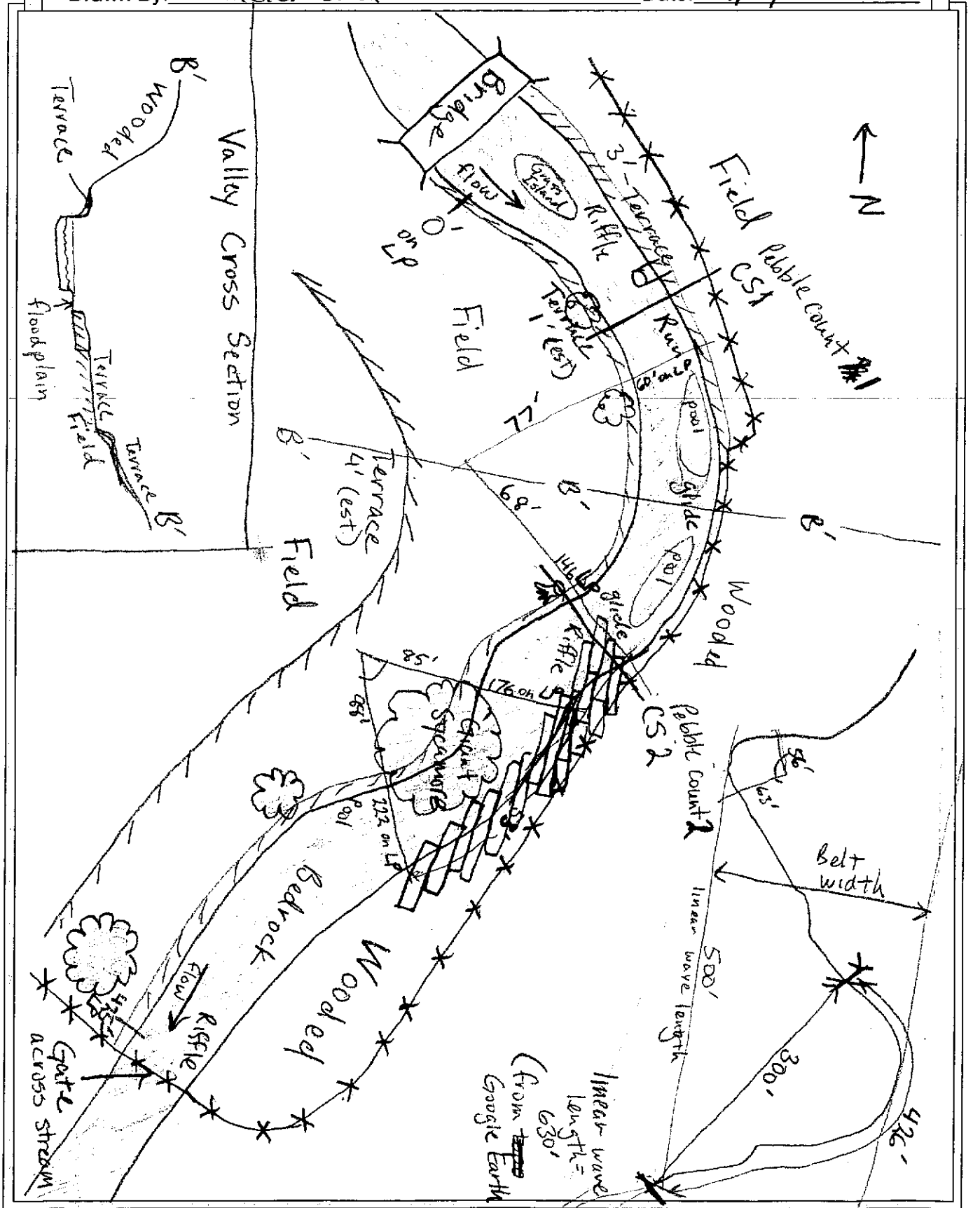
AREA-SITE LOCATION....REACH MAP

Stream/Drainage: Little Conocacheague Cr. Site/Reach: 4

Drawn By: Trometer et al Date: 4/11/17



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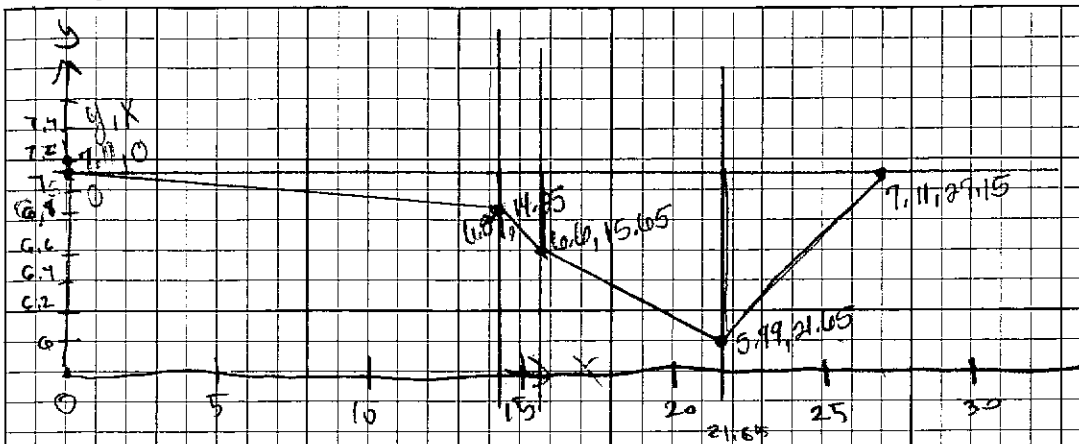
8.410 BF



$A_1 = \frac{B \times H/2}{0.24 \times 7.11/2} = 0.8532$

$A_2 = \frac{b_1 + b_2}{2} h = \frac{6.87 + 6.6}{2}(1.4) = 9.429$

$A_3 \; \frac{b_1 + b_2}{2} h = \frac{6.6 + 5.99}{2}(6) = 37.77$

$A_4 = \frac{B \times H/2}{1.12 \times 27.15/2} = 17.02848$

$A_1 = 2.304$
2.784 m

$A_2 = 2.415$
2.835 m

$A_3 = 2.065$
2.345 m

$A_4 = 11.49$
12.69 m

$A_5 = 9.13$
10.23 m

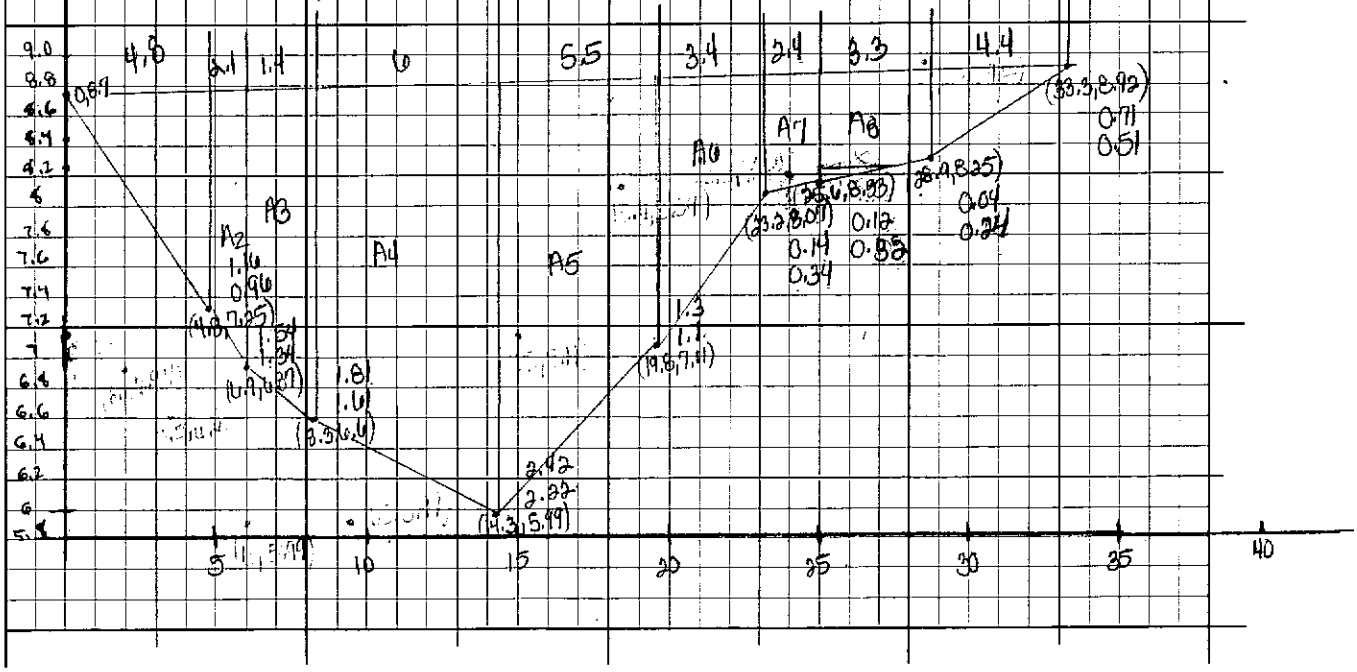
$A_6 = 2.108$
2.788 m

$A_7 = 0.09$
0.792 m

$A_8 = .$
.924 m

$A_9 = 1.122$ m

8.21
8.41



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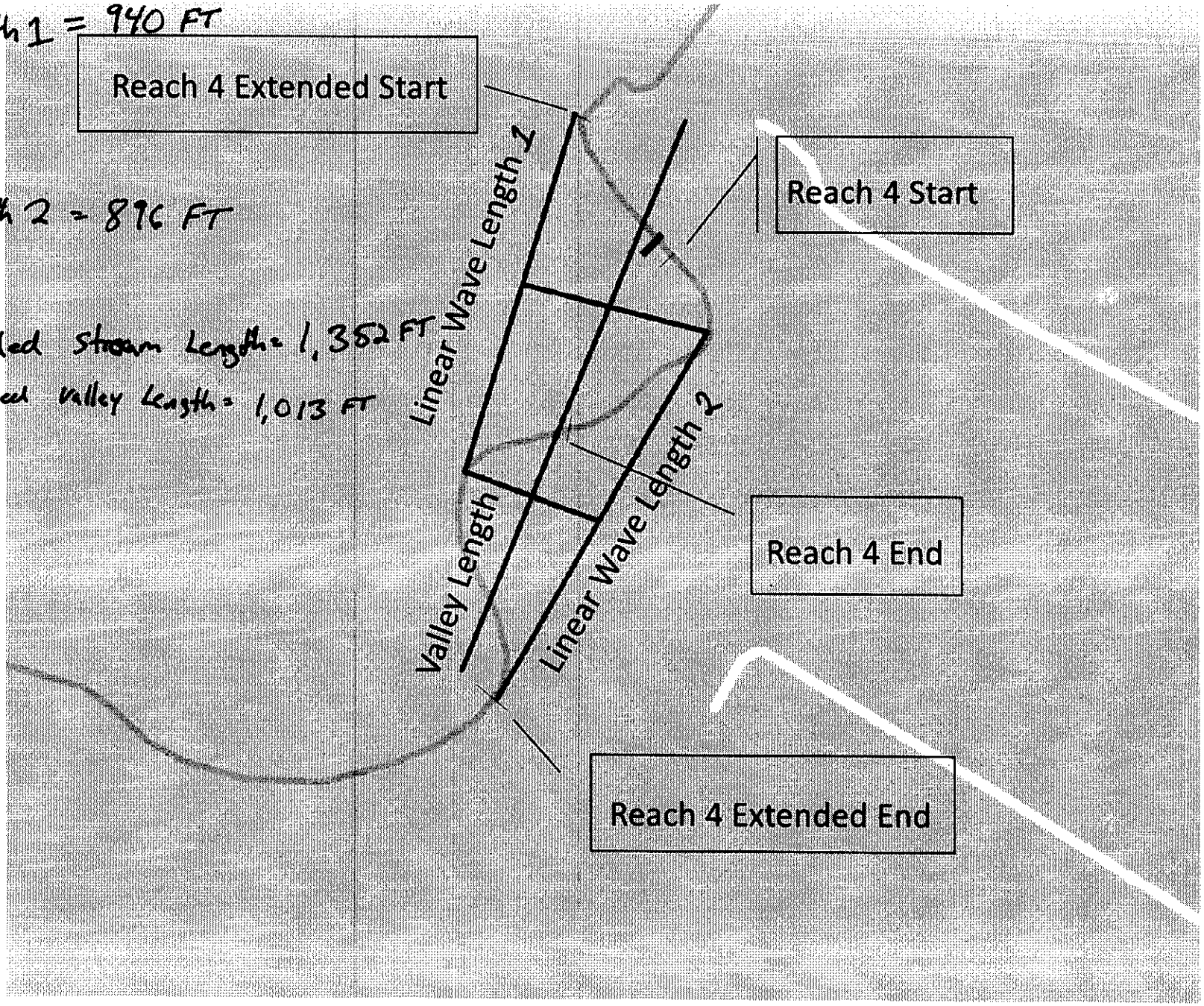
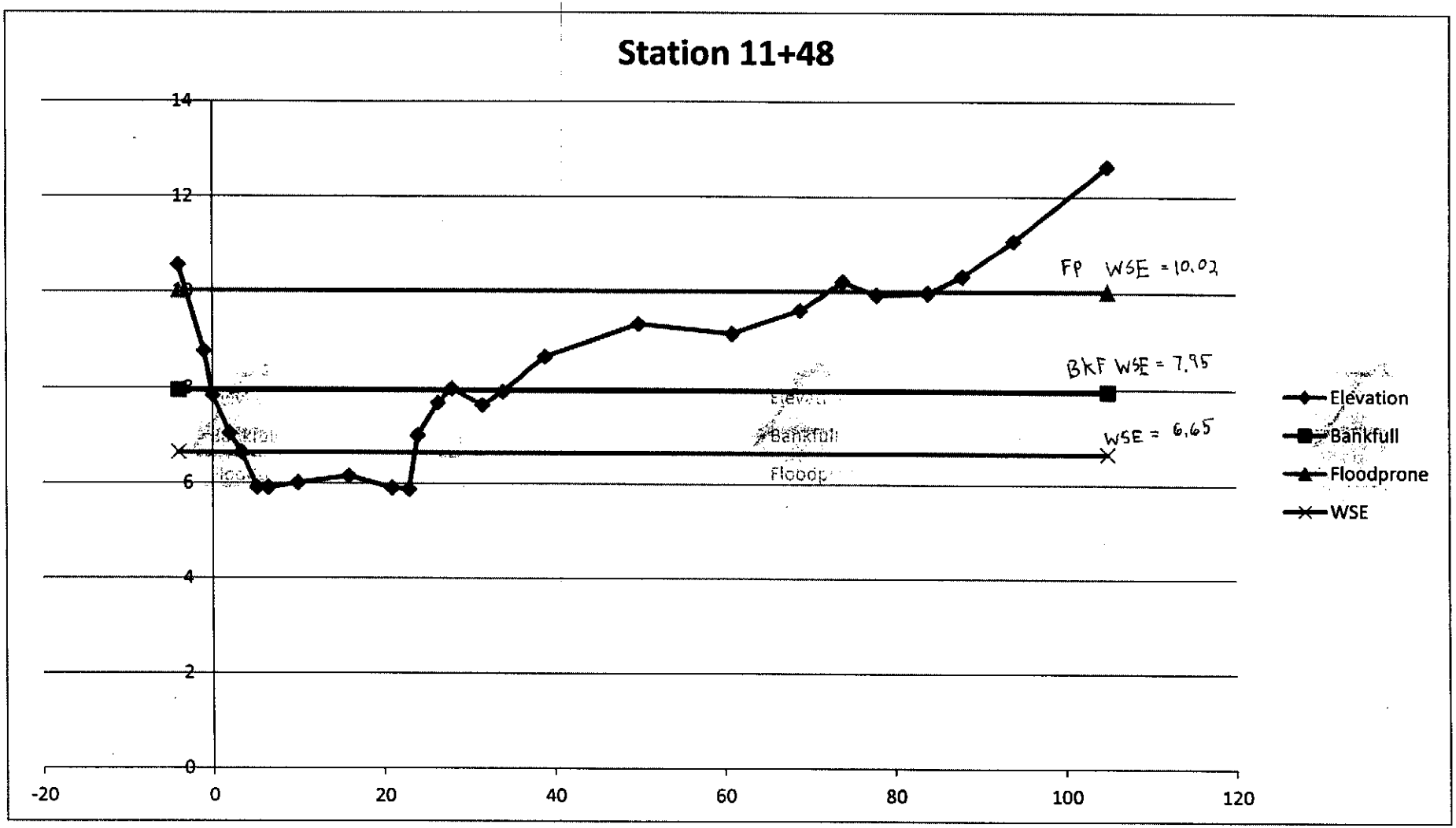
Linear Wave Length 1 = 940 FT

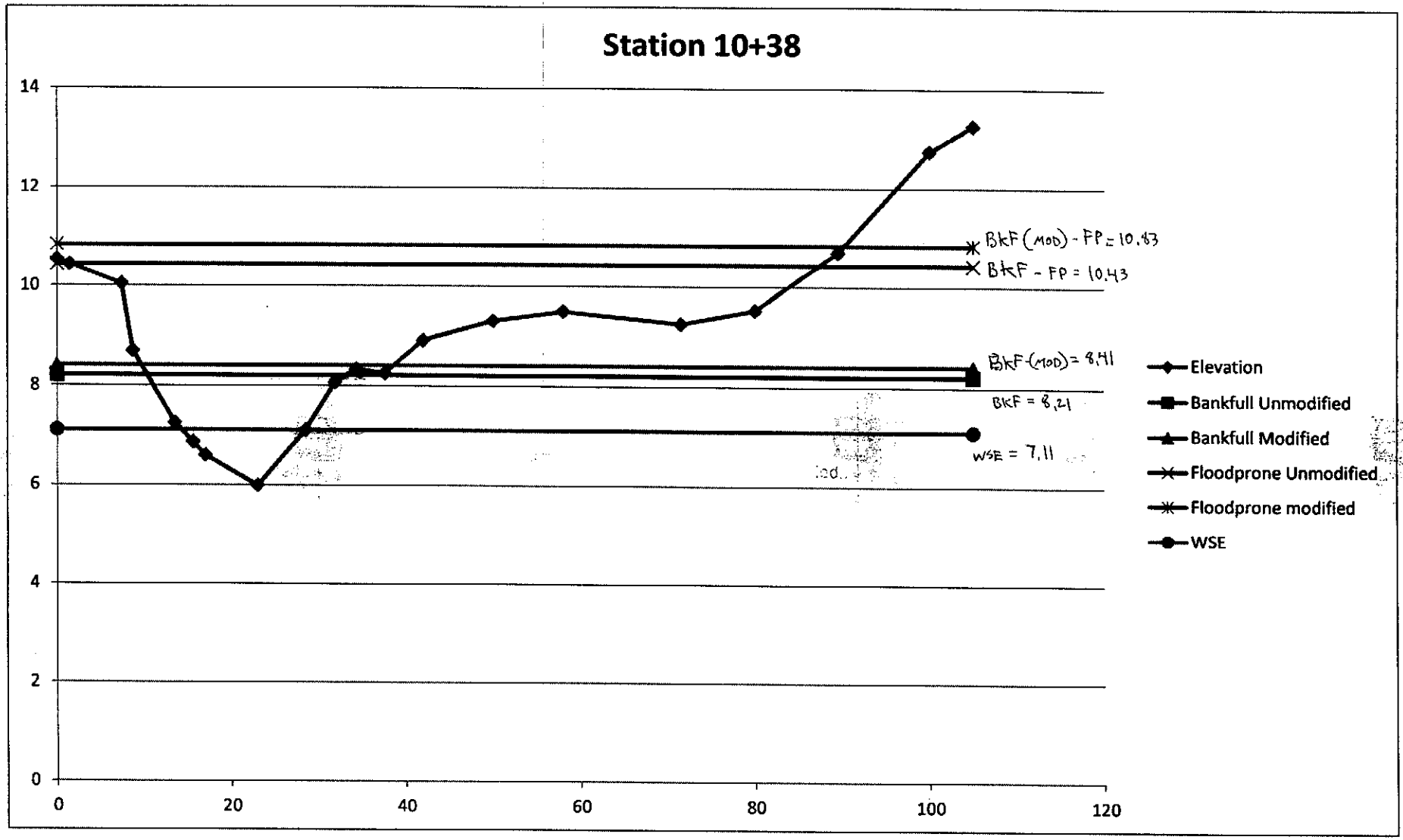
Linear Wave Length 2 = 896 FT

Reach 4 Extended stream Length = 1,382 FT

Reach 4 Extended valley Length = 1,013 FT




Station 11+48
14
12
10
8
6
4
2
0
-20
0
20
40
60
80
100
120
FP WSE = 10.02
BKF WSE = 7.95
WSE = 6.65
Elevation
Bankfull
Floodprone
WSE


Station 10+38
14
12
10
8
6
4
2
0
0
20
40
60
80
100
120
BkF (MOD) - FP = 10.83
BkF - FP = 10.43
BkF (MOD) = 8.41
BkF = 8.21
WSE = 7.11
Elevation
Bankfull Unmodified
Bankfull Modified
Floodprone Unmodified
Floodprone modified
WSE

SURVEY DATA ⟹ LONGITUDINAL PROFILE 1

SITE: LITTLE CONOCACHEAGUE CREEK Date: 4/11/17

Location: REACH 4

Observers: TEAM 4 HUC: _____

	Distance, Point, or	Back-Sight	Height of Instru-ment	Thalweg		Water Surface		Bankfull		Low Bank HI		NOTES
				Fore-Sight	Elevation	Fore-Sight	Elevation	Fore-Sight	Elevation	Fore-Sight	Elevation	e.g. Riffle Run Pool Glide
	STATION	BS	HI	FS	Elev.	FS	Elev.	FS	Elev.	FS	Elev.	
	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	
1	10+00	10.0	13.09	6.15	6.94	5.71	7.38					RIFFLE
2	10+08		5	6.22	6.87	5.75	7.34					
3	10+38			7.13	5.96	6.17	6.98	4.66	8.11			X-SEC 1
4	10+70			7.58	5.51	6.60	6.49					RUN
5	10+77			9.68	3.41	6.69	6.49					POOL
6	10+88			9.15	3.95	6.66	6.48			5.79	7.30	
7	10+96			8.36	4.73	6.59	6.50	5.64	7.45			'BREAK 1'
8	10+99			8.25	4.84	6.58	6.50					
9	11+06			7.90	5.19	6.61	6.48			6.15	6.94	'BREAK 2'
10	11+13			9.09	4.0	6.61	6.48					MID ~~POOL~~
11	11+30			7.76	5.33	6.63	6.46					GLIDE
12	11+45			7.28	5.81	6.69	6.40					RIFFLE
13	11+48			7.40	5.69	6.71	6.38	5.14	7.95			X-SEC 2
14												
15	11+81			8.07	5.02	7.16	5.93	*5.64	7.45			RUN
16	11+94			8.10	4.99	7.22	5.87					POOL
17	11+97			8.95	4.14	7.20	5.89					
18	12+17			6.62	6.47	7.21	5.88					RIFFLE ETC
19	12+37			9.02	4.07	7.27	5.82					
20	~~12+55~~			~~9.66~~	~~3.49~~	~~7.26~~	~~5.83~~	~~5.96~~	~~7.13~~			OMIT
21	12+77			10.27	2.82	7.38	5.71	6.00	7.09			
22												
23		3.81	13.81									
24	13+06			10.23	3.58	7.94	5.70					
25	13+38			10.41	3.40	7.96	5.68					
26	13+50			10.71	3.10	7.97	5.67	*6.55	7.26			GLIDE
27												

RESET

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SURVEY DATA → LONGITUDINAL PROFILE 2

SITE: LITTLE CONOCACHEAGUE CREEK Date: 4/11/17

Location: REACH 4

Observers: TEAM 4 HUC: _____

	Distance, Point, or	Back-Sight	Height of Instru-ment	Thalweg		Water Surface		Bankfull		Low Bank HI		NOTES
				Fore-Sight	Elevation	Fore-Sight	Elevation	Fore-Sight	Elevation	Fore-Sight	Elevation	e.g. Riffle Run Pool Glide
	STATION	BS	HI	FS	Elev.	FS	Elev.	FS	Elev.	FS	Elev.	
	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	
28	13+80		13.81	8.92	4.89	8.00	5.81					RIFFLE
29	14+05			8.93	4.88	8.10	5.71	6.80	7.01			
30	14+25			9.45	4.36	8.15	5.66					GATE
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												
41												
42												
43												
44												
45												
46												
47												
48												
49												
50												
51												
52												
53												
54												

13.81

.65

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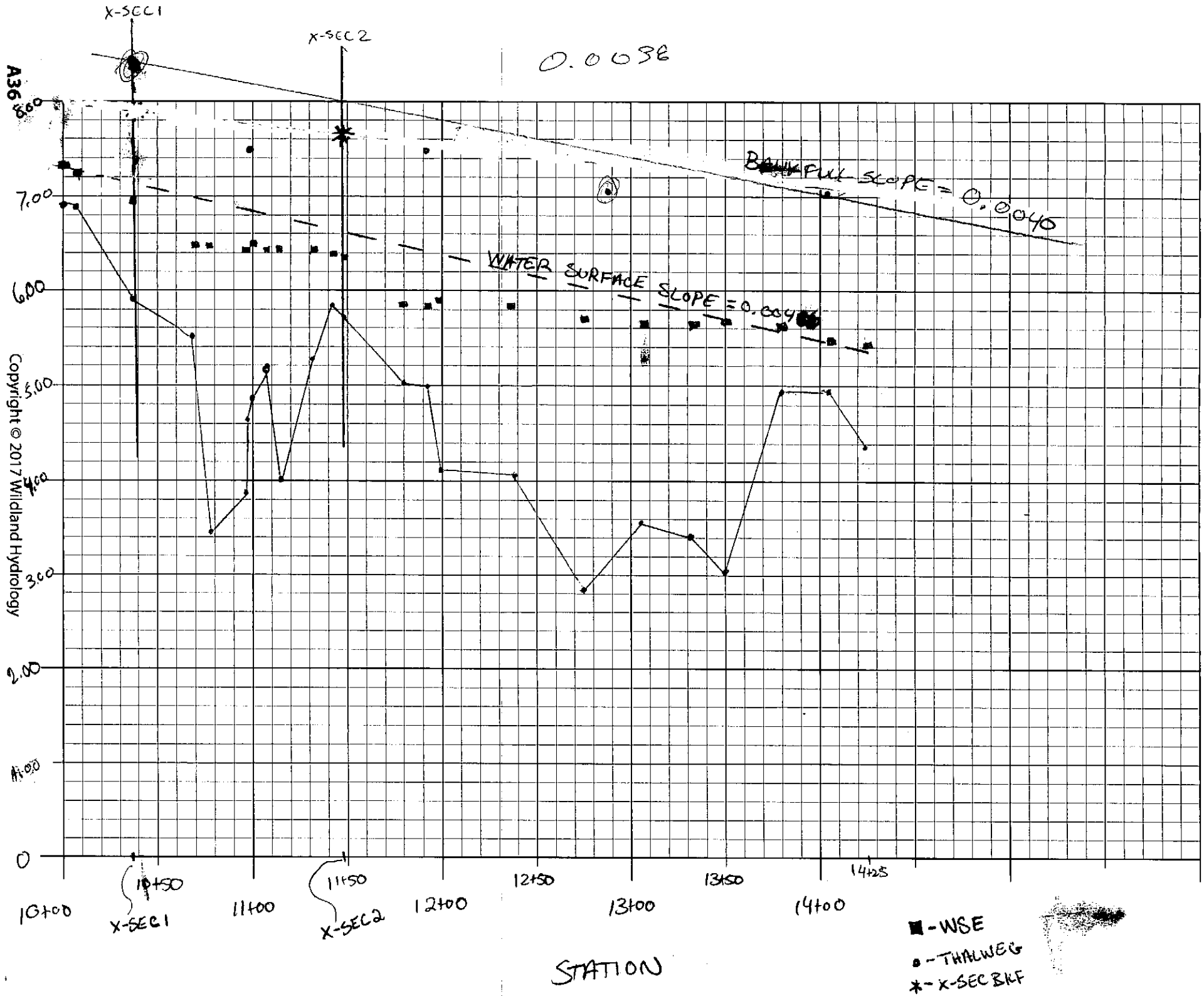

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Reach Length - 350 ft
Pool - 50%
Riffle - 50%

Site: Little Conococheague, Washington Co., MD
Location: Reach 4 HUC:
Observers: Ali, Amanda, David

Inches	PARTICLE	Millimeters		Dot Count for RIFFLE 1	POOL 2	COMP. 3	RIFFLE (1) Reach: Date: 4-11-2017 TOT #	ITEM %	% CUM	POOL (2) Reach: Date: 4-11-2017 TOT #	ITEM %	% CUM	COMPOSITE (3) Reach: Date: 4-11-2017 TOT #	ITEM %	% CUM
	Silt / Clay	< .062	S/C	•	⊠ :		1	2	2	13	26	26	14	14	14
	Very Fine	.062 - .125	SAND												
	Fine	.125 - .25													
	Medium	.25 - .50													
	Coarse	.50 - 1.0													
.04 - .08	Very Coarse	1.0 - 2			•					1	2	28	1	1	15
.08 - .16	Very Fine	2 - 4	GRAVEL	•	:		1	2	4	2	4	32	3	3	18
.16 - .22	Fine	4 - 5.7													
.22 - .31	Fine	5.7 - 8			•					1	2	34	1	1	19
.31 - .44	Medium	8 - 11.3			•					2	4	38	2	2	21
.44 - .63	Medium	11.3 - 16		:	•		4	8	12	2	4	42	6	6	27
.63 - .89	Coarse	16 - 22.6		•	•		1	2	14	2	4	46	3	3	30
.89 - 1.3	Coarse	22.6 - 32		⊠ !	•		14	28	42	2	4	50	16	16	46
1.3 - 1.8	Very Coarse	32 - 45		:	:		4	8	50	4	8	58	8	8	54
1.8 - 2.5	Very Coarse	45 - 64		⊓	:		7	14	64	5	10	68	12	12	66
2.5 - 3.5	Small	64 - 90	COBBLE	⊓	:		8	16	80	4	8	76	12	12	78
3.5 - 5.0	Small	90 - 128		⊓			8	16	96				8	8	86
5.0 - 7.1	Large	128 - 180		•			1	2	98				1	1	87
7.1 - 10.1	Large	180 - 256			:					3	6	82	3	3	90
10.1 - 14.3	Small	256 - 362	BOULDER												
14.3 - 20	Small	362 - 512													
20 - 40	Medium	512 - 1024													
40 - 80	Large-Vry Large	1024 - 2048			x										
	Bedrock		BDRK	•	⊠		1	2	100	9	18	100	10	10	100
Stream Type:			**Landscape Type:**			TOTAL→	50	100	100	50	100	100	100	100	100

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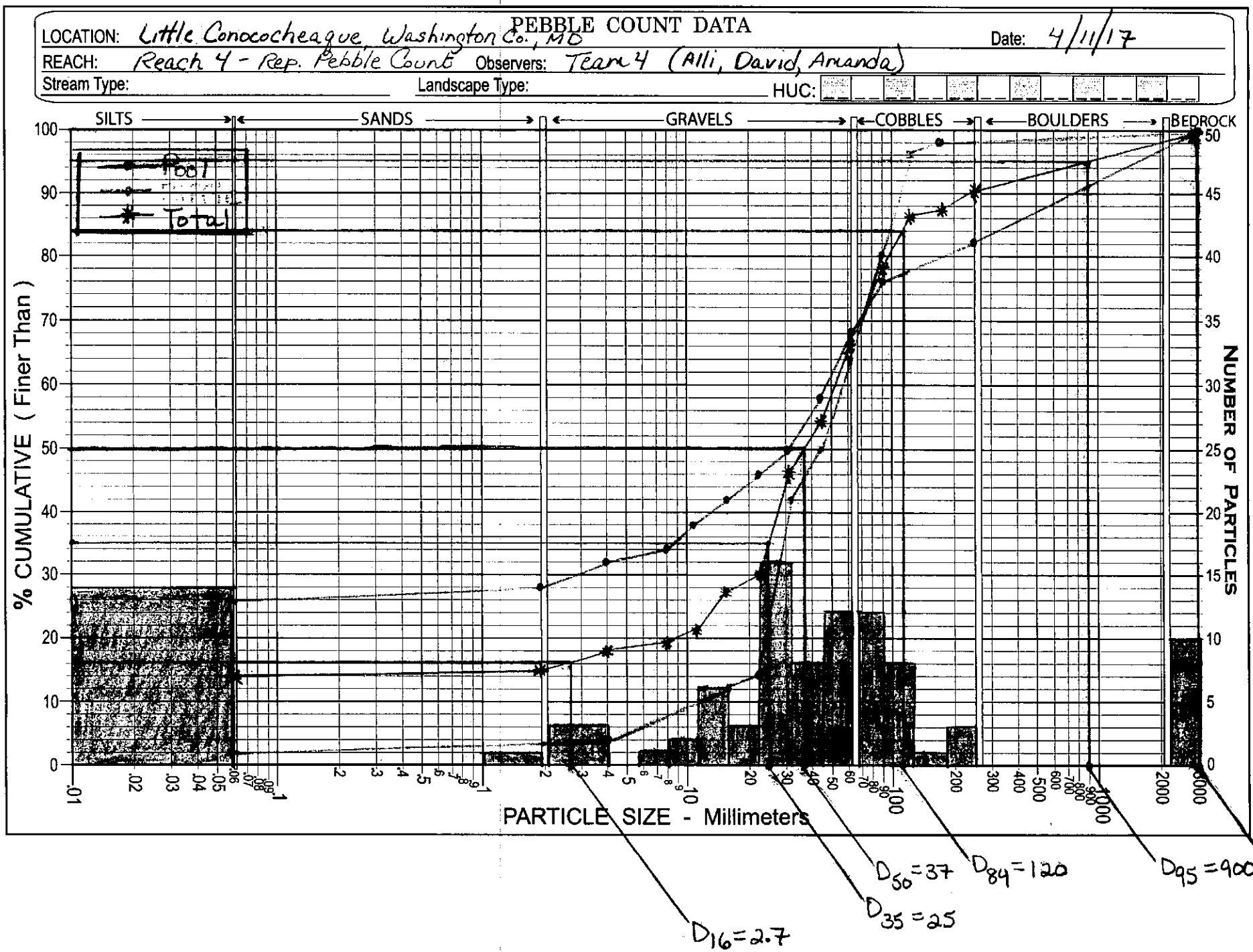
Representative Pebble Count

Approx. 50/50 pool vs. riffle



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Site:

Location: Reach 4, Active #2 Bed HUC:

Observers: Allie, Amanda, David

Inches	PARTICLE	Millimeters		Dot Count for RIFFLE 1	POOL 2	COMP. 3	RIFFLE (1) TOT #	RIFFLE (1) ITEM %	RIFFLE (1) % CUM	POOL (2) TOT #	POOL (2) ITEM %	POOL (2) % CUM	COMPOSITE (3) TOT #	COMPOSITE (3) ITEM %	COMPOSITE (3) % CUM
							Reach: Reach 4			Reach:			Reach:		
							Date: 04/11, 6:55pm			Date:			Date:		
	Silt / Clay	< .062	S/C	:			2	2	2						
	Very Fine	.062 - .125	SAND												
	Fine	.125 - .25													
	Medium	.25 - .50													
	Coarse	.50 - 1.0													
.04 - .08	Very Coarse	1.0 - 2													
.08 - .16	Very Fine	2 - 4	GRAVEL												
.16 - .22	Fine	4 - 5.7													
.22 - .31	Fine	5.7 - 8													
.31 - .44	Medium	8 - 11.3		.			1	1	3						
.44 - .63	Medium	11.3 - 16		:.			4	4	7						
.63 - .89	Coarse	16 - 22.6		::			4	4	11						
.89 - 1.3	Coarse	22.6 - 32		⊡			18	18	29						
1.3 - 1.8	Very Coarse	32 - 45		⊏			17	17	46						
1.8 - 2.5	Very Coarse	45 - 64		⊡⊏			26	26	72						
2.5 - 3.5	Small	64 - 90	COBBLE	⊡⊏			16	16	88						
3.5 - 5.0	Small	90 - 128		:⊏			5	5	93						
5.0 - 7.1	Large	128 - 180													
7.1 - 10.1	Large	180 - 256		⊏			1	1	94						
10.1 - 14.3	Small	256 - 362	BOULDER												
14.3 - 20	Small	362 - 512													
20 - 40	Medium	512 - 1024													
40 - 80	Large-Vry Large	1024 - 2048													
	Bedrock		BDRK	⊏			6	6	100						
						TOTAL →	100	100%	100%						

Stream Type: **Landscape Type:**

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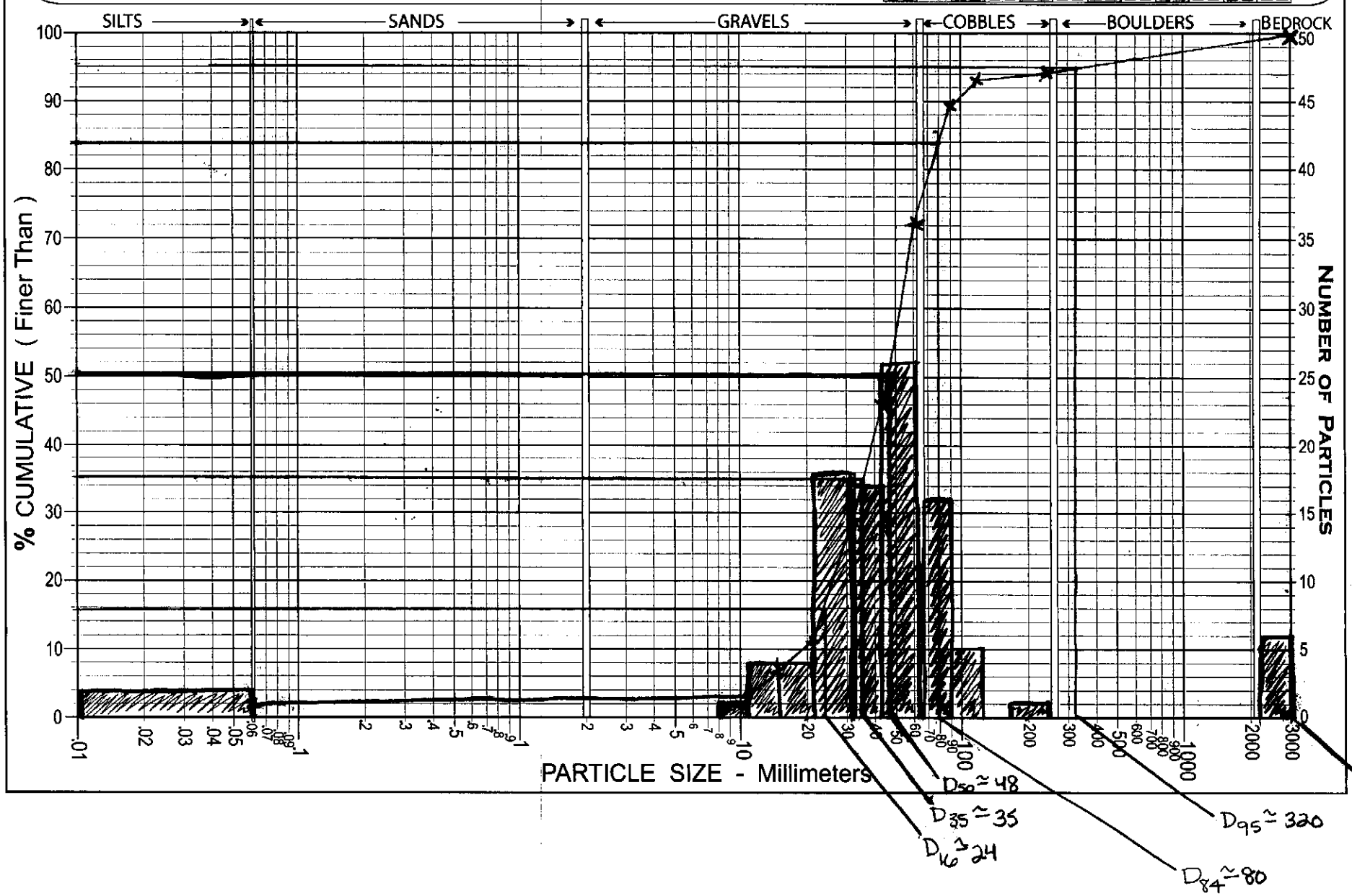
PEBBLE COUNT DATA

LOCATION: Little Canocacheague, Washington, MD Date: 04/11/17

REACH: Reach 4 - Active Riffle #2 Observers: Amanda, Alli, & David

Stream Type: Landscape Type: HUC:



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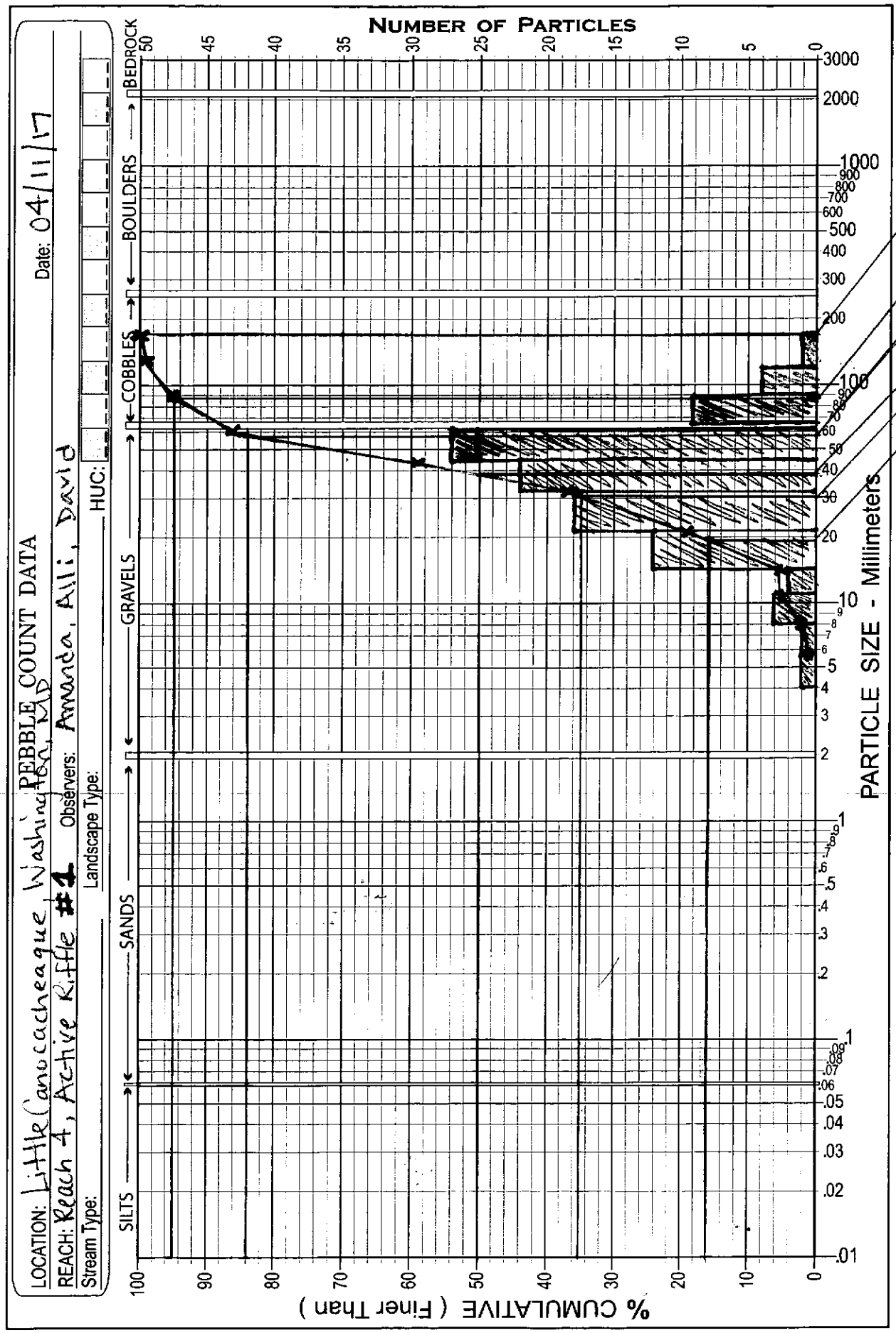

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Worksheet A-1. Field Form for Level II Stream Classification.

Stream: Little Conocacheague Reach 4 XS-2	
Basin:	Drainage Area: acres 12 mi^2
Location: Washington Co, MD	
Twp.&Rge:	Sec.&Qtr.:
Cross-Section Monuments (Lat./Long.):	Date: 4/11/17
Observers: Team 4	Landscape Type:

Bankfull Width (W_{bkf}) The surface width of the stream at bankfull stage elevation, in a riffle section.	27.23	ft
Bankfull Mean Depth (d_{bkf}) Mean depth of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A_{bkf} / W_{bkf}$).	1.64	ft
Bankfull Cross-Sectional Area (A_{bkf}) Area of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	44.70	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) *Bankfull Width* divided by *Bankfull Mean Depth*, in a riffle section.	16.6	ft/ft
Bankfull Maximum Depth (d_{max}) Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.	2.07	ft
Flood-Prone Area Width (W_{fpa}) Width of the channel at an elevation that is twice the *Bankfull Maximum Depth*, measured perpendicular to the fall line of the valley in a riffle section.	77.69	ft
Entrenchment Ratio (ER) The *Flood-Prone Area Width* divided by *Bankfull Width* (W_{fpa} / W_{bkf}), in a riffle section.	2.85	ft/ft
Channel Materials (Particle Size Index D_{50}) The D_{50} particle size index represents the median or dominant diameter of channel materials, as sampled proportionately from the channel surface between the bankfull stage and Thalweg elevations.	37	mm
Average Water Surface Slope (S) The elevation difference of water surface measurements over the stream length between two similar bed features (e.g., start of riffle to start of last riffle) for several riffle-pool or step-pool sequences, representing channel gradient.	0.0046	ft/ft
Channel Sinuosity (k) An index of channel pattern determined from stream length divided by valley length (SL / VL), or from valley slope divided by average water surface slope (S_{val} / S).	1.42 / 1.34	ft/ft

Stream Type C4-1 **See Classification Key (Figure A-2)**

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Worksheet A-2. Computations of velocity and discharge using various methods.

Bankfull VELOCITY & DISCHARGE Estimates

Stream:	Little Conocacheague R4 XS-2	Location:	Washington Co. MD
Date:	4/11/17	Stream Type:	C-4/1
Landscape Type:	Confined C-AL-AD		
Observers:	Team 4	HUC:	

INPUT VARIABLES

Bankfull Riffle Cross-Sectional Area	44.70	A_{bkf} (ft^2)	Bankfull Riffle Mean Depth	1.64	d_{bkf} (ft)
Bankfull Riffle Width	27.23	W_{bkf} (ft)	Wetted Perimeter ≈ (2 * d_{bkf}) + W_{bkf}	30.51	W_p (ft)
D_{84} Particle Size at Riffle	80	D_{84} (mm)	D_{84} Particle Size in Feet D_{84} (mm) / 304.8	0.26	D_{84} (ft)
WSE Bankfull Slope	0.0046	S_{bkf} (ft / ft)	Hydraulic Radius A_{bkf} / Wp	1.47	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	5.63	R / D_{84} (ft / ft)
Drainage Area	12	DA (mi^2)	Shear Velocity $u^* = (gRS)^{½}$	0.467	u^* (ft / sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $\bar{u} = [\,2.83 + 5.66 * Log\{R / D_{84}\}\,]\,u^*$	3.31	ft / sec	148	cfs
2. Roughness Coefficient: a) Manning's *n* from Friction Factor/Relative Roughness (Figs. A-27, A-28) $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0.041	3.19	ft / sec	143	cfs
2. Roughness Coefficient: b) Manning's *n* from Stream Type (Fig. A-29) $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0.042	3.11	ft / sec	139	cfs
2. Roughness Coefficient: c) Manning's *n* from Jarrett (USGS): $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n = 0.39 * S^{0.38} * R^{-0.16}$ **Note:** This equation is applicable to **steep, step/pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for $n =$	NA	ft / sec	NA	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.)	NA	ft / sec	NA	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.)	NA	ft / sec	NA	cfs
4. Continuity Equations: a) USGS Gage Data $\bar{u} = Q / A$ Return Period for Bankfull Q $Q =$ ____ year	NA	ft / sec	NA	cfs
4. Continuity Equations: b) Regional Curves $\bar{u} = Q / A$	4.78	ft / sec	214	cfs

Protrusion Height Options for the D_{84} Term in the Relative Roughness Relation (R/D_{84}) – Estimation Method 1

Option 1.	For **sand-bed** channels: Measure 100 **"protrusion heights"** of sand dunes from the downstream side of feature to the top of feature. Substitute the D_{84} sand dune protrusion height in ft for the D_{84} term in method 1.
Option 2.	For **boulder-dominated** channels: Measure 100 **"protrusion heights"** of boulders on the sides from the bed elevation to the top of the rock on that side. Substitute the D_{84} boulder protrusion height in ft for the D_{84} term in method 1.
Option 3.	For **bedrock-dominated** channels: Measure 100 **"protrusion heights"** of rock separations, steps, joints or uplifted surfaces above channel bed elevation. Substitute the D_{84} bedrock protrusion height in ft for the D_{84} term in method 1.
Option 4.	For **log-influenced** channels: Measure **"protrusion heights"** proportionate to channel width of log diameters or the height of the log on upstream side if embedded. Substitute the D_{84} protrusion height in ft for the D_{84} term in method 1.

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Worksheet A-3. Summary of Morphological Variables.

Stream: Little Conocacheague R4 xs-2		Location: Washington Co, MD	
Team: 4	Date: 4/11/17	Drainage Area: 12 sq mi	

Riffle Channel Dimensions

1. Bankfull Width (W_{bkf}) (ft)	27.23	2. Bankfull Mean Depth (d_{bkf}) (ft)	1.64
3. Width/Depth Ratio (W_{bkf} / d_{bkf})	16.60	4. Bankfull Cross-Sectional Area (A_{bkf}) (ft^2)	44.70
5. Bankfull Maximum Depth (d_{max}) (ft)	2.07	6. Width of Flood-Prone Area (W_{fpa}) (ft)	77.69
7. Entrenchment Ratio (ER) (W_{fpa} / W_{bkf})	2.85		

Channel Pattern / Dimensionless Ratios

8. Belt Width (W_{blt}) (ft)	Mean	280.5	9. Meander Width Ratio (MWR) (W_{blt} / W_{bkf})	Mean	10.3
	Min	237		Min	8.7
	Max	324		Max	11.9
10. Stream Meander Length (L_m) (ft)	Mean	918	11. Meander Length Ratio (MLR) (L_m / W_{bkf})	Mean	33.7
	Min	896		Min	32.9
	Max	940		Max	34.5
12. Linear Wavelength (λ) (ft)	Mean	683.5	13. Linear Wavelength to Bankfull Width (λ / W_{bkf})	Mean	25.1
	Min	642		Min	23.6
	Max	725		Max	26.6
14. Radius of Curvature (R_c) (ft)	Mean	79.5 / 72.8	15. Radius of Curvature to Bankfull Width (R_c / W_{bkf})	Mean	2.92 / 2.67
	Min	68 / 56		Min	2.67 / 2.06
	Max	88		Max	3.23 / 3.23

Channel Particles

Representative Pebble Count

16. D_{16} (mm)	2.7	17. D_{35} (mm)	25	18. D_{50} (mm)	37
19. D_{84} (mm)	120	20. D_{95} (mm)	900	21. D_{100} (mm)	3,000

Active Bed Riffle Pebble Count

22. D_{16} (mm)	24	23. D_{35} (mm)	35	24. D_{50} (mm)	48
25. D_{84} (mm)	80	26. D_{95} (mm)	320	27. D_{100} (mm)	3,000

Classification

28. Sinuosity (k)	1.42/1.34	29. Average Water Surface Slope (S)	0.0046
30. Stream Type	C4-1	31. Landscape Type Confined	C-AL-AD

Velocity & Discharge

32. Friction Factor ($\bar{u}$ / u*)	7.09	33. Relative Roughness (R / D_{84})	5.63
34. Manning's 'n' from Friction Factor / Relative Roughness	0.041	35. Manning's 'n' from Stream Type	0.042
36. Estimated Bankfull Mean Velocity ($\bar{u}_{bkf}$) (ft/sec)	3.2	37. Estimated Bankfull Discharge (cfs)	143
38. Estimation Method Selected for Velocity & Discharge	Average		

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Worksheet A-1. Field Form for Level II Stream Classification.

Stream: Little Conocacheague Reach 4 XS-1			
Basin:	Drainage Area:	acres	12 mi²
Location: Washington Co, MD			
Twp.&Rge:	Sec.&Qtr.:		
Cross-Section Monuments (Lat./Long.):		Date: 4/11/17	
Observers: Team 4		Landscape Type:	

Bankfull Width (W_{bkf}) The surface width of the stream at bankfull stage elevation, in a riffle section.	33.3	ft
Bankfull Mean Depth (d_{bkf}) Mean depth of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A_{bkf} / W_{bkf}$).	[illegible]	ft
Bankfull Cross-Sectional Area (A_{bkf}) Area of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	36.51	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) *Bankfull Width* divided by *Bankfull Mean Depth*, in a riffle section.	36.51	ft/ft
Bankfull Maximum Depth (d_{max}) Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.	2.42	ft
Flood-Prone Area Width (W_{fpa}) Width of the channel at an elevation that is twice the *Bankfull Maximum Depth*, measured perpendicular to the fall line of the valley in a riffle section.	(Assumed) 105	ft
Entrenchment Ratio (ER) The *Flood-Prone Area Width* divided by *Bankfull Width* (W_{fpa} / W_{bkf}), in a riffle section.	3.15	ft/ft
Channel Materials (Particle Size Index D_{50}) The D_{50} particle size index represents the median or dominant diameter of channel materials, as sampled proportionately from the channel surface between the bankfull stage and Thalweg elevations.	37	mm
Average Water Surface Slope (S) The elevation difference of water surface measurements over the stream length between two similar bed features (e.g., start of riffle to start of last riffle) for several riffle–pool or step–pool sequences, representing channel gradient.	0.0046	ft/ft
Channel Sinuosity (k) An index of channel pattern determined from stream length divided by valley length (SL / VL), or from valley slope divided by average water surface slope (S_{val} / S).	1.42/1.34	ft/ft

Stream Type C4-1 **See Classification Key (Figure A-2)**

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Worksheet A-2. Computations of velocity and discharge using various methods.

Bankfull VELOCITY & DISCHARGE Estimates

Stream:	Little Conocacheague XS-1	Location:	Washington Co, MD
Date:	4/11/17 Stream Type: C4/1	Landscape Type:	Alluvial w/ Bedrock
Observers:	Team 4	HUC:	

INPUT VARIABLES

Bankfull Riffle Cross-Sectional Area	36.51	A_{bkf} (ft^2)	Bankfull Riffle Mean Depth	1.10	d_{bkf} (ft)
Bankfull Riffle Width	33.3	W_{bkf} (ft)	Wetted Perimeter ≈ $(2 * d_{bkf}) + W_{bkf}$	35.5	W_p (ft)
D_{84} Particle Size at Riffle	57	D_{84} (mm)	D_{84} Particle Size in Feet D_{84} (mm) / 304.8	0.19	D_{84} (ft)
~~Bankfull~~ WSE Slope	0.00460	S_{bkf} (ft / ft)	Hydraulic Radius A_{bkf} / W_p	1.02	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	5.37	R / D_{84} (ft / ft)
Drainage Area	12	DA (mi^2)	Shear Velocity $u^* = (gRS)^{½}$	0.389	u^* (ft / sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $\bar{u} = [2.83 + 5.66 * Log\{R / D_{84}\}] u^*$	2.71	ft / sec	98.87	cfs
2. Roughness Coefficient: a) Manning's n from Friction Factor/Relative Roughness (Figs. A-27, A-28) $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0.041	2.50	ft / sec	91.28	cfs
2. Roughness Coefficient: b) Manning's n from Stream Type (Fig. A-29) $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0.040	2.56	ft / sec	93.47	cfs
2. Roughness Coefficient: c) Manning's n from Jarrett (USGS): $n = 0.39 * S^{0.38} * R^{-0.16}$ Note: This equation is applicable to **steep, step/pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for $n =$	NA	ft / sec	NA	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.)	NA	ft / sec	NA	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.)	NA	ft / sec	NA	cfs
4. Continuity Equations: a) USGS Gage Data $\bar{u} = Q / A$ Return Period for Bankfull Q $Q =$ year	NA	ft / sec	NA	cfs
4. Continuity Equations: b) Regional Curves $\bar{u} = Q / A$	5.86	ft / sec	214	cfs

Protrusion Height Options for the D_{84} Term in the Relative Roughness Relation (R/D_{84}) – Estimation Method 1

Option 1.	For **sand-bed** channels: Measure 100 **"protrusion heights"** of sand dunes from the downstream side of feature to the top of feature. Substitute the D_{84} sand dune protrusion height in ft for the D_{84} term in method 1.
Option 2.	For **boulder-dominated** channels: Measure 100 **"protrusion heights"** of boulders on the sides from the bed elevation to the top of the rock on that side. Substitute the D_{84} boulder protrusion height in ft for the D_{84} term in method 1.
Option 3.	For **bedrock-dominated** channels: Measure 100 **"protrusion heights"** of rock separations, steps, joints or uplifted surfaces above channel bed elevation. Substitute the D_{84} bedrock protrusion height in ft for the D_{84} term in method 1.
Option 4.	For **log-influenced** channels: Measure **"protrusion heights"** proportionate to channel width of log diameters or the height of the log on upstream side if embedded. Substitute the D_{84} protrusion height in ft for the D_{84} term in method 1.

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Worksheet A-3. Summary of Morphological Variables.

Stream: Little Conococheague XS-1		Location: Washington Co. MD	
Team: cf		Date: 4/11/17	Drainage Area: 12 sq. mi.

Riffle Channel Dimensions

1. Bankfull Width (W_{bkf}) (ft)	33.3	2. Bankfull Mean Depth (d_{bkf}) (ft)	0.912
3. Width/Depth Ratio (W_{bkf} / d_{bkf})	36.51	4. Bankfull Cross-Sectional Area (A_{bkf}) (ft^2)	36.51
5. Bankfull Maximum Depth (d_{max}) (ft)	1.10	6. Width of Flood-Prone Area (W_{fpa}) (ft)	165
7. Entrenchment Ratio (ER) (W_{fpa} / W_{bkf})	3.15		

Channel Pattern / Dimensionless Ratios

8. Belt Width (W_{blt}) (ft)	Mean	280.5 FT	9. Meander Width Ratio (MWR) (W_{blt} / W_{bkf})	Mean	8.42
	Min	237 FT		Min	7.12
	Max	324 FT		Max	9.73
10. Stream Meander Length (L_m) (ft)	Mean	918 FT	11. Meander Length Ratio (MLR) (L_m / W_{bkf})	Mean	27.57
	Min	~~940~~ 896 FT		Min	[redacted]
	Max	940 FT		Max	28.23
12. Linear Wavelength (λ) (ft)	Mean	683.5 FT	13. Linear Wavelength to Bankfull Width (λ / W_{bkf})	Mean	20.53
	Min	642 FT		Min	19.28
	Max	725 FT		Max	21.77
14. Radius of Curvature (R_c) (ft)	Mean	79.5 ; 72.83 FT	15. Radius of Curvature to Bankfull Width (R_c / W_{bkf}) — Extended Reach	Mean	2.39 | 2.19
	Min	68 ; 56 FT		Min	2.04 | 1.68
	Max	88 ; 88 FT		Max	2.64 | 2.64

Channel Particles

Representative Pebble Count

16. D_{16} (mm)	2.7	17. D_{35} (mm)	25	18. D_{50} (mm)	37
19. D_{84} (mm)	120	20. D_{95} (mm)	900	21. D_{100} (mm)	3,000

Active Bed Riffle Pebble Count

22. D_{16} (mm)	19	23. D_{35} (mm)	30	24. D_{50} (mm)	38
25. D_{84} (mm)	57	26. D_{95} (mm)	87	27. D_{100} (mm)	175

Classification

28. Sinuosity (k)	1.42 / 1.34	29. Average Water Surface Slope (S)	0.0046
30. Stream Type	C4-1	31. Landscape Type	Alluvial w/ Bedrock

Velocity & Discharge

32. Friction Factor (ū / u*)	7	33. Relative Roughness (R / D_{84})	5.37
34. Manning's 'n' from Friction Factor / Relative Roughness	0.041	35. Manning's 'n' from Stream Type	0.040
36. Estimated Bankfull Mean Velocity ($\bar{u}_{bkf}$) (ft/sec)	2.58	37. Estimated Bankfull Discharge (cfs)	94.24
38. Estimation Method Selected for Velocity & Discharge	Average		

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