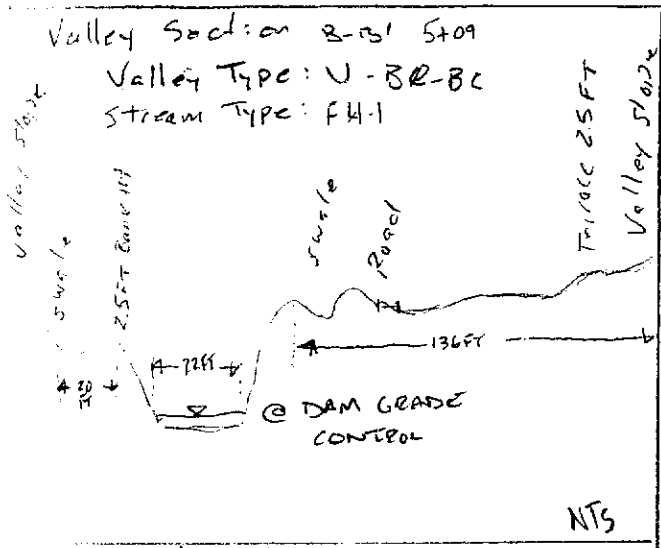
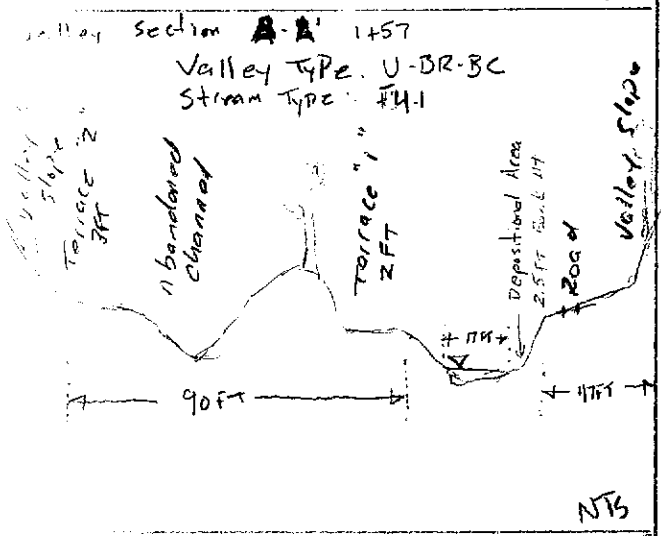
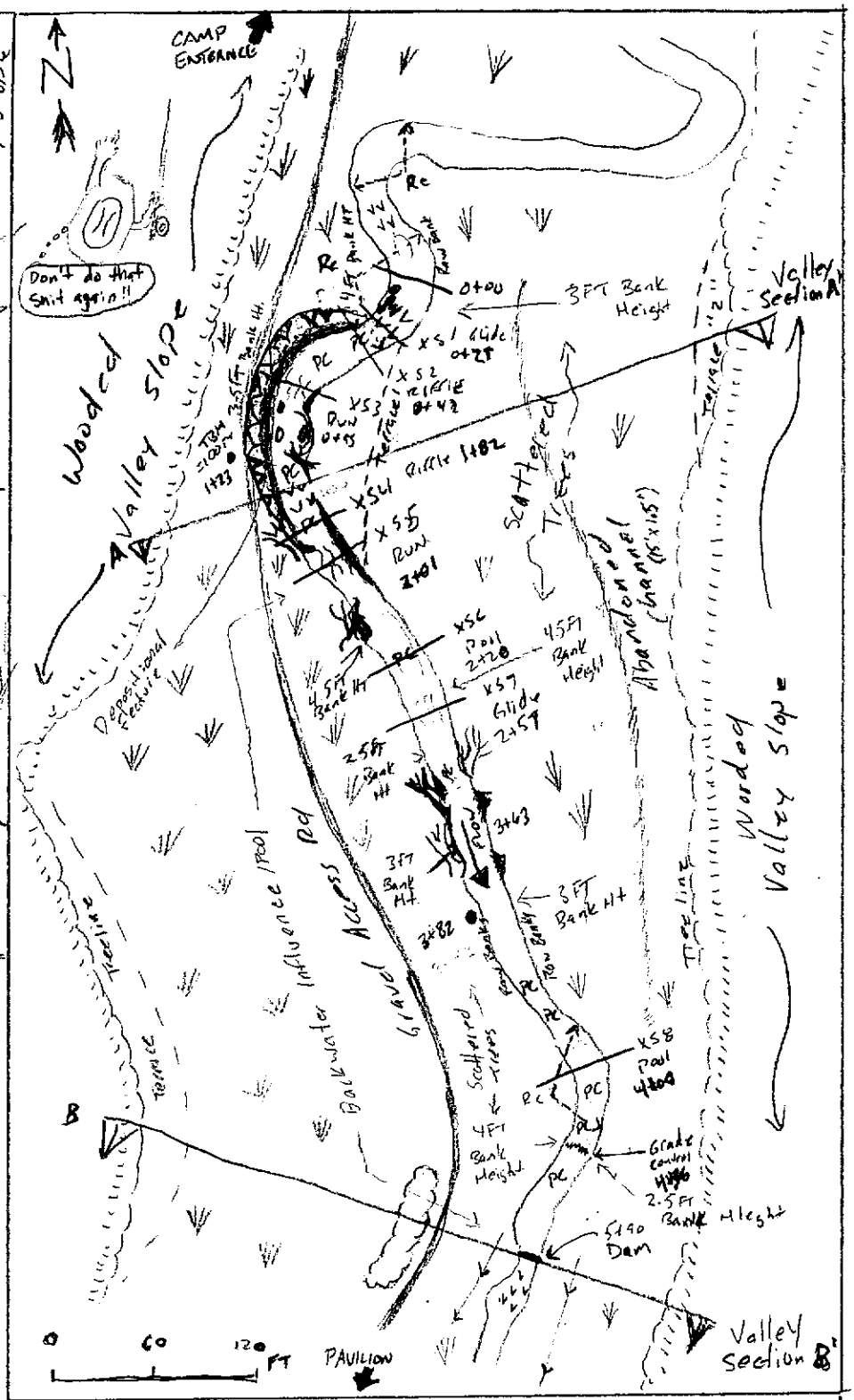




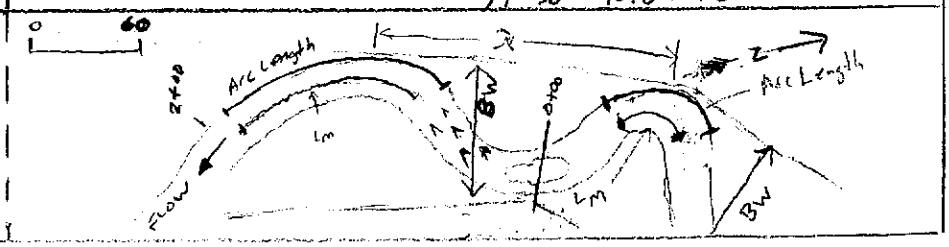


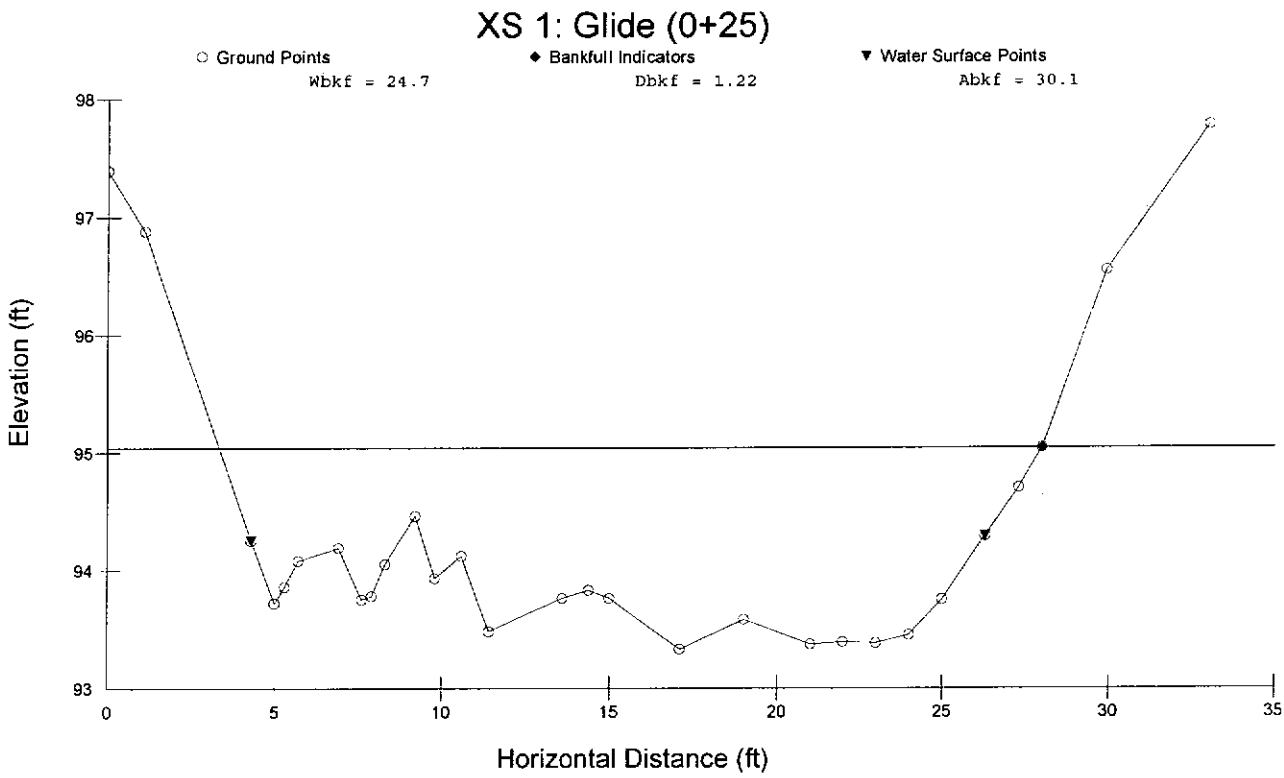
Herbaceous (grass/wildflowers)
Toe Valley Slope
Gravel Road
Abandoned channel
Boulders / Boulder slab
RUN
Riffle
Pool
Root Wads
= Treeline
PC = Pebble Count
= Grade Control
= Group of Trees
= TBM
= Duck Box
= Depositional Feature
= Single Tree
= Swale

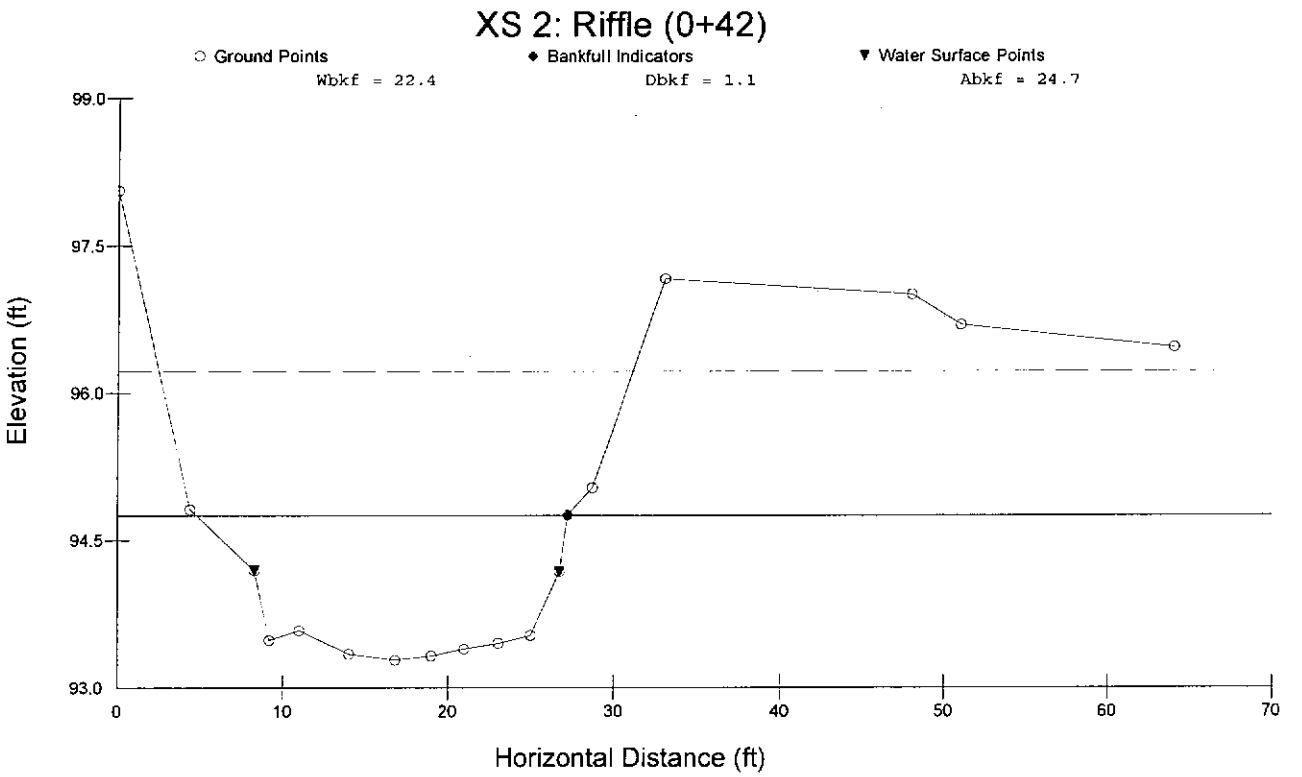
Marsh Run at Grimes
16951 Sprecher Rd
Camp Mary Mac
Crew: "The Group Two"

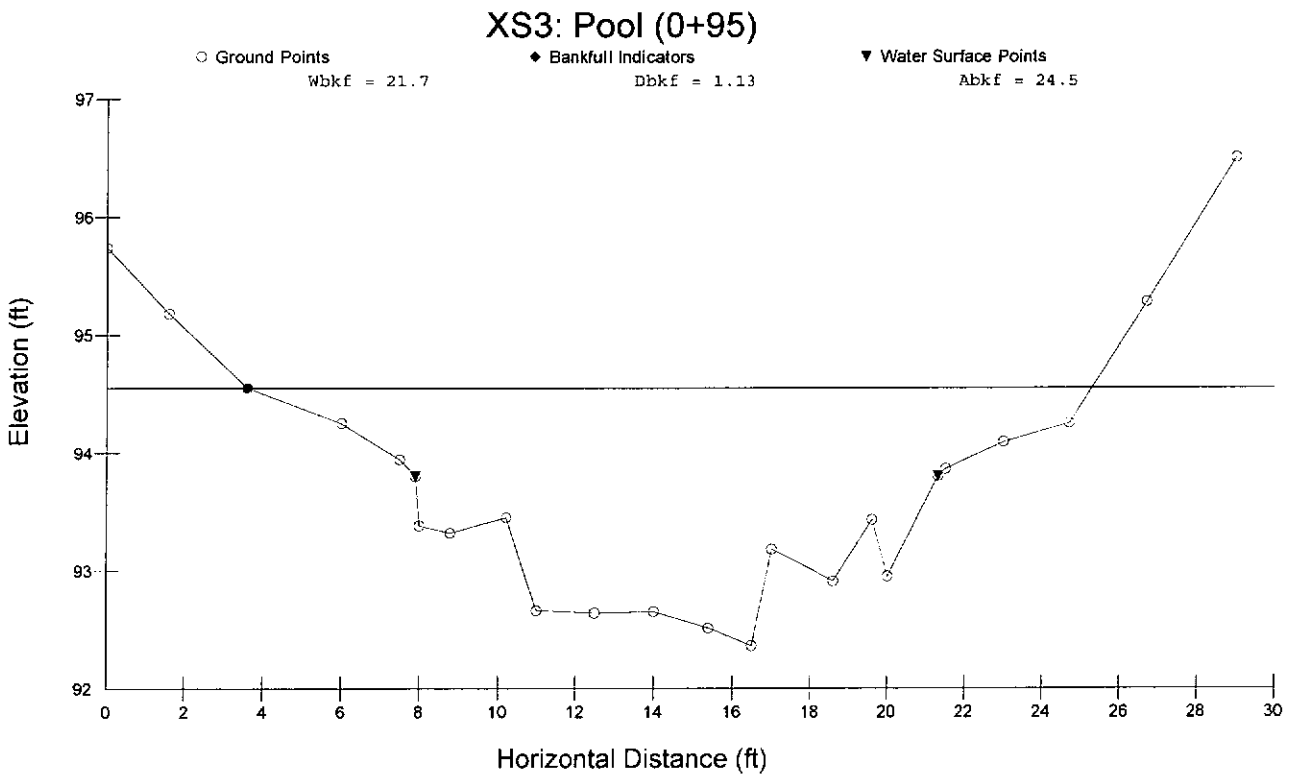
~680 FT DOWNSTREAM BRIDGE @ SPRECHER RD
Approx 350 FT AMSL
77° 46' 40.75" W
39° 30' 46.07" N
4-17-14

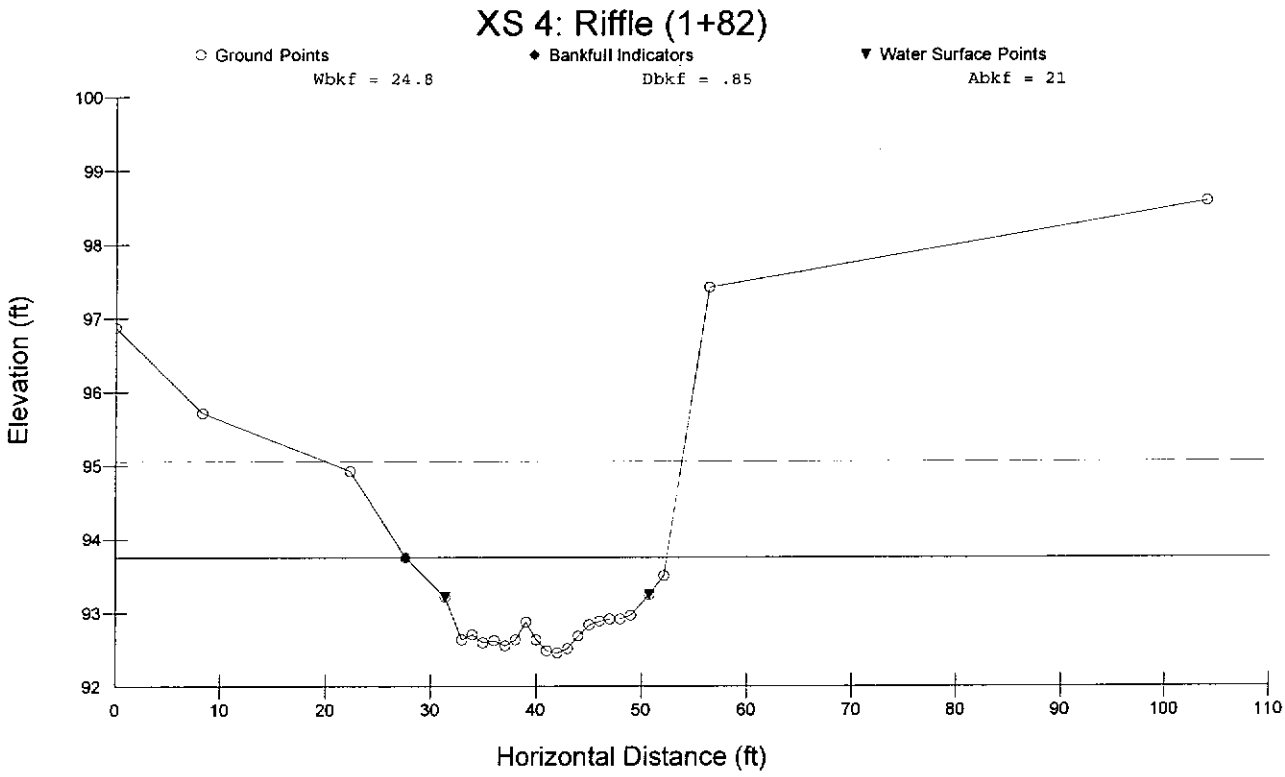
Belt Widths 44.5 Field 47.5 Field (US of Reach)
Wavelength 137 Field 205 Field (DS of Reach)
Arc Length 71 Ft 176 FT
Meander Length 51 Ft 62 FT

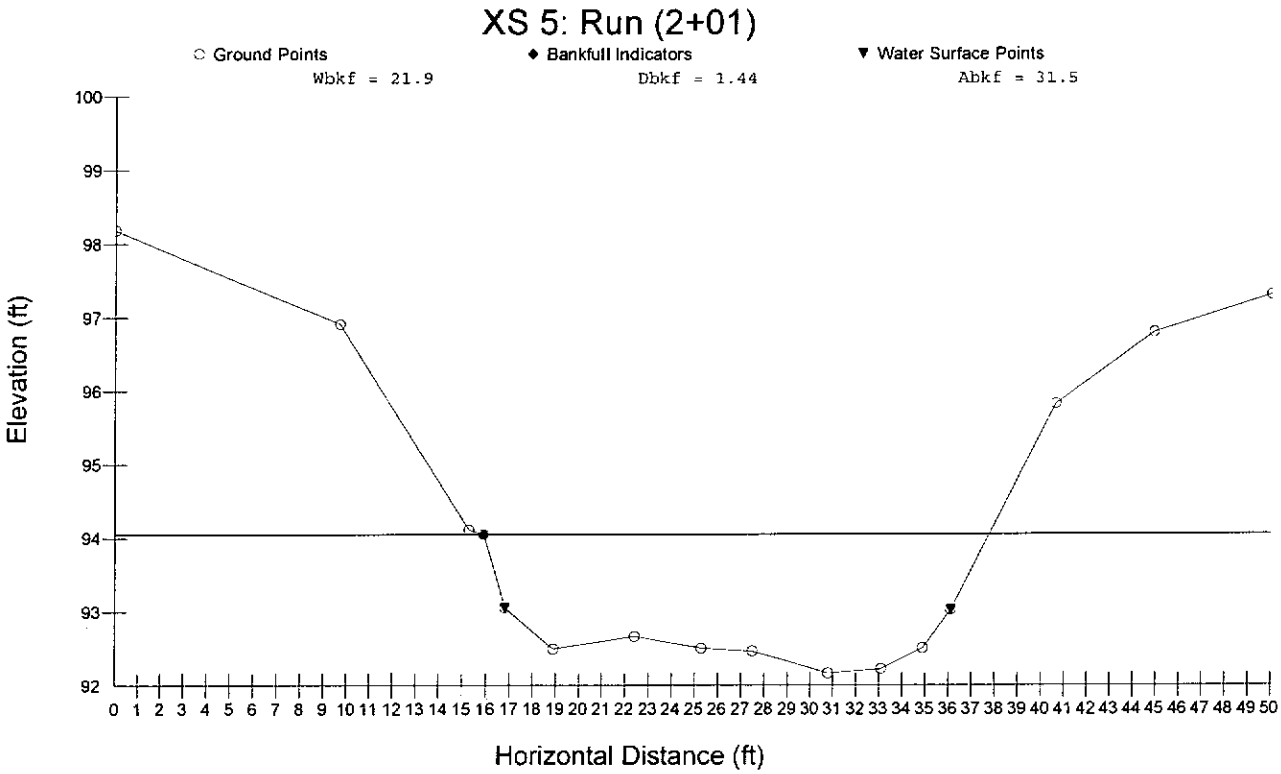


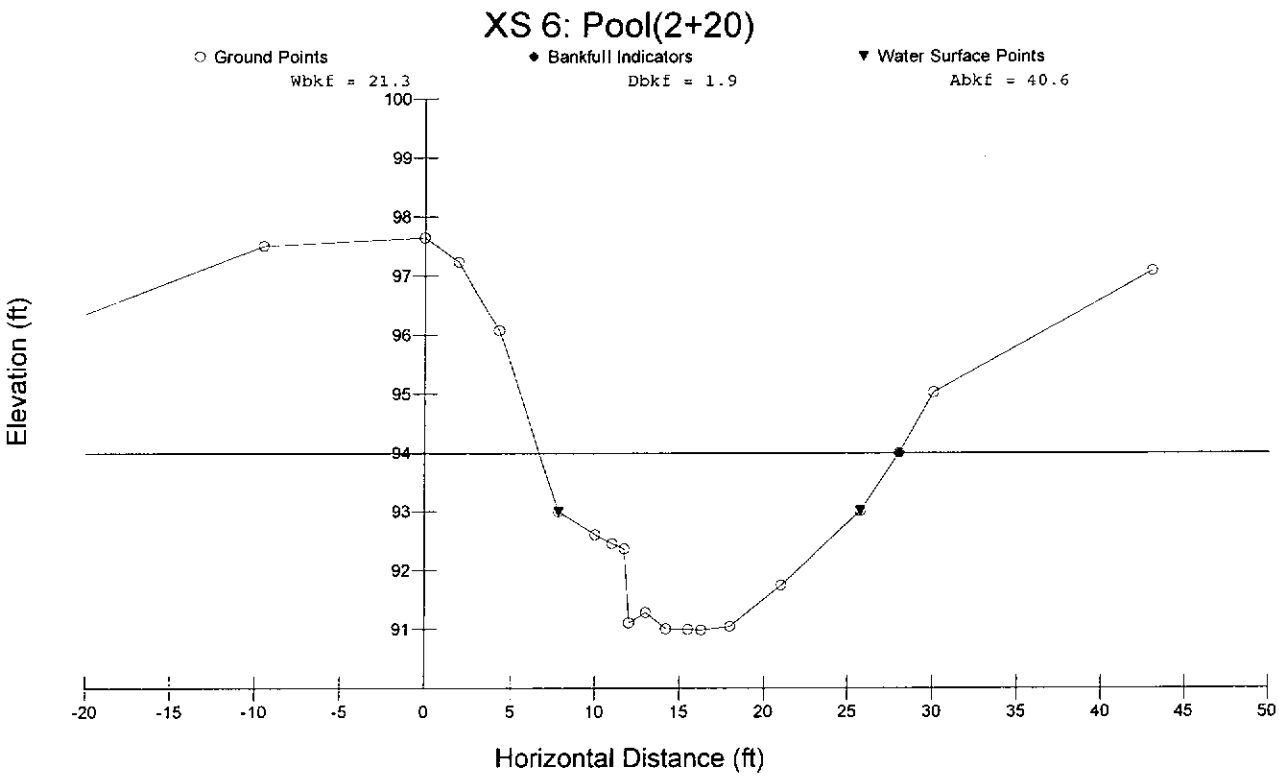

XS 1: Glide (0+25)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 24.7
Dbkf = 1.22
Abkf = 30.1
Elevation (ft)
98
97
96
95
94
93
0
5
10
15
20
25
30
35
Horizontal Distance (ft)

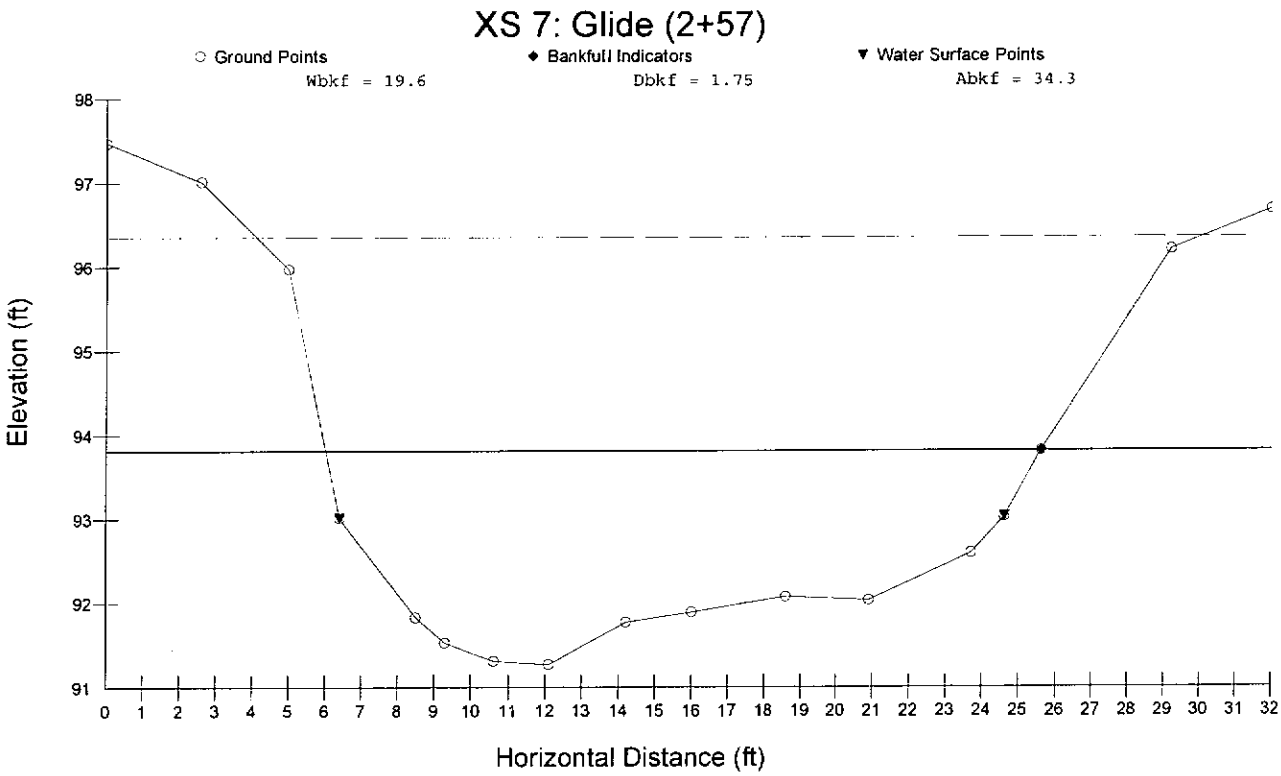

XS 2: Riffle (0+42)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 22.4
Dbkf = 1.1
Abkf = 24.7
99.0
97.5
96.0
94.5
93.0
Elevation (ft)
0
10
20
30
40
50
60
70
Horizontal Distance (ft)

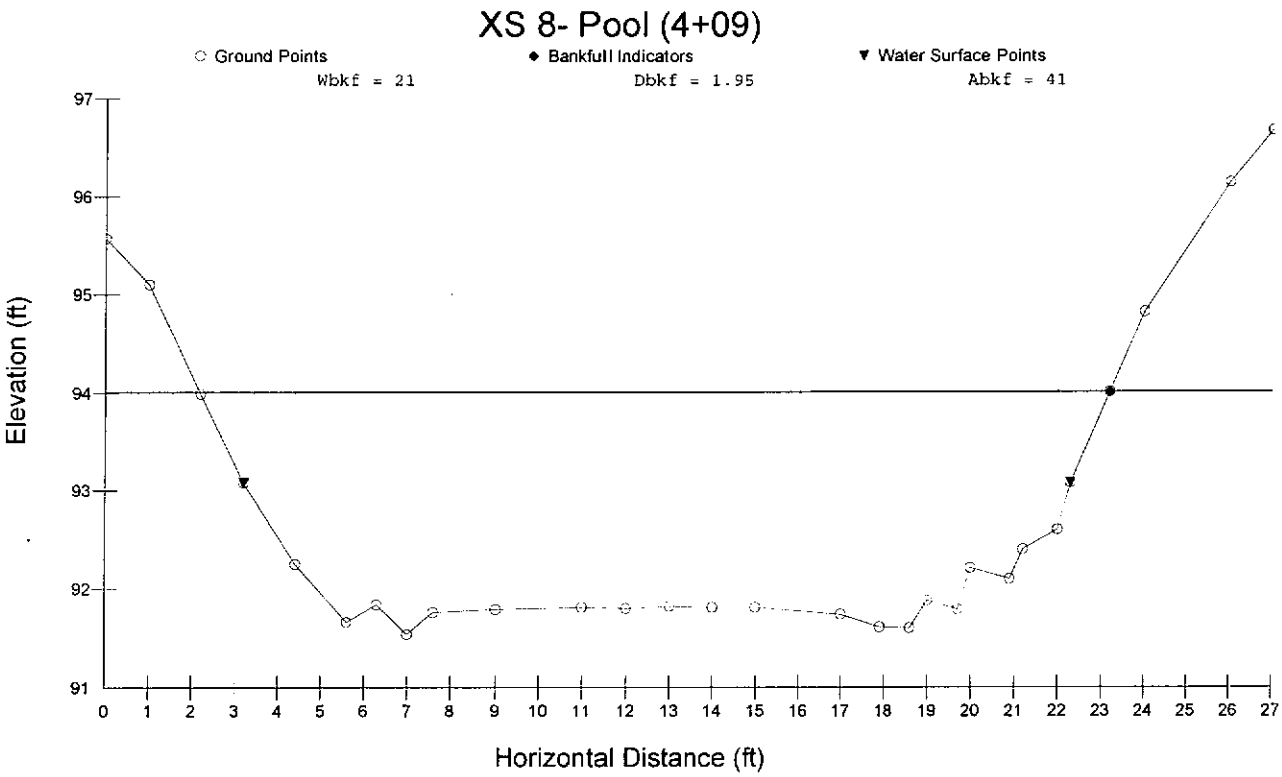

XS3: Pool (0+95)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 21.7
Dbkf = 1.13
Abkf = 24.5
Elevation (ft)
Horizontal Distance (ft)
97
96
95
94
93
92
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30

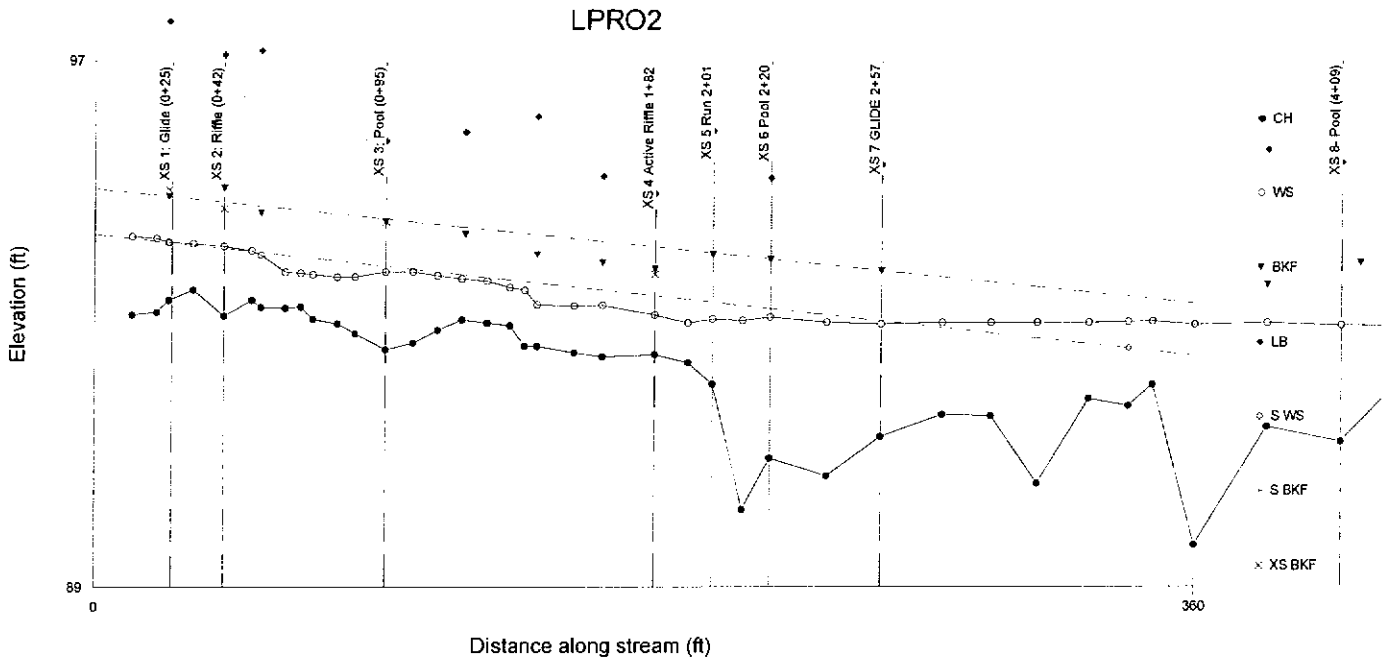

XS 4: Riffle (1+82)
Ground Points
Wbkf = 24.8
Bankfull Indicators
Dbkf = .85
Water Surface Points
Abkf = 21
Elevation (ft)
100
99
98
97
96
95
94
93
92
0
10
20
30
40
50
60
70
80
90
100
110
Horizontal Distance (ft)

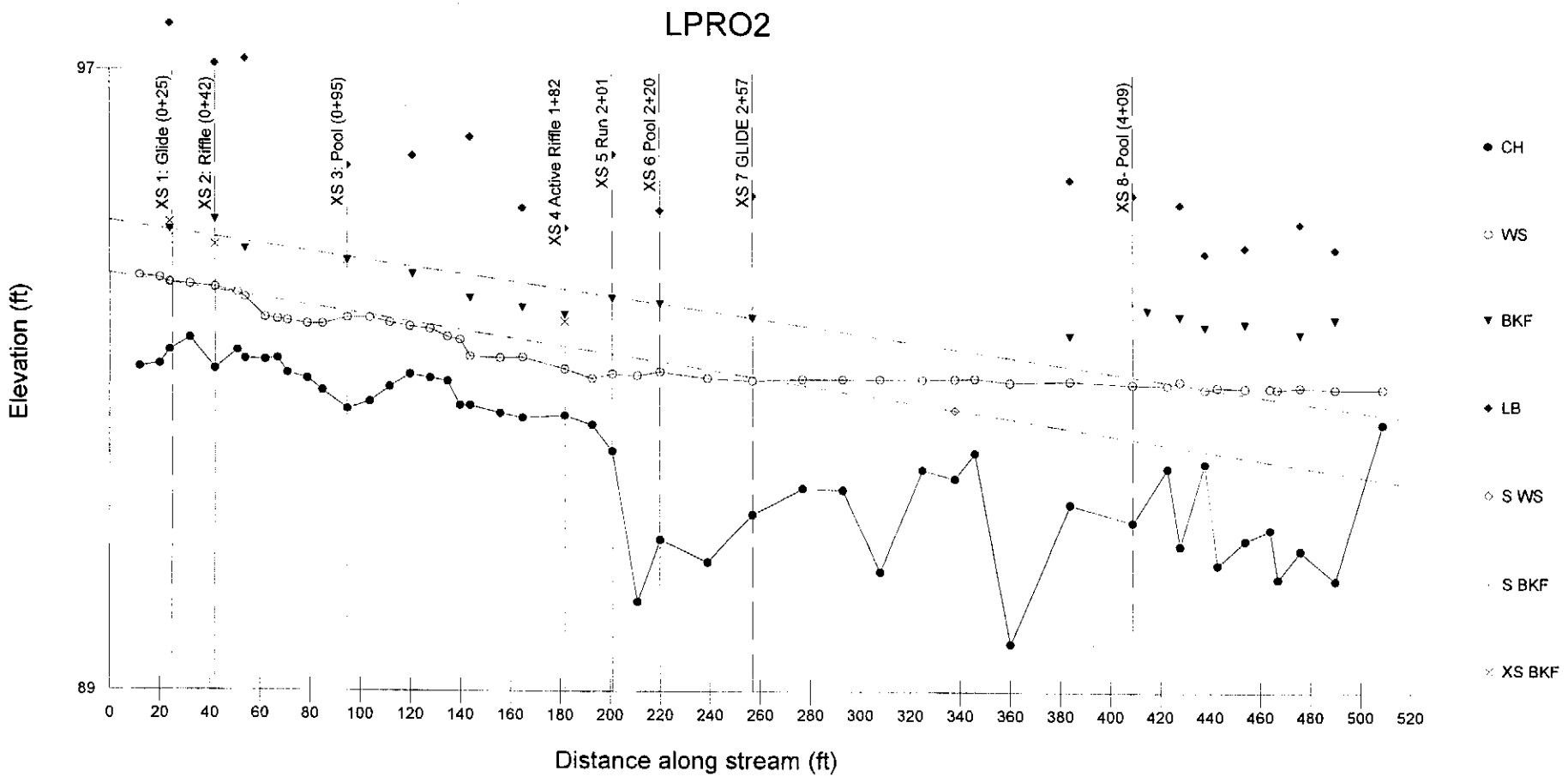

XS 5: Run (2+01)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 21.9
Dbkf = 1.44
Abkf = 31.5
Elevation (ft)
Horizontal Distance (ft)

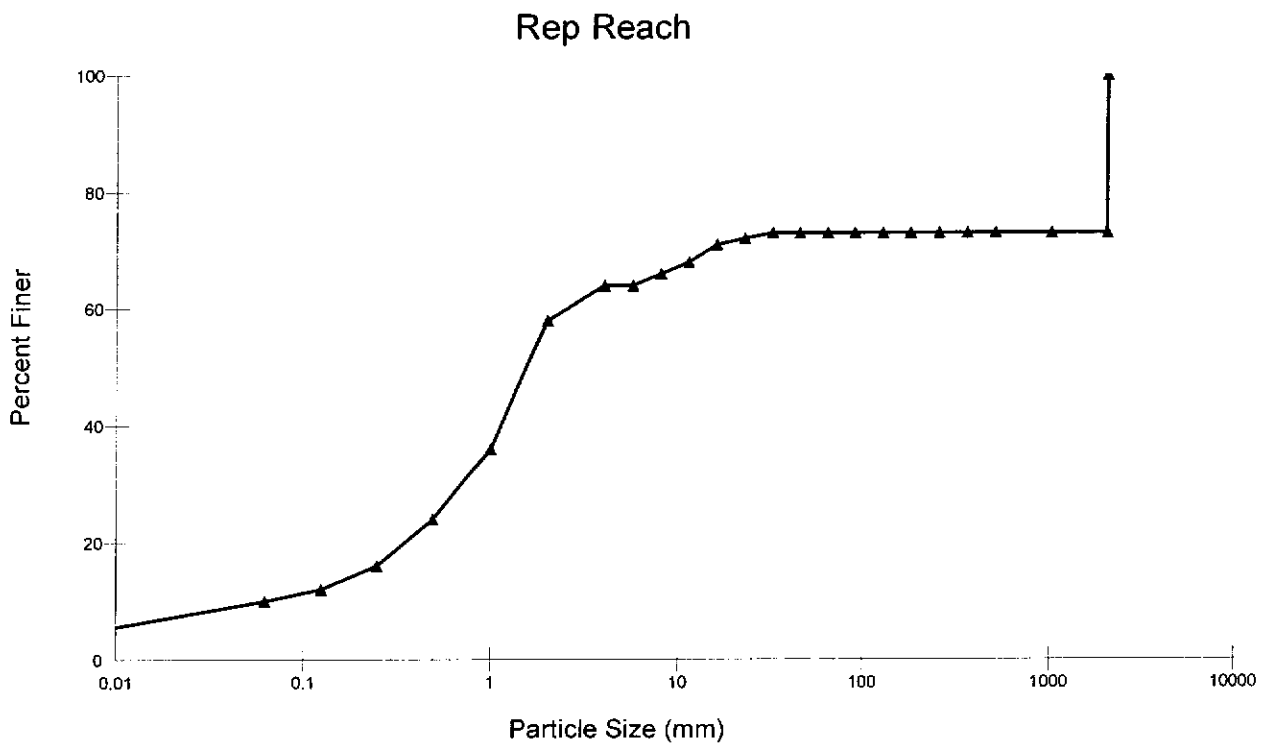

XS 6: Pool(2+20)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 21.3
Dbkf = 1.9
Abkf = 40.6
Elevation (ft)
Horizontal Distance (ft)
100
99
98
97
96
95
94
93
92
91
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40
45
50

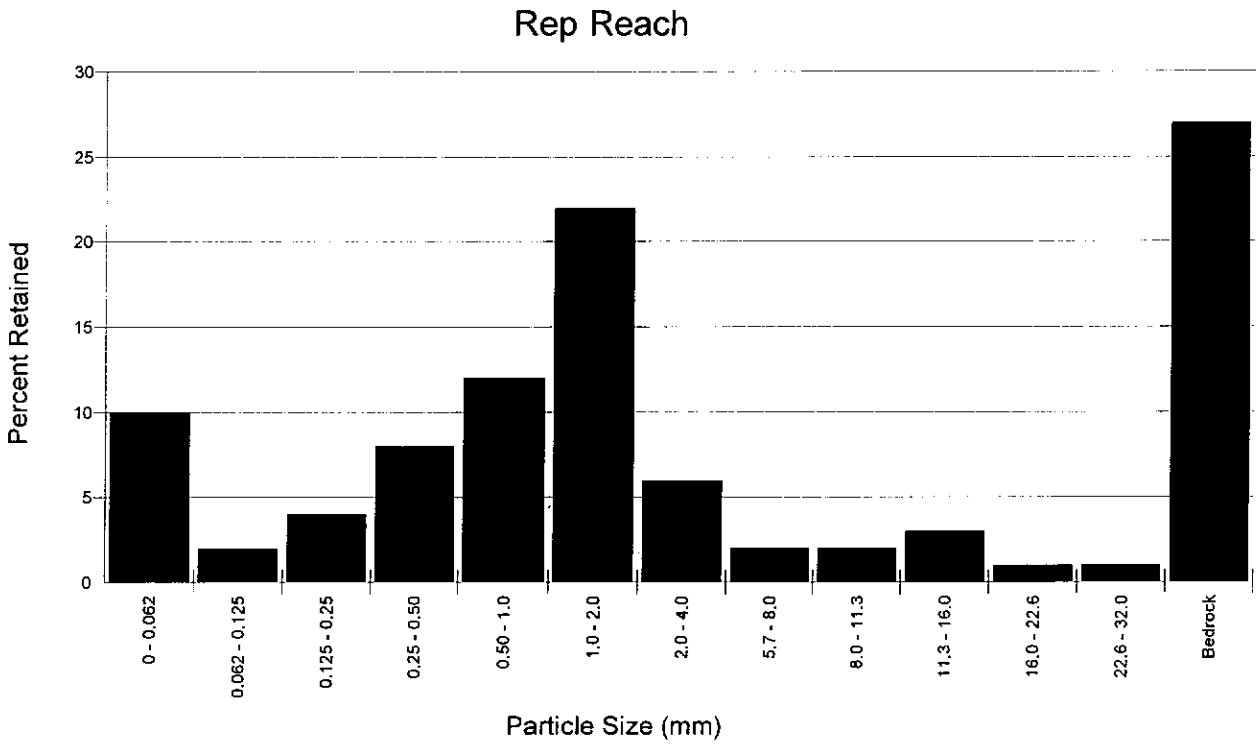

XS 7: Glide (2+57)
Ground Points
Wbkf = 19.6
Bankfull Indicators
Dbkf = 1.75
Water Surface Points
Abkf = 34.3
Elevation (ft)
Horizontal Distance (ft)
98
97
96
95
94
93
92
91
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

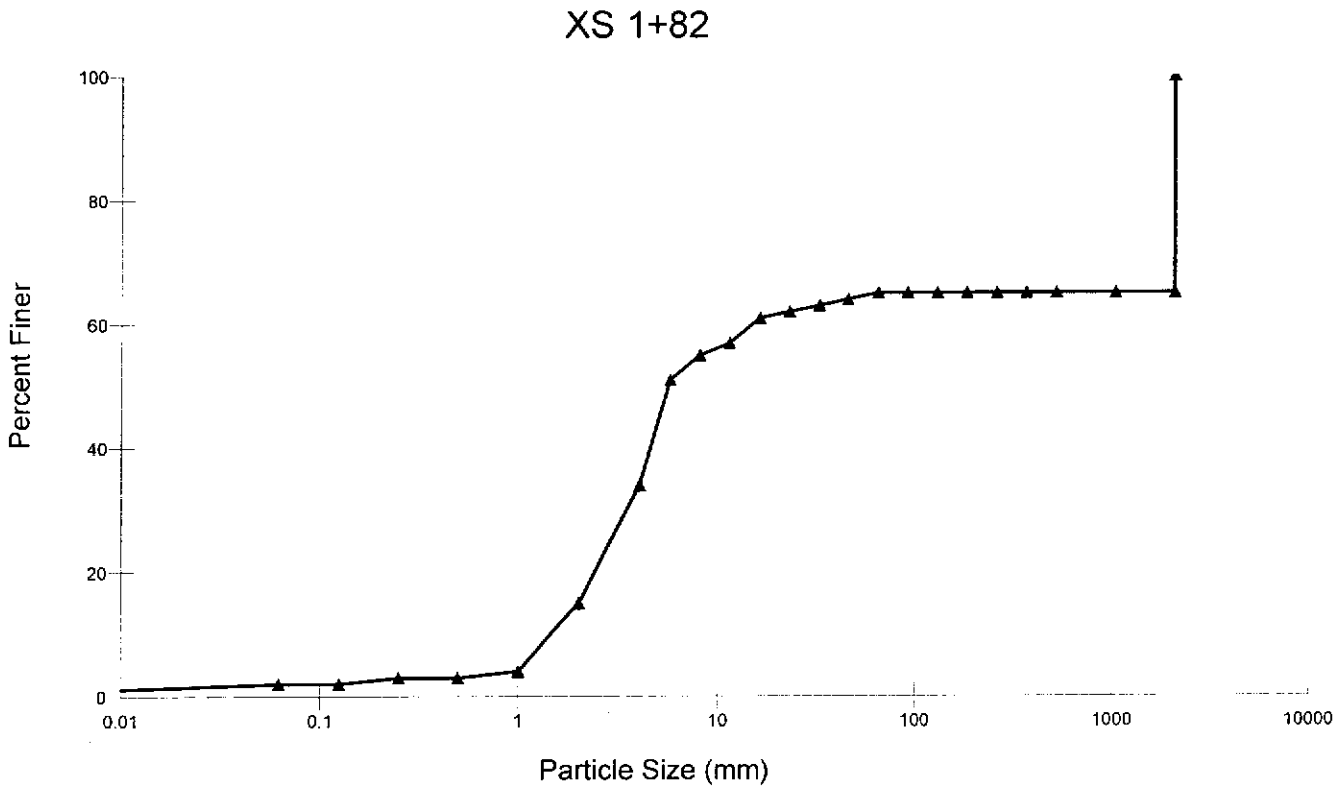

XS 8- Pool (4+09)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 21
Dbkf = 1.95
Abkf = 41
Elevation (ft)
Horizontal Distance (ft)
97
96
95
94
93
92
91
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

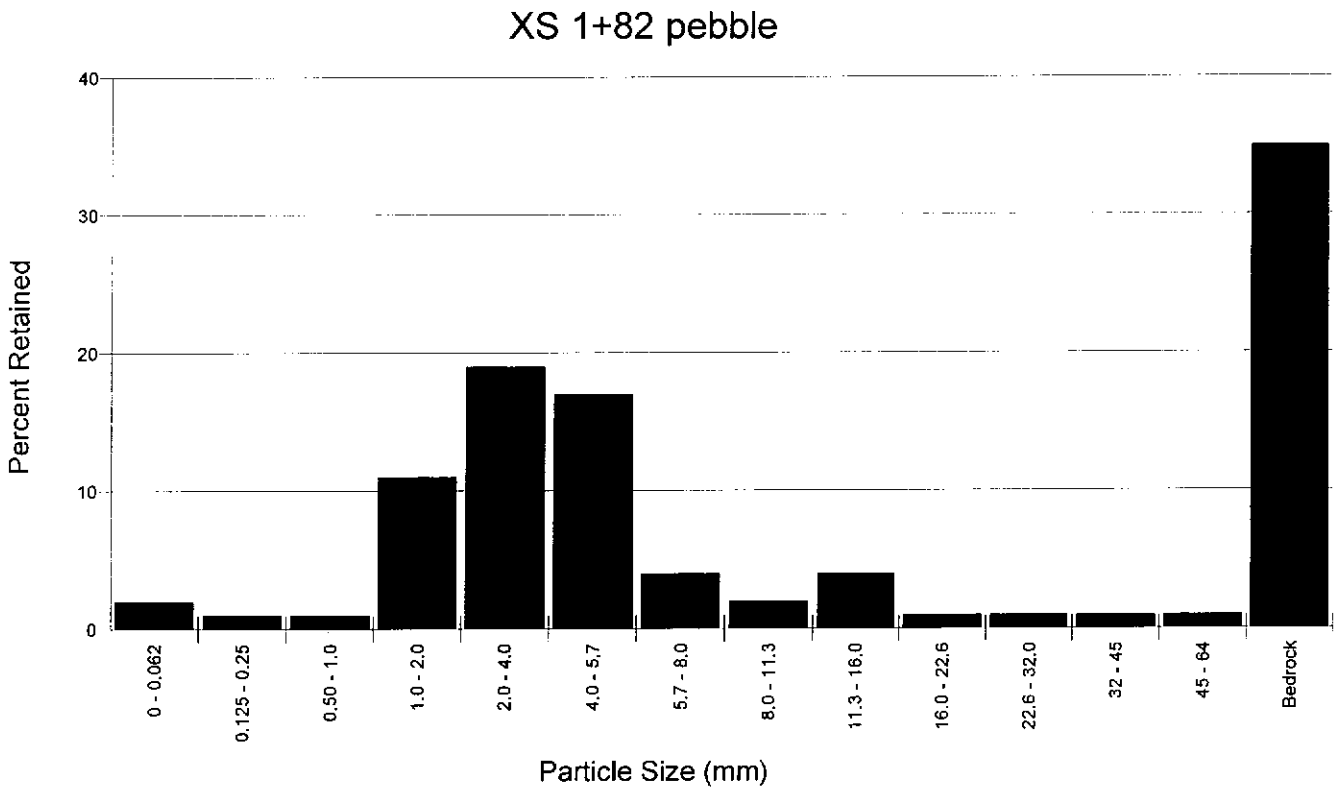

LPRO2
97
89
0
360
Elevation (ft)
Distance along stream (ft)
XS 1: Glide (0+25)
XS 2: Riffle (0+42)
XS 3: Pool (0+95)
XS 4 Active Riffle 1+82
XS 5 Run 2+01
XS 6 Pool 2+20
XS 7 GLIDE 2+57
XS 8- Pool (4+09)
CH
WS
BKF
LB
S WS
S BKF
XS BKF

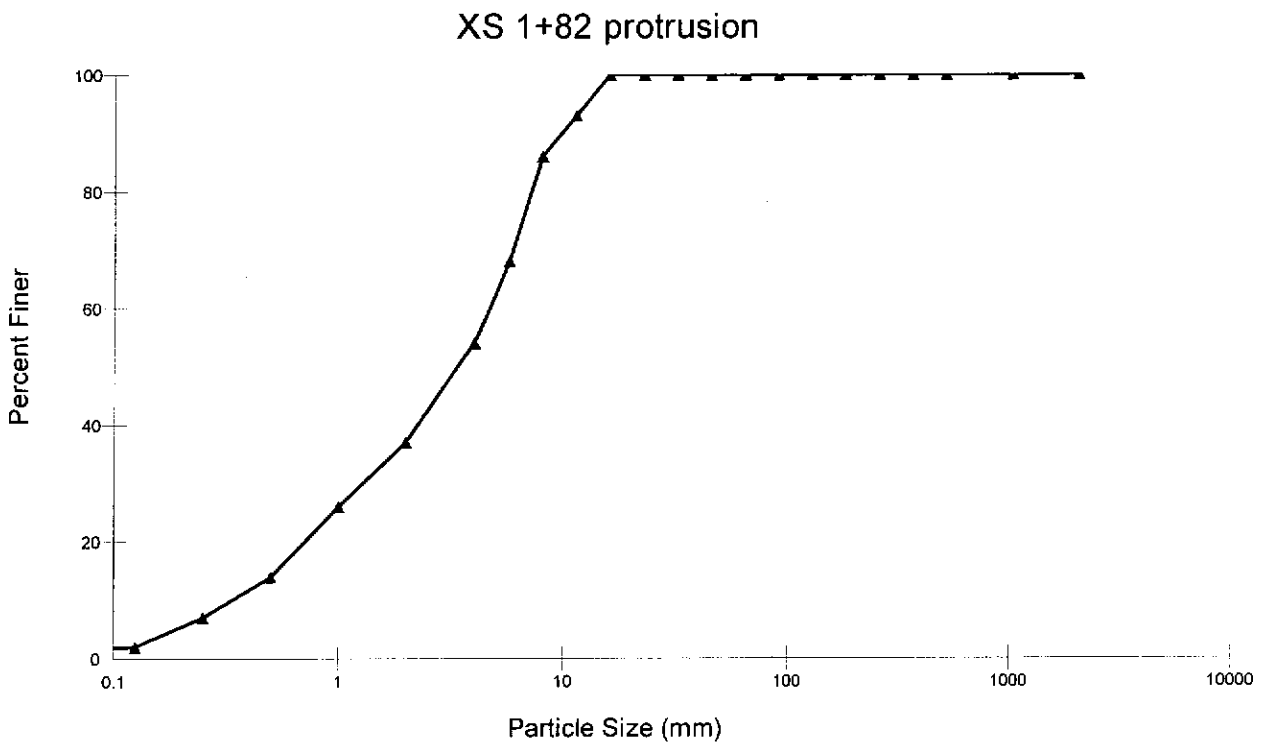

LPRO2
Elevation (ft)
97
89
XS 1: Glide (0+25)
XS 2: Riffle (0+42)
XS 3: Pool (0+95)
XS 4 Active Riffle 1+82
XS 5 Run 2+01
XS 6 Pool 2+20
XS 7 GLIDE 2+57
XS 8- Pool (4+09)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
Distance along stream (ft)
CH
WS
BKF
LB
S WS
S BKF
XS BKF

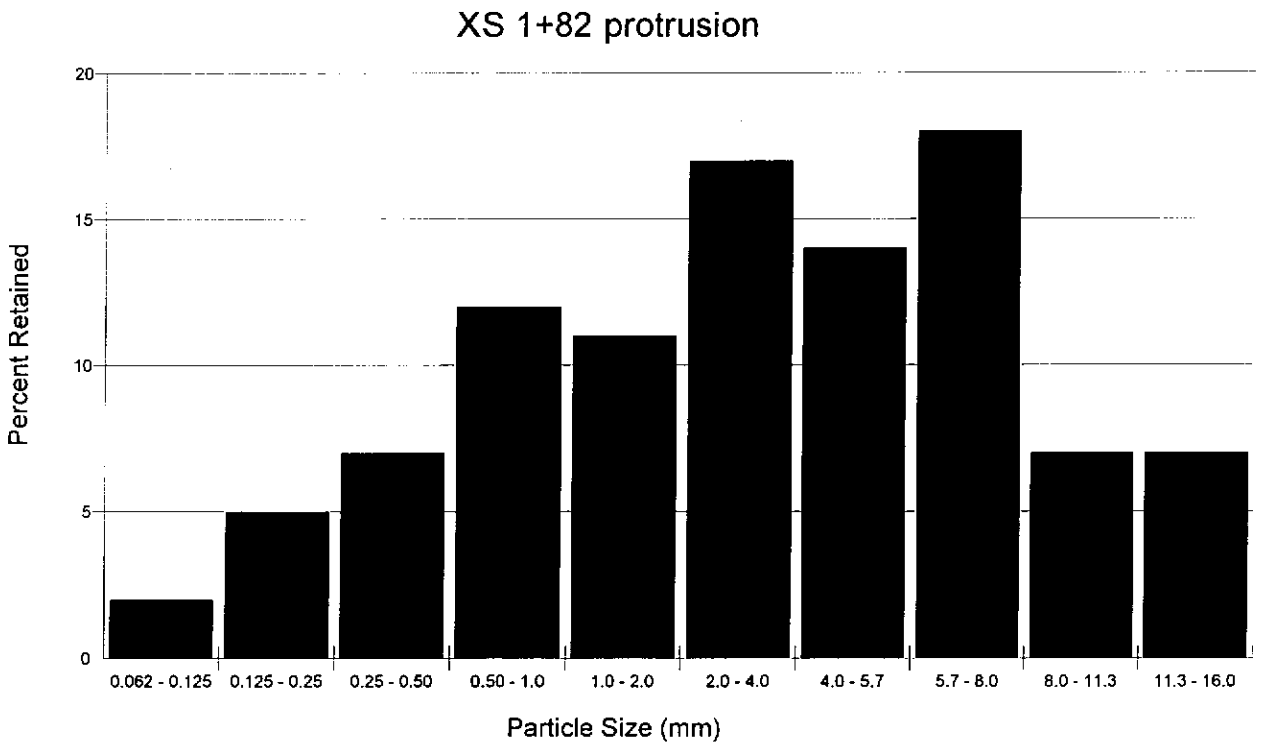

Rep Reach
Percent Finer
100
80
60
40
20
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)


Rep Reach
Percent Retained
30
25
20
15
10
5
0
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
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
Bedrock
Particle Size (mm)


XS 1+82
Percent Finer
100
80
60
40
20
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)


XS 1+82 pebble
Percent Retained
40
30
20
10
0
0 - 0.062
0.125 - 0.25
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
32 - 45
45 - 64
Bedrock
Particle Size (mm)


XS 1+82 protrusion
Percent Finer
100
80
60
40
20
0
0.1
1
10
100
1000
10000
Particle Size (mm)


XS 1+82 protrusion
Percent Retained
20
15
10
5
0
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
Particle Size (mm)

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 3
Date:		Stream Type: F4	Valley Type: VIIIc
Observers:	Group 2	HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	20.99	A_{bkf} (ft^2)	Bankfull Riffle Mean DEPTH	0.85	d_{bkf} (ft)
Bankfull Riffle WIDTH	24.77	W_{bkf} (ft)	Wetted PERMIMETER ~ $(2 * d_{bkf}) + W_{bkf}$	25.17	W_p (ft)
D_{84} at Riffle	7.74	Dia. (mm)	D_{84} (mm) / 304.8	0.03	D_{84} (ft)
Bankfull SLOPE	0.0049	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	0.83	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R(ft) / D_{84} (ft)	33.20	R / D_{84}
Drainage Area	18.9	DA (mi^2)	Shear Velocity $u^* = (gRS)^{½}$	0.362	u^* (ft/sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $u = [2.83 + 5.66 * Log\{R / D_{84}\}] u^*$	4.14	ft / sec	86.81	cfs
2. Roughness Coefficient: a) Manning's n from Friction Factor / Relative Roughness (Figs. 2-18, 2-19) $u = 1.49*R^{2/3}*S^{1/2}/n$ $n =$ 0.0214	4.30	ft / sec	90.34	cfs
2. Roughness Coefficient: b) Manning's n from Stream Type (Fig. 2-20) $u = 1.49*R^{2/3}*S^{1/2}/n$ $n =$ 0.041	2.25	ft / sec	47.14	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 $n =$ 0.053	1.73	ft / sec	36.33	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach (Leopold, Wolman and Miller)	4.24	ft / sec	88.95	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 = 1.7 year	4.29	ft / sec	90.00	cfs
4. Continuity Equations: b) USGS Gage Data $u = Q / A$	4.29	ft / sec	90.00	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 - Reach 3**		
Basin:	Drainage Area: **12192** acres	**19.05**	mi^2
Location:			
Twp.&Rge: ;	Sec.&Qtr.: ;		
Cross-Section Monuments (Lat./Long.):	**0 Lat / 0 Long**	Date: **04/17/14**	
Observers: **Group 2**		Valley Type: VIIIc	

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	**24.77**	ft
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A / W_{bkf}$).	**0.85**	ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	**20.99**	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	**29.14**	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.	**1.3**	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.	**33.76**	ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	**1.36**	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.	**1.64**	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.	**0.00516**	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).	**1.28**	

Stream Type **F5/4/1** (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 3**			
Observers: **Group 2**			Date: **04/17/14**		Valley Type: **VIIIc**		Stream Type: **F5/4/1**	

River Reach Dimension Summary Data.....1

Riffle Dimensions*, **, ***	Mean	Min	Max		Riffle Dimensions & Dimensionless Ratios****	Mean	Min	Max
Riffle Width (W_{bkf})	23.6	22.4	24.8	ft	Riffle Cross-Sectional Area (A_{bkf}) (ft^2)	22.86	20.99	24.73
Mean Riffle Depth (d_{bkf})	0.98	0.85	1.1	ft	Riffle Width/Depth Ratio (W_{bkf} / d_{bkf})	24.76	20.38	29.14
Maximum Riffle Depth (d_{max})	1.39	1.3	1.47	ft	Max Riffle Depth to Mean Riffle Depth (d_{max} / d_{bkf})	1.433	1.336	1.529
Width of Flood-Prone Area (W_{fpa})	35	33.8	36.2	ft	Entrenchment Ratio (W_{fpa} / W_{bkf})	1.488	1.363	1.613
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*, **, ***	Mean	Min	Max		Pool Dimensions & Dimensionless Ratios****	Mean	Min	Max
Pool Width (W_{bkfp})	21.5	21.3	21.7	ft	Pool Width to Riffle Width (W_{bkfp} / W_{bkf})	0.911	0.904	0.919
Mean Pool Depth (d_{bkfp})	1.52	1.13	1.9	ft	Mean Pool Depth to Mean Riffle Depth (d_{bkfp} / d_{bkf})	1.551	1.153	1.939
Pool Cross-Sectional Area (A_{bkfp})	32.5	24.5	40.6	ft	Pool Area to Riffle Area (A_{bkfp} / A_{bkf})	1.423	1.071	1.776
Maximum Pool Depth (d_{maxp})	2.6	2.19	3.01	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	2.653	2.235	3.071
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*	Mean	Min	Max		Run Dimensionless Ratios****	Mean	Min	Max
Run Width (W_{bkfr})	21.9	21.9	21.9	ft	Run Width to Riffle Width (W_{bkfr} / W_{bkf})	0.926	0.926	0.926
Mean Run Depth (d_{bkfr})	1.44	1.44	1.44	ft	Mean Run Depth to Mean Riffle Depth (d_{bkfr} / d_{bkf})	1.469	1.469	1.469
Run Cross-Sectional Area (A_{bkfr})	31.5	31.5	31.5	ft	Run Area to Riffle Area (A_{bkfr} / A_{bkf})	1.377	1.377	1.377
Maximum Run Depth (d_{maxr})	1.89	1.89	1.89	ft	Max Run Depth to Mean Riffle Depth (d_{maxr} / d_{bkf})	1.929	1.929	1.929
Run Width/Depth Ratio (W_{bkfr} / d_{bkfr})	15.2	15.2	15.2	ft				

Glide Dimensions*	Mean	Min	Max		Glide Dimensions & Dimensionless Ratios	Mean	Min	Max
Glide Width (W_{bkfg})	22.1	19.6	24.7	ft	Glide Width to Riffle Width (W_{bkfg} / W_{bkf})	0.937	0.830	1.045
Mean Glide Depth (d_{bkfg})	1.49	1.22	1.75	ft	Mean Glide Depth to Mean Riffle Depth (d_{bkfg} / d_{bkf})	1.520	1.245	1.786
Glide Cross-Sectional Area (A_{bkfg})	32.2	30.1	34.3	ft	Glide Area to Riffle Area (A_{bkfg} / A_{bkf})	1.410	1.318	1.502
Maximum Glide Depth (d_{maxg})	2.13	1.71	2.54	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	2.173	1.745	2.592
Glide Width/Depth Ratio (W_{bkfg} / d_{bkfg})	15.7	11.2	20.2	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**	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.

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

Stream: **Marsh Run**		Location: **Reach - Reach 3**	
Observers: **Group 2**	Date: **04/17/14**	Valley Type: **VIIIc**	Stream Type: **F5/4/1**

River Reach Summary Data.....2

Hydraulics

Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})	4.295	ft/sec	Estimation Method		
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})	90.152	cfs	Drainage Area	19.05	mi^2

Channel Pattern

Geometry	Mean	Min	Max		Dimensionless Geometry Ratios	Mean	Min	Max
Linear Wavelength (λ)	162	137	205	ft	Linear Wavelength to Riffle Width (λ / W_{bkf})	6.877	5.805	8.686
Stream Meander Length (L_m)	58.6	56	62	ft	Stream Meander Length Ratio (L_m / W_{bkf})	2.483	2.373	2.627
Radius of Curvature (R_c)	35.2	27	41	ft	Radius of Curvature to Riffle Width (R_c / W_{bkf})	1.492	1.144	1.737
Belt Width (W_{blt})	55.6	44.5	75	ft	Meander Width Ratio (W_{blt} / W_{bkf})	2.356	1.886	3.178
Arc Length (L_a)	108	71	176	ft	Arc Length to Riffle Width (L_a / W_{bkf})	4.589	3.008	7.458
Riffle Length (L_r)	46.4	19.5	73.3	ft	Riffle Length to Riffle Width (L_r / W_{bkf})	1.966	0.826	3.106
Individual Pool Length (L_p)	58.7	53.3	64.1	ft	Individual Pool Length to Riffle Width (L_p / W_{bkf})	2.487	2.258	2.715
Pool to Pool Spacing (P_s)	116	116	116	ft	Pool to Pool Spacing to Riffle Width (P_s / W_{bkf})	4.908	4.908	4.908

Channel Profile

Valley Slope (S_{val})	0.0071	ft/ft	Average Water Surface Slope (S)	0.00516	ft/ft	Sinuosity (S_{val} / S)	1.28
Stream Length (SL)	0	ft	Valley Length (VL)	0	ft	Sinuosity (SL / VL)	

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})	0.007	0.005	0.009	ft/ft	Riffle Slope to Average Water Surface Slope (S_{rif} / S)	1.372	0.936	1.806
Run Slope (S_{run})	0.006	0.005	0.006	ft/ft	Run Slope to Average Water Surface Slope (S_{run} / S)	1.095	0.953	1.234
Pool Slope (S_p)	0.001	0.000	0.001	ft/ft	Pool Slope to Average Water Surface Slope (S_p / S)	0.167	0.064	0.269
Glide Slope (S_g)	0.003	0.001	0.004	ft/ft	Glide Slope to Average Water Surface Slope (S_g / S)	0.576	0.200	0.814
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})	1.63	1.53	1.73	ft	Max Riffle Depth to Mean Riffle Depth (d_{maxrif} / d_{bkf})	1.663	1.561	1.77
Max Run Depth (d_{maxrun})	2.34	1.84	2.83	ft	Max Run Depth to Mean Riffle Depth (d_{maxrun} / d_{bkf})	2.388	1.878	2.89
Max Pool Depth (d_{maxp})	2.92	1.96	3.88	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	2.98	2	3.96
Max Glide Depth (d_{maxg})	1.46	1.37	1.61	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.49	1.398	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

	Reach[b]	Riffle[c]	Bar		Reach[b]	Riffle	Bar	Protrusion Height[d]	
% Silt/Clay					D_{16}			0.58	mm
% Sand					D_{35}			1.82	mm
% Gravel					D_{50}			3.53	mm
% Cobble					D_{84}			7.74	mm
% Boulder					D_{95}			12.64	mm
% Bedrock					D_{100}			16	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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Step 11

Summarize USGS gage data:

Summary of USGS Gage Station Data

Station Name:	MARSH RUN AT GRIMES				Station Number:	01617800	
Station Location:	WASHINGTON COUNTY, MD				Period of Record:	51	yrs
Drainage Area (DA):	18.95	acres	19.05	mi^2	D.A. Mean Elevation:		ft
Stream Type:	F5/4/1	Valley Type: VIIIC		U-AL-FD	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})	24.77	ft	Bankfull Width (W_{bkf})	22	ft
Bankfull Mean Depth (d_{bkf})	0.85	ft	Bankfull Mean Depth (d_{bkf})	1.75	ft
Bankfull XS Area (A_{bkf})	20.99	ft^2	Bankfull XS Area (A_{bkf})	38	ft^2
Wetted Perimeter (W_p)	25.17	ft	Wetted Perimeter (W_p)	25.5	ft
Bankfull Stage (Gage Ht.)	2.2	ft	Bankfull Stage (Gage Ht.)	2.2	ft
Est. Mean Velocity ($\bar{u}$)	4.30	ft/sec	Mean Velocity ($\bar{u}$)	2.2	ft/sec
Est. BKF. Discharge (Q_{bkf})	90.34	cfs	Bankfull Discharge (Q_{bkf})	90	cfs

Bankfull Discharge associated with "field-determined" Bankfull Stage	90	cfs
Recurrence Interval (R.I.) associated with "field-determined" Bankfull Stage	1.67	yrs

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

1.5 Year **R.I.** Discharge =	75.5	cfs	**10** Year **R.I.** Discharge =	275.0	cfs
2.0 Year **R.I.** Discharge =	105.0	cfs	**25** Year **R.I.** Discharge =	445.0	cfs
5.0 Year **R.I.** Discharge =	190.0	cfs	**50** Year **R.I.** Discharge =	455.0	cfs

MEANDER GEOMETRY

Linear Wavelength (λ)	162.3	ft	Stream Meander Length (L_m)	58.6	ft
Radius of Curvature (R_c)	35.2	ft	Belt Width (W_{blt})	55.6	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)				
Slope Exponent (b)				

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

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

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Total Reach - 509

42
77
155

111

RIFFLE

Site: Marsh Run - XS Pebble. Date:

Location: 1+82 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				2			2					
	Very Fine	.062 - .125	SAND				2			0					
	Fine	.125 - .25	SAND				4			0					
	Medium	.25 - .50	SAND				9			1					
	Coarse	.50 - 1.0	SAND				3			1					
.04 - .08	Very Coarse	1.0 - 2	SAND				19			1					
.08 - .16	Very Fine	2 - 4	GRAVEL				16			3					
.16 - .22	Fine	4 - 5.7	GRAVEL				12			0					
.22 - .31	Fine	5.7 - 8	GRAVEL				11			1					
.31 - .44	Medium	8 - 11.3	GRAVEL				20								
.44 - .63	Medium	11.3 - 16	GRAVEL				2								
.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												
2.5 - 3.5	Small	64 - 90	COBBLE												
3.5 - 5.0	Small	90 - 128	COBBLE												
5.0 - 7.1	Large	128 - 180	COBBLE												
7.1 - 10.1	Large	180 - 256	COBBLE												
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		BDRK							21					
Stream Type:			Valley Type:			TOTAL→	100								

9 10
300
145
219
205

300
206
194
205
399 - PL - 83%

0
286
25
181 - RF - 38%

460

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Site: Marsh Run Date:

Location: 0+42 HUC:

Party: 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:		
							Date:			Date:			Date:		
	Silt / Clay	< .062	S/C				3			8			11		
	Very Fine	.062 - .125	SAND				2			2			4		
	Fine	.125 - .25					3			4			7		
	Medium	.25 - .50					6			7			13		
	Coarse	.50 - 1.0					4			11			15		
.04 - .08	Very Coarse	1.0 - 2					5			21			26		
.08 - .16	Very Fine	2 - 4	GRAVEL				3			3			6		
.16 - .22	Fine	4 - 5.7					2			0			2		
.22 - .31	Fine	5.7 - 8					2			1			3		
.31 - .44	Medium	8 - 11.3					0			2			2		
.44 - .63	Medium	11.3 - 16					0			3			3		
.63 - .89	Coarse	16 - 22.6					0			1			1		
.89 - 1.3	Coarse	22.6 - 32					0			1			1		
1.3 - 1.8	Very Coarse	32 - 45													
1.8 - 2.5	Very Coarse	45 - 64													
2.5 - 3.5	Small	64 - 90	COBBLE												
3.5 - 5.0	Small	90 - 128													
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				0			6			6		
Stream Type:			**Valley Type:**			TOTAL→	30			70			100		

Riffle
1 0+42
2 0+77
3 1+55

Pool
1 - 2+20
2 - 3+00
3 - 3+90
3 - 3+72
4 - 3+90
5 - 4+23

6 - 4+58
7 - 4+89

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PROTRUSION RE-DONE

Site: XS 1+82 Date:

Location: HUC:

Party:

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:		
							Date:			Date:			Date:		
	Silt / Clay	< .062	S/C				0								
	Very Fine	.062 - .125	SAND				2								
	Fine	.125 - .25					5								
	Medium	.25 - .50					7								
	Coarse	.50 - 1.0					12								
.04 - .08	Very Coarse	1.0 - 2					11								
.08 - .16	Very Fine	2 - 4	GRAVEL				17								
.16 - .22	Fine	4 - 5.7					14								
.22 - .31	Fine	5.7 - 8					18								
.31 - .44	Medium	8 - 11.3					7								
.44 - .63	Medium	11.3 - 16					7								
.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												
3.5 - 5.0	Small	90 - 128													
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				0								
Stream Type:			**Valley Type:**			TOTAL→									

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Pebble

Site: Date:

Location: X-82 HUC:

Party:

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				2								
	Very Fine	.062 - .125	SAND				0								
	Fine	.125 - .25					1								
	Medium	.25 - .50					0								
	Coarse	.50 - 1.0					1								
.04 - .08	Very Coarse	1.0 - 2					11								
.08 - .16	Very Fine	2 - 4	GRAVEL				19								
.16 - .22	Fine	4 - 5.7					17								
.22 - .31	Fine	5.7 - 8					4								
.31 - .44	Medium	8 - 11.3					2								
.44 - .63	Medium	11.3 - 16					4								
.63 - .89	Coarse	16 - 22.6					1								
.89 - 1.3	Coarse	22.6 - 32					1								
1.3 - 1.8	Very Coarse	32 - 45					1								
1.8 - 2.5	Very Coarse	45 - 64					1								
2.5 - 3.5	Small	64 - 90	COBBLE												
3.5 - 5.0	Small	90 - 128													
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				35								
Stream Type:			**Valley Type:**			TOTAL→									

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Worksheet 4-7. 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(s) (**Figure 2-3**).
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 2-18**) (Example in **Figure 4-10**).
14. Plot Manning's "n" by friction factor (**Figure 2-19**) (Example in **Figure 4-11**).
15. Plot Manning's "n" by stream type (**Figure 2-20**) (Example in **Figure 4-12**).

Gaging Station Name: Marsh Run **Gaging Station Number:** 01617800

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^*
18.9	90.0	24.77	1.16	20.99	4.29	0.00516	7.74	0.025	F4/5/1	0.09	45.2	0.361	11.88

$Q = W \cdot d \cdot u$

$Q = A \cdot u$

$u =$

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