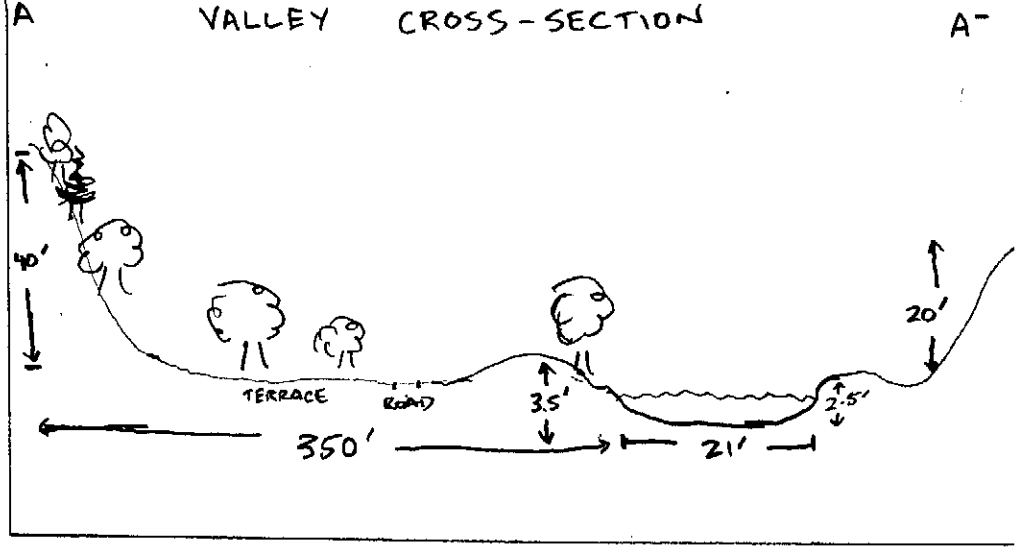
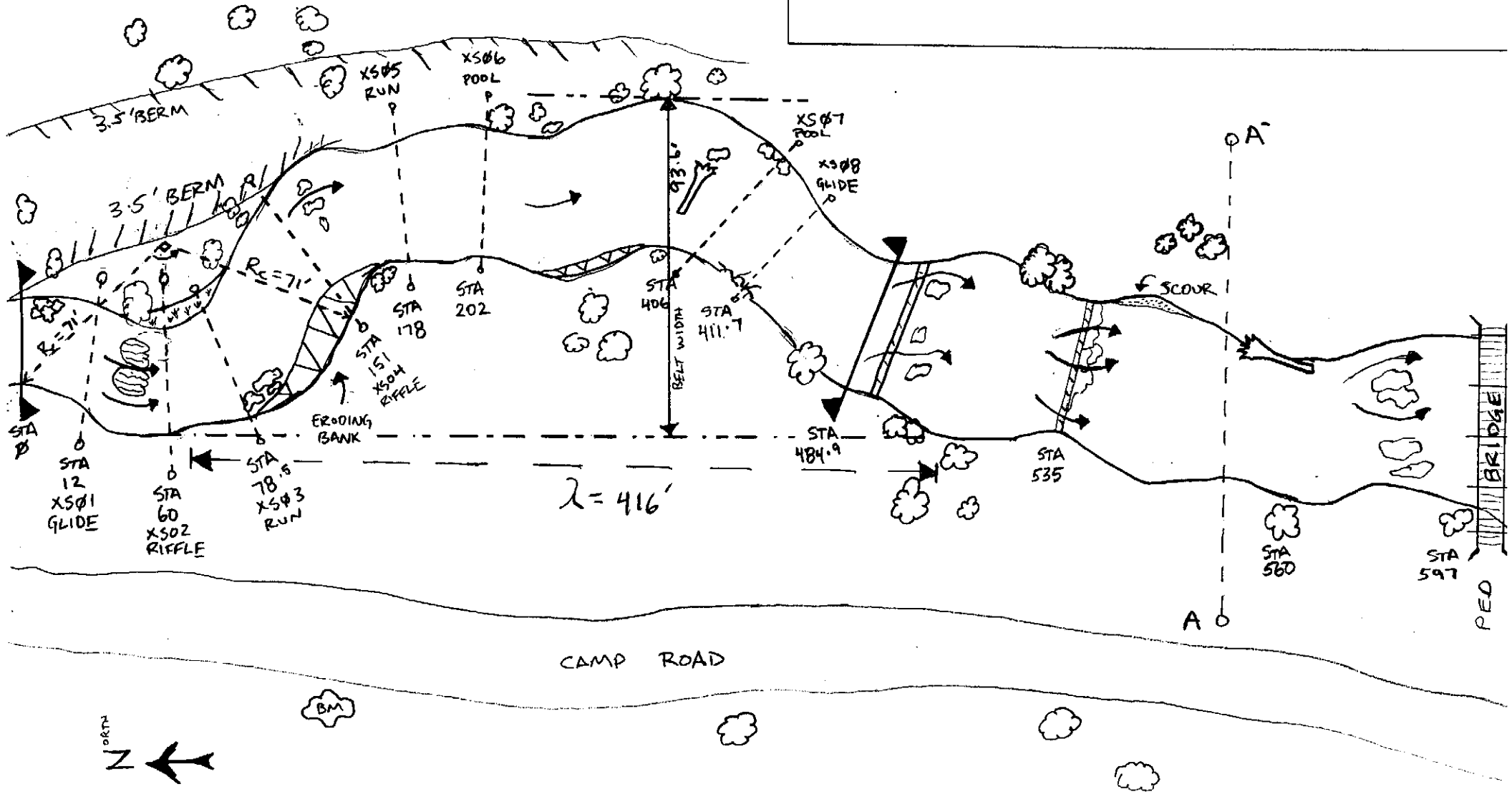
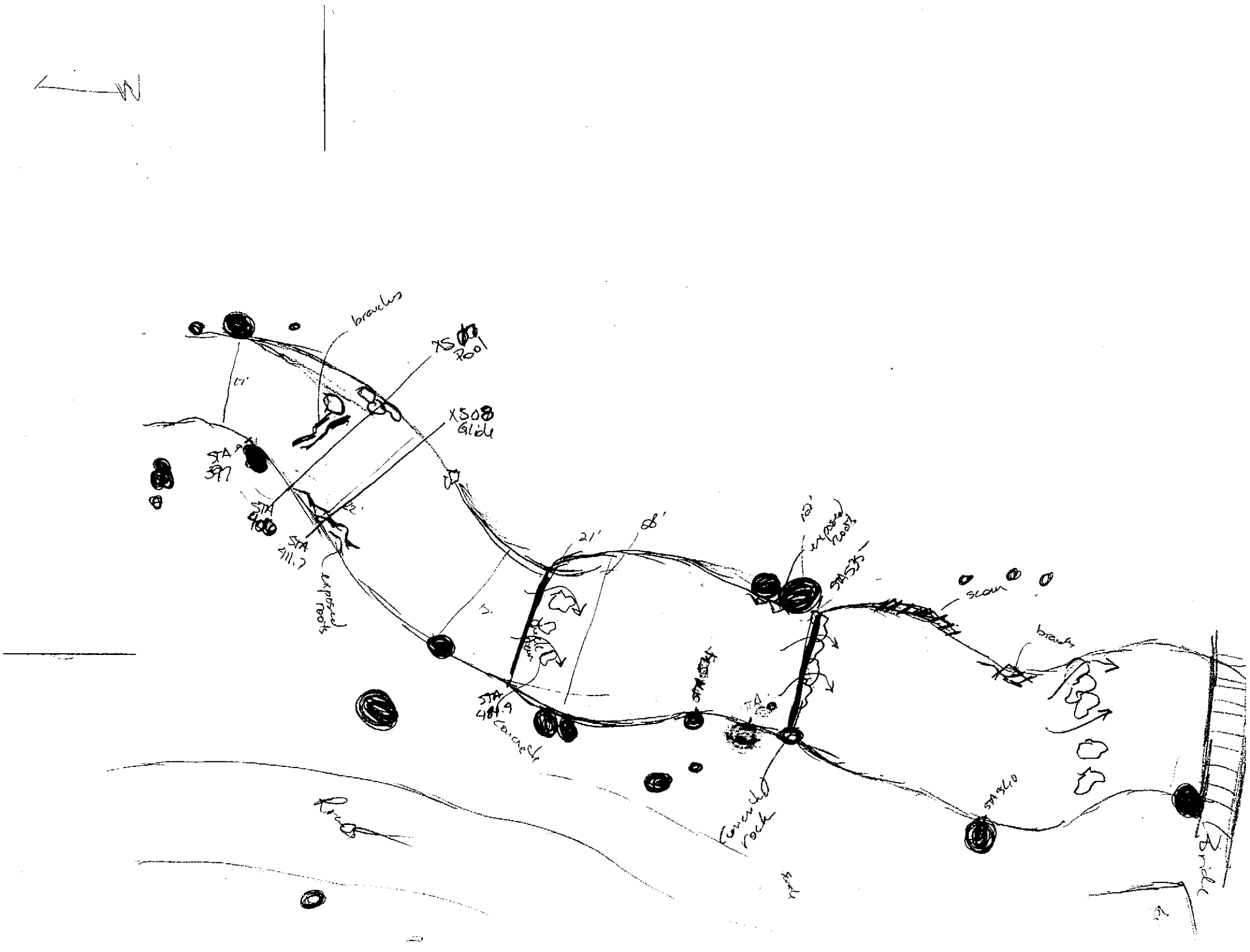
MARSH RUN
APRIL 26th 2012
TEAM 3
WASHINGTON Co. MD

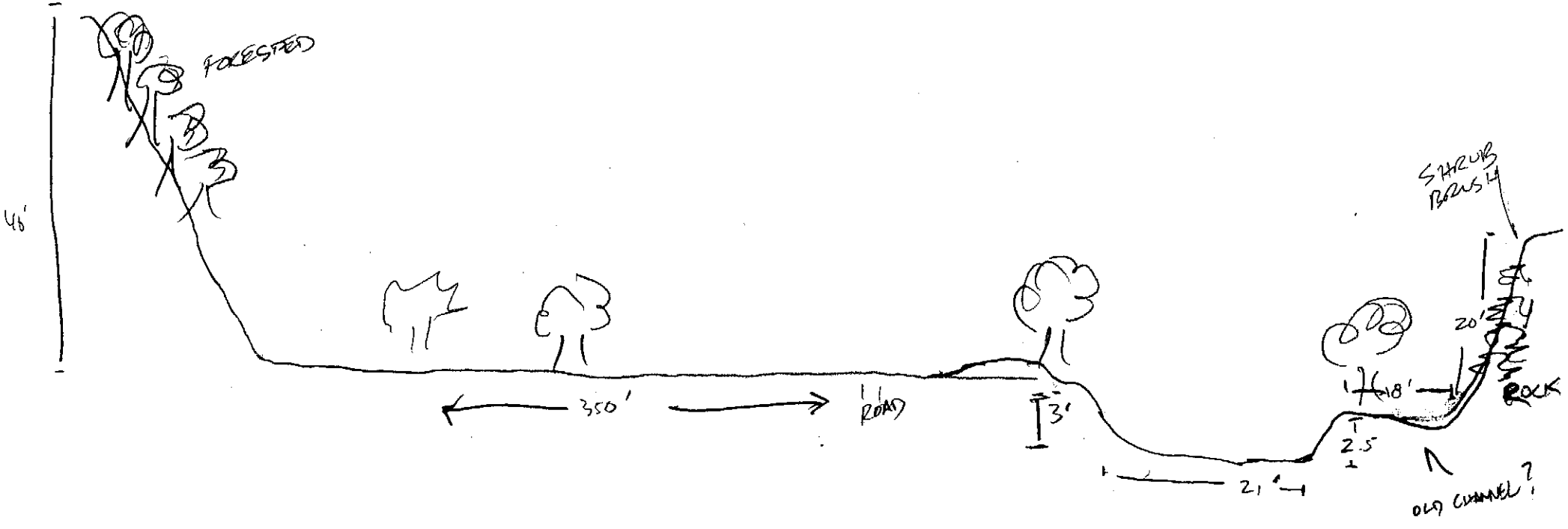




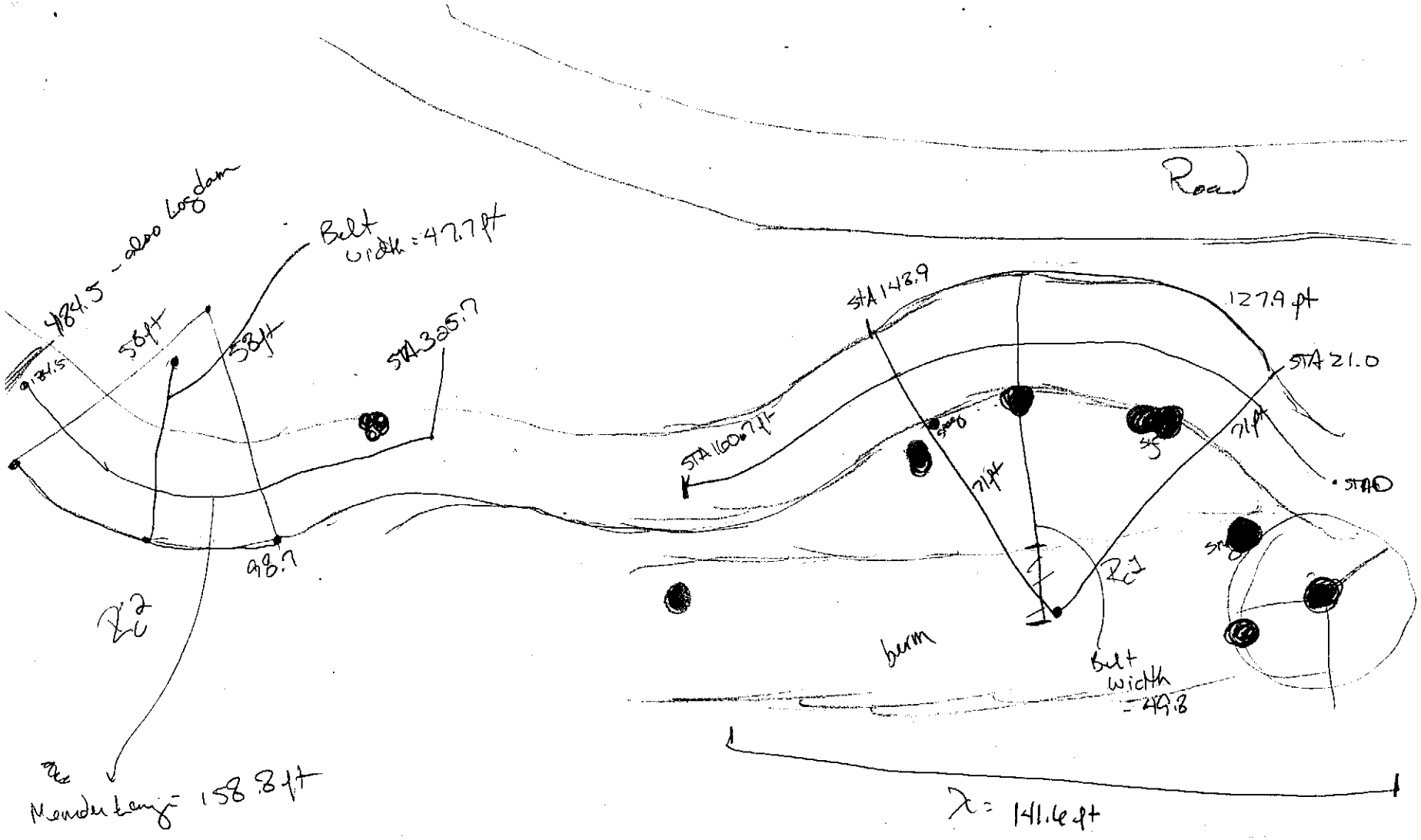


W
branches
XS Pool
XS08 Glide
STA 397
STA 411.7
exposed roots
21'
68'
12'
exposed roots
STA 535
scour
branches
STA 484.9
concrete
concrete rock
STA 540
Bridge

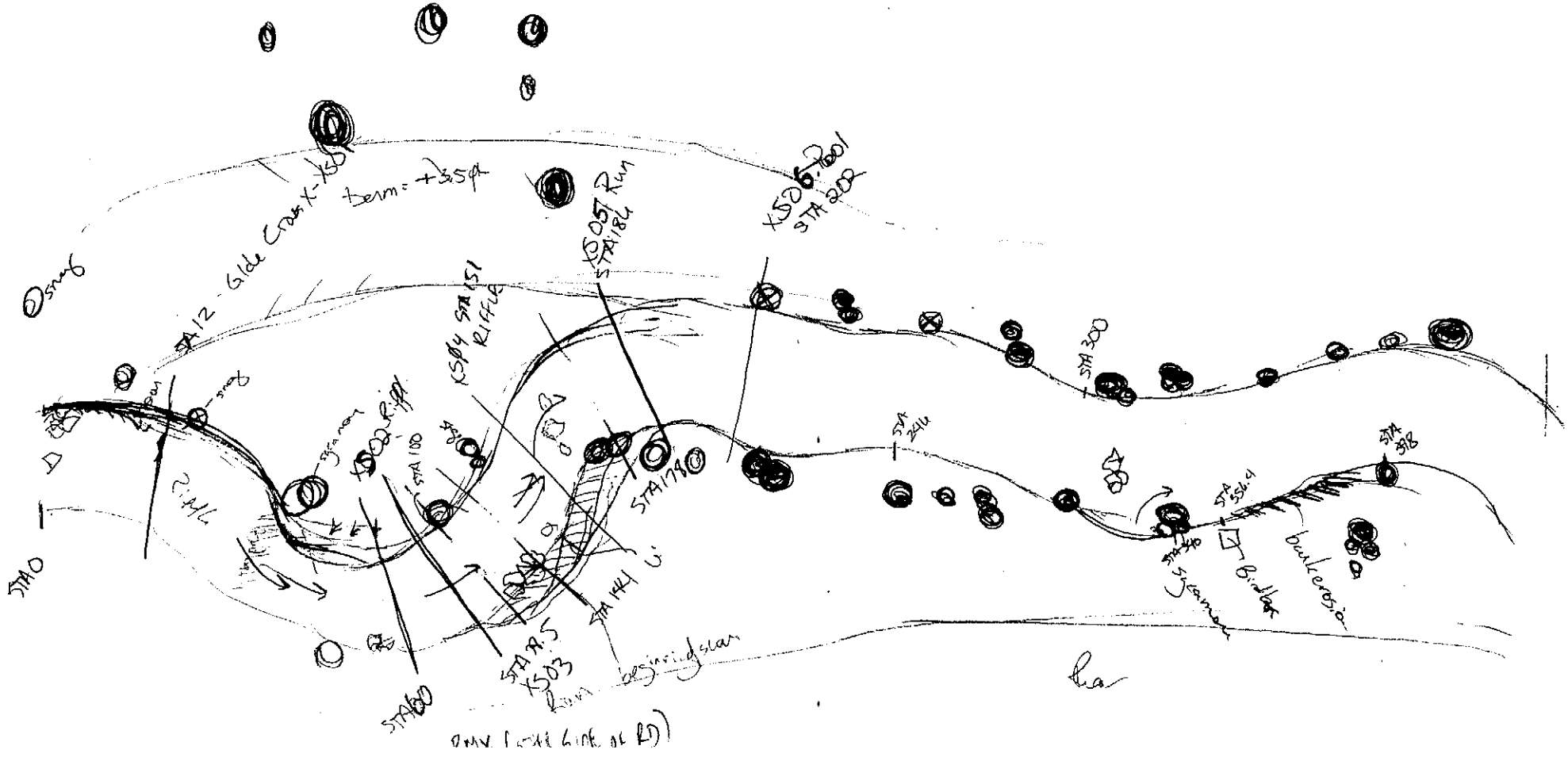
Marsh Run
Reach 3
4/26/2012



Marsh Run
Team 3
4/26/12

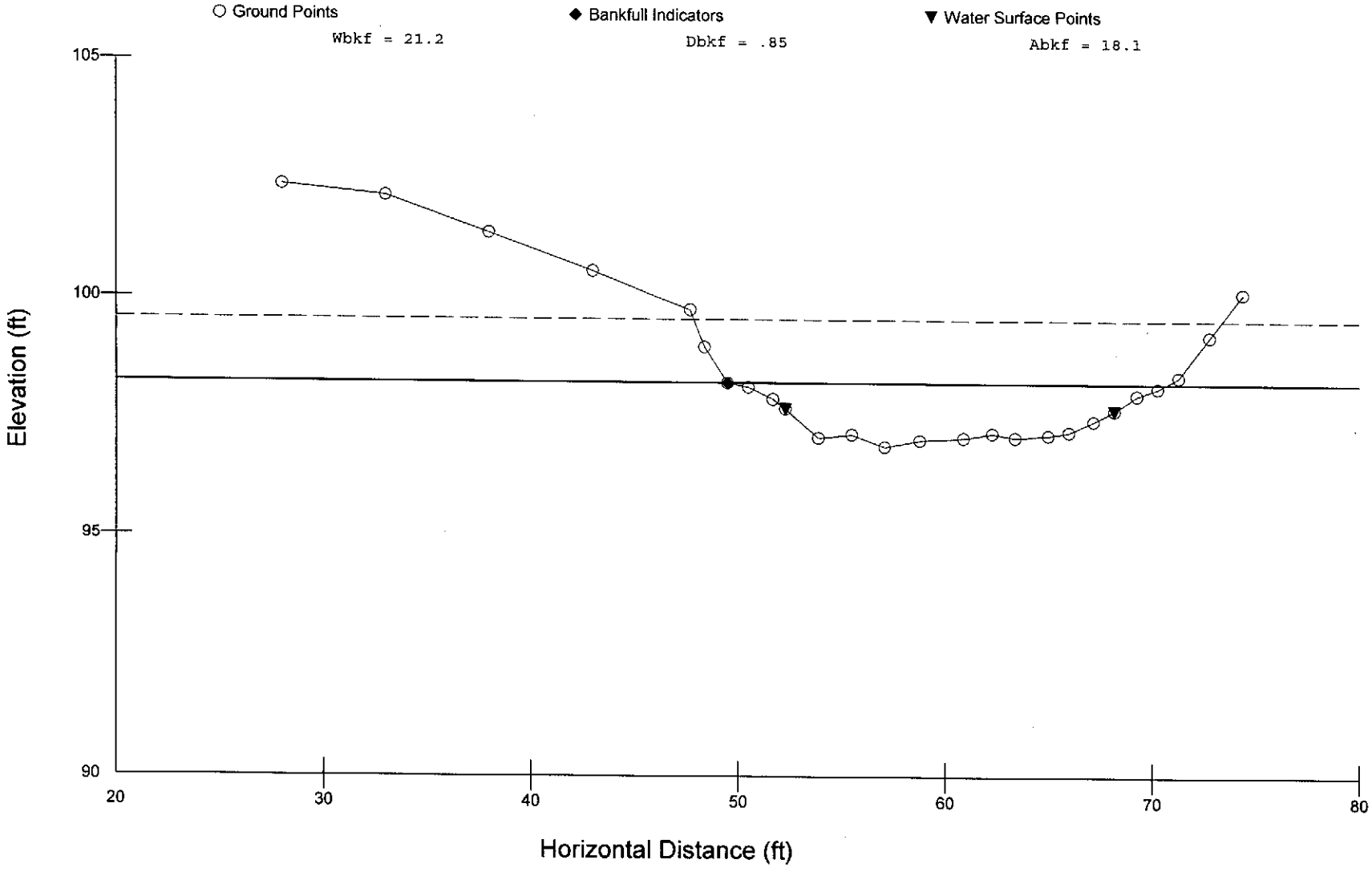


Marsh Run
Team 3
4/26/2012



Marsh Run
Reach 3
4/26/2012

Riffle 1 st. ~~12.0~~ 60.0



bench pin
3.99

Team 3

SURVEY DATA ⟶ **CROSS - SECTION 7**

SITE: Marsh Run Riffle XS/Station 60.0' **Date:** 4/26/12

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29		3.05				
30	0			4.39		
31	6.0			4.17		
32	11.0			4.02		
33	20.0			3.62		
34	28.0			3.19		
35	33.0			3.42		
36	38.0			4.20		
37	43.0			4.99		
38	47.7			5.81		
39	48.4			6.59		
40	49.5			7.34		BKF
41	50.5			7.43		
42	51.7			7.68		
43	52.3			7.88		water surface
44	53.9			8.49		
45	55.5			8.41		
46	57.1			8.67		
47	58.8			8.53		
48	60.9			8.48		
49	62.3			8.38		
50	63.4			8.47		
51	65.0			8.42		
52	66.0			8.35		
53	67.2			8.12		
54	68.2			7.90		water surface
55	69.3			7.58		
56	70.3			7.43		BKF (better)
57	71.3			7.19		
58	72.8			6.34		
59	74.4			5.43		
	76.0			5.12		edge of road
	82.0			4.79		middle of road
	89.0			4.24		
				3.76		

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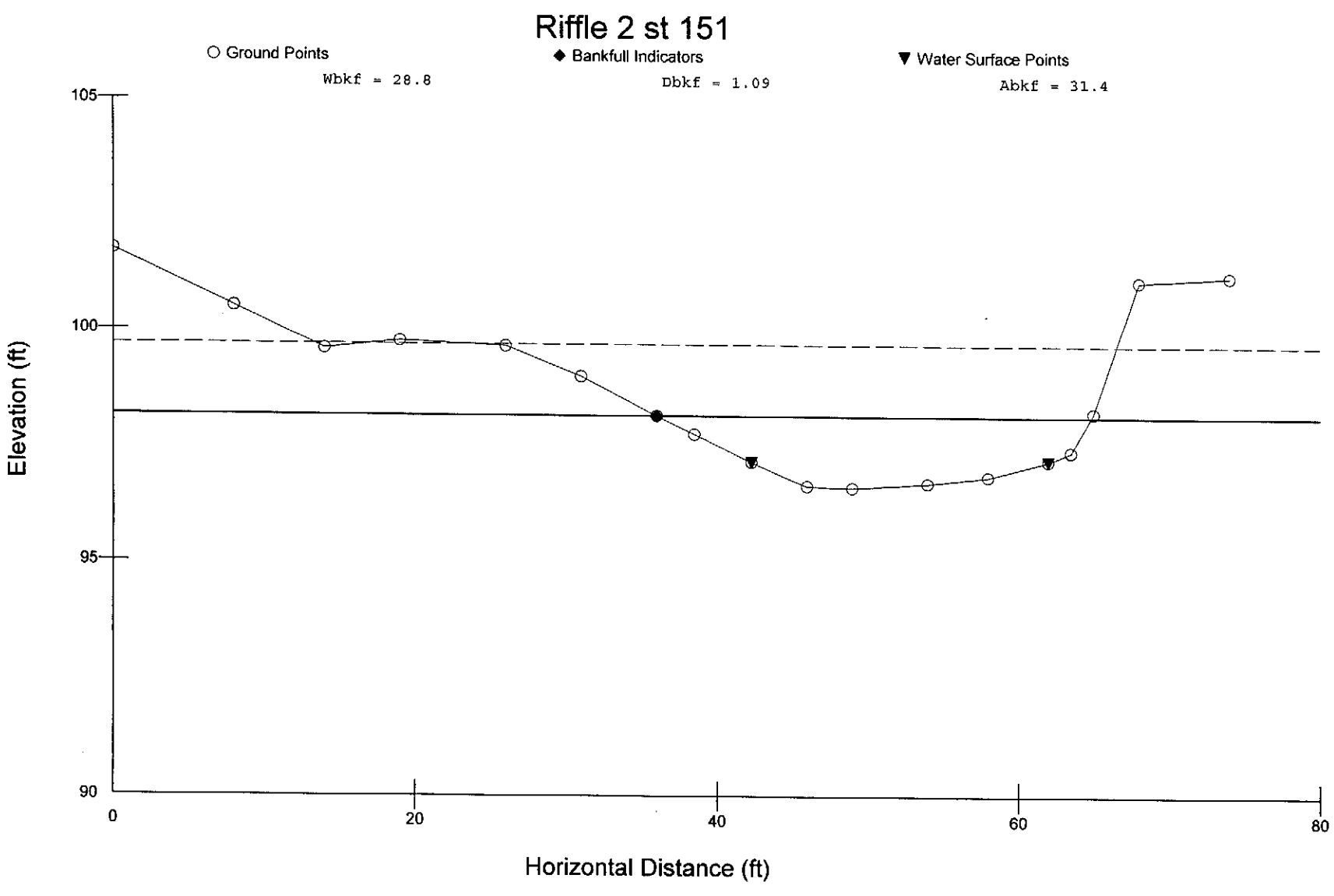
Marsh Run
Reach 3
4/26/2012



SURVEY DATA → CROSS-SECTION 1

SITE: Marsh Run **Date:** 4/26/12

Location: Reach 3 (LONG PRO STATION 151) - RIFFLE

Party / Notes: Team 3 **HUC:**

Item	Distance, Point, or STATION (ft)	102.496 Back-Sight BS (ft)	Height of Instrument HI (ft)	Fore-Sight FS (ft)	Elevation (ft)	REMARKS / COMMENTS / NOTES
1		3.38			105.876	BENCHMARK
2	0.0			4.69		
3	6.0			4.80		
4	9.0			7.64		
5	10.5			8.48		
6	12.0			8.68		R EOW
7	16.0			9.02		
8	20.0			9.16		
9	25.0			9.26		THALWEG
10	28.0			9.23		
11	31.7			8.72		L EOW
12	35.5			8.12		
13	38.0			7.73		BKF
14	43.0			6.88		
15	48.0			6.24		
16	55.0			6.31		
17	60.0			6.30		
18	66.0			5.37		
19	74.0			4.15		
20						
21						FLOOD PRO WIDTH = 70
22						
23						BM ELEVATION = 102.496
24						
25						
26						
27						
28						

RIGHT BANK

74 ~~72.5~~
68 ~~66.5~~
65 ~~63.5~~
63.5 ~~62.0~~
62 ~~60.5~~
58 ~~56.5~~
54 ~~52.5~~
49 ~~47.5~~
46 ~~44.5~~
42.3
38.5
36
31
26
19
14
8
0

LEFT BANK

9.26
7.73
1.53
3.06

105.876

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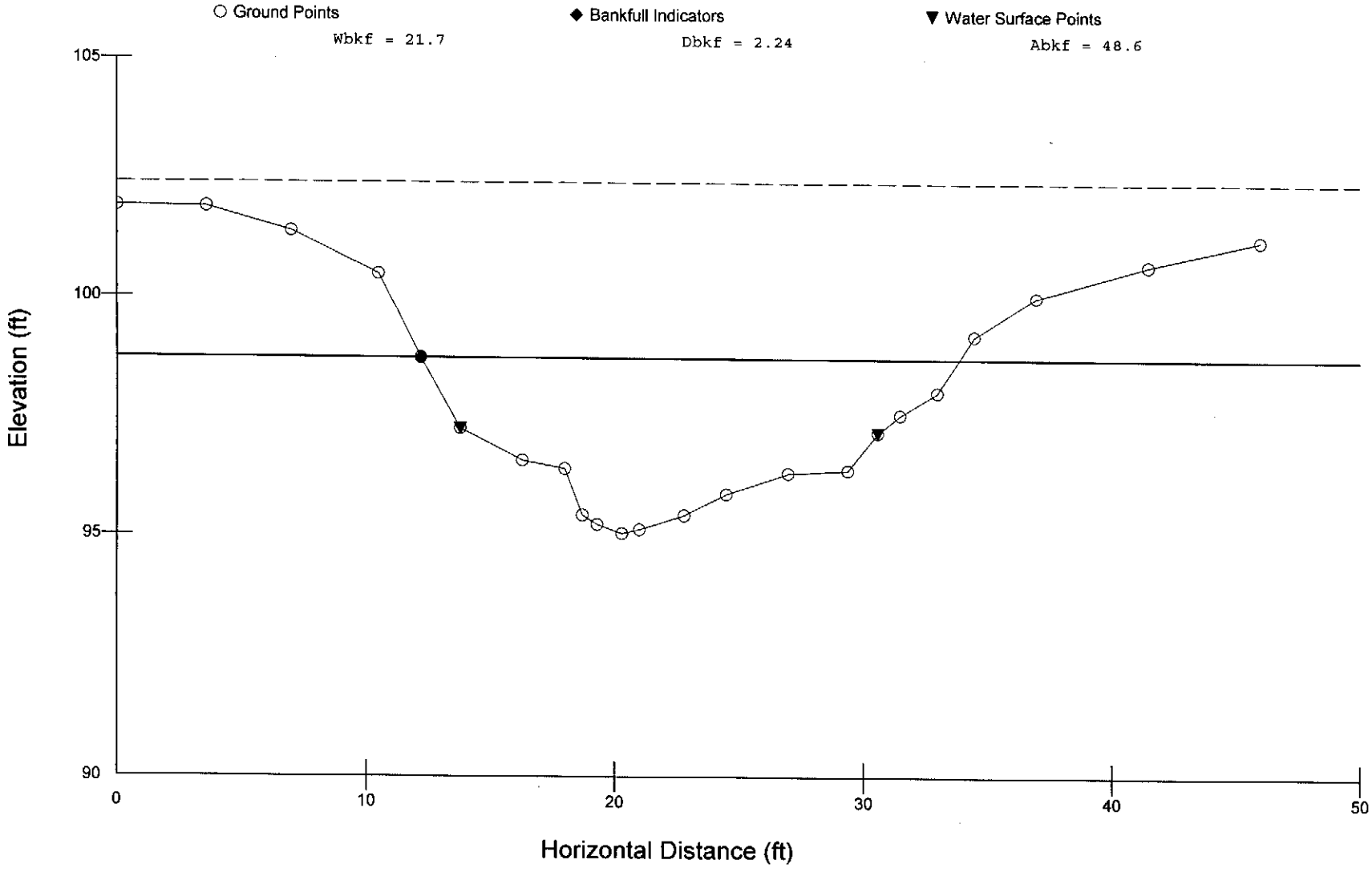
Marsh Run
Reach 3
4/26/12

Pool @ ~~Run 2~~ st 202



SURVEY DATA ⟹ **CROSS-SECTION 3**

SITE: MARSH RUN (LONG PRO STATION 202) - POOL **Date:** 4/26/12

	Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
46	29	0			4.66		
41.5	30	4.5			5.19		
37	31	9			5.86		
34.5	32	11.5			6.68		
33	33	13			7.85		[redacted]
31.5	34	14.5			8.33		
30.6	35	15.4			8.71		REW
29.4	36	16.6			9.50		
27	37	19.0			9.56		
24.5	38	21.5			10.01		
22.8	39	23.2			10.46		
21	40	25			10.75		
20.3	41	25.7			10.84		THALWEG
19.3	42	26.7			10.65		
18.7	43	27.3			10.46		
18	44	28			9.48		
16.3	45	29.7			9.31		BEDROCK SHELF
13.8	46	32.2			8.64		LEW
12.2	47	33.8			6.76		
10.5	48	35.5			5.40		
7	49	39			4.50		
3.6	50	42.4			4.0		
0	51	46			3.98		
	52						
	53						
	54						
	55						
	56						
	57						
	58						
	59						

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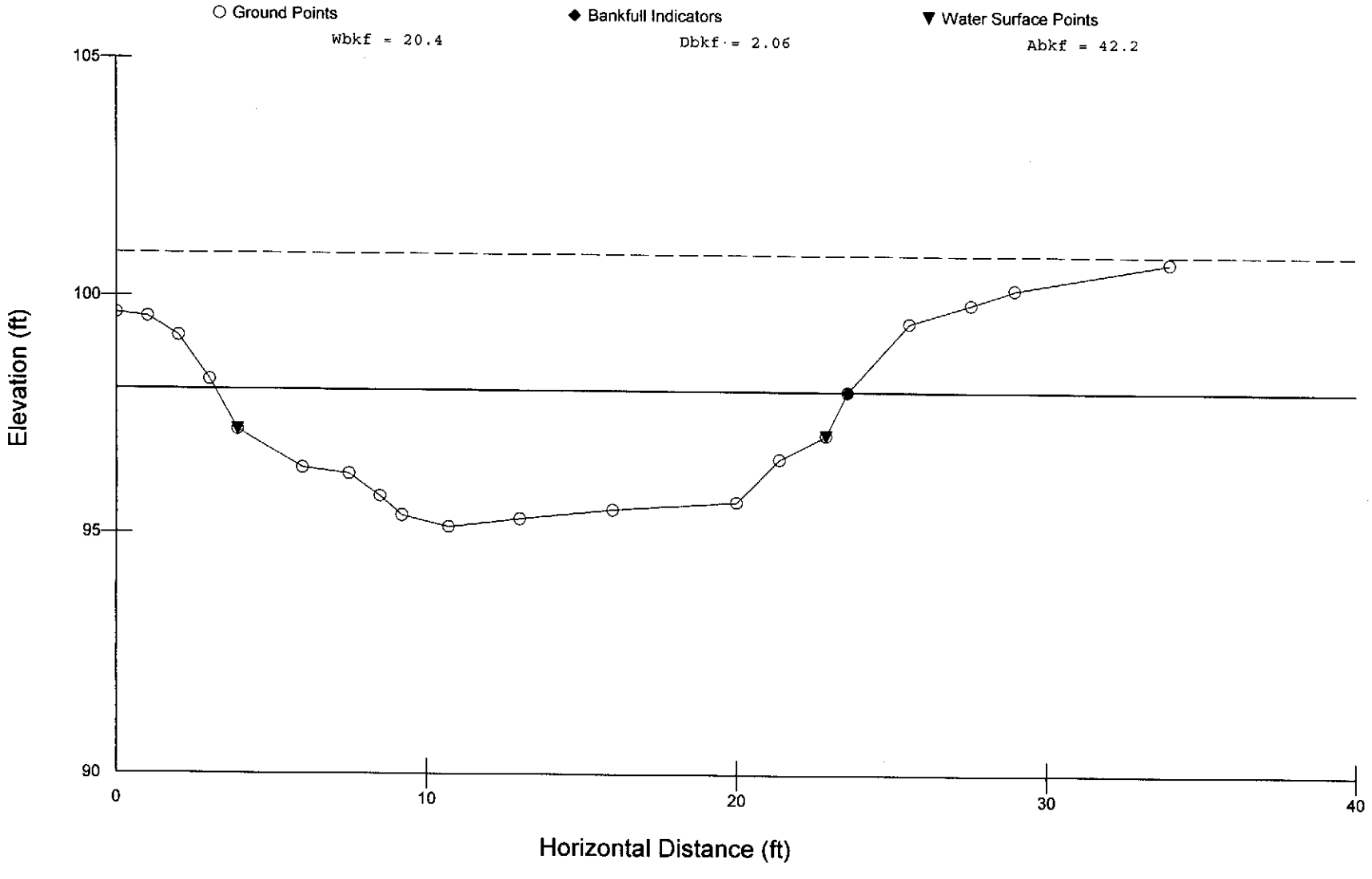
* NO INDICATOR FOR BANKFULL

Marsh Run
4/26/2012
Reach 3

Pool 2 st 406



SURVEY DATA → **CROSS-SECTION** 4

SITE: MARSH RUN (LONG PRO STATION 406) – POOL Date: 4/26/12

	Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS	
34	29	0	1.22		2.97			
29	30	5			3.53			
27.6	31	6.4			3.86			
25.6	32	8.4			4.25			
23.6	33	10.4			5.70		BKF 1	} 0.93
22.9	34	11.1			6.63		REW	
21.4	35	12.6			7.14			
20	36	14			8.05			
16	37	18			8.22			
13	38	21			8.41			
10.7	39	23.3			8.58		TW/LW EG	
9.2	40	24.8			8.35			
8.5	41	25.5			7.94			
7.5	42	26.5			7.48			
6	43	28			7.36			
3.9	44	30.1			6.55		LEW	
3	45	31			5.49			
2	46	32			4.57			
1	47	33			4.18			
0	48	34			4.10			
	49							
	50							
	51							
	52							
	53							
	54							
	55							
	56							
	57							
	58							
	59							

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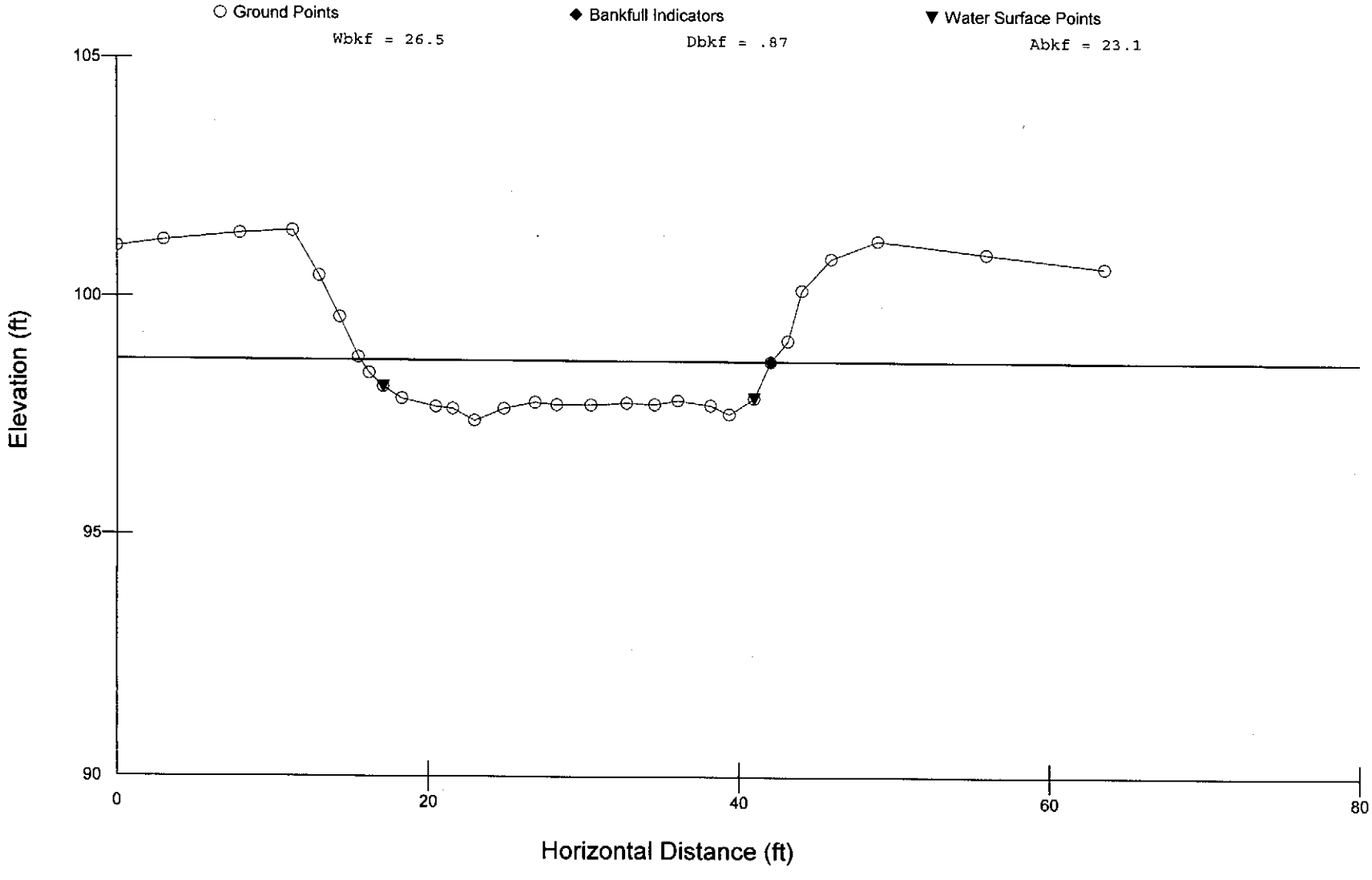
* POOL U/S OF ANTHROPAGENIC STRUCTURE

Marsh Run
Reach 3
4/26/12

Run @ Sta. 785
~~Glide 1 st. 12.3~~



Team 3

SURVEY DATA → **CROSS-SECTION 8**

SITE: Marsh Run Run XS / Station 78.5 **Date:** 4/26/12

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29		3.07				
30	0			3.75		
31	3			3.53		
32	5.4			3.41		
33	8.6			3.65		
34	11.0			4.00		
35	15			4.49		
36	18			4.92		
37	21.7			5.69		
38	30.0			5.09		
39	34.1			5.44		
40	37.8			5.80		
41	39.2			6.08		
42	40.7			6.65		
43	42.1			7.06		
44	44.3			7.30		
45	45.5			7.55		BKF
46	46.4			7.74		
47	47.1			~~8.50~~ 7.85		water surface
48	47.9			8.30		
49	48.6			8.52		
50	50.3			8.54		
51	51.5			8.50		
52	53.0			8.62		
53	54.6			8.74		
54	56.1			8.36		
55	57.9			8.26		
56	59.3			8.16		
57	60.7			8.08		
58	61.6			7.82		water surface
59	62.7			7.55		BKF

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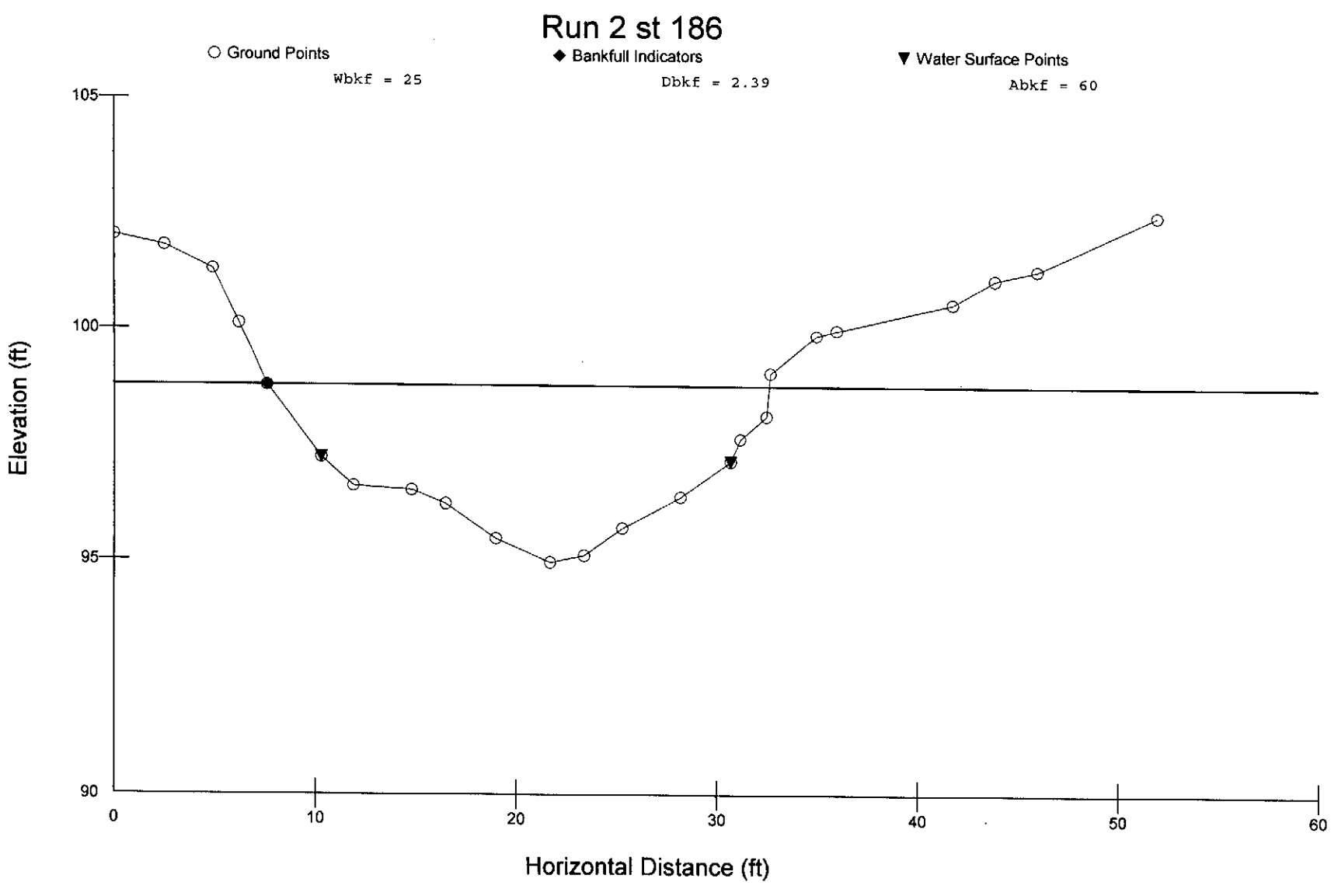
more on back

Station	F.S.	
64.2	7.15	
65.1	6.50	
66.0	5.55	
67.5	5.09	
68.9	4.91	edge of road
79.5	4.43	edge of road
84.0	3.69	

Marsh Run
Reach 3
4/16/2012



SURVEY DATA → CROSS-SECTION 2

SITE: MARSH RUN ((LONG PRO STATION 186) - RUN **Date:** 4/26/12

	Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
52	29	0	3.38		4.64		
46	30	6	4.57				
43.9	31	8.1	4.78				
41.8	32	10.2	5.30				
36	33	16	5.88				
35	34	17	6.0				
32.7	35	19.3	6.82				BIG ROOT (VERY IMPORTANT)
32.5	36	19.5	7.75				
31.2	37	20.8	8.25				
30.7	38	21.3	8.73				REW
28.2	39	23.8	9.50				
25.3	40	26.7	10.17				
23.4	41	28.6	10.76				
21.7	42	30.3	10.91				THALWEG
19	43	33	10.40				
16.5	44	35.5	9.66				
14.8	45	37.2	9.37				
11.9	46	40.1	9.28				
10.3	47	41.7	8.66				LEW
7.6	48	44.4	7.04				
6.2	49	45.8	5.76				
4.9	50	47.1	4.58				
2.5	51	49.5	4.07				
0	52	52	3.84				
	53						
	54						
	55						
	56						
	57						
	58						
	59						

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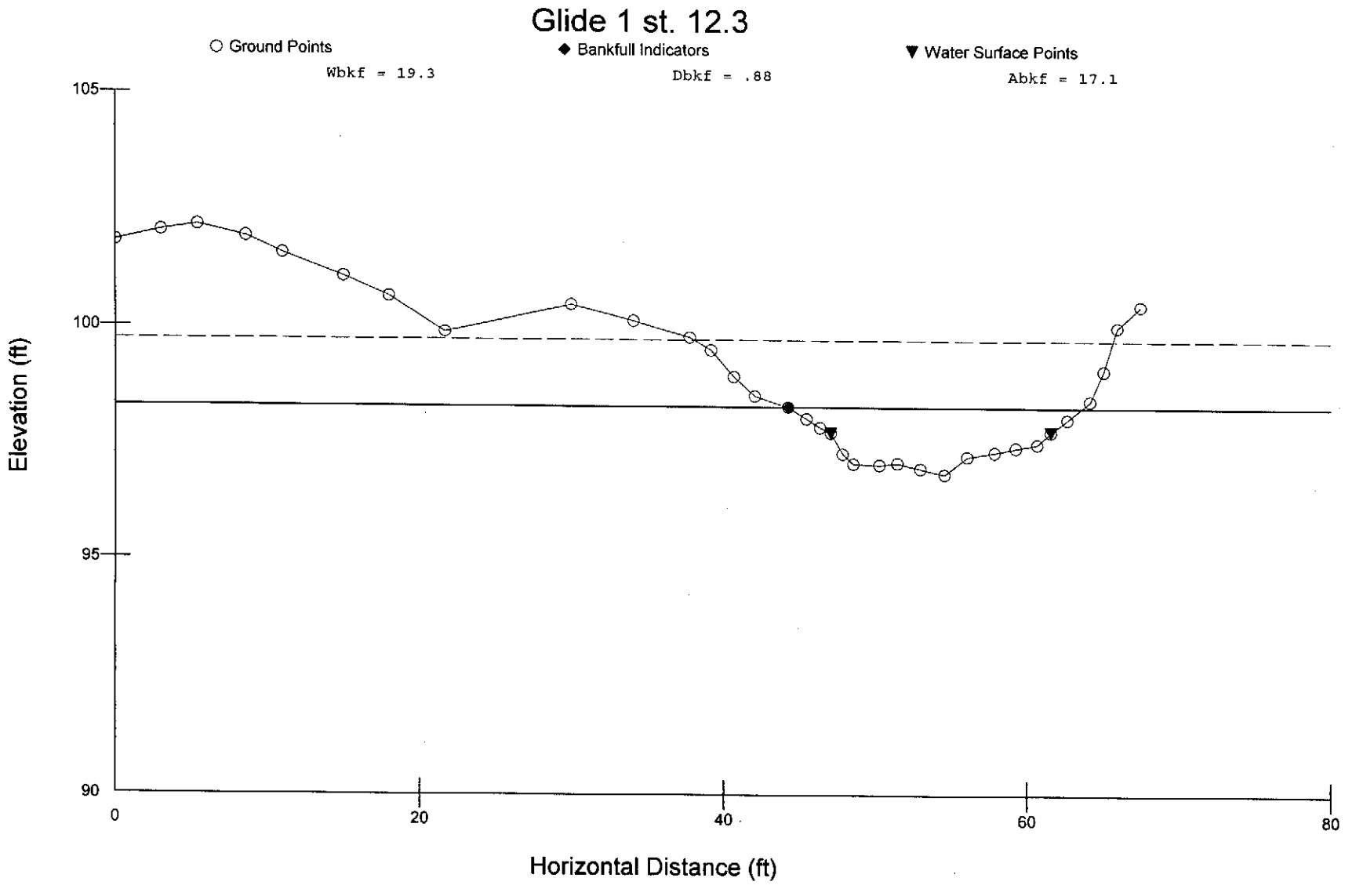
* NO INDICATOR FOR BANKFULL

Marsh Run
Reach 3
4/26/2012



bench pin
3.99'
(101.556)

Team 3

SURVEY DATA ⟶ **CROSS - SECTION 6**

SITE: Marsh Run Glide/station 12.3' **Date:** 4/26/12

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29		3.05				
30	0			4.49		
31	3			4.36		
32	7.9			4.21		
33	11.3			4.15		
34	13			5.09		
35	14.3			5.98		
36	15.5			6.83		
37	16.2			7.16		
38	17.1			7.45		water surface
39	18.3			7.69		
40	20.5			7.86		
41	21.6			7.90		
42	23.0			8.15		
43	24.9			7.89		
44	26.9			7.76		
45	28.3			7.81		
46	30.5			7.81		
47	32.8			7.77		
48	34.6			7.79		
49	36.1			7.71		
50	38.2			7.81		
51	39.4			7.99		
52	41.0			7.66		~~BKF~~ water surface
53	42.1			6.89		BKF
54	43.2			6.45		
55	44.1			5.37		
56	46.0			4.70		
57	49.0			4.32		
58	56.0			4.59		
59	63.6			4.88		road surface

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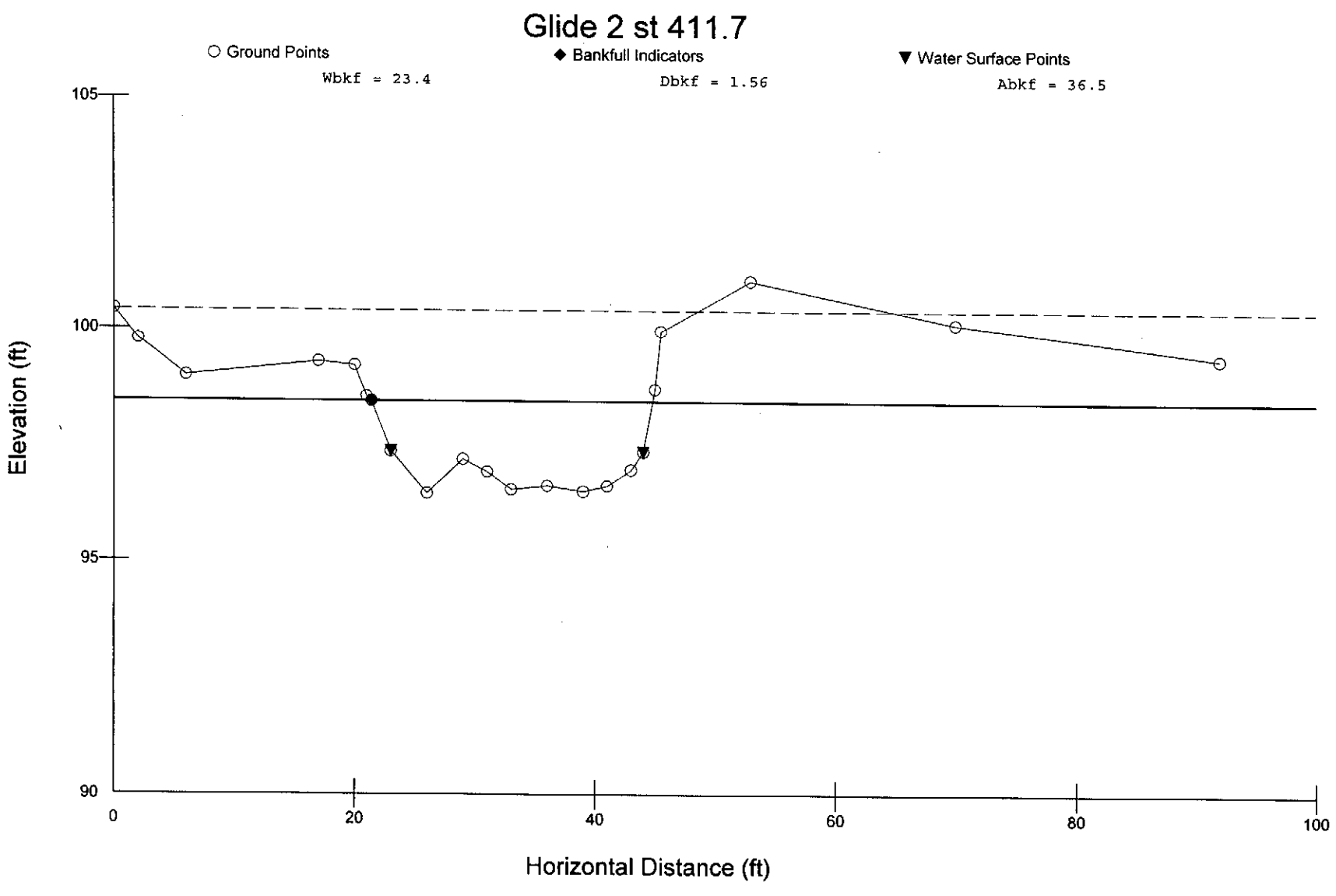
Marsh Run
Reach 3
4/26/12



Team3

SURVEY DATA ⟶ **CROSS-SECTION 5**

SITE: Marsh Run - Glide/Station 411.7' **Date:**

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29		2.10				
30	0			4.18		
31	2			4.84		
32	6			5.63		
33	17			5.32		
34	20			5.40		
35	21			6.08		
36	21.4			6.18		BkF better
37	23			7.26		water surface
38	26			8.17		
39	29			7.43		
40	31			7.70		
41	33			8.08		
42	36			8.00		
43	39			8.12		
44	41			8.00		
45	43			7.65		
46	44			—		water surface
47	45			5.91		
48	45.5			4.64		
49	53			3.54		
50	70			4.47		
51	92			5.22		edge of road
52						
53						
54						
55						
56						
57						
58						
59						

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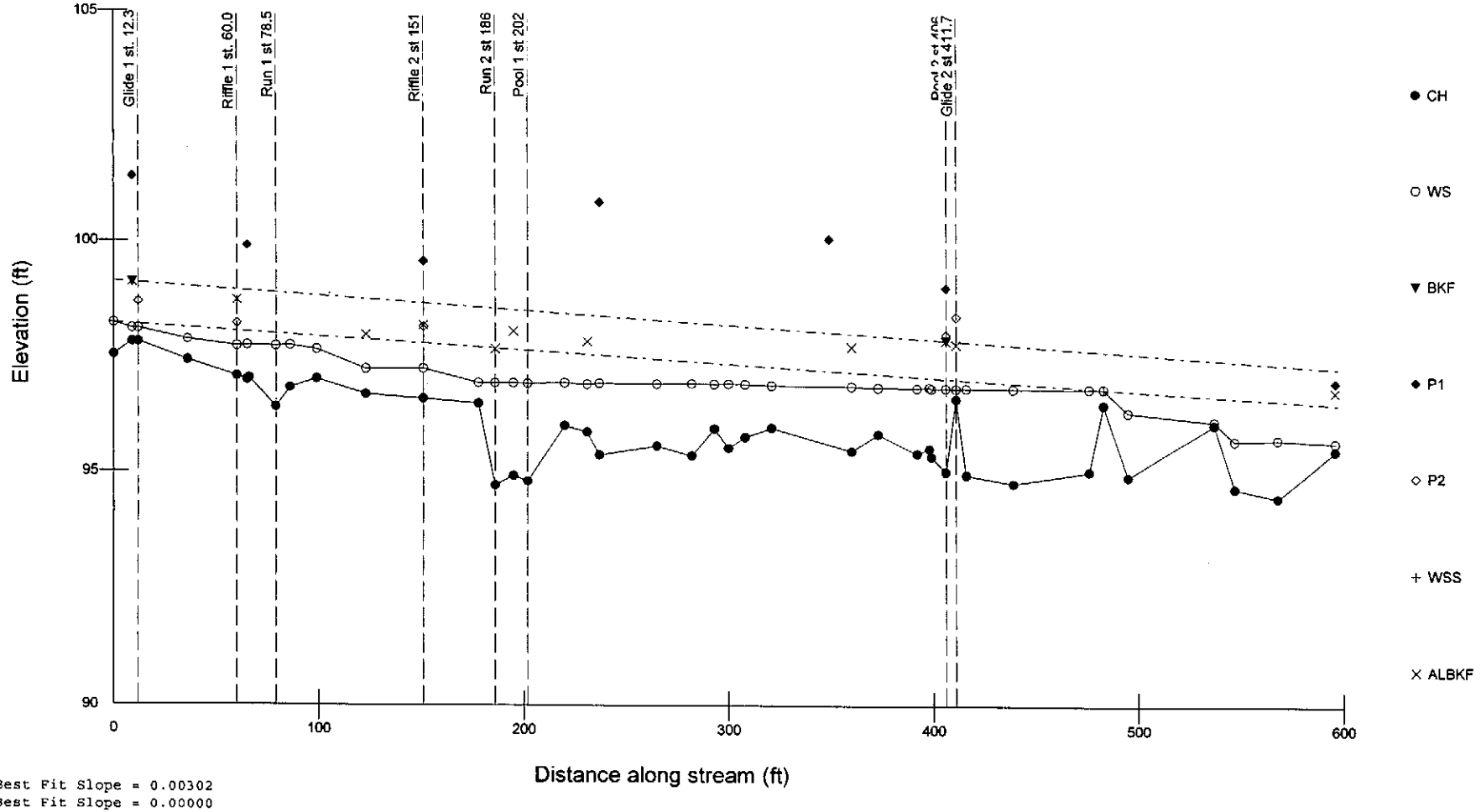
Reach 3 Marsh Run Longitudinal Profile - 26 April 2012



BKF Best Fit Slope = 0.00302
WSS Best Fit Slope = 0.00000

BM1 elev. 102.496

SURVEY DATA → LONGITUDINAL PROFILE 1

SITE: Marsh Run Date: 4/26/12

Location: Reach 3

Party / Notes: Team 3 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	~~BM1~~	~~3.03~~	~~103.03~~									
2	BM1	2.99	102.99									
3	0			7.98	95.01	7.28	95.71	~~6.40~~	~~96.59~~	~~4.09~~ 3.99	~~98.9~~ 98.99	~~Top~~ Riffle Glide
4	9			7.70	95.29	7.40	95.59	6.40	96.59	4.09	98.9	Top of Riffle
5	36			8.09	94.9	7.64	95.35					
6	65			~~8.50~~ 8.26	94.49	~~7.36~~ 8.26	95.23			5.58	97.41	
7	79			9.1	93.89	7.78	95.21					Deeper-small pool Run
8	99			8.48	94.51	7.85	95.14					
9	123			8.81	94.18	8.26	94.73	7.52	95.47			
10	166			8.46	94.53							
11	86			8.67	94.32	7.76	95.23					Bottom of Run
12	~~BM2~~		~~111.096~~									Rocks jutting out from bank - small constriction
13	151			8.90	94.09	8.25	94.74	7.31	95.68	5.92	97.07	XS1 - Riffle 98.15
14	178			9.0	93.99	8.55	94.44					End of Riffle
15	186			10.76	92.23	8.55		7.82				XS2 - Run
16	195			10.55	92.44	8.55		7.43				Top of Pool
17	202			10.67	92.32	8.56						XS3 - Pool
18	220			9.47	93.52	8.51	94.45					Glide
19	231			9.60	93.39	8.57		7.65				
20	237			10.10	92.89	8.55				4.61		
21	265			9.9	93.09	8.56						
22	282			10.11	92.88	8.55						End of Pool
23	293			9.52	93.47	8.56						Glide
24	300			9.94	93.05	8.55						
25	308			9.70	93.29	8.56						
26	321			9.50	93.49	8.58						Check Dam
27	349									~~5.11~~ 5.39		

BKF-WS

1.0

0.76

0.94

X 0.73

1.12

0.92

 BM2 9.54 111.096

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SURVEY DATA → LONGITUDINAL PROFILE 2

SITE: Marsh Run Date: 4/26/12

Location: Team 3

Party / Notes: HUC:

	Distance, Point, or STATION ft	Back-Sight BS ft	Height of Instru-ment 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
28	360			10.0	92.99	8.60		7.79				Glide
29	373			9.63	93.36	8.62						
30	392			10.05		8.63						
31	398			10.12		8.64						Top Pool
32	398			9.94		8.61*						+ Don + put much sizzle in
33	406			10.44	92.55	8.63		7.60		6.45		XS4-Pool 98.02
34	411			8.87		8.64		7.68				XS5-Glide 98.42
35	416			10.5		8.63						
36	439			10.09		8.64						
37	476			10.43		8.64						
38	483			8.99	94.00	8.64						Funky old stuff
39	495			10.54	92.45	9.15						
40	537			9.40	93.59	9.34						Check dam
41	547			10.79		9.75						
42	568			11.00		9.72						
43	596			9.97		9.79		9.79+ 1.11		8.48		
44								↑ w/ pocket rod				
45	12			7.70		7.40						XS-Glide 98.60
46	100			8.42		7.78		10.18	frag			XS-Riffle 98.24
47								not where XS team flagged				98.12
48												
49												
50												
51												
52												
53												
54												

0.85

1.03

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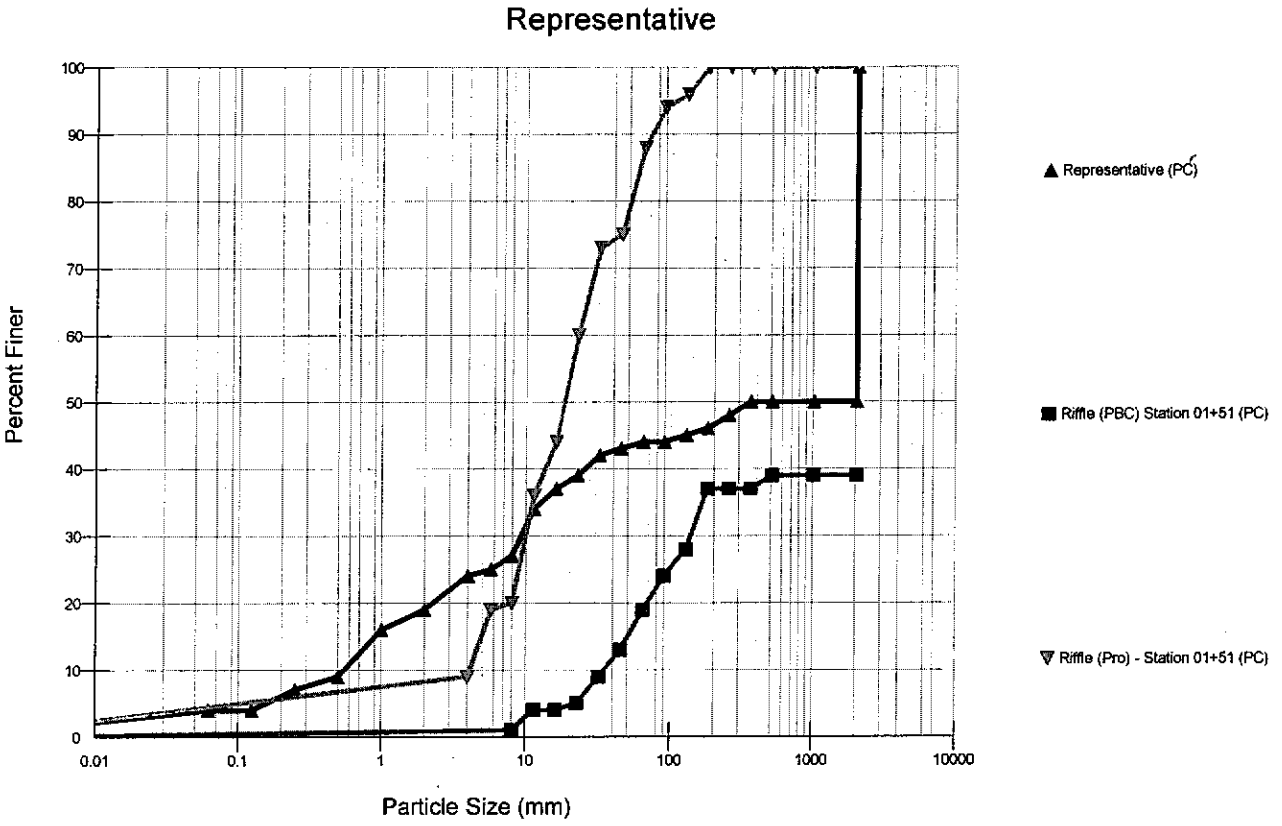
Marsh Run
Reach 3
4/26/2012



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 - Reach3
Date:	4/26/2012	Stream Type:	C1	Valley Type:	VIII
Observers:	Team 3			HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	31.36	A_{bkf} (ft^2)	Bankfull Riffle Mean DEPTH	1.09	d_{bkf} (ft)
Bankfull Riffle WIDTH	28.84	W_{bkf} (ft)	Wetted PERMIMETER ~ (2 * d_{bkf}) + W_{bkf}	29.18	W_p (ft)
D_{84} at Riffle	58.15	Dia. (mm)	D_{84} (mm) / 304.8	0.19	D_{84} (ft)
Bankfull SLOPE	0.0030	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	1.07	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R(ft) / D_{84} (ft)	5.60	R / D_{84}
Drainage Area	19.1	DA (mi^2)	Shear Velocity $u^* = (gRS)^{½}$	0.321	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	71.53	cfs
2. Roughness Coefficient: a) Manning's n from Friction Factor / Relative Roughness (Figs. 2-18, 2-19) $u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0.0424	2.02	ft / sec	63.19	cfs
2. Roughness Coefficient: b) Manning's n from Stream Type (Fig. 2-20) $u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0.0345	2.48	ft / sec	77.65	cfs
2. Roughness Coefficient: c) Manning's n from Jarrett (USGS): $u = 1.49 * R^{2/3} * S^{1/2} / n$ $n = 0.39 * S^{0.38} * R^{-0.16}$ Note: This equation is applicable to steep, step/pool, high boundary roughness, cobble- and boulder-dominated stream systems; i.e., for Stream Types A1, A2, A3, B1, B2, B3, C2 & E3 $n =$ 0.042	2.02	ft / sec	63.19	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach (Leopold, Wolman and Miller)	2.33	ft / sec	73.02	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	3.03	ft / sec	95.00	cfs
4. Continuity Equations: b) USGS Gage Data $u = Q / A$	3.03	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 **"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 5-3. Field form for Level II stream classification (Rosgen, 1996; Rosgen and Silvey, 2005).

Stream:	**Marsh Run, Reach - Reach3**		
Basin:	Drainage Area: **12192** acres	**19.05**	mi^2
Location:			
Twp.&Rge: ;	Sec.&Qtr.: ;		
Cross-Section Monuments (Lat./Long.):	**0 Lat / 0 Long**	Date: **04/26/12**	
Observers: **Team 3**		Valley Type: VIII	

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	**28.84**	ft
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A / W_{bkf}$).	**1.09**	ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	**31.36**	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	**26.46**	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.	**1.53**	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.	**46.65**	ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	**1.62**	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.	BEDROCK ~~402~~	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.	**0.003**	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).	**1.15**	

Stream Type **F1** (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 - Reach3**

Observers: **Team 3** Date: **04/26/12** Valley Type: **VIII** Stream Type: **F1**

River Reach Summary Data.....2

Hydraulics

Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})	0	ft/sec	Estimation Method		
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})	95	cfs	Drainage Area	19.05	mi^2

Channel Pattern

Geometry	Mean	Min	Max		Dimensionless Geometry Ratios	Mean	Min	Max
Linear Wavelength (λ)	442	395	478	ft	Linear Wavelength to Riffle Width (λ / W_{bkf})	15.326	13.703	16.588
Stream Meander Length (L_m)	160	159	161	ft	Stream Meander Length Ratio (L_m / W_{bkf})	[illegible]		
Radius of Curvature (R_c)	64.5	58	71	ft	Radius of Curvature to Riffle Width (R_c / W_{bkf})	2.236	2.011	2.462
Belt Width (W_{blt})	94.9	62.4	120	ft	Meander Width Ratio (W_{blt} / W_{bkf})	3.291	2.164	4.147
Arc Length (L_a)	113	98.7	128	ft	Arc Length to Riffle Width (L_a / W_{bkf})	3.929	3.422	4.435
Riffle Length (L_r)	66	53	79	ft	Riffle Length to Riffle Width (L_r / W_{bkf})	2.288	1.838	2.739
Individual Pool Length (L_p)	15	14	16	ft	Individual Pool Length to Riffle Width (L_p / W_{bkf})	0.520	0.485	0.555
Pool to Pool Spacing (P_s)	93.5	45.3	209	ft	Pool to Pool Spacing to Riffle Width (P_s / W_{bkf})	3.242	1.572	7.264

Channel Profile

Valley Slope (S_{val})	0.0035	ft/ft	Average Water Surface Slope (S)	0.003	ft/ft	Sinuosity (S_{val} / S)	1.15
Stream Length (SL)	484.4	ft	Valley Length (VL)	421	ft	Sinuosity (SL / VL)	1.1506

Low Bank Height (LBH)	start	0	ft	Max Depth (d_{max})	start	0	ft	Bank-Height Ratio (BHR) (LBH / d_{max})	start	
	end	0	ft		end	0	ft		end	

Facet Slopes	Mean	Min	Max		Dimensionless Facet Slope Ratios	Mean	Min	Max
Riffle Slope (S_{rif})	0.008	0.007	0.009	ft/ft	Riffle Slope to Average Water Surface Slope (S_{rif} / S)	2.610	2.263	2.953
Run Slope (S_{run})	0.001	0.000	0.001	ft/ft	Run Slope to Average Water Surface Slope (S_{run} / S)	0.240	0.000	0.477
Pool Slope (S_p)	0.000	0.000	0.001	ft/ft	Pool Slope to Average Water Surface Slope (S_p / S)	0.103	0.000	0.207
Glide Slope (S_g)	0.001	0.001	0.002	ft/ft	Glide Slope to Average Water Surface Slope (S_g / S)	0.410	0.303	0.513
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 Depths[a]	Mean	Min	Max		Dimensionless Depth Ratios	Mean	Min	Max
Max Riffle Depth (d_{maxrif})	1.84	1.59	2.09	ft	Max Riffle Depth to Mean Riffle Depth (d_{maxrif} / d_{bkf})	1.68807	1.4587	1.9174
Max Run Depth (d_{maxrun})	2.57	2.19	2.94	ft	Max Run Depth to Mean Riffle Depth (d_{maxrun} / d_{bkf})	2.3578	2.0092	2.6972
Max Pool Depth (d_{maxp})	3.28	2.86	3.7	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	3.00917	2.6239	3.3945
Max Glide Depth (d_{maxg})	1.74	1.27	2.25	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.59633	1.1651	2.0642
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

	Reach[b]	Riffle[c]	Bar		Reach[b]	Riffle[c]	Bar	Protrusion Height[d]	
% Silt/Clay	4	0		D_{16}	1	54.5		5.19	mm
% Sand	15	0		D_{35}	12.87	168.44		11.09	mm
% Gravel	25	19		D_{50}	362	Bedrock		18.48	mm
% Cobble	4	18		D_{84}	Bedrock	Bedrock		58.15	mm
% Boulder	2	2		D_{95}	Bedrock	Bedrock		109	mm
% Bedrock	50	61		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 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2007; Rosgen, 2008).

Stream: **Marsh Run** Location: **Reach - Reach3**

Observers: **Team 3** Date: **04/26/12** Valley Type: **VIII** Stream Type: **F1**

River Reach Dimension Summary Data.....1

Riffle Dimensions*, **, ***

Riffle Dimensions*, **, ***	Mean	Min	Max		Riffle Dimensions & Dimensionless Ratios****	Mean	Min	Max
Riffle Width (W_{bkf})	28.8	23.4	28.8	ft	Riffle Cross-Sectional Area (A_{bkf}) (ft^2)	31.36	30.87	31.36
Mean Riffle Depth (d_{bkf})	1.09	1.09	1.32	ft	Riffle Width/Depth Ratio (W_{bkf} / d_{bkf})	22.09	17.71	26.46
Maximum Riffle Depth (d_{max})	1.72	1.53	1.9	ft	Max Riffle Depth to Mean Riffle Depth (d_{max} / d_{bkf})	1.422	1.404	1.439
Width of Flood-Prone Area (W_{fpa})	39.4	32.2	46.7	ft	Entrenchment Ratio (W_{fpa} / W_{bkf})	1.497	1.376	1.618
Riffle Inner Berm Width (W_{ib})	0	0	0	ft	Riffle Inner Berm Width to Riffle Width (W_{ib} / W_{bkf})	0.000	0.000	0.000
Riffle Inner Berm Depth (d_{ib})	0	0	0	ft	Riffle Inner Berm Depth to Mean Depth (d_{ib} / d_{bkf})	0.000	0.000	0.000
Riffle Inner Berm Area (A_{ib})	0	0	0	ft^2	Riffle Inner Berm Area to Riffle Area (A_{ib} / A_{bkf})	0.000	0.000	0.000
Riffle Inner Berm W/D Ratio (W_{ib} / d_{ib})	0	0	0					

Pool Dimensions*, **, ***

Pool Dimensions*, **, ***	Mean	Min	Max		Pool Dimensions & Dimensionless Ratios****	Mean	Min	Max
Pool Width (W_{bkfp})	21.1	20.4	21.7	ft	Pool Width to Riffle Width (W_{bkfp} / W_{bkf})	0.730	0.708	0.752
Mean Pool Depth (d_{bkfp})	2.15	2.06	2.24	ft	Mean Pool Depth to Mean Riffle Depth (d_{bkfp} / d_{bkf})	1.972	1.890	2.055
Pool Cross-Sectional Area (A_{bkfp})	45.4	42.2	48.6	ft	Pool Area to Riffle Area (A_{bkfp} / A_{bkf})	1.447	1.344	1.549
Maximum Pool Depth (d_{maxp})	3.28	2.88	3.68	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	3.009	2.642	3.376
Pool Inner Berm Width (W_{ibp})	0	0	0	ft	Pool Inner Berm Width to Pool Width (W_{ibp} / W_{bkfp})	0.000	0.000	0.000
Pool Inner Berm Depth (d_{ibp})	0	0	0	ft	Pool Inner Berm Depth to Pool Depth (d_{ibp} / d_{bkfp})	0.000	0.000	0.000
Pool Inner Berm Area (A_{ibp})	0	0	0	ft^2	Pool Inner Berm Area to Pool Area (A_{ibp} / A_{bkfp})	0.000	0.000	0.000
Point Bar Slope (S_{pb})	0.000	0.000	0.000	ft/ft	Pool Inner Berm Width/Depth Ratio (W_{ibp} / d_{ibp})	0.000	0.000	0.000

Run Dimensions*

Run Dimensions*	Mean	Min	Max		Run Dimensionless Ratios****	Mean	Min	Max
Run Width (W_{bkfr})	22.2	19.3	25	ft	Run Width to Riffle Width (W_{bkfr} / W_{bkf})	0.769	0.671	0.868
Mean Run Depth (d_{bkfr})	1.64	0.88	2.39	ft	Mean Run Depth to Mean Riffle Depth (d_{bkfr} / d_{bkf})	1.505	0.807	2.193
Run Cross-Sectional Area (A_{bkfr})	38.5	17.1	60	ft	Run Area to Riffle Area (A_{bkfr} / A_{bkf})	1.229	0.545	1.912
Maximum Run Depth (d_{maxr})	2.62	1.44	3.8	ft	Max Run Depth to Mean Riffle Depth (d_{maxr} / d_{bkf})	2.404	1.321	3.486
Run Width/Depth Ratio (W_{bkfr} / d_{bkfr})	16.2	10.5	22	ft				

Glide Dimensions*

Glide Dimensions*	Mean	Min	Max		Glide Dimensions & Dimensionless Ratios****	Mean	Min	Max
Glide Width (W_{bkfg})	25.3	23.4	27.1	ft	Glide Width to Riffle Width (W_{bkfg} / W_{bkf})	0.876	0.811	0.941
Mean Glide Depth (d_{bkfg})	1.29	1.01	1.56	ft	Mean Glide Depth to Mean Riffle Depth (d_{bkfg} / d_{bkf})	1.183	0.927	1.431
Glide Cross-Sectional Area (A_{bkfg})	32	27.4	36.5	ft	Glide Area to Riffle Area (A_{bkfg} / A_{bkf})	1.019	0.874	1.164
Maximum Glide Depth (d_{maxg})	1.71	1.42	1.99	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.569	1.303	1.826
Glide Width/Depth Ratio (W_{bkfg} / d_{bkfg})	20.9	15	26.9	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**	Mean	Min	Max		Step Dimensionless Ratios****	Mean	Min	Max
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					

*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.

Reach 3
4/26/2012

Step 11

Summarize USGS gage data:

Summary of USGS Gage Station Data

Station Name:	Marsh Run @ Grimes		Station Number:	01617800	
Station Location:	Washington Co.		Period of Record:	47	yrs
Drainage Area (DA):	~~19.05~~ acres	19.05 mi²	D.A. Mean Elevation:		ft
Stream Type:		Valley Type:	Mean Annual Disch.:	[illegible]	cfs
Reference Reach Slope:		ft/ft	HUC:		

BANKFULL CHARACTERISTICS

Determined from FIELD MEASUREMENT			Determined from GAGE DATA ANALYSIS		
Bankfull Width (W_{bkf})	28.8	ft	Bankfull Width (W_{bkf})	22	ft
Bankfull Mean Depth (d_{bkf})	1.09	ft	Bankfull Mean Depth (d_{bkf})	1.8	ft
Bankfull XS Area (A_{bkf})	31.4	ft²	Bankfull XS Area (A_{bkf})	40	ft²
Wetted Perimeter (W_p)	30.98	ft	Wetted Perimeter (W_p)	30.98	ft
Bankfull Stage (Gage Ht.)	2.27	ft	Bankfull Stage (Gage Ht.)	2.27	ft
Est. Mean Velocity (ū)	2.26	ft/sec	Mean Velocity (ū)	2.80	ft/sec
Est. BKF. Discharge (Q_{bkf})	95	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	1.7	yrs

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

1.5 Year **R.I.** Discharge =	70	cfs	**10** Year **R.I.** Discharge =	275	cfs
2.0 Year **R.I.** Discharge =	97	cfs	**25** Year **R.I.** Discharge =	450	cfs
5.0 Year **R.I.** Discharge =	195	cfs	**50** Year **R.I.** Discharge =	460	cfs

MEANDER GEOMETRY

Linear Wavelength (λ)	442	ft	Stream Meander Length (L_m)	159.75	ft
Radius of Curvature (R_c)	64.5	ft	Belt Width (W_{blt})	94.9	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 (ū), 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. (ū)
Intercept Coefficient (a)	9.19	0.381	3.506	0.284
Slope Exponent (b)	0.188	0.333	0.522	0.481

Hydraulic Radius: $R = A / W_p$	1.01	ft	Manning's 'n' at Bankfull Stage	.028	Coeff.

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

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Marsh Run
Reach 3
4/26/2012

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: $n = (1.49R^{2/3}S^{1/2})/u$ (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: 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: **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 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 u/u*
19.05	95	28.8	1.09	31.4	3.03	.003	[redacted]	.19	~~F6~~	.028	5.6	.32	9.42
							58.15		F6/1		under-estimates velocity		

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Marsh Run
Team 3 4/26/2012

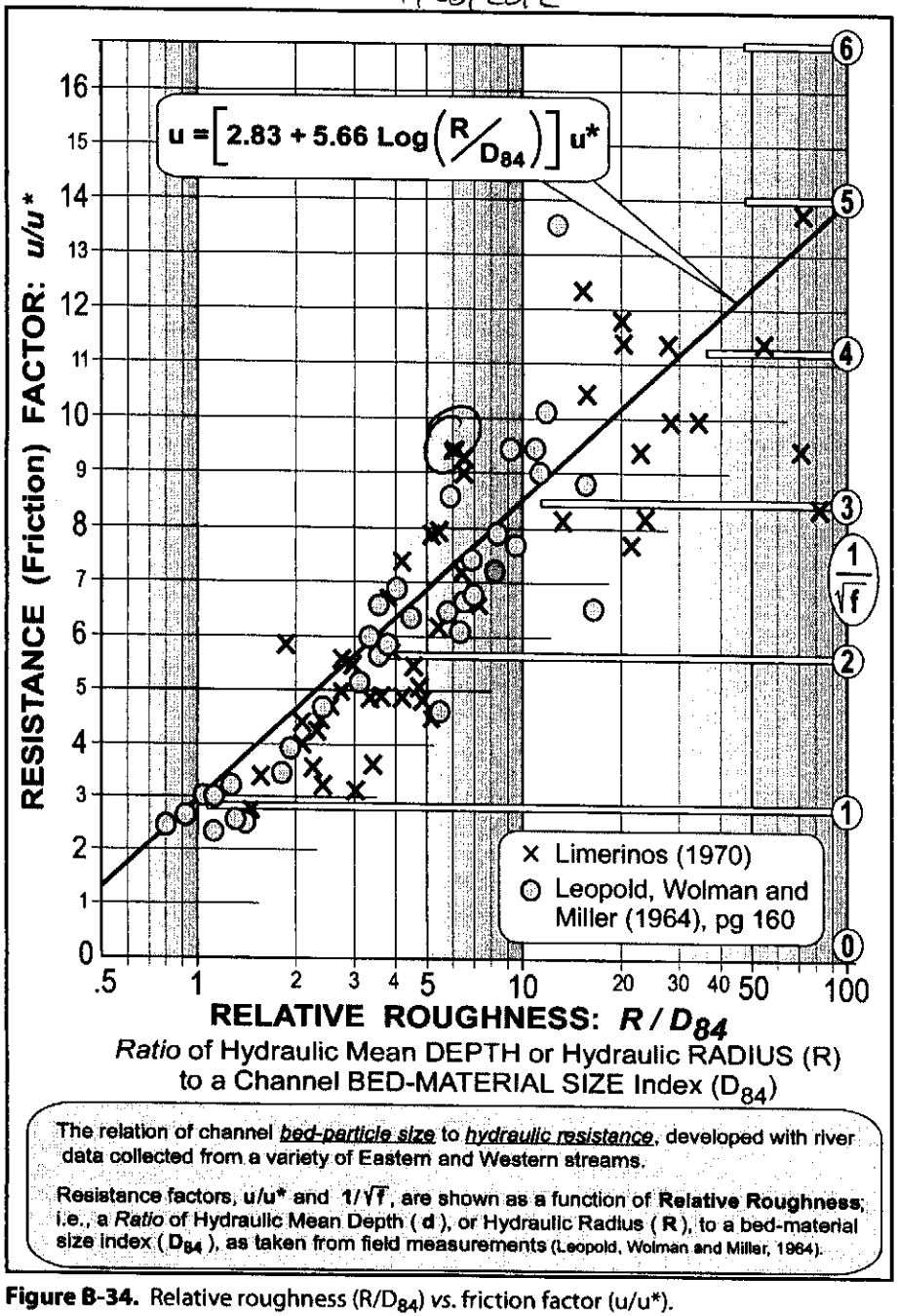

Figure B-34. Relative roughness (R/D_{84}) *vs.* friction factor (u/u*).

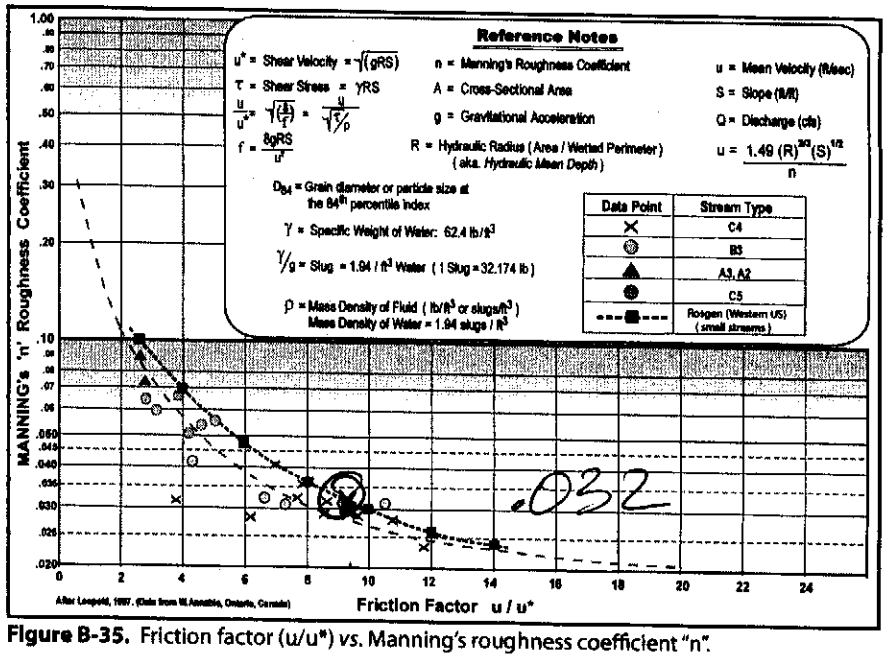

Figure B-35. Friction factor (u/u*) *vs.* Manning's roughness coefficient "n".

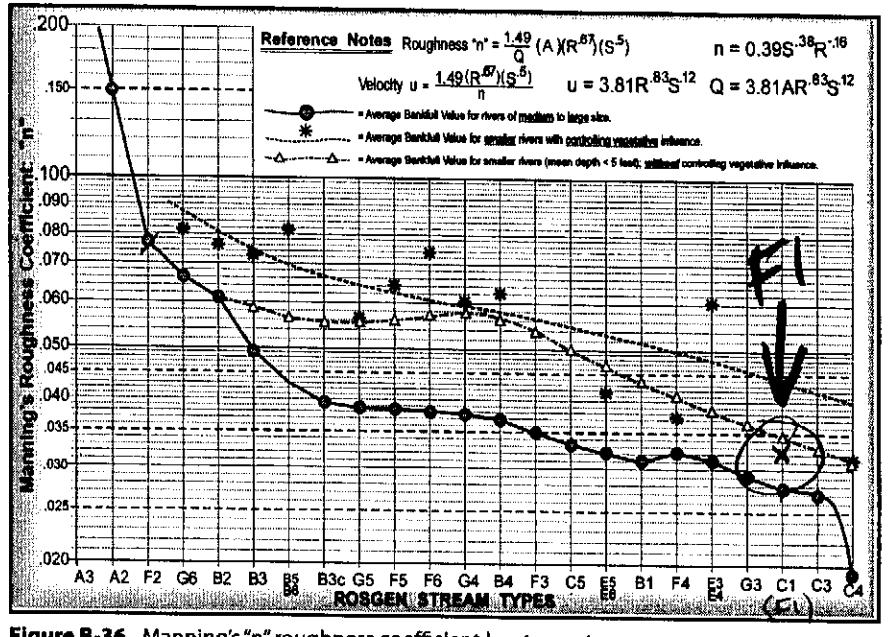

Figure B-36. Manning's "n" roughness coefficient by stream type.

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