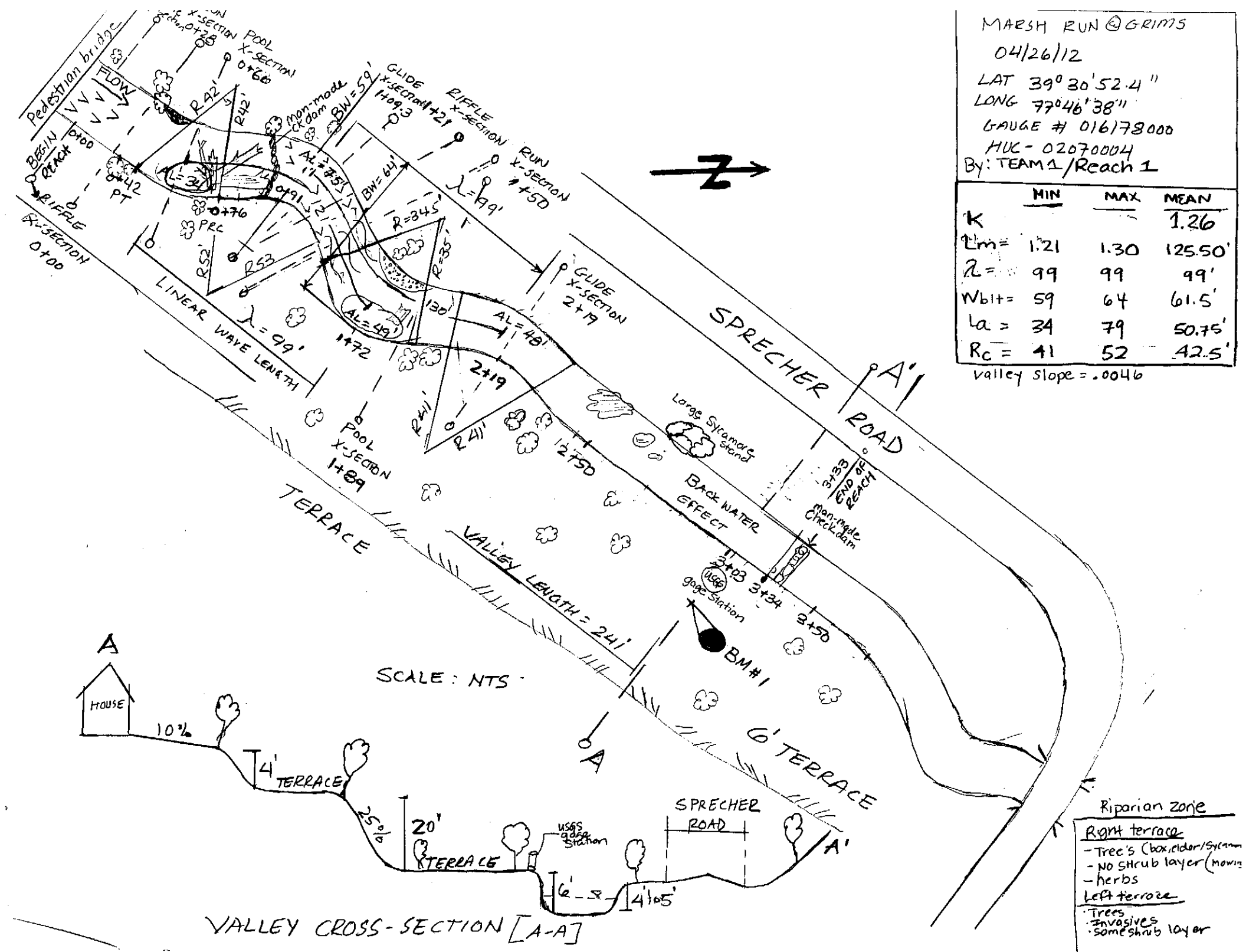
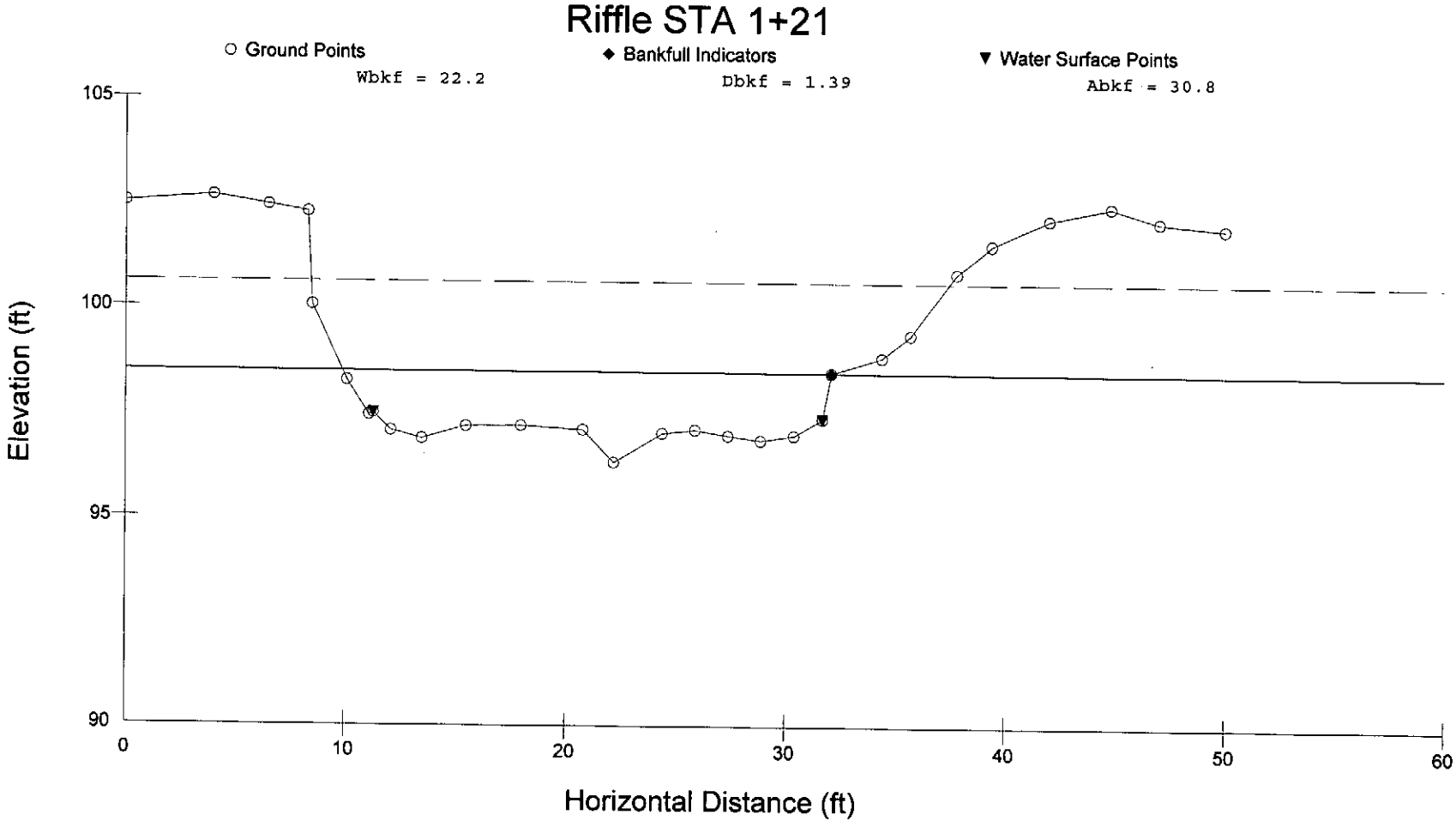
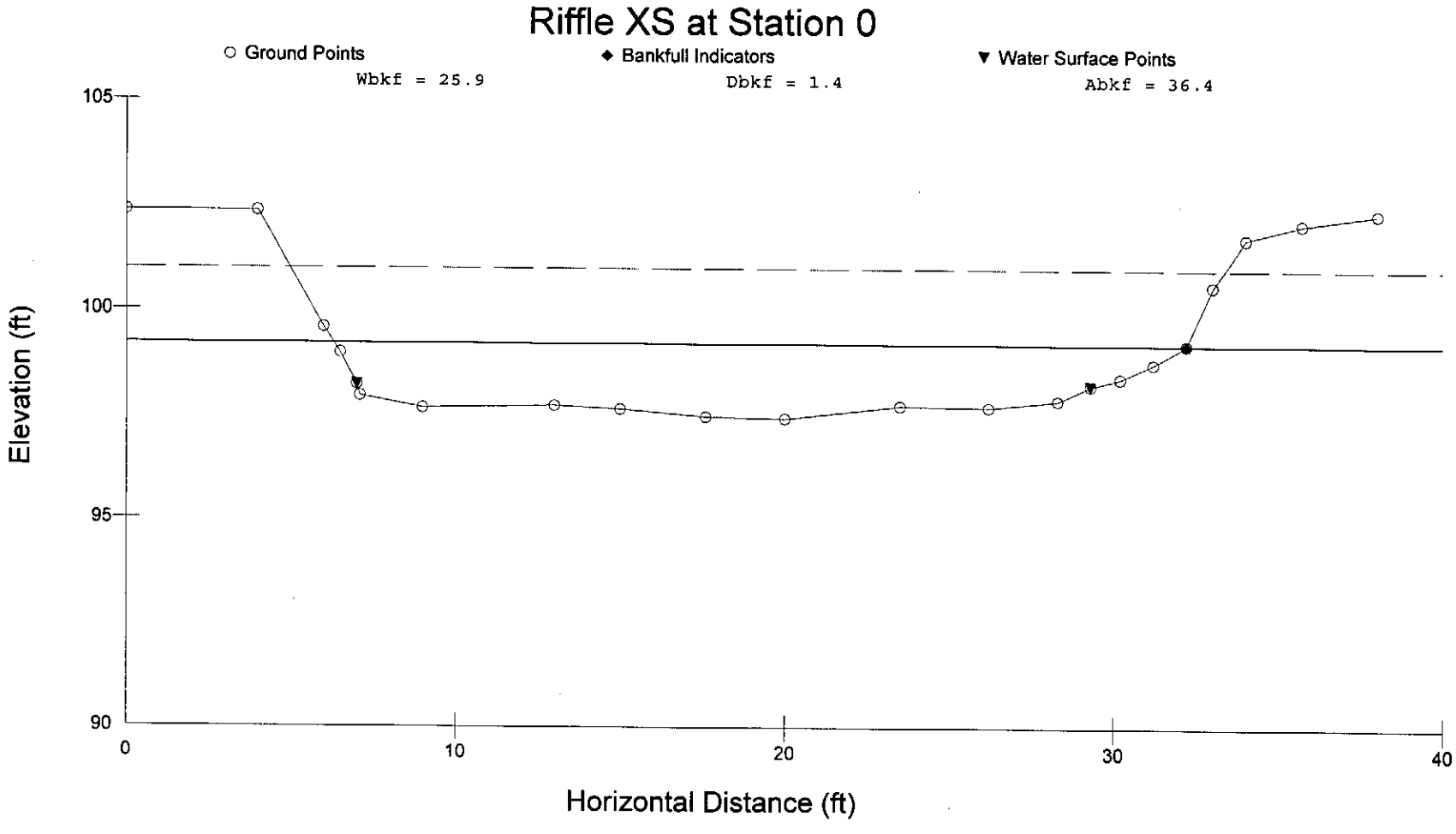
MARSH RUN @ GRIMS
04/26/12
LAT 39° 30' 52.4"
LONG 77° 46' 38"
GAUGE # 016178000
HUC - 02070004
By: TEAM 1 / Reach 1

	MIN	MAX	MEAN
K			1.26
Lm =	1.21	1.30	125.50'
λ =	99	99	99'
Wblt =	59	64	61.5'
La =	34	79	50.75'
Rc =	41	52	42.5'

valley slope = .0046




Riffle STA 1+21
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 22.2
Dbkf = 1.39
Abkf = 30.8
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
60
Horizontal Distance (ft)


Riffle XS at Station 0
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 25.9
Dbkf = 1.4
Abkf = 36.4
105
100
95
90
Elevation (ft)
0
10
20
30
40
Horizontal Distance (ft)

Riffle XS @ STA 0.0 - 84.0 Team 1

SURVEY DATA → CROSS - SECTION 3

SITE: MARSH RUN @ USGS Gauge # 01617800 / Grimes, MD **Date:** 27 Apr 12

Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES COMMENTS REMARKS
29	BM 1	5.51	105.51		100	Benchmark 1
30	0			3.16		
31	4			3.17		TLT
32	6			5.93		
33	6.5			6.53		PT of Alluvium & Limestone
34	7.0			7.29		WEL
35	7.1			7.56		
36	9.0			7.85		
37	13.0			7.79		
38	15.0			7.87		
39	17.6			8.05		
40	20.0			8.09		Thalwag
41	23.5			7.78		
42	26.2			7.81		
43	28.3			7.64		
44	29.3			7.28		WER
45	30.2			7.10		
46	31.2			6.75		IBR
47	32.2			6.30		BFR
48	33.0			4.91		
49	34.0			3.81		TRT
50	35.7			3.47		
51	38.0			3.22		
52						
53						3.58 Flood Prone Elevation
54						~30' Flood Prone width
55						~26' BKF
56						
57						
58						
59						

7.28 / 5.97 / 1.31

7.28 / 6.30 / .98

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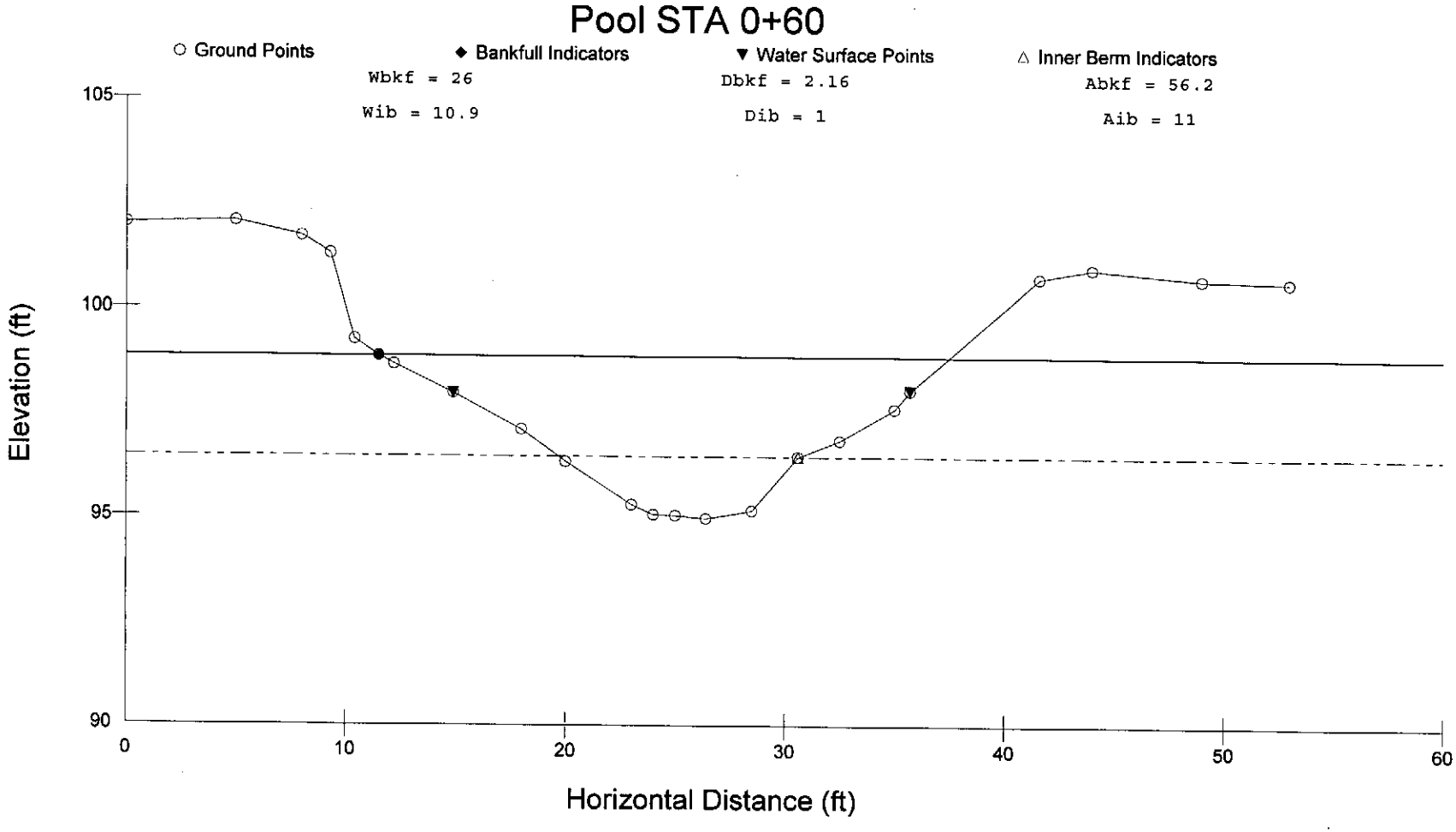
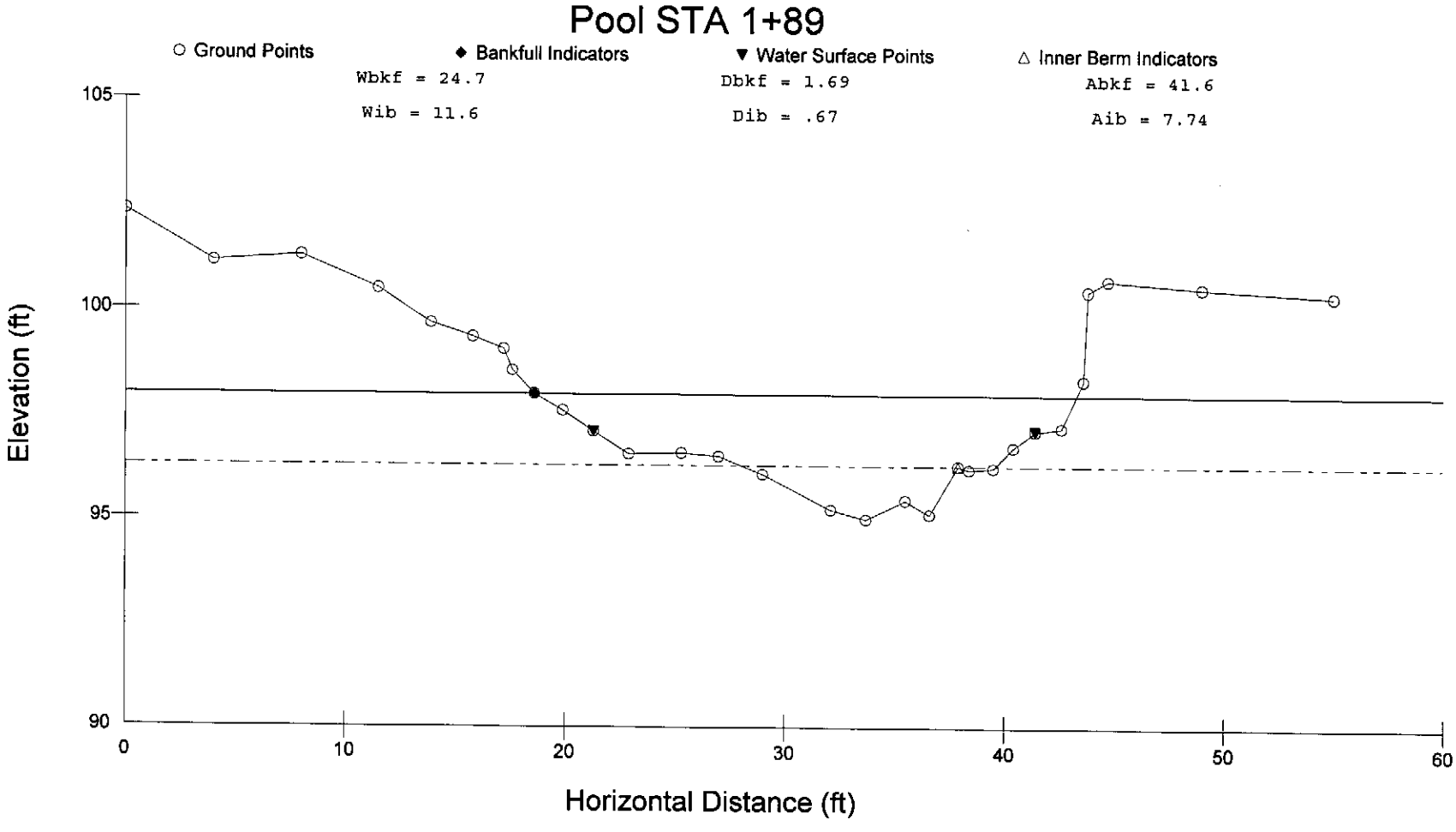

Pool STA 0+60
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
△ Inner Berm Indicators
Wbkf = 26
Wib = 10.9
Dbkf = 2.16
Dib = 1
Abkf = 56.2
Aib = 11
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
60
Horizontal Distance (ft)


Pool STA 1+89
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
△ Inner Berm Indicators
Wbkf = 24.7
Wib = 11.6
Dbkf = 1.69
Dib = .67
Abkf = 41.6
Aib = 7.74
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
60
Horizontal Distance (ft)

SURVEY DATA → **CROSS - SECTION** 8

SITE: STA ~~WP~~ 189 POOL-2 Date:

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES COMMENTS 'REMARKS
29		4.70	104.70			
30	0			2.38		
31	4			3.57		
32	8			3.43		
33	11.5			4.22		
34	13.9			5.03		
35	15.8			5.36		
36	17.2			5.64		TOB
37	17.6			6.16		
38	18.6			6.71	97.99	BKF
39	19.9			7.11		
40	21.3			7.61	~~97.90~~ 97.09	INSEL
41	22.9			8.15		
42	25.3			8.12		
43	27.0			8.20		
44	29.0			8.63		
45	32.1			9.47		
46	33.7			9.70	95.0	THALWEG
47	35.5			9.24		
48	36.6			9.58		
49	37.9			8.42		
50	38.4			8.50		
51	39.5			8.46		TOE SLOPE
52	40.4			7.97		
53	41.4			7.58	97.12	INSEL
54	42.6			7.50		
55	43.6			6.86		
56	43.8			4.24		TOB
57	44.7			3.99		
58	49.0			4.16		
59	55.0			4.33		

98.4
97.64
~~97.65~~
~~96.52~~

7.58
6.71

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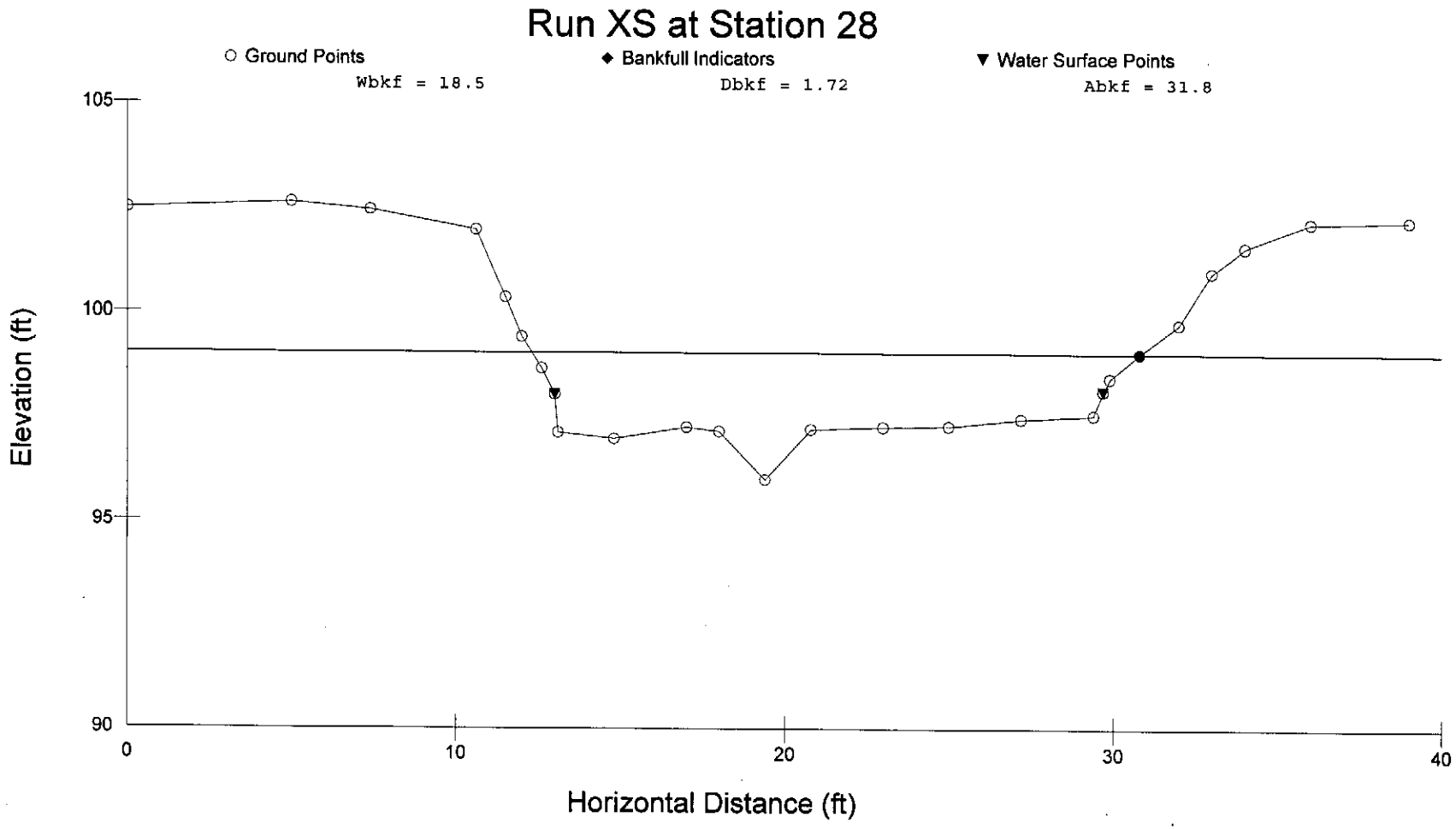
Run XS at Station 28
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 18.5
Dbkf = 1.72
Abkf = 31.8
105
100
95
90
Elevation (ft)
0
10
20
30
40
Horizontal Distance (ft)

RUN @ STA - 28.0

Team 1

SURVEY DATA → CROSS - SECTION 4

SITE: Date:

Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES COMMENTS REMARKS
29	BM 1	5.51	105.51	[illegible]	100	BM 1
30	0			3.05		
31	5			2.91		
32	7.4			3.09		TFT
33	10.6			3.57		
34	11.5			5.16		
35	12.0			6.09		
36	12.6			6.84		
37	13.0			7.36		WEL
38	13.1			8.37		
39	14.8			8.52		
40	17.0			8.24		[illegible]
41	18.0			8.34		
42	19.4			9.5		Thalweg
43	20.8			8.29		
44	23.0			8.23		
45	25.0			8.21		
46	27.2			8.03		
47	29.4			7.94		
48	29.7			7.36		WER
49	29.9			7.05		
50	30.8			6.47		BFR
51	32.0			5.77		
52	33.0			4.54		
53	34.0			3.97		
54	36.0			3.40		TRT
55	39.0			3.35		
56						
57						
58						
59						

7.44
6.47
.97

7.34 6.
6.47
.87

7.36
6.45
.91

7.36
6.47
.99

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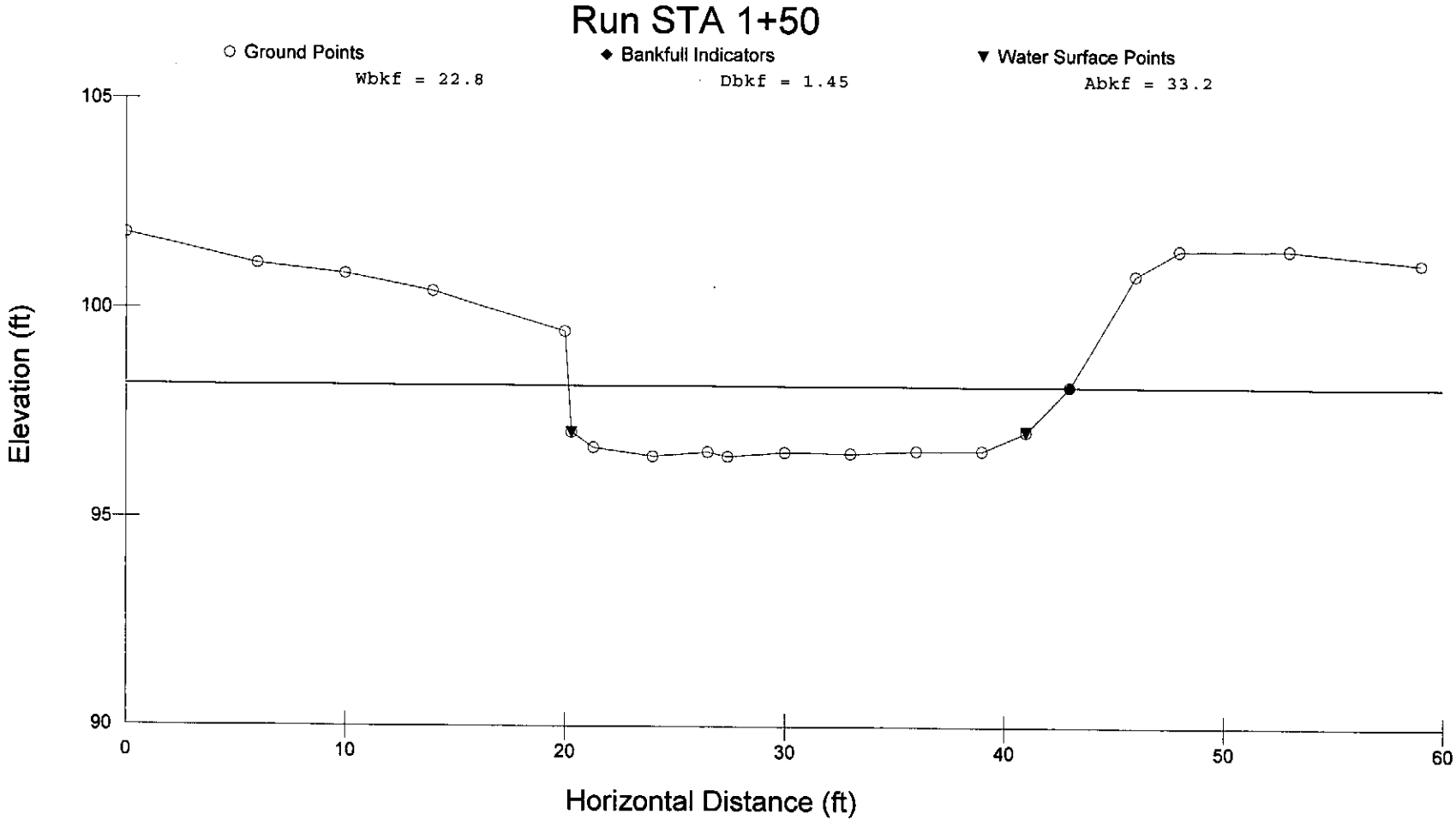
Run STA 1+50
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 22.8
Dbkf = 1.45
Abkf = 33.2
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
60
Horizontal Distance (ft)

SURVEY DATA → CROSS - SECTION 7

SITE: RUN **Date:**

Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES COMMENTS REMARKS
29		4.98	104.98			
30	0.08			3.22		
31	6.0			3.92		
32	10.0			4.16		
33	14.0			4.57		
34	20.0			5.51		
35	20.3			7.91	97.07	WS
36	21.3			8.28		
37	24.0			8.48		
38	26.5			8.37		
39	27.4			8.48		
40	30.0			8.38		
41	33.0			8.40		
42	36.0			8.34		
43	39.0			8.33		
44	41.0			7.88		WS=Ground
45	43.0			6.80		BKF
46	46.0			4.16		TOB
47	48.0			3.56		
48	53.0			3.54		
49	59.0			3.85		
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						

~~LB~~ LEW 97.07

REW 97.1

BKF 98.18

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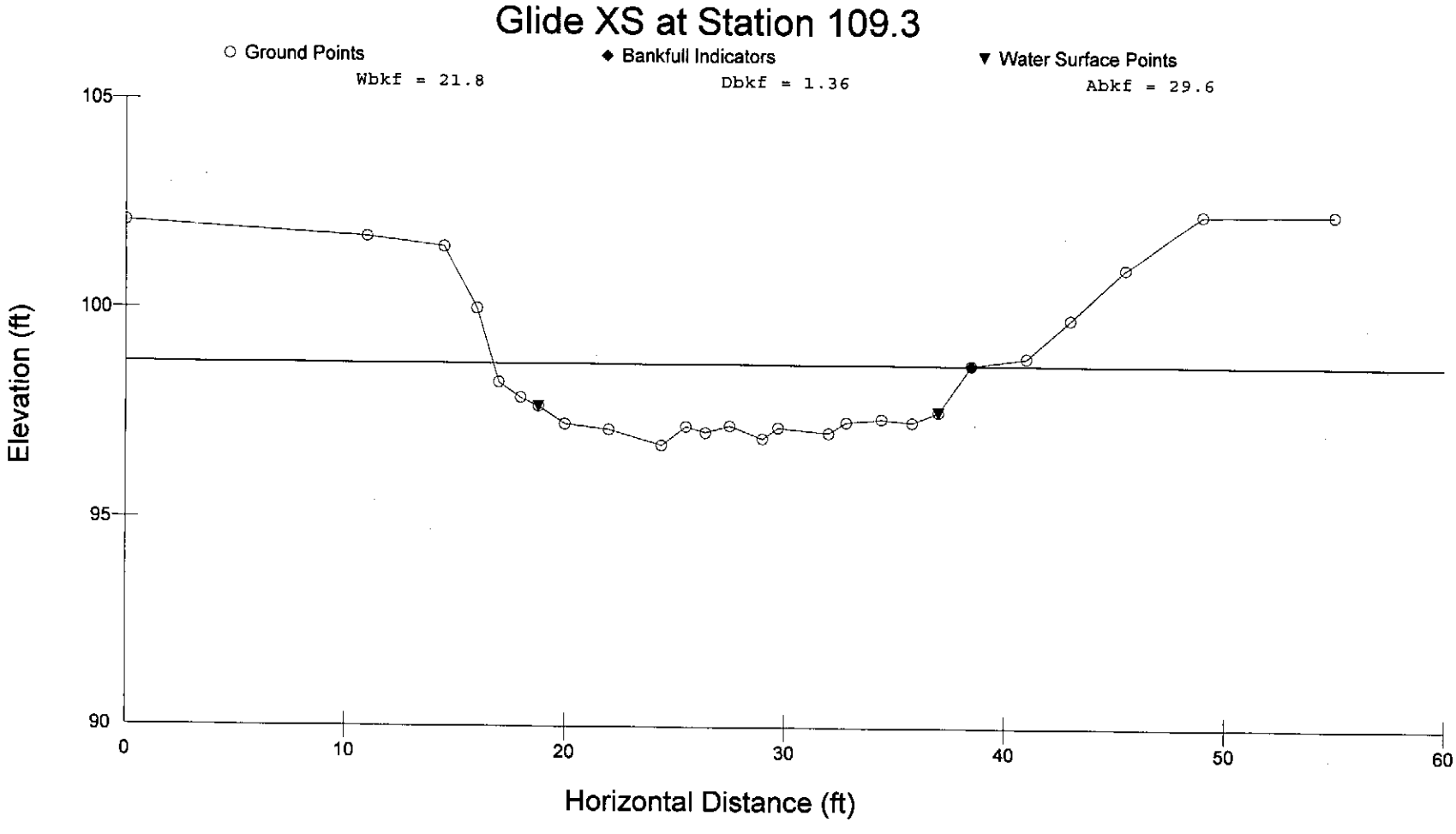
Glide XS at Station 109.3
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 21.8
Dbkf = 1.36
Abkf = 29.6
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
60
Horizontal Distance (ft)

Glide XS @ STA ~~25.5~~ 109.3

Team 1

SURVEY DATA ⟶ **CROSS-SECTION 2**

SITE: Marsh Run @ U.S.G.S. Gauge #01617800 / Brimes, MD **Date:** 24 Apr 12

Item	STATION (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	NOTES / COMMENTS / REMARKS
29	BM 1	5.51	105.51		100	Benchmark 1
30	0			3.43		
31	11			3.79		TLT
32	14.5			4.02		
33	16.0			5.49		
34	17.0			7.25		
35	18.0			7.60		
36	18.8			7.81		WEL
37	20.0			8.23		
38	22.0			8.36		
39	24.4			8.63		Thalweg
40	25.5			8.28		
41	26.4			8.42		
42	27.5			8.26		
43	29.0			8.56		
44	29.7			8.30		
45	32.0			8.42		
46	32.8			8.16		
47	34.4			8.08		
48	35.8			8.16		
49	37.0			7.91		WER
50	38.5			6.80		BFR
51	41.0			6.62		
52	43.0			5.70		
53	45.5			4.48		
54	49.0			3.23		TRT
55	55.0			3.21		
56						
57						
58						
59						

7.81 BF
6.81
1.00

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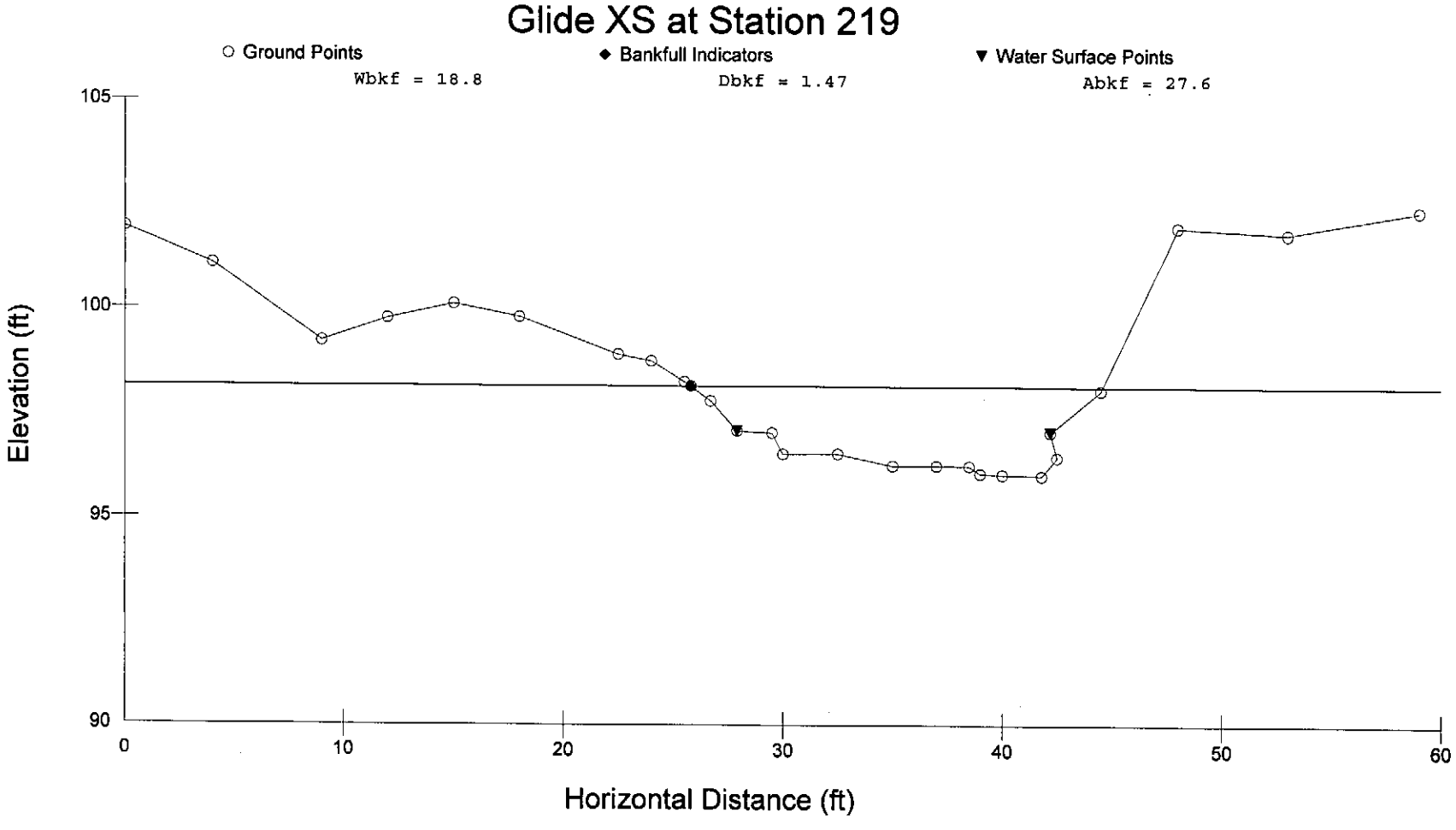
Glide XS at Station 219
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 18.8
Dbkf = 1.47
Abkf = 27.6
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
60
Horizontal Distance (ft)

Glide [redacted] X-S @ station ~~135.0~~ 219.0 Team 1

SURVEY DATA → CROSS-SECTION 1

SITE: Marsh Run Date: 26 Apr 12

Location: Near USGS Gauge # 01617800 @ Grimes, MD.

Party / Notes: Team 1 HUC: [redacted]

Item	Distance, Point, or STATION ft	Back-Sight BS ft	Height of Instrument HI ft	Fore-Sight FS ft	Elevation ft	REMARKS / COMMENTS / NOTES
1	BM 1	5.51	105.51		100	Benchmark
2	0			3.59		TLT (Top of Left Terrace)
3	4			4.44		
4	9			6.29		
5	12			5.75		
6	15			5.40		
7	18			5.72		
8	22.5			6.60		
9	24			6.76		
10	25.5			7.25		
11	25.8			7.35		BF (Left)
12	26.7			7.70		[redacted]
13	27.9			[redacted]	8.41	WEL
14	29.5			8.46		Top of Rock
15	30			8.97		Below Rock 8.41 − 7.35 = 1.06
16	32.5			8.86		
17	35.0			9.24		
18	37.0			9.24		
19	38.5			9.25		9.48 − 7.35 = 2.13
20	39.0			9.48		
21	40.0			9.45		
22	41.8			9.48		Thalweg
23	42.5			9.04		
24	42.2			8.44		WER
25	44.5			7.44		
26	48			3.59		TRT
27	53			3.74		
28	59			3.19		

15'

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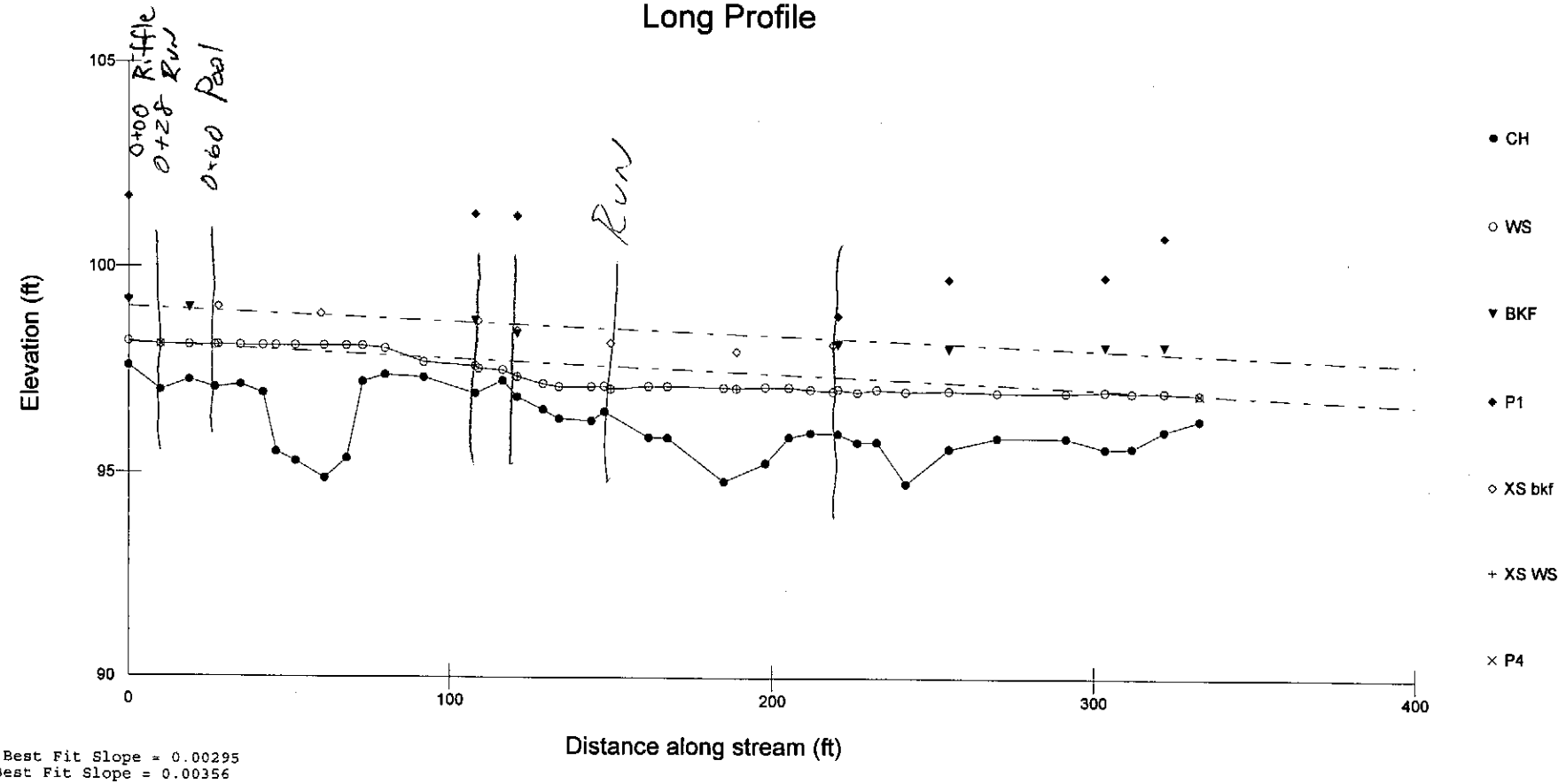

BKF Best Fit Slope = 0.00295
P4 Best Fit Slope = 0.00356

SURVEY DATA → LONGITUDINAL PROFILE 1

SITE: Marsh Run @ Grimes, Washington County Date: 04/26/12

Location: Reach #1

Party / Notes: Team 1, Tim + Amber HUC: _____

	Distance, Point, or	Back-Sight	Height of Instrument	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	Rm-3	8.14		[illegible]	[illegible]							
2	Rm-4			2.82								
3	Rm-3	8.14										
4												
5	[illegible]	5.47	105.47		100							
6	30	87		7.6		7.73						Top Riffle
7	0	84										XS 1 - riffle
8	8.0	92		8.13		7.76						Top Run
9	24.0	108		8.52		[illegible]		6.76		4.16		Run - midway 1.09
10	32.5	116.5		8.21		7.94						Top riffle
11	37.0 / 50.0	121 / 134		8.60 / 9.17		8.11		7.07		4.20		XS2 - mid riffle 1.04
12	60.0	144		9.17		8.3		–		–		riffle bottom Riffle, top run
13	64.0	148		8.94		8.3		–		–		Run mid
14	77.8	161.8		9.57		8.33		–		–		bottom run / top pool
15	83.6	167.6		9.58		8.33		–		–		bottom pool
16	101.0	185		10.64		8.36		–		–		bottom pool
17	114.0	198		10.19		8.34		7.30		6.31		transition pool glide 1.04
18	121.3	205.3		9.56		8.35		–		–		start Glide
19	128.0	212		9.45		8.40		–		–		run
20	136.5	220.5		9.47		8.39		7.31		6.61		run 1.08
21	142.5	226.5		9.68		8.46						run
22	148.5	232.5		9.67		8.39						start/end pool / run
23	157.5	241.5		10.68		8.44						deepest pool
24	171.0	255		9.85		8.42		7.41		5.72		pool
25	186	270		9.56		8.46						glide / Run
26	207.5	291.5		9.56		8.46						Run
27	219.6	303.6		9.82		8.4		7.35		5.66		Run @ gage/plate 1.08

45

1.24

1.08

2.32 - BF @ staff

Staff plate 1.24 - BKF

8.46

7.35

1.11

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SURVEY DATA → LONGITUDINAL PROFILE 2

SITE: Marsh Run @ Grimes, Washington Co **Date:** 4/26/12

Location: Reach #1

Party / Notes: Team 1, TF A **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	228	312		9.80		8.46						Run
29	238	322		9.38		8.45		7.34		4.68		Run
30	249	333		9.12		8.50						Run → end of segment just above riffle
31	45	129		8.90		9.28						
32	-84	0		7.87		7.28		6.30		3.76		Riffle top of reach below bridge
33	-74	10		8.46		7.35						riffle
34	-65	19		8.21		7.36		6.47				bot riffle
35	-57	27		8.39		7.37						start Run
36	-49	35		8.32		7.38						Run
37	-42	42		8.52		7.37						Pool/Run
38	-38	46		9.95		7.37						Pool
39	-32	52		10.17		7.37						Pool
40	-23	61		10.58		7.37						Pool
41	-16	68		10.10		7.37						Pool
42	-11	73		8.24		7.37						Glide
43	-4	80		8.07		7.43						Glide
44												
45												
46												
47												
48												
49												
50												
51												
52												
53												
54												

jam in stream

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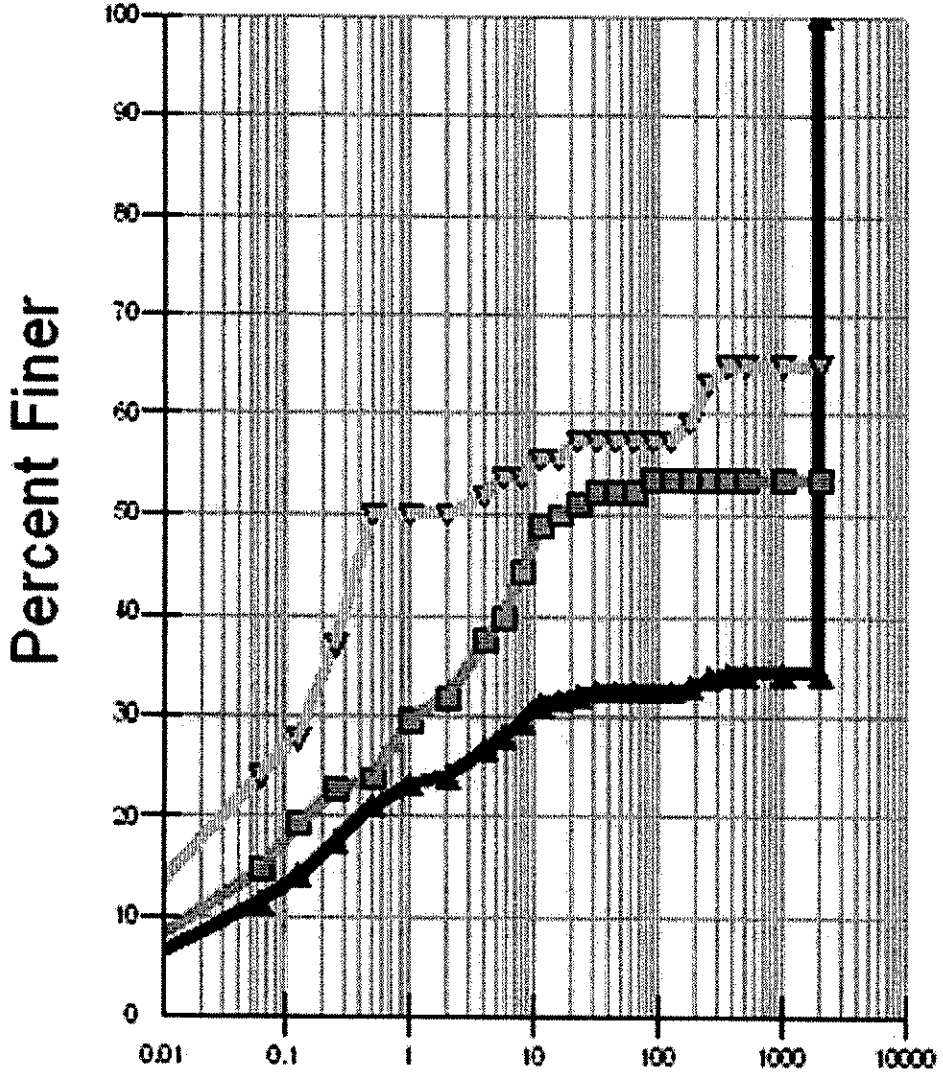
Representative pebble count

composite for classification

D_{50} = Bedrock



Percent Retained
0
20
40
60
80
Particle Size (mm)
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.50
0.50 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
128 - 180
180 - 256
256 - 362
Bedrock
composite

Representative Pebble Count

Classification

Site: Marsh Run | Date: 4/26/12
Location: Thru | HUC:
Party: 1 TEAM

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: more			Reach:			Reach:		
							Date:			Date:			Date:		
	Silt / Clay	< .062	S/C				13	4		11					
	Very Fine	.062 - .125	SAND				3	1		2					
	Fine	.125 - .25	SAND				2	1		2 3					
	Medium	.25 - .50	SAND							3 4					
	Coarse	.50 - 1.0	SAND				2	11							
.04 - .08	Very Coarse	1.0 - 2	SAND				1	1							
.08 - .16	Very Fine	2 - 4	GRAVEL				4	9		1					
.16 - .22	Fine	4 - 5.7	GRAVEL					t 1		1					
.22 - .31	Fine	5.7 - 8	GRAVEL				2	7							
.31 - .44	Medium	8 - 11.3	GRAVEL				2	1		1					
.44 - .63	Medium	11.3 - 16	GRAVEL				1								
.63 - .89	Coarse	16 - 22.6	GRAVEL							1					
.89 - 1.3	Coarse	22.6 - 32	GRAVEL				1								
1.3 - 1.8	Very Coarse	32 - 45	GRAVEL												
1.8 - 2.5	Very Coarse	45 - 64	GRAVEL												
2.5 - 3.5	Small	64 - 90	COBBLE												
3.5 - 5.0	Small	90 - 128	COBBLE												
5.0 - 7.1	Large	128 - 180	COBBLE							1					
7.1 - 10.1	Large	180 - 256	COBBLE							1 1					
10.1 - 14.3	Small	256 - 362	BOULDER							1					
14.3 - 20	Small	362 - 512	BOULDER												
20 - 40	Medium	512 - 1024	BOULDER												
40 - 80	Large-Vry Large	1024 - 2048	BOULDER												
	Bedrock		BDRK				46	85		16					
Stream Type:		Valley Type:				TOTAL→				43					

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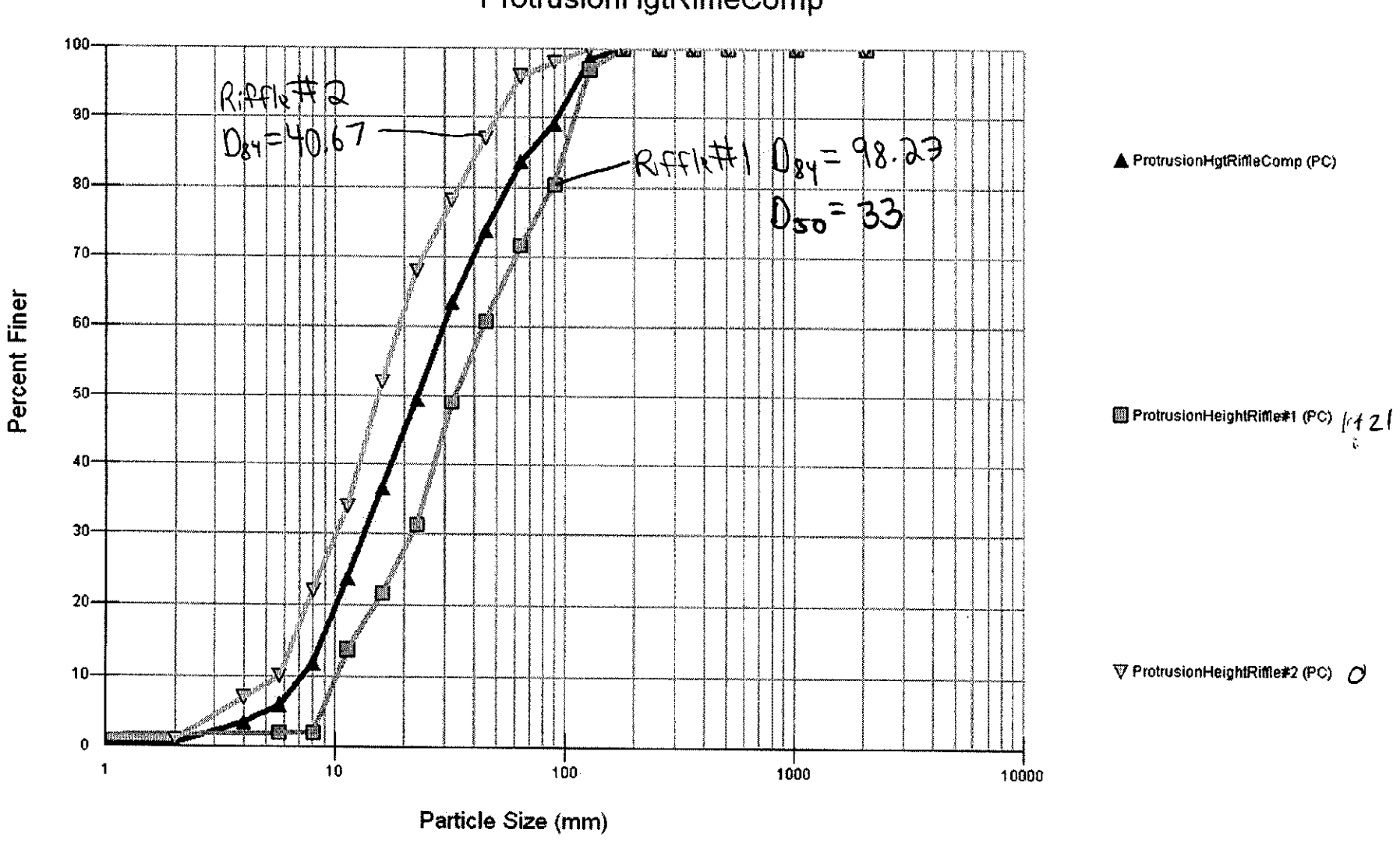
ProtrusionHgtRiffleComp
Percent Finer
Particle Size (mm)
100
90
80
70
60
50
40
30
20
10
0
1
10
100
1000
10000
Riffle #2
D84=40.67
Riffle #1 D84=98.23
D50=33
ProtrusionHgtRiffleComp (PC)
ProtrusionHeightRiffle#1 (PC) 1121
ProtrusionHeightRiffle#2 (PC) 0

Active Ch. Riffle #1 Protrusion Height

Hydraulic [redacted]

Site: Marsh Run Date: 4/26/12

Location: 37 cross HUC:

Party: #1 TEAM

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:			Reach:		
							Date:			Date:			Date:		
	Silt / Clay	< .062	S/C	[redacted]											
	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		••			2								
.22 - .31	Fine	5.7 - 8													
.31 - .44	Medium	8 - 11.3		[redacted]			12								
.44 - .63	Medium	11.3 - 16		[redacted]			8								
.63 - .89	Coarse	16 - 22.6		[redacted]			10								
.89 - 1.3	Coarse	22.6 - 32		[redacted]			18								
1.3 - 1.8	Very Coarse	32 - 45		[redacted]			12								
1.8 - 2.5	Very Coarse	45 - 64		[redacted]			11								
2.5 - 3.5	Small	64 - 90	COBBLE	[redacted]			9								
3.5 - 5.0	Small	90 - 128		[redacted]			17								
5.0 - 7.1	Large	128 - 180		••			3								
7.1 - 10.1	Large	180 - 256													
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		DR												
Stream Type:			***Valley Type:***			TOTAL →	102								

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Active bed

Protrusion heights for hydraulic calcs.

Site: Marsh Run Riffle #2 Date:

Location: HUC:

Party:

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
	Silt / Clay	< .062	S/C												
	Very Fine	.062 - .125	SAND												
	Fine	.125 - .25													
	Medium	.25 - .50													
	Coarse	.50 - 1.0													
.04 - .08	Very Coarse	1.0 - 2		•			1								
.08 - .16	Very Fine	2 - 4	GRAVEL	T.			6								
.16 - .22	Fine	4 - 5.7		.			3								
.22 - .31	Fine	5.7 - 8		⊠.			12								
.31 - .44	Medium	8 - 11.3		⊠.			12								
.44 - .63	Medium	11.3 - 16		⊠□			18								
.63 - .89	Coarse	16 - 22.6		⊠T.			16								
.89 - 1.3	Coarse	22.6 - 32		⊠			10								
1.3 - 1.8	Very Coarse	32 - 45		⊠			9								
1.8 - 2.5	Very Coarse	45 - 64		⊠			9								
2.5 - 3.5	Small	64 - 90	COBBLE	•			2								
3.5 - 5.0	Small	90 - 128		•			2								
5.0 - 7.1	Large	128 - 180													
7.1 - 10.1	Large	180 - 256													
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												

Stream Type: ***Valley Type:*** *TOTAL→*

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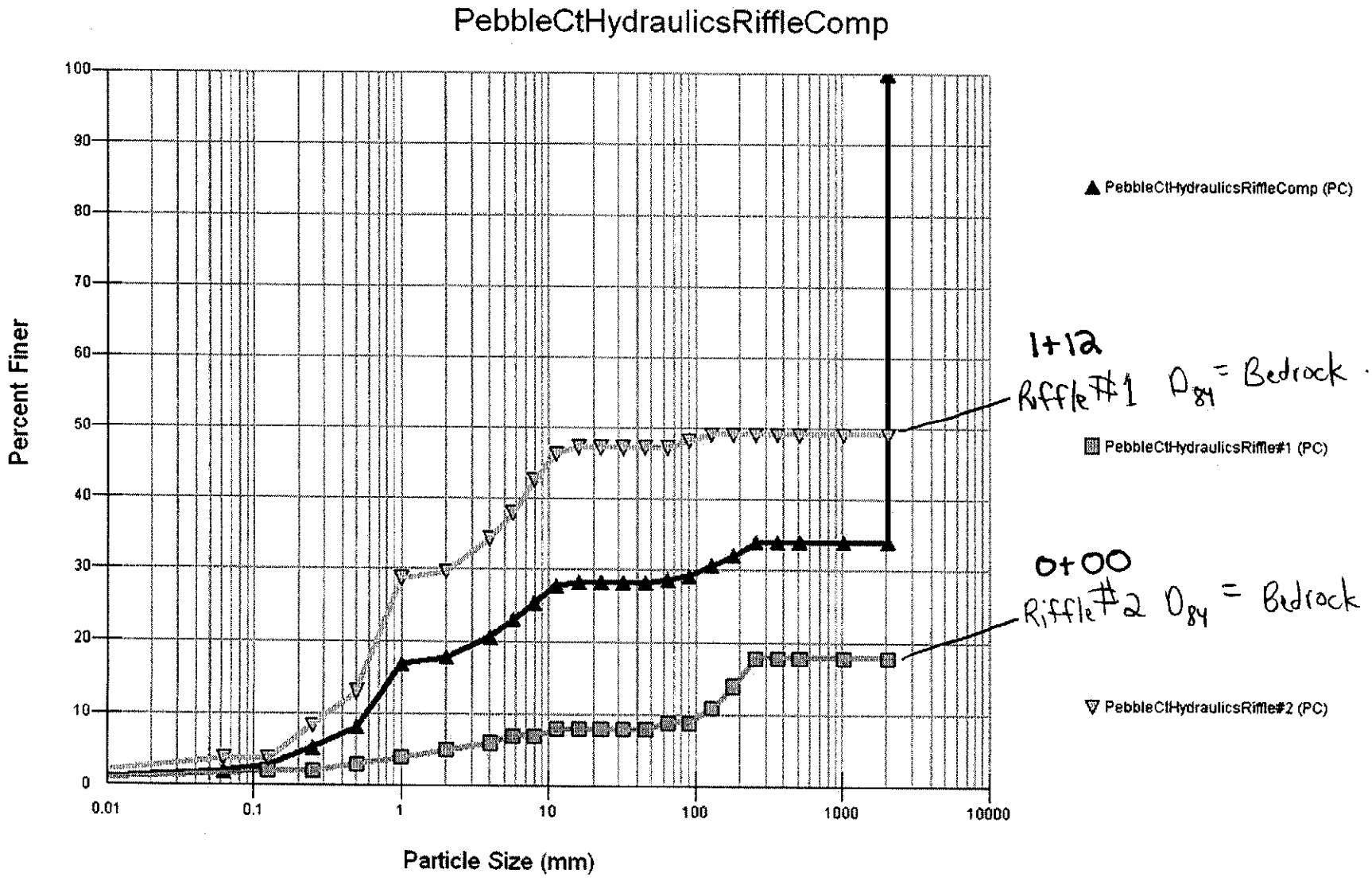
PebbleCtHydraulicsRiffleComp
Percent Finer
Particle Size (mm)
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
PebbleCtHydraulicsRiffleComp (PC)
PebbleCtHydraulicsRiffle#1 (PC)
PebbleCtHydraulicsRiffle#2 (PC)
1+12
Riffle #1 D_{84} = Bedrock.
0+00
Riffle #2 D_{84} = Bedrock

Pebble Active Ch. Riffle #1

Site: Marsh Run
Date: 4/26/12
Location: [illegible]
HUC:
Party: #1 Team

Inches	PARTICLE	Millimeters		Dot Count for RIFFLE 1		POOL 2	COMP. 3	RIFFLE (1) Reach: Date: for TOT #	ITEM %	% CUM	POOL (2) Reach: Date: TOT #	ITEM %	% CUM	COMPOSITE (3) Reach: Date: TOT #	ITEM %	% CUM
	Silt / Clay	< .062	S/C	90	10											
	Very Fine	.062 - .125	SAND					2								
	Fine	.125 - .25	SAND													
	Medium	.25 - .50	SAND					1								
	Coarse	.50 - 1.0	SAND					1								
.04 - .08	Very Coarse	1.0 - 2	SAND					1								
.08 - .16	Very Fine	2 - 4	GRAVEL					1								
.16 - .22	Fine	4 - 5.7	GRAVEL					1								
.22 - .31	Fine	5.7 - 8	GRAVEL													
.31 - .44	Medium	8 - 11.3	GRAVEL					1								
.44 - .63	Medium	11.3 - 16	GRAVEL													
.63 - .89	Coarse	16 - 22.6	GRAVEL													
.89 - 1.3	Coarse	22.6 - 32	GRAVEL													
1.3 - 1.8	Very Coarse	32 - 45	GRAVEL													
1.8 - 2.5	Very Coarse	45 - 64	GRAVEL					1								
2.5 - 3.5	Small	64 - 90	COBBLE													
3.5 - 5.0	Small	90 - 128	COBBLE					2								
5.0 - 7.1	Large	128 - 180	COBBLE					3								
7.1 - 10.1	Large	180 - 256	COBBLE					4								
10.1 - 14.3	Small	256 - 362	BOULDER													
14.3 - 20	Small	362 - 512	BOULDER													
20 - 40	Medium	512 - 1024	BOULDER													
40 - 80	Large-Vry Large	1024 - 2048	BOULDER													
	Bedrock		DRK	⊠⊠⊠				83								
Stream Type:			Valley Type:				TOTAL→	102								

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Active bed Pebble counts for hydraulics, Riffle #2

Site: Marsh Run Riffle #2 Date:

Location: HUC:

Party:

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:			Reach:		
							Date:			Date:			Date:		
	Silt / Clay	< .062	S/C	⁚			4								
	Very Fine	.062 - .125	SAND												
	Fine	.125 - .25		⁞			5								
	Medium	.25 - .50		⁞			5								
	Coarse	.50 - 1.0		⊠ ⁞			17								
.04 - .08	Very Coarse	1.0 - 2					1								
.08 - .16	Very Fine	2 - 4	GRAVEL	⁞			5								
.16 - .22	Fine	4 - 5.7		⁞			4								
.22 - .31	Fine	5.7 - 8		⁞			5								
.31 - .44	Medium	8 - 11.3		⁞			4								
.44 - .63	Medium	11.3 - 16					1								
.63 - .89	Coarse	16 - 22.6													
.89 - 1.3	Coarse	22.6 - 32													
1.3 - 1.8	Very Coarse	32 - 45													
1.8 - 2.5	Very Coarse	45 - 64													
2.5 - 3.5	Small	64 - 90	COBBLE	⁚			1								
3.5 - 5.0	Small	90 - 128		⁚			1								
5.0 - 7.1	Large	128 - 180													
7.1 - 10.1	Large	180 - 256													
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	⊠ ⊠ ⊠ ⊠ ⁞			55								
						TOTAL →	108								

Stream Type: **Valley Type:**

Worksheet 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007). Riffle not representative

Bankfull VELOCITY & DISCHARGE Estimates

Stream:	Marsh Run	Location:	Reach - Reach 1 Riffle #2 010
Date:		Stream Type:	F
Observers:		Valley Type:	VIII
		HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	36.38	A_{bkf} (ft^2)	Bankfull Riffle Mean DEPTH	1.40	d_{bkf} (ft)
Bankfull Riffle WIDTH	25.89	W_{bkf} (ft)	Wetted PERIMETER $= (2 * d_{bkf}) + W_{bkf}$	26.89	W_p (ft)
D_{84} at Riffle	40.67	Dia. (mm)	D_{84} (mm) / 304.8	0.13	D_{84} (ft)
Bankfull SLOPE	0.0030	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	1.35	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R(ft) / D_{84} (ft)	10.15	R / D_{84}
Drainage Area	18.9	DA (mi^2)	Shear Velocity $u^* = (gRS)^{½}$	0.361	u^* (ft/sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66 * Log\ \{ R / D_{84} \}\ ]\ u^*$	3.08	ft / sec	112.11	cfs
2. Roughness Coefficient: a) Manning's n from Friction Factor / Relative Roughness (Figs. 2-18, 2-19) $u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0.0306	3.26	ft / sec	118.42	cfs
2. Roughness Coefficient: b) Manning's n from Stream Type (Fig. 2-20) $u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0	0.00	ft / sec	0.00	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 Stream Types A1, A2, A3, B1, B2, B3, C2 & E3 $n =$ 0.041	2.44	ft / sec	88.59	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach (Leopold, Wolman and Miller)	3.20	ft / sec	116.27	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Chezy C	0.00	ft / sec	0.00	cfs
4. Continuity Equations: a) Regional Curves $u = Q / A$ Return Period for Bankfull Discharge $Q =$ 0.0 year	0.00	ft / sec	0.00	cfs
4. Continuity Equations: b) USGS Gage Data $u = Q / A$	0.00	ft / sec	0.00	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 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007).

Bankfull VELOCITY & DISCHARGE Estimates

Stream:	Marsh Run			Location:	Reach - Reach 1 Riffle # 1 1+21
Date:	4/26/2012	Stream Type:	F1	Valley Type:	VIII
Observers:				HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	30.84	A_{bkf} (ft^2)	Bankfull Riffle Mean DEPTH	1.39	d_{bkf} (ft)
Bankfull Riffle WIDTH	22.20	W_{bkf} (ft)	Wetted PERMIMETER ~ $(2 * d_{bkf}) + W_{bkf}$	23.87	W_p (ft)
D50 - D_{84} at Riffle	33.08	Dia. (mm)	D_{84} (mm) / 304.8	0.11	D_{84} (ft)
Bankfull SLOPE	0.0030	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	1.29	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R(ft) / D_{84} (ft)	11.84	R / D_{84}
Drainage Area	18.9	DA (mi^2)	Shear Velocity $u^* = (gRS)^{½}$	0.353	u* (ft/sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66 * Log\ (R / D_{84})\ ]\ u^*$	3.15	ft / sec	97.17	cfs
2. Roughness Coefficient: a) Manning's n from Friction Factor / Relative Roughness (Figs. 2-18, 2-19) $u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0.029	3.33	ft / sec	102.70	cfs
2. Roughness Coefficient: b) Manning's n from Stream Type (Fig. 2-20) $u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0	0.00	ft / sec	0.00	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 Stream Types A1, A2, A3, B1, B2, B3, C2 & E3 $n =$ 0.041	2.34	ft / sec	72.29	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach (Leopold, Wolman and Miller)	3.37	ft / sec	103.84	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Chezy C	0.00	ft / sec	0.00	cfs
4. Continuity Equations: a) Regional Curves $u = Q / A$ Return Period for Bankfull Discharge $Q =$ 1.8 year	3.08	ft / sec	95.00	cfs
4. Continuity Equations: b) USGS Gage Data $u = Q / A$	3.08	ft / sec	95.00	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 "protrustion 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 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007). Method not chosen

Bankfull VELOCITY & DISCHARGE Estimates

Stream:	Marsh Run			Location:	Sta. 1+21 (D84, protrusion) Cliff #1
Date:	4/26/2012	Stream Type:	F1	Valley Type:	VIII
Observers:				HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	~~27.63~~ 20.84	A_{bkf} (ft^2)	Bankfull Riffle Mean DEPTH	~~1.47~~ 1.39	d_{bkf} (ft)
Bankfull Riffle WIDTH	~~18.78~~ 22.20	W_{bkf} (ft)	Wetted PERMIMETER $= (2 * d_{bkf}) + W_{bkf}$	~~20.65~~ 25.87	W_p (ft)
D_{84} at Riffle	98.23	Dia. (mm)	D_{84} (mm) / 304.8	0.32	D_{84} (ft)
Bankfull SLOPE	0.0030	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	1.34	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R(ft) / D_{84} (ft)	4.16	R / D_{84}
Drainage Area	18.9	DA (mi^2)	Shear Velocity $u^* = (gRS)^{½}$	0.360	u^* (ft/sec)

ESTIMATION METHODS		Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness	$u = [\ 2.83 + 5.66 * Log\ \{ R / D_{84} \}\ ]\ u^*$	2.28	ft / sec	62.87	cfs
2. Roughness Coefficient: a) Manning's n from Friction Factor / Relative Roughness (Figs. 2-18, 2-19)	$u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0.0398	2.48	ft / sec	68.63	cfs
2. Roughness Coefficient: b) Manning's n from Stream Type (Fig. 2-20)	$u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0	0.00	ft / sec	0.00	cfs
2. Roughness Coefficient: c) Manning's n from Jarrett (USGS): Note: This equation is applicable to steep, step/pool, high boundary roughness, cobble- and boulder-dominated stream systems; i.e., for Stream Types A1, A2, A3, B1, B2, B3, C2 & E3	$u = 1.49 * R^{2/3} * S^{1/2} / n$ $n = 0.39 * S^{0.38} * R^{-0.16}$ $n =$ 0.041	2.42	ft / sec	66.78	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach (Leopold, Wolman and Miller)		2.49	ft / sec	68.86	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Chezy C		0.00	ft / sec	0.00	cfs
4. Continuity Equations: a) Regional Curves Return Period for Bankfull Discharge	$u = Q / A$ Q = 1.8 year	3.44	ft / sec	95.00	cfs
4. Continuity Equations: b) USGS Gage Data	$u = Q / A$	3.44	ft / sec	95.00	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 "**protrustion 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 5-3. Field form for Level II stream classification (Rosgen, 1996; Rosgen and Silvey, 2005).

Stream:	**Marsh Run, Reach - Reach 1**			
Basin:		Drainage Area: **12096** acres	**18.9**	mi^2
Location:	**Grimes, MD**			
Twp.&Rge:	**;**	Sec.&Qtr.: **;**		
Cross-Section Monuments (Lat./Long.):	**0 Lat / 0 Long**		Date: **04/26/12**	
Observers:			Valley Type: VIII	

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	**22.2**	ft
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A / W_{bkf}$).	**1.39**	ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	**30.84**	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	**15.97**	ft/ft
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.	**2.14**	ft
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or ($2 \times d_{mbkf}$) = the stage/elevation at which flood-prone area WIDTH is determined in a riffle section.	**29.01**	ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	**1.31**	ft/ft
Channel Materials (Particle Size Index) D_{50} The D_{50} particle size index represents the mean diameter of channel materials, as sampled from the channel surface, between the bankfull stage and Thalweg elevations.	**2048**	mm
Water Surface SLOPE (S) Channel slope = "rise over run" for a reach approximately 20–30 bankfull channel widths in length, with the "riffle-to-riffle" water surface slope representing the gradient at bankfull stage.	**0.00364**	ft/ft
Channel SINUOSITY (k) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL / VL); or estimated from a ratio of valley slope divided by channel slope (VS / S).	**1.26**	

Stream Type [redacted] (See **Figure 2-14**)

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Worksheet 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2007; Rosgen, 2008).

Stream: **Marsh Run** Location: **Reach - Reach 1**

Observers: Date: **04/26/12** Valley Type: **VIII** Stream Type: **F 1** /6

River Reach Dimension Summary Data.....1

Riffle Dimensions*, **, ***	Riffle Width (W_{bkf})	24.1	22.2	25.9	ft	Riffle Cross-Sectional Area (A_{bkf}) (ft^2)	33.61	30.84	36.38
	Mean Riffle Depth (d_{bkf})	1.4	1.39	1.4	ft	Riffle Width/Depth Ratio (W_{bkf} / d_{bkf})	17.23	15.97	18.49
	Maximum Riffle Depth (d_{max})	1.97	1.79	2.14	ft	Max Riffle Depth to Mean Riffle Depth (d_{max} / d_{bkf})	1.410	1.279	1.540
	Width of Flood-Prone Area (W_{fpa})	28.7	28.4	29	ft	Entrenchment Ratio (W_{fpa} / W_{bkf})	1.202	1.097	1.307
	Riffle Inner Berm Width (W_{ib})	0	0	0	ft	Riffle Inner Berm Width to Riffle Width (W_{ib} / W_{bkf})	0.948	0.948	0.948
	Riffle Inner Berm Depth (d_{ib})	0	0	0	ft	Riffle Inner Berm Depth to Mean Depth (d_{ib} / d_{bkf})	0.728	0.728	0.728
	Riffle Inner Berm Area (A_{ib})	0	0	0	ft^2	Riffle Inner Berm Area to Riffle Area (A_{ib} / A_{bkf})	0.688	0.688	0.688
	Riffle Inner Berm W/D Ratio (W_{ib} / d_{ib})	0	0	0					
Pool Dimensions*, **, ***	Pool Width (W_{bkfp})	25.3	24.7	26	ft	Pool Width to Riffle Width (W_{bkfp} / W_{bkf})	1.054	1.027	1.080
	Mean Pool Depth (d_{bkfp})	1.93	1.69	2.16	ft	Mean Pool Depth to Mean Riffle Depth (d_{bkfp} / d_{bkf})	1.379	1.207	1.543
	Pool Cross-Sectional Area (A_{bkfp})	48.9	41.6	56.2	ft	Pool Area to Riffle Area (A_{bkfp} / A_{bkf})	1.456	1.238	1.673
	Maximum Pool Depth (d_{maxp})	3.45	2.99	3.9	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	2.464	2.136	2.786
	Pool Inner Berm Width (W_{ibp})	11.2	10.9	11.6	ft	Pool Inner Berm Width to Pool Width (W_{ibp} / W_{bkfp})	0.445	0.421	0.468
	Pool Inner Berm Depth (d_{ibp})	0.84	0.67	1	ft	Pool Inner Berm Depth to Pool Depth (d_{ibp} / d_{bkfp})	0.431	0.396	0.465
	Pool Inner Berm Area (A_{ibp})	9.36	7.74	11	ft^2	Pool Inner Berm Area to Pool Area (A_{ibp} / A_{bkfp})	0.191	0.186	0.195
	Point Bar Slope (S_{pb})	0.366	0.366	0.366	ft/ft	Pool Inner Berm Width/Depth Ratio (W_{ibp} / d_{ibp})	####	####	####
Run Dimensions*	Run Width (W_{bkfr})	20.7	18.5	22.8	ft	Run Width to Riffle Width (W_{bkfr} / W_{bkf})	0.859	0.769	0.950
	Mean Run Depth (d_{bkfr})	1.59	1.45	1.72	ft	Mean Run Depth to Mean Riffle Depth (d_{bkfr} / d_{bkf})	1.136	1.036	1.229
	Run Cross-Sectional Area (A_{bkfr})	32.5	31.8	33.2	ft	Run Area to Riffle Area (A_{bkfr} / A_{bkf})	0.967	0.947	0.987
	Maximum Run Depth (d_{maxr})	2.36	1.68	3.03	ft	Max Run Depth to Mean Riffle Depth (d_{maxr} / d_{bkf})	1.686	1.200	2.164
	Run Width/Depth Ratio (W_{bkfr} / d_{bkfr})	13.3	10.8	15.8	ft				
Glide Dimensions*	Glide Width (W_{bkfg})	20.3	18.8	21.8	ft	Glide Width to Riffle Width (W_{bkfg} / W_{bkf})	0.843	0.781	0.905
	Mean Glide Depth (d_{bkfg})	1.42	1.36	1.47	ft	Mean Glide Depth to Mean Riffle Depth (d_{bkfg} / d_{bkf})	1.014	0.971	1.050
	Glide Cross-Sectional Area (A_{bkfg})	28.6	27.6	29.6	ft	Glide Area to Riffle Area (A_{bkfg} / A_{bkf})	0.852	0.822	0.882
	Maximum Glide Depth (d_{maxg})	2.03	1.93	2.13	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.450	1.379	1.521
	Glide Width/Depth Ratio (W_{bkfg} / d_{bkfg})	14.4	12.8	16	ft/ft	Glide Inner Berm Width/Depth Ratio (W_{ibg} / d_{ibg})	0.000	0.000	0.000
	Glide Inner Berm Width (W_{ibg})	0	0	0	ft	Glide Inner Berm Width to Glide Width (W_{ibg}/W_{bkfg})	0.000	0.000	0.000
	Glide Inner Berm Depth (d_{ibg})	0	0	0	ft	Glide Inner Berm Depth to Glide Depth (d_{ibg} / d_{bkfg})	0.000	0.000	0.000
	Glide Inner Berm Area (A_{ibg})	0	0	0	ft^2	Glide Inner Berm Area to Glide Area (A_{ibg} / A_{bkfg})	0.000	0.000	0.000
Step**	Step Width (W_{bkfs})	0	0	0	ft	Step Width to Riffle Width (W_{bkfs} / W_{bkf})	0.000	0.000	0.000
	Mean Step Depth (d_{bkfs})	0	0	0	ft	Mean Step Depth to Riffle Depth (d_{bkfs} / d_{bkf})	0.000	0.000	0.000
	Step Cross-Sectional Area (A_{bkfs})	0	0	0	ft	Step Area to Riffle Area (A_{bkfs} / A_{bkf})	0.000	0.000	0.000
	Maximum Step Depth (d_{maxs})	0	0	0	ft	Max Step Depth to Mean Riffle Depth (d_{maxs} / d_{bkf})	0.000	0.000	0.000
	Step Width/Depth Ratio (W_{bkfs} / d_{bkfs})	0	0	0					

Mean 14.068
Min 10.897
Max 17.239

*Riffle–Pool system (i.e., C, E, F stream types) bed features include riffles, runs, pools and glides.

**Step–Pool system (i.e., A, B, G stream types) bed features include riffles, rapids, chutes, pools and steps (note: include rapids and chutes in riffle category).

***Convergence-Divergence system (i.e., D stream types) bed features include riffles and pools; cross-sections taken at riffles for classification purposes.

****Mean values are used as the normalization parameter for all dimensionless ratios; e.g., minimum pool width to riffle width ratio uses the *mean* riffle width value.

Worksheet 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2007; Rosgen, 2008).

Discharge < 97

Stream: **Marsh Run**	Location: **Reach - Reach 1**		
Observers:	Date: **04/26/12**	Valley Type: **VIII**	Stream Type: **F 1**

River Reach Summary Data.../...2

Hydraulics

Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})	0.39	ft/sec	Estimation Method	
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})	12	cfs	Drainage Area	19 mi^2

Channel Pattern

Linear Wavelength (λ)	99	99	99	ft	Linear Wavelength to Riffle Width (λ / W_{bkf})	4.116	4.116	4.116
Stream Meander Length (L_m)	126	121	130	ft	Stream Meander Length Ratio (L_m / W_{bkf})	5.218	5.031	5.405
Radius of Curvature (R_c)	42.5	41	52	ft	Radius of Curvature to Riffle Width (R_c / W_{bkf})	1.767	1.705	2.162
Belt Width (W_{blt})	61.5	59	64	ft	Meander Width Ratio (W_{blt} / W_{bkf})	2.557	2.453	2.661
Arc Length (L_a)	50.8	34	79	ft	Arc Length to Riffle Width (L_a / W_{bkf})	2.110	1.414	3.285
Riffle Length (L_r)	13.7	9.91	17.5	ft	Riffle Length to Riffle Width (L_r / W_{bkf})	0.570	0.412	0.729
Individual Pool Length (L_p)	28.8	20.3	35.6	ft	Individual Pool Length to Riffle Width (L_p / W_{bkf})	1.198	0.845	1.479
Pool to Pool Spacing (P_s)	90.5	57.2	124	ft	Pool to Pool Spacing to Riffle Width (P_s / W_{bkf})	3.761	2.377	5.145

Channel Profile

Valley Slope (S_{val})	0.00458	ft/ft	Average Water Surface Slope (S)	0.00295	ft/ft	Sinuosity (S_{val} / S)	1.66	→ 1.26
Stream Length (SL)	333	ft	Valley Length (VL)	241	ft	Sinuosity (SL / VL)	1.38	
Low Bank Height (LBH)	start 2.88 / end 4.69	ft	Max Depth (d_{max})	start 2.27 / end 2.03	ft	Bank-Height Ratio (BHR) (LBH / d_{max})	start 1.27 / end 2.31	

Riffle Slope (S_{rif})	0.014	0.004	0.025	ft/ft	Riffle Slope to Average Water Surface Slope (S_{rif} / S)	4.831	1.325	8.336
Run Slope (S_{run})	0.000	0.000	0.000	ft/ft	Run Slope to Average Water Surface Slope (S_{run} / S)	0.000	0.000	0.000
Pool Slope (S_p)	0.000	0.000	0.000	ft/ft	Pool Slope to Average Water Surface Slope (S_p / S)	0.000	0.000	0.000
Glide Slope (S_g)	0.001	0.001	0.001	ft/ft	Glide Slope to Average Water Surface Slope (S_g / S)	0.210	0.210	0.210
Step Slope (S_s)	0.000	0.000	0.000	ft/ft	Step Slope to Average Water Surface Slope (S_s / S)	0.000	0.000	0.000
Max Riffle Depth (d_{maxrif})	1.76	1.67	1.85	ft	Max Riffle Depth to Mean Riffle Depth (d_{maxrif} / d_{bkf})	1.26	1.193	1.32
Max Run Depth (d_{maxrun})	2.03	1.77	2.29	ft	Max Run Depth to Mean Riffle Depth (d_{maxrun} / d_{bkf})	1.45	1.264	1.64
Max Pool Depth (d_{maxp})	3.63	3.4	3.94	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	2.59	2.429	2.81
Max Glide Depth (d_{maxg})	0.62	1.57	2.29	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	0.44	1.121	1.64
Max Step Depth (d_{maxs})	0	0	0	ft	Max Step Depth to Mean Riffle Depth (d_{maxs} / d_{bkf})	0	0	0

Channel Materials

% Silt/Clay	11.4	0	D_{16}	0.19	221.07	12.66	mm
% Sand	12.72	4.95	D_{35}	Bedrock	Bedrock	24.53	mm
% Gravel	8.34	3.96	D_{50}	Bedrock	Bedrock	33.08	mm
% Cobble	1.31	8.91	D_{84}	Bedrock	Bedrock	98.23	mm
% Boulder	0.44	0	D_{95}	Bedrock	Bedrock	123.3	mm
% Bedrock	65.79	82.18	D_{100}	Bedrock	Bedrock	180	mm

[a] Min, max & mean depths are measured from Thalweg to bankfull at mid-point of feature for riffles and runs, the deepest part of pools, & at the tail-out of glides.
[b] Composite sample of riffles and pools within the designated reach. [c] Active bed of a riffle. [d] Height of roughness feature above bed.

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Worksheet B-4. Procedure to validate hydraulic relations using gage station data.

1. Obtain the drainage area associated with the gaging station.
2. Obtain the field-determined bankfull discharge at the gaging station (**Figure B-43**).
3. Obtain the bankfull channel dimensions from the gaging station hydraulic geometry relationships (discharge vs. width, depth, area and velocity).
4. Measure the average water surface slope.
5. Perform an active bed pebble count on the riffle to obtain D_{84}.
6. Determine the stream type.
7. Solve for Manning's 'n' at the bankfull stage: $n = (1.49R^{2/3}S^{1/2})/\bar{u}$ (use the bankfull mean velocity from Step 3).
8. Calculate relative roughness: R/D_{84}. Make sure that D_{84} is converted from millimeters to feet. Hydraulic radius (R) and mean depth (d_{bkf}) are often used interchangeably when width/depth ratios are greater than 12.
9. Calculate shear velocity: $u^* = (gRS)^{1/2}$.
10. Calculate friction factor: $\bar{u}/u^*$.
11. Plot bankfull discharge as a function of drainage area on the appropriate regional curve.
12. Plot bankfull channel dimensions as a function of drainage area on the appropriate regional curve (note stream type of plotted values using unique symbols).
13. Plot relative roughness by friction factor (**Figure B-34**) (Example in **FigureB-40**).
14. Plot Manning's 'n' by friction factor (**Figure B-35**) (Example in **Figure B-41**).
15. Plot Manning's 'n' by stream type (**Figure B-36**) (Example in **Figure B-42**).

Gaging Station Name: Marsh Run Gaging Station **Gaging Station Number:**

Drainage Area (mi^2)	Bankfull Discharge Q_{bkf} (cfs)	Bankfull Width W_{bkf}	Bankfull Mean Depth d_{bkf} (ft)	Bankfull Area A_{bkf} (ft^2)	Bankfull Velocity $\bar{u}_{bkf}$ (ft/s)	Ave. Water Surface Slope S (ft/ft)	D_{84} (mm)	D_{84} (ft)	Stream Type	Manning's 'n'	Relative Roughness R/D_{84} (ft/ft)	Shear Velocity u^* (ft/s)	Friction Factor $\bar{u}/u^*$
18.9	97	22.2	2.1	30.84	3.1	.00064	208	.68	F1/6	~~0.0336~~ .044	13.9	.353	8.8

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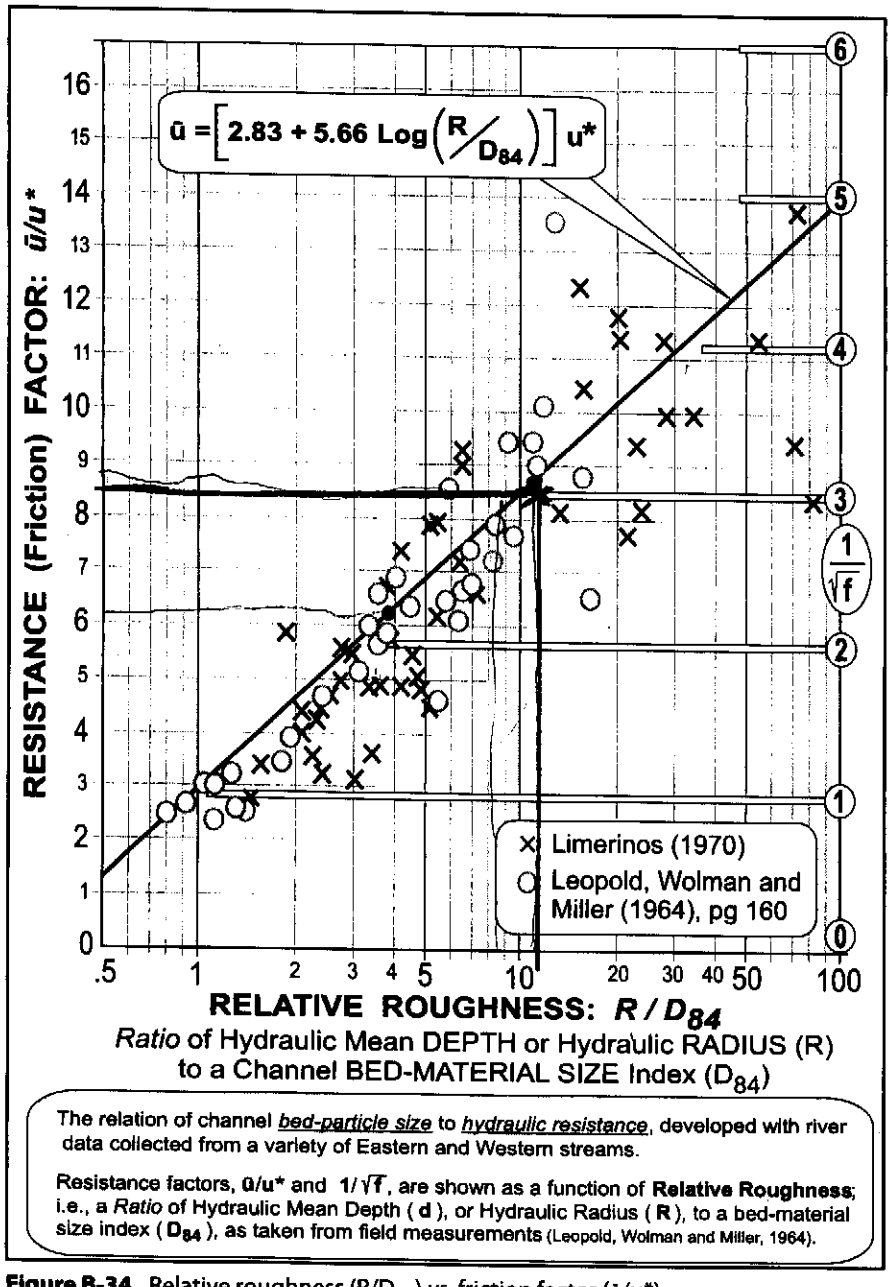

Figure B-34. Relative roughness (R/D_{84}) *vs.* friction factor ($\bar{u}/u^*$).

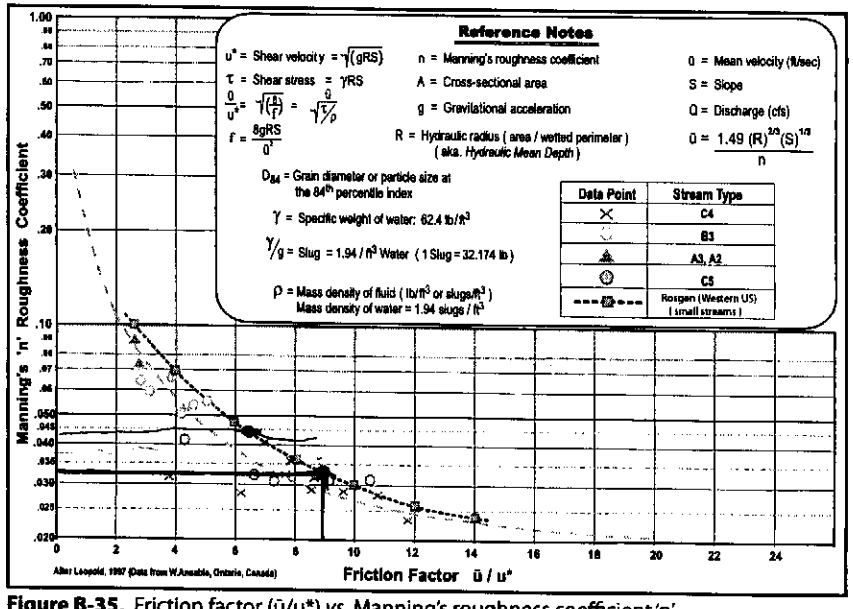

Figure B-35. Friction factor ($\bar{u}/u^*$) *vs.* Manning's roughness coefficient 'n'.

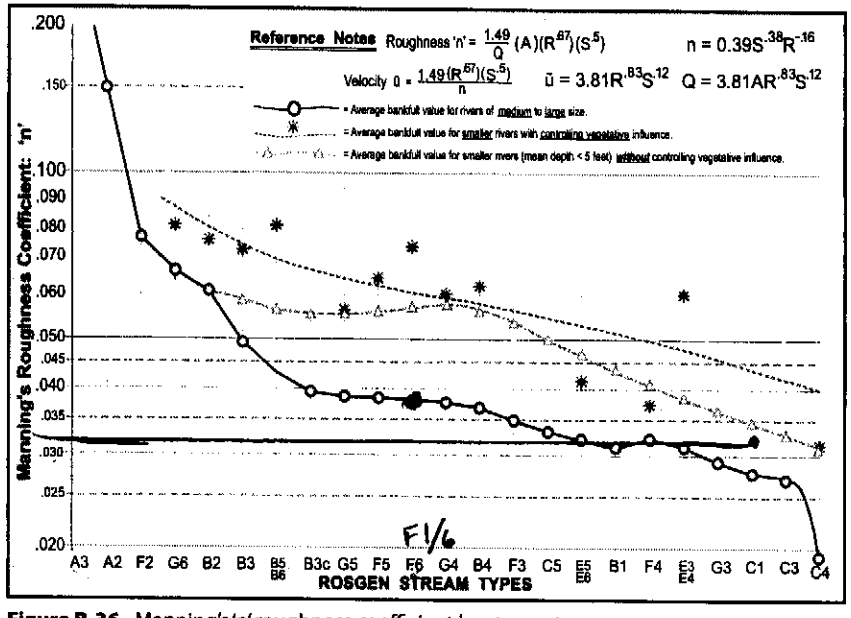

Figure B-36. Manning's 'n' roughness coefficient by stream type.

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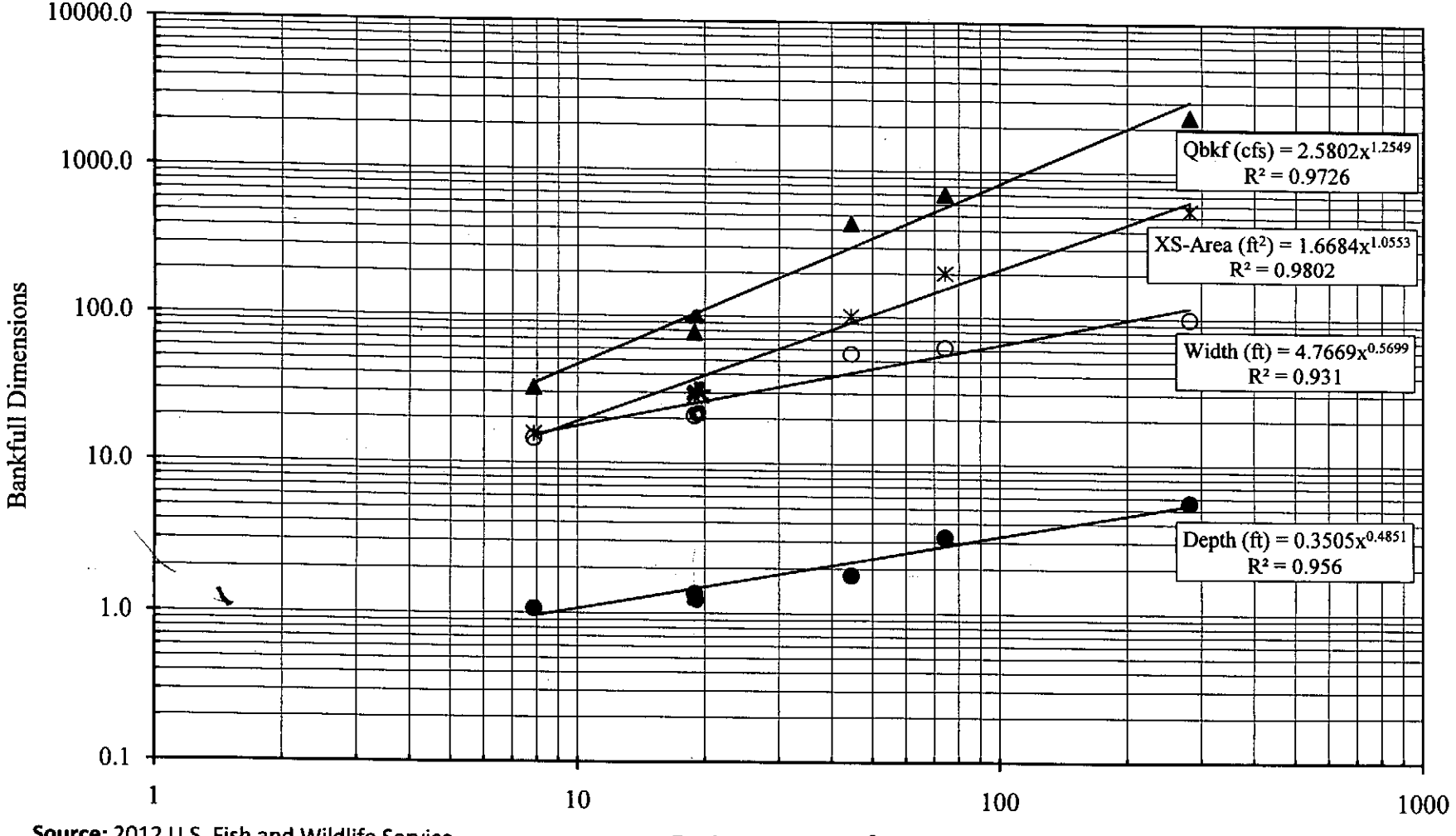
Bankfull Characteristics for Selected USGS Gages in the PA and MD Carbonate Great Valley Section of the Ridge and Valley Province



Source: 2012 U.S. Fish and Wildlife Service, Chesapeake Bay Field Office - Annapolis, MD

Step 11

Summarize USGS gage data:

Summary of USGS Gage Station Data

Station Name:	MARSH RUN - GRIMES				Station Number:	01617800	
Station Location:	MARSH RUN @ GRIMES				Period of Record:	40	yrs
Drainage Area (DA):	12096	acres	18.9	mi^2	D.A. Mean Elevation:	354.72	ft
Stream Type:	E1	Valley Type:	8		Mean Annual Disch.:		cfs
Reference Reach Slope:		ft/ft			HUC:		

BANKFULL CHARACTERISTICS

Determined from FIELD MEASUREMENT			Determined from GAGE DATA ANALYSIS		
Bankfull Width (W_{bkf})	22.2	ft	Bankfull Width (W_{bkf})	22	ft
Bankfull Mean Depth (d_{bkf})	1.39	ft	Bankfull Mean Depth (d_{bkf})	2.1	ft
Bankfull XS Area (A_{bkf})	30.84	ft^2	Bankfull XS Area (A_{bkf})	34	ft^2
Wetted Perimeter (W_p)	23.87	ft	Wetted Perimeter (W_p)	26.2	ft
Bankfull Stage (Gage Ht.)	2.22	ft	Bankfull Stage (Gage Ht.)	2.2	ft
Est. Mean Velocity ($\bar{u}$)	3.15	ft/sec	Mean Velocity ($\bar{u}$)	2.2	ft/sec
Est. BKF. Discharge (Q_{bkf})	97.17	cfs	Bankfull Discharge (Q_{bkf})	95	cfs

Bankfull Discharge associated with "field-determined" Bankfull Stage	95	cfs
Recurrence Interval (R.I.) associated with "field-determined" Bankfull Stage	1.8	yrs

From the *Annual Peak Flow Frequency Analysis* for the Gage Station, determine:

1.5 Year **R.I.** Discharge =	60	cfs	**10** Year **R.I.** Discharge =	285	cfs
2.0 Year **R.I.** Discharge =	102	cfs	**25** Year **R.I.** Discharge =	450	cfs
5.0 Year **R.I.** Discharge =	190	cfs	**50** Year **R.I.** Discharge =	470	cfs

MEANDER GEOMETRY

Linear Wavelength (λ)	99	ft	Stream Meander Length (L_m)	125.50	ft
Radius of Curvature (R_c)	42.5	ft	Belt Width (W_{blt})	61.5	ft/ft

HYDRAULIC GEOMETRY

Based on *USGS Discharge Summary Notes* data (Form 9-207) and regression analyses of measured discharge (**Q**) with the hydraulic parameters of Width (**W**), Area (**A**), Mean Depth (**d**) & Mean Velocity ($\bar{u}$), determine the *intercept coefficient* (**a**) and the *slope exponent* (**b**) values for a power function of the form $Y = aX^b$, when Y is one of the selected hydraulic parameters and X is a given discharge value (**Q**).

		Width (**W**)	Depth (**d**)	Area (**A**)	Vel. ($\bar{u}$)
Intercept Coefficient	(a)	9.6307	0.4066	3.916	0.258
Slope Exponent	(b)	0.1934	0.3106	0.504	0.4928

Hydraulic Radius: $R = A / W_p$	1.29	ft	Manning's 'n' at Bankfull Stage	.035 Coeff.

$n = 1.49\ [(\text{Area})\ (\text{Hydraulic Radius}^{2/3})\ (\text{Slope}^{1/2})] / Q_{bkf}$

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