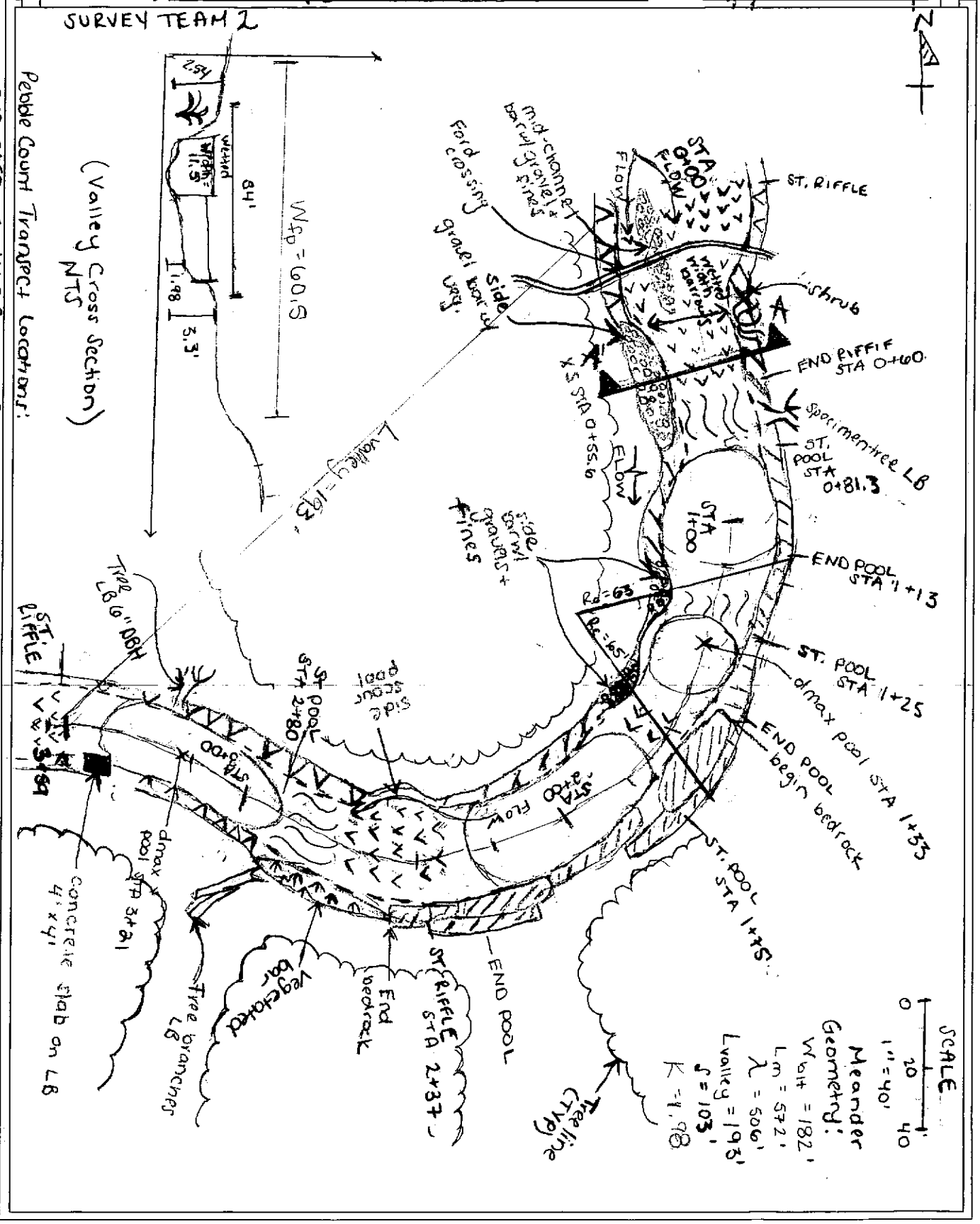
AREA-SITE LOCATION....REACH MAP

Stream/Drainage: Little Conococheague Creek Site/Reach: Reach 2

Drawn By: CHS Team 2 (Washington County, MD) Date: 4/11/17 80° sunny



* Legend Attached

SURVEY DATA ⟹ **CROSS - SECTION 1** Pg 1/2

SITE: Little Conocacheague Creek Date: 4/11/17

Location: Cross Section, Reach 2

Observers: ACL, Nick, Jared Team 2 HUC: 0 2 0 7 0 0 0 4 1 1 0 2

104.59

Item	Distance, Point, or STATION ft	Back-Sight BS ft	Height of Instrument HI ft	Fore-Sight FS ft	Elevation ft	NOTES / COMMENTS / REMARKS	
1		4.29	104.29		100		
2	0+00	4.		4.73	99.56	LBKPN	
3	0+02			4.65	99.64	GS	
4	0+04			5.00	99.29	LTOB	
5	0+07.5			6.59	97.70	LBKF	0
6	0+08.5			7.54	96.75	LEW	0.95
7	0+10			8.02	96.27	CS	1.43
8	0+11			8.39	95.90	CS	1.80
9	0+12			8.54	95.75	CS/TW	1.95
10	0+13			8.40	95.89	CS	1.81
11	0+14			8.45	95.84	CS	1.86
12	0+15			8.36	95.93	CS	1.77
13	0+16			8.30	95.99	CS	1.71
14	0+17			8.12	96.17	CS	1.53
15	0+18			8.03	96.26	CS	1.44
16	0+19			7.79	96.50	CS	1.20
17	0+20			7.59	96.70	REW	1.00
18	0+22			7.21	97.08	GS	0.63
19	0+24			6.96	97.33	GS	0.37
20	0+26			6.96	97.33	GS	0.37
21	0+28			6.75	97.54	GS	0.16
22	0+30			6.54	97.75	RBKF (Long-pro read 3.68@sta. 55.6)	0.05
23	0+32			6.65	97.64	GS	
24	0+34			6.64	97.65	GS	
25	0+36			6.20	98.09	GS	
26	0+38			5.72	98.57	GS	
27	0+40			5.42	98.87	GS	
28	0+42			5.05	99.24	GS	

LBKPN
LTOB
GS
CS
BKF
LEW
TW
REW

60.5' = floodprone width

20.03

98.69 — off of long Pro by 0.94H

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SURVEY DATA ⟹ **CROSS - SECTION 2** Pg 2/2

SITE: Little Conococheague Creek, Date: 4/11/17

Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES / COMMENTS / REMARKS
29	0+44			4.70	99.59	GS
30	0+46			4.52	99.77	GS
31	0+48			4.2[illegible]	100.00	GS RTB
32	0+50			4.38	99.91	GS
33	0+52			4.56	99.73	GS
34	0+54			4.76	99.53	LBKPN
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						

Left side FPA: Pin +3.[illegible]
Right Side FPA: Pin+3.5

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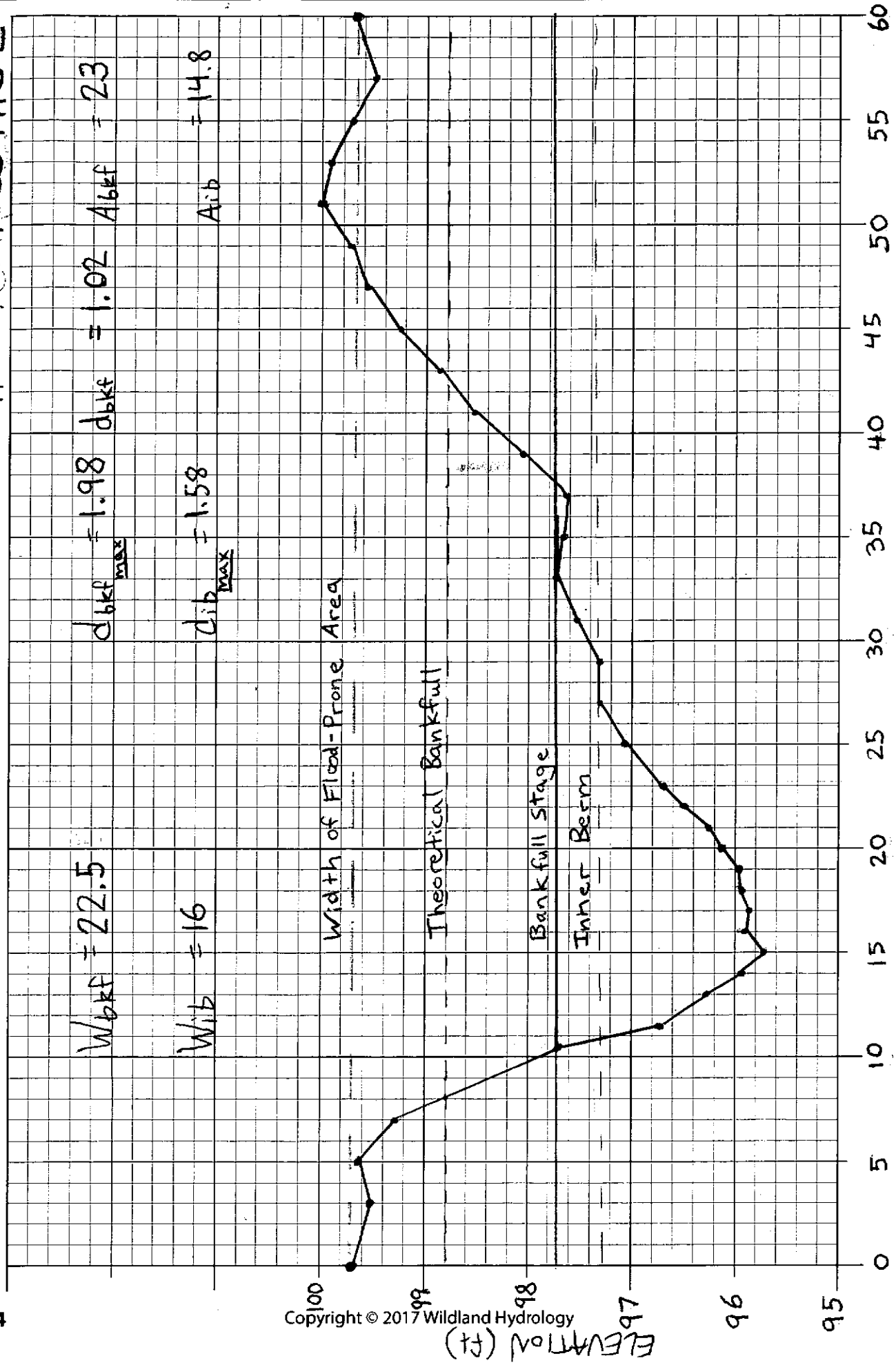
4/11/17, Team 2
Little Conococheague Creek, Reach 2
HUC: 02070004110 2

RIFFLE CROSS SECTION



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Stream: C4/1

X section team 6.54 @ 55.6

Pg 1/1 3.68

Day 2: Field Day 55.6 XS

Station

Long Prof Diff = 2.86

SURVEY DATA → **LONGITUDINAL PROFILE 1**

SITE: Little Conocacheague Creek **Date:** 4/11/17

Location: 2, Reach 2

Observers: Shannon, Mark, Andrea Team 2 **HUC:** 0 2 0 7 0 0 0 4 1 1 0 2

	Distance, Point, or STATION (ft)	Back-Sight BS (ft)	Height of Instrument HI (ft)	Thalweg Fore-Sight FS (ft)	Thalweg Elevation Elev. (ft)	Water Surface Fore-Sight FS (ft)	Water Surface Elevation Elev. (ft)	Bankfull Fore-Sight FS (ft)	Bankfull Elevation Elev. (ft)	Low Bank HI Fore-Sight FS (ft)	Low Bank HI Elevation Elev. (ft)	NOTES e.g. Riffle Run Pool Glide
1	0	2.37	~~100~~ 102.37									Bench mark on bed rock
2	~~0~~			~~5.13~~		~~1.22~~						
3	0			5.13	97.24	3.92	98.45	2.70	99.67			Top of Riffle (TOR)
4	27			5.00	97.37	4.27	98.1			1.59	100.78	U/S of ford (BOR)
5	42.2			5.12	97.25	4.42	97.95			1.69	100.68	Top of Run
6	55.6							3.68	98.69			XS location
7	69.5			6.04	96.33	4.81	4.76 97.68 X			1.23	101.14	Start of run
8	81.3			5.97	96.4	4.79	4.8 X	3.65	98.72			Start of pool
9	95.7			7.95	94.42	4.79	X	~~[illegible]~~		2.41	99.96	mid pool
10	106.					4.73	X			2.54	99.83	
11	113			5.45	96.92	4.72	4.69 4.69 4.69			2.39	99.98	top of glide
12	120.5			5.18	97.19	[illegible]	4.69			2.76	99.61	TO Riffle
13	121			5.35	97.02	4.69				2.78	99.59	Short Riffle (run)
14	133.6			6.61	95.76	4.73	97.64	3.52	98.85	[illegible]		Pool Max D
15	154.7			6.03	96.34	4.76	97.61	3.47	98.9			start of glide
16	159			5.86	96.51	4.98	97.39			3.22	99.15	bed rock
17	168.5			6.27	96.1	5.06	97.31			2.98	99.39	bed rock
18	203.9			7.10	95.27	5.57	96.8	4.38	97.99			BNKF point
19	220.5			7.91	94.46	5.61	96.76			4.30	98.07	pool max d
20	237.0			6.71	95.66	5.87	96.5	4.77	97.6			top of riffle
21												
22												
23												
24												
25												
26												
27												

These points balance w/ the XS loop

4.45

4.55

237 97.24 − 95.66 = 1.58, 1.58/237 = 0.0067 → Thalweg Slope

22.5 water slope 0.008

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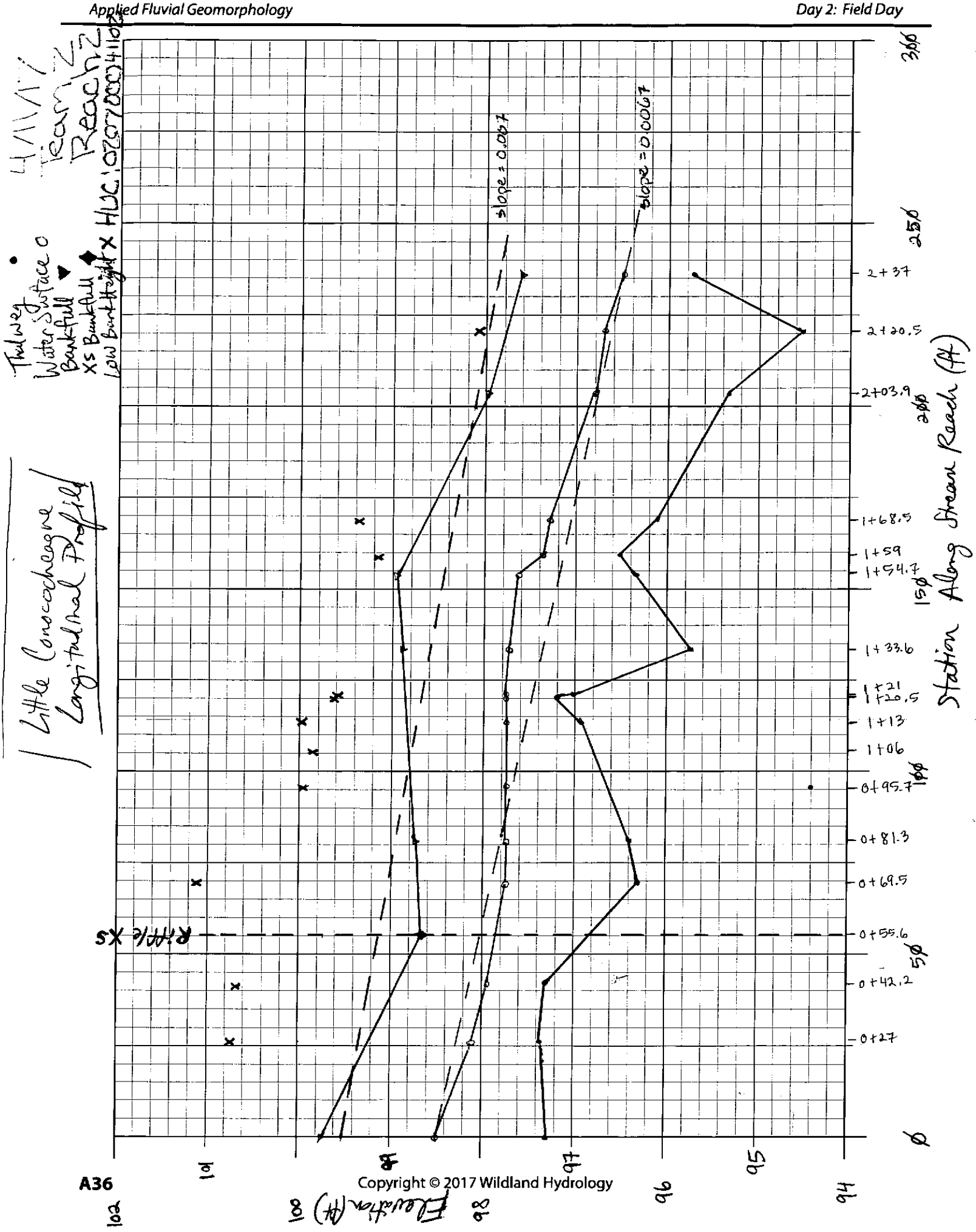

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Pg 1/1

Little Conococheague Creek 4/11/17

Site: Representative Pebble Count

Location: Reach 2 HUC: 02070004 1107

Observers: Team 2

Inches	PARTICLE	Millimeters		Dot Count for RIFFLE 1	POOL 2	COMP. 3	RIFFLE (1) TOT #	ITEM %	% CUM	POOL (2) TOT #	ITEM %	% CUM	COMPOSITE (3) TOT #	ITEM %	% CUM
							Reach: 2			Reach: 2			Reach: 2		
							Date:			Date:			Date:		
	Silt / Clay	< .062	S/C	I	~~IIII~~	6	1	1/30 0.01	0.01	5	5/30 0.17	17	6	6	6
	Very Fine	.062 - .125	SAND		I	I	0	0	1	1	0.033	20	1	1	7
	Fine	.125 - .25	SAND		I	I	0	0	1	1	0.033	23	1	1	8
	Medium	.25 - .50	SAND				0	0	1	0	0	23	0	0	8
	Coarse	.50 - 1.0	SAND		I	I	0	0	1	1	0.03	26	1	1	9
.04 - .08	Very Coarse	1.0 - 2	SAND	I		I	1	0.11	0.26	0	0	26	1	1	10
.08 - .16	Very Fine	2 - 4	GRAVEL				0	0	2	0	0	26	0	0	10
.16 - .22	Fine	4 - 5.7	GRAVEL				0	0	2	0	0	26	0	0	10
.22 - .31	Fine	5.7 - 8	GRAVEL	III	I	3	2	0.3	0.5	1	0.03	29	3	3	13
.31 - .44	Medium	8 - 11.3	GRAVEL	IIII		4	4	0.66	0.11	0	0	29	4	4	17
.44 - .63	Medium	11.3 - 16	GRAVEL	IIII	I	5	4	0.66	0.17	1	0.03	32	5	5	22
.63 - .89	Coarse	16 - 22.6	GRAVEL	~~IIII~~ IIII	II	11	9	0.13	0.30	2	0.07	39	11	11	33
.89 - 1.3	Coarse	22.6 - 32	GRAVEL	~~IIII~~ I		6	6	0.99	0.39	0	0	39	6	6	39
1.3 - 1.8	Very Coarse	32 - 45	GRAVEL	~~IIII~~ ~~IIII~~ I		11	11	0.18	0.55	0	0	39	11	11	50
1.8 - 2.5	Very Coarse	45 - 64	GRAVEL	~~IIII~~ IIII	IIII	13	9	0.13	0.68	4	0.13	52	13	13	63
2.5 - 3.5	Small	64 - 90	COBBLE	~~IIII~~ II	II	9	7	0.10	0.78	2	0.07	59	9	9	72
3.5 - 5.0	Small	90 - 128	COBBLE	~~IIII~~	I	6	5	0.77	0.85	1	0.03	62	6	6	78
5.0 - 7.1	Large	128 - 180	COBBLE	I	I	2	1	0.11	0.96	1	0.03	65	2	2	80
7.1 - 10.1	Large	180 - 256	COBBLE		I	1	0	0	0.96	1	0.03	70	1	1	81
10.1 - 14.3	Small	256 - 362	BOULDER	III		3	3	0.43	0.96	0	0	70	3	3	84
14.3 - 20	Small	362 - 512	BOULDER	III		3	3	0.43	0.99	0	0	70	3	3	87
20 - 40	Medium	512 - 1024	BOULDER			0	0	0	99	0	0	70	0	0	87
40 - 80	Large-Vry Large	1024 - 2048	BOULDER				0	0	99	0	0	70	0	0	87
	Bedrock		BDRK	IIII	~~IIII~~ IIII	13	4	0.66	100	9	0.3	100	13	13	100
Stream Type:		Landscape Type:				TOTAL→	70			30			100		

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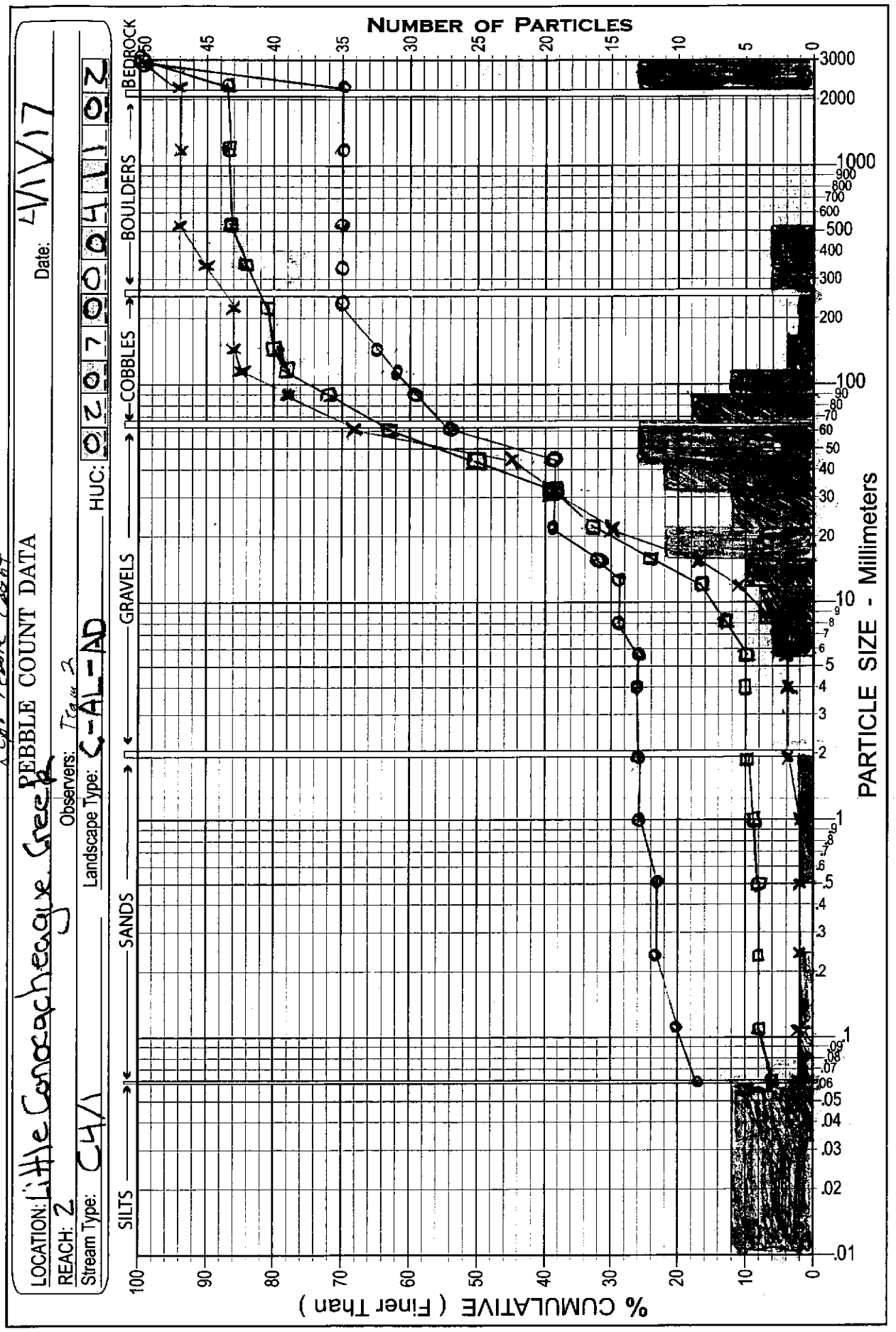

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Pg 1/1

Little Conococheague Creek 4/11/17

Site: Active Bed Riffle

Location: Reach 2 HUC: 02070004110 2

Observers: Team 2

Inches	PARTICLE	Millimeters		Dot Count for RIFFLE 1	POOL 2	COMP. 3	RIFFLE (1) TOT #	ITEM %	% CUM	POOL (2) TOT #	ITEM %	% CUM	COMPOSITE (3) TOT #	ITEM %	% CUM
				Reach:			Reach:			Reach:			Reach:		
				Date:			Date:			Date:			Date:		
	Silt / Clay	< .062	S/C		1		1	1	1						
	Very Fine	.062 - .125	SAND				0	0	0						
	Fine	.125 - .25					0	0	0						
	Medium	.25 - .50			1		1	1	2						
	Coarse	.50 - 1.0					0	0	2						
.04 - .08	Very Coarse	1.0 - 2					0	0	2						
.08 - .16	Very Fine	2 - 4	GRAVEL				0	0	2						
.16 - .22	Fine	4 - 5.7			2		2	2	4						
.22 - .31	Fine	5.7 - 8			2		2	2	6						
.31 - .44	Medium	8 - 11.3			1		1	1	7						
.44 - .63	Medium	11.3 - 16			6		6	6	13						
.63 - .89	Coarse	16 - 22.6			10		10	10	23						
.89 - 1.3	Coarse	22.6 - 32			10		10	10	33						
1.3 - 1.8	Very Coarse	32 - 45			25		25	25	58						
1.8 - 2.5	Very Coarse	45 - 64			22		22	22	80						
2.5 - 3.5	Small	64 - 90	COBBLE		13		13	13	93						
3.5 - 5.0	Small	90 - 128			6		6	6	99						
5.0 - 7.1	Large	128 - 180			1		1	1	100						
7.1 - 10.1	Large	180 - 256					0	0	100						
10.1 - 14.3	Small	256 - 362	BOULDER				0	0	100						
14.3 - 20	Small	362 - 512					0	0	100						
20 - 40	Medium	512 - 1024					0	0	100						
40 - 80	Large-Vry Large	1024 - 2048					0	0	100						
	Bedrock		BDRK												
						TOTAL→	100	100	100						

Stream Type: **Landscape Type:**

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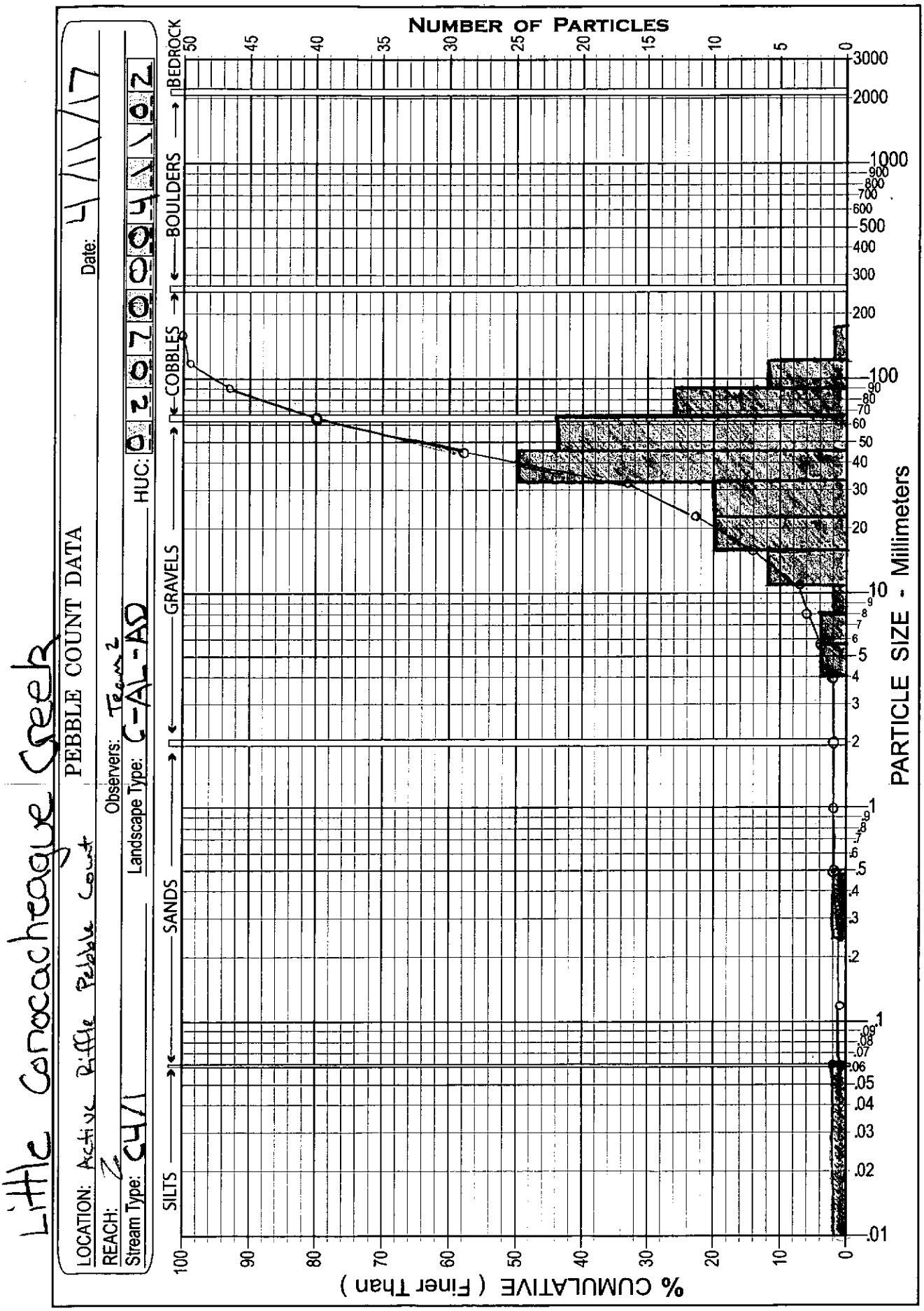

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Worksheet A-1. Field Form for Level II Stream Classification.

Stream: Little Conococheague Creek, Reach 2	
Basin: Mid Atlantic Region	Drainage Area: 31.08 acres 12 mi²
Location: Washington County, Maryland	
Twp.&Rge:	Sec.&Qtr.:
Cross-Section Monuments (Lat./Long.): 39.62387° -77.90397°	Date: 4/11/17
Observers: Team 2	Landscape Type: C-AL-AD

Bankfull Width (W_{bkf}) The surface width of the stream at bankfull stage elevation, in a riffle section.	22.50	ft
Bankfull Mean Depth (d_{bkf}) Mean depth of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A_{bkf} / W_{bkf}$).	1.02	ft
Bankfull Cross-Sectional Area (A_{bkf}) Area of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	23.00	ft²
Width/Depth Ratio (W_{bkf} / d_{bkf}) *Bankfull Width* divided by *Bankfull Mean Depth*, in a riffle section.	22.06	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.	1.98	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.	60.50	ft
Entrenchment Ratio (ER) The *Flood-Prone Area Width* divided by *Bankfull Width* (W_{fpa} / W_{bkf}), in a riffle section.	2.69	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.	43	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.	0.0067	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).	1.86	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 Conococheague	Location:	Washington County, Maryland
Date:	4/11/17	Stream Type:	C4/1
Landscape Type:	C-AL-AD		
Observers:	Team 2	HUC:	02070004 1 1 02

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional Area	23.00	A_{bkf} (ft^2)	Bankfull Riffle Mean Depth	1.02	d_{bkf} (ft)
Bankfull Riffle Width	22.50	W_{bkf} (ft)	Wetted Perimeter $\approx (2 * d_{bkf}) + W_{bkf}$	24.54	W_p (ft)
D_{84} Particle Size at Riffle	70	D_{84} (mm)	D_{84} Particle Size in Feet D_{84} (mm) / 304.8	0.23	D_{84} (ft)
Bankfull Slope	0.007	S_{bkf} (ft / ft)	Hydraulic Radius A_{bkf} / W_p	0.94	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	4.09	R / D_{84} (ft / ft)
Drainage Area	12.0	DA (mi^2)	Shear Velocity $u^* = (gRS)^{½}$	0.46	u^* (ft / sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $\bar{u} = [2.83 + 5.66 * Log\{R / D_{84}\}] u^*$	2.89	ft / sec	66.55	cfs
2. Roughness Coefficient: a) Manning's n from Friction Factor/Relative Roughness (Figs. A-27, A-28) $\bar{u} = 1.49*R^{2/3}*S^{1/2}/n$ $n =$ 0.037	3.23	ft / sec	74.36	cfs
2. Roughness Coefficient: b) Manning's n from Stream Type (Fig. A-29) $\bar{u} = 1.49*R^{2/3}*S^{1/2}/n$ $n =$ 0.031	3.86	ft / sec	88.76	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	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 = NA year	NA	ft / sec	NA	cfs
4. Continuity Equations: b) Regional Curves $\bar{u} = Q / A$	13.52	ft / sec	310.91	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. HUC: 02070004 1102

Stream: Little Conococheague		**Location:** Washington County, Maryland	
Team: 2, Reach 2	**Date:** 4/11/17	**Drainage Area:** 12 mi² 31.08 acre²	

Riffle Channel Dimensions

1. Bankfull Width (W_{bkf}) (ft)	22.50	2. Bankfull Mean Depth (d_{bkf}) (ft)	1.02
3. Width/Depth Ratio (W_{bkf} / d_{bkf})	22.06	4. Bankfull Cross-Sectional Area (A_{bkf}) (ft^2)	23.00
5. Bankfull Maximum Depth (d_{max}) (ft)	1.98	6. Width of Flood-Prone Area (W_{fpa}) (ft)	60.50
7. Entrenchment Ratio (ER) (W_{fpa} / W_{bkf})	2.69		

Channel Pattern / Dimensionless Ratios

8. Belt Width (W_{blt}) (ft)	Mean	182 ft	9. Meander Width Ratio (MWR) (W_{blt} / W_{bkf})	Mean	15.83
	Min			Min	
	Max			Max	
10. Stream Meander Length (L_m) (ft) L_m/λ = Sinuosity	Mean	572 ft	11. Meander Length Ratio (MLR) (L_m / W_{bkf})	Mean	25.42
	Min			Min	
	Max			Max	
12. Linear Wavelength (λ) (ft)	Mean	506 ft	13. Linear Wavelength to Bankfull Width (λ / W_{bkf})	Mean	22.49
	Min			Min	
	Max			Max	
14. Radius of Curvature (R_c) (ft)	Mean	63 ft	15. Radius of Curvature to Bankfull Width (R_c / W_{bkf})	Mean	2.80
	Min			Min	
	Max			Max	

Sinuosity measured in Reach 2

Measured in Reach 3

Channel Particles

Representative Pebble Count

16. D_{16} (mm)	16	17. D_{35} (mm)	26	18. D_{50} (mm)	43
19. D_{84} (mm)	350	20. D_{95} (mm)	2500	21. D_{100} (mm)	3000+

Active Bed Riffle Pebble Count

22. D_{16} (mm)	18	23. D_{35} (mm)	32	24. D_{50} (mm)	40
25. D_{84} (mm)	70	26. D_{95} (mm)	100	27. D_{100} (mm)	180

Classification

28. Sinuosity (k)	1.86	29. Average Water Surface Slope (S)	0.0067
30. Stream Type	C4/1	31. Landscape Type	C-AL-AD

Velocity & Discharge

32. Friction Factor ($\bar{u}$ / u^*)	6.5	33. Relative Roughness (R / D_{84})	4.09
34. Manning's 'n' from Friction Factor / Relative Roughness	0.041	35. Manning's 'n' from Stream Type	0.031
36. Estimated Bankfull Mean Velocity ($\bar{u}_{bkf}$) (ft/sec)	2.89	37. Estimated Bankfull Discharge (cfs)	66.55
38. Estimation Method Selected for Velocity & Discharge	$\bar{u}$ / u^*		

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4/11/17, Little Conococheague Creek, Reach 2, Team 2

Table A-1. List of morphological relations and variables to estimate.

Estimate the Following Morphological Relations and Variables			
1. Bankfull Riffle Width (W_{bkf}) (ft)	22.50	2. Bankfull Riffle Mean Depth (d_{bkf})	1.02
3. Width/Depth Ratio (W_{bkf} / d_{bkf})	22.06	4. Bankfull Riffle Cross-Sectional Area (A_{bkf})	23.00
5. Width of Flood-Prone Area (W_{fpa})	60.50	6. Entrenchment Ratio (ER) (W_{fpa} / W_{bkf})	2.69
7. Sinuosity (k)	1.86	8. Average Water Surface Slope (S)	0.0067
9. D_{50} Particle Size for Reach	43 mm	10. Bankfull Discharge (Q_{bkf})	30.91
11. Landscape Type	C-AL-AD	12. Stream Type	C4/1

Level II Stream Classification

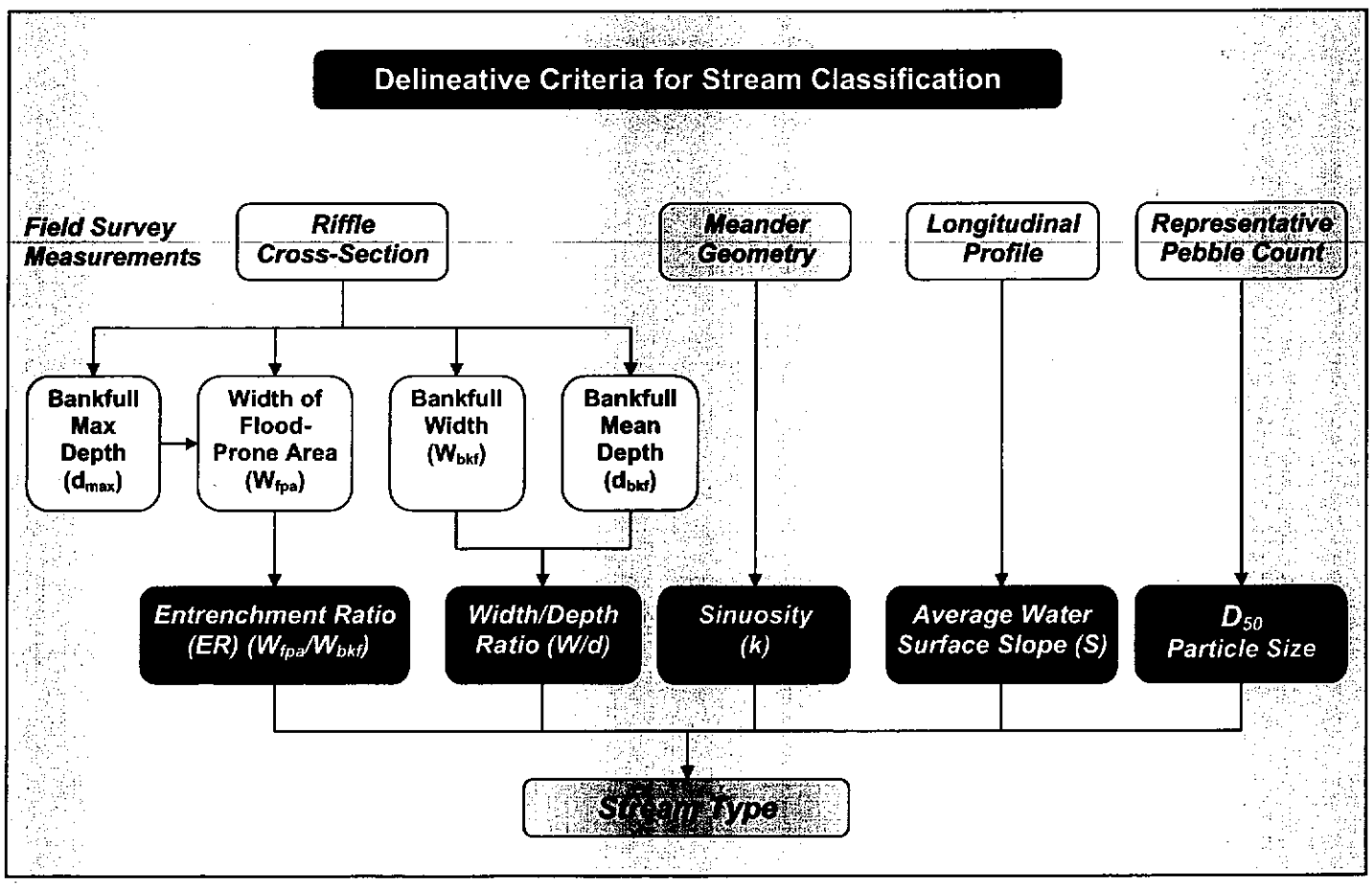

Figure A-1. Field survey methods to obtain delineative criteria for stream classification.

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