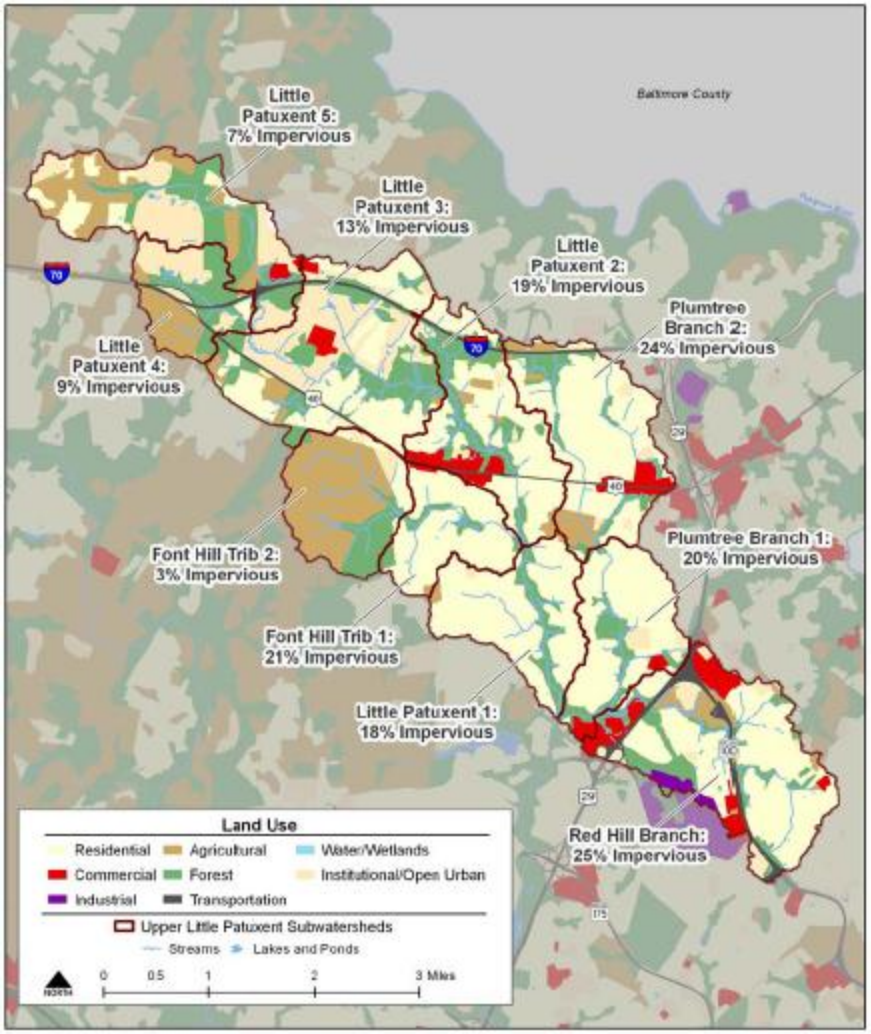
- **Upper Little Patuxent Watershed Management Plan**
  - **Completed 2009**
  - **Components**
    - SCA, Landuse Analysis, Pollutant Loading Modeling
    - Subwatershed Prioritization
    - Identification of Potential Projects

Subwatershed	Nitrogen Load Rank	Phosphorus Load Rank	Total Suspended Solids Rank	Zinc Rank	Severe SCA Points Rank	Final Score	Final Rank
Red Hill Branch	1	1	1	1	1	5	1
Plumtree Branch 2	2	2	3	2	4	13	2
Little Patuxent 3	3	3	2	3	7	18	3
Little Patuxent 2	4	4	4	4	6	22	4
Plumtree Branch 1	5	5	5	5	3	23	5
Little Patuxent 1	6	9	7	8	2	32	6
Little Patuxent 5	8	6	6	6	8	34	7
Font Hill Trib 1	7	10	8	10	5	40	8
Little Patuxent 4	9	8	9	7	9	42	9
Font Hill Trib 2	10	7	10	9	10	46	10

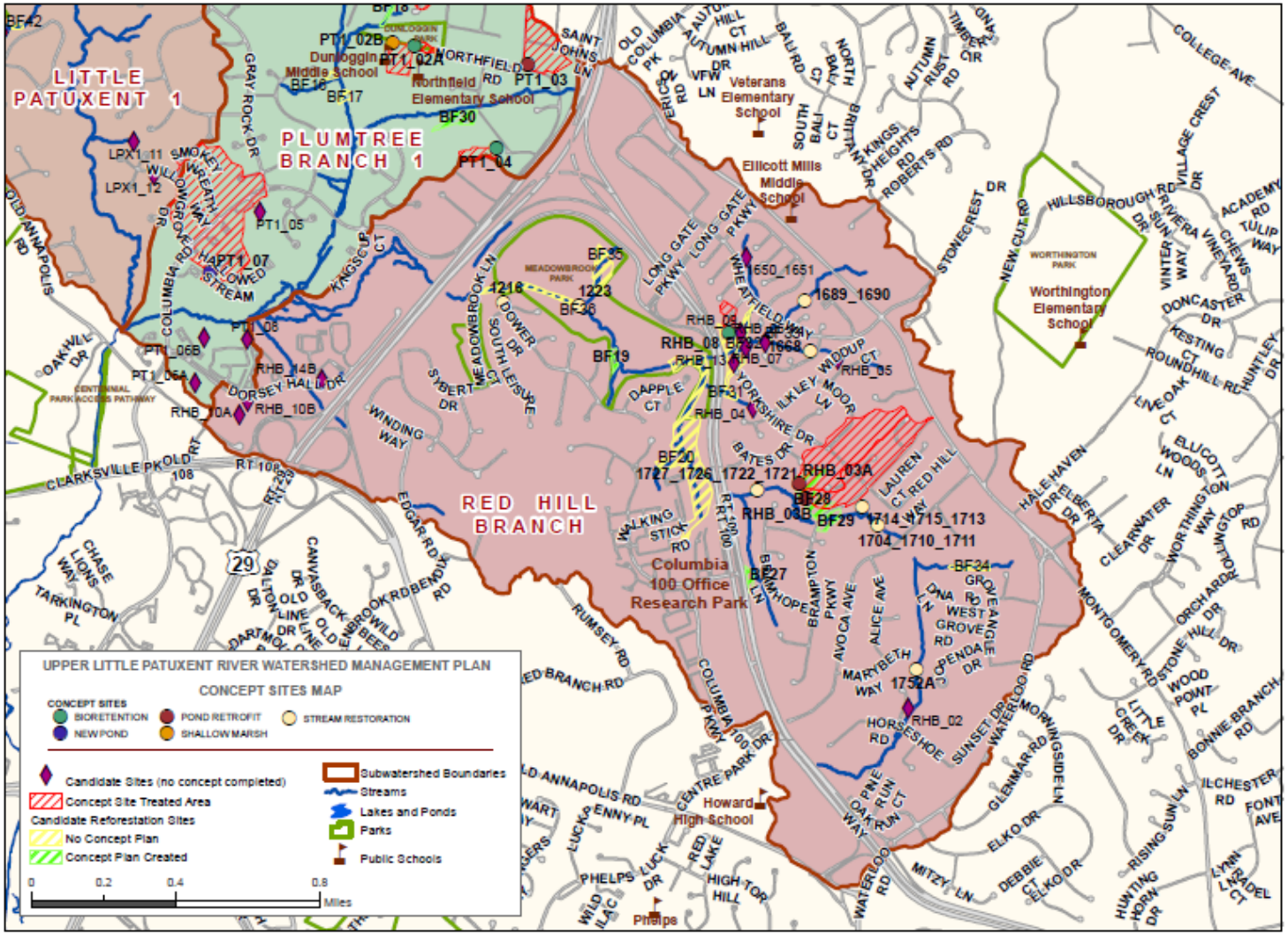
1 – 3 4 – 7 8 – 10

Study Area

- **Red Hill Branch**
  - 1,718 acres (2.68 sq miles)
  - 7.18 miles of stream
- **Landuse**
  - 55% Residential
  - 13% Comm/Ind
  - 12% Forest/Brush
  - 8% Transportation
  - 8% Agricultural
- **Imperviousness**
  - 25% Imperviousness
  - 53% Untreated / 47% Treated

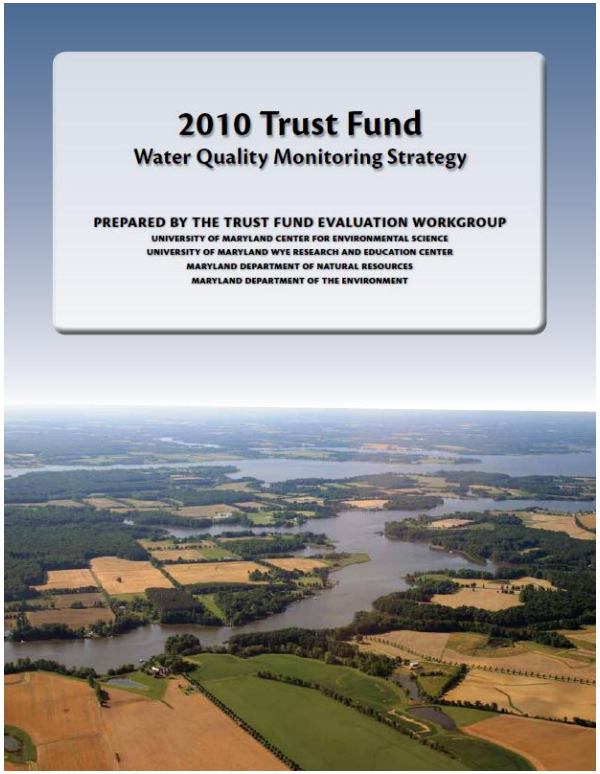


Study Area

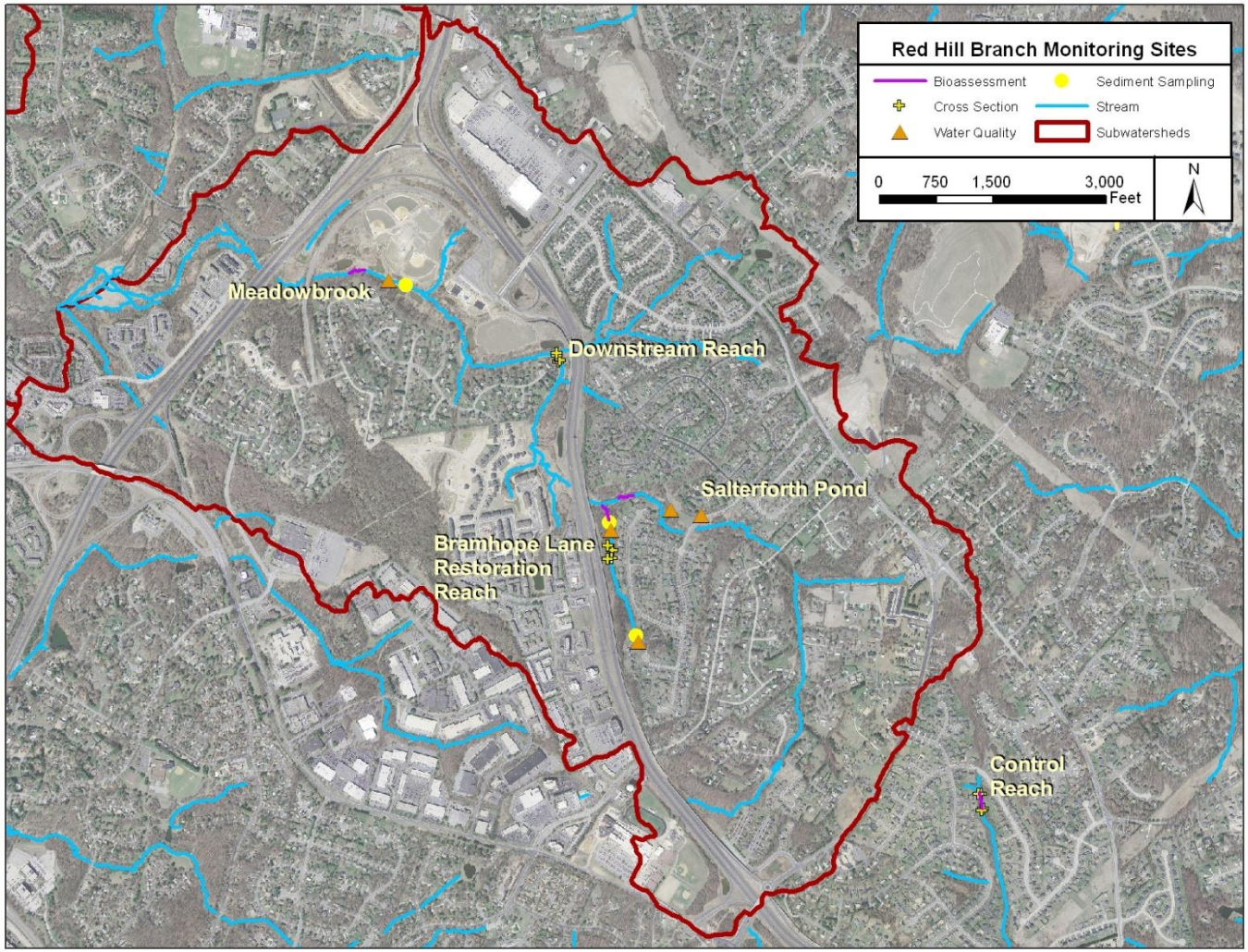

LITTLE PATUXENT 1
PLUMTREE BRANCH 1
RED HILL BRANCH
Dunloggin Middle School
Northfield Elementary School
Veterans Elementary School
Ellicott Mills Middle School
Worthington Elementary School
Columbia 100 Office Research Park
Howard High School
Phelps
UPPER LITTLE PATUXENT RIVER WATERSHED MANAGEMENT PLAN
CONCEPT SITES MAP
CONCEPT SITES
BIORETENTION
POND RETROFIT
STREAM RESTORATION
NEW POND
SHALLOW MARSH
Candidate Sites (no concept completed)
Concept Site Treated Area
Candidate Reforestation Sites
No Concept Plan
Concept Plan Created
Subwatershed Boundaries
Streams
Lakes and Ponds
Parks
Public Schools
0
0.2
0.4
0.8
Miles

Monitoring Strategy

- **Scale**
  - **Project Specific**
    - Salterforth Pond Retrofit
    - Bramhope Stream Restoration
  - **Subwatershed Scale**
    - Red Hill Branch at Meadowbrook Park
  - **Watershed Scale**
    - Little Patuxent
- **BACI Design**
  - Before – pre-restoration
  - After – post-restoration
  - Control – upstream / watershed
  - Impact - downstream



Monitoring Strategy

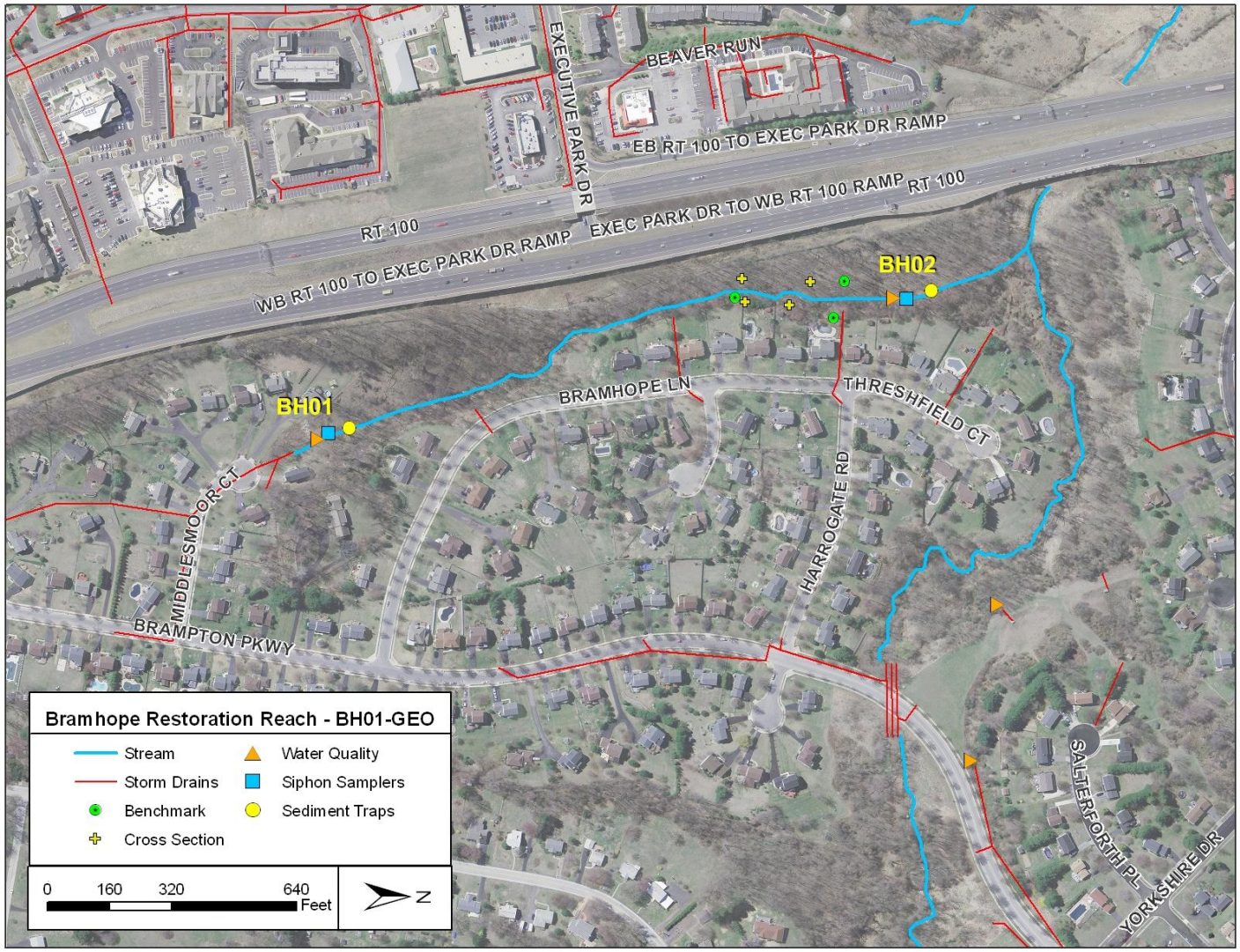


Monitoring Strategy

Parameters	Salterforth Ponds	Bramhope Stream	Downstream Bramhope	Meadowbrook Park	Watershed Control
Discharge	US/DS (c)	US/DS (c)		US/DS (c)	
Baseflow WQ	US/DS (8x)	US/DS (8x)		1 (8x)	
Stormflow WQ	US/DS (8x)	US/DS (8x)		1 (8x)	
Bed/washload		US/DS (8x)		1 (8x)	
Suspended Sediment		US/DS (8x)		1 (8x)	
Biological	1	1		1	1
Cross-sections		4	2		1
Bank pins		3 (4x)	4 (4x)		3 (4x)
Scour chains		3 (4x)	3 (4x)		3 (4x)
Pebble Count		2	2		2
Facies mapping		1	1		1
Bulk bar samples		1	1		1

Chart indicates number of locations and frequency in () if more than one time per year.

Bramhope Stream Restoration



Bramhope Stream Restoration






Bramhope Monitoring Design

- **Project Specific Goals**
  - Functional assessment, Rates over time
  - Compare pre- and post-restoration conditions
  - Compare to unimproved control reach
- **Monitoring Constraints and Confounding Factors**
  - No upstream reach for control & confluence immediately downstream
  - Numerous stormwater outfalls
  - SHA ditch from RT. 100
- **Three Monitoring Reaches**
  - Within restoration reach
  - Downstream of restoration
  - Adjacent subwatershed (control)

Bramhope Monitoring Design

- **Suite of Parameters: Some Common, Some Unique**
  - Discharge – continuous discharge monitoring
  - Water Quality – TKN, NO2, NO3, TN, TP, TSS (baseflow, stormflow)
  - Sediment – Bedload/washload, suspended sediment
  - Biological – benthic macroinvertebrates, physical habitat
  - Geomorphic – cross-section, profile, substrate characterization facies mapping, bank pins, scour chains, bulk bar samples
- **Time scale / Schedule**
  - Two years of pre-restoration data
  - October 2009 – November 2011

Discharge and Water Quality

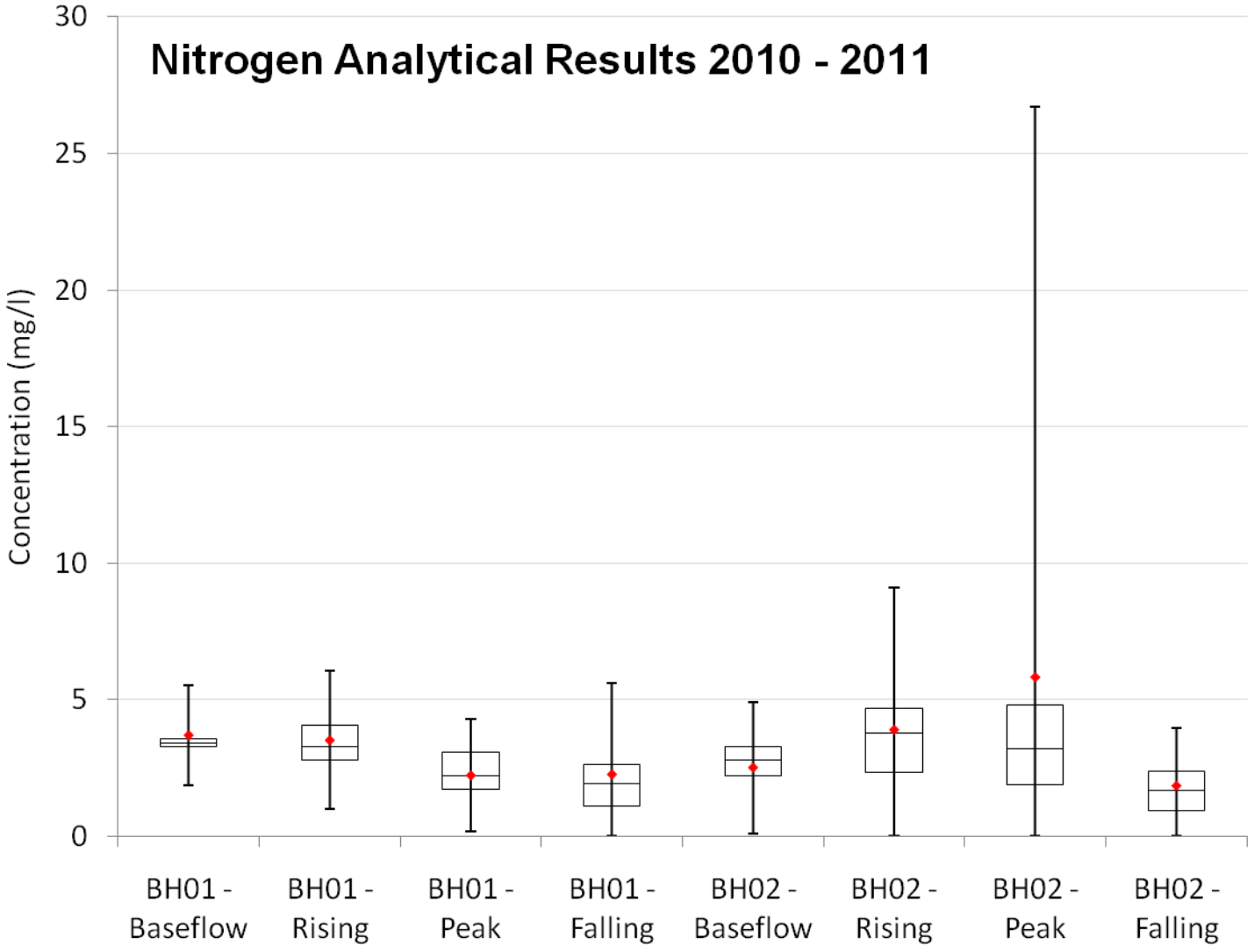
Continuous Discharge

Water Quality

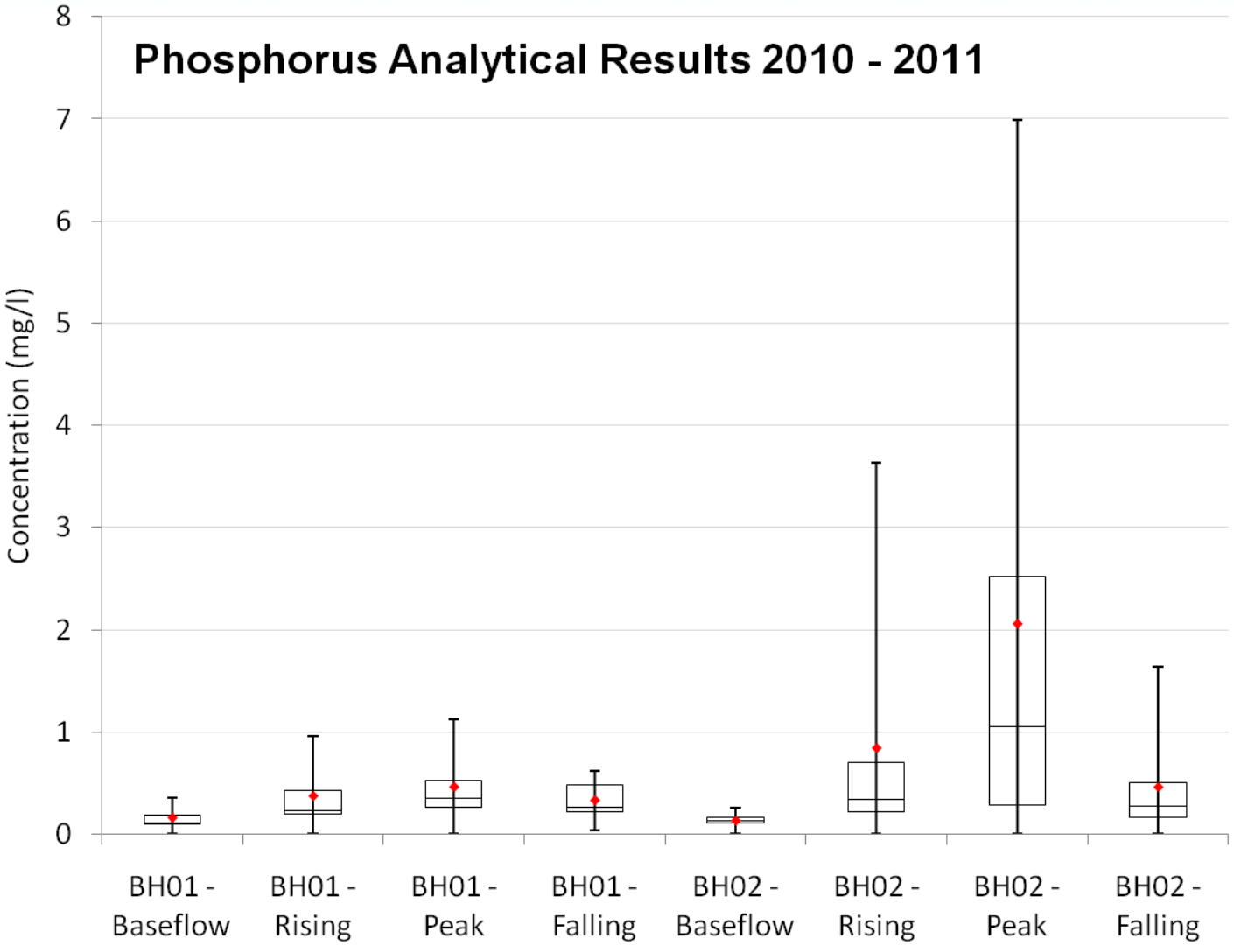
Continuous Discharge Monitoring

- Continuous flow data have been collected in partnership with Maryland Department of Natural Resources
- Flow data are undergoing QC and verification, and are not available at this time
- Accurate flow data required for estimation of loads and quantifying load reductions

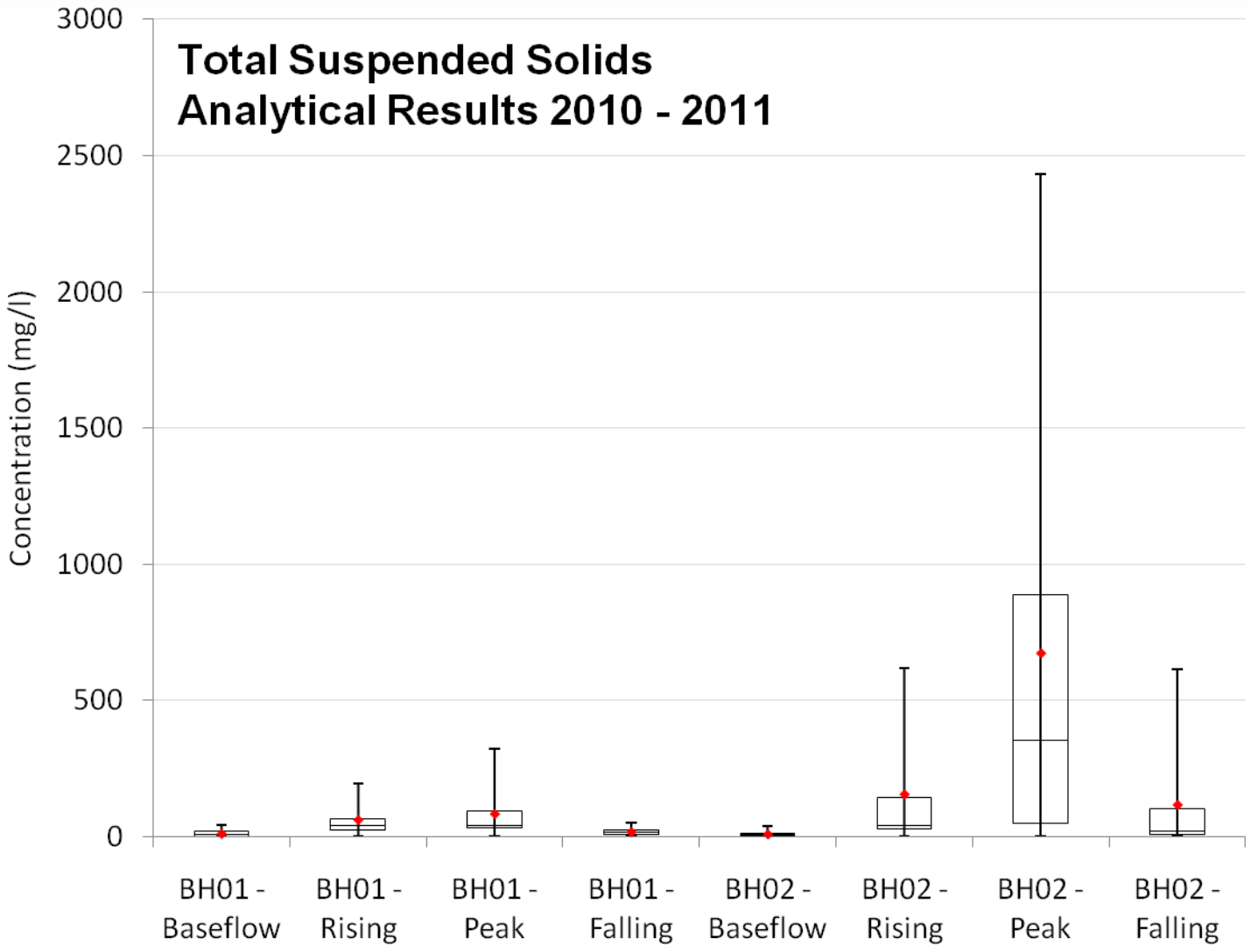
Water Quality Monitoring



Water Quality Monitoring



Water Quality Monitoring

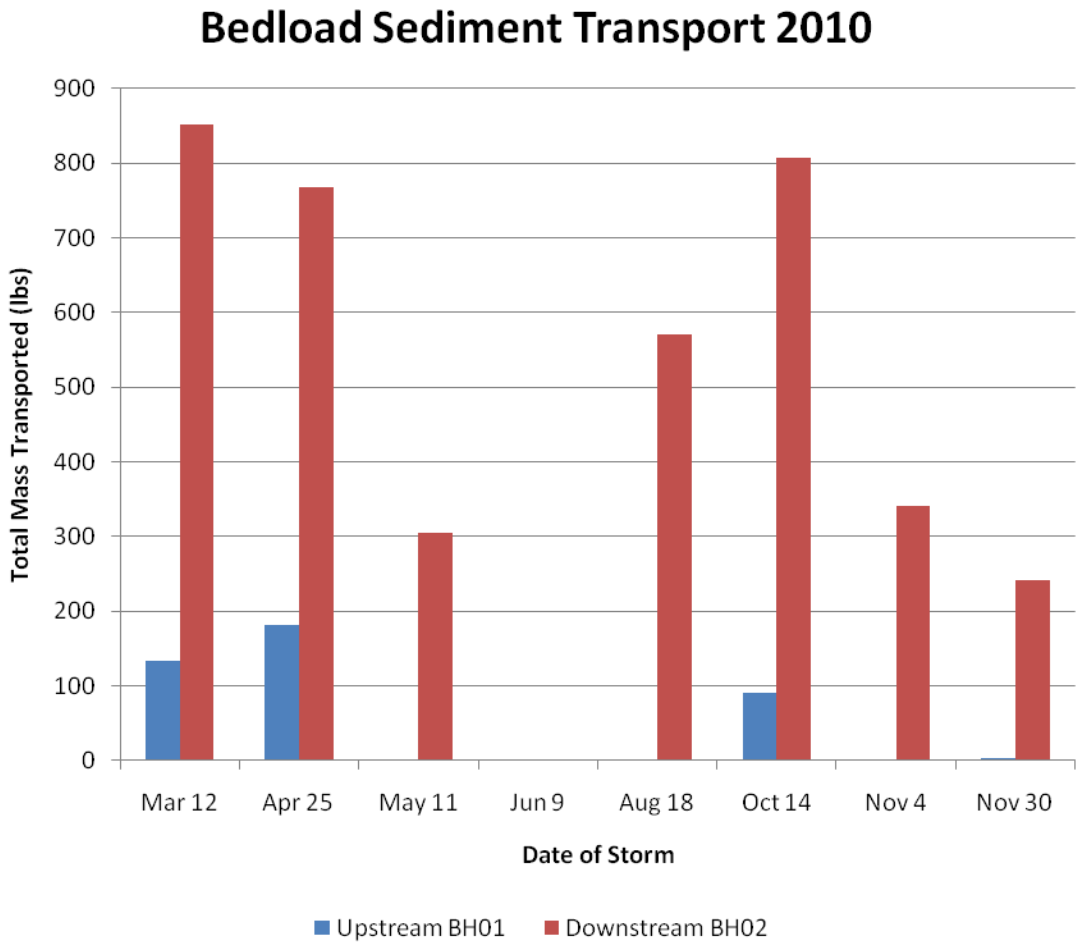


Sediment Sampling

Pit Traps for Bedload/Washload

Siphon Samplers for Suspended Sediments

Sediment Sampling - Bedload



- Bedload transport considerably greater at downstream end of restoration reach
- Pit trap capacity was often exceeded at downstream reach
- Dominant particle size is sand

Sediment Sampling - Suspended

- Suspended sediment monitored during storm events with siphon sampler
- Allows samples to be collected at multiple stages of the rising limb of the hydrograph
- Relating to gauge discharge data will enable creation of sediment transport curve

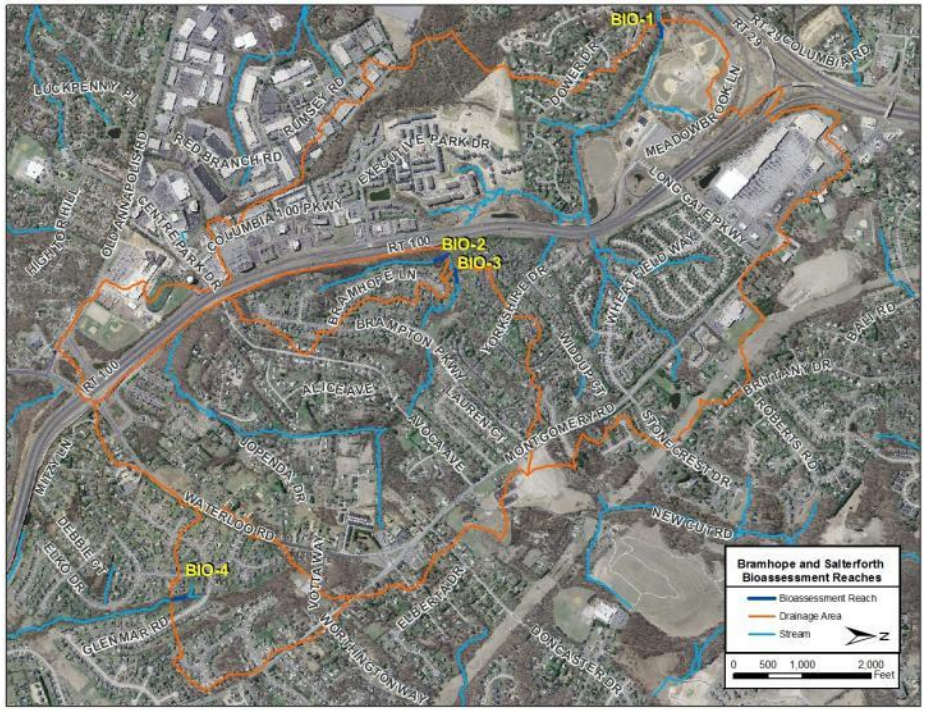
Biological Sampling

Benthic Macroinvertebrates

Physical Habitat

Biological Monitoring

- **Monitoring Stations**
  - **BIO-1: Downstream Reach**
  - **BIO-2: Restoration Reach**
  - **BIO-3: BMP Retrofit Reach**
  - **BIO-4: Control Reach**



Biological Monitoring

- **Biological conditions stable across the two years**
- **BIO-2 showed additional degradation in 2011**
- **All sites with degraded benthic communities**

SITE	2010 BIBI		2011 BIBI	
BIO-1	1.67	Very Poor	1.67	Very Poor
BIO-2	2.67	Poor	1.67	Very Poor
BIO-3	2.33	Poor	2.33	Poor
BIO-4	1	Very Poor	1.67	Very Poor

Physical Habitat Assessment

- **Physical Habitat Assessment scores consistently indicate degraded conditions across all sites and years**

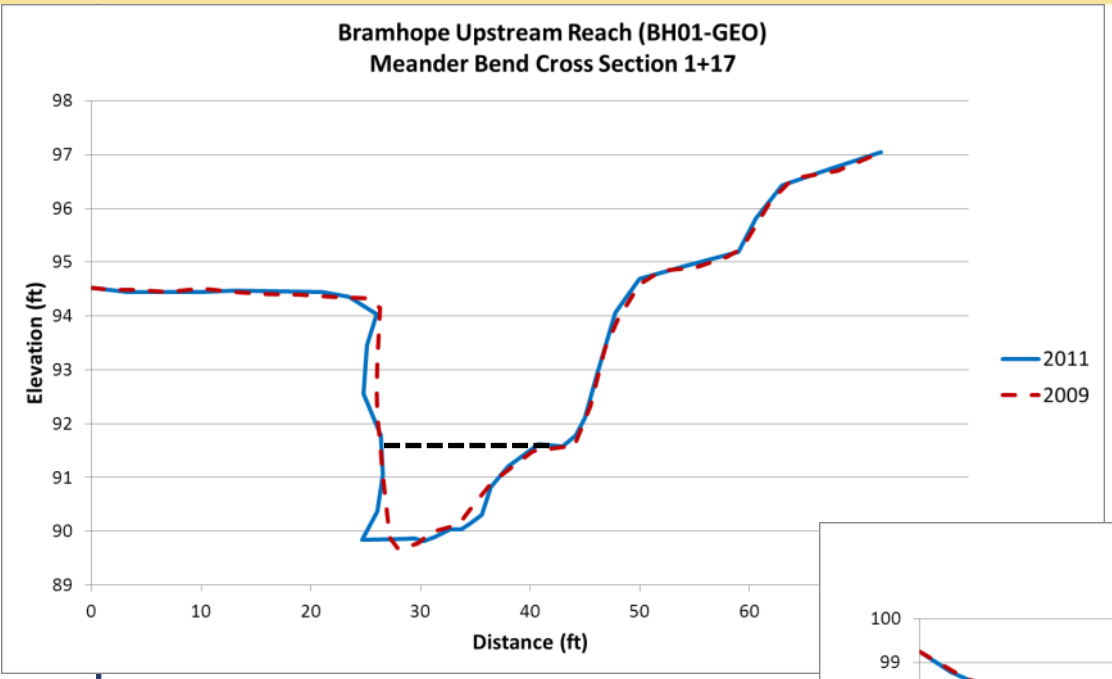
Site	2010 RBP		2011 RBP	
BIO-1	58.5	Non-Supporting	58.6	Non-Supporting
BIO-2	60	Partially Supporting	59.7	Non-Supporting
BIO-3	60	Partially Supporting	72.4	Partially Supporting
BIO-4	60.5	Partially Supporting	65.8	Partially Supporting

Geometry and Profile

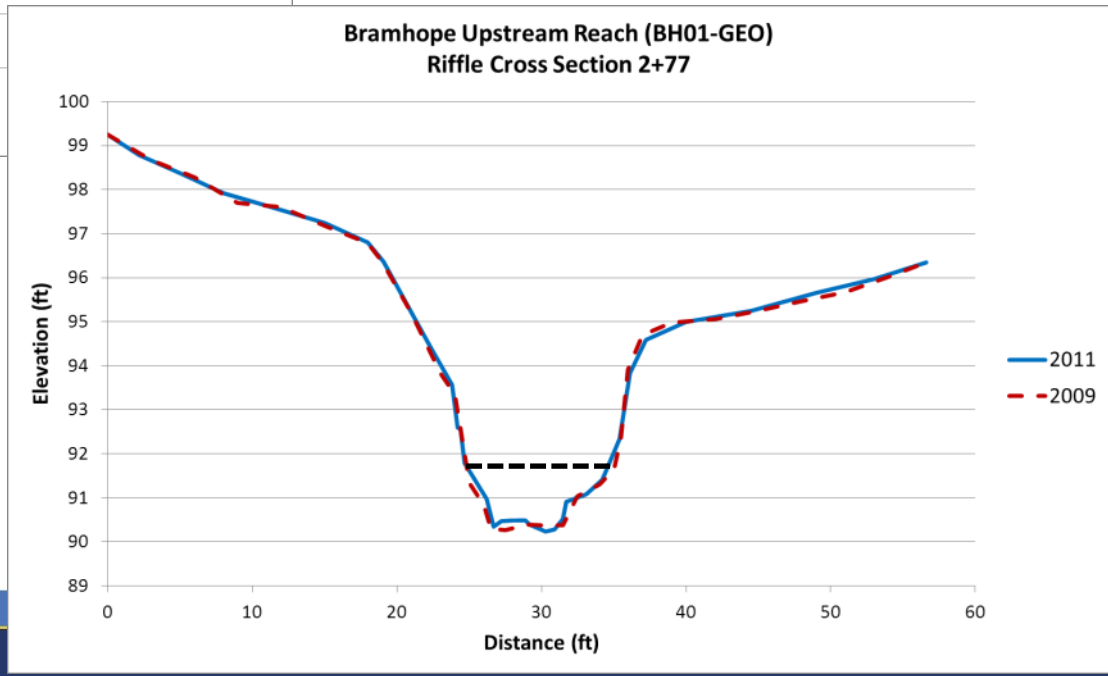
Cross-section

Longitudinal Profile

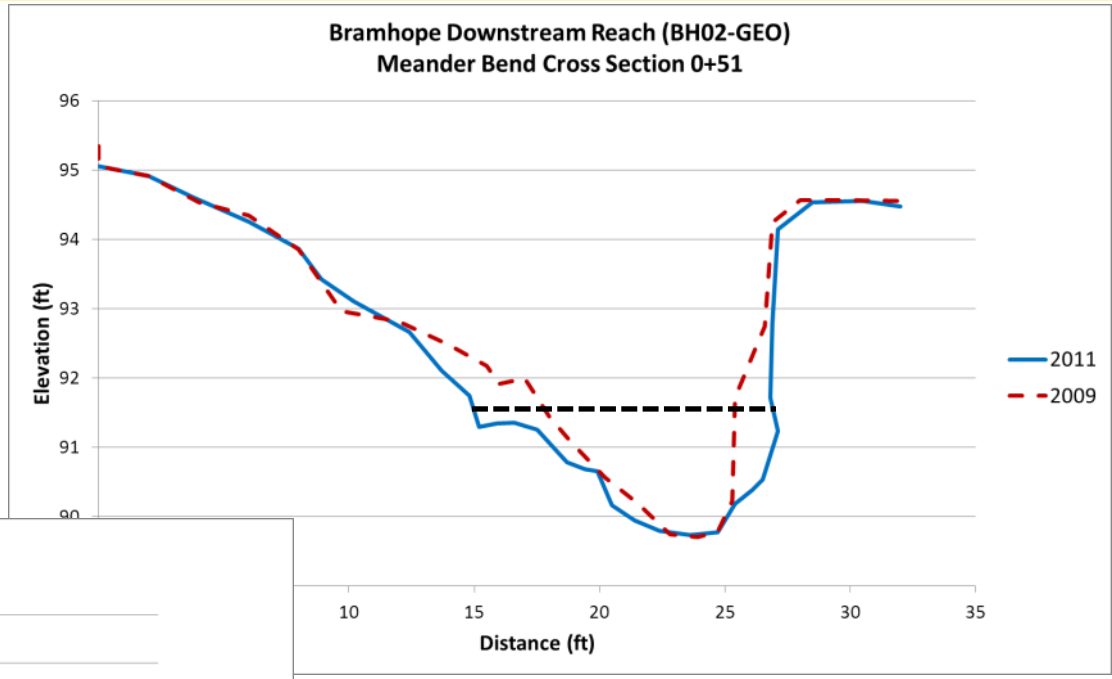
Cross Section Comparisons

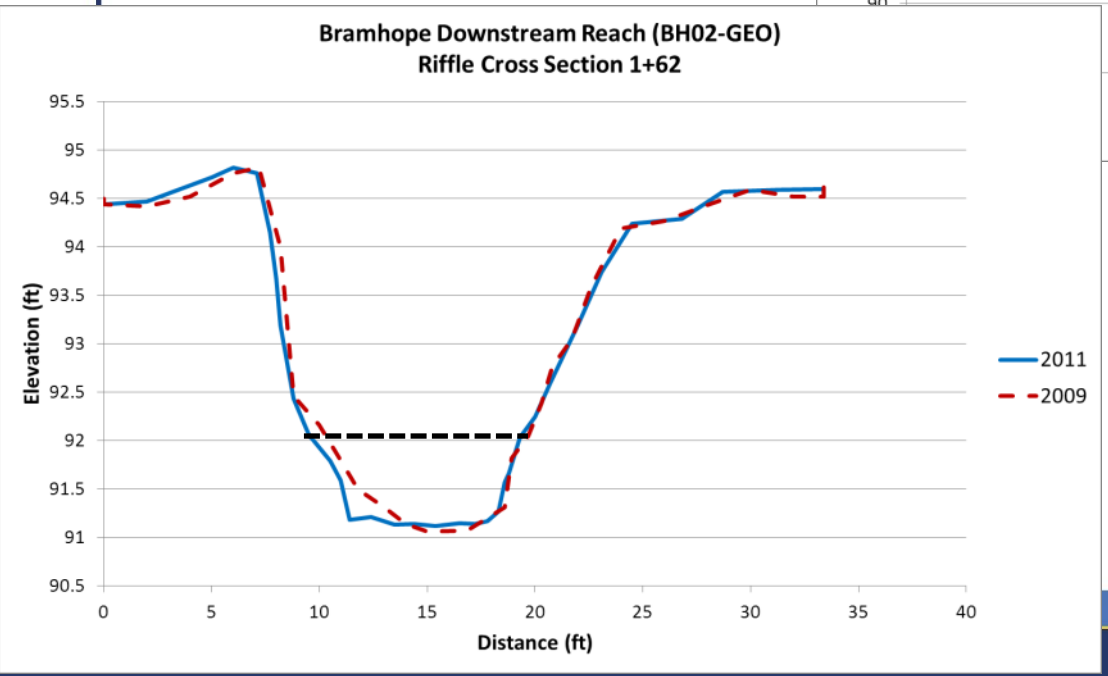


- **Enable evaluation of changes in**
  - **Bed Stability**
  - **Channel Enlargement**
  - **Lateral Accretion**

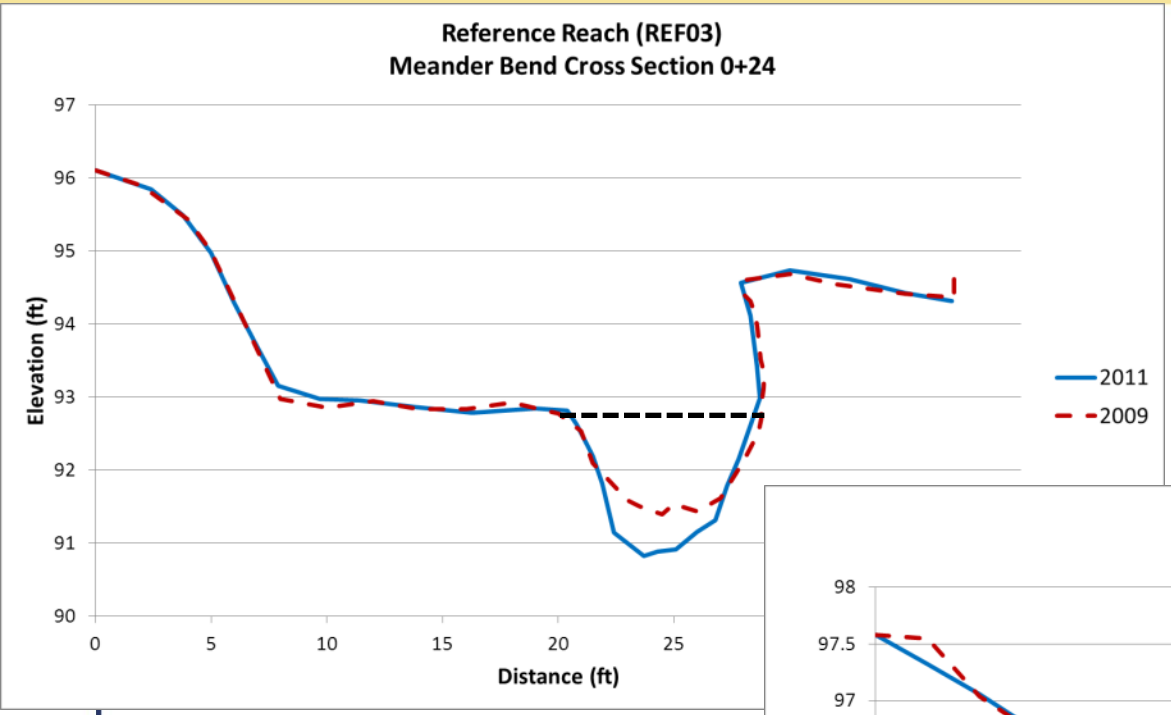


Cross Section Comparisons



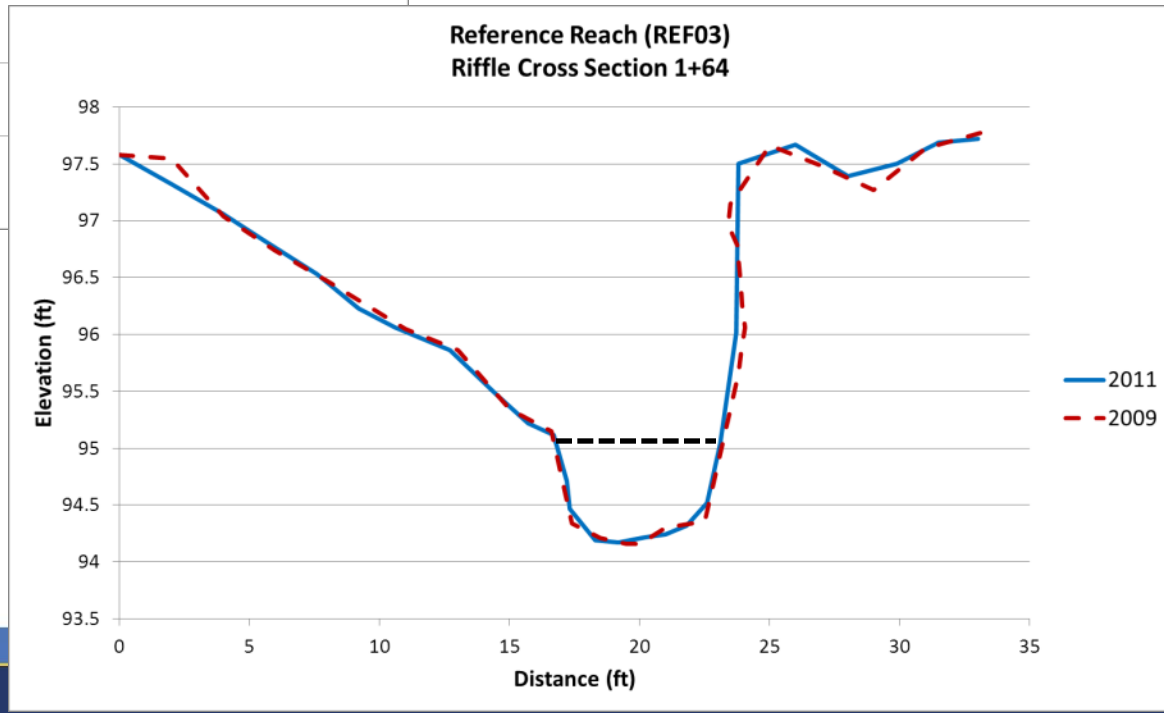


Cross Section Comparisons



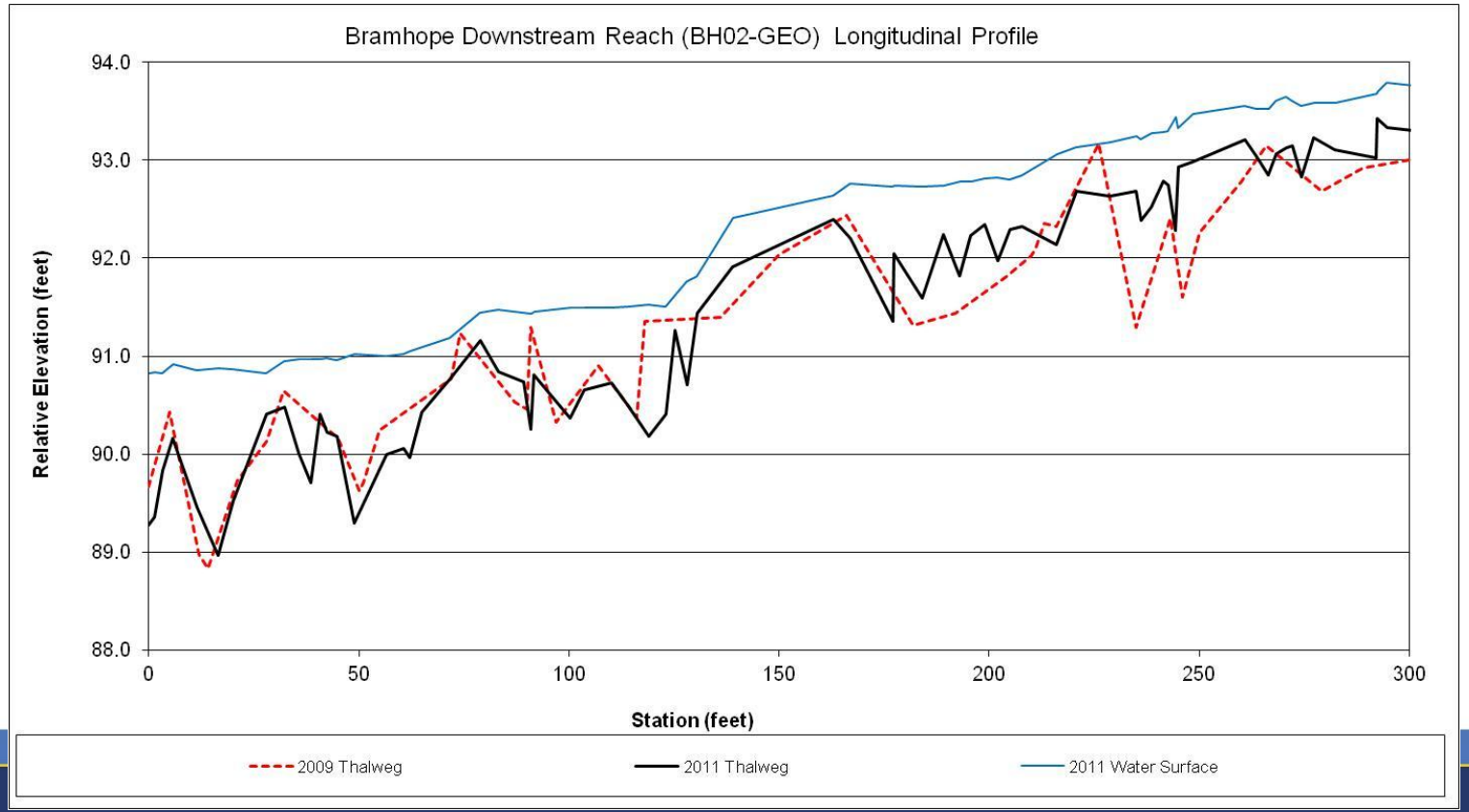
- Over the course of 1.5 years, all meander bends losing material from bed and/or banks

- Riffles remain relatively unchanged



Longitudinal Profiles

- **Enable evaluation of changes in**
  - **Slope**
  - **Bed features**
  - **Aggradation/Degradation**



Channel Substrate Composition

Substrate Facies Mapping

Pebble Count and Bulk Bar Samples

Sediment Facies Data

- Quantify percentages of facies types in reach
- Compare proportions of dominant substrate types over time
- Map areas of accumulated fine sediment and observe transport through reach

Bramhope Reference Reach - REF03 10/30/09

Station (ft)	Facies/ Feature		
300	G	G	G
295	G	G	G
290	R	R	R
285	R	R	R
280	N	N	N
275	N	N	N
270	R	R	R
265	R	R	R
260	R	R	R
255	R	R	R
250	R	R	R
245	P	P	P
240	P	P	P
235	P	P	P
230	P	P	P
225	G	G	G
220	G	G	G
215	G	G	G
210	G	G	G
205	N	N	N
200	N	N	N
195	N	N	D
190	R	R	R
185	N	N	N
180	N	N	N
175	D	N	N
170	D	R	R
165	D	R	R
160	P	P	P
155	P	P	P

Station (ft)	Facies/ Feature		
150	R	R	R
145	R	R	R
140	P	P	P
135	D	P	P
130	D	P	P
125	R	R	R
120	R	R	R
115	N	N	D
110	P	P	D
105	P	P	D
100	R	R	D
95	N	N	D
90	D	N	N
85	D	N	N
80	D	N	N
75	D	P	P
70	D	R	R
65	D	N	N
60	N	N	N
55	N	N	N
50	N	N	N
45	P	P	D
40	P	P	D
35	N	N	D
30	N	N	D
25	N	N	D
20	R	R	D
15	P	P	D
10	P	P	D
5	R	R	R

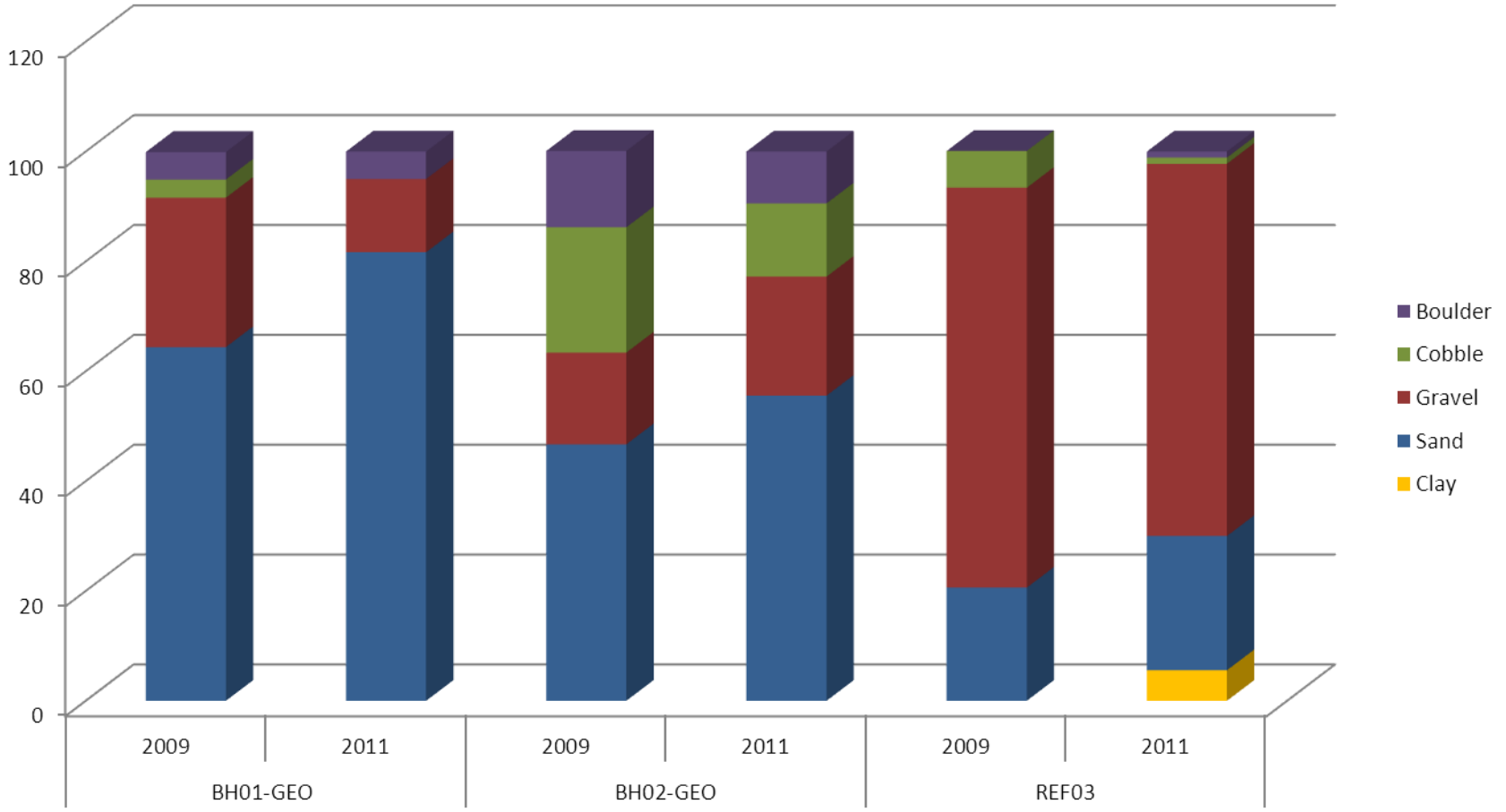
Facies ID	Facies Type	Percent Composition	Count	Percent of Reach
	S	100	9	5.0
	gS	20/80	5	2.8
	gS	30/70	10	5.6
	gS	40/60	5	2.8
	cgS	10/30/60	8	4.4
	sG	20/80	40	22.2
	sG	30/70	31	17.2
	sG	40/60	28	15.6
	csG	10/40/50	4	2.2
	scG	20/20/60	12	6.7
	scG	10/30/60	8	4.4
	sbG	10/30/60	8	4.4
	sgC	20/30/50	3	1.7
	bgC	20/30/50	9	5.0
		TOTAL	180	

Facies Key	
s, S =	sand
g, G =	gravel
c, C =	cobble
b, B =	boulder

Feature Key	
D	depositional bar
R	riffle
N	run
P	pool
G	glide

Dominant Substrate	Count	Percent of Reach
sand	37	20.6
gravel	131	72.8
cobble	12	6.7
boulder	0	0.0

Facies Composition Comparison

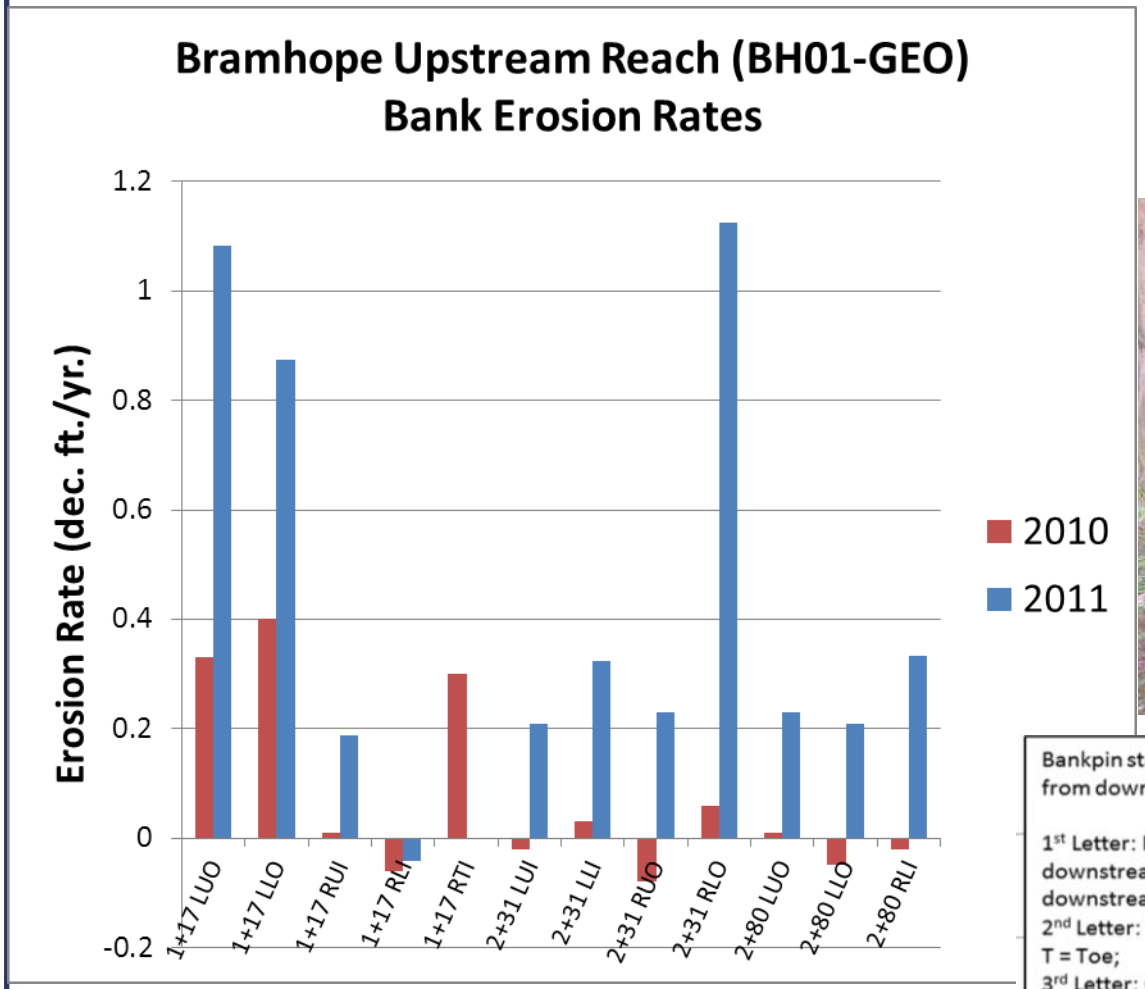


Bed and Bank Erosion

Bank Pins

Scour Chains

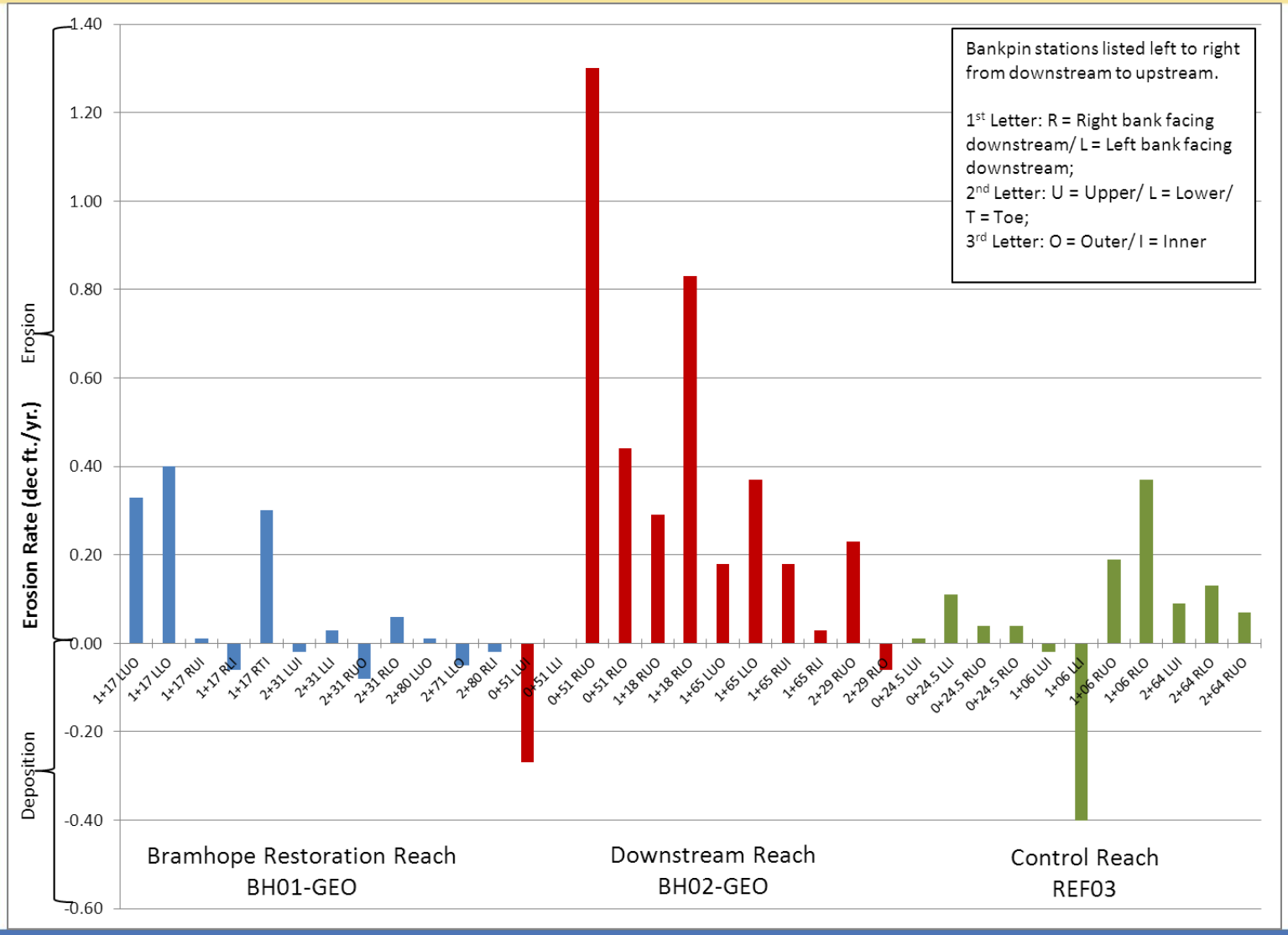
Example Bank Pin Data



Bankpin stations listed left to right from downstream to upstream.

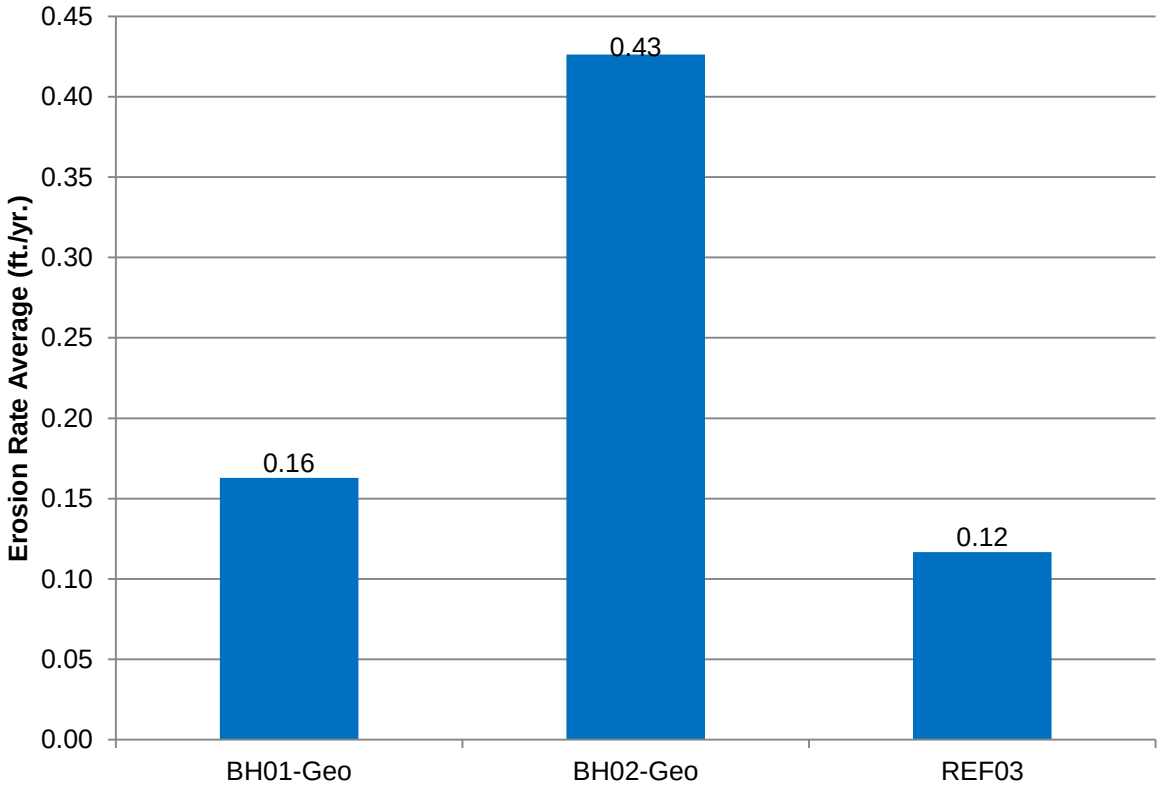
1st Letter: R = Right bank facing downstream/ L = Left bank facing downstream;
2nd Letter: U = Upper/ L = Lower/ T = Toe;
3rd Letter: O = Outer/ I = Inner

Example Bank Pin Data



Example Bank Pin Data

Average of Erosion Rates Measured (2010)



Summary

Parameter	Condition
Biology	Poor to Very Poor
Physical Habitat	Non-Supporting
Pollutant Loading	TN – High throughout TP – High downstream / storm TSS – High downstream / storm Sediment – High volumes
Channel Stability	Unstable – actively widening
Channel Substrate	Highly Mobile - sands

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