TEAM #4

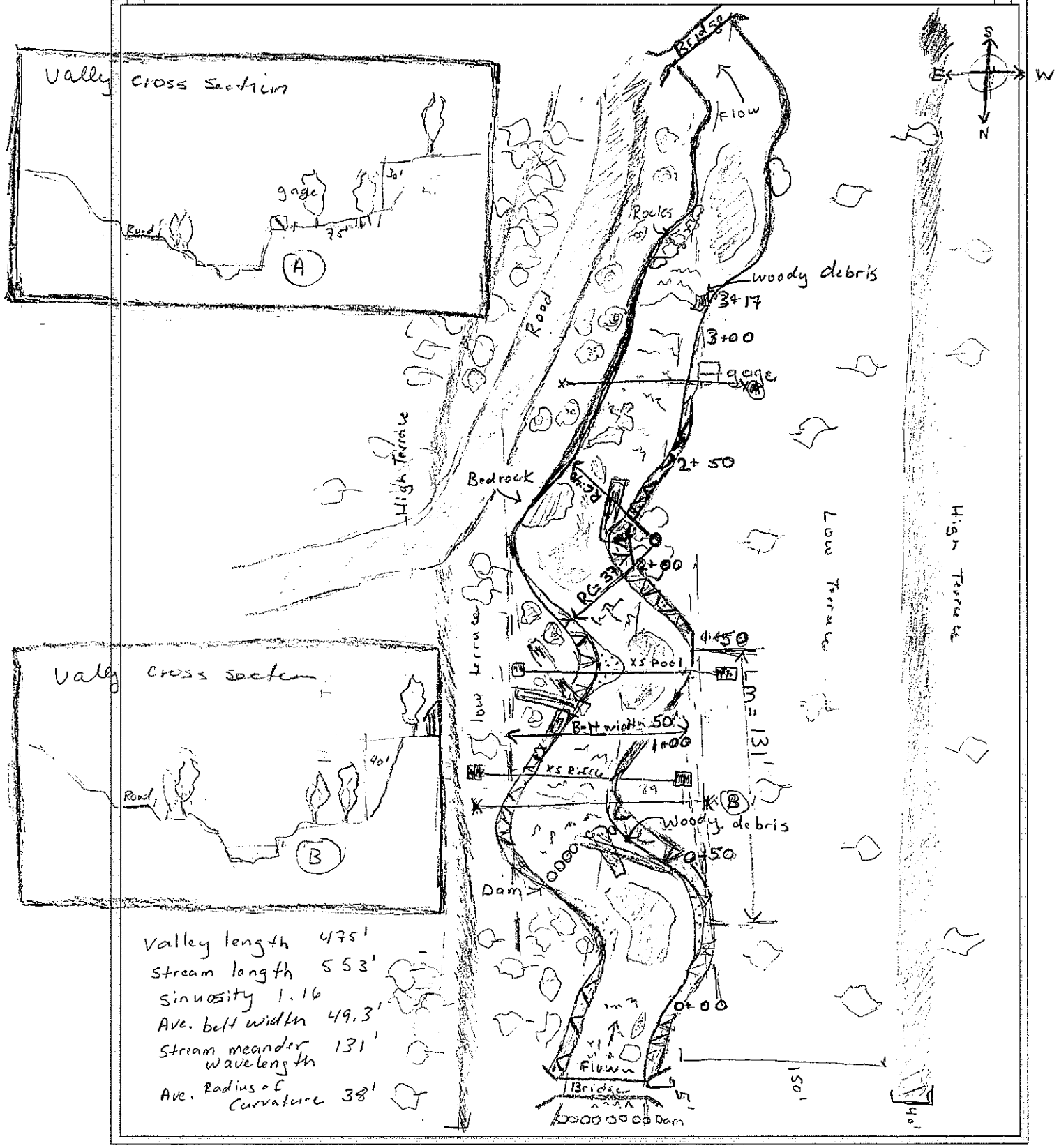
Field Day 2 Presentation Order: Gage Station
River Morphology and Applications

- **Sketch Map** Gabby
- **Cross-sections**
  - Riffle cross-section
  - Pool cross-section
- **Longitudinal Profile**
- **Pebble Counts**
  - Representative pebble count
  - Riffle pebble count
- **Velocity (Worksheet B-2)**
- **Stream Classification (Worksheet B-1)**
- **Dimensionless Ratios (Worksheet B-3)**

AREA-SITE LOCATION....REACH MAP

Stream: Marsh Run Reach: upstream

Drawn By: Team 4 Date: 4/30/09



Valley length 475'
Stream length 553'
Sinuosity 1.16
Ave. belt width 49.3'
Stream meander wavelength 131'
Ave. Radius of Curvature 38'

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BF=7.74 1.01
WS=8.73

Yuyra3! Mata9
Yuyra!3Mata9

Station 0+91

SURVEY DATA ⟶ **CROSS - SECTION 1**

SITE: Team 4 Riffle - Marsh Run Crk. Date: 4-30-09

Location: Riffle

Party / Notes: HUC:

Item	Distance, Point, or STATION ft	Back-Sight BS ft	Height of Instrument HI ft	Fore-Sight FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
1	0.0			3.86	96.14	LBF (Pin)
2	3.1			3.68	96.32	BS Break slope
3	4.8			4.29	95.71	BS
4	6.0			6.40	93.60	BS
5	7.0			7.30	92.70	BS
6	7.6			7.74	92.26	BF (BF)
7	8.3			8.26	91.74	BS
8	9.5			8.67	91.33	Water Surface (LEW)
9	9.5			8.69	91.31	S Bed Strm Bed
10	12.0			9.04	90.96	S Bed
11	14.0			8.97	91.03	S Bed
12	16.0			9.11	90.89	S Bed
13	18.0			9.05	90.95	S Bed
14	20.0			9.04	90.96	S Bed
15	22.0			9.04	90.96	S Bed
16	24.0			9.05	90.95	S Bed
17	26.0			9.12	90.88	S Bed Thalweg
18	28.0			9.00	91.00	S Bed
19	28.8			8.73	91.27	Water Surface (REW)
20	28.8			8.86	91.14	BS (REW)
21	29.0			8.20	91.80	BS
22	32.0			7.46	92.54	BS
23	34.5			6.52	93.48	BS
24	37.5			5.00	95.01	BS
25	39.0			4.43	95.57	BS
26	41.5			3.92	96.08	BS
27	43.4			3.91		RBF (Pin)
28						

7.6

91

30.5 30.5 7.74

BF (RB)

A=26.27
MD=1.15
MaxD 1.58
Surf Width 2
FP_w=28.84
E_{Ratio}=1.26
W/D=19.9
Floodplane L=1
Floodplane Elev @Rt toeslope 4

6.2 = Lft station @ Flood prone
34.8 = station @ Flood prone
6.38 = Elev @ flood prone

28.6 = Flood prone width
22.9 = Bf width

Entr = 1.25

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SURVEY DATA ⟹ CROSS - SECTION 2

SITE: Station 1457 Pool - Date: 4/30/09

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29	0.0			5.29		LB Pin is -1.0
30	4.6			6.56		BS Break in Slope
31	7.0			7.05		BS
32	7.5			7.67		BS
33	8.4			8.49		LBF Bank Full
34	9.2			8.71		BS
35	10.2			8.84		BS point Bar (PB)
36	12.0			8.98		BS Point Bar
37	13.0			9.04		BS PB
38	14.0			9.08		BS PB
39	15.0			9.11		BS PB
40	17.0			9.24		L Edge Surface Water
41	19.0			9.75		Stream Bed (SB)
42	21.0			10.35		SB
43	22.0			10.73		SB
44	23.0			10.89		SB
45	24.0			11.18		SB
46	25.5			11.40		SB Thalweg
47	26.0			10.67		SB
48	27.0			10.62		SB
49	28.0			10.29		SB
50	29.0			10.58		SB
51	30.0			9.94		SB
52	31.0			9.75		SB
53	33.0			9.32		SB
54	33.3			9.21		Water Surface Right
55	34.0			9.21		R Edge Water
56	34.5			8.99		BS
57	34.8			8.49		RBF
58	35.8			7.82		BS
59	37.0			6.47		Top of Bank Edge
	38.0			6.22		Top of Bank
	39.0			6.22		Pin

9.24
8.49
0.75/BF

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SURVEY DATA → LONGITUDINAL PROFILE 1

SITE: Marsh Run Creek Team 4 **Date:** 4/30/09

Location:

Party / Notes: Kieth/Alex/Allen HUC:

use staff gage elevation.

Rod Depth

Plot graph in gage datum

	Distance, Point, or STATION ft	Back-Sight BS ft	Height of Instrument HI ft	Thalweg (CH) Fore-Sight FS ft	Thalweg (CH) Elevation Elev. ft	Water Surface (WS) Fore-Sight FS ft	Water Surface (WS) Elevation Elev. ft	Bankfull (BKF) Fore-Sight FS ft	Bankfull (BKF) Elevation Elev. ft	Low Bank HI Fore-Sight FS ft	Low Bank HI Elevation Elev. ft	NOTES e.g. Riffle Run Pool Glide	
1			1.0										
2	0			8.9		~~7.25~~						run - beginning	
3	3			9.00		8.21		7.4	(.7)	4.23		run	
4	6			9.12								run	
1.9	5	19			9.44	8.24						Pool - T	
	6	2X5			10.15	8.26		7.34	(.9)			Pool	underwater shoot crossvein bring H2O to le bank
2.70	7	29			10.95							Pool	
2.78	8	34			11.10							Pool	
2.92	9	37			11.19							Pool	
3.2	10	40			11.3							Pool - Dmax	
	11	50			9.89	8.23						Glide - T	
	12	61			9.4	8.26						Riffle - T	concrete bag on bedrock
	13	63			9.2	8.57						Riffle	
	14	70			9.32	8.65						Run - T	
	15	78			9.65	8.65						Run	
	16	91			9.15	8.67		7.74	)			Riffle - T	Riffle Xse
	17	106			10.05	9.23						Run - T	
	18	112			~~9.82~~					4.62		Run	
	19	130			9.93	9.24						Run	
	20	139			10.58	9.26						Run	
	21	154			10.8	9.26						T - Pool	
	22	158			11.28	9.26		8.55	(.7)			Pool	
	23	162			11.20	9.26						Pool	
	24	168			11.20	9.26						Pool	
	25	175			10.96	9.26						T - Glide	
	26	185			10.00	9.28						T - Riffle	
	27	190			10.37	9.29						T - Run	

Ignore Note. Note - For All readings (~~back~~ on reverse read rod) greater than 9.04, there is an error we need to correct - adjust - just add some distance w/ pocket rod. - error is in the hundreds

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P = Pool
R = Riffle
U = Run
G = Glide

SURVEY DATA → LONGITUDINAL PROFILE 2

SITE: Marsh Run Creek Team 4 Date: 4/30/09

Location:

Party / Notes: Kieth / Alex / Allen HUC:

Rod Depth		Distance, Point, or STATION (ft)	Back-Sight BS (ft)	Height of Instrument HI (ft)	Thalweg Fore-Sight FS (ft)	Thalweg Elevation Elev. (ft)	Water Surface Fore-Sight FS (ft)	Water Surface Elevation Elev. (ft)	Bankfull Fore-Sight FS (ft)	Bankfull Elevation Elev. (ft)	Low Bank HI Fore-Sight FS (ft)	Low Bank HI Elevation Elev. (ft)	NOTES e.g. Riffle Run Pool Glide	
	28	~~201~~			~~10.38~~		~~9.31~~						~~Run~~	
	29	196			10.39		9.35		8.49	(.86)			Run	
	30	212			10.80		9.29						T Pool	- Good H2O surface El.
2.2	31	214			11.44								Pool	- D Max
	32	221			11.40								~~T Run~~	
	33	226			10.67		9.29		8.25	(1.04)			T Run	
	34	234			10.70								Run	
	35	245			10.24								Run	
	36	277.8											⊗	- Measure on staff height of gage -
	37	285					9.35		8.39	(.96)			Run	
	38	308			9.81		9.41				Bedrock		- T Riffle	
	39	317			11.12		10.44						B Riffle / T Run	277.8 - station
	40	~~157 Is the Pool X sec~~												Rod @ 7.5
	41													
	42													Staff Plate @ Rod = 3.00
	43													
	44													
	45													
	46													
	47													
	48													
	49													
	50													
	51													
	52													
	53													
	54													

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Team 4 - Marsh Run Crk. 4/30/2009

Table A-7. Procedure to validate hydraulic relations using gage station data from the West Fork San Juan River, Colorado.

Validation of Hydraulic Relationships Using Gaging 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 A-22**).
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: $u^* = (gRS)^{1/2}$. $32.2 * 1.26 * 0.0046 = \sqrt{0.19} = 0.43$
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 A-16**) (Example in **FigureA-19**).
14. Plot Manning's "n" by friction factor (**Figure A-17**) (Example in **Figure A-20**). 1.26
15. Plot Manning's "n" by stream type (**Figure A-18**) (Example in **Figure A-21**).

Gaging Station Name: ~~West Fork San Juan River near Pagosa Springs, Colorado~~ ~~Gaging Station Number: 09341500~~

1	2	3a	3b	3c	3d	4	5	6	7	8	9	10	11
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}~~ D_{50} (mm)	(ft)	Stream Type	Manning's "n"	Relative Roughness R/D_{84} (ft/ft)	Shear Velocity u* (ft/s)	Friction Factor u/u*
18.90	82.87	22	1.9	35	15	0.0046	.77	0.003	F6/C	0.008	0.084	0.43	0.20

1 cm = .3937 in 1 in = 0.083'

.077cm = 0.03 inches

Used D_{50} because D_{84} is bedrock

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

Bankfull VELOCITY / DISCHARGE Estimates

Site:	Marsh Creek	Location:	Team 4
Date:	4/30/09	Stream Type:	F5/6/1
Valley Type:	VIII		
Observers:		HUC:	02070004

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Cross-sectional AREA	32.41	A_{bkf} (ft^2)	Bankfull Mean DEPTH	1.31	d_{bkf} (ft)
Bankfull WIDTH	24.69	W_{bkf} (ft)	Wetted PERIMETER ~ $2 * d_{bkf} + W_{bkf}$	25.82	W_p (ft)
D_{84} @ Riffle	119.23	Dia. (mm)	D_{84} mm / 304.8 =	0.39	D_{84} (ft)
Bankfull SLOPE	0.0045	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	1.26	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	0.011	
Drainage AREA	18.9	DA (mi^2)	Shear Velocity $u^* = \sqrt{gRS}$	0.42	u^* (ft / sec)

$\sqrt{0.18}$
0.42

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $u = [2.83 + 5.66 \text{ Log}\{R/D_{84}\}]u^*$	2.43	ft / sec	72.73	cfs
2. Roughness Coefficient: a) Manning's 'n' from friction factor / relative roughness $u = 1.4865 * R^{2/3} * S^{1/2}/n$ n = 0.044	2.63	ft / sec	85.24	cfs
2. Roughness Coefficient: $u = 1.4865 * R^{2/3} * S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n = 0.39 S^{.38} R^{-.16}$ n = 0.0482. Note: This equation is for applications involving steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream systems; i.e., for stream types A1, A2, A3, B1, B2, B3, C2 and E3.	2.41	ft / sec	78.11	cfs
2. Roughness Coefficient: $u = 1.4865 * R^{2/3} * S^{1/2}/n$ c) Manning's 'n' from Stream Type F6 n = 0.062	1.87	ft / sec	60.61	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) F factor = 0.2423	2.46	ft / sec	79.59	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.)	—	ft / sec	—	cfs
4. Continuity Equations: a) Regional Curves $u = Q / A$ Return Period for Bankfull Discharge Q = 1.6 Year	2.9	ft / sec	101.	cfs
4. Continuity Equations: b) USGS Gage Data $u = Q / A$	2.37	ft / sec	82.87	cfs

V= 101 / 34

Options for using the D_{84} term in the relative roughness relation (R/D_{84}), when using estimation method 1.

Option 1.	For **sand-bed** channels: Measure the **"protrusion height"** (h_{sd}) of sand dunes above channel bed elevations. Substitute an average sand dune protrusion height (h_{sd} in ft) for the D_{84} term in estimation method 1.
Option 2.	For **boulder-dominated** channels: Measure several **"protrusion heights"** (h_{bo}) of boulders above channel bed elevations. Substitute an ave. boulder protrusion height (h_{bo} in ft) for the D_{84} term in estimation method 1.
Option 3.	For **bedrock-dominated** channels: Measure several **"protrusion heights"** (h_{br}) of rock separations/steps/joints/ uplifted surfaces above channel bed elevations. Substitute an average bedrock protrusion height (h_{br} in feet) for the D_{84} term in estimation method 1.

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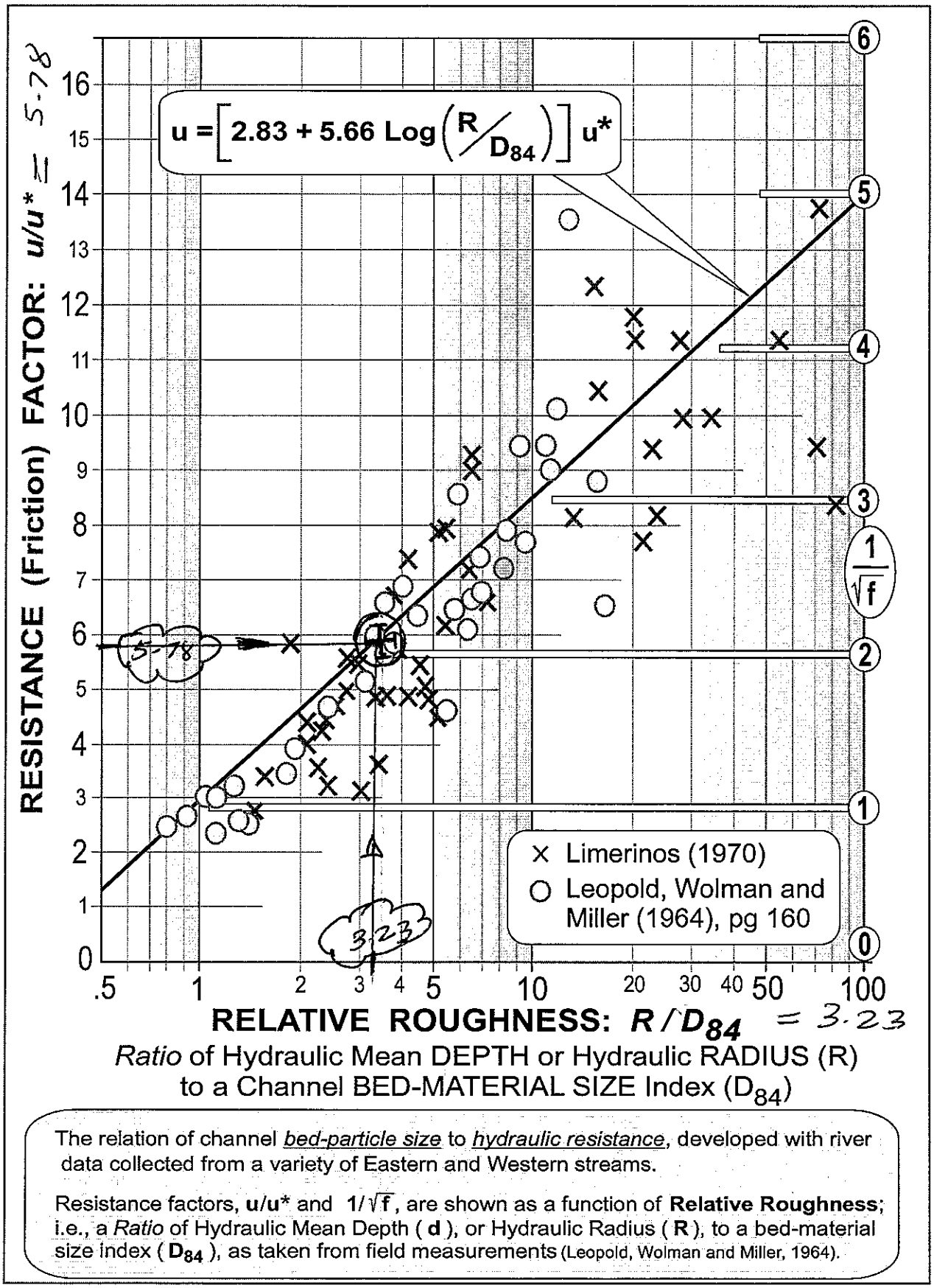

The relation of channel *bed-particle size* to *hydraulic resistance*, developed with river data collected from a variety of Eastern and Western streams.

Resistance factors, **u/u*** and $1/\sqrt{f}$, are shown as a function of **Relative Roughness**; i.e., a *Ratio* of Hydraulic Mean Depth (**d**), or Hydraulic Radius (**R**), to a bed-material size index ($\mathbf{D_{84}}$), as taken from field measurements (Leopold, Wolman and Miller, 1964).

Figure B-2. Relative roughness (R/D_{84}) vs. friction factor (u/u*) (Rosgen, 2006b; Rosgen and Silvey, 2007).

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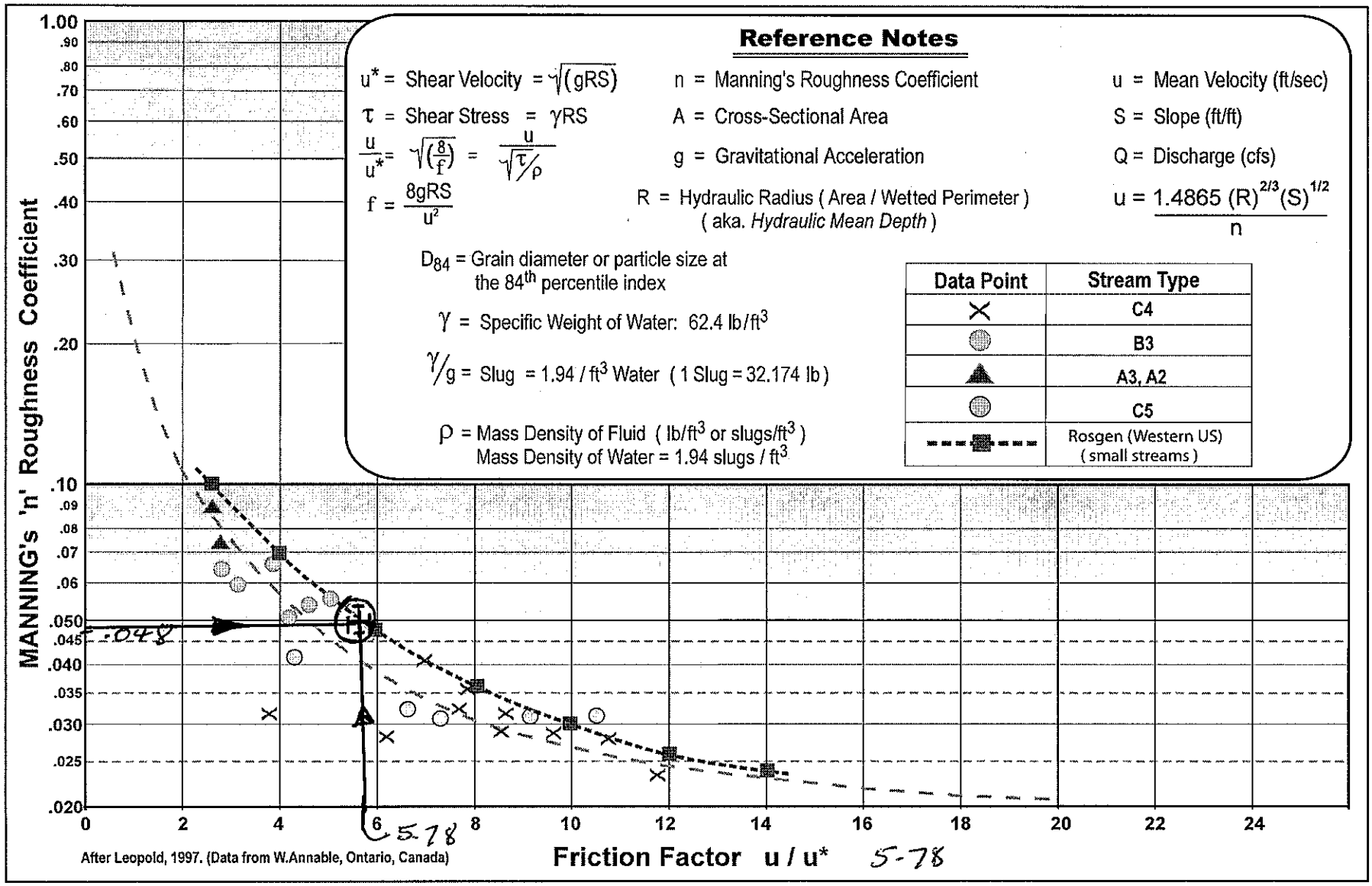

Figure B-3. Friction factor (u/u*) vs. Manning's roughness coefficient "n" (Rosgen, 2006b; Rosgen and Silvey, 2007).

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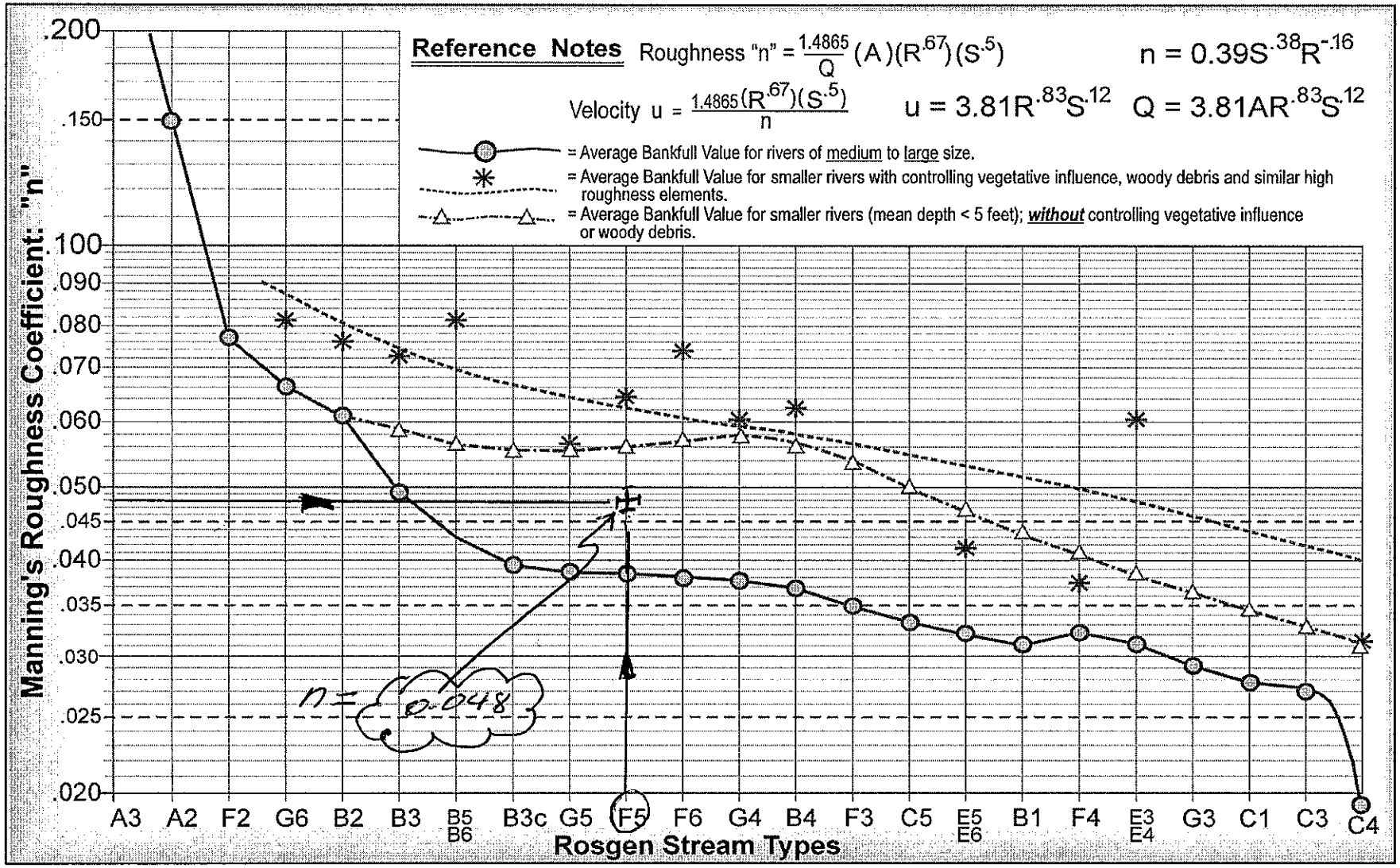

Figure B-4. Manning's "n" by stream type (Rosgen and Silvey, 2007).

F5/6/1

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Team 4 4/30/09

Step 14

Summarize USGS gage data:

Summary....*USGS GAGE STATION* Data / Records for STREAM CHANNEL CLASSIFICATION

Station NAME:	MARSH RUN @ GRIMES			Station Number:	01617800
LOCATION:	WASHINGTON COUNTY MD				
Period of Record:	45 yrs			Mean Annual DISCHARGE:	— cfs
Drainage AREA:	12,096 acres	18.9 mi²		Drainage Area Mn Elev:	ft
Reference REACH SLOPE:	0.04 ft/ft			Valley Type:	VIII
Stream Type:	F5/1			HUC:	

"BANKFULL" CHARACTERISTICS

Determined from FIELD MEASUREMENT			Determined from GAGE DATA Analysis		
Bankfull WIDTH (W_{bkf})	24.69	ft	Bankfull WIDTH (W_{bkf})	22	ft
Bankfull Mean DEPTH (d_{bkf})	1.31	ft	Bankfull MEAN DEPTH (d_{bkf})	1.7	ft
Bankfull Xsec AREA (A_{bkf})	32.41	ft²	Bankfull Xsec AREA (A_{bkf})	35	ft²
Wetted PERIMETER (W_P)	25.82	ft	Wetted PERIMETER (W_P)	27.6	ft
Bankfull STAGE (Gage Ht)	2.15	ft	Bankfull STAGE (Gage Ht)	2.15	ft
Est. Mean VELOCITY (u)	2.57	ft/sec	Mean VELOCITY (u)	2.37	ft/sec
Est. Bkf. DISCHARGE (Q_{bkf})	83	cfs	Bankfull DISCHARGE (Q_{bkf})	82.87	cfs

Bankfull DISCHARGE associated with **"field-determined"** Bankfull STAGE (From Gage Height reading at Staff Plate and tabular Stage-Discharge curve data)	82.87	cfs
Recurrence Interval (Log-Pearson) associated with **"field-determined"** Bankfull Discharge	1.6	yrs

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

1.5 Year R.I. Discharge =	70	cfs	10 Year R.I. Discharge =	300	cfs
2.0 Year R.I. Discharge =	102	cfs	25 Year R.I. Discharge =	450	cfs
5.0 Year R.I. Discharge =	201	cfs	50 Year R.I. Discharge =	520	cfs

MEANDER GEOMETRY

Meander Wavelength (L_m)	131	ft	Radius of Curvature (R_C)	38	ft
Belt Width (W_{blt})	49.33	ft	Meander Width Ratio (W_{blt}/W_{bkf})	5.72	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 (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)	Velocity (u)
Intercept Coefficient a)	9.4161	0.4077	3.838	.2638
Slope Exponent b)	.1968	.3111	.508	.487

Hydraulic Radius $R = A / W_P$	1.26	ft	Manning's "n" at Bankfull Stage	.0442	Coeff.

"n" = 1.4895 [(Area) (Hydraulic Radius$^{2/3}$) (Slope)$^{1/2}$] / Q_{bkf}

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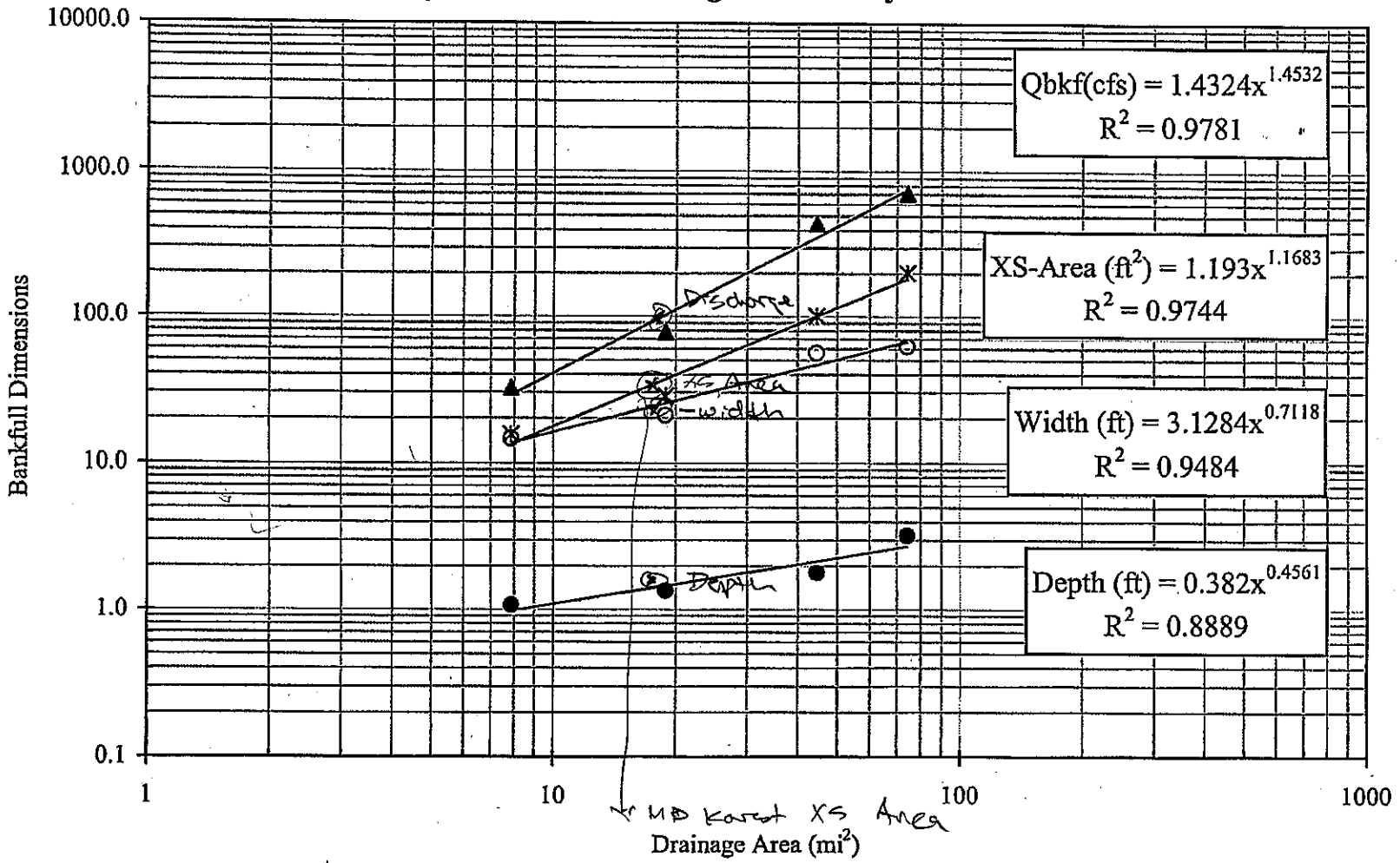
Team 4
4/30/09

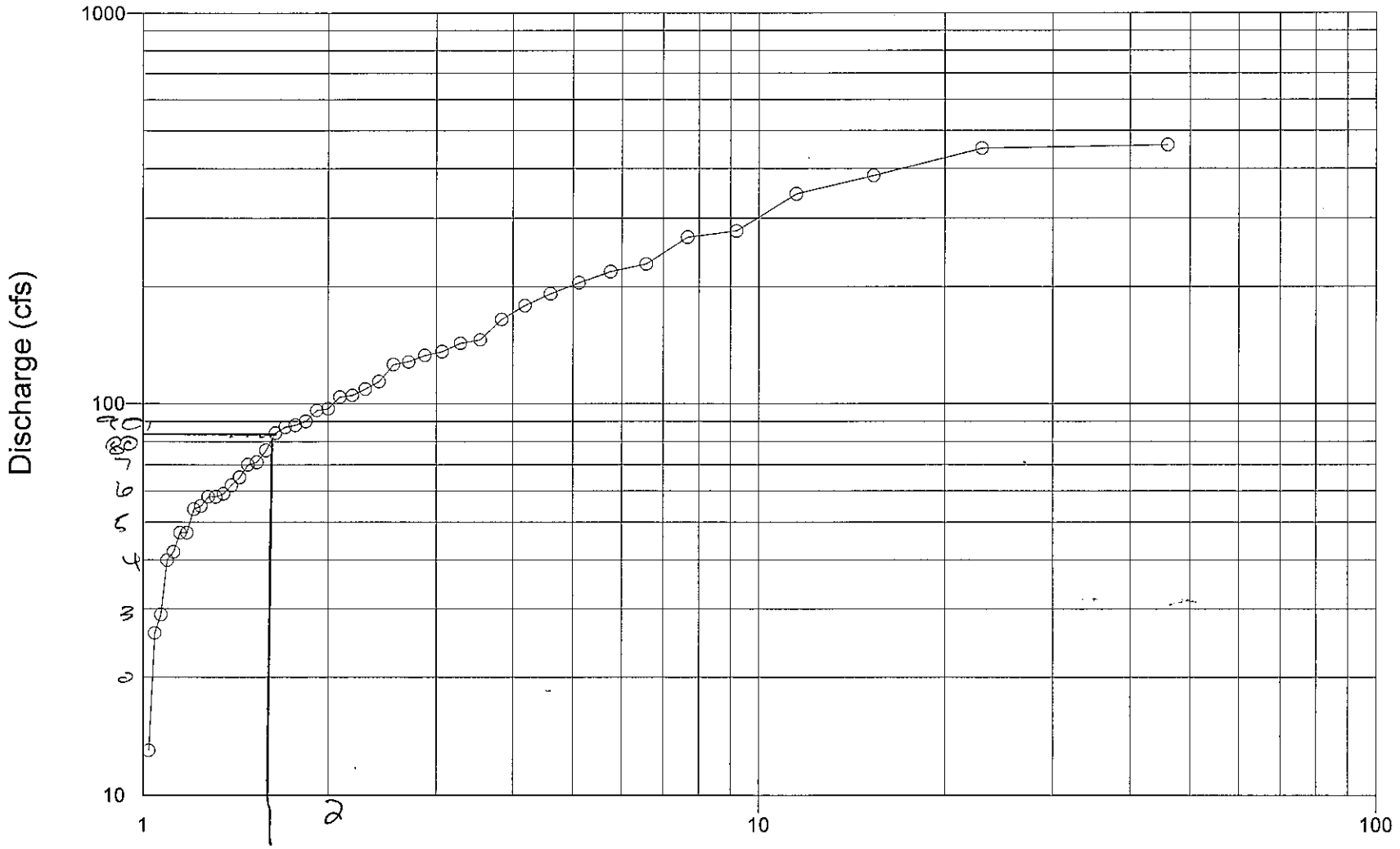
Bankfull Characteristics for Selected USGS Gages in the Pennsylvania Great Valley Section of the Ridge and Valley Province



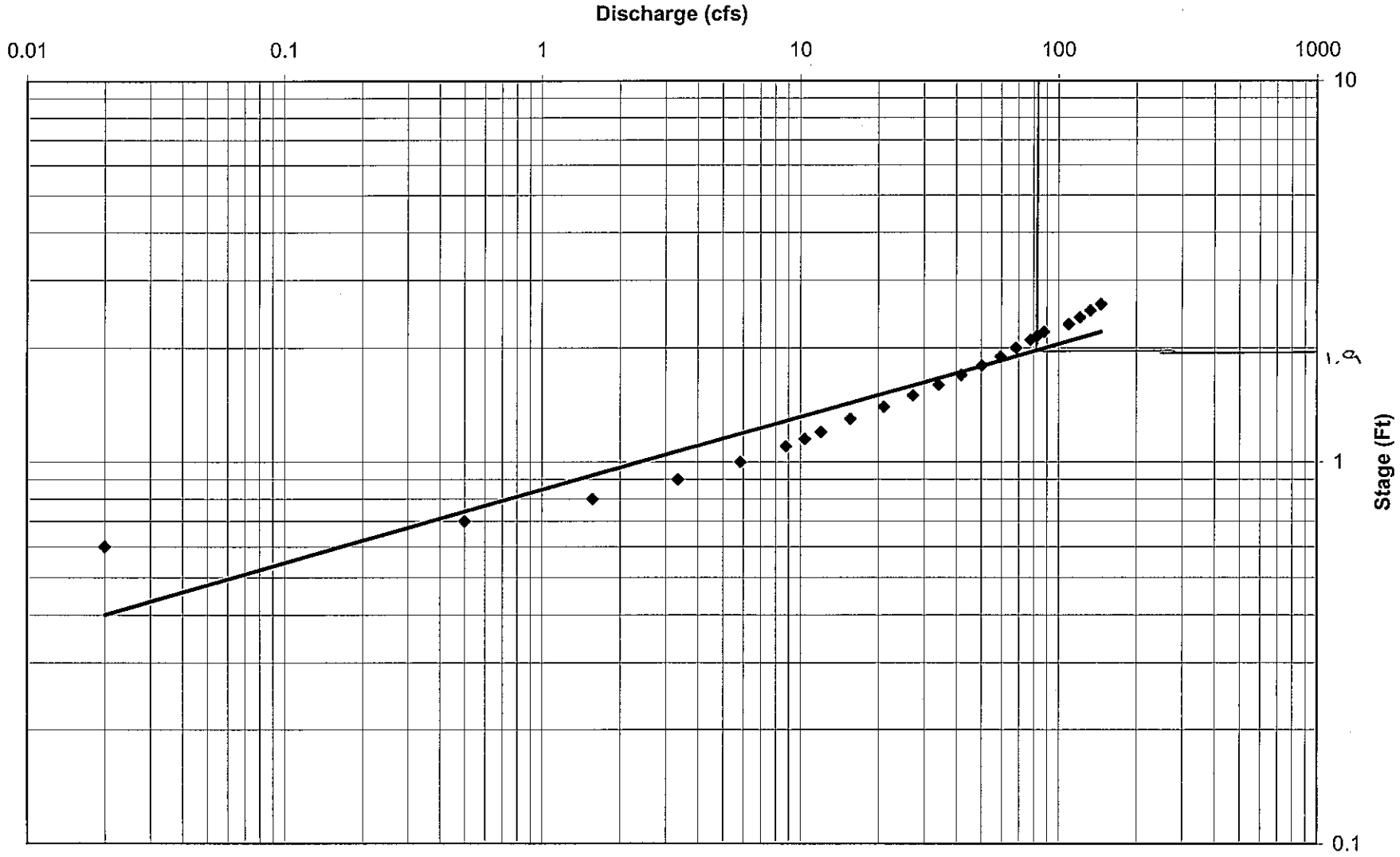
C4 Stream Type = 12 w/d ratio

almost E4

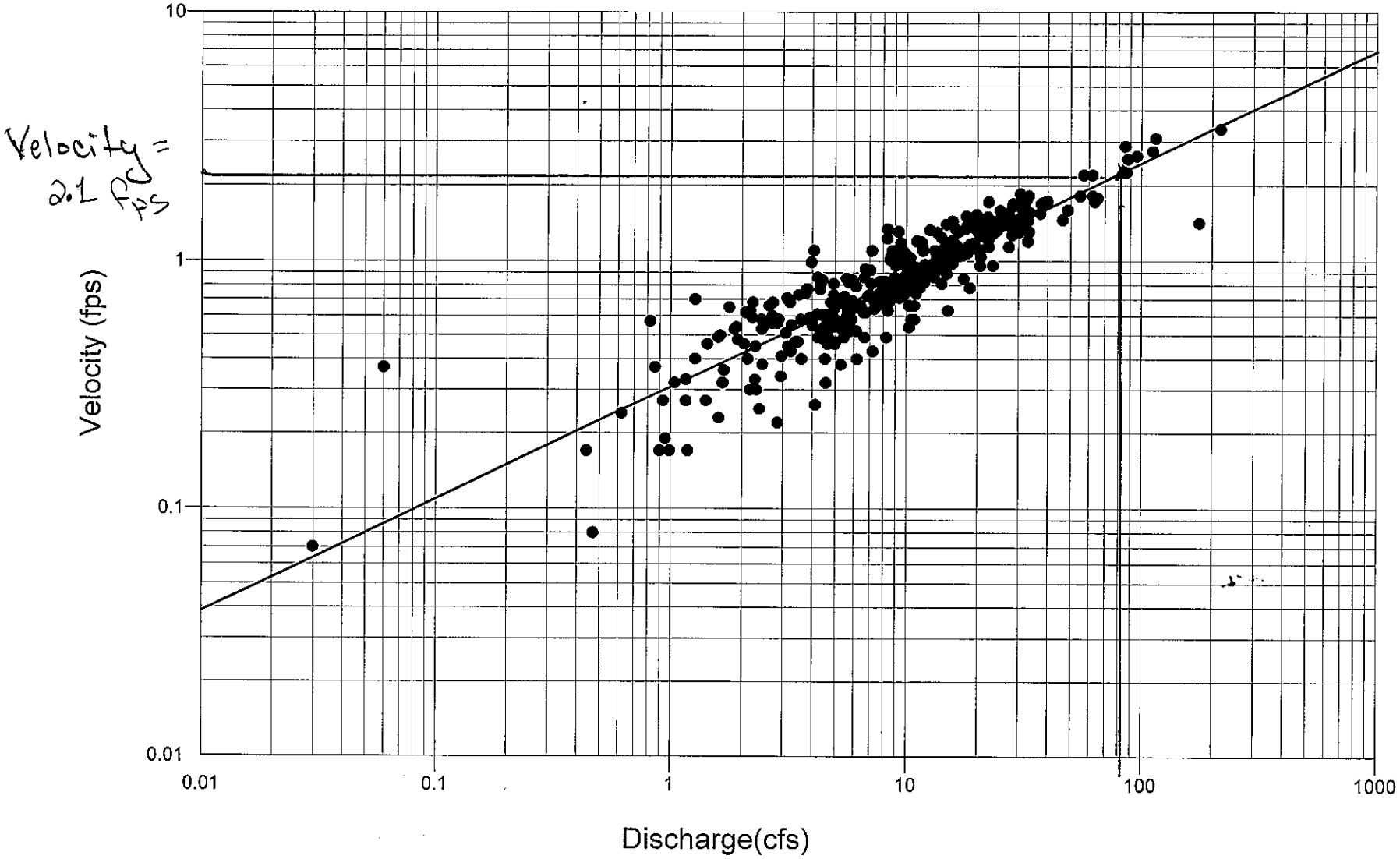
Marsh Run


1000
100
10
1
2
10
100
Discharge (cfs)
Return Interval (yr)
Return Interval = 1.7

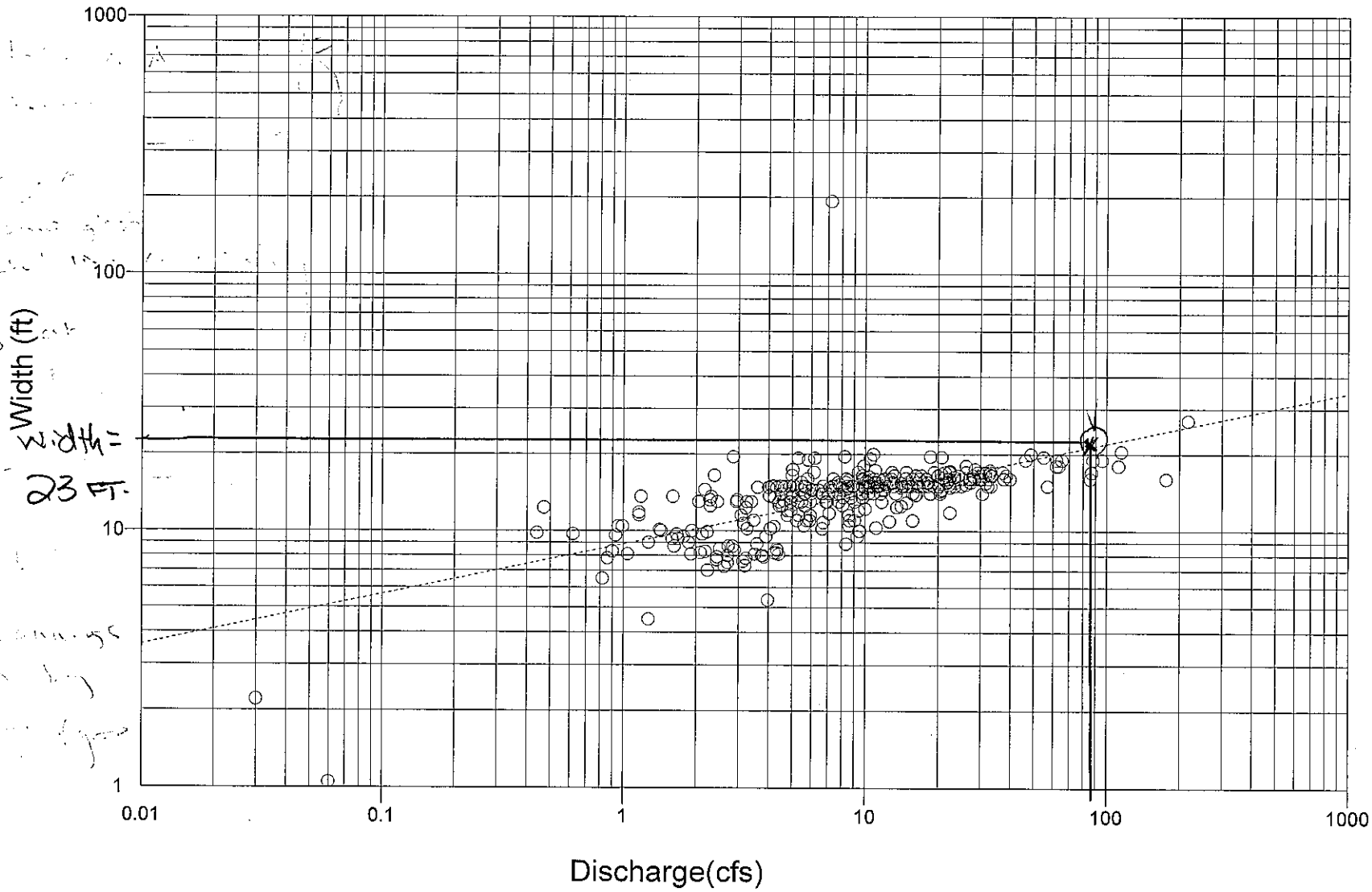
Stage vs Discharge



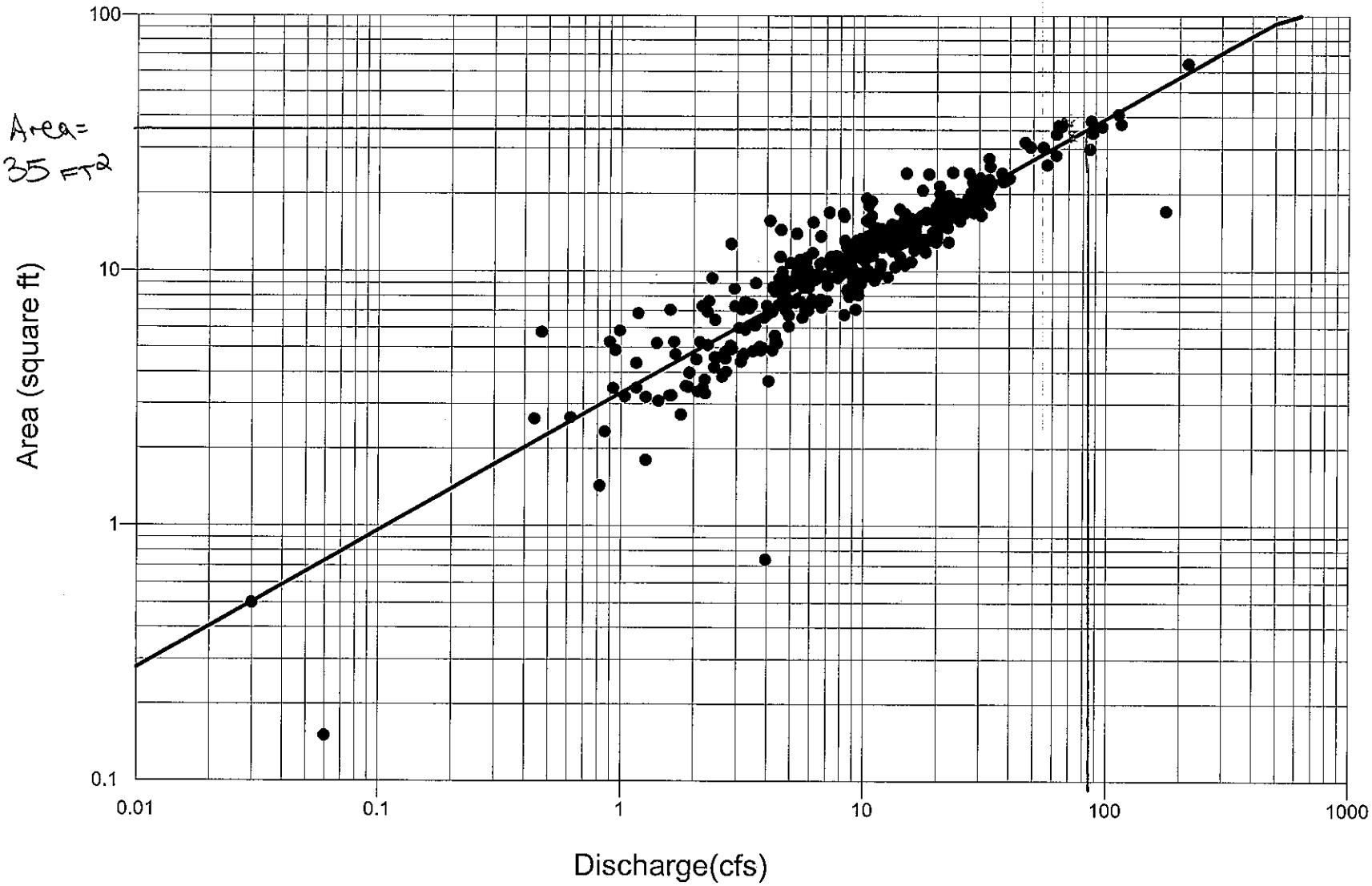
Hydraulic Geometry - Marsh Run



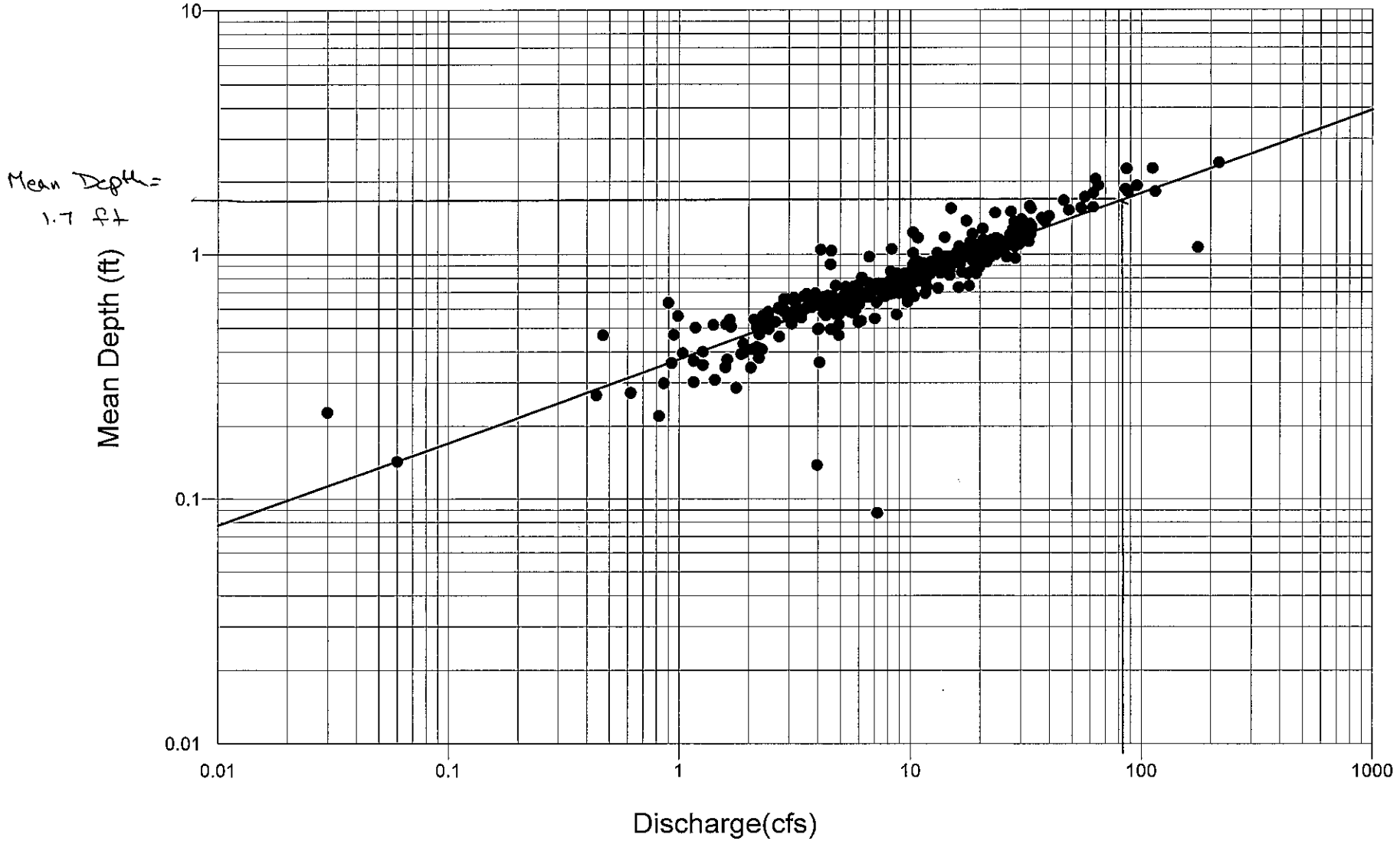
Hydraulic Geometry - Marsh Run



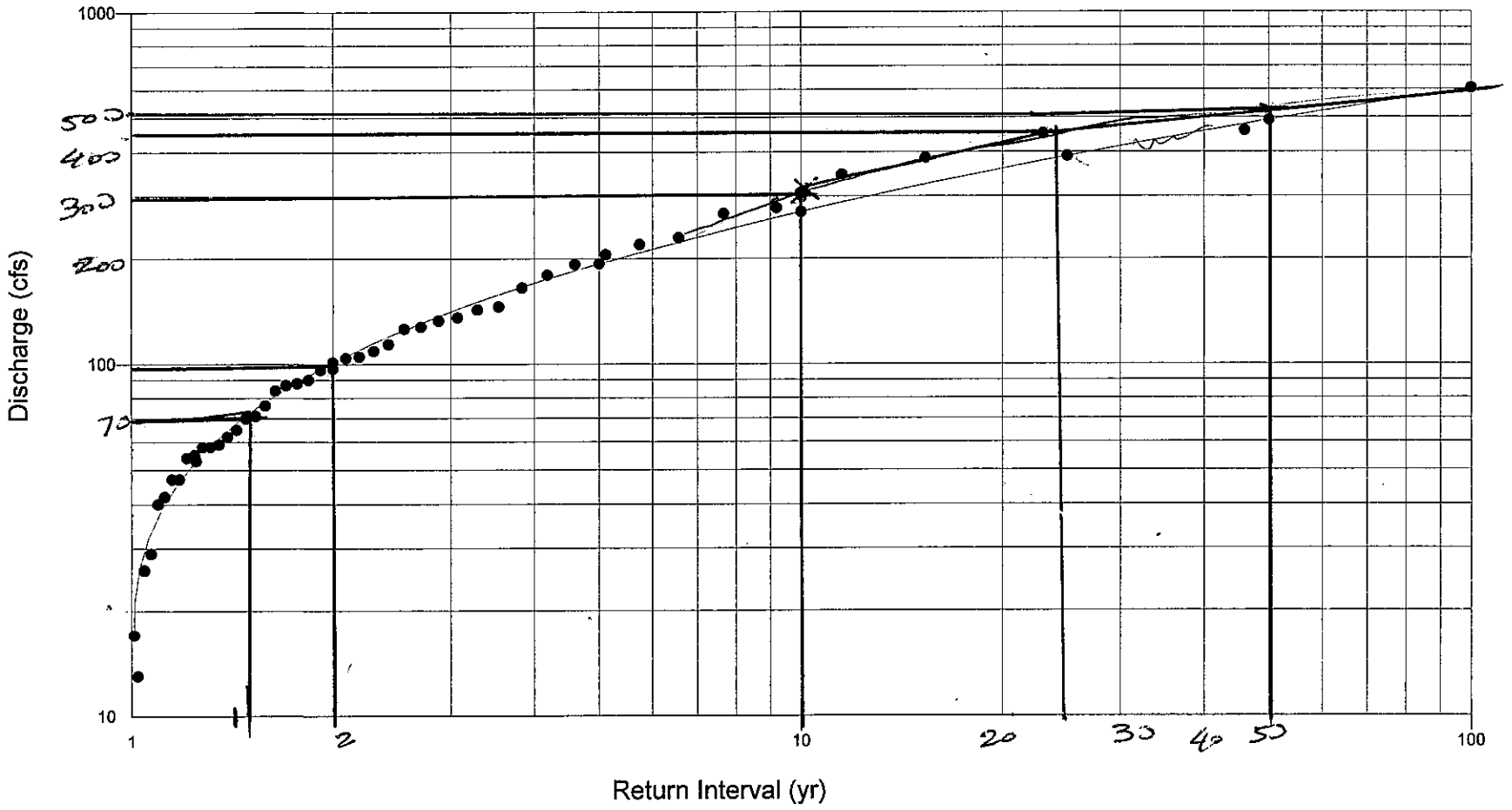
Hydraulic Geometry - Marsh Run



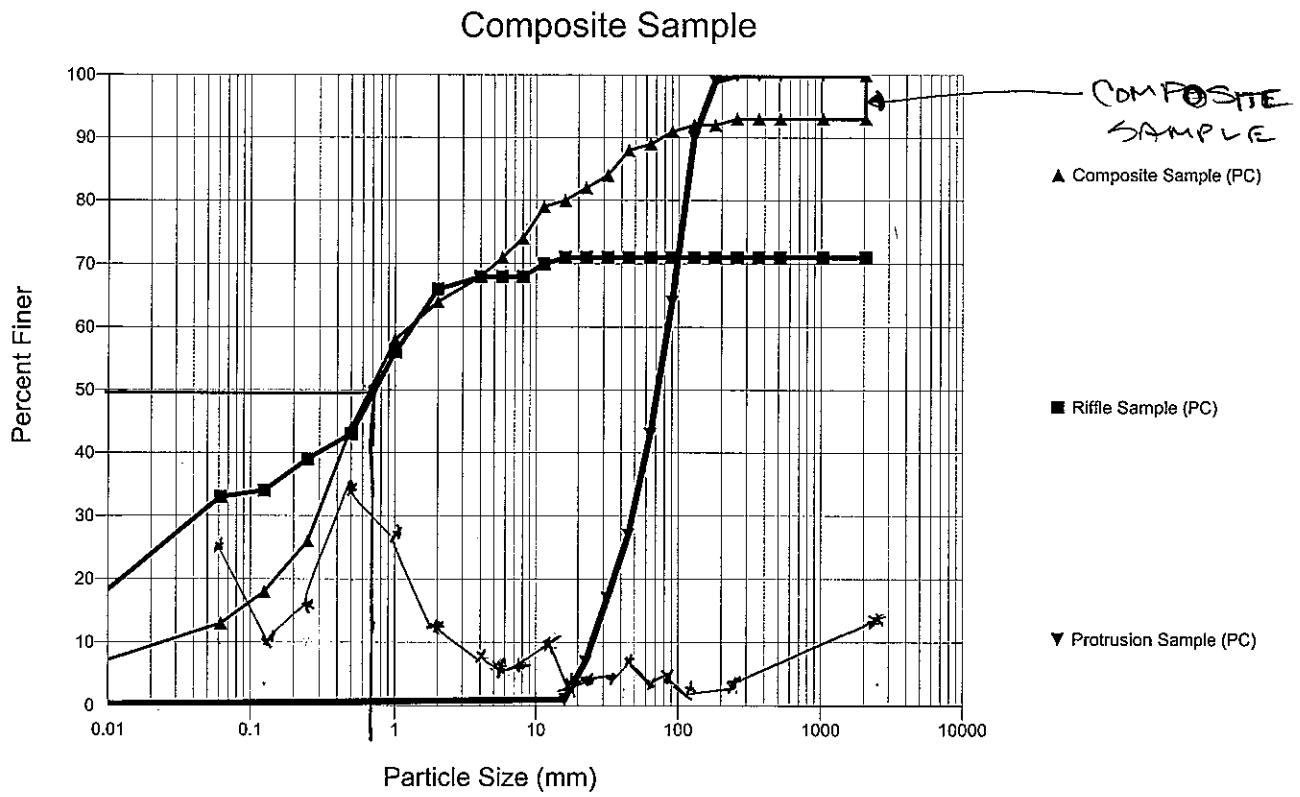
Hydraulic Geometry - Marsh Run



rivermarsh gage

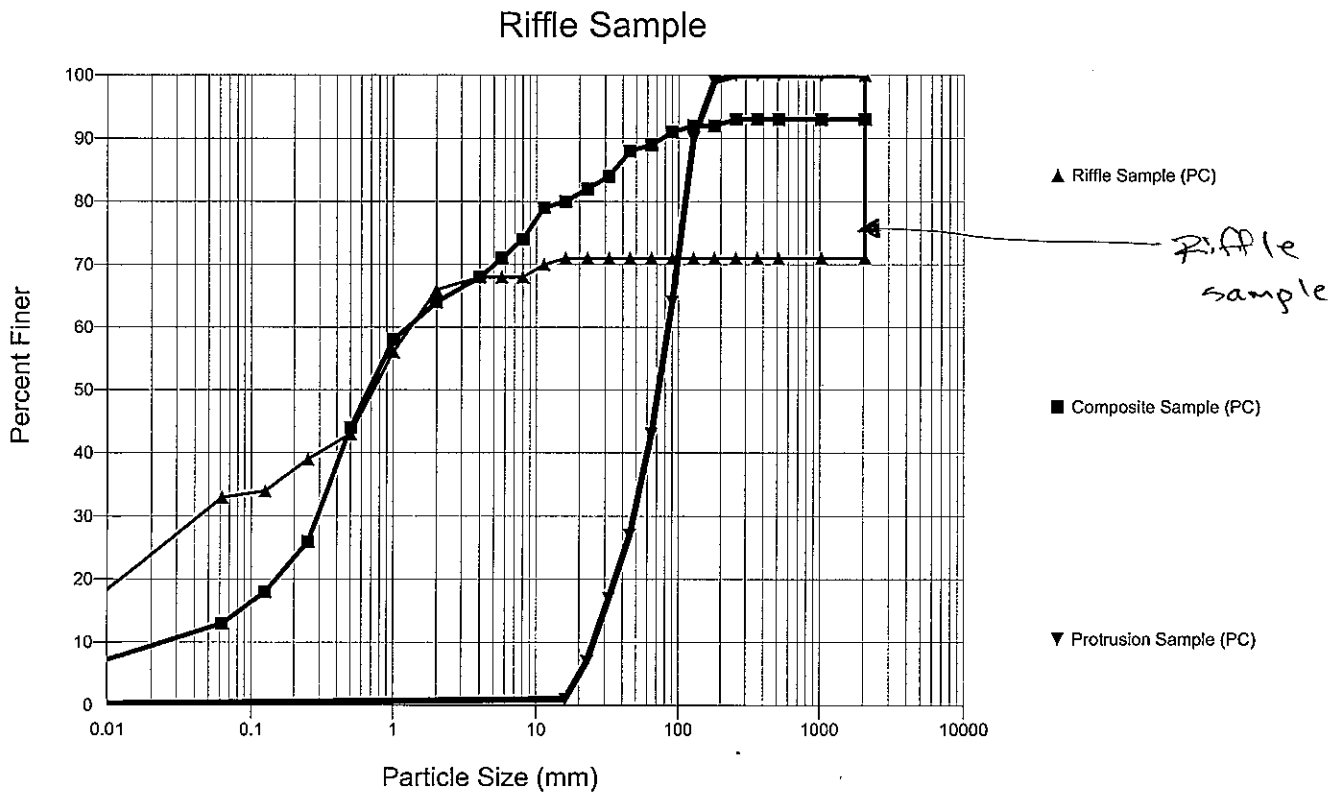


TEAM #4 4/30/09 Marsh Run

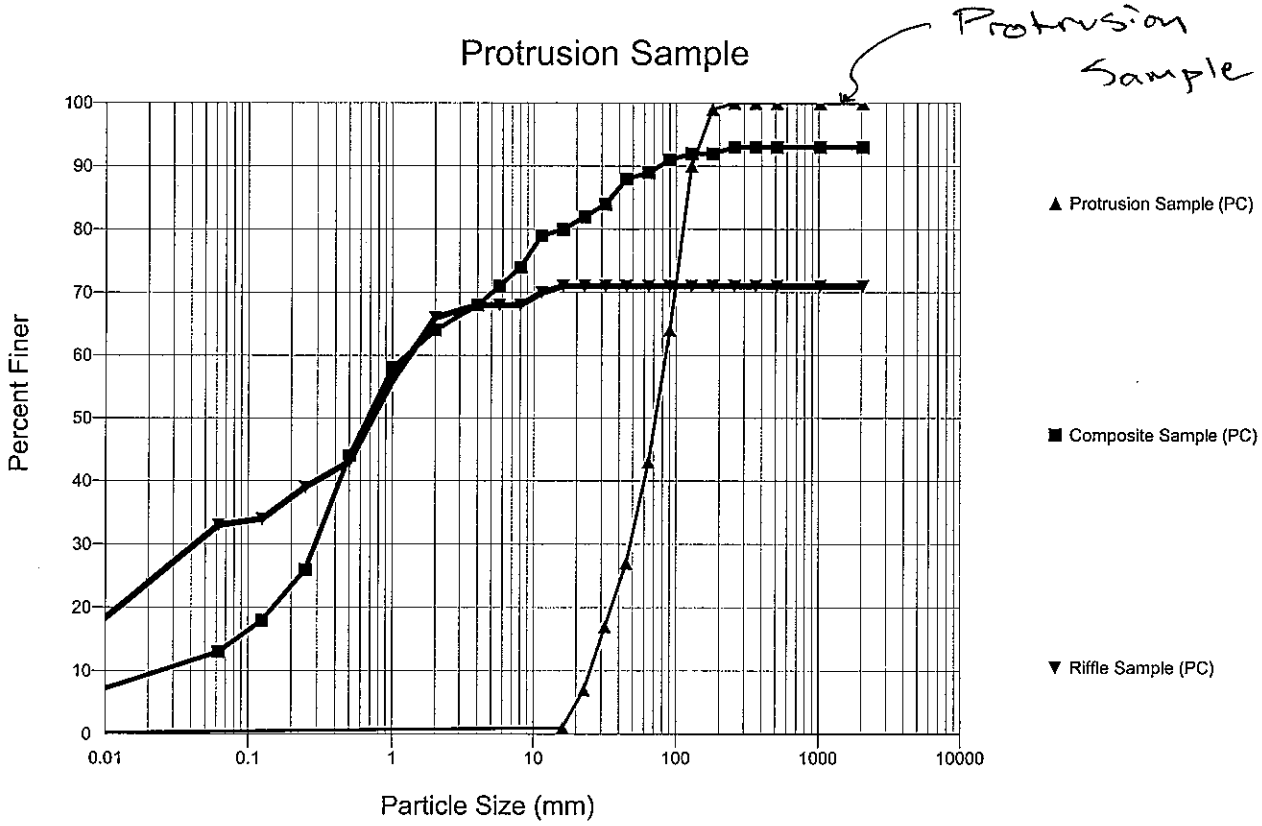


D_{50} = 0.70 MM - COARSE SAND

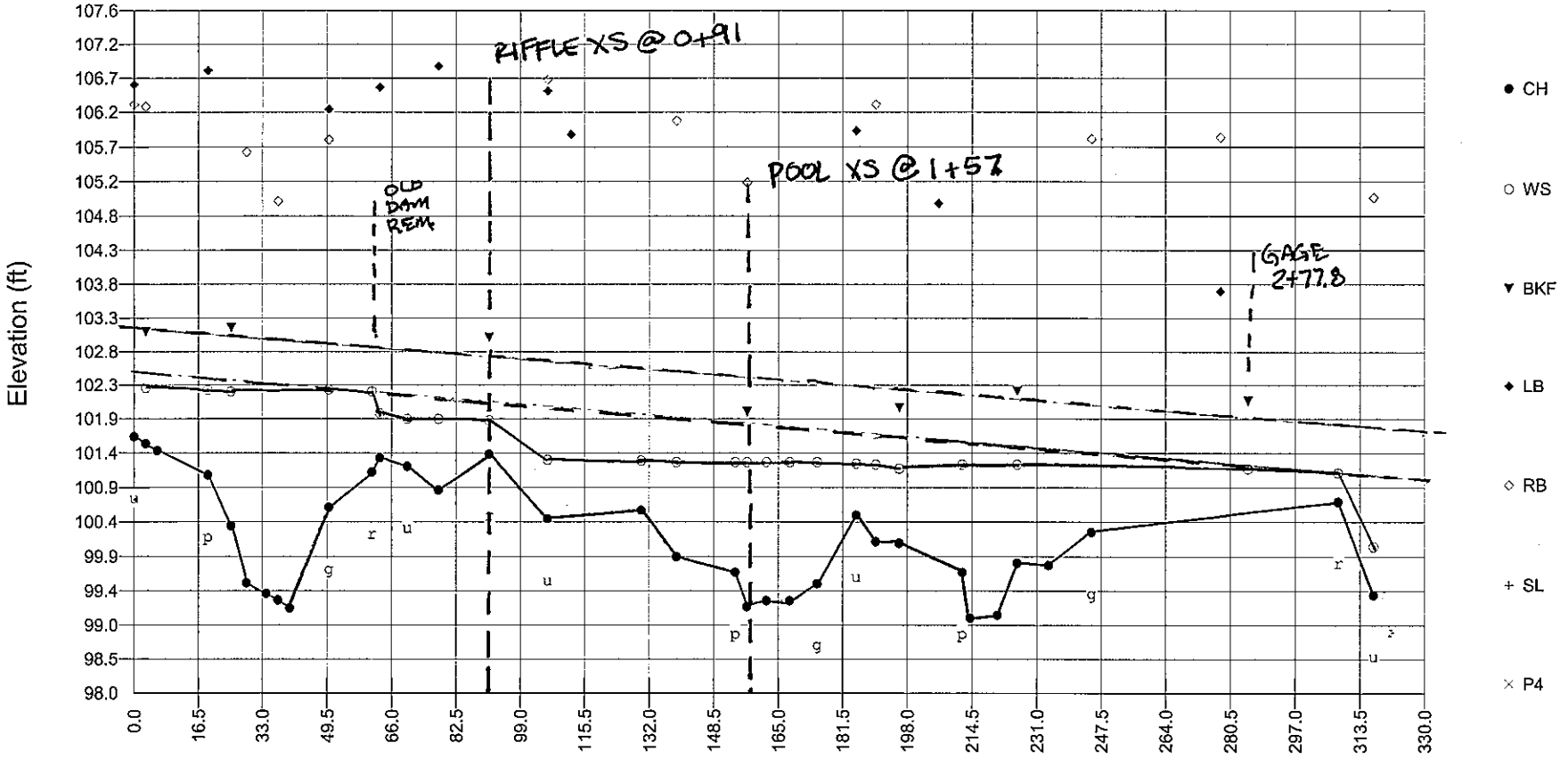
TEAM #4 4/30/09 Marsh Run



Team #4 4/30/09 Marsh Run

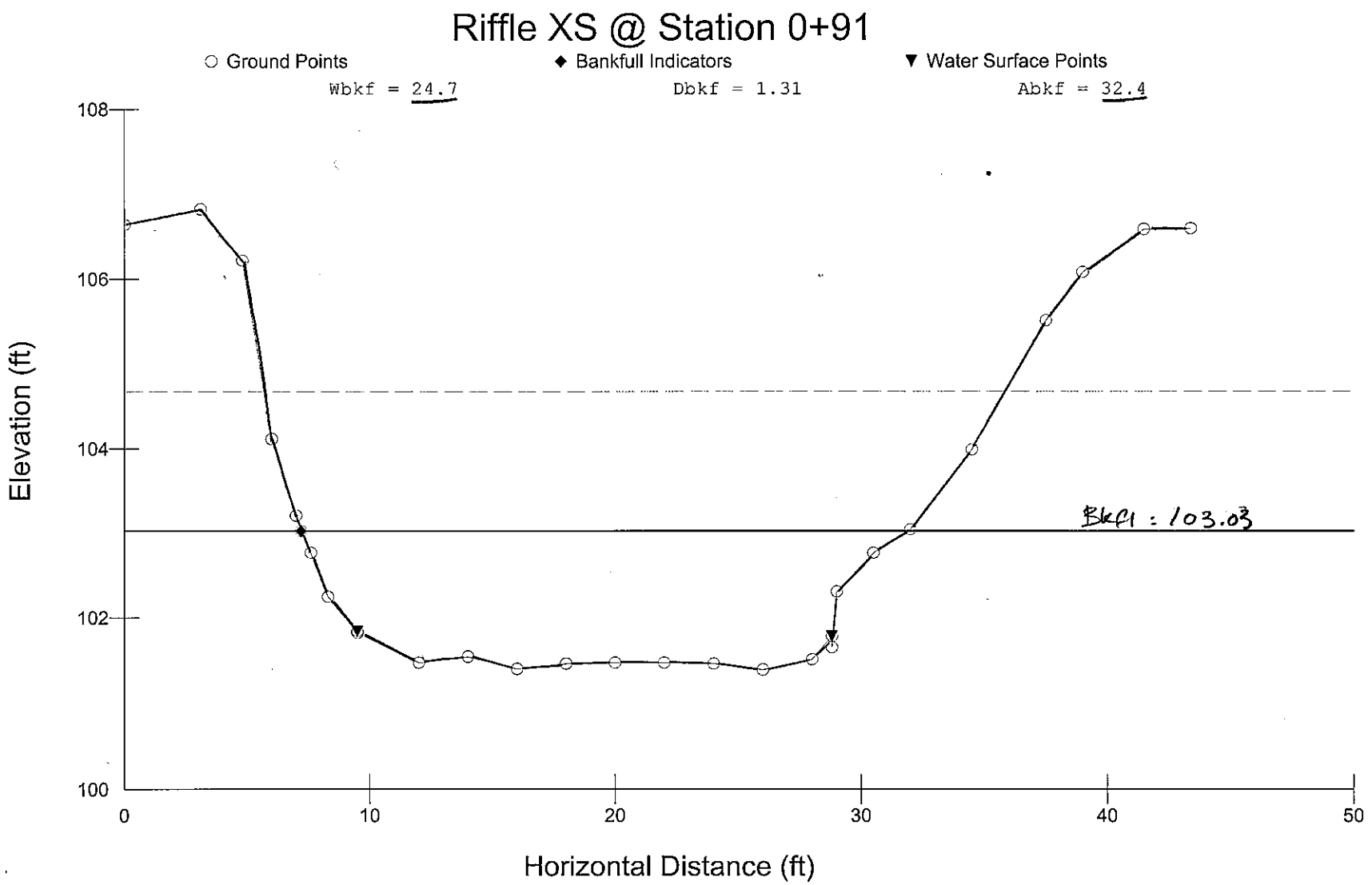


Profile Team 4



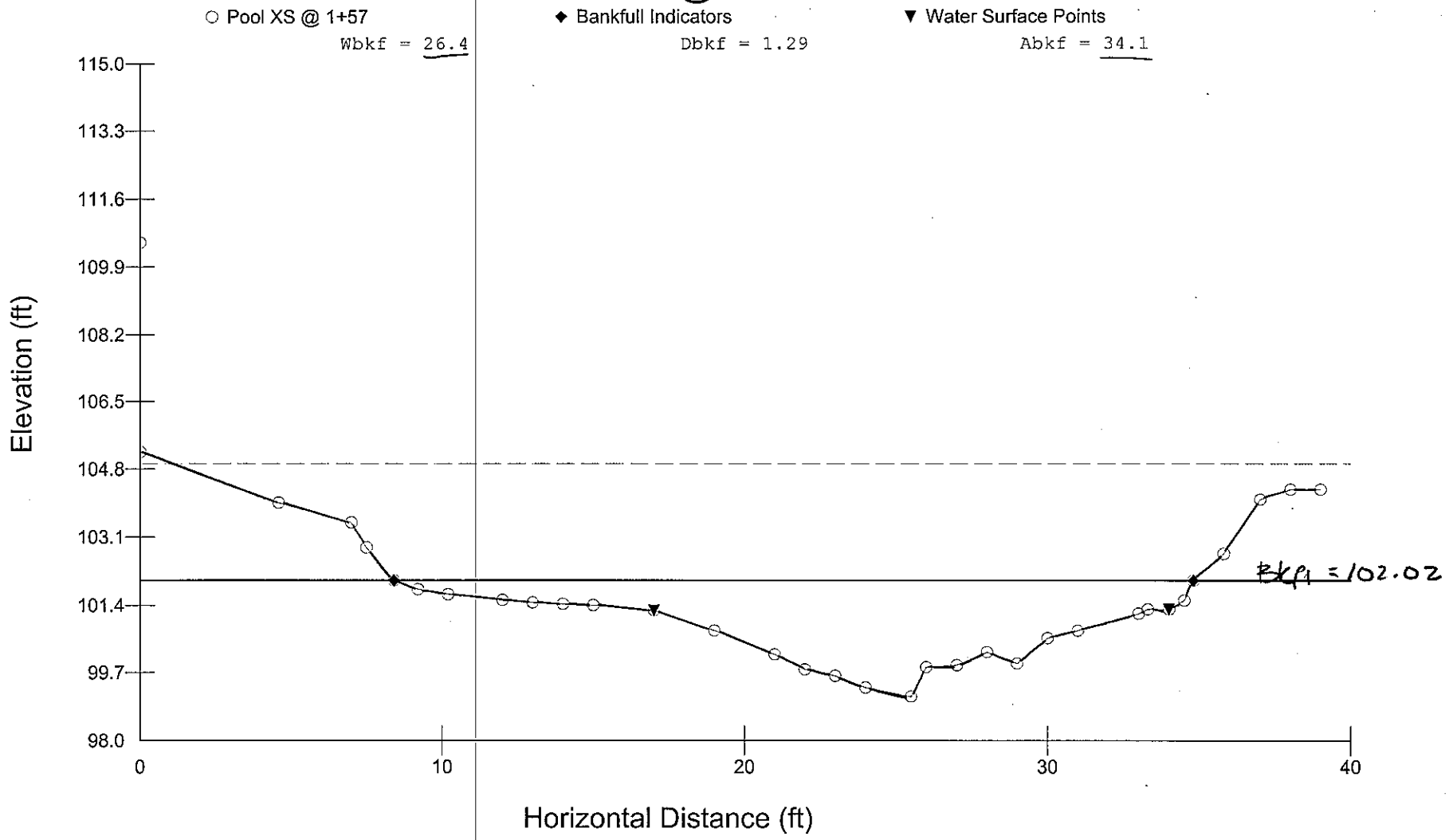
BKF Best Fit Slope = 0.00451
SL Best Fit Slope = 0.00466

Team 4


Riffle XS @ Station 0+91
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 24.7
Dbkf = 1.31
Abkf = 32.4
Elevation (ft)
108
106
104
102
100
0
10
20
30
40
50
Horizontal Distance (ft)
Bkfl = 103.03

Team 4

POOL XS @ 1+57



Worksheet 5-3. Field form for Level II stream classification (Rosgen, 1996; Rosgen and Silvey, 2005).

Stream:	**Marsh Run\, Reach - Reach 1** - Team 4			
Basin:		Drainage Area: **12096** acres	**18.9**	mi^2
Location:				
Twp.&Rge: **;**		Sec.&Qtr.: **;**		
Cross-Section Monuments (Lat./Long.):	**0 Lat / 0 Long**		Date:	**04/30/09**
Observers:			Valley Type:	VIII

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	**24.69**	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}).	**1.31**	ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	**32.41**	ft^2
Width/Depth Ratio (W_{bkf}/ d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	**18.85**	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.	**1.64**	ft
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined in a riffle section.	**30.16**	ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	**1.22**	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.	**0.71**	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.	**0.00451**	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).	**1.16**	

Stream Type **F5/6/1** (See **Figure 2-14**)

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With Riffle Sample

Worksheet 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2005).

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

Observers: Date: **04/30/09** Valley Type: **VII** Stream Type: **F5/6/1**

River Reach Summary Data

Channel Dimension

Mean Riffle Depth (d_{bkf})	1.31	ft	Riffle Width (W_{bkf})	24.69	ft	Riffle Area (A_{bkf})	32.41	ft^2
Mean Pool Depth (d_{bkfp})	1.29	ft	Pool Width (W_{bkfp})	26.4	ft	Pool Area (A_{bkfp})	34.11	ft^2
Mean Pool Depth/Mean Riffle Depth	0.98	d_{bkfp}/d_{bkf}	Pool Width/Riffle Width	1.07	W_{bkfp}/W_{bkf}	Pool Area / Riffle Area	1.05	A_{bkfp}/A_{bkf}
Max Riffle Depth (d_{maxrif})	0.66	ft	Max Pool Depth (d_{maxp})	3.37	ft	Max Riffle Depth/Mean Riffle Depth	0.504	
Max Pool Depth/Mean Riffle Depth	2.573		Point Bar Slope	0	ft/ft	Inner Berm Width (W_{ib})	0	ft
Inner Berm Depth (d_{ib})	0	ft	Inner Berm Width/Depth Ratio	0	W_{ib}/d_{ib}	Inner Berm Area (A_{ib})	0	ft^2
Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})			85.24	ft/s	Estimation Method			
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})			2.63	cfs	Drainage Area		18.9	mi^2

Channel Pattern

Geometry	Mean	Min	Max		Dimensionless Geometry Ratios	Mean	Min	Max
Meander Wavelength (L_m)	131	0	0	ft	Meander Length Ratio (L_m/W_{bkf})	5.31	0.00	0.00
Radius of Curvature (R_c)	38	0	0	ft	Radius of Curvature/Riffle Width (R_c/W_{bkf})	1.54	0.00	0.00
Belt Width (W_{blt})	49.3	0	0	ft	Meander Width Ratio (W_{blt}/W_{bkf})	2.00	0.00	0.00
Individual Pool Length	27.1	17.7	33.8	ft	Pool Length/Riffle Width	1.10	0.72	1.37
Pool to Pool Spacing	89.2	59.3	119	ft	Pool to Pool Spacing/Riffle Width	3.61	2.40	4.83
Riffle Length	12.3	8.49	16.6	ft	Riffle Length/Riffle Width	0.50	0.34	0.67

Channel Profile

Valley Slope (VS)	0.00523	ft/ft	Average Water Surface Slope (S)	0.00451	ft/ft	Sinuosity (VS/S)	1.16	
Stream Length (SL)	553	ft	Valley Length (VL)	475	ft	Sinuosity (SL/VL)	1.16	
Low Bank Height (LBH)	start 2.55 ft, end 3.78 ft		Max Riffle Depth	start 0 ft, end 0 ft		Bank-Height Ratio (BHR) (LBH/Max Riffle Depth)	start, end	

Facet Slopes	Mean	Min	Max		Dimensionless Slope Ratios	Mean	Min	Max
Riffle Slope (S_{rif})	0.043	0.000	0.000	ft/ft	Riffle Slope/Average Water Surface Slope (S_{rif} / S)	9.424	0.000	0.000
Run Slope (S_{run})	0.012	0.002	0.045	ft/ft	Run Slope/Average Water Surface Slope (S_{run} / S)	2.678	0.344	9.945
Pool Slope (S_p)	0.001	0.001	0.003	ft/ft	Pool Slope/Average Water Surface Slope (S_p / S)	0.310	0.166	0.585
Glide Slope (S_g)	0.002	0.000	0.004	ft/ft	Glide Slope/Average Water Surface Slope (S_g / S)	0.459	0.000	0.916

Feature Midpoint [a]	Mean	Min	Max		Dimensionless Depth Ratios	Mean	Min	Max
Max Riffle Depth (d_{maxrif})	0.66	0	1.32	ft	Max Riffle Depth/Mean Riffle Depth (d_{maxrif} / d_{bkf})	0.5	0	1.01
Max Run Depth (d_{maxrun})	1.54	0.66	2.31	ft	Max Run Depth/Mean Riffle Depth (d_{maxrun} / d_{bkf})	1.18	0.5	1.76
Max Pool Depth (d_{maxp})	3.37	3.13	3.76	ft	Max Pool Depth/Mean Riffle Depth (d_{maxp} / d_{bkf})	2.57	2.39	2.87
Max Glide Depth (d_{maxg})	1.21	0	2.97	ft	Max Glide Depth/Mean Riffle Depth (d_{maxg} / d_{bkf})	0.92	0	2.27

Channel Materials

	Reach [b]	Riffle [c]	Bar		Reach [b]	Riffle [c]	Bar	Protrusion Height [d]	
% Silt/Clay	13	33		D_{16}	0.1	0.03		0	mm
% Sand	51	33		D_{35}	0.38	0.15		0	mm
% Gravel	25	5		D_{50}	0.71	0.77		0	mm
% Cobble	4	0		D_{84}	32	Bedrock		0	mm
% Boulder	0	0		D_{95}	Bedrock	Bedrock		0	mm
% Bedrock	7	29		D_{100}	Bedrock	Bedrock		0	mm

[a] Min, max, mean depths are ave. mid-point values except pools: taken at deepest part of pool.

[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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With Protrusion

Worksheet 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2005).

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

Observers: Date: **04/30/09** Valley Type: **VII** Stream Type: **F5/6/1**

River Reach Summary Data

Channel Dimension

Mean Riffle Depth (d_{bkf})	1.31	ft	Riffle Width (W_{bkf})	24.69	ft	Riffle Area (A_{bkf})	32.41	ft^2
Mean Pool Depth (d_{bkfp})	1.29	ft	Pool Width (W_{bkfp})	26.4	ft	Pool Area (A_{bkfp})	34.11	ft^2
Mean Pool Depth/Mean Riffle Depth	0.98	d_{bkfp}/d_{bkf}	Pool Width/Riffle Width	1.07	W_{bkfp}/W_{bkf}	Pool Area / Riffle Area	1.05	A_{bkfp}/A_{bkf}
Max Riffle Depth (d_{maxrif})	0.66	ft	Max Pool Depth (d_{maxp})	3.37	ft	Max Riffle Depth/Mean Riffle Depth	0.504	
Max Pool Depth/Mean Riffle Depth	2.573		Point Bar Slope ?	0	ft/ft	Inner Berm Width (W_{ib})	0	ft
Inner Berm Depth (d_{ib})	0	ft	Inner Berm Width/Depth Ratio	0	W_{ib}/d_{ib}	Inner Berm Area (A_{ib})	0	ft^2
Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})				85.24	ft/s	Estimation Method		
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})				2.63	cfs	Drainage Area	18.9	mi^2

Channel Pattern

Geometry	Mean	Min	Max		Dimensionless Geometry Ratios	Mean	Min	Max
Meander Wavelength (L_m)	131	0	0	ft	Meander Length Ratio (L_m/W_{bkf})	5.31	0.00	0.00
Radius of Curvature (R_c)	38	0	0	ft	Radius of Curvature/Riffle Width (R_c/W_{bkf})	1.54	0.00	0.00
Belt Width (W_{blt})	49.3	0	0	ft	Meander Width Ratio (W_{blt}/W_{bkf})	2.00	0.00	0.00
Individual Pool Length	27.1	17.7	33.8	ft	Pool Length/Riffle Width	1.10	0.72	1.37
Pool to Pool Spacing	89.2	59.3	119	ft	Pool to Pool Spacing/Riffle Width	3.61	2.40	4.83
Riffle Length	12.3	8.49	16.6	ft	Riffle Length/Riffle Width	0.50	0.34	0.67

Channel Profile

Valley Slope (VS)	0.00523	ft/ft	Average Water Surface Slope (S)	0.00451	ft/ft	Sinuosity (VS/S)	1.16	
Stream Length (SL)	559	ft	Valley Length (VL)	475	ft	Sinuosity (SL/VL)	1.16	

Low Bank Height (LBH)	start	2.55	ft	Max Riffle Depth	start	0	ft	Bank-Height Ratio (BHR) (LBH/Max Riffle Depth)	start	
	end	3.78	ft		end	0	ft		end	

Facet Slopes	Mean	Min	Max		Dimensionless Slope Ratios	Mean	Min	Max
Riffle Slope (S_{rif})	0.043	0.000	0.000	ft/ft	Riffle Slope/Average Water Surface Slope (S_{rif} / S)	9.424	0.000	0.000
Run Slope (S_{run})	0.012	0.002	0.045	ft/ft	Run Slope/Average Water Surface Slope (S_{run} / S)	2.678	0.344	9.945
Pool Slope (S_p)	0.001	0.001	0.003	ft/ft	Pool Slope/Average Water Surface Slope (S_p / S)	0.310	0.166	0.585
Glide Slope (S_g)	0.002	0.000	0.004	ft/ft	Glide Slope/Average Water Surface Slope (S_g / S)	0.459	0.000	0.916

Feature Midpoint [a]	Mean	Min	Max		Dimensionless Depth Ratios	Mean	Min	Max
Max Riffle Depth (d_{maxrif})	0.66	0	1.32	ft	Max Riffle Depth/Mean Riffle Depth (d_{maxrif} / d_{bkf})	0.5	0	1.01
Max Run Depth (d_{maxrun})	1.54	0.66	2.31	ft	Max Run Depth/Mean Riffle Depth (d_{maxrun} / d_{bkf})	1.18	0.5	1.76
Max Pool Depth (d_{maxp})	3.37	3.13	3.76	ft	Max Pool Depth/Mean Riffle Depth (d_{maxp} / d_{bkf})	2.57	2.39	2.87
Max Glide Depth (d_{maxg})	1.21	0	2.97	ft	Max Glide Depth/Mean Riffle Depth (d_{maxg} / d_{bkf})	0.92	0	2.27

Channel Materials

	Reach [b]	Riffle [c] (Protrusion)	Bar
% Silt/Clay	13	0	
% Sand	51	0	
% Gravel	25	43	
% Cobble	4	57	
% Boulder	0	0	
% Bedrock	7	0	

	Reach [b]	Riffle [c] (Protrusion)	Bar	Protrusion Height [d]	
D_{16}	0.1	31.06		0	mm
D_{35}	0.38	54.5		0	mm
D_{50}	0.71	72.67		0	mm
D_{84}	32	119.23		0	mm
D_{95}	Bedrock	156.89		0	mm
D_{100}	Bedrock	255.99		0	mm

[a] Min, max, mean depths are ave. mid-point values except pools: taken at deepest part of pool.

[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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