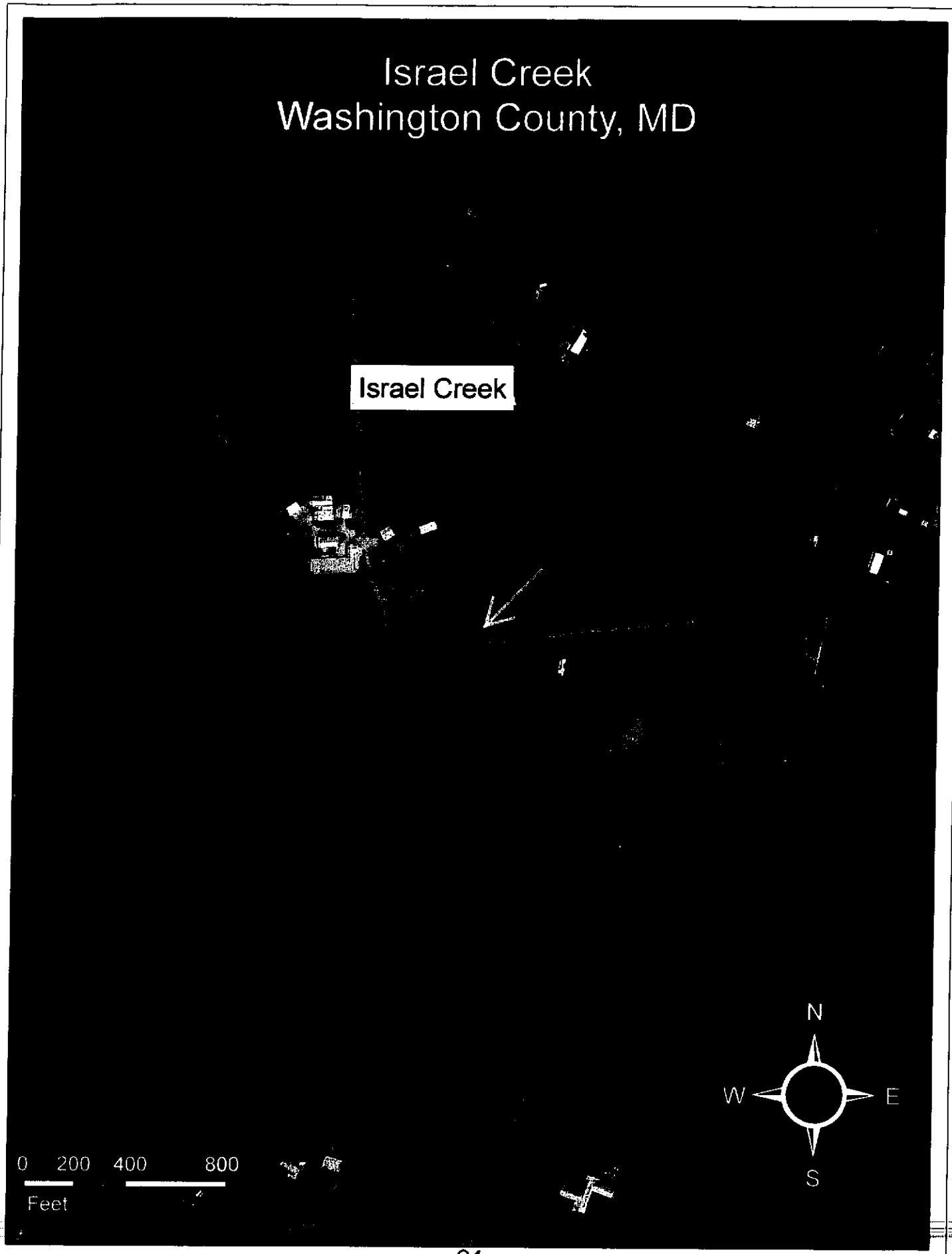
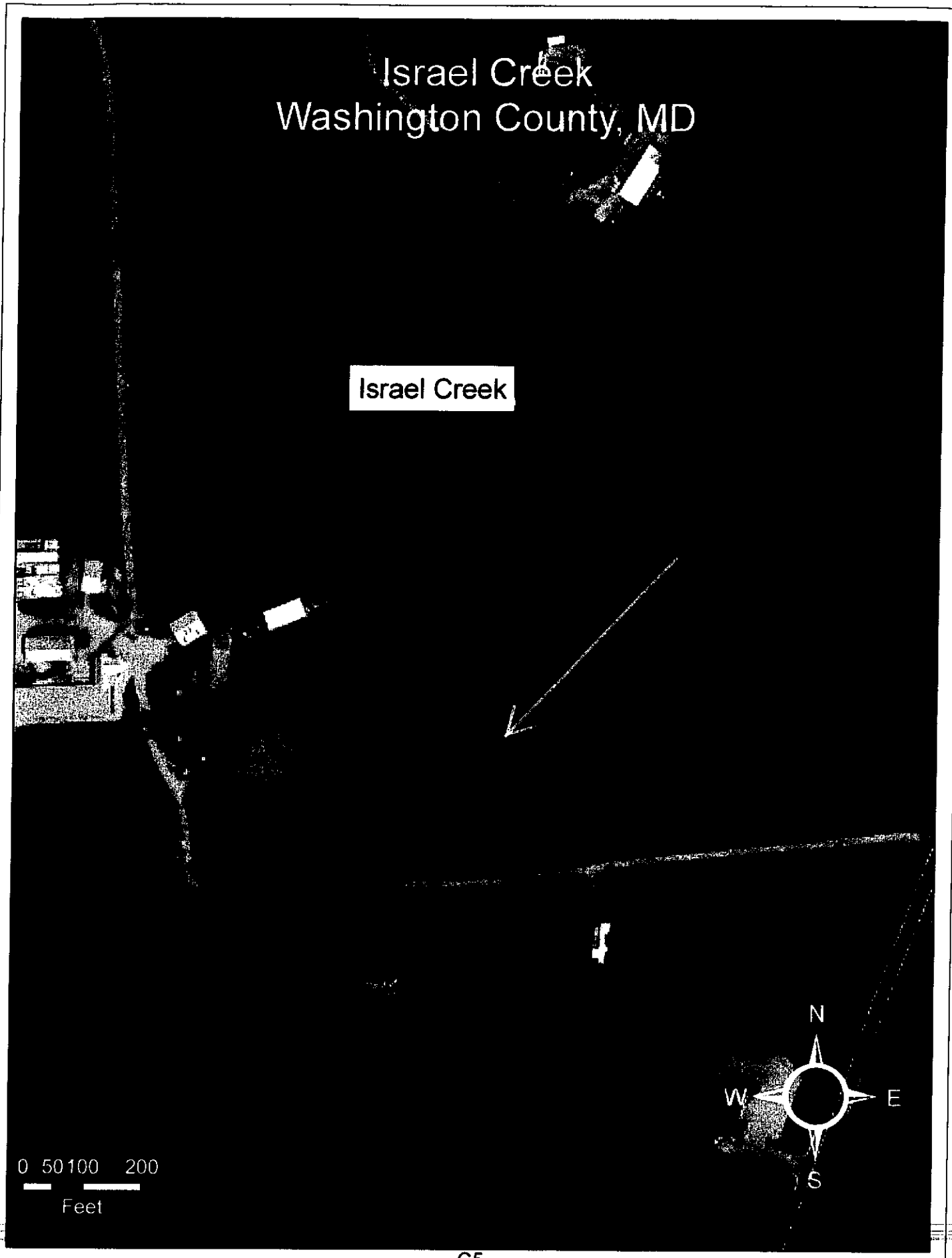
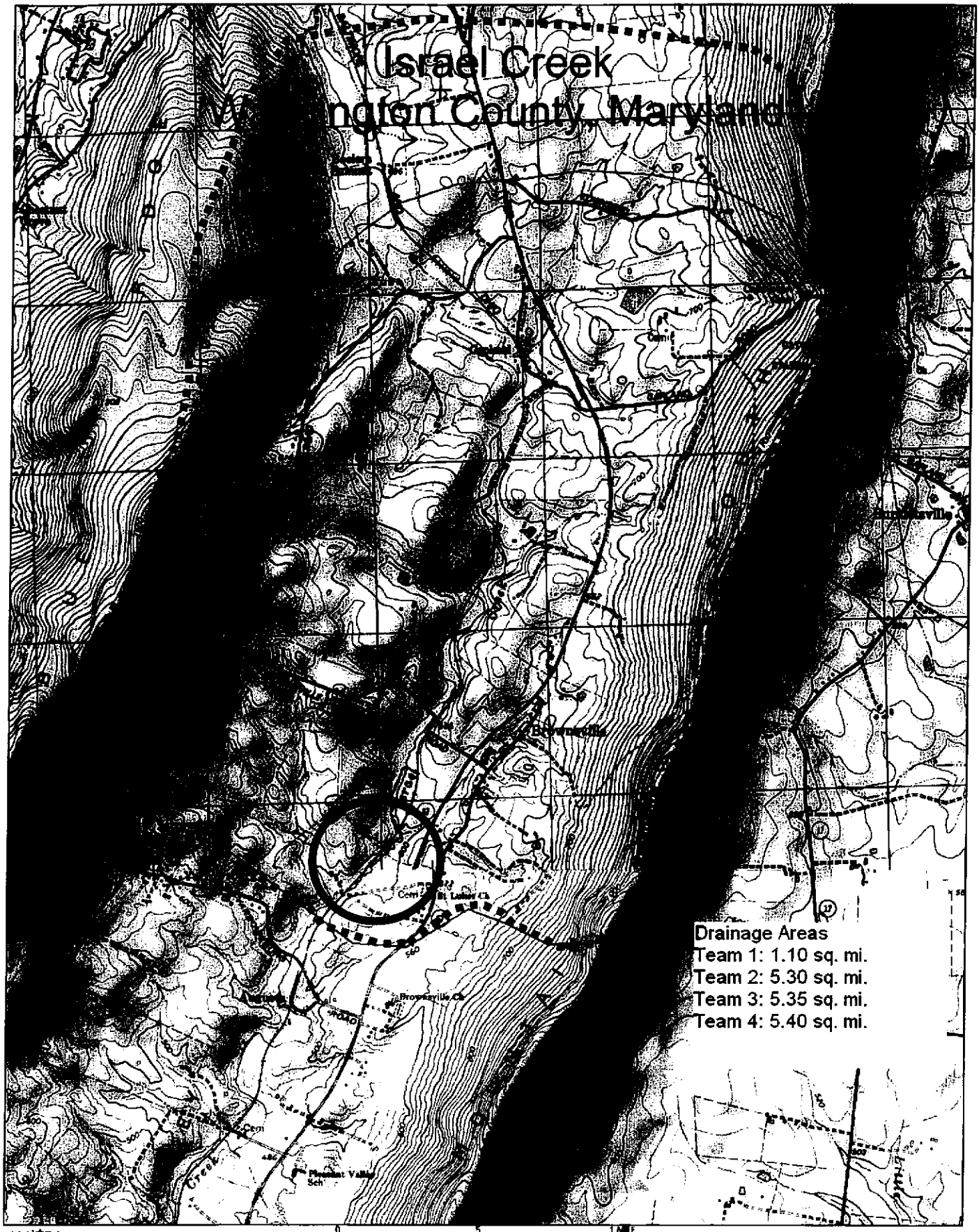

Israel Creek
Washington County, MD
Israel Creek
N
W
E
S
0 200 400 800
Feet


Israel Creek
Washington County, MD
Israel Creek
N
W
E
S
0 50100 200
Feet



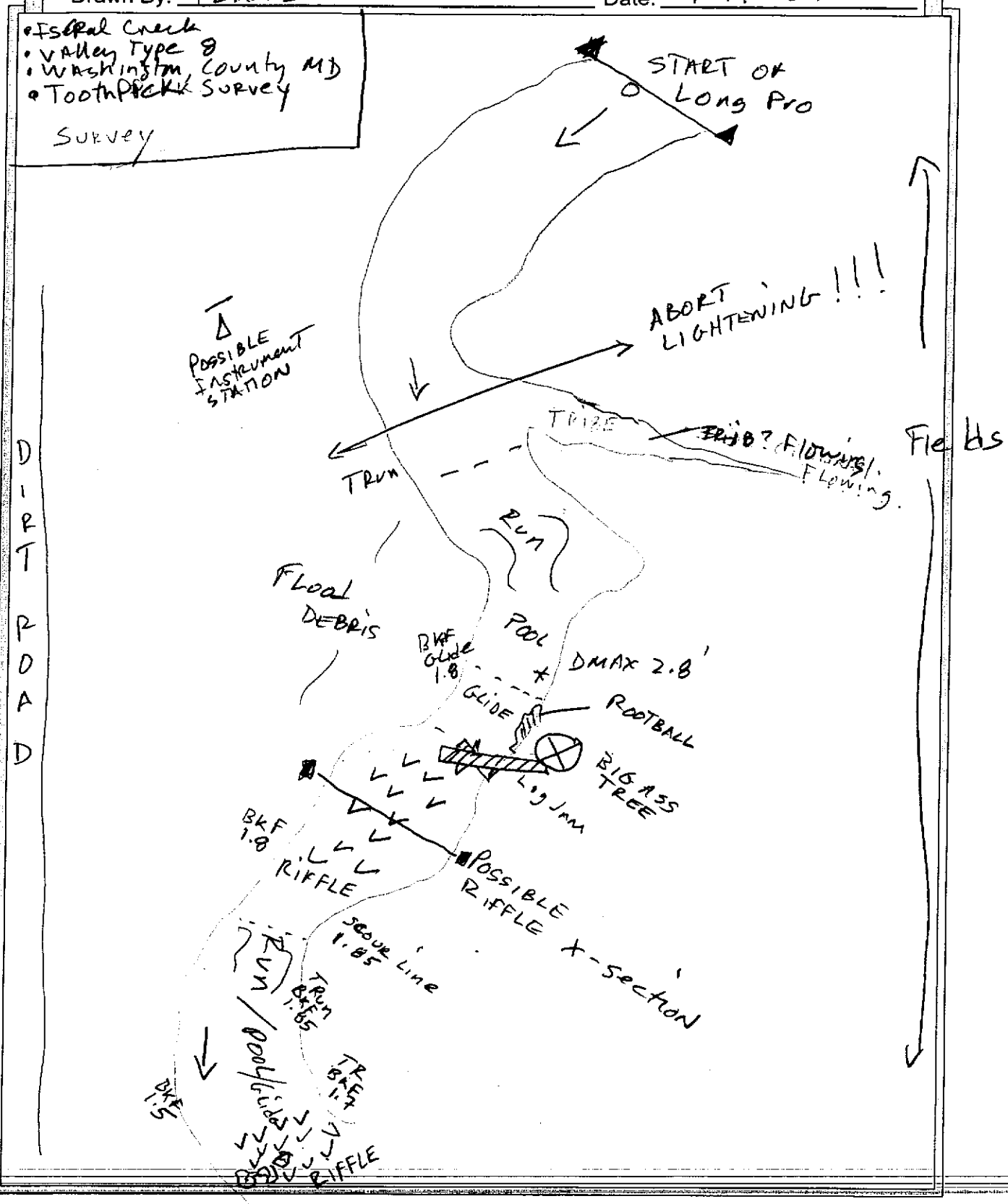
Map created with TOPO!® ©2002 National Geographic (www.nationalgeographic.com/topo)

ToothPick

AREA-SITE LOCATION....REACH MAP

Stream: Isabel Creek Reach: TEAM 3

Drawn By: TEAM 3 Date: 4-19-2011



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Team 2 -2006

Steven Begg Amy Hennessy
Erin Britton Russ Manley
Mark Eberle Dennis Mackey

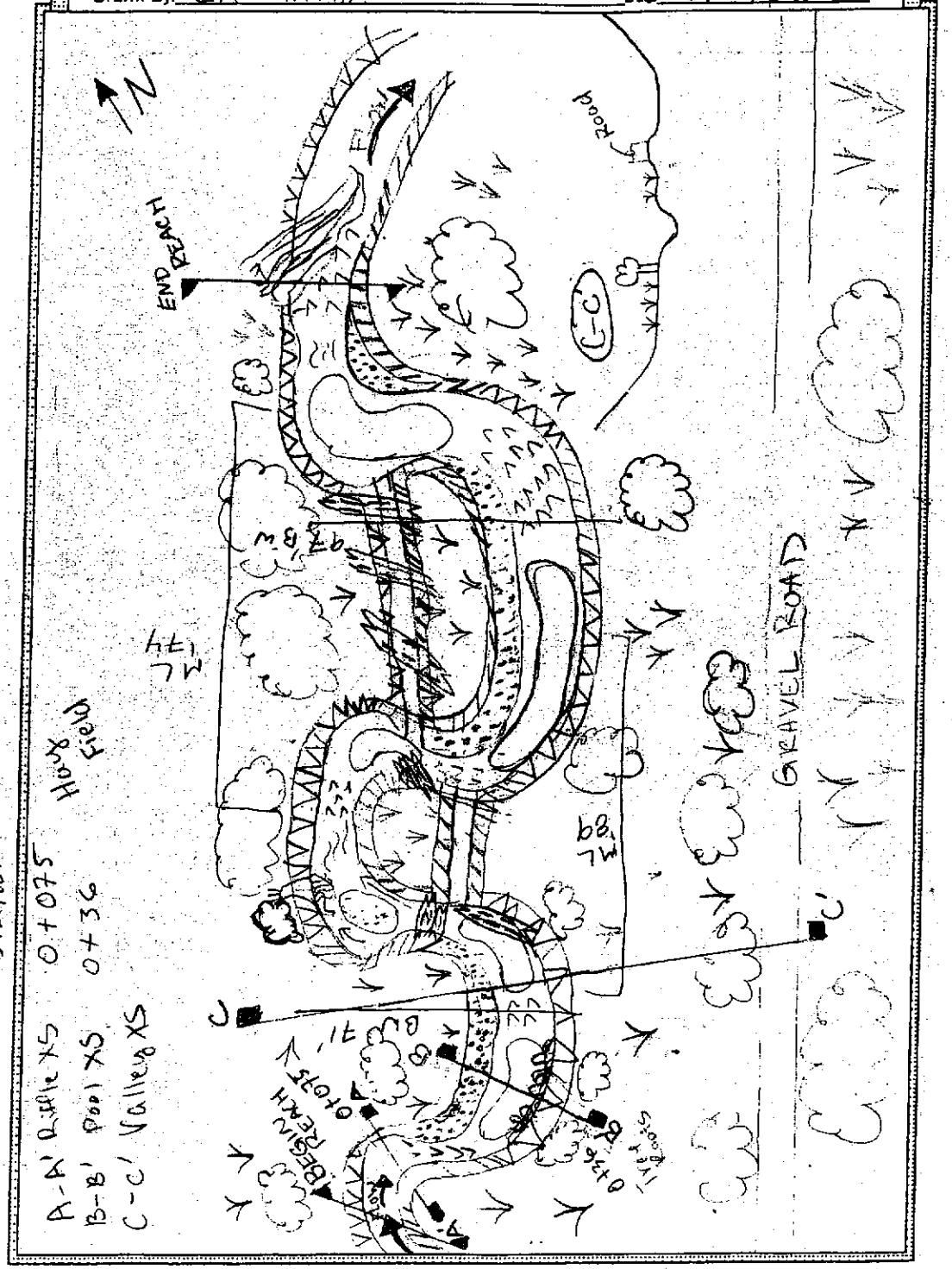
Team 3 - 2011

Richard Nelle Troy Smith
Molly Katz
Jessica Rhodes

AREA SITE LOCATION...REACH MAP

Stream/Drainage: Jerne Creek Site/Reach Approx. 600' downstream of road

Drawn By: Erin Britton Date 5/2/06



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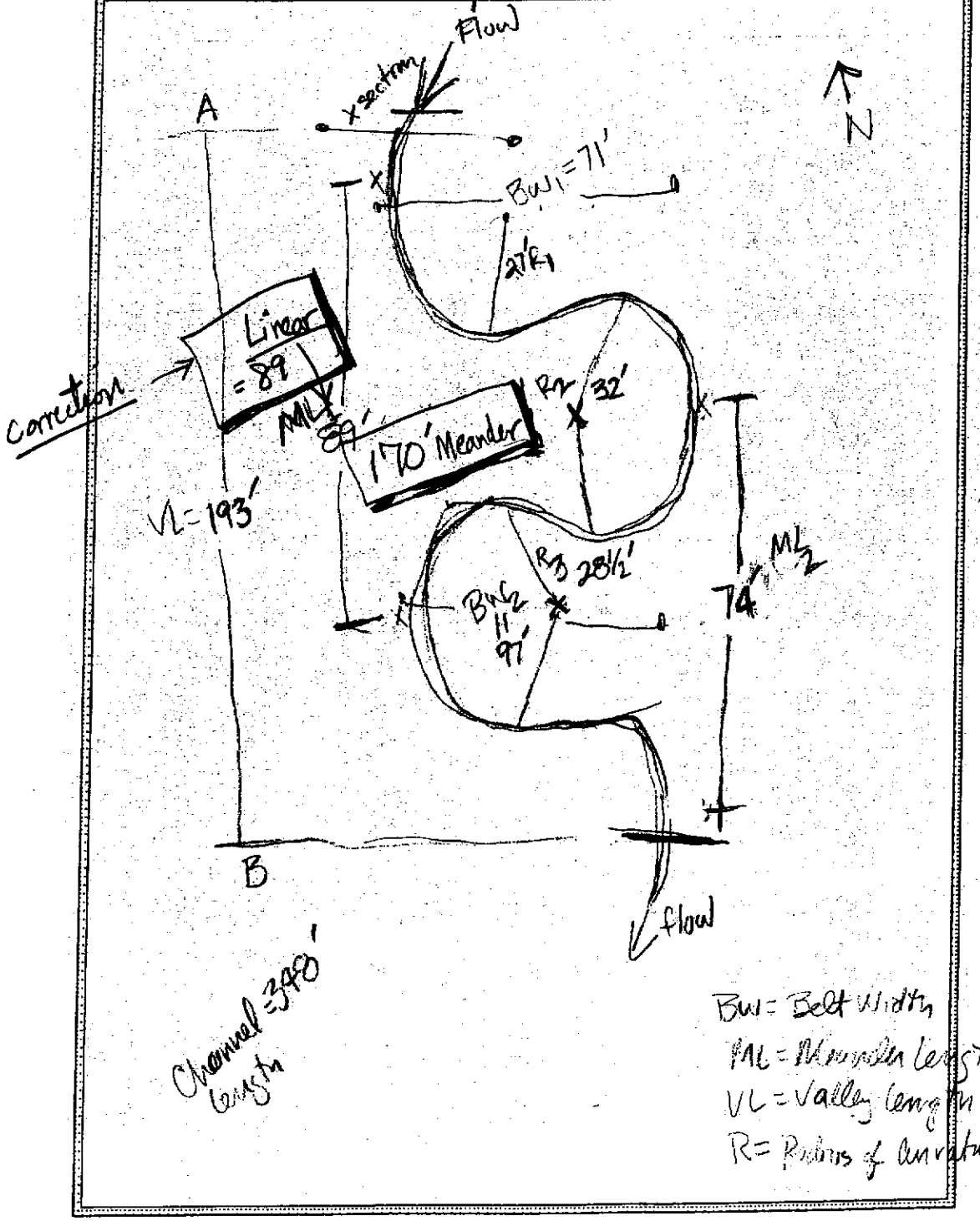
STREAM GEOMETRY Team 2-2006
Team 3: 2011

AREA-SITE LOCATION...REACH MAP

Stream/Drainage: Isreal Ck. Site/Reach #2

Drawn By: Dennis Mackay Date 5/2/06



Ratios

BW Ratio
3.7
5.1

R_2 Ratios
1.68
1.50

Meander WL
4.6

$\frac{348}{193} = 1.8$

BW = Belt Width
ML = Meander length
VL = Valley length
R = Radius of curvature

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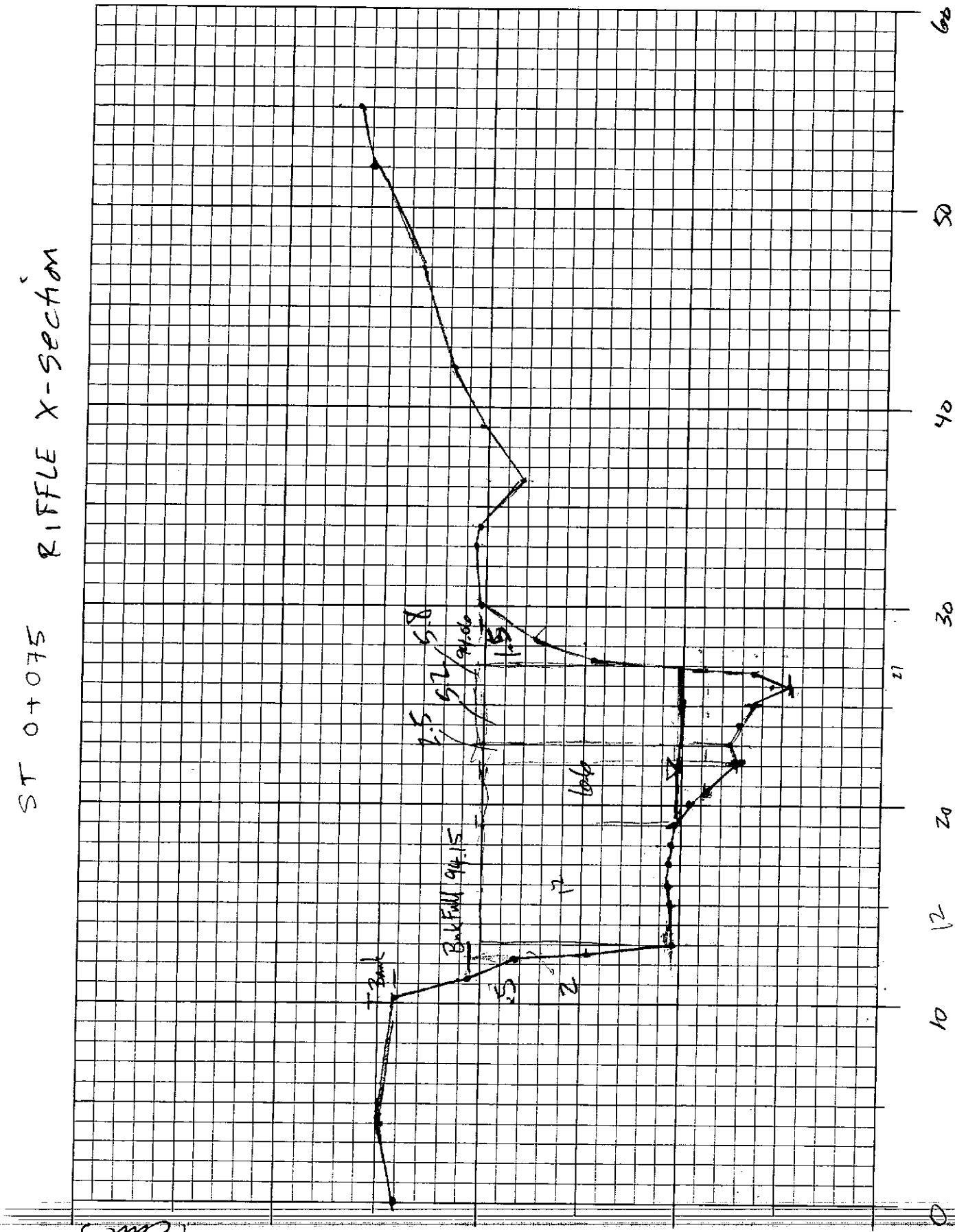

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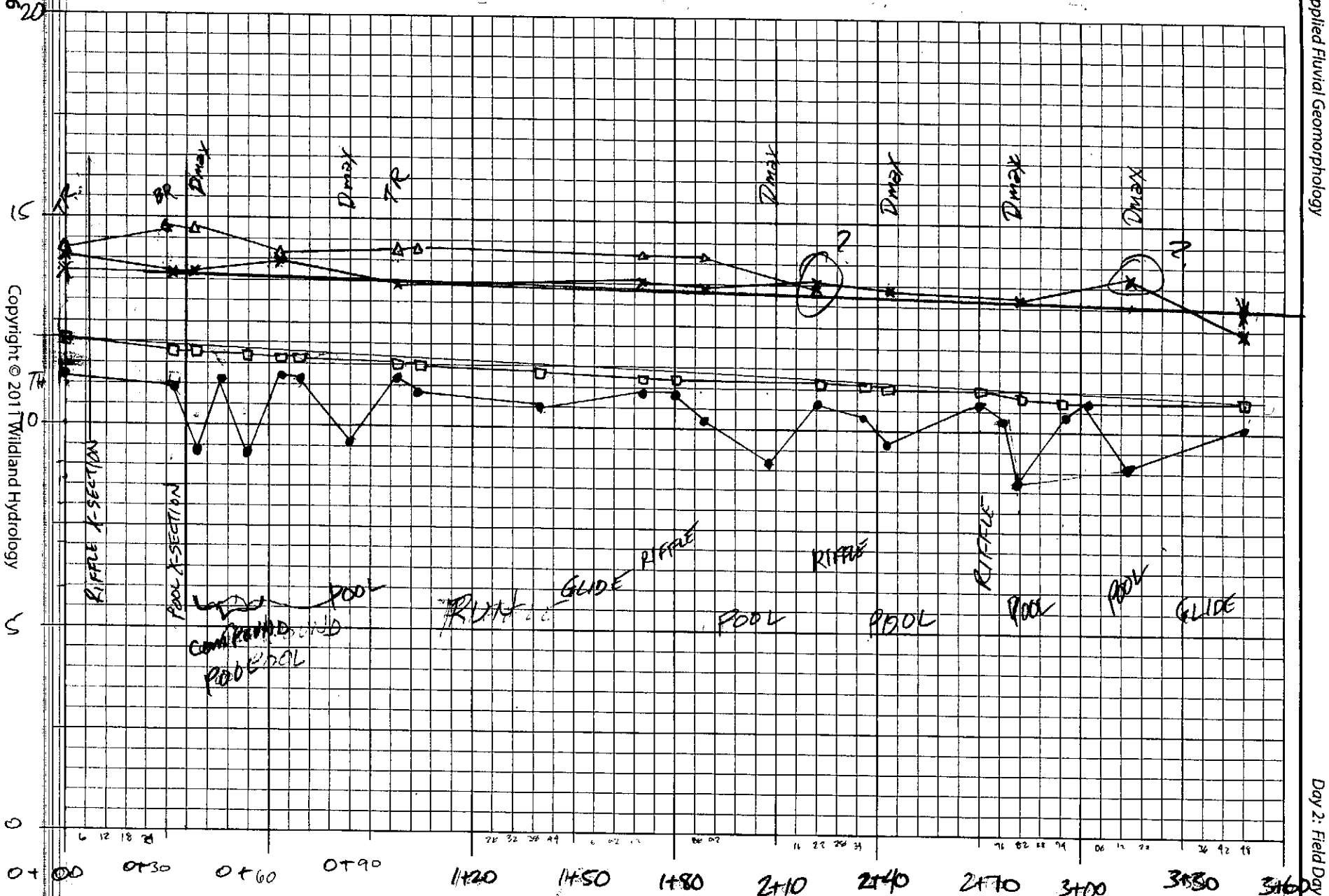
● = TH
□ = WS
x = BF
Δ = LB

ISRAELCREEK GROUP 3

TEAM 2 2006 DATA / TEAM 3 2011 ANALYSIS

LONGITUDINAL PROFILE



WATERSLOPE 0.0037

BANKFULL SLOPE 0.0034

STATION

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Team 3 - 2011

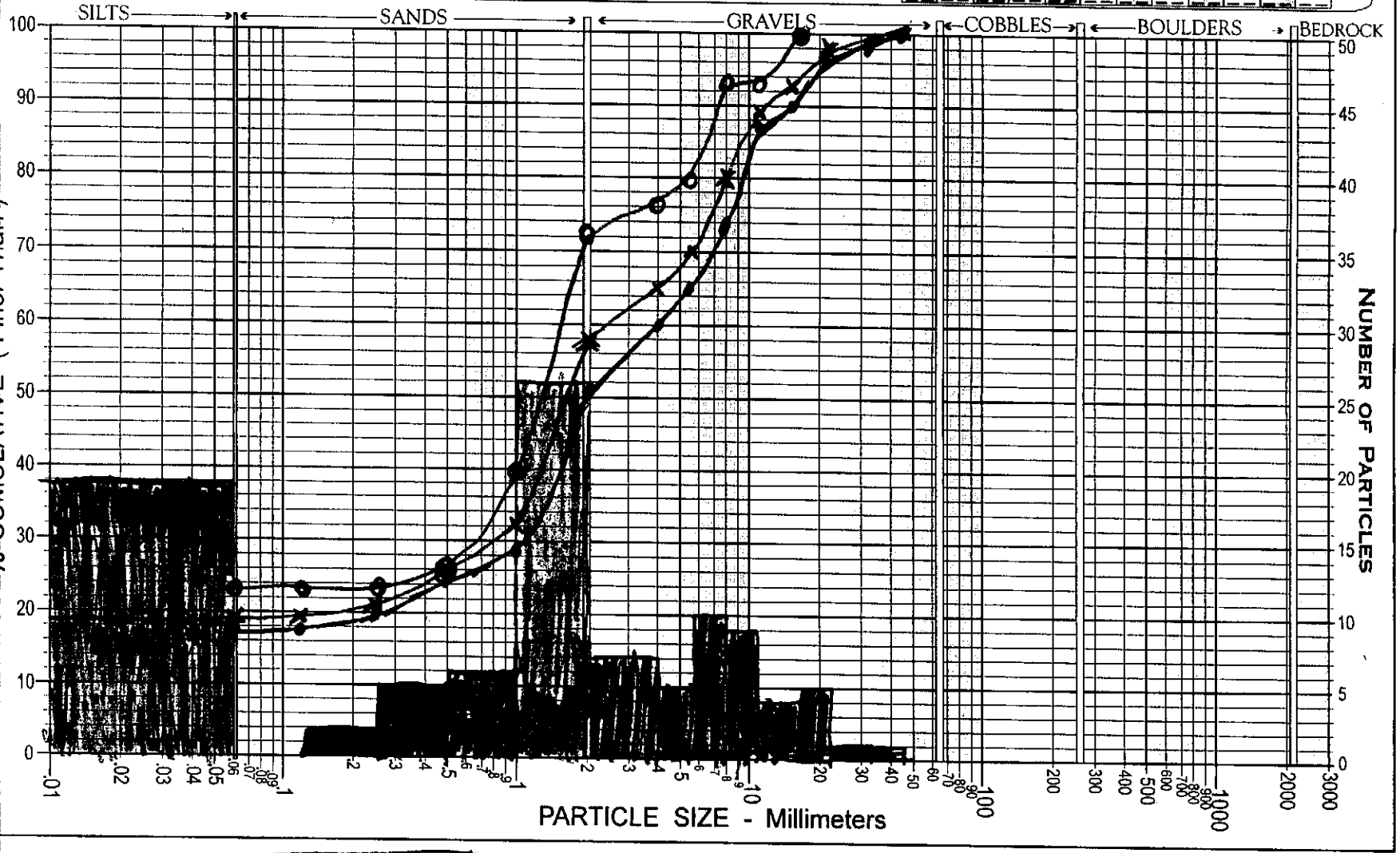
Representative Pebble Count Date Collected Team 3 2006

PEBBLE COUNT DATA

LOCATION: Israel Creek Date: April 19, 2011

REACH: PARTY: Team 3

Stream Type: B3 C5 Valley Type: VIII HUC:



X = composite
O = pool
● = riffle

D_{50} = 1.75mm composite

D_{84} = 9.00mm composite

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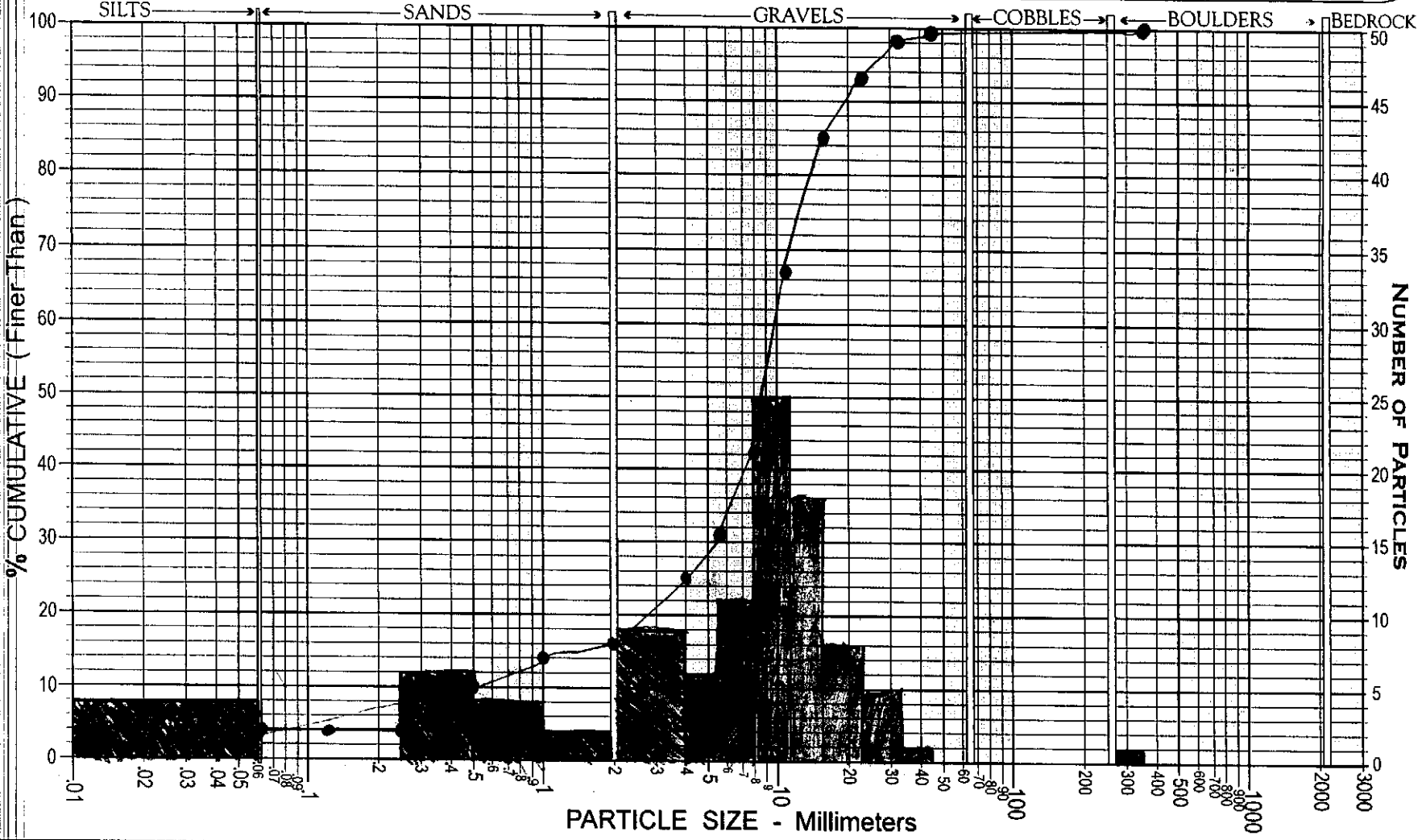
Active BED

Riffle Pebble Count Team 3

Team 3 - 2011
Team 2
Data Collected 2006

PEBBLE COUNT DATA

LOCATION: Israel Creek
REACH:
Stream Type:
PARTY: Team 3
Valley Type: VIII
HUC:
Date: April 19, 2011



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Team 2 - 2006 Team 3 - 2011 640 acre / 5.3 mi²

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

Stream:	Israel Creek
Basin:	Drainage Area: 3392 acres 5.30 mi²
Location:	Washington County Maryland
Twp.&Rge:	Sec.&Qtr.:
Cross-Section Monuments (Lat./Long.):	Date: 4/18/11
Observers:	Team 3 - 2011 & Team 2 - 2006 Valley Type: B

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	19.5 ft
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A_{bkf} / W_{bkf}$). 35.1 / 19 =	1.85 ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	35.1 ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	10.27 ft/ft
Maximum DEPTH (d_{max}) Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.	3.17 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.	~400 ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	21 ft/ft
Channel Materials (Particle Size Index) D_{50} The D_{50} particle size index represents the median or dominant diameter of channel materials, as sampled proportionately from the channel surface, between the bankfull stage and Thalweg elevations.	1.75 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.	0.0038 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 (S_{val} / S).	1.8

Stream Type E4 or 5 **See Classification Key (Figure A-2)**

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TEAM 2 - 2006 TEAM 3 - 2011 $W_p = 2$

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

Bankfull VELOCITY & DISCHARGE Estimates

Stream:	Israel Creek	Location:	Washington Co. MD
Date:		Stream Type:	E5
Valley Type:	VIII		
Observers:		HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	35.1	A_{bkf} (ft²)	Bankfull Riffle Mean DEPTH	1.85	d_{bkf} (ft)
Bankfull Riffle WIDTH	19	W_{bkf} (ft)	Wetted PERMIMETER ~ (2 * d_{bkf}) + W_{bkf}	22.7	W_p (ft)
D_{84} at Riffle	18	Dia. (mm)	D_{84} (mm) / 304.8	.059	D_{84} (ft)
Bankfull SLOPE	.0034 ~~.0001~~	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	1.54	R (ft)
Gravitational Acceleration	32.2	g (ft / sec²)	Relative Roughness R(ft) / D_{84} (ft) 1.54/.059	26.1	R / D_{84}
Drainage Area	5.30	DA (mi²)	Shear Velocity u* = (gRS)½	0.41	u* (ft/sec)

ESTIMATION METHODS				
1. Friction Factor / Relative Roughness $u = [2.83 + 5.66 * Log\{R/D_{84}\}]\,u^*$ 1.54/.059 0.41	4.45	ft / sec	156	cfs
2. Roughness Coefficient: a) Manning's *n* from Friction Factor / Relative Roughness (Figs. ~~A-27, A-28~~ 64, 65) $u = 1.49*R^{2/3}*S^{1/2}/n$ $n =$ 0.027	4.3	ft / sec	151	cfs
2. Roughness Coefficient: b) Manning's *n* from Stream Type ~~(Fig. A-30)~~ B-54 $u = 1.49*R^{2/3}*S^{1/2}/n$ $n =$ .054	2.1	ft / sec	74	cfs
~~2.~~ Roughness Coefficient: c) Manning's *n* from Jarrett (USGS): $u = 1.49*R^{2/3}*S^{1/2}/n$ $n = 0.39*S^{0.38}*R^{-0.16}$ $n =$ N/A. 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	—	ft / sec	—	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.)	—	ft / sec	—	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 Q = 164 year	4.67	ft / sec	164	cfs
4. Continuity Equations: b) USGS Gage Data $u = Q / A$	no gage	ft / sec	no gage	cfs

B53 B54 N/A E5 B47

$\frac{u}{u^*} = \frac{4.45}{0.41} = 10.85$

Protrusion Height Options for the D_{84} Term in the Relative Roughness Relation (R/D_{84}) – Estimation Method 1

Option 1.	For **sand-bed** channels: Measure 100 **"protrusion heights"** of sand dunes from the downstream side of feature to the top of feature. Substitute the D_{84} sand dune protrusion height in ft for the D_{84} term in method 1.
Option 2.	For **boulder-dominated** channels: Measure 100 **"protrusion heights"** of boulders on the sides from the bed elevation to the top of the rock on that side. Substitute the D_{84} boulder protrusion height in ft for the D_{84} term in method 1.
Option 3.	For **bedrock-dominated** channels: Measure 100 **"protrusion heights"** of rock separations, steps, joints or uplifted surfaces above channel bed elevation. Substitute the D_{84} bedrock protrusion height in ft for the D_{84} term in method 1.
Option 4.	For **log-influenced** channels: Measure **"protrustion heights"** proportionate to channel width of log diameters or the height of the log on upstream side if embedded. Substitute the D_{84} protrusion height in ft for the D_{84} term in method 1.

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Team 2 - 2006 TEAM 3 - 2011

Worksheet A-3. Summary of Morphological Variables.

Stream: Israel Creek Location: Washington County, Maryland

Team: Team 3'11 - Date: 4/18/11 Drainage Area: 5.30 mi²

Riffle Channel Dimensions			
1. Bankfull Width (W_{bkf}) (ft)	19	2. Bankfull Mean Depth (d_{bkf}) (ft)	1.85
3. Width/Depth Ratio (W_{bkf} / d_{bkf}) 19 / 1.85	10.27	4. Bankfull Cross-Sectional Area (A_{bkf}) (ft^2)	35.1
5. Bankfull Maximum Depth (d_{max}) (ft)	3.17	6. Width of Flood-Prone Area (W_{fpa}) (ft)	≈400
7. Entrenchment Ratio (ER) (W_{fpa} / W_{bkf})	21		

Channel Pattern			**Dimensionless Ratios**		
8. Belt Width (W_{blt}) (ft)	Mean	84	9. Meander Width Ratio (MWR) (W_{blt} / W_{bkf})	Mean	4.4
	Min	71		Min	3.7
	Max	97		Max	5.1
10. Stream Meander Length (L_m) (ft)	Mean	170	11. Meander Length Ratio (MLR) (L_m / W_{bkf})	Mean	8.9
	Min			Min	—
	Max			Max	—
12. Linear Wavelength (λ) (ft)	Mean	81.5	13. Linear Wavelength to Bankfull Width (λ / W_{bkf})	Mean	4.2
	Min	74		Min	3.9
	Max	89		Max	4.6
14. Radius of Curvature (R_c) (ft)	Mean	30.25	15. Radius of Curvature to Bankfull Width (R_c / W_{bkf})	Mean	1.6
	Min	28.5		Min	1.5
	Max	32.0		Max	1.7

not measured in field

Channel Particles					
Representative Pebble Count					
16. D_{16} (mm)	2.062	17. D_{35} (mm)	1.20	18. D_{50} (mm)	1.75
19. D_{84} (mm)	9.0	20. D_{95} (mm)	18	21. D_{100} (mm)	45
Active Bed Riffle Pebble Count					
22. D_{16} (mm)	2.2	23. D_{35} (mm)	6.25	24. D_{50} (mm)	8.5
25. D_{84} (mm)	18	26. D_{95} (mm)	25	27. D_{100} (mm)	362

Classification			
28. Sinuosity (k)	1.8	29. Average Water Surface Slope (S)	.0038
30. Stream Type	E4-5	31. Valley Type	8

Velocity & Discharge			
32. Friction Factor (u / u*)	10.85	33. Relative Roughness (R / D_{84})	26.1
34. Manning's "n" from Friction Factor / Relative Roughness	0.027	35. Manning's "n" from Stream Type	0.054
36. Estimated Mean Velocity (u_{bkf}) (ft/sec)	4.45	37. Estimated Bankfull Discharge (cfs)	156
38. Estimation Method Selected for Velocity & Discharge			

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0+07.50

Team 3 - 2016
Team 2 - 2006

Benchmark = 100

est. 42 sq.ft (cross sectional area)

s

THE REFERENCE REACH FIELD BOOK

SURVEY DATA ⟹ CROSS - SECTION Part I

SITE: Israel Creek Date: 5/2/06

Location: Maryland

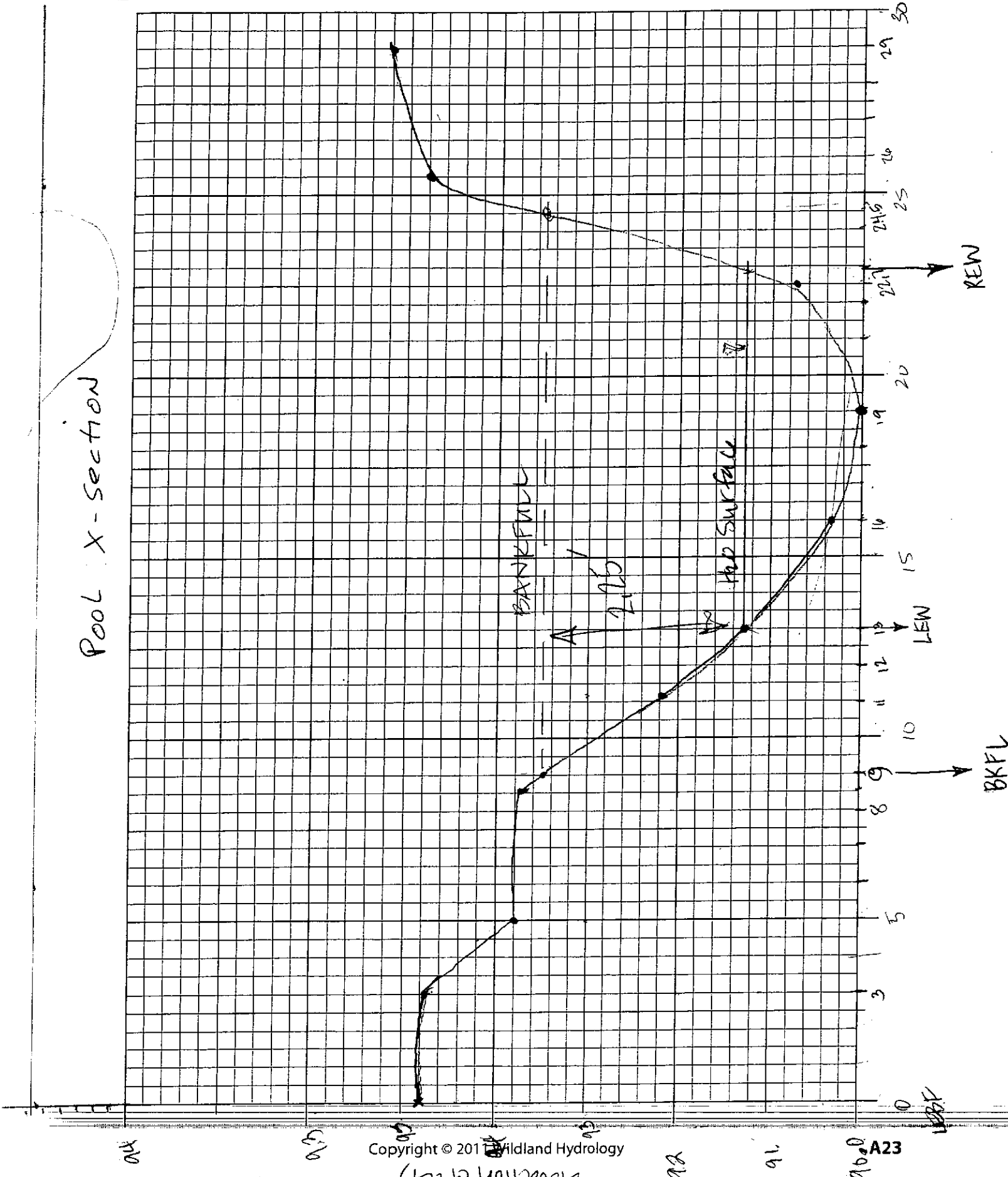
Party / Notes: Cross Section - riffle furthest upstream of our reach

Item	Distance; Point; or Riffle STATION Ft	Back-Sight BS Ft	Height of Instrument HI Ft	Change Sight Fore-Sight FS Ft.	Height; Depth; or Elevation Ft.	NOTES COMMENT REMARKS
1	0			5.20	94.8	start (left bank)
2	4			5.05	94.95	
3	10.3			5.19	94.81	Top of bank.
4	11.1			5.85	94.15	bankfull?
5	12.1			6.38	93.62	slope break
6	12.7			7.05	92.95	slope break
7	13.5			7.96	92.04	Toe of bank (gully) (LEW)
8	15.0			7.89	92.11	start of point bar
9	16.0			7.83	92.17	point bar
10	17.0			7.85	92.15	point bar
11	18.0			7.90	92.10	point bar
12	19.0			7.97	92.03	point bar
13	20.0			8.05	91.95	point bar
14	20.9			8.21	91.79	water
15	22			8.36	91.64	depth 0.22
16	23			8.42	91.58	water
17	24			8.57	91.43	water
18	25			8.67	91.33	thalweg
19	26			9.06	90.94	water (max depth)
20	26.6			8.68	91.32	Toe of bank (right bank)
21	26.9			8.16	91.84	REW
22	27.2			7.06	92.94	slope break (inner berm)
23	28.1			6.49	93.51	slope break
24	30.1			5.94	94.06	bankfull?
25	33.0			5.84	94.16	top of bank
26	34.0			5.94	94.06	top of gully
27	36.2			6.33	93.67	gully
28	39.0			5.94	94.06	top of gully
29	42.0			5.61	94.39	
30	47			6.27	93.73	gully
31	52			4.81	95.19	
32	55			4.64	95.36	edge of road
33						
34	≈400 ft	floodprone width				
35						

94.11
~~94.15~~
~~91.33~~ 90.94

3.

← BKF



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Team 2 2006
Team 3 2014

POOL

THE REFERENCE REACH FIELD BOOK 9

SURVEY DATA ⟹ CROSS - SECTION Part II

SITE: Israel Creek Channel + POOL Date: 5/2/06

POO Item	STATION Ft	BS Ft	HI Ft	FS Ft	Elevation Ft	NOTES COMMENT REMARKS
36	0			5.18	94.82	start (left bank)
37	3.0			5.24	94.76	Top of Bank
38	5.0			6.20	93.80	
39	8.6			6.22	93.78	
40	9.0			6.50	93.50	Bankfull
41	11.2			7.82	92.18	
42	13.0			8.75	91.25	LEW
43	13.0			8.75	91.25	water surface
44	16.0			9.63	90.37	water
45	19.0			9.91	90.09	water
46	22.7			9.23	90.77	Edge of bank
47	25.5			5.32	94.68	Top of bank
48	29.0			4.92	95.18	End
49						
50						
51						
52						
53						
54						
55						
56						
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71						
72						
73						
74						

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SURVEY DATA ⟹ **LONGITUDINAL PROFILE** Part I

SITE: Israel Creek - Camp 2 Date:

Location:

Party / Notes: WS BF TOB WS-BF EL DIFF

Item	Distance; Point; or STATION Ft	TW Back-Sight Ft	Height of Instrument HI Ft	Fore-Sight Ft	Height; Depth; or Elevation Ft	REMARKS / COMMENT / NOTES
TR 1	0+00	8.55	7.96	5.88	5.79	2.08 → BF 2.17 = Diff
BR 2	0+32	9.06	8.30	6.38	5.11	1.92
DMax 3	0+36	10.08	8.30	6.16	5.19	2.14 (Pool X-section)
Pool 4	0+46	8.61				
Pool 5	0+55	10.16	8.34			
TR 6	0+62	8.79	8.37	5.91	5.54	2.46
BR 7	0+65	8.87	8.34			Debris Jam caused negative slope
DMax 8	0+84	10.48				
TR 9	0+98	8.88	8.52	6.54	5.74	Debris
BR 10	01+11	9.22	8.55		5.66	BF - under table
TR 11	01+71	9.23	8.80	6.48	5.72	2.32
BR 12	01+80	9.17	8.80			
TP 13	01+90	9.88	8.80	6.54	5.78	
DMax 14	02+06	10.62				→ BF
TR 15	02+23	9.44	8.82		6.67	2.15
BR 16	02+36	9.65	8.70	6.69	Probably BF	2.21
DMax 17	2+48	10.45	8.91			
TR 18	2+70	9.39	9.00	6.27	Probably BF =	2.73
BR 19	2+77	9.75	9.09	⇓	⇓	
DMax 20	2+80	11.39				
TR 21	2+95	9.55	9.15			
BR 22	3+01	9.64	9.19			
DMax 23	3+13	10.9				
TR 24	3+48	9.99	9.88	7.08	⇒ Same	2.8
EoR 25	1+39	9.50	8.67			DMax Pool
26						
27	0+07.5					(Riffle X-section)
28						
29						
30						
31						
32						
33						
34						
35						

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Team 2 - 2006
Team 3 - 2011

SURVEY DATA ⟶ LONGITUDINAL PROFILE 1

SITE: Date:

Location:

Party / Notes: HUC:

		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
TR	1	0+00				11.45		12.04		14.12		14.21	
BR	2	0+32				10.94		11.70		~~13.82~~	1.92	14.89	
DMax	3	0+36				9.92		11.70		13.84	2.14	14.81	
C Pool	4	0+46				11.39							
Pool	5	0+55				9.84		11.66					
TR	6	0+62				11.21		11.63		14.09	2.46	14.46	
BR	7	0+65				11.13		11.66					
DMax	8	0+84				9.52							
TR	9	0+98				11.92		~~11.48~~		13.46	1.98	14.26	
BR	10	~~01+11~~				10.78		11.45				14.34	
	11	~~01+39~~				10.50		~~11.20~~	11.33				
TR	12	01+71				10.77		~~11.20~~	11.20	13.52	2.32	14.~~8~~	
BR	13	01+80				10.83		~~11.20~~	11.20				
TP	14	01+90				10.12		11.20		13.46	2.26	14.22	
DMax	15	02+06				9.38		~~11.18~~					
TR	16	02+23				10.56		~~11.10~~	11.18			13.33 → Probably BF	
BR	17	02+36				10.35		~~11.09~~	11.10	13.31			
DMax	18	02+~~42~~				9.55		~~11.00~~	11.09				
TR	19	02+~~70~~				10.61		~~10.91~~	11.00	~~13.73~~			
BR	20	02+77				10.25		—	10.91	13.73	2.4		
DMax	21	02+80				8.61		10.85					
TR	22	02+95				10.45		~~10.82~~	10.85				
BR	23	3+01				10.36		—	10.82				
DMax	24	3+13				9.1		~~10.72~~					
TR	25	3+~~48~~				10.01		10.72		12.92	2.20		
	26												
	27												

12.04
10.72
1.32 ft
1 rise
348 ft

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Water slope = 0.00379

Team 2 - 2006

Team 3 April 19 2011

Representative Reach Pebble Count

Site: Israel Creek Date:

Location: Washington Co MN HUC:

Party:

Inches	PARTICLE	Millimeters		Dot Count for RIFFLE	POOL (2)	COMP. (3)	RIFFLE (1) TOT #	RIFFLE (1) ITEM %	RIFFLE (1) % CUM	POOL (2) TOT #	POOL (2) ITEM %	POOL (2) % CUM	COMPOSITE (3) TOT #	COMPOSITE (3) ITEM %	COMPOSITE (3) % CUM
	Silt / Clay	< .062	S/C				12	17.1	17.1	7	23.3	23.3	19	19	19
	Very Fine	.062 - .125	SAND				0	0	17.1	0	0	23.3	0	0	19
	Fine	.125 - .25	SAND				2	2.9	20.0	0	0	23.3	2	2	21
	Medium	.25 - .50	SAND				4	5.7	25.7	1	3.3	26.6	5	5	26
	Coarse	.50 - 1.0	SAND				2	2.9	28.6	4	13.3	39.9	6	6	32
.04 - .08	Very Coarse	1.0 - 2	SAND				16	22.9	51.5	10	33.3	73.2	26	26	58
.08 - .16	Very Fine	2 - 4	GRAVEL				6	8.6	60.1	1	3.3	76.5	7	7	65
.16 - .22	Fine	4 - 5.7	GRAVEL				4	5.7	65.8	1	3.3	79.8	5	5	70
.22 - .31	Fine	5.7 - 8	GRAVEL				6	8.6	74.4	4	13.3	93.1	10	10	80
.31 - .44	Medium	8 - 11.3	GRAVEL				9	12.9	87.3	0	0	93.1	9	9	89
.44 - .63	Medium	11.3 - 16	GRAVEL				2	2.9	90.2	2	6.6	99.7	4	4	93
.63 - .89	Coarse	16 - 22.6	GRAVEL				5	7.1	97.3	0			5	5	98
.89 - 1.3	Coarse	22.6 - 32	GRAVEL				1	1.4	98.7	0			1	1	99
1.3 - 1.8	Very Coarse	32 - 45	GRAVEL				1	1.4	100.1	0			1	1	100
1.8 - 2.5	Very Coarse	45 - 64	GRAVEL				0			0			0	0	
2.5 - 3.5	Small	64 - 90	COBBLE				0			0					
3.5 - 5.0	Small	90 - 128	COBBLE				0			0					
5.0 - 7.1	Large	128 - 180	COBBLE				0			0					
7.1 - 10.1	Large	180 - 256	COBBLE				0			0					
10.1 - 14.3	Small	256 - 362	BOULDER				0			0					
14.3 - 20	Small	362 - 512	BOULDER				0			0					
20 - 40	Medium	512 - 1024	BOULDER				0			0					
40 - 80	Large-Vry Large	1024 - 2048	BOULDER				0			0					
	Bedrock		BDRK												
TOTAL→							70			30			100		

Stream Type: **Valley Type:**

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Riffle Pebble Count

Team 3 - 2011
Team 2 - 2006

Site: Date:

Location: HUC:

Party:

Inches	PARTICLE	Millimeters		Dot Count for RIFFLE 1	POOL 2	COMP. 3	RIFFLE (1) TOT #	RIFFLE (1) ITEM %	RIFFLE (1) % CUM	POOL (2) TOT #	POOL (2) ITEM %	POOL (2) % CUM	COMPOSITE (3) TOT #	COMPOSITE (3) ITEM %	COMPOSITE (3) % CUM
							Reach:			Reach:			Reach:		
							Date:			Date:			Date:		
	Silt / Clay	< .062	S/C	::			4		4						
	Very Fine	.062 - .125	SAND				0		4						
	Fine	.125 - .25					0		4						
	Medium	.25 - .50		:T			6		10						
	Coarse	.50 - 1.0		::			4		14						
.04 - .08	Very Coarse	1.0 - 2		:			2		16						
.08 - .16	Very Fine	2 - 4	GRAVEL	⊠			9		25						
.16 - .22	Fine	4 - 5.7		:T			6		31						
.22 - .31	Fine	5.7 - 8		⊠ .			11		42						
.31 - .44	Medium	8 - 11.3		⊠ ⊠ ::			25		67						
.44 - .63	Medium	11.3 - 16		⊠ □			18		85						
.63 - .89	Coarse	16 - 22.6		⊡			8		93						
.89 - 1.3	Coarse	22.6 - 32		::			5		98						
1.3 - 1.8	Very Coarse	32 - 45		.			1		99						
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	.			1		100						
14.3 - 20	Small	362 - 512													
20 - 40	Medium	512 - 1024													
40 - 80	Large-Vry Large	1024 - 2048													
	Bedrock		BDRK												
Stream Type:			**Valley Type:**			TOTAL →	100		100						

$D_{84} = 18$

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