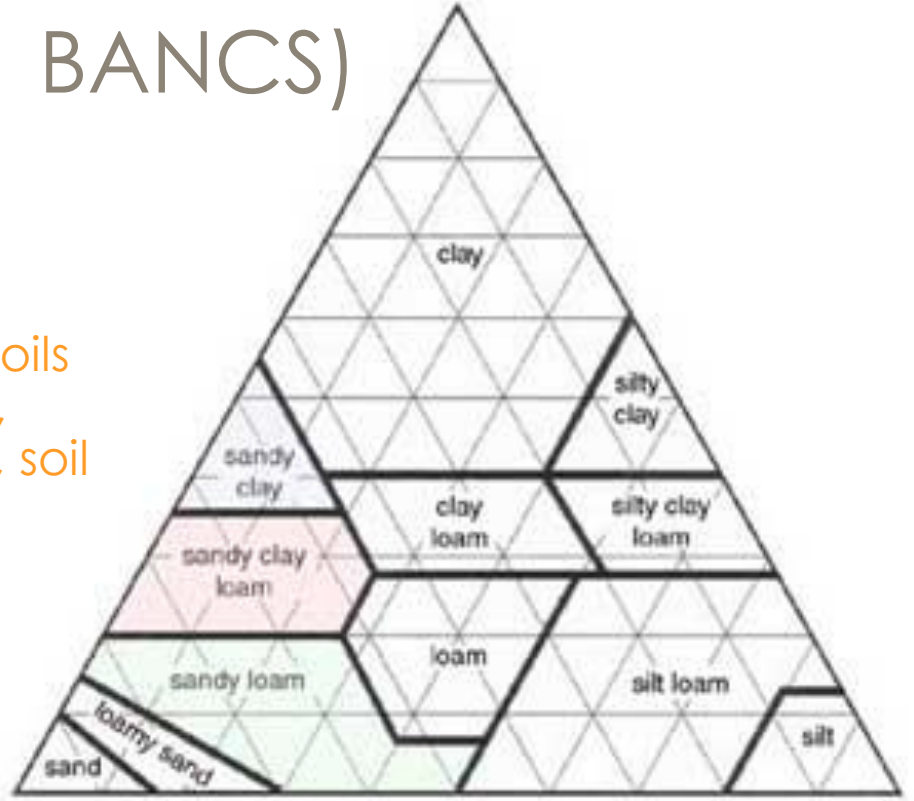
Default Nutrient Concentration in Stream Bank Soils (P1 BANCS)

One Size fits all?

1.05 lbs TP/1 ton Sediment

Nutrient Concentration in stream bank soils can vary widely depending on soil type, geology, vegetation, historical land use, soil applications, and other factors



➢ Protocol 1 – Prevented Sediment

Acceptable Approaches:

- BANCS Method (BEHI/NBS) for yearly tonnage with default concentration of 1.05 lb/ton P, 2.28 lb/ton N
- Site monitoring with bank pins/toe pins/cross-sections, soil samples and precipitation monitoring
- Alternative Modeling Approach

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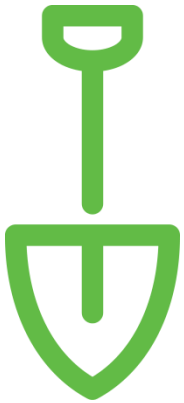
Protocol 1 – Two Test Case Examples



- **Test Case #1** – Lateral Stream Bank Erosion Rate

  Comparison of:

  a.) Default Removal Rate

  b.) Application of BANCS Method with default nutrient concentration values

  c.) Site monitoring of Stream Bank retreat rates over time with bank pins

- **Test Case #2** – Nutrient Concentrations in Stream bank Soils

  Comparison of:

  a.) Default Nutrient Concentration Value (cited in P1)

  b.) Measured Nutrient Concentration values

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Protocol 1 – Sediment Prevention

Test Case #1 – Lateral Stream Bank Erosion Rate

Test Case #1 – Example

Project Example:
Zombie Apocalypse

10'+ Headcut
12-24' Banks
No Vegetation left
Highly erodible soils
Just nasty

Protocol 1 Comparison

(Test Case #1)

Approved Default Removal Rate:

419 LF @ 0.068 lbs TP/ft/yr = 28.5 lbs TP/yr

419 LF @ 0.075 lbs TN/ft/yr = 31.4 lbs TN/yr

BANCS Method (using NC Curves & actual bank heights of 15 ft – 23 ft)

BEHI = Extreme; NBS = Moderate

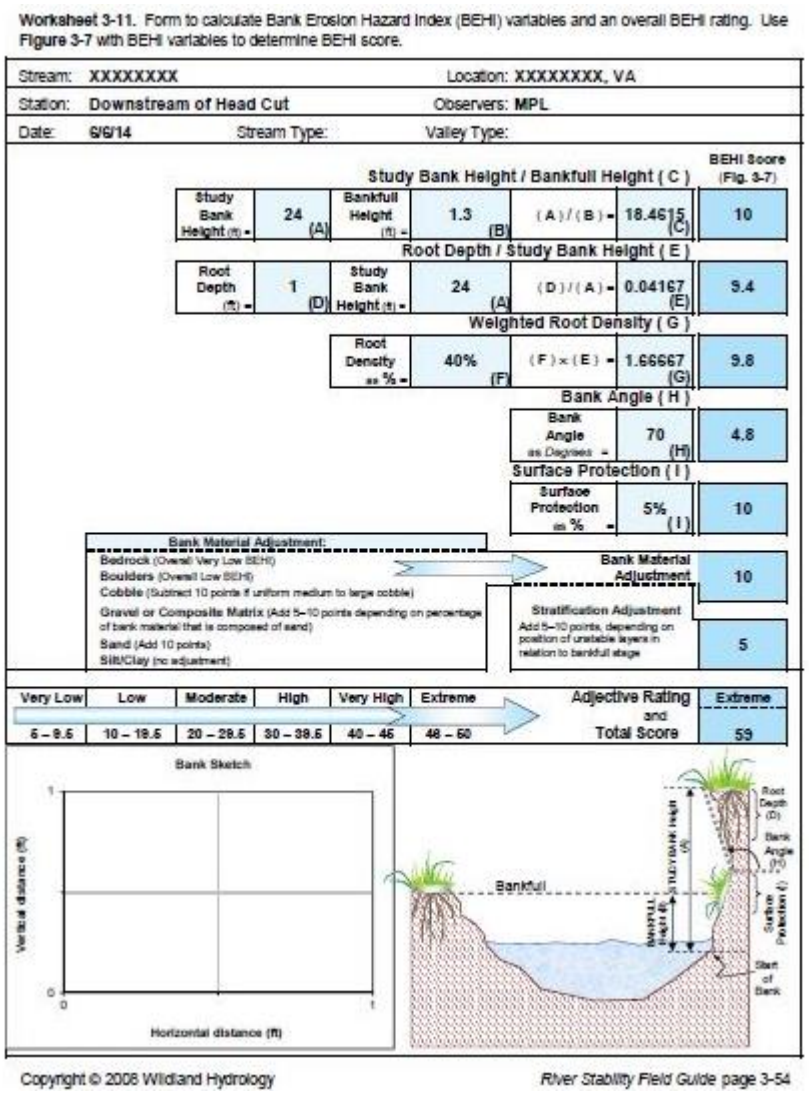
Total Erosion = 2518 Tons/Yr
(1322 lbs TP/yr, 2871 lbs TN/yr)*

*Using default concentrations, after 50% reduction

Modified BANCS (using NC Curves & reduced bank heights of 10' max)

Total Erosion = 1049 Tons/Yr
(551 lbs TP/yr, 1196 lbs TN/yr)*

*Using default concentrations, after 50% reduction



Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream: XXXXXXXX Location: XXXXXXXX, VA

Station: Downstream of Head Cut Observers: MPL

Date: 6/6/14 Stream Type: Valley Type:

						BEHI Score (Fig. 3-7)
Study Bank Height (C)						
Study Bank Height (ft) =	24 (A)	Bankfull Height (ft) =	1.3 (B)	(A)/(B) =	18.4615 (C)	10
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1 (D)	Study Bank Height (ft) =	24 (A)	(D)/(A) =	0.04167 (E)	9.4
Weighted Root Density (G)						
Root Density as % =	40% (F)			(F)x(E) =	1.66667 (G)	9.8
Bank Angle (H)						
Bank Angle as Degrees =	70 (H)					4.8
Surface Protection (I)						
Surface Protection as % =	5% (I)					10

Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment: 10

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage: 5

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		59

Bank Sketch

Vertical distance (ft)

Horizontal distance (ft)

Bankfull

Root Depth (D)

Bank Angle (H)

Surface Protection (I)

Start of Bank

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River Stability Field Guide page 3-54

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Monitoring Needed

(Test Case #1)

- Network of Bank Pins
- Soil Concentrations
- Rainfall Observation
- ½ year – No Bankfull events (conservative)

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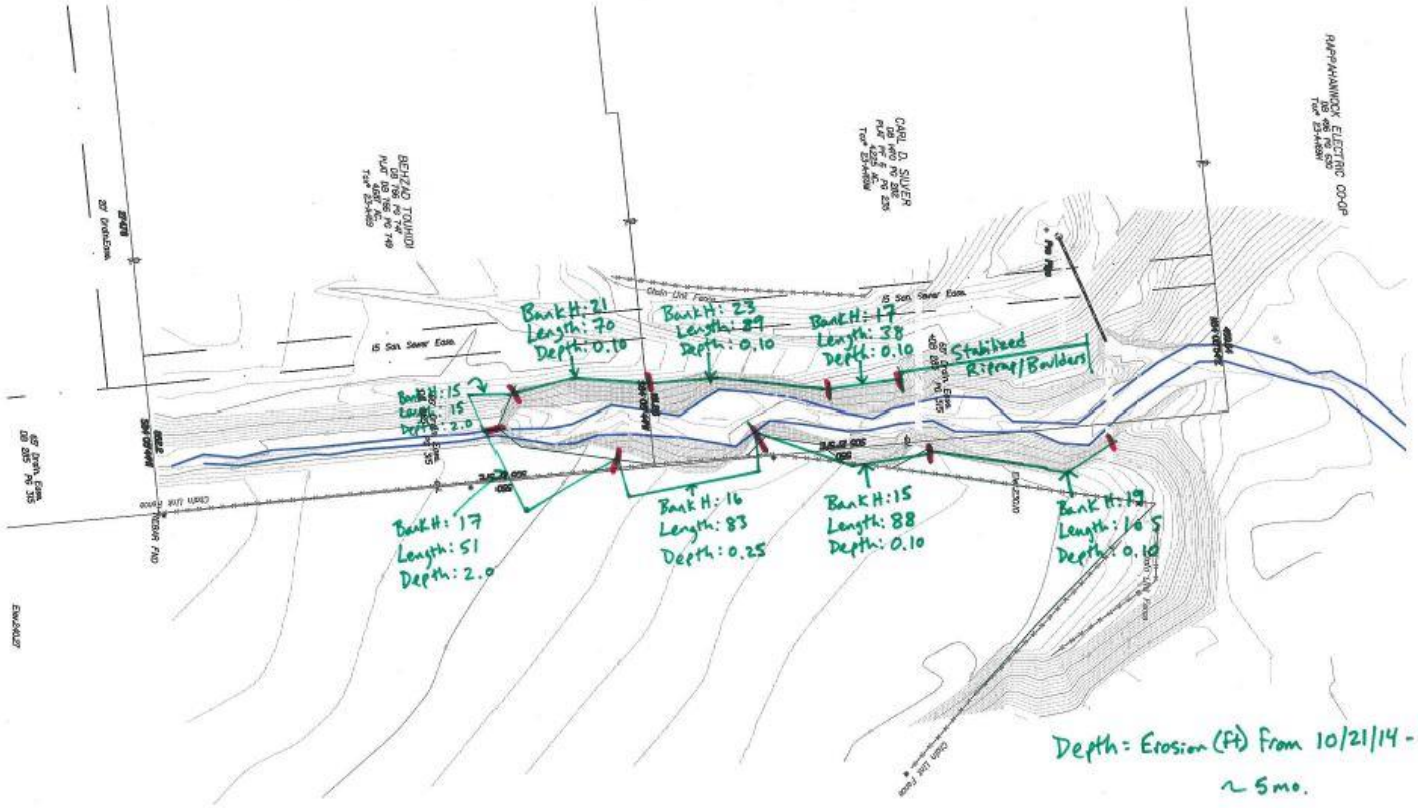
7621 Whitepine Road Richmond, Virginia 23237 (804) 743-9401 Fax (804) 271-6446
www.aleastern.com

REPORT OF ANALYSIS

Lab No	Sample ID Sample Date and Time	Nitrogen, Total (Inorganic + [illegible]) CALCULATION	Total Kjeldahl Nitrogen SM-4500-NH3C-TKN	Total Phosphorus SW 6010C
			ppm	
07099	1	821	820	155
07100	2	281	280	< 100



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CBPO Protocol 1

Page 33 :

"Monitoring through methods such as cross section surveys or bank pins is the preferred approach…"

Page 36 :

"The Panel felt that efficiencies greater than 50% should be allowed for projects that have shown through monitoring that the higher rates can be justified subject to approval by the states. This will hopefully promote monitoring (e.g., Big Spring Run in Pennsylvania) of stream restoration projects."

Monitoring Results
(Test Case #1)

Extrapolated for 1 year

Provided range using lower soils concentration

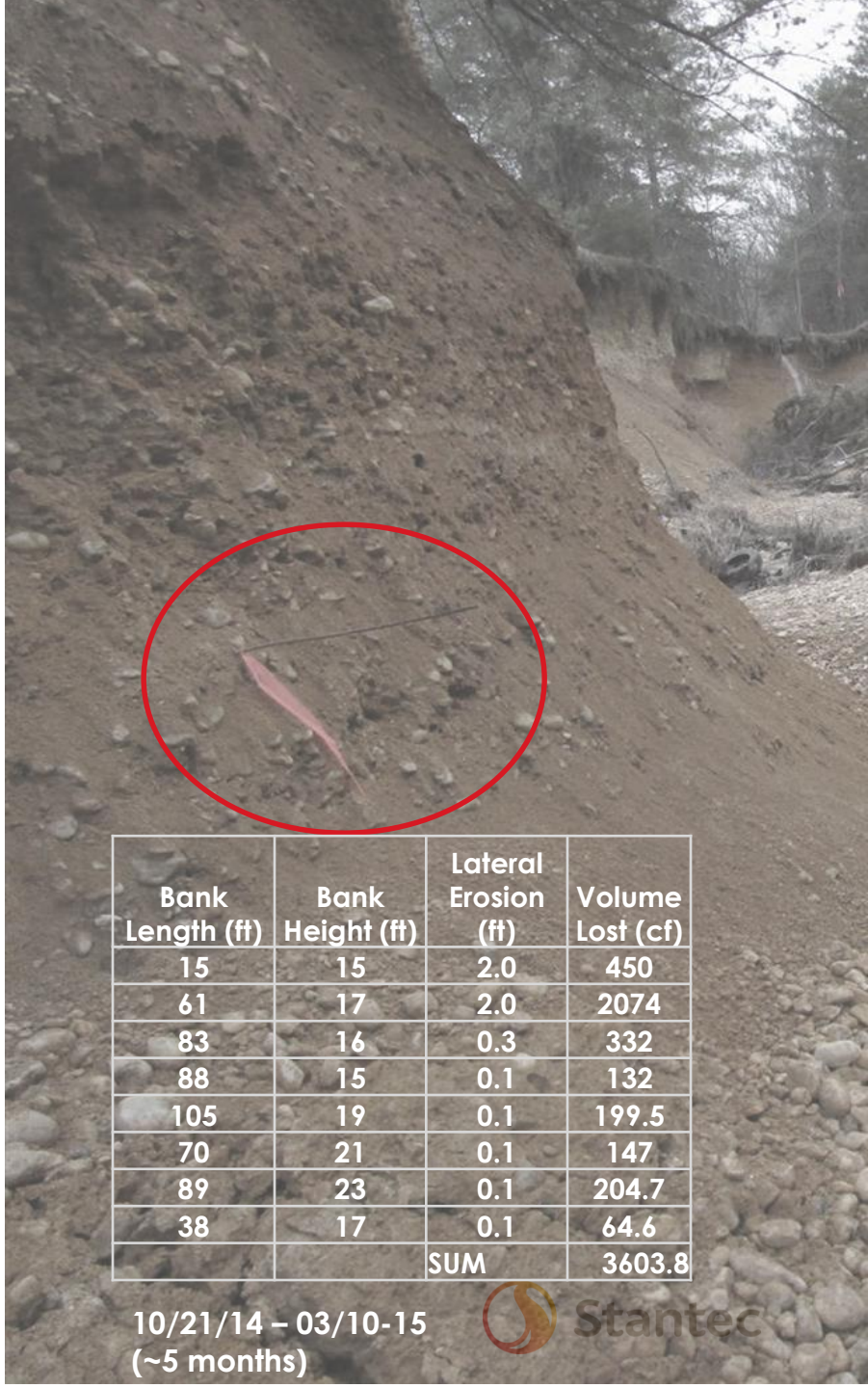
90% efficiency was estimated (rather then 50%)

	TP (lb/yr)		TN (lb/yr)[3]		TP Reductions (90%)[2]		TN Reductions (90%)[3]	
	Low[1]	High[1]	Low	High	Low	High	Low	High
Soil Sample 1	129.10	167.82	683.79	888.93	116	151	615	800
Soil Sample 2	83.29	108.27	234.04	304.25	75	97	211	274
Average	106.19	138.05	458.92	596.59	96	124	413	537

[1]Low vs. High values based on bulk densities of 96 lbs/ft3 from Rivermorph and 125 lbs/ft3 from Bay Protocol. Low and high bulk densities yield sediment erosion rates of 416.44 tons/year and 541.37 tons/year, respectively.

[2] The CBP TP concentration default value is 525 ppm versus the average measured value of 128 ppm used here. If the default concentration had been utilized instead, the TP annual reported reductions would have averaged approximately453 lbs/yr at 90% efficiency.

[3] The CBP TN concentration default value is 1,140 ppm versus the average measured value of 551 ppm used here. If the default concentration had been utilized instead, the TN annual reported reductions would have averaged approximately 983 lbs/yr at 90% efficiency.



Bank Length (ft)	Bank Height (ft)	Lateral Erosion (ft)	Volume Lost (cf)
15	15	2.0	450
61	17	2.0	2074
83	16	0.3	332
88	15	0.1	132
105	19	0.1	199.5
70	21	0.1	147
89	23	0.1	204.7
38	17	0.1	64.6
		SUM	3603.8

10/21/14 – 03/10-15
(~5 months)

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Monitoring Results
(Test Case #1)

#	Method Description	Notes	TP (lbs/yr)	TN (lbs/yr)
1	Default Removal Rate	Fixed Rate	28.5	31.4
2	BANCS	15 ft–23 ft bank hts	1322	2871
3	BANCS	10 ft max bank hts	551	1196
4	Monitoring (bank pins) @90%	w/ 525 ppm TP (default)	502	1090
5	Monitoring (bank pins) @90%	w/ 128 ppm TP (measrd)	110	475

Zombie Apocalypse

(Test Case #1)

- Phosphorous : $15,000 LB in WS
- Phosphorous value (110 LB TP@ $15K = $1.65M)
- Project Implementation : $700K (includes construction and soft cost)
- Project Cost per pound ($700k/111lb TP= $6,364 lb TP)
- Cost to monitor & produce justification $5,000

- Having data to support your MS4? : Priceless

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Protocol 1 – Sediment Prevention

Test Case #2 – Nutrient Concentration in Stream bank Soils

➢ Protocol 1 – Sediment Prevention

(Test Case #2 – Nutrient Concentrations in Stream bank Soils)

- **CBPO Default TP concentration:**

Table 5. TN and TP Concentrations in Sediments in Different Parts of the Urban Landscape[1]

Location	Mean TP	TP Range	Mean TN	TN Range	Location	Reference
Upland Soils	0.18	0.01-2.31	3.2	0.2-13.2	MD	Pouyat et al., 2007
Street Solids	2.07	0.76-2.87	4.33	1.30-10.83	MD	Diblasi, 2008
Catch Basin [3]	1.96	0.23-3.86	6.96	0.23-25.08	MD	Law et al., 2008
BMP Sediments	1.17	0.06-5.51	5.86	0.44-22.4	National	Schueler, 1994
Streambank Sediments	0.439	0.19-0.90	--	--	MD	BDPW, 2006
	1.78		5.41		MD	Stewart, 2012
	1.43	0.93-1.87	4.4	2.8-6.8	PA	Land Studies, 2005 [2]
	1.05	0.68-1.92	2.28	0.83-4.32	PA	Walter et al., 2007 [2,4]

[1] all units are lb/ton
[2] the Pennsylvania data on streambank sediments were in rural/agricultural subwatersheds
[3] catch basin values are for sediment only, excluding leaves
[4] median TN and TP values are reported

1.05 lbs TP/ton sediment (~525mg/kg) selected as CBPO default value for ALL projects. However, range is **0.19 – 1.92 (10 x)**

- **2013 White Paper Sample Findings:**

Looked at 16 past Restoration Reaches w/ 124 bankline soil samples

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Protocol 1 – Sediment Prevention

(Test Case #2 – Nutrient Concentrations in Stream bank Soils)

Appendix C. Nutrient Concentrations in Stream Bank Soils

Project Number	Location by Physiographic Province	Test Year	# Samples	Total N Conc. Range (ppm)	Total N Conc. Avg. (ppm)	Total P Conc. Range (ppm)	Total P Conc. Avg. (ppm)
1	Coastal Plain	2013	2	n/a	n/a	<100-504	302
2	Coastal Plain	2011	n/a	n/a	n/a	n/a	133
3	Coastal Plain	2011	5	n/a	n/a	<100-138	112
4	Coastal Plain	2011	5	n/a	n/a	168-204	189
5	Coastal Plain	2011	5	n/a	n/a	<100-188	136.6
6	Coastal Plain	2011	5	n/a	n/a	<100-249	164
7	Coastal Plain	2013	1	n/a	n/a	103	103
8	Coastal Plain	2013	1	n/a	n/a	<100	100
9	Piedmont, lowlands	2010	4	120-890	445	40-130	90
10	Piedmont, lowlands	2010	4	40-560	255	50-100	65
11	Piedmont, lowlands	2010	4	50-660	273	20-180	130
12	Piedmont, lowlands	2010	2	200-290	245	40-110	75
13	Coastal Plain	2011	10	30-1560	340	109-2120	568
14	Piedmont, upland	2008	12	n/a	n/a	10-200	101
15	Piedmont, upland	2008	48	n/a	n/a	100-740	280
16	Piedmont, upland	2009	16	n/a	n/a	10-150	61
TOTAL			124				
AVERAGE					312		163
MEDIAN					273		121

NOTE 1: Soil concentrations reported as "<100" reported here as 100; therefore actual average will be less.

NOTE 2: All samples tested at A&L Eastern Laboratories in Richmond, VA.

NOTE 3: Project 9, 10, 11, and 12 are at one project location, which contained 4 physically disparate reaches grouped into a large watershed.

NOTE 4: In all cases, USEPA SW-846 method was used to measure Total Phosphorus

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Protocol 1 – Sediment Prevention

(Test Case #2 – Nutrient Concentrations in Stream bank Soils)

- **WEG (Stantec) 2013 White Paper Findings:**

Number of Projects	Sample Locations by Physiographic Province[1]	Test Year	Total # of Samples[1]	TKN Conc. Range (lbs TN/ton SED)[2]	TKN Conc. Avg. (lbs TN/ton SED)	TP Conc. Range (lbs TP/ton SED)[2]	TP Conc. Avg. (lbs TP/ton SED)
16	Piedmont lowland & upland, Coastal Plain	2008-2013	124	0.06-3.12	0.62	0.02-4.24	0.33

[1] All projects in tidewater and northern Virginia; most projects tested 2-5 samples; three projects contained a large number of samples;

[2] TKN as Total Kjeldahl Nitrogen; TP tested with USEPA SW-846 method; total samples for TKN less than TP

[3] All samples tested at A&L Eastern Laboratories in Richmond, VA and reported as ppm; results coverted to lbs/ton of SED by WEG.

Summary:

124 sample Average = **0.33 lbs** TP/Ton Sediment w/ range of 0.02 – 4.24 (vs. **1.05 lbs** TP/Ton Sediment CBPO default)

(High value is 100 x greater than low value)

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Test Case #2 - Nutrient Concentrations in Stream bank Soils (Example)

- Potential Mitigation Bank Located in the Piedmont
- Required to show uptick in water quality value to proceed
- Spring-fed streams eroding into pasture, minimal wooded riparian corridor

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Quick Data needed

- Didn't have time to monitor the site for even ½ year.
- Performed a BANCS (NC Curve) : 358 tons/year
- Collected soil samples within the channel and in the field

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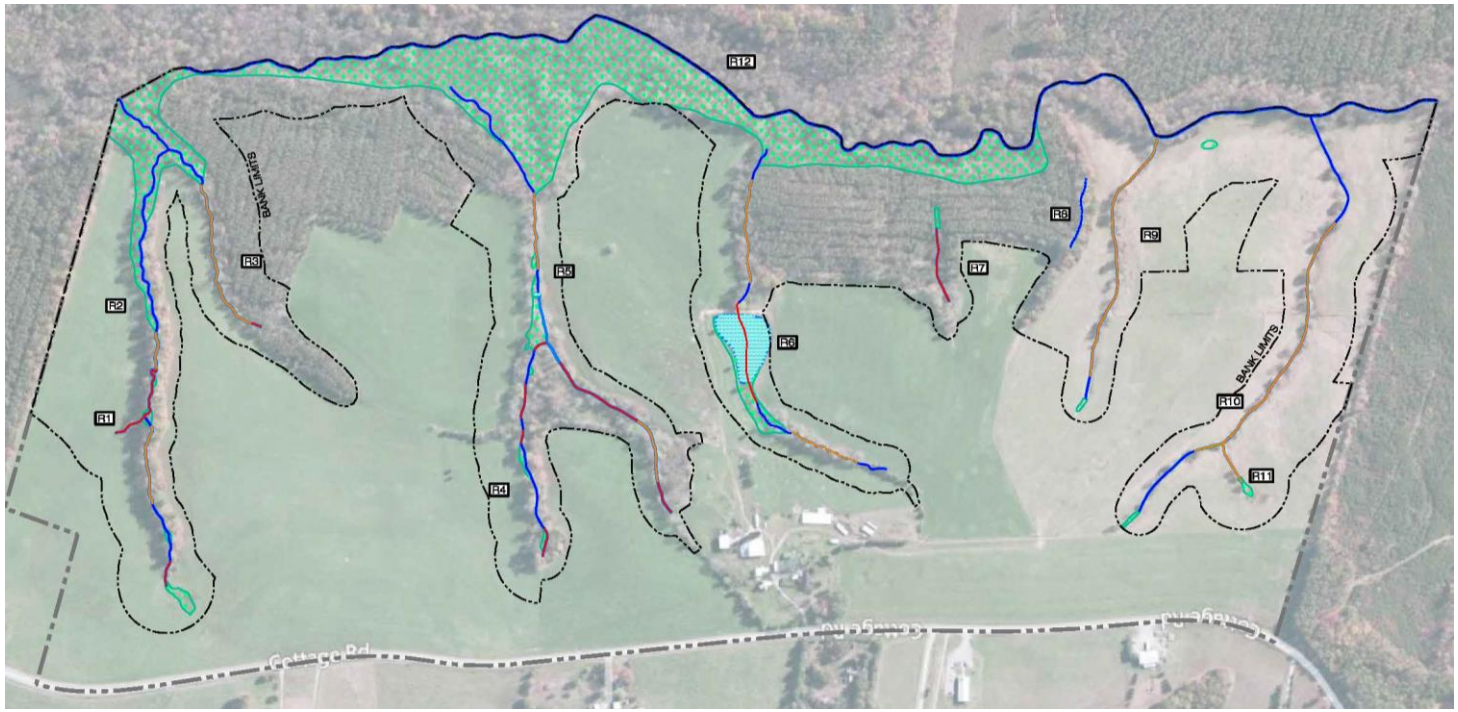
7621 Whitepine Road Richmond, Virginia 23237 (804) 743-9401 Fax (804) 271-6446
www.aleastern.com

REPORT OF ANALYSIS

Lab No	Sample ID Sample Date and Time	Nitrogen, Total (Inorganic + Organic) CALCULATION	Total Kjeldahl Nitrogen SM-4500-NH3C-TKN	Total Phosphorus SW 6010C
			ppm	
20787	COMPOSITE	2000	2000	1250
20788	SITE 1	1500	1490	325
20789	SITE 2	1600	1590	308
20790	SITE 3	933	930	309



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Results

- Soils within Woods:
  314 ppm TP, 1344 ppm TN
- Soils within the field:
  1250 ppm TP, 2000 ppm TN
- Need to consider the heads as a large percentage of nutrient input.
- Major difference in field vs woods?

Nutrient Contributions	Quantities
Erosion Rate (tons/yr)	358
Wooded Contributions	*(lb/yr)*
Total Phosphorus	224.8
Total Nitrogen	962.3
Field Contributions	*(lb/yr)*
Total Phosphorus	895.0
Total Nitrogen	1432.0

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Bio-solids!

Findings: Pluses and Minuses

- Default Removal Rate: Ok for Planning purposes, but final estimates should be based on site specific methods.
  - Default rate does not factor in bank height, severity of channel degradation, watershed land use, or soils and may over/under estimate SIGNIFICANTLY (10 x or more).
  - Could incentivize selection of streams w/ only minor degradation (same credit for <$). Over time, this could potentially lead to decreased reductions (lb/LF)

- Expert Panel SR Protocols: Does offer better approach to capture site specific conditions. Monitoring is best, both for sake of accuracy, but also may lift 50% efficiency cap, nearly doubling credit.

Findings: Pluses and Minuses

P1: Prevented Sediment

- BANCS: More site specific stream channel conditions and can be assessed in a short period of time. However, limited availability of regional Bank Erosion Rate Curves…and Hickey Run or NC? Selection can affect results by multiples (~4x). Need exists for local Bank Erosion Rate Curve(s).

- Nutrient Concentrations: Observed conc. in stream bank soils varied by multiple of 100 times (10 – 2100 ppm TP); Default value in CBPO may be high on average; actual is sometimes +/- and is site dependent. Sampling costs are very low ($25 lab fee).

- Monitoring (Toe/Bank Pins): Time consuming, more expensive, but…
  - **Greater Reductions** -Ability to measure/document much greater erosion in severely eroding streams;
  - **Search for 'Gross Pollutors'** - Encourages/rewards search for and fixes to the 'gross pollutors', aka the "Zombie Apocalypse"
  - **Increased Efficiency** - Able to increase efficiency (pre to post restoration), nearly doubling credit;
  - **Headcut Migration** - Able to capture reductions from repair of activity migrating headcuts . P1 (BANCS) accounts only for lateral erosion of existing centerline, not upstream migration
  - **Improved Accuracy** - Better science and encouraged by CBPO.