DOCUMENT #GB-1093

P-10855

FINAL REPORT

Dead River Recovery Post-Event Additional Environmental Assessment: Survey of Morphological Stream Parameters Using Rosgen Method

Marquette County, Michigan

April 2005

Part 3 of 3

Prepared by:

BUCK
ENGINEERING

1347 Harding Place
Suite 100
Charlotte, NC 28204
Phone: 704.334.4454
FAX: 704.334.4482
www.buckengineering.com

Under Contract to:

Upper Peninsula Power Company

UPPCO

Appendix 7

Reference Reach Data and Deliverables

Task 1.2.1 from original Work Plan
(reference Section 2.2.1 from Report)

Reference ID, Survey, and Analysis

PM: Sam D. Ch

Date: 12/14/2004

QA/QC: S. Paige Baker

Date: 12/14/2004

Initials	Work Item
SRB	Perform a minimum of three (3) reference reach surveys. List reach names below:

Site #1: **Peshekee River**

Site #2: **Perch River**

Site #3: **Clark Creek**

Site #4 (optional): **Harlow Creek**

Site #5 (optional): _____

Site #6 (optional): _____

Peshekee River

Initials	Work Item
AB	Collect the following data at a minimum for each reference reach.

Reach ID: **Peshekee River**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 20 times bankfull width
- ☑ Survey a minimum of two (2) cross-sections (one each at a riffle and pool)
- ☑ Measure plan form features:
  - ☑ Sinuosity
  - ☑ Meander length
  - ☑ Radius of curvature
  - ☑ Belt width
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sample pavement/sub-pavement per Rosgen, 1996
- ☑ Sketch site per Harrelson et al., 1994
- ☑ Photograph site

Initials	Work Item
SPB	Provide the following items for each reference reach in electronic and hard copy format.

Reach ID: **Peshekee River**

- ☑ Morphological Data Table
- ☑ Plot of longitudinal profile
- ☑ Plot of cross-sections
- ☑ Grain size distribution
  - ☑ Bed material
  - ☑ Pavement/sub-pavement material
- ☑ Site sketch
- ☑ Photographs and photo log
- ☑ GIS data layer depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)

Initials	Work Item
SB	Collect the following data at a minimum for each LUC reach.

Reach ID: **Peshekee (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☑ Photograph site.

Initials	Work Item
SMB	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Peshekee (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☑ Limited Use Curves
  - ☑ DA versus Wbkf
  - ☑ DA versus Dbkf
  - ☑ DA versus CSA
  - ☑ DA versus Qbkf
- ☑ Plot of longitudinal profile
- ☑ Plot of cross-section
- ☑ Grain size distribution for bed material
- ☑ Site sketch
- ☑ Photographs and photo log.
- ☑ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)
- n/a ☐ Calculations (single section analysis)
- n/a ☐ Plot of Single Section Analysis versus Regression Equation

> gauge data available

MORPHOLOGICAL CHARACTERISTICS OF THE REFERENCE CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

Assessment Site (Name of stream and location) Peshekee River
Marquette County, MI

	Variables	Existing Channel		
1	Stream Type		Bc3	
2	Drainage Area, mi2		66.50	
3	Bankfull Width, ft (Wbkf)	Mean	59.4	
		Range	57.8	61
4	Bankfull Mean Depth, ft (dbkf)	Mean	2.87	
		Range	2.56	3.17
5	Width/Depth Ratio (Wbkf/dbkf)	Mean	21.0	
		Range	18.23	23.83
6	Bankfull Cross-Sectional Area, ft2 (Abkf)	Mean	169.6	
		Range	156.2	183
7	Bankfull Mean Velocity, ft/s (Ubkf)	Mean	5.7	
		Range	5.2	6.1
8	Bankfull Discharge, ft3/s (Qbkf)		955	
9	Bankfull Maximum Depth, ft (dmbkf)	Mean	4.3	
		Range	4.05	4.61
10	Max Riffle Depth/Mean Riffle Depth (dmbkf/dbkf)	Mean	1.5	
		Range	1.5	1.6
11	Low Bank Height to Max Riffle Depth (LBH/dmbkf)	Mean	1.5	
		Range	1.2	2.7
12	Width of Floodprone Area, ft (Wfpa)	Mean	99.8	
		Range	86.5	113.2
13	Entrenchment Ratio (Wfpa/Wbkf)	Mean	1.5	
		Range	1.2	1.9
14	Meander Length, ft (Lm)	Mean	348	
		Range	100	400
15	Meander Length Ratio, (Lm/Wbkf)	Mean	4.33	
		Range	1.73	6.92
16	Radius of Curvature, ft (Rc)	Mean	95	
		Range	78	112
17	Ratio of Radius of Curvature to Bankfull Width (Rc/Wbkf)	Mean	1.54	
		Range	1.35	1.72
18	Belt Width, ft (Wblt)	Mean	252	
		Range	252	252
19	Meander Width Ratio (Wblt/Wbkf)	Mean	4.36	
		Range	4.36	4.36
20	Sinuosity (K)		1.16	
21	Valley Slope (VS)		0.0066	
22	Average Water Surface Slope, (S) = (VS/K)		0.0057	
23	Pool Slope (water surface facet slope) (Sp)	Mean	0.0005	
		Range	0.0001	0.0008
24	Ratio of Pool Slope/Average Water Surface Slope (Sp/S)	Mean	0.08	
		Range	0.02	0.14
25	Riffle Slope (water surface facet slope) (Srif)	Mean	0.012	
		Range	0.010	0.014
26	Ratio Riffle Slope to Average Water Surface Slope (Srif/S)	Mean	2.11	
		Range	1.75	2.46

MORPHOLOGICAL CHARACTERISTICS OF THE REFERENCE CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

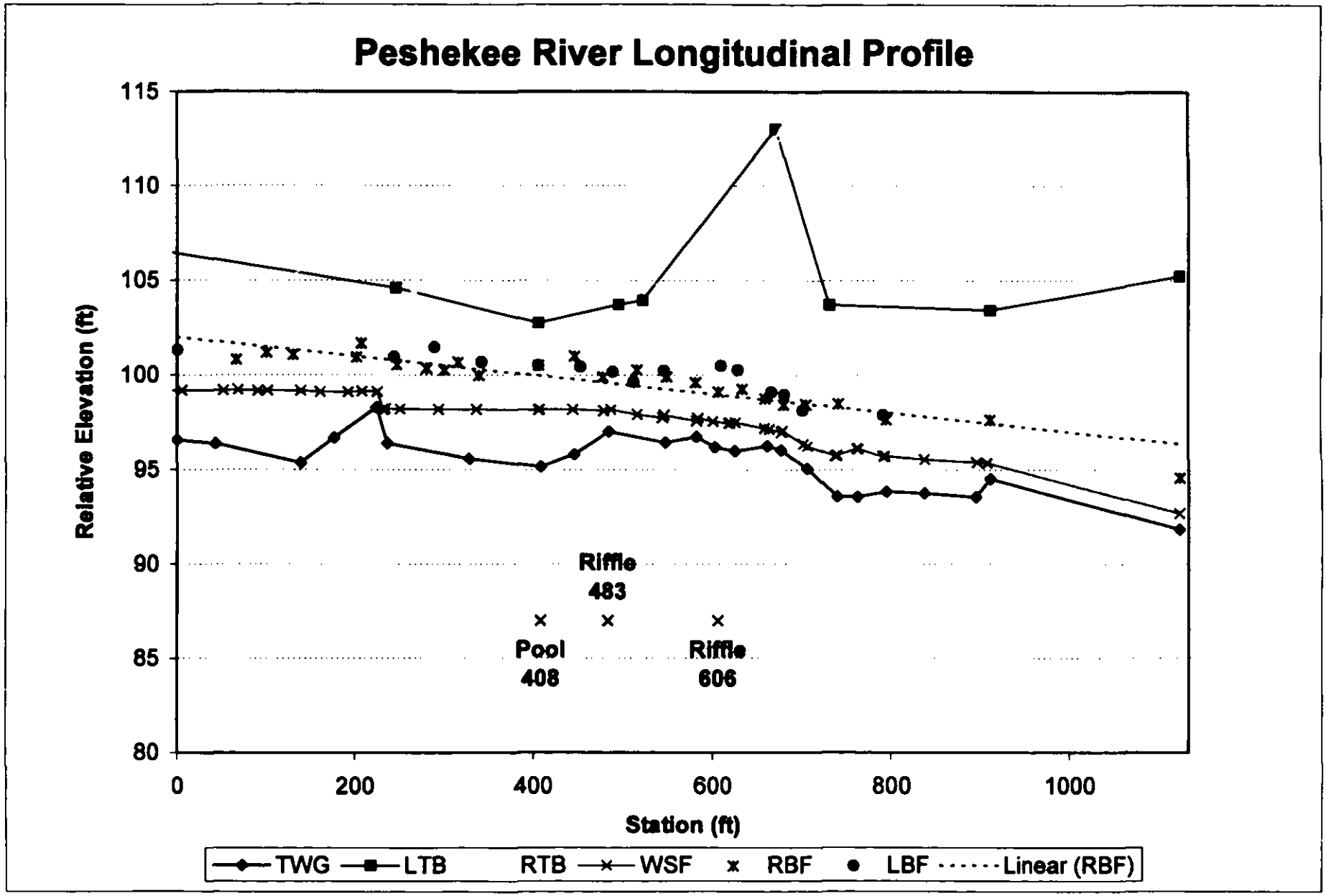
Assessment Site (Name of stream and location) Peshekee River
Marquette County, MI

	Variables	Existing Channel		
27	Run Slope (water surface facet slope) (Srun)	Mean	0.01	
		Range	0.01	0.01
28	Ratio Run Slope/Average Water Surface Slope (Srun/S)	Mean	1.75	
		Range	1.75	1.75
29	Glide Slope (water surface facet slope) (Sg)	Mean	0.0033	
		Range	0.0033	0.0033
30	Ratio Glide Slope/Average Water Surface Slope (Sg/S)	Mean	0.58	
		Range	0.58	0.58
31	Max Pool Depth, ft (dmbfkp)	Mean	5.69	
		Range	4.1	6
32	Ratio Max Pool Depth/Bankfull Mean Depth (dmbfkp/dbkf)	Mean	1.59	
		Range	1.29	1.89
33	Max Run Depth, ft (drun)	Mean	4.58	
		Range	4.5	4.66
34	Ratio Max Run Depth/Bankfull Mean Depth (drun/dbkf)	Mean	1.53	
		Range	1.50	1.55
35	Max Glide Depth, ft (dg)	Mean	4.31	
		Range	3.90	4.59
36	Ratio Max Glide Depth/Bankfull Mean Depth (dg/dbkf)	Mean	1.44	
		Range	1.30	1.53
37	Pool Width, ft (Wbkfp)	Mean	63.47	
		Range	56.83	70.1
38	Ratio of Pool Width to Bankfull Width (Wbkfp/Wbkf)	Mean	1.10	
		Range	1.00	1.21
	Pool Area	Mean	199.1	
		Range	199.1	199.1
39	Ratio of Pool Area to Bankfull Area	Mean	1.17	
		Range	1.17	1.17
40	Point Bar Slope	Mean	0.119	
		Range	0.117	0.122
41	Pool to Pool Spacing, ft (p-p)	Mean	297	
		Range	200	450
42	Ratio of p-p Spacing to Bankfull Width (p-p/Wbkf)	Mean	5.62	
		Range	3.46	7.79
	MATERIALS			
43	Particle Size Distribution of Channel Material (active bed)			
	D16 (mm)		66.2	
	D35 (mm)		101.8	
	D50 (mm)		146.7	
	D84 (mm)		406.2	
	D95 (mm)		487.7	

MORPHOLOGICAL CHARACTERISTICS OF THE REFERENCE CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

Assessment Site (Name of stream and location) Peshekee River
Marquette County, MI

	MATERIALS			
44	Particle Size Distribution of Bar Material			
	D16 (mm)		5.7	
	D35 (mm)		17.1	
	D50 (mm)		28.0	
	D84 (mm)		58.3	
	D95 (mm)		68.2	
	Largest size particle at the toe (lower third) of bar (mm)		76.0	
45	Particle Size Distribution of Channel Material (Pavement)			
	D16 (mm)		66.2	
	D35 (mm)		101.8	
	D50 (mm)		146.7	
	D84 (mm)		406.2	
	D95 (mm)		487.7	
46	Particle Size Distribution of Subpavement			
	D16 (mm)		5.7	
	D35 (mm)		17.1	
	D50 (mm)		28.0	
	D84 (mm)		58.3	
	D95 (mm)		68.2	
	Largest size particle at the toe (lower third) of bar (mm)		76.0	
47	Reach Wide Particle Size Distribution			
	D16 (mm)		27	
	D35 (mm)		64	
	D50 (mm)		102	
	D84 (mm)		1024	
	D95 (mm)		> 2048	
	D100(mm)		> 2048	



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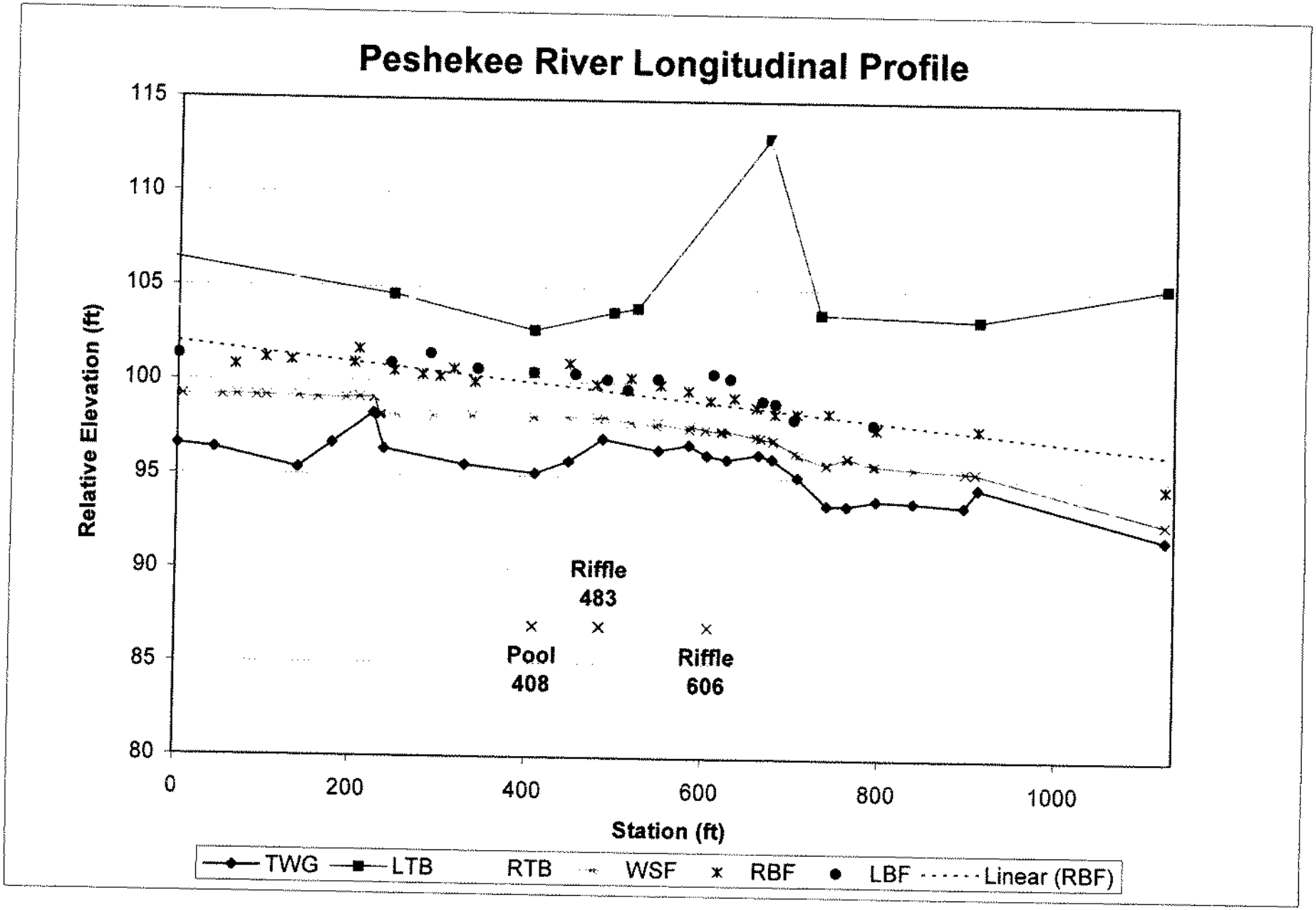
Peshekee Xsecs and Profile
Profile Chart 1



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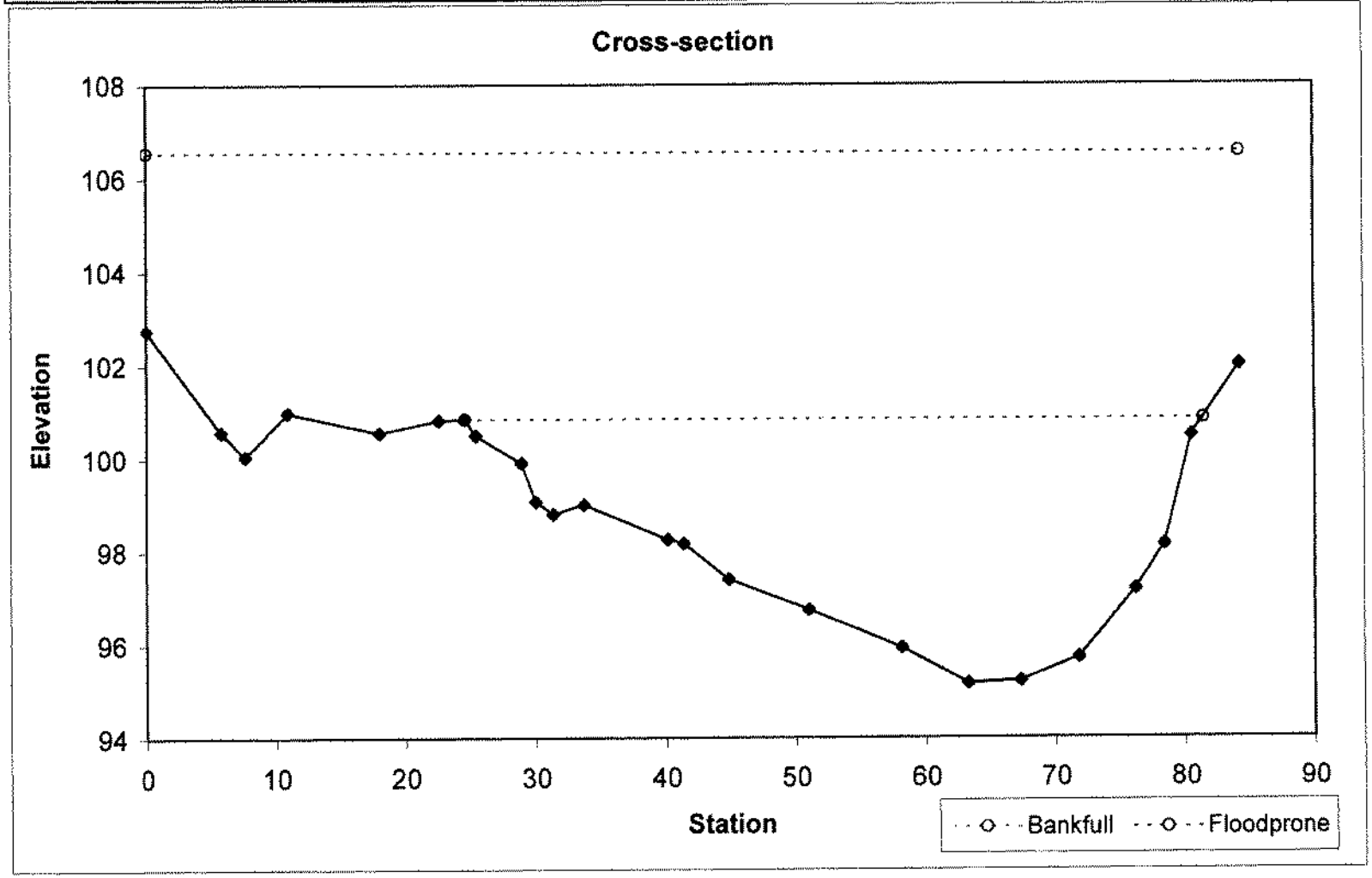
Peshekee Xsecs and Profile
Profile Chart 1

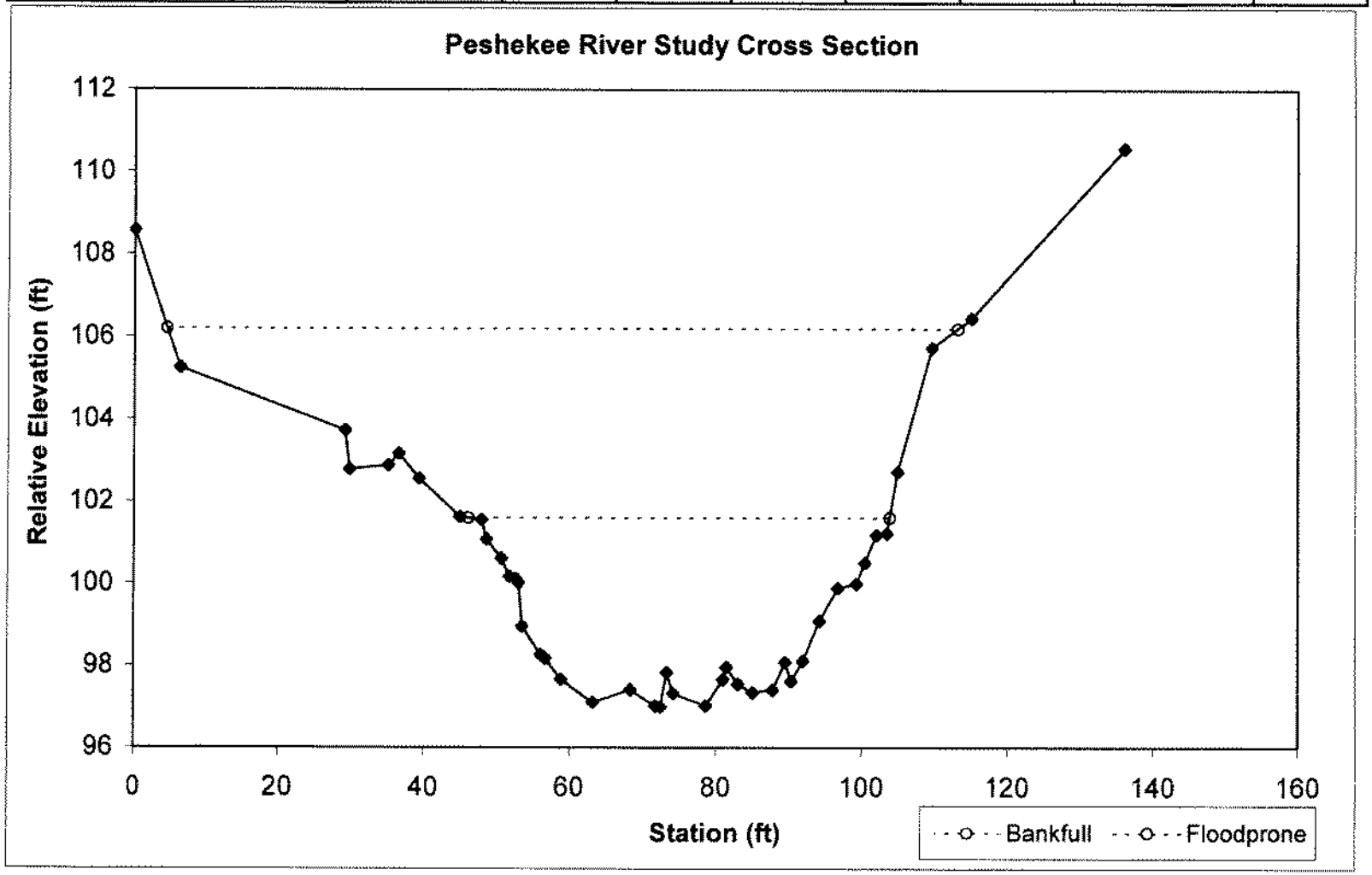
Pool @ Station 4+08

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		199.1	56.83	3.5	5.69	16.22	1.2	1.5	100.86	102.01



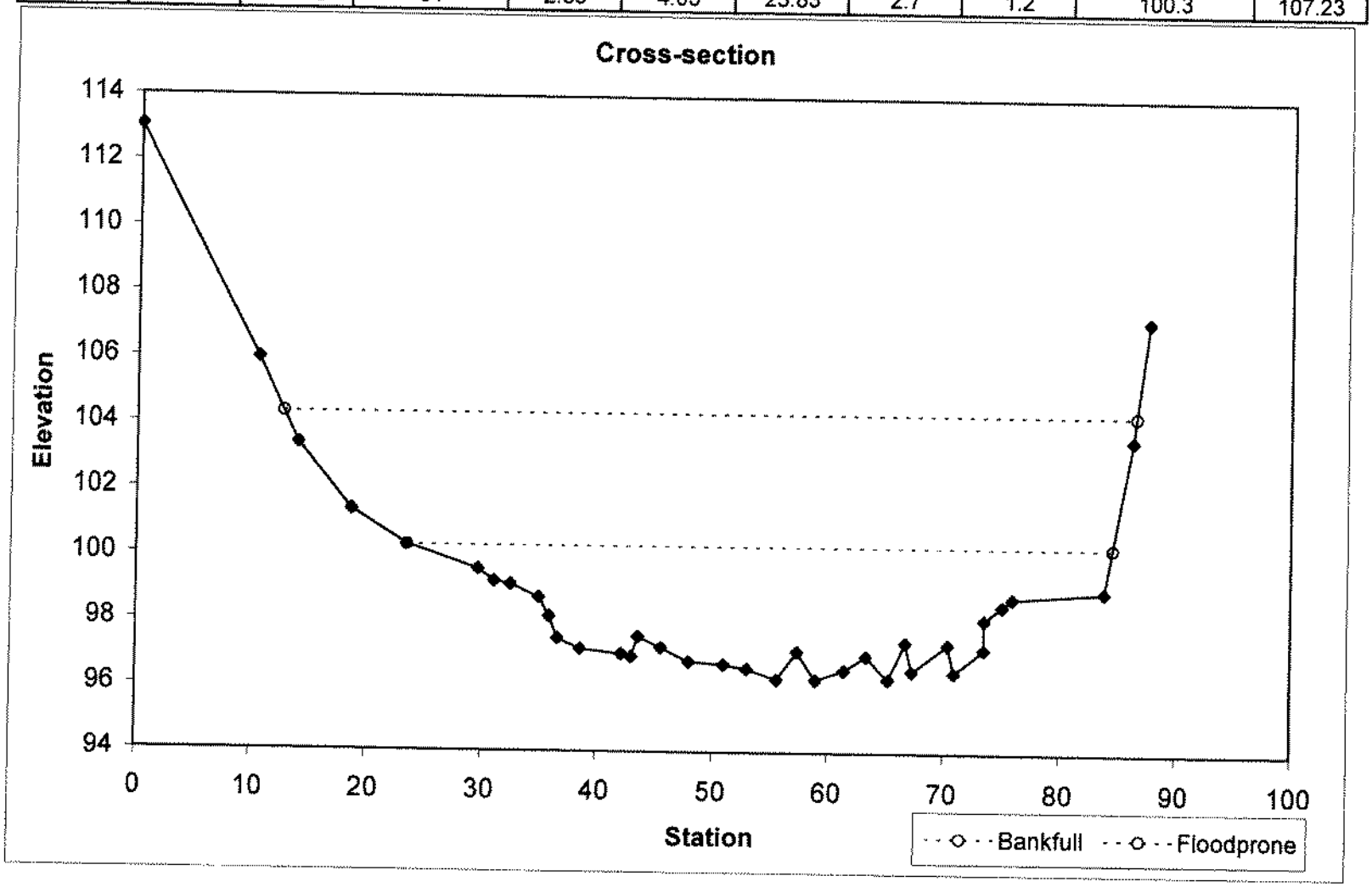
Riffle @ Station 4+83

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Bc3	183	57.77	3.17	4.61	18.23	1.5	1.9	101.6	103.73



Riffle @ Station 6+61

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle		156.2	61	2.56	4.05	23.83	2.7	1.2	100.3	107.23



PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	Dead River
REACH/LOCATION:	Peshekee @ Gauge
DATE COLLECTED:	7/28/2.4
FIELD COLLECTION BY:	SB
DATA ENTERED BY:	SDC

SEDIMENT ANALYSIS DATA SHEET

MATERIAL	PARTICLE	SIZE (mm)	PARTICLE CLASS			Reach Summary		Riffle Summary		Pool Summary	
			Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063					0.00		0.00		0.00
SAND	Very Fine	.063 - .125	1		1	1.00	1.00	1.25	1.25		0.00
	Fine	.125 - .25	1		1	1.00	2.00	1.25	2.50		0.00
	Medium	.25 - .50	3	1	4	4.00	6.00	3.75	6.25	5.00	5.00
	Coarse	.50 - 1.0	2	1	3	3.00	9.00	2.50	8.75	5.00	10.00
	Very Coarse	1.0 - 2.0	1		1	1.00	10.00	1.25	10.00		10.00
GRAVEL	Very Fine	2.0 - 2.8					10.00		10.00		10.00
	Very Fine	2.8 - 4.0					10.00		10.00		10.00
	Fine	4.0 - 5.6	1		1	1.00	11.00	1.25	11.25		10.00
	Fine	5.6 - 8.0	1		1	1.00	12.00	1.25	12.50		10.00
	Medium	8.0 - 11.0					12.00		12.50		10.00
	Medium	11.0 - 16.0	1	1	2	2.00	14.00	1.25	13.75	5.00	15.00
	Coarse	16 - 22.6		1	1	1.00	15.00		13.75	5.00	20.00
	Coarse	22.6 - 32	1	1	2	2.00	17.00	1.25	15.00	5.00	25.00
	Very Coarse	32 - 45	9	2	11	11.00	28.00	11.25	26.25	10.00	35.00
	Very Coarse	45 - 64	5	2	7	7.00	35.00	6.25	32.50	10.00	45.00
COBBLE	Small	64 - 90	8	3	11	11.00	46.00	10.00	42.50	15.00	60.00
	Small	90 - 128	9	2	11	11.00	57.00	11.25	53.75	10.00	70.00
	Large	128 - 180	2	1	3	3.00	60.00	2.50	56.25	5.00	75.00
	Large	180 - 256	4	2	6	6.00	66.00	5.00	61.25	10.00	85.00
BOULDER	Small	256 - 362	8		8	8.00	74.00	10.00	71.25		85.00
	Small	362 - 512	4	1	5	5.00	79.00	5.00	76.25	5.00	90.00
	Medium	512 - 1024	4	1	5	5.00	84.00	5.00	81.25	5.00	95.00
	Large-Very Large	1024 - 2048		1	1	1.00	85.00		81.25	5.00	100.00
BEDROCK	Bedrock	> 2048	15		15	15.00	100.00	18.75	100.00		100.00
			80	20	100			100	100	100	100

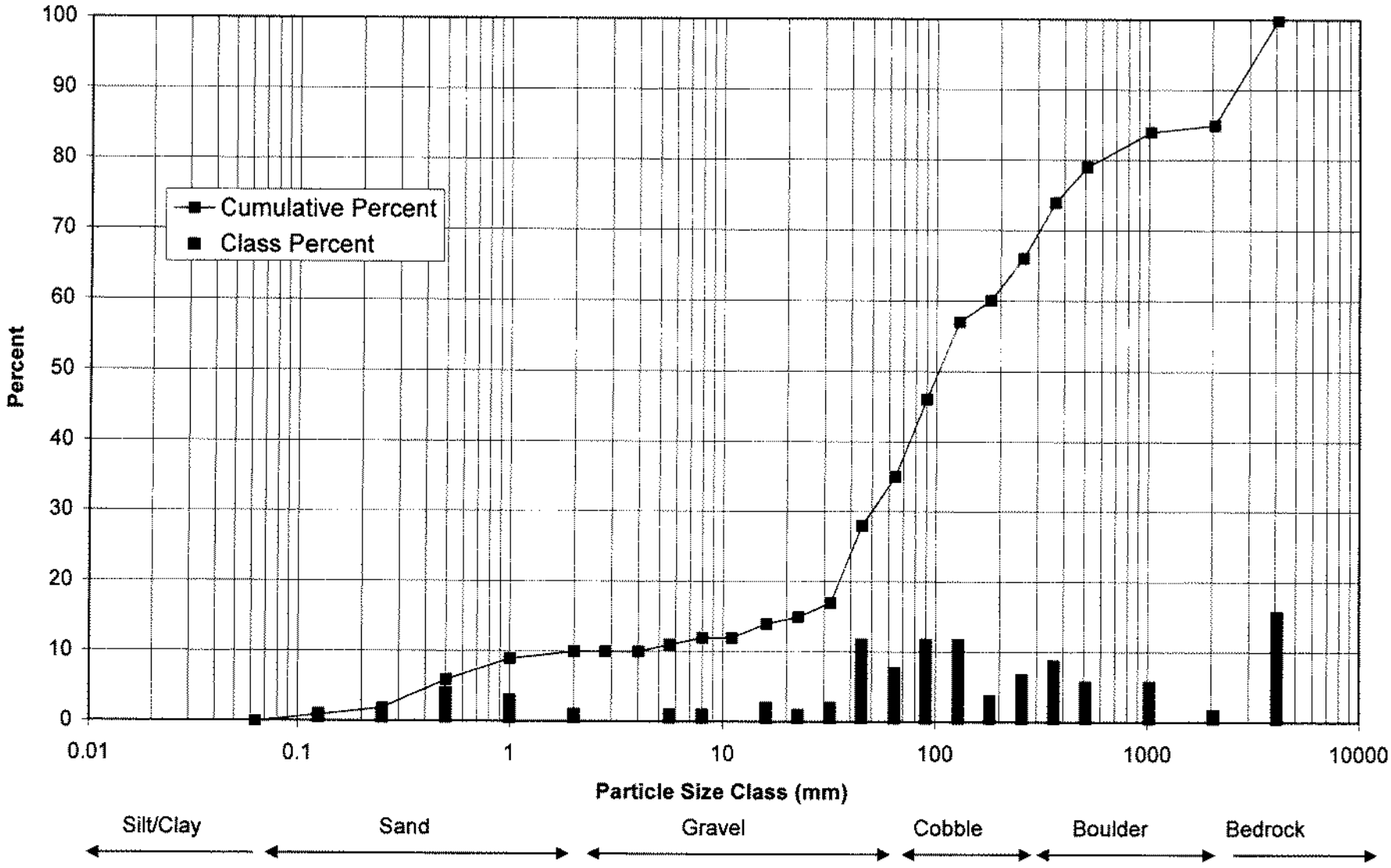
Cummulative
Channel materials
D_{16} = 26.89
D_{35} = 64.00
D_{50} = 102.30
D_{84} = 1024.00
D_{95} = 3251.00
D_{100} = > 2048

Riffle
Channel materials
D_{16} = 32.98
D_{35} = 69.69
D_{50} = 113.82
D_{84} = 2267.15
D_{95} = 3404.75
D_{100} = > 2048

Pool
Channel materials
D_{16} = 17.14
D_{35} = 45.00
D_{50} = 71.70
D_{84} = 247.14
D_{95} = 1024.00
D_{100} = 1024 - 2048

Sediment Distribution

Dead River - Peshekee @ Gauge



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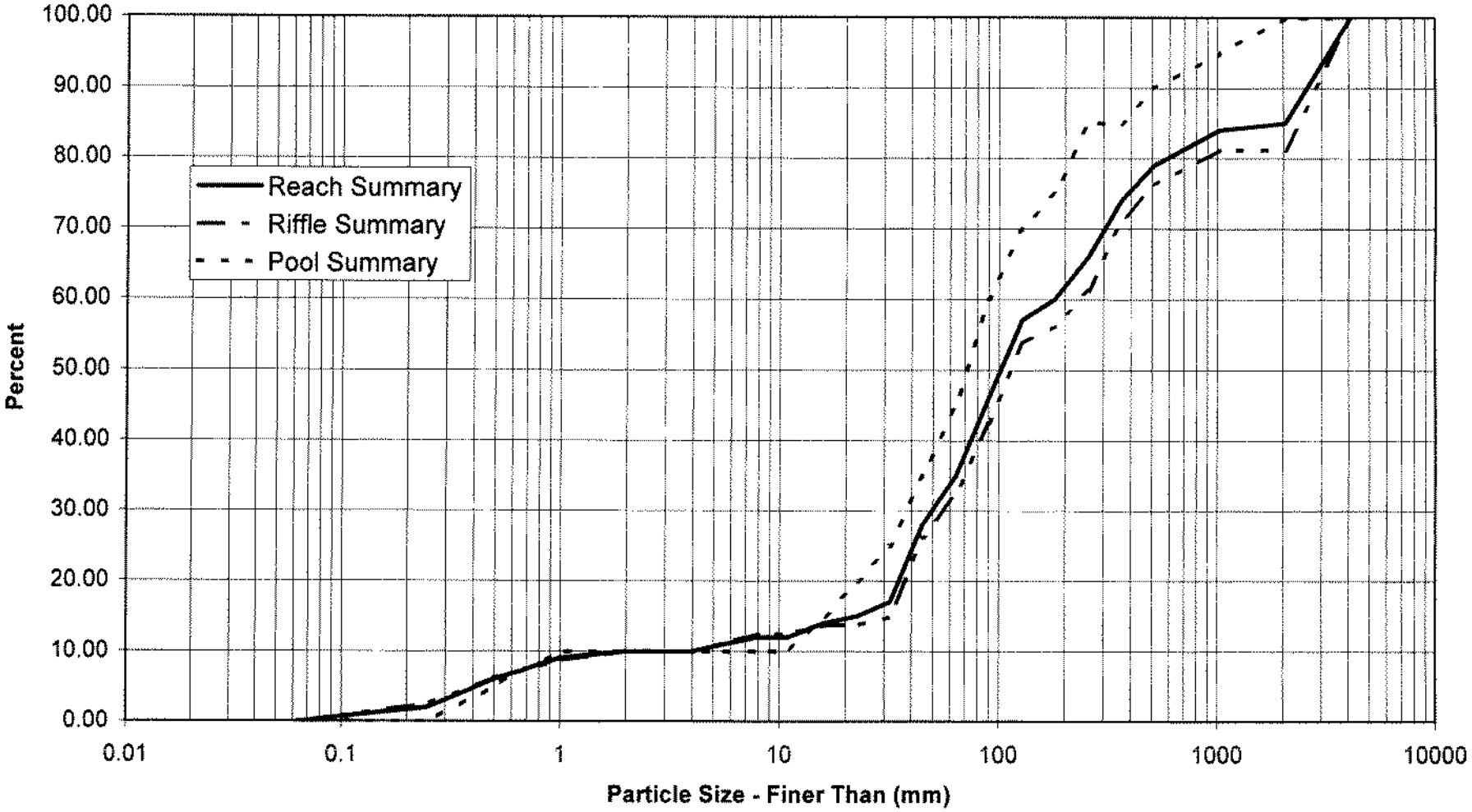
Pebble Count for Classification
LogHistogram

Sediment Distribution by Feature

Dead River - Peshekee @ Gauge



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Pebble Count for Classification
Feature Summary

PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	**Dead River**
REACH/LOCATION:	**Peshekee - Wetted** Surface
DATE COLLECTED:	**10-Oct-04**
FIELD COLLECTION BY:	**SRB**
DATA ENTERED BY:	**SRB**

SEDIMENT ANALYSIS DATA SHEET

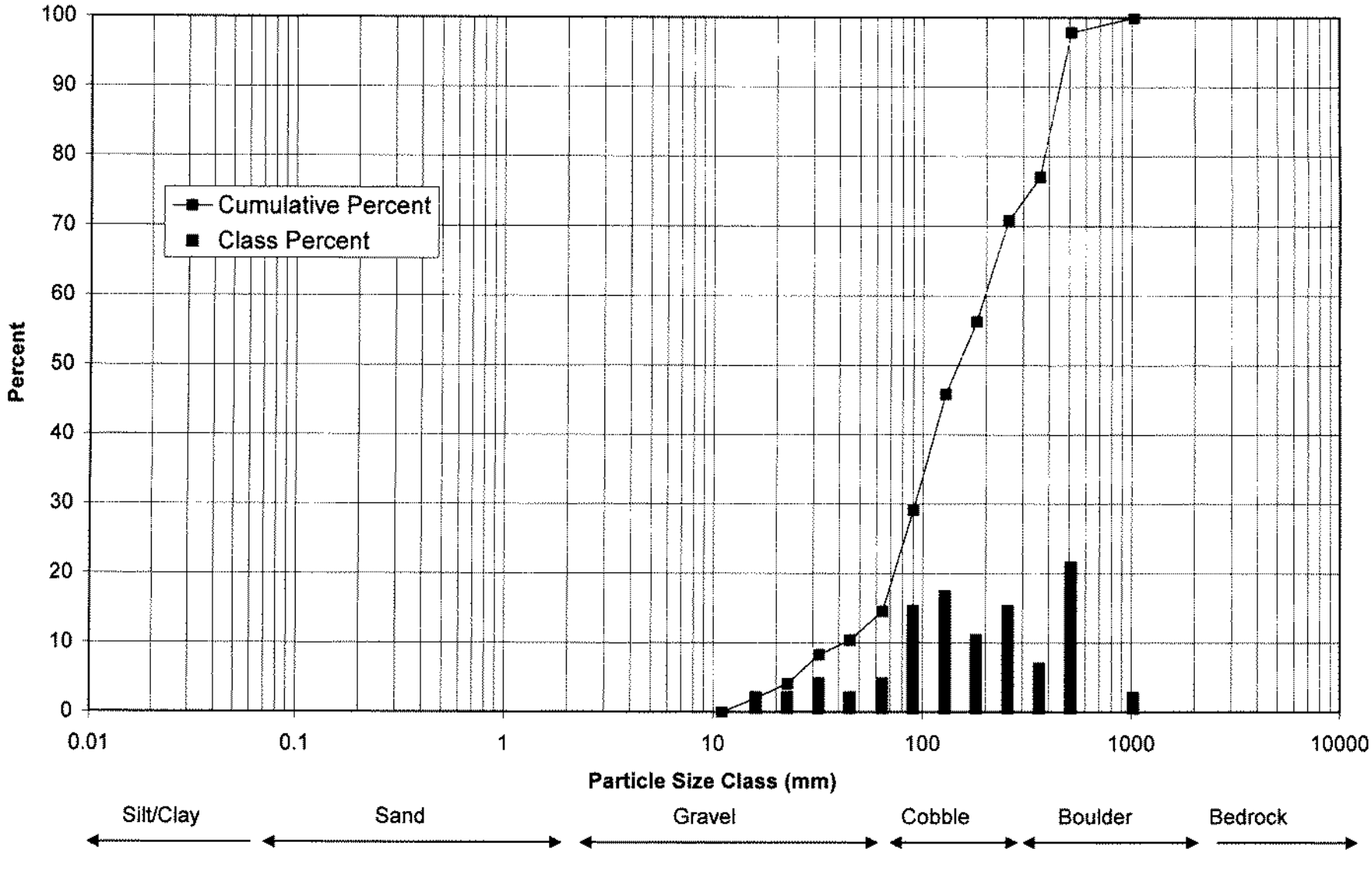
			PARTICLE CLASS			Reach Summary		Riffle Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063					0.00		0.00
SAND	Very Fine	.063 - .125					0.00		0.00
	Fine	.125 - .25					0.00		0.00
	Medium	.25 - .50					0.00		0.00
	Coarse	.50 - 1.0					0.00		0.00
	Very Coarse	1.0 - 2.0					0.00		0.00
GRAVEL	Very Fine	2.0 - 2.8					0.00		0.00
	Very Fine	2.8 - 4.0					0.00		0.00
	Fine	4.0 - 5.6					0.00		0.00
	Fine	5.6 - 8.0					0.00		0.00
	Medium	8.0 - 11.0					0.00		0.00
	Medium	11.0 - 16.0	1		1	2.08	2.08	2.08	2.08
	Coarse	16 - 22.6	1		1	2.08	4.17	2.08	4.17
	Coarse	22.6 - 32	2		2	4.17	8.33	4.17	8.33
	Very Coarse	32 - 45	1		1	2.08	10.42	2.08	10.42
	Very Coarse	45 - 64	2		2	4.17	14.58	4.17	14.58
COBBLE	Small	64 - 90	7		7	14.58	29.17	14.58	29.17
	Small	90 - 128	8		8	16.67	45.83	16.67	45.83
	Large	128 - 180	5		5	10.42	56.25	10.42	56.25
	Large	180 - 256	7		7	14.58	70.83	14.58	70.83
BOULDER	Small	256 - 362	3		3	6.25	77.08	6.25	77.08
	Small	362 - 512	10		10	20.83	97.92	20.83	97.92
	Medium	512 - 1024	1		1	2.08	100.00	2.08	100.00
	Large-Very Large	1024 - 2048					100.00		100.00
BEDROCK	Bedrock	> 2048					100.00		100.00
			48	0	48			100	100

Cummulative Channel materials	
D_{16} =	66.16
D_{35} =	101.81
D_{50} =	146.70
D_{84} =	406.16
D_{95} =	487.74
D_{100} =	512 - 1024

Riffle Channel materials	
D_{16} =	66.16
D_{35} =	101.81
D_{50} =	146.70
D_{84} =	406.16
D_{95} =	487.74
D_{100} =	512 - 1024

Sediment Distribution

Dead River - Peshekee - Wetted Surface



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Wetted SurfcaeSediment Distribution
LogHistogram

Pavement/Subpavement Analysis

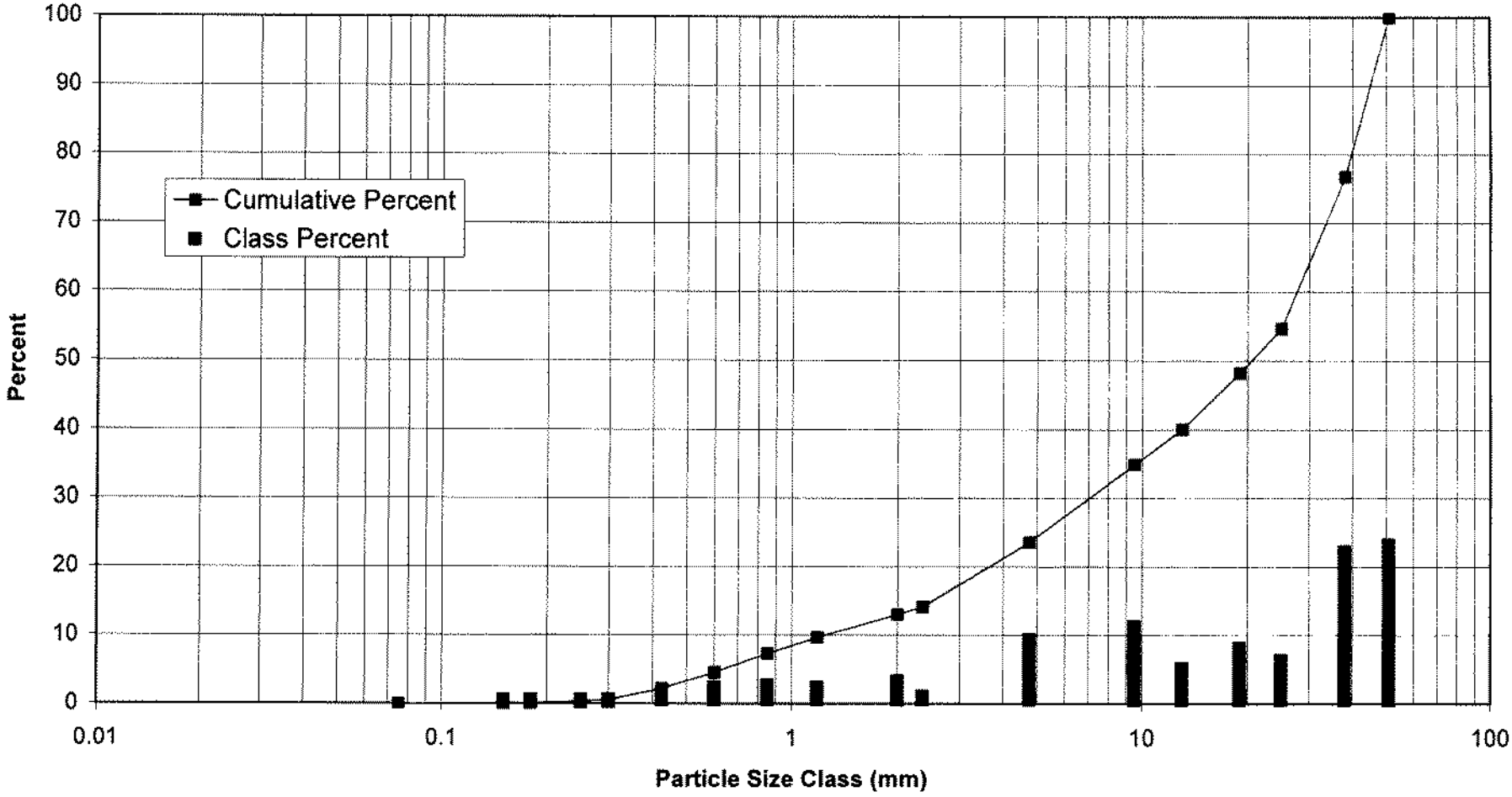
SITE OR PROJECT:	Dead R. Limited Use Curves
REACH/LOCATION:	Peshekee Sub
DATE COLLECTED:	10/13/04
FIELD COLLECTION BY:	SRB
DATA ENTERED BY:	STS/SRB

SEDIMENT ANALYSIS DATA SHEET

MATERIAL	PARTICLE	SIZE (mm)	Sample 1 (g)		Pavement Class %	Pavement % Cum	Subpavement Class %	Subpavement % Cum
	Silt / Clay	< .075				0.00		
SAND	Very Fine	.075 - .15	1.5		0.01	0.01		
	Fine	.15 - .18	2.9		0.02	0.04		
	Fine	.18 - .25	7.7		0.07	0.10		
	Fine	0.25 - 0.3	9.8		0.08	0.19		
	Medium	0.3 - 0.425	50.2		0.43	0.61		
	Medium	0.425 - 0.6	79.6		0.68	1.29		
	Medium	0.6 - 0.85	94.9		0.81	2.10		
	Medium	0.85 - 1.18	92.2		0.79	2.89		
	Medium	1.18 - 2.0	230.9		1.97	4.86		
	Coarse	2.0 - 2.36	105.6		0.90	5.76		
	Coarse	2.36 - 4.75	884.6		7.54	13.30		
GRAVEL	Small	4.75 - 9.5	1259.6		10.74	24.04		
	Small	9.5 - 13	621.4		5.30	29.33		
	Fine	13 - 19	924.6		7.88	37.22		
	Large	19 - 25	1025.1		8.74	45.96		
	Large	25 - 38	1763.4		15.03	60.99		
	Large	38 - 51	1405.3		11.98	72.97		
	Large	51 - 64	2186.2		18.64	91.61		
COBBLE	Small	64 - 75	984.3		8.39	100.00		
	Medium	75 - 90				100.00		
	Medium	90 - 128				100.00		
	Medium	128 - 180				100.00		
	Large	180 - 256				100.00		
BOULDER	Small	256 - 362				100.00		
	Medium	362 - 512				100.00		
	Medium	512 - 1024				100.00		
	Large-Very Large	1024 - 2048				100.00		
BEDROCK	Bedrock	> 2048				100.00		
			11730	0	100	100		

Channel materials	Sample 1	
D_{16} =	5.65	
D_{35} =	17.08	
D_{50} =	27.98	
D_{84} =	58.33	
D_{95} =	68.24	
D_{100} =	75.00	

Dead R. Limited Use Curves - Peshekee Subpavement



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PeshekeeSTSPavement Sub Pavement
LogHistogramDetail

LEGEND

~~~ STEEP VALLEY WALLS

BUCK ENGINEERING
1347 Harding Place
Suite 100
Charlotte, North Carolina 28204
Phone: 704.334.4454
Fax: 704.334.4492
www.buckengineering.com

Sheet 1 of 1

Peshekee River Sketch

Dead *River Post-Event Additional Environmental Assessment*
~~~

Work Plan Photograph Key

Dead River Recovery Post-Event Additional Environmental Assessment: Survey of Morphological Stream Parameters Using Rosgen Method

Number [1]	Subject	Location [2]
1	Bankfull stage indicator	location that best depicts indicator (Rosgen, 1996)
2	Stream downstream of the cross-section	standing mid-stream at the tape
3	Stream upstream of the cross-section	standing mid-stream at the tape
4	Cross-section photo	downstream of the cross-section facing upstream
5	Cross-section photo	upstream of the cross-section facing downstream
6	Right floodplain	right top of bank at the cross-section
7	Left floodplain	left top of bank at the cross-section
8	Stream upstream of the reach	standing mid-stream at the start of the longitudinal profile
9	Stream downstream of the reach	standing mid-stream at the end of the longitudinal profile
10	A sufficient number of photographs to provide a continuous visual documentation of the survey reach	facing downstream

Notes:

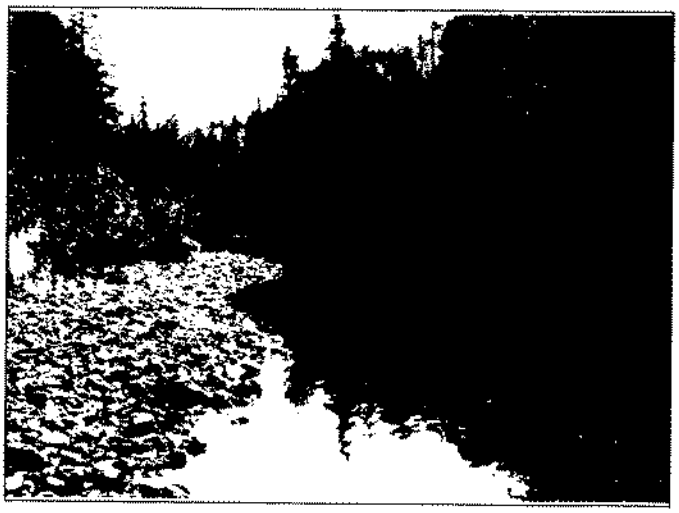
1. A letter designation is used in addition to the photo number (e.g. 10A, 10B, 10C, etc.) if more than one photograph was taken of a particular subject or from a single location.
2. Location from which photograph was taken.

PESHEKEE POOL XS #1

PESHEKEE POOL XS #2

PESHEKEE POOL XS #3

PESHEKEE POOL XS #4



PESHEKEE POOL XS #5

PESHEKEE POOL XS #6

PESHEKEE POOL XS #7

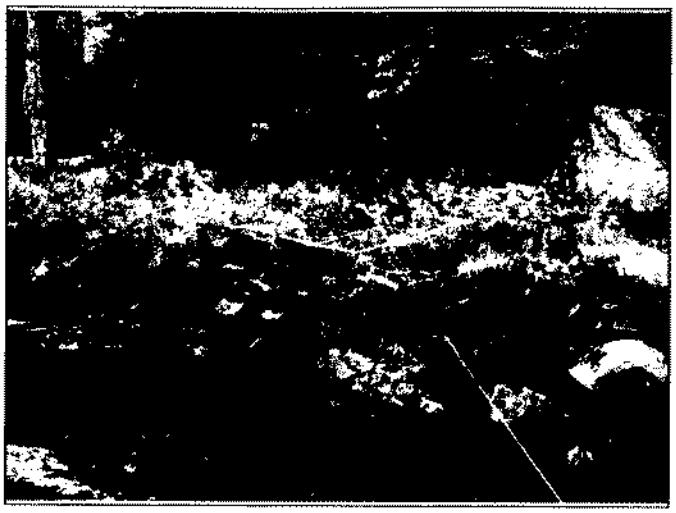
PESHEKEE RIFFLE XS #1

PESHEKEE RIFFLE XS #2

PESHEKEE RIFFLE XS #3

PESHEKEE RIFFLE XS #4

PESHEKEE RIFFLE XS #5



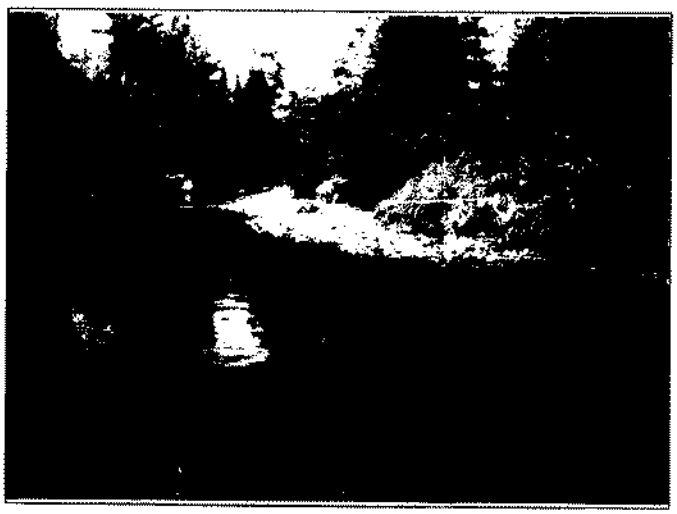
PESHEKEE RIFFLE XS #6

PESHEKEE RIFFLE XS #7

PESHEKEE #8

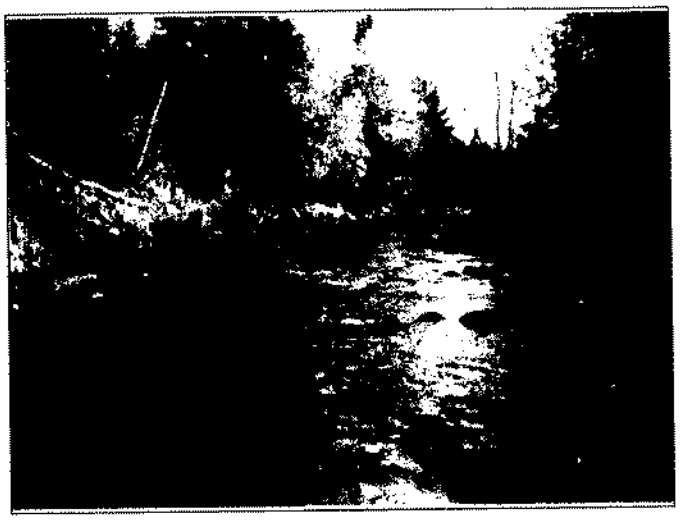
PESHEKEE #9

PESHEKEE #10A



PESHEKEE #10B

PESHEKEE #10C

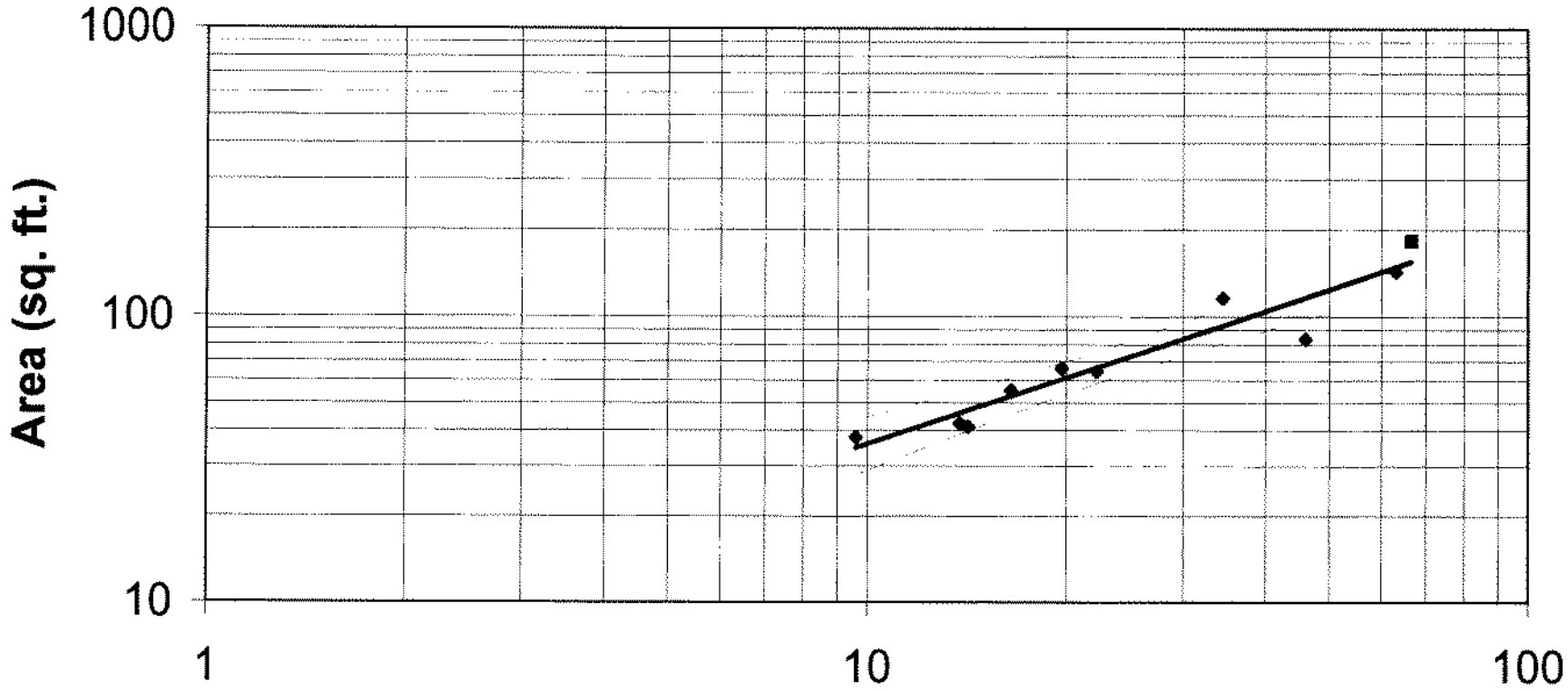


PESHEKEE #10D

PESHEKEE #10E

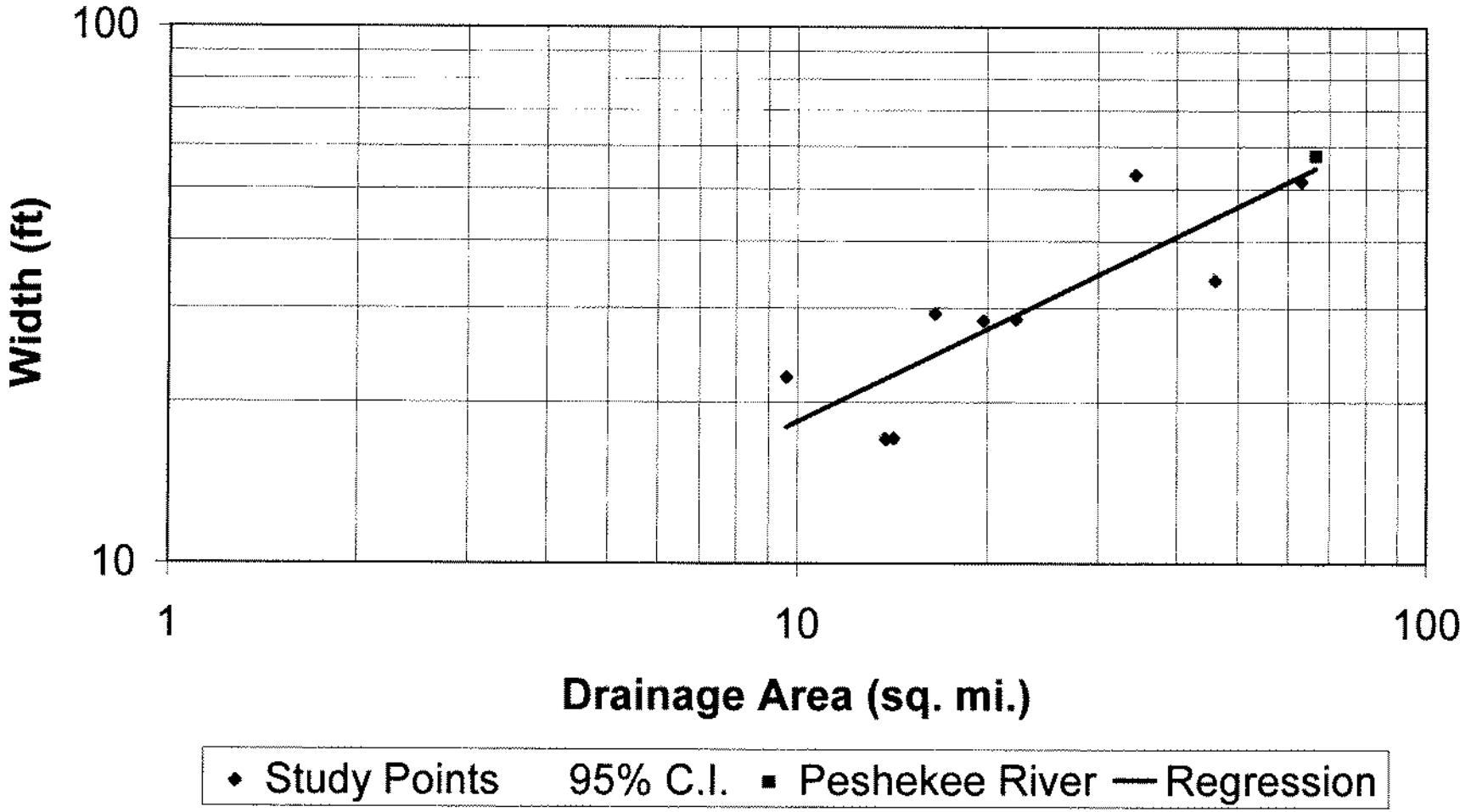
Cross Sectional Area vs. Drainage Area

$y = 6.0x^{0.77}$, $r^2 = 0.91$



Bankfull Width vs. Drainage Area

$y = 4.9x^{0.57}$, $r^2 = 0.76$



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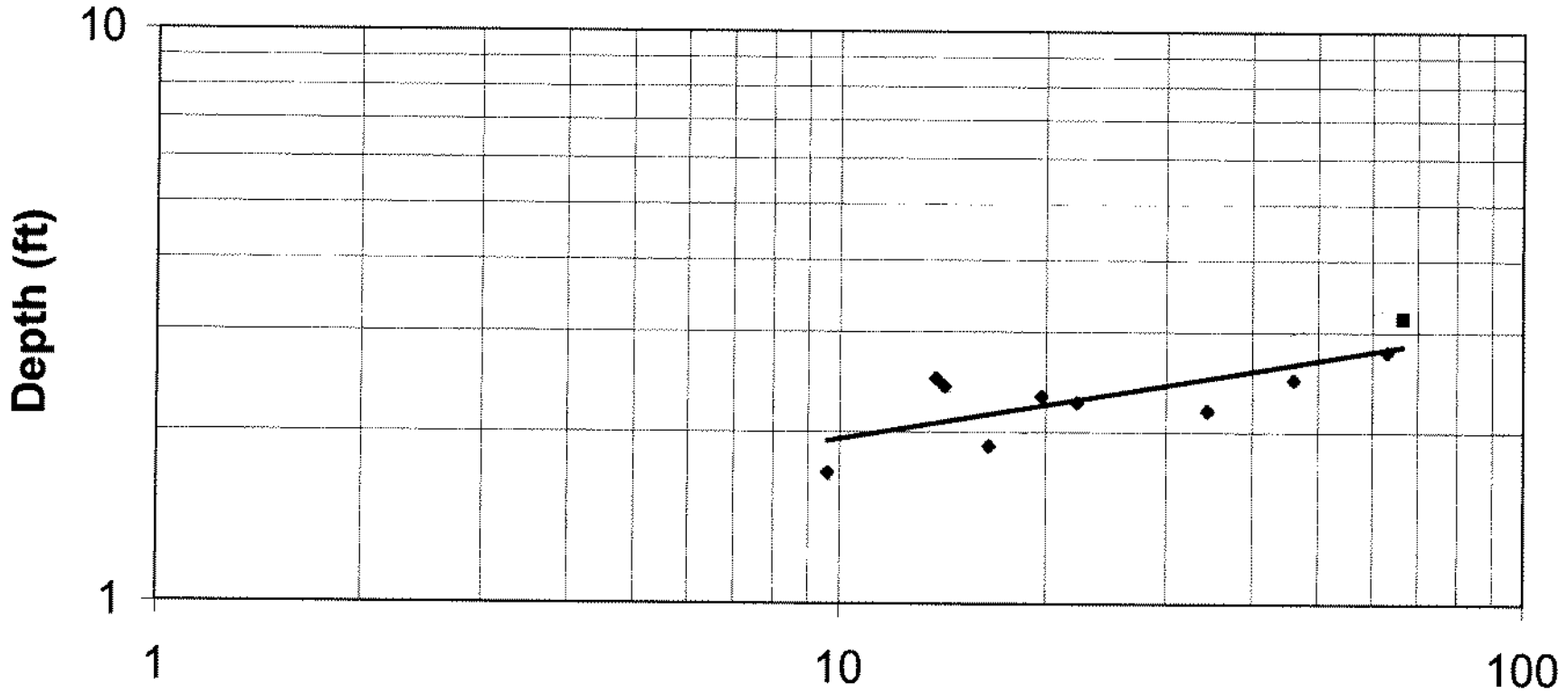
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Peshekee
Curves Chart 2

Bankfull Mean Depth vs. Drainage Area

$y = 1.2x^{0.20}$, $r^2 = 0.57$



◆ Study Points 95% C.I. ■ Peshekee River — Regression

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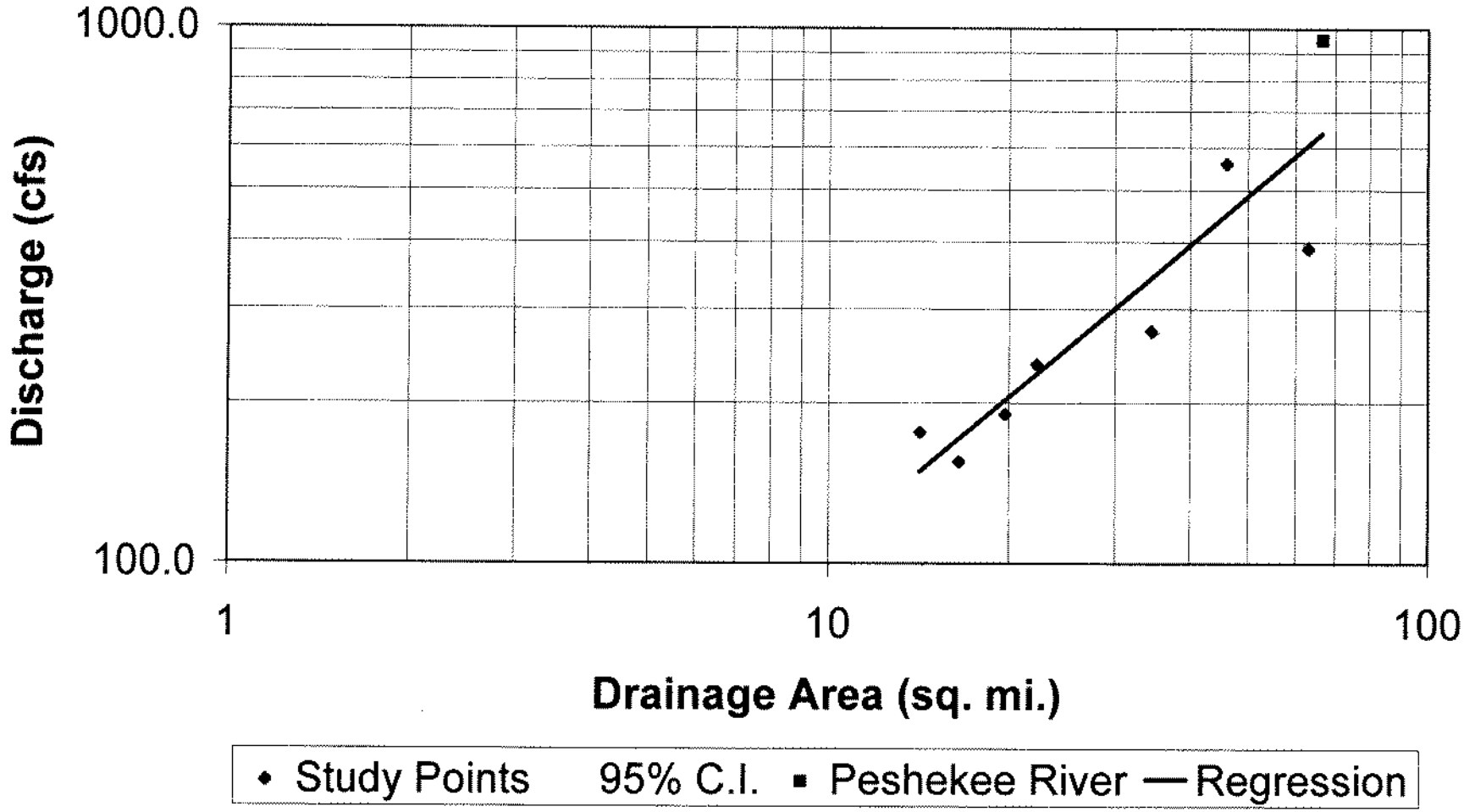
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Peshekee
Curves Chart 3

Bankfull Discharge vs. Drainage Area

$y = 12.2x^{0.94}$, $r^2 = 0.82$



Perch River

Initials	Work Item
JE	Collect the following data at a minimum for each LUC reach.

Reach ID: **Perch (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end) .
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☑ Photograph site.

Initials	Work Item
DB	Collect the following data at a minimum for each reference reach.

Reach ID: **Perch River**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 20 times bankfull width
- ☑ Survey a minimum of two (2) cross-sections (one each at a riffle and pool)
- ☑ Measure plan form features:
  - ☑ Sinuosity
  - ☑ Meander length
  - ☑ Radius of curvature
  - ☑ Belt width
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sample pavement/sub-pavement per Rosgen, 1996
- ☑ Sketch site per Harrelson et al., 1994
- ☑ Photograph site

Initials	Work Item
SPB	Provide the following items for each reference reach in electronic and hard copy format.

Reach ID: **Perch River**

- ✓ Morphological Data Table
- ✓ Plot of longitudinal profile
- ✓ Plot of cross-sections
- ✓ Grain size distribution
  - ✓ Bed material
  - ✓ Pavement/sub-pavement material
- ✓ Site sketch
- ✓ Photographs and photo log
- ✓ GIS data layer depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)

Initials	Work Item
SPB	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Perch (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

☑ Limited Use Curves

- ☑ -- DA versus Wbkf
- ☑ -- DA versus Dbkf
- ☑ -- DA versus CSA
- ☑ -- DA versus Qbkf

☑ Plot of longitudinal profile

☑ Plot of cross-section

☑ Grain size distribution for bed material

☑ Site sketch

☑ Photographs and photo log.

☑ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)

- Reach
  - Reach limits (line shape)
  - Reach ID (name or number)
  - Stream Type
  - DA
- Survey Locations
  - Location ID (i.e. – X1, X2, X3, etc.)
  - Location type (pool, riffle)

N/A ☐ Calculations (single section analysis)

N/A ☐ Plot of Single Section Analysis versus Regression Equation

} gauge data available

MORPHOLOGICAL CHARACTERISTICS OF THE REFERENCE CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

Assessment Site (Name of stream and location) — Perch River, Baraga County, MI

	Variables	Existing Channel		
1	Stream Type		B4c/C4	
2	Drainage Area, mi2		63.10	
3	Bankfull Width, ft (Wbkf)	Mean	48.1	
		Range	44.55	51.57
4	Bankfull Mean Depth, ft (dbkf)	Mean	2.55	
		Range	2.32	2.77
5	Width/Depth Ratio (Wbkf/dbkf)	Mean	18.9	
		Range	18.62	19.17
6	Bankfull Cross-Sectional Area, ft2 (Abkf)	Mean	123.2	
		Range	103.5	142.8
7	Bankfull Mean Velocity, ft/s (Ubkf)	Mean	3.2	
		Range	2.7	3.8
8	Banfull Discharge, ft3/s (Qbkf)		389	
9	Bankfull Maximum Depth, ft (dmbkf)	Mean	3.8	
		Range	3.42	4.17
10	Max Riffle Depth/Mean Riffle Depth (dmbkf/dbkf)	Mean	1.5	
		Range	1.5	1.5
11	Low Bank Height to Max Riffle Depth (LBH/dmbkf)	Mean	1.2	
		Range	1.0	1.4
12	Width of Floodprone Area, ft (Wfpa)	Mean	224.7	
		Range	195.7	253.6
13	Entrenchment Ratio (Wfpa/Wbkf)	Mean	4.5	
		Range	3.7	5.3
14	Meander Length, ft (Lm)	Mean	498	
		Range	400	500
15	Meander Length Ratio, (Lm/Wbkf)	Mean	10.10	
		Range	8.98	11.22
16	Radius of Curvature, ft (Rc)	Mean	88.063638	
		Range	67.127275	109
17	Ratio of Radius of Curvature to Bankfull Width (Rc/Wbkf)	Mean	1.89	
		Range	1.51	2.27
18	Belt Width, ft (Wblt)	Mean	221	
		Range	221	221
19	Meander Width Ratio (Wblt/Wbkf)	Mean	4.96	
		Range	4.96	4.96
20	Sinuosity (K)		1.28	
21	Valley Slope (VS)		0.01	
22	Average Water Surface Slope, (S) = (VS/K)		0.0079	
23	Pool Slope (water surface facet slope) (Sp)	Mean	0.0005	
		Range	0.0001	0.0008
24	Ratio of Pool Slope/Average Water Surface Slope (Sp/S)	Mean	0.06	
		Range	0.01	0.10
25	Riffle Slope (water surface facet slope) (Srif)	Mean	0.011	
		Range	0.010	0.014
26	Ratio Riffle Slope to Average Water Surface Slope (Srif/S)	Mean	1.39	
		Range	1.27	1.77

MORPHOLOGICAL CHARACTERISTICS OF THE REFERENCE CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

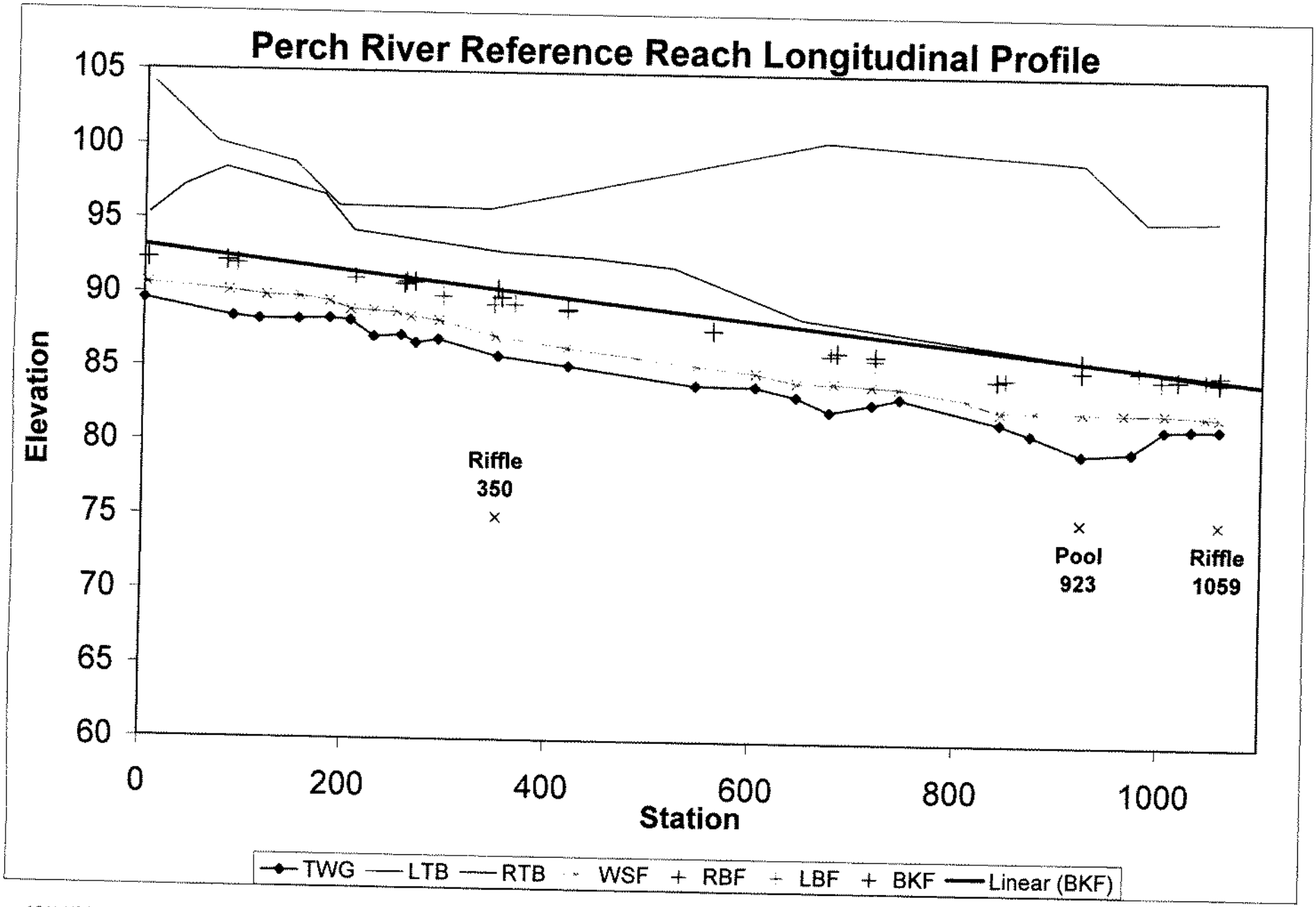
Assessment Site (Name of stream and location) — Perch River, Baraga County, MI

	Variables	Existing Channel		
27	Run Slope (water surface facet slope) (Srun)	Mean	0.01	
		Range	0.01	0.01
28	Ratio Run Slope/Average Water Surface Slope (Srun/S)	Mean	1.27	
		Range	1.27	1.27
29	Glide Slope (water surface facet slope) (Sg)	Mean	0.0035	
		Range	0.0035	0.0035
30	Ratio Glide Slope/Average Water Surface Slope (Sg/S)	Mean	0.44	
		Range	0.44	0.44
31	Max Pool Depth, ft (dmbfkp)	Mean	6.29	
		Range	3.9	6.3
32	Ratio Max Pool Depth/Bankfull Mean Depth (dmbfkp/dbkf)	Mean	1.84	
		Range	1.41	2.27
33	Max Run Depth, ft (drun)	Mean	4.58	
		Range	4.5	4.66
34	Ratio Max Run Depth/Bankfull Mean Depth (drun/dbkf)	Mean	1.53	
		Range	1.50	1.55
35	Max Glide Depth, ft (dg)	Mean	4.31	
		Range	3.90	4.59
36	Ratio Max Glide Depth/Bankfull Mean Depth (dg/dbkf)	Mean	1.44	
		Range	1.30	1.53
37	Pool Width, ft (Wbkfp)	Mean	51.47	
		Range	51.47	51.47
38	Ratio of Pool Width to Bankfull Width (Wbkfp/Wbkf)	Mean	1.16	
		Range	1.16	1.16
	Pool Area	Mean	180.3	
		Range	180.3	180.3
39	Ratio of Pool Area to Bankfull Area	Mean	1.46	
		Range	1.46	1.46
40	Point Bar Slope	Mean	0.1293537	
		Range	0.1074874	0.15122
41	Pool to Pool Spacing, ft (p-p)	Mean	264.73	
		Range	100	350
42	Ratio of p-p Spacing to Bankfull Width (p-p/Wbkf)	Mean	5.05	
		Range	2.24	7.86
	MATERIALS			
43	Particle Size Distribution of Channel Material (active bed)			
	D16 (mm)		27.5	
	D35 (mm)		53.7	
	D50 (mm)		77.6	
	D84 (mm)		173.2	
	D95 (mm)		301.8	

MORPHOLOGICAL CHARACTERISTICS OF THE REFERENCE CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

Assessment Site (Name of stream and location) — Perch River, Baraga County, MI

	MATERIALS			
44	Particle Size Distribution of Bar Material			
	D16 (mm)		2.7	
	D35 (mm)		9.6	
	D50 (mm)		20.5	
	D84 (mm)		41.6	
	D95 (mm)		47.9	
	Largest size particle at the toe (lower third) of bar (mm)		102.0	
45	Particle Size Distribution of Channel Material (Pavement)			
	D16 (mm)		27.5	
	D35 (mm)		53.7	
	D50 (mm)		77.6	
	D84 (mm)		173.2	
	D95 (mm)		301.8	
46	Particle Size Distribution of Subpavement			
	D16 (mm)		2.7	
	D35 (mm)		9.6	
	D50 (mm)		20.5	
	D84 (mm)		41.6	
	D95 (mm)		47.9	
	Largest size particle at the toe (lower third) of bar (mm)		102.0	
47	Reach Wide Particle Size Distribution			
	D16 (mm)		0.24	
	D35 (mm)		14.37	
	D50 (mm)		32	
	D84 (mm)		92.18	
	D95 (mm)		158.85	
	D100(mm)		> 2048	



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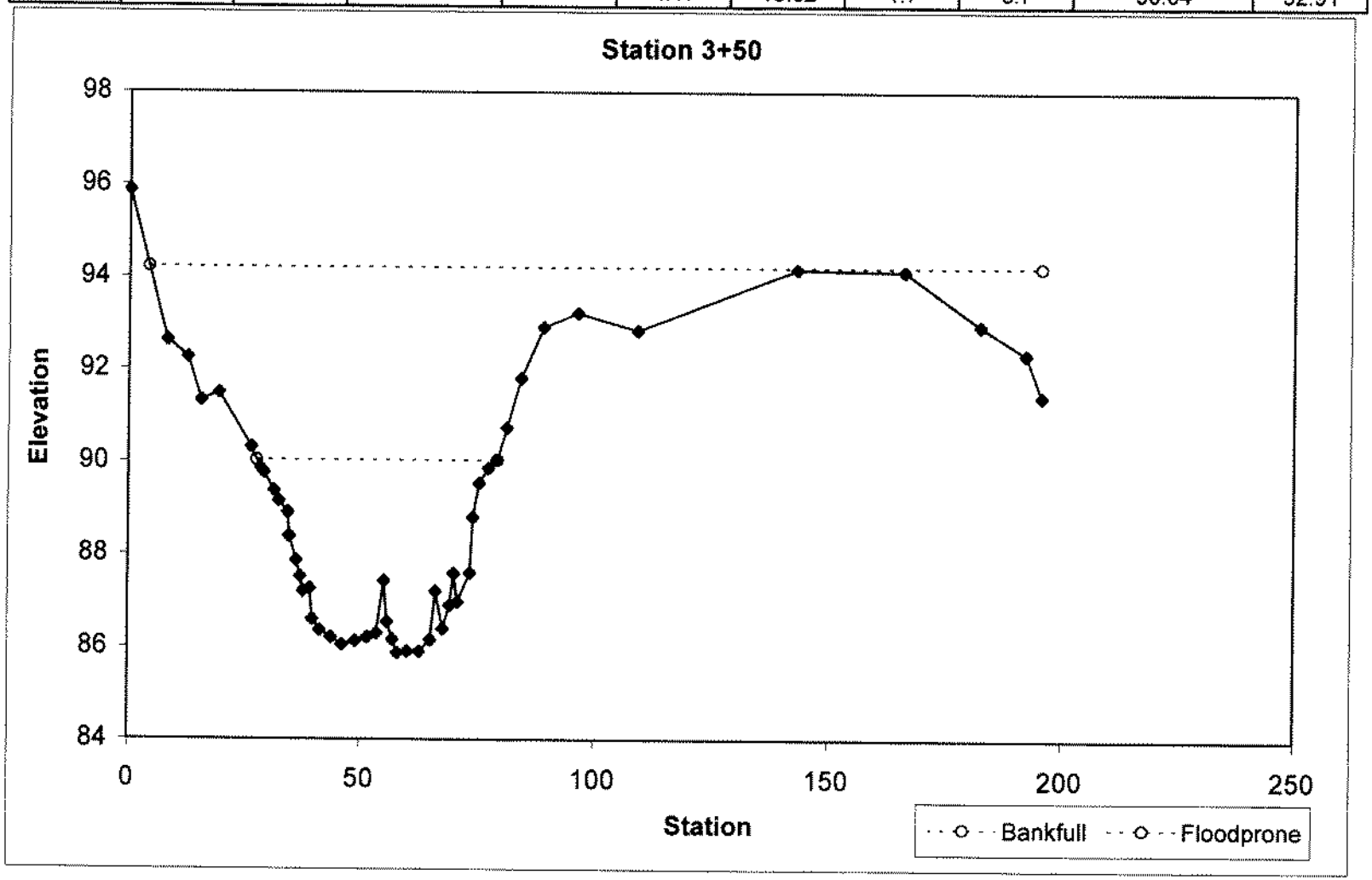
PerchMorph
Profile Chart 1

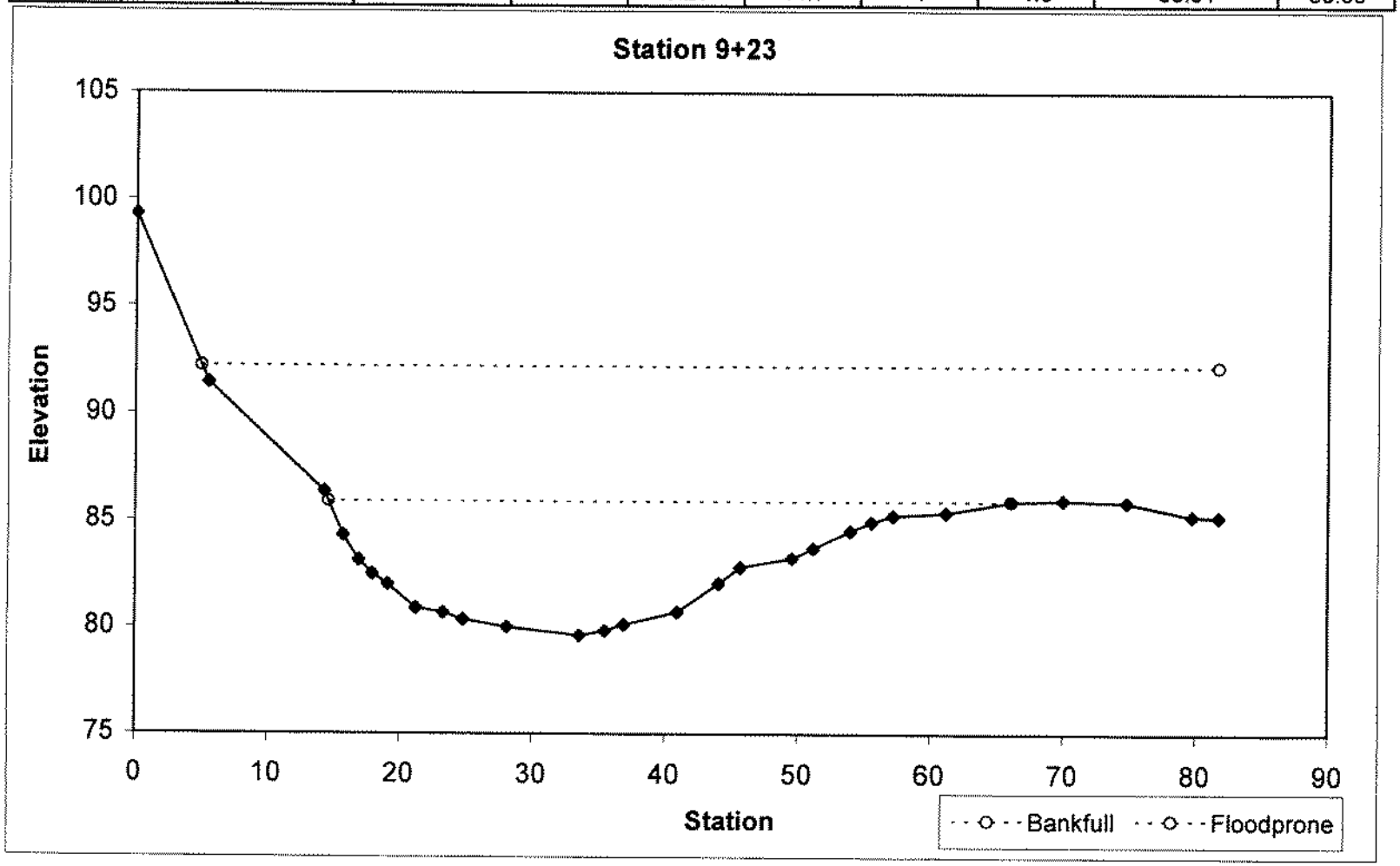
Riffle @ Station 3+50

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	B3c	142.8	51.57	2.77	4.17	18.62	1.7	3.7	90.04	92.91



Pool @ Station 9+23

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		180.3	51.47	3.5	6.29	14.7	1	1.5	85.91	85.98



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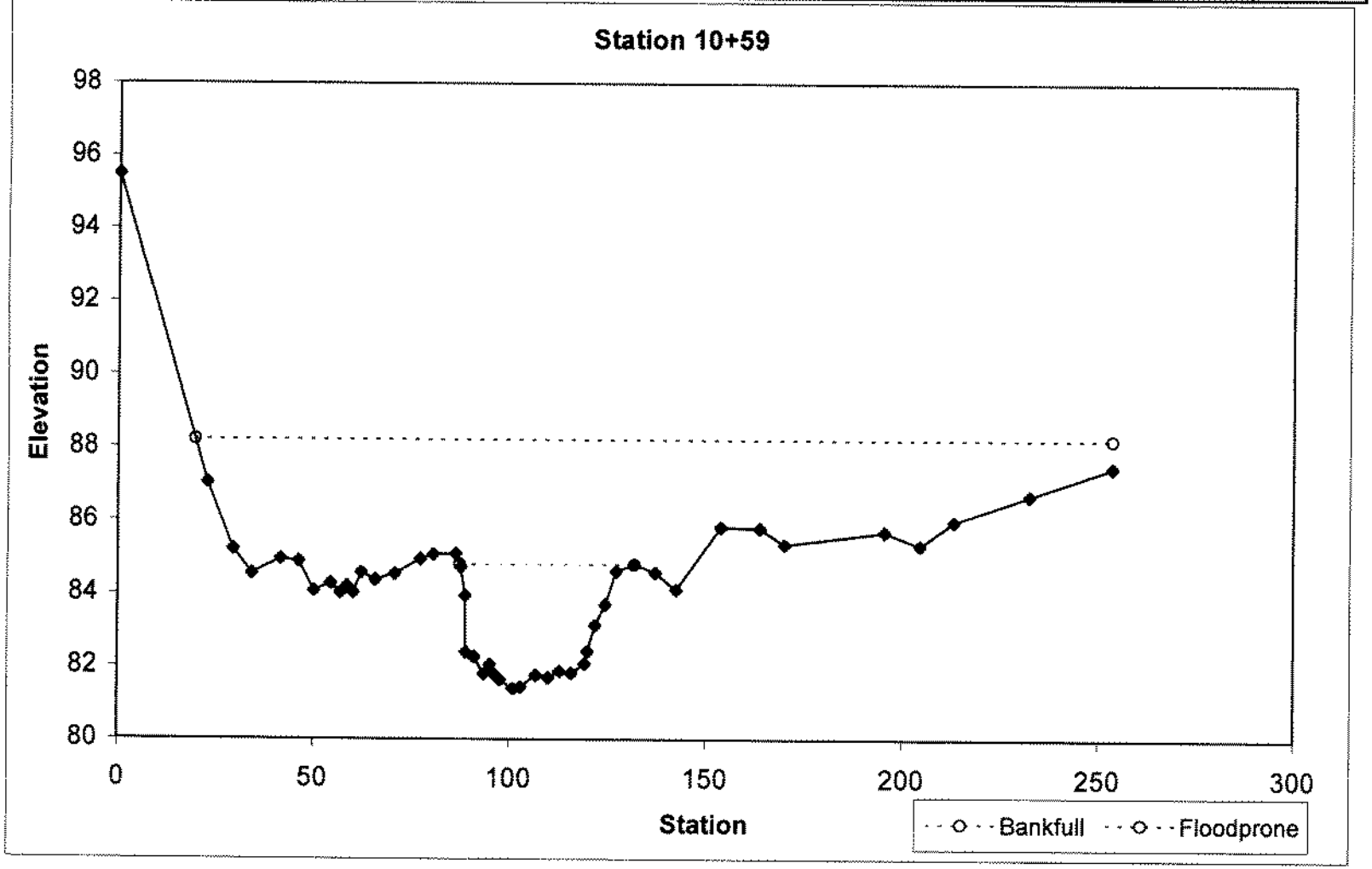
PerchMorph
XSEC 923.3

Riffle @ Station 10+59

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle		103.5	44.55	2.32	3.42	19.17	1	5.3	84.8	84.8



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PerchMorph
XSEC 1058.6

PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	**Dead River**
REACH/LOCATION:	**Perch @ Gauge**
DATE COLLECTED:	**31-Jul-04**
FIELD COLLECTION BY:	**SRB**
DATA ENTERED BY:	**SDC**

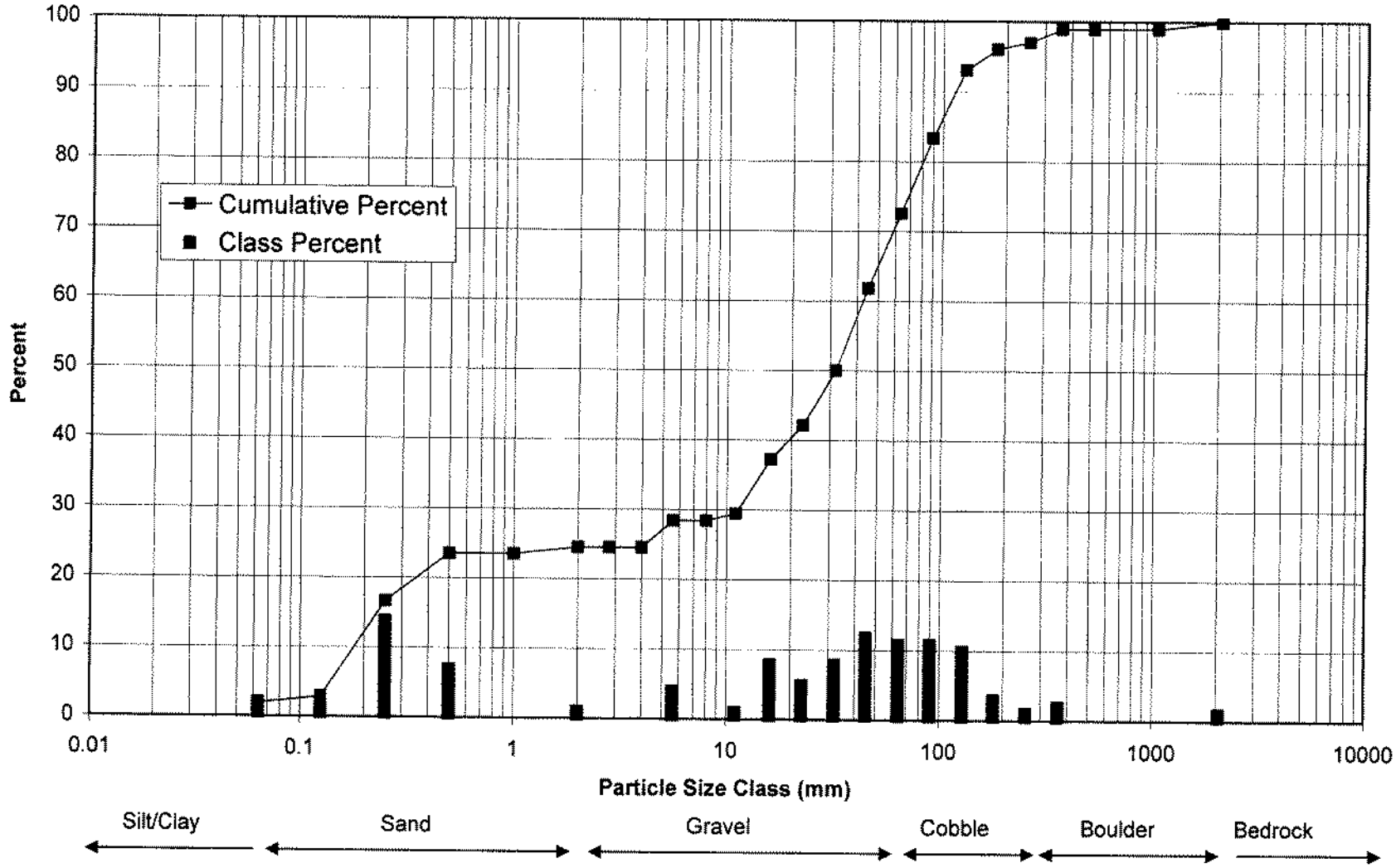
SEDIMENT ANALYSIS DATA SHEET

MATERIAL	PARTICLE	SIZE (mm)	PARTICLE CLASS Riffle	PARTICLE CLASS Pool	PARTICLE CLASS Total	Reach Summary Class %	Reach Summary % Cum	Riffle Summary Class %	Riffle Summary % Cum	Pool Summary Class %	Pool Summary % Cum
	Silt / Clay	< .063	1	1	2	1.96	1.96	1.25	1.25	4.55	4.55
SAND	Very Fine	.063 - .125	1		1	0.98	2.94	1.25	2.50		4.55
SAND	Fine	.125 - .25	9	5	14	13.73	16.67	11.25	13.75	22.73	27.27
SAND	Medium	.25 - .50	2	5	7	6.86	23.53	2.50	16.25	22.73	50.00
SAND	Coarse	.50 - 1.0					23.53		16.25		50.00
SAND	Very Coarse	1.0 - 2.0		1	1	0.98	24.51		16.25	4.55	54.55
GRAVEL	Very Fine	2.0 - 2.8					24.51		16.25		54.55
GRAVEL	Very Fine	2.8 - 4.0					24.51		16.25		54.55
GRAVEL	Fine	4.0 - 5.6	3	1	4	3.92	28.43	3.75	20.00	4.55	59.09
GRAVEL	Fine	5.6 - 8.0					28.43		20.00		59.09
GRAVEL	Medium	8.0 - 11.0	1		1	0.98	29.41	1.25	21.25		59.09
GRAVEL	Medium	11.0 - 16.0	5	3	8	7.84	37.25	6.25	27.50	13.64	72.73
GRAVEL	Coarse	16 - 22.6	4	1	5	4.90	42.16	5.00	32.50	4.55	77.27
GRAVEL	Coarse	22.6 - 32	5	3	8	7.84	50.00	6.25	38.75	13.64	90.91
GRAVEL	Very Coarse	32 - 45	10	2	12	11.76	61.76	12.50	51.25	9.09	100.00
GRAVEL	Very Coarse	45 - 64	11		11	10.78	72.55	13.75	65.00		100.00
COBBLE	Small	64 - 90	11		11	10.78	83.33	13.75	78.75		100.00
COBBLE	Small	90 - 128	10		10	9.80	93.14	12.50	91.25		100.00
COBBLE	Large	128 - 180	3		3	2.94	96.08	3.75	95.00		100.00
COBBLE	Large	180 - 256	1		1	0.98	97.06	1.25	96.25		100.00
BOULDER	Small	256 - 362	2		2	1.96	99.02	2.50	98.75		100.00
BOULDER	Small	362 - 512					99.02		98.75		100.00
BOULDER	Medium	512 - 1024					99.02		98.75		100.00
BOULDER	Large-Very Large	1024 - 2048	1		1	0.98	100.00	1.25	100.00		100.00
BEDROCK	Bedrock	> 2048					100.00		100.00		100.00
			80	22	102			100	100	100	100

Cummulative	Riffle	Pool
Channel materials	Channel materials	Channel materials
D_{16} = 0.24	D_{16} = 0.47	D_{16} = 0.18
D_{35} = 14.37	D_{35} = 25.97	D_{35} = 0.32
D_{50} = 32.00	D_{50} = 43.49	D_{50} = 1.00
D_{84} = 92.18	D_{84} = 104.35	D_{84} = 26.83
D_{95} = 158.85	D_{95} = 180.00	D_{95} = 37.31
D_{100} = 1024 - 2048	D_{100} = 1024 - 2048	D_{100} = 32 - 45

Sediment Distribution

Dead River - Perch @ Gauge



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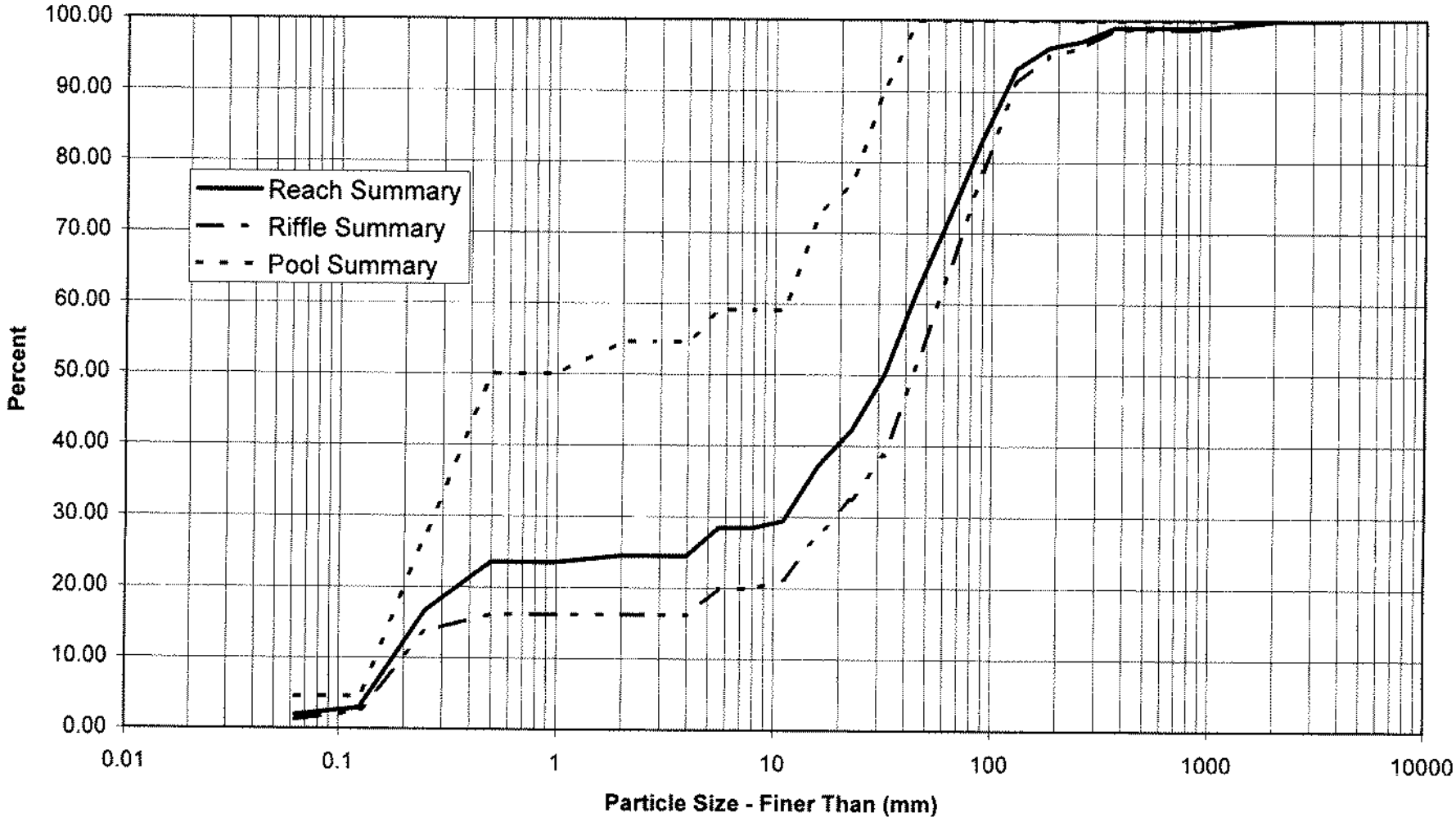
Pebble Count for Classification
LogHistogram

Sediment Distribution by Feature

Dead River - Perch @ Gauge



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Pebble Count for Classification
Feature Summary

PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	**Dead River**
REACH/LOCATION:	**Perch - Wetted Surface**
DATE COLLECTED:	**11-Oct-04**
FIELD COLLECTION BY:	**SRB**
DATA ENTERED BY:	**SRB**

SEDIMENT ANALYSIS DATA SHEET

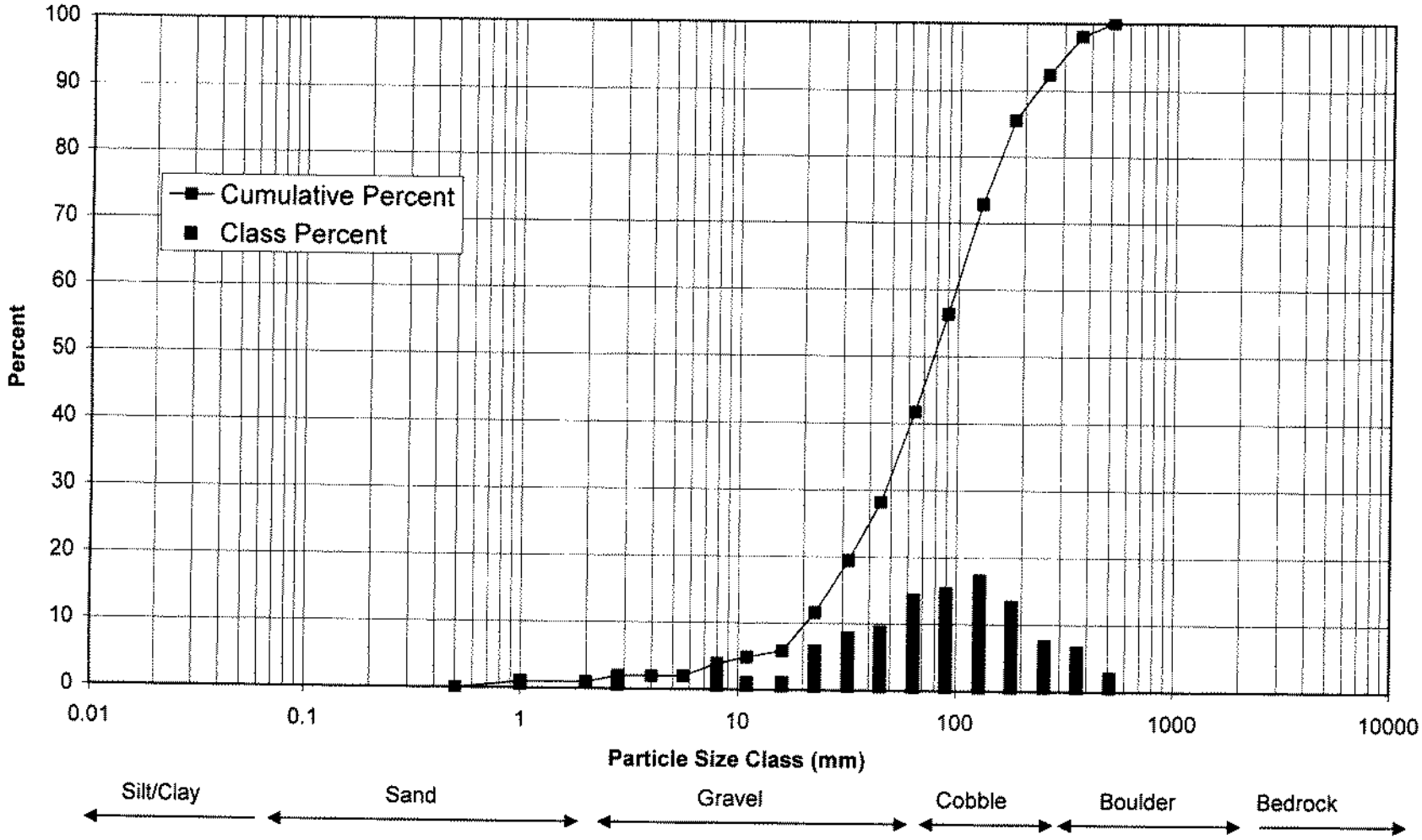
			PARTICLE CLASS			Reach Summary		Riffle Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063					0.00		0.00
SAND	Very Fine	.063 - .125					0.00		0.00
	Fine	.125 - .25					0.00		0.00
	Medium	.25 - .50					0.00		0.00
	Coarse	.50 - 1.0	1		1	0.97	0.97	0.97	0.97
	Very Coarse	1.0 - 2.0					0.97		0.97
GRAVEL	Very Fine	2.0 - 2.8	1		1	0.97	1.94	0.97	1.94
	Very Fine	2.8 - 4.0					1.94		1.94
	Fine	4.0 - 5.6					1.94		1.94
	Fine	5.6 - 8.0	2		2	1.94	3.88	1.94	3.88
	Medium	8.0 - 11.0	1		1	0.97	4.85	0.97	4.85
	Medium	11.0 - 16.0	1		1	0.97	5.83	0.97	5.83
	Coarse	16 - 22.6	6		6	5.83	11.65	5.83	11.65
	Coarse	22.6 - 32	8		8	7.77	19.42	7.77	19.42
	Very Coarse	32 - 45	9		9	8.74	28.16	8.74	28.16
	Very Coarse	45 - 64	14		14	13.59	41.75	13.59	41.75
COBBLE	Small	64 - 90	15		15	14.56	56.31	14.56	56.31
	Small	90 - 128	17		17	16.50	72.82	16.50	72.82
	Large	128 - 180	13		13	12.62	85.44	12.62	85.44
	Large	180 - 256	7		7	6.80	92.23	6.80	92.23
BOULDER	Small	256 - 362	6		6	5.83	98.06	5.83	98.06
	Small	362 - 512	2		2	1.94	100.00	1.94	100.00
	Medium	512 - 1024					100.00		100.00
	Large-Very Large	1024 - 2048					100.00		100.00
BEDROCK	Bedrock	> 2048					100.00		100.00
			103	0	103			100	100

Cummulative
Channel materials
D_{16} = 27.46
D_{35} = 53.73
D_{50} = 77.64
D_{84} = 173.15
D_{95} = 301.80
D_{100} = 362 - 512

Riffle
Channel materials
D_{16} = 27.46
D_{35} = 53.73
D_{50} = 77.64
D_{84} = 173.15
D_{95} = 301.80
D_{100} = 362 - 512

Sediment Distribution

Dead River - Perch - Wetted Surface



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Wetted SurfcaeSediment Distribution
LogHistogram

Pavement/Subpavement Analysis

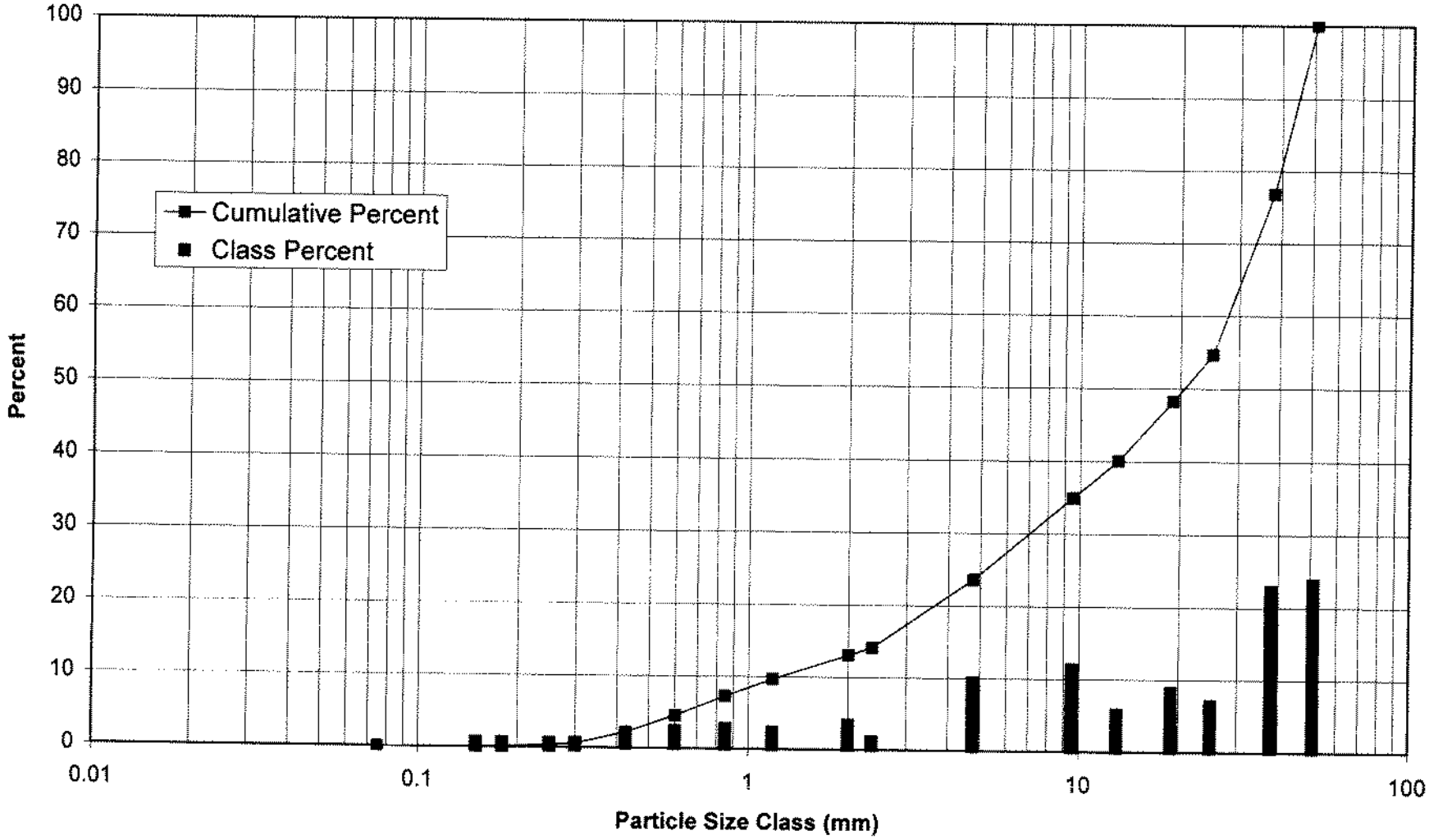
SITE OR PROJECT:	Dead R. Limited Use Curves
REACH/LOCATION:	Perch Subpavement
DATE COLLECTED:	10/14/04
FIELD COLLECTION BY:	SRB
DATA ENTERED BY:	STS/SRB

SEDIMENT ANALYSIS DATA SHEET

MATERIAL	PARTICLE	SIZE (mm)	Sample 1 (g)		Pavement Class %	Pavement % Cum
	Silt / Clay	< .075				0.00
SAND	Very Fine	.075 - .15	6.8		0.08	0.08
	Fine	.15 - .18	5.9		0.07	0.16
	Fine	.18 - .25	19		0.23	0.39
	Fine	0.25 - 0.3	20.9		0.26	0.65
	Medium	0.3 - 0.425	128.5		1.58	2.22
	Medium	0.425 - 0.6	193.8		2.38	4.61
	Medium	0.6 - 0.85	223.7		2.75	7.35
	Medium	0.85 - 1.18	190.3		2.34	9.69
	Medium	1.18 - 2.0	272.7		3.35	13.04
	Coarse	2.0 - 2.36	90.1		1.11	14.15
	Coarse	2.36 - 4.75	763.7		9.38	23.53
GRAVEL	Small	4.75 - 9.5	920.8		11.31	34.84
	Small	9.5 - 13	422.2		5.19	40.03
	Fine	13 - 19	668.9		8.22	48.25
	Large	19 - 25	522		6.41	54.66
	Large	25 - 38	1806		22.19	76.84
	Large	38 - 51	1884.9		23.16	100.00
	Large	51 - 64				100.00
COBBLE	Small	64 - 75				100.00
	Medium	75 - 90				100.00
	Medium	90 - 128				100.00
	Medium	128 - 180				100.00
	Large	180 - 256				100.00
BOULDER	Small	256 - 362				100.00
	Medium	362 - 512				100.00
	Medium	512 - 1024				100.00
	Large-Very Large	1024 - 2048				100.00
BEDROCK	Bedrock	> 2048				100.00
			8140	0	100	100

Channel materials	Sample 1	
D_{16} =	2.71	
D_{35} =	9.59	
D_{50} =	20.48	
D_{84} =	41.62	
D_{95} =	47.86	
D_{100} =	51.00	

Dead R. Limited Use Curves - Perch Subpavement



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PerchSTSPavement Sub Pavement
LogHistogramDetail

LEGEND

.... FOOT TRAIL

FISH HABITAT STRUCTURES

BANK / TERRACE

BUCK

1347 Harding Place
Suite 100
Charlotte, North Carolina 28204
Phone: 704.334.4454
Fax: 704.334.4492
www.buckengineering.com

Sheet 1 of 1

Perch River Sketch

Dead *River Post-Event Additional Environmental Assessment*

Work Plan Photograph Key

Dead River Recovery Post-Event Additional Environmental Assessment: Survey of Morphological Stream Parameters Using Rosgen Method

Number [1]	Subject	Location [2]
1	Bankfull stage indicator	location that best depicts indicator (Rosgen, 1996)
2	Stream downstream of the cross-section	standing mid-stream at the tape
3	Stream upstream of the cross-section	standing mid-stream at the tape
4	Cross-section photo	downstream of the cross-section facing upstream
5	Cross-section photo	upstream of the cross-section facing downstream
6	Right floodplain	right top of bank at the cross-section
7	Left floodplain	left top of bank at the cross-section
8	Stream upstream of the reach	standing mid-stream at the start of the longitudinal profile
9	Stream downstream of the reach	standing mid-stream at the end of the longitudinal profile
10	A sufficient number of photographs to provide a continuous visual documentation of the survey reach	facing downstream

Notes:

1. A letter designation is used in addition to the photo number (e.g. 10A, 10B, 10C, etc.) if more than one photograph was taken of a particular subject or from a single location.
2. Location from which photograph was taken.

PERCH POOL XS #1

PERCH POOL XS #2

PERCH POOL XS #3

PERCH POOL XS #4

PERCH POOL XS #5

PERCH POOL XS #6

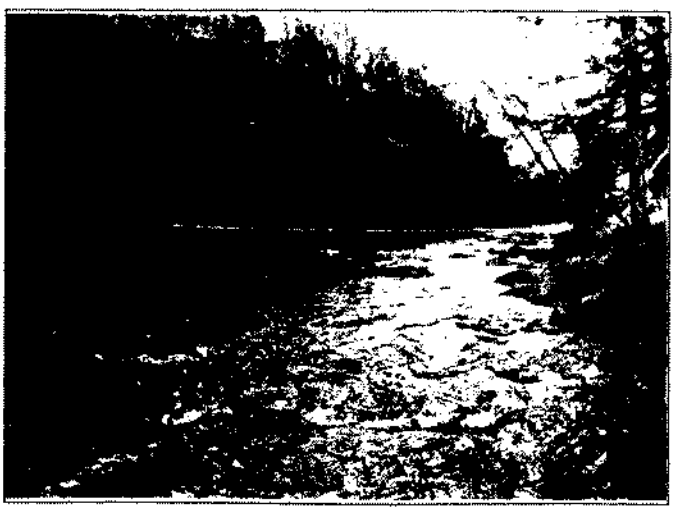
PERCH POOL XS #7

PERCH RIFFLE XS1 #1

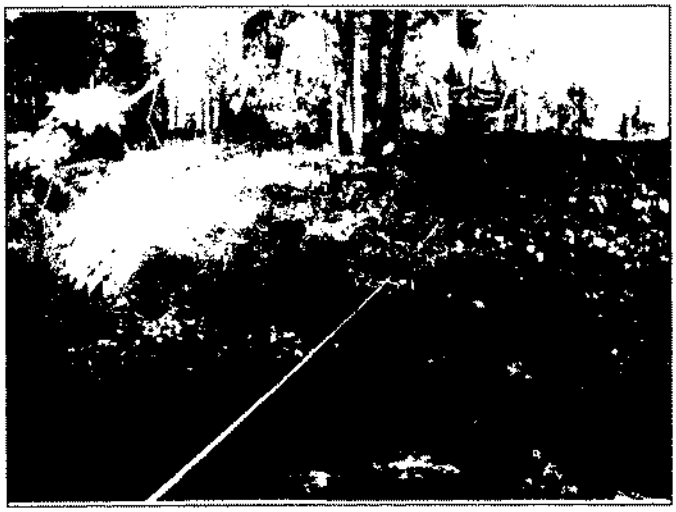
PERCH RIFFLE XS1 #2

PERCH RIFFLE XS1 #3

PERCH RIFFLE XS1 #4

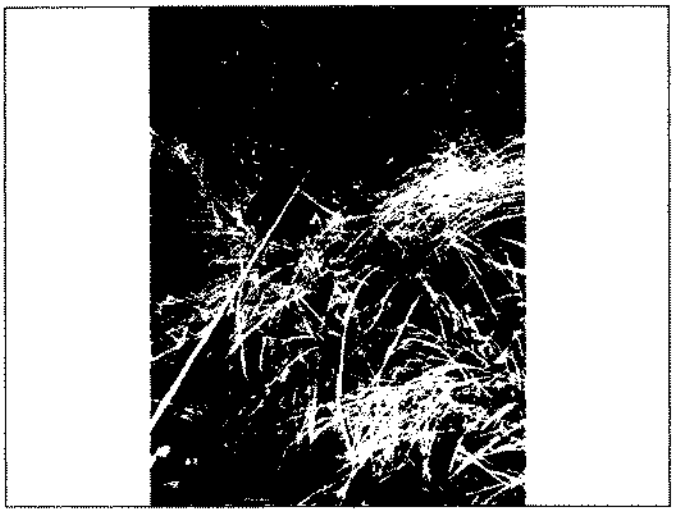


PERCH RIFFLE XS1 #5



PERCH RIFFLE XS1 #6

PERCH RIFFLE XS1 #7



PERCH RIFFLE XS2 #1A

PERCH RIFFLE XS2 #1B

PERCH RIFFLE XS2 #2

PERCH RIFFLE XS2 #4

PERCH RIFFLE XS2 #5

PERCH RIFFLE XS2 #6

PERCH RIFFLE XS2 #7

PERCH #9

PERCH #10A

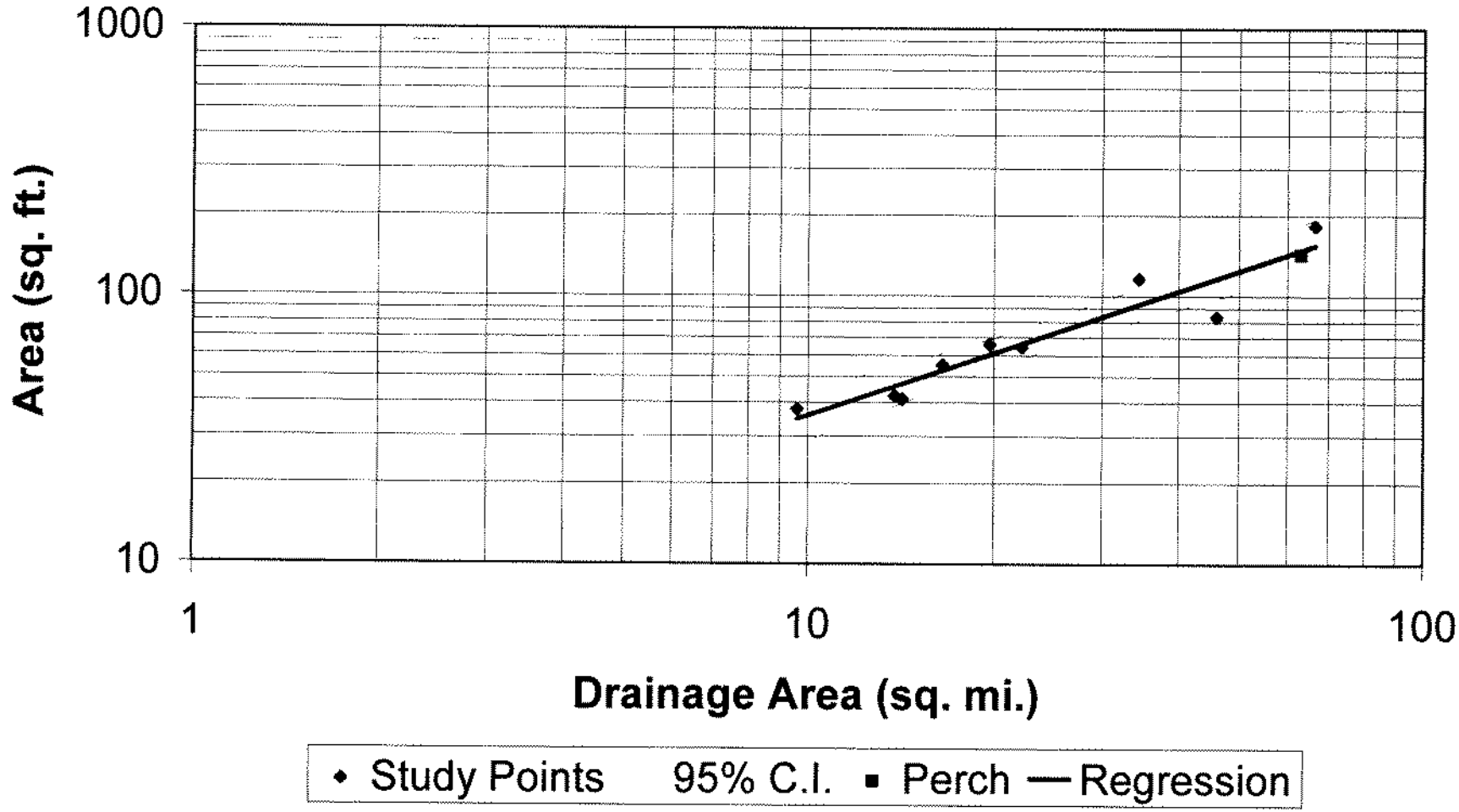
PERCH #10B

PERCH #10C

PERCH #10D

Cross Sectional Area vs. Drainage Area

$y = 6.0x^{0.77}$, $r^2 = 0.91$



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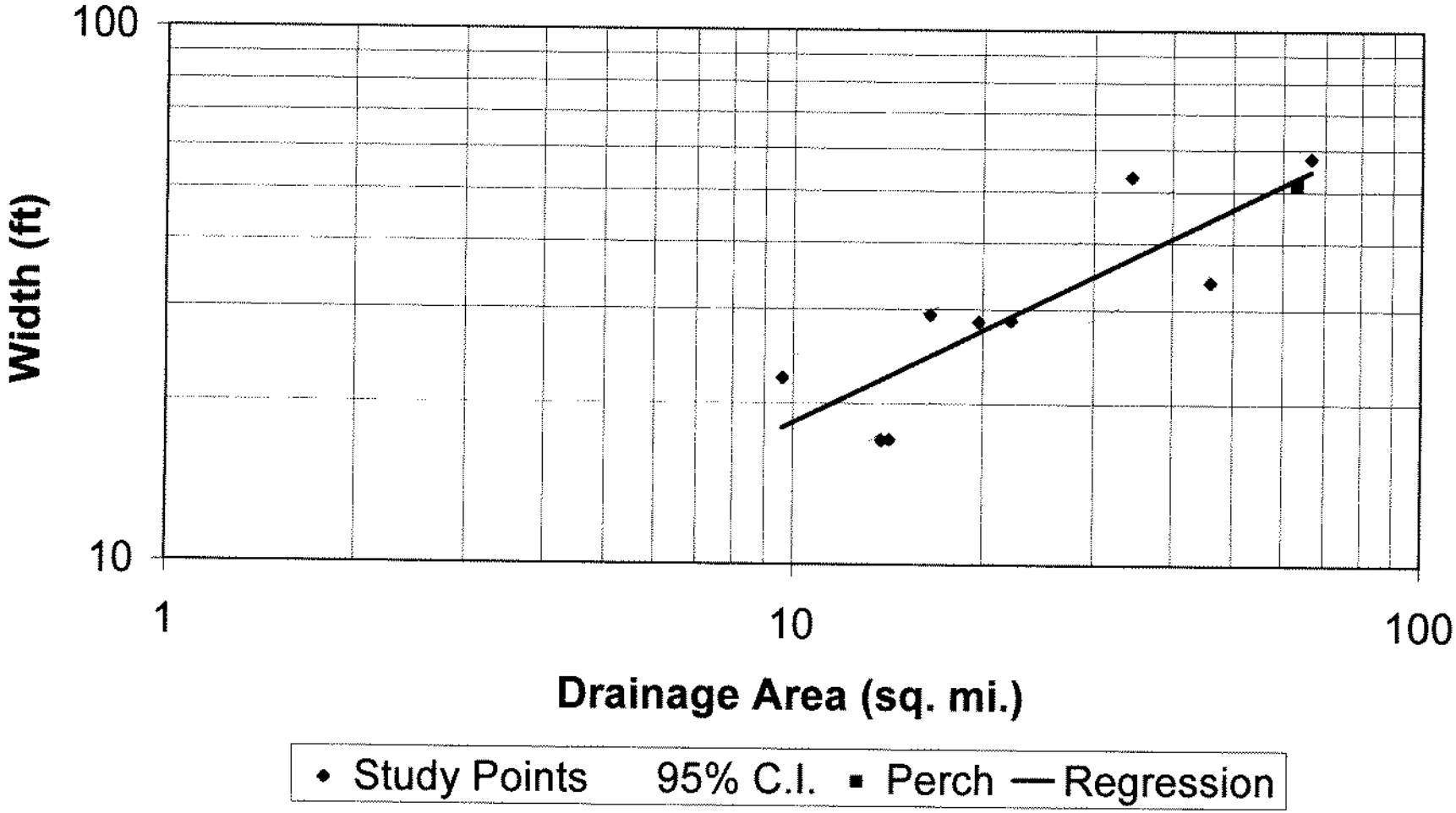
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Perch
Curves Chart 1

Bankfull Width vs. Drainage Area

$y = 4.9x^{0.57}$, $r^2 = 0.76$



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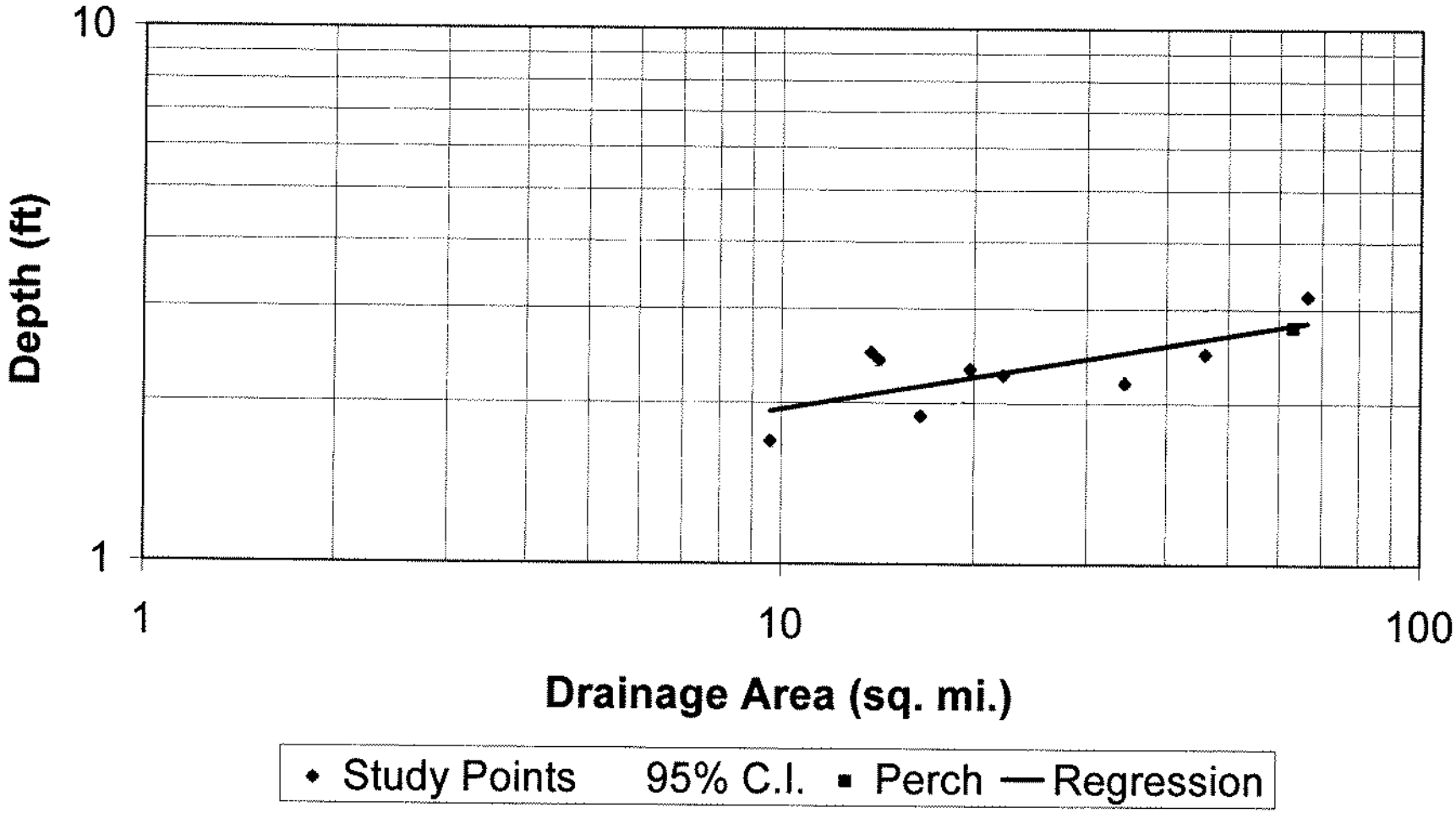
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Perch
Curves Chart 2

Bankfull Mean Depth vs. Drainage Area

$y = 1.2x^{0.20}$, $r^2 = 0.57$



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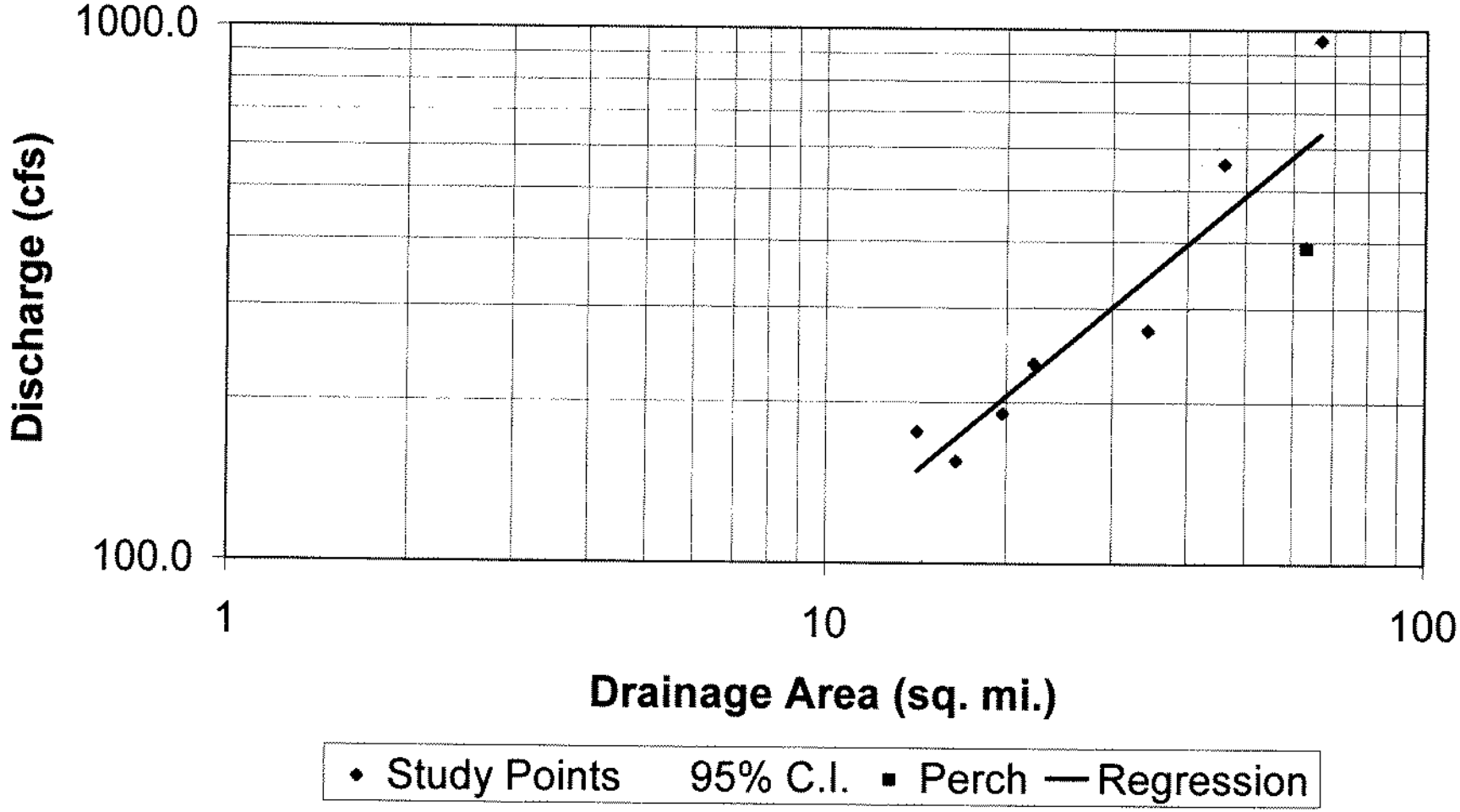
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Perch
Curves Chart 3

Bankfull Discharge vs. Drainage Area

$y = 12.2x^{0.94}$, $r^2 = 0.82$



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NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Perch
Curves Chart 6

Clark Creek

Initials	Work Item
AB	Collect the following data at a minimum for each reference reach.

Reach ID: **Clark Creek**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 20 times bankfull width
- ☑ Survey a minimum of two (2) cross-sections (one each at a riffle and pool)
- ☑ Measure plan form features:
  - ☑ -- Sinuosity
  - ☑ -- Meander length
  - ☑ -- Radius of curvature
  - ☑ -- Belt width
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sample pavement/sub-pavement per Rosgen, 1996
- ☑ Sketch site per Harrelson et al., 1994
- ☑ Photograph site

Initials	Work Item
LB	Collect the following data at a minimum for each LUC reach.

Reach ID: **Clark (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☑ Photograph site.

Initials	Work Item
SPB	Provide the following items for each reference reach in electronic and hard copy format.

Reach ID: **Clark Creek**

- ☑ Morphological Data Table
- ☑ Plot of longitudinal profile
- ☑ Plot of cross-sections
- ☑ Grain size distribution
  - ☑ -- Bed material
  - ☑ -- Pavement/sub-pavement material
- ☑ Site sketch
- ☑ Photographs and photo log
- ☑ GIS data layer depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)

Initials	Work Item
SMB	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Clark (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ✓ Limited Use Curves
  - ✓ DA versus Wbkf
  - ✓ DA versus Dbkf
  - ✓ DA versus CSA
  - ✓ DA versus Qbkf
- ✓ Plot of longitudinal profile
- ✓ Plot of cross-section
- ✓ Grain size distribution for bed material
- ✓ Site sketch
- ✓ Photographs and photo log.
- ✓ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)
- ✓ Calculations (single section analysis)
- ✓ Plot of Single Section Analysis versus Regression Equation

MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

Assessment Site (Name of stream and location) Clark Creek
Marquette, MI

	Variables	Existing Channel		
1	Stream Type		C4	
2	Drainage Area, mi2		19.70	
3	Bankfull Width, ft (Wbkf)	Mean	33.02	
		Range	28.43	37.61
4	Bankfull Mean Depth, ft (dbkf)	Mean	2.41	
		Range	2.31	2.51
5	Width/Depth Ratio (Wbkf/dbkf)	Mean	13.635	
		Range	12.29	14.98
6	Bankfull Cross-Sectional Area, ft2 (Abkf)	Mean	80.1	
		Range	65.8	94.4
7	Bankfull Mean Velocity, ft/s (Ubkf)	Mean	3.26	
		Range	2.89	3.64
8	Bankfull Discharge, ft3/s (Qbkf)		190.2	
9	Bankfull Maximum Depth, ft (dmbkf)	Mean	3.07	
		Range	3.06	3.08
10	Max Riffle Depth/Mean Riffle Depth (dmbkf/dbkf)	Mean	1.25	
		Range	1.2	1.3
11	Low Bank Height to Max Riffle Depth (LBH/dmbkf)	Mean	1.05	
		Range	1	1.1
12	Width of Floodprone Area, ft (Wfpa)	Mean	105.8	
		Range	93.2	118.4
13	Entrenchment Ratio (Wfpa/Wbkf)	Mean	3.32	
		Range	2.48	4.17
14	Meander Length, ft (Lm)	Mean	290	
		Range	240	340
15	Meander Length Ratio, (Lm/Wbkf)	Mean	8.8	
		Range	7.3	10.3
16	Radius of Curvature, ft (Rc)	Mean	72	
		Range	52	101
17	Ratio of Radius of Curvature to Bankfull Width (Rc/Wbkf)	Mean	2.32	
		Range	1.57	3.06
18	Belt Width, ft (Wblt)	Mean	285	
		Range	220	350
19	Meander Width Ratio (Wblt/Wbkf)	Mean	8.63	
		Range	6.66	10.60
20	Sinuosity (K)		1.26	
21	Valley Slope (VS)		0.0036	
22	Average Water Surface Slope (S) = (VS/K)		0.0027	
23	Pool Slope (water surface facet slope) (Sp)	Mean	0.0006	
		Range	0.0002	0.0009
24	Ratio of Pool Slope/Average Water Surface Slope (Sp/S)	Mean	0.21	
		Range	0.07	0.34
25	Riffle Slope (water surface facet slope) (Srif)	Mean	0.0066	
		Range	0.0037	0.0095
26	Ratio Riffle Slope to Average Water Surface Slope (Srif/S)	Mean	2.45	
		Range	1.39	3.50

MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

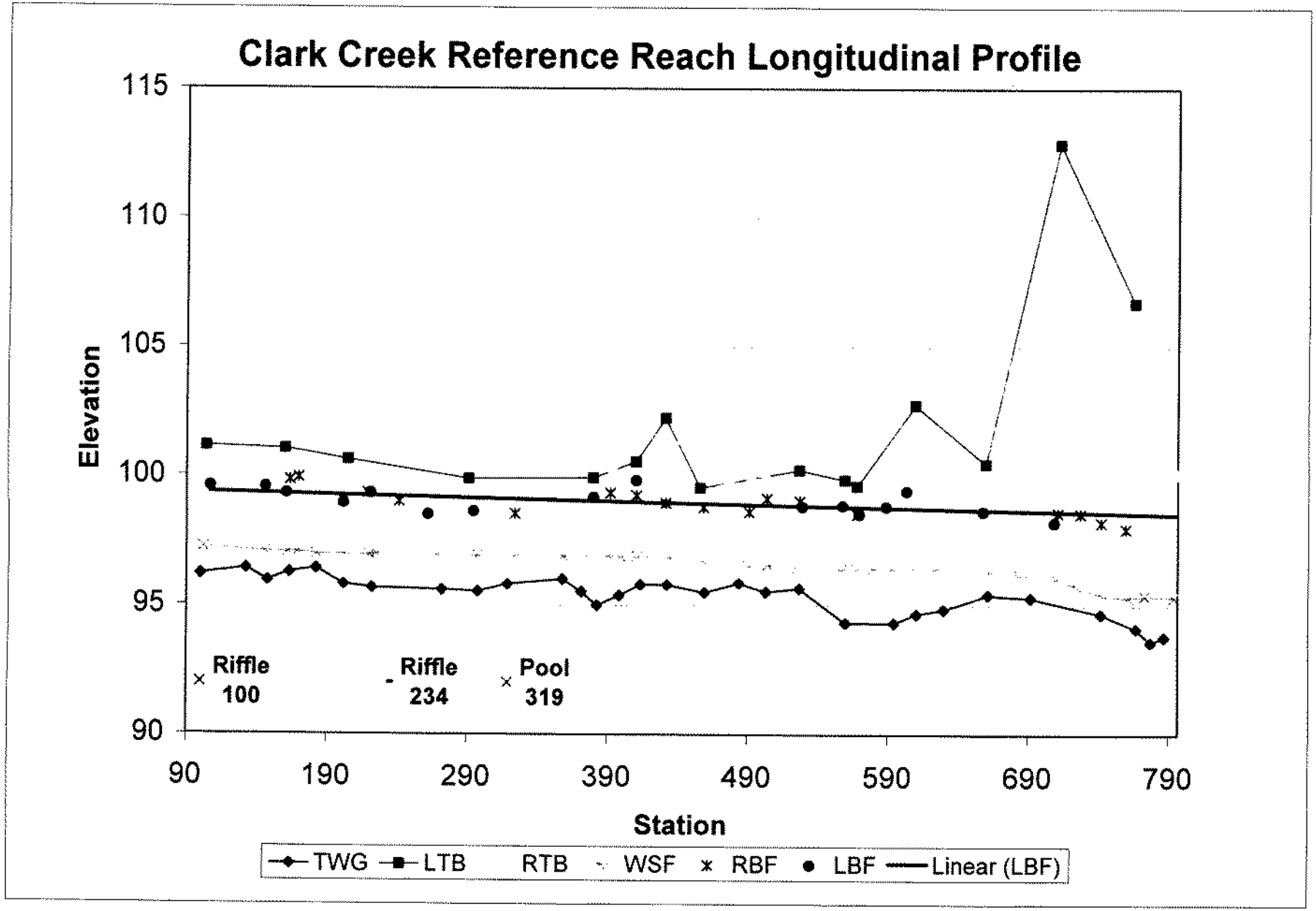
Assessment Site (Name of stream and location) Clark Creek
Marquette, MI

	Variables	Existing Channel		
27	Run Slope (water surface facet slope) (Srun)	Mean	0.00438	
		Range	0.00297	0.00549
28	Ratio Run Slope/Average Water Surface Slope (Srun/S)	Mean	1.57	
		Range	1.10	2.03
29	Glide Slope (water surface facet slope) (Sg)	Mean	0.0005	
		Range	0.0002	0.0007
30	Ratio Glide Slope/Average Water Surface Slope (Sg/S)	Mean	0.17	
		Range	0.07	0.26
31	Max Pool Depth, ft (dmbfkp)	Mean	4.34	
		Range	4.34	4.34
32	Ratio Max Pool Depth/Bankfull Mean Depth (dmbfkp/dbkf)	Mean	1.81	
		Range	1.73	1.88
33	Max Run Depth, ft (drun)	Mean	3.90	
		Range	3.80	4.00
34	Ratio Max Run Depth/Bankfull Mean Depth (drun/dbkf)	Mean	1.62	
		Range	1.51	1.73
35	Max Glide Depth, ft (dg)	Mean	4.05	
		Range	3.90	4.20
36	Ratio Max Glide Depth/Bankfull Mean Depth (dg/dbkf)	Mean	1.69	
		Range	1.55	1.82
37	Pool Width, ft (Wbkfp)	Mean	39.12	
		Range	39.12	39.12
38	Ratio of Pool Width to Bankfull Width (Wbkfp/Wbkf)	Mean	1.28	
		Range	1.18	1.38
	Pool Area	Mean	114.8	
		Range	114.8	114.8
39	Ratio of Pool Area to Bankfull Area	Mean	1.59	
		Range	1.43	1.74
40	Point Bar Slope	Mean	0.13	
		Range	0.12	0.13
41	Pool to Pool Spacing, ft (p-p)	Mean	290	
		Range	240	340
42	Ratio of p-p Spacing to Bankfull Width (p-p/Wbkf)	Mean	9.61	
		Range	7.27	11.96
	MATERIALS			
43	Particle Size Distribution of Channel Material (active bed)			
	D16 (mm)		10.3	
	D35 (mm)		32.8	
	D50 (mm)		52.1	
	D84 (mm)		162.7	
	D95 (mm)		316.5	

MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

Assessment Site (Name of stream and location) Clark Creek
Marquette, MI

	MATERIALS			
44	Particle Size Distribution of Bar Material			
	D16 (mm)		1.6	
	D35 (mm)		6.8	
	D50 (mm)		15.0	
	D84 (mm)		39.8	
	D95 (mm)		47.2	
	Largest size particle at the toe (lower third) of bar (mm)		70.0	
45	Particle Size Distribution of Channel Material (Pavement)			
	D16 (mm)		10.3	
	D35 (mm)		32.8	
	D50 (mm)		52.1	
	D84 (mm)		162.7	
	D95 (mm)		316.5	
46	Particle Size Distribution of Subpavement			
	D16 (mm)		1.6	
	D35 (mm)		6.8	
	D50 (mm)		15.0	
	D84 (mm)		39.8	
	D95 (mm)		47.2	
	Largest size particle at the toe (lower third) of bar (mm)		70.0	
47	Reach Wide Particle Size Distribution			
	D16 (mm)		0.2	
	D35 (mm)		22.9	
	D50 (mm)		50.6	
	D84 (mm)		154.0	
	D95 (mm)		288.0	
	D100(mm)		362.0	



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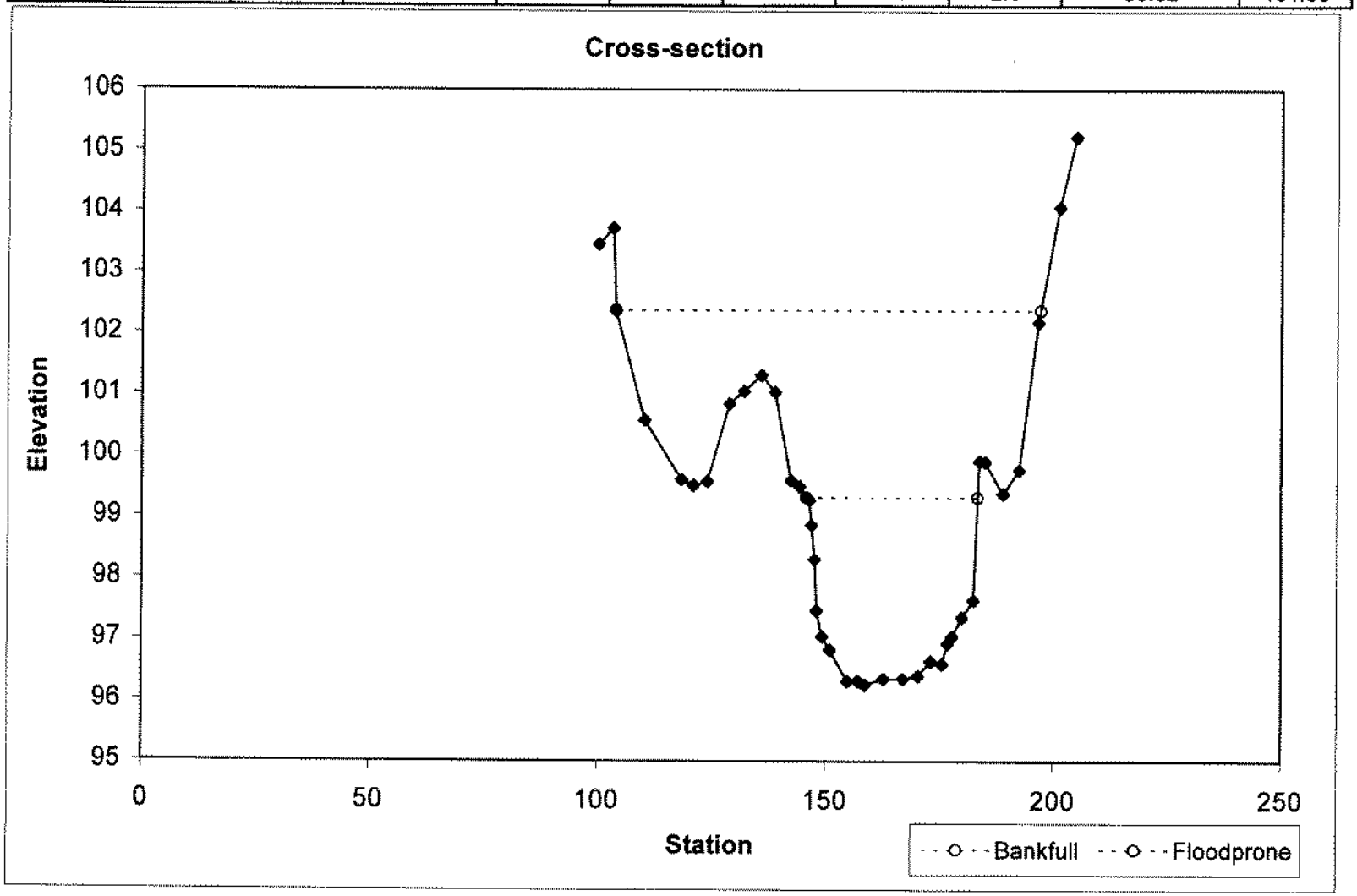
ClarkMorph
Profile Chart 1

Riffle @ Station 1+00

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle		94.4	37.61	2.51	3.06	14.98	1.6	2.5	99.32	101.03



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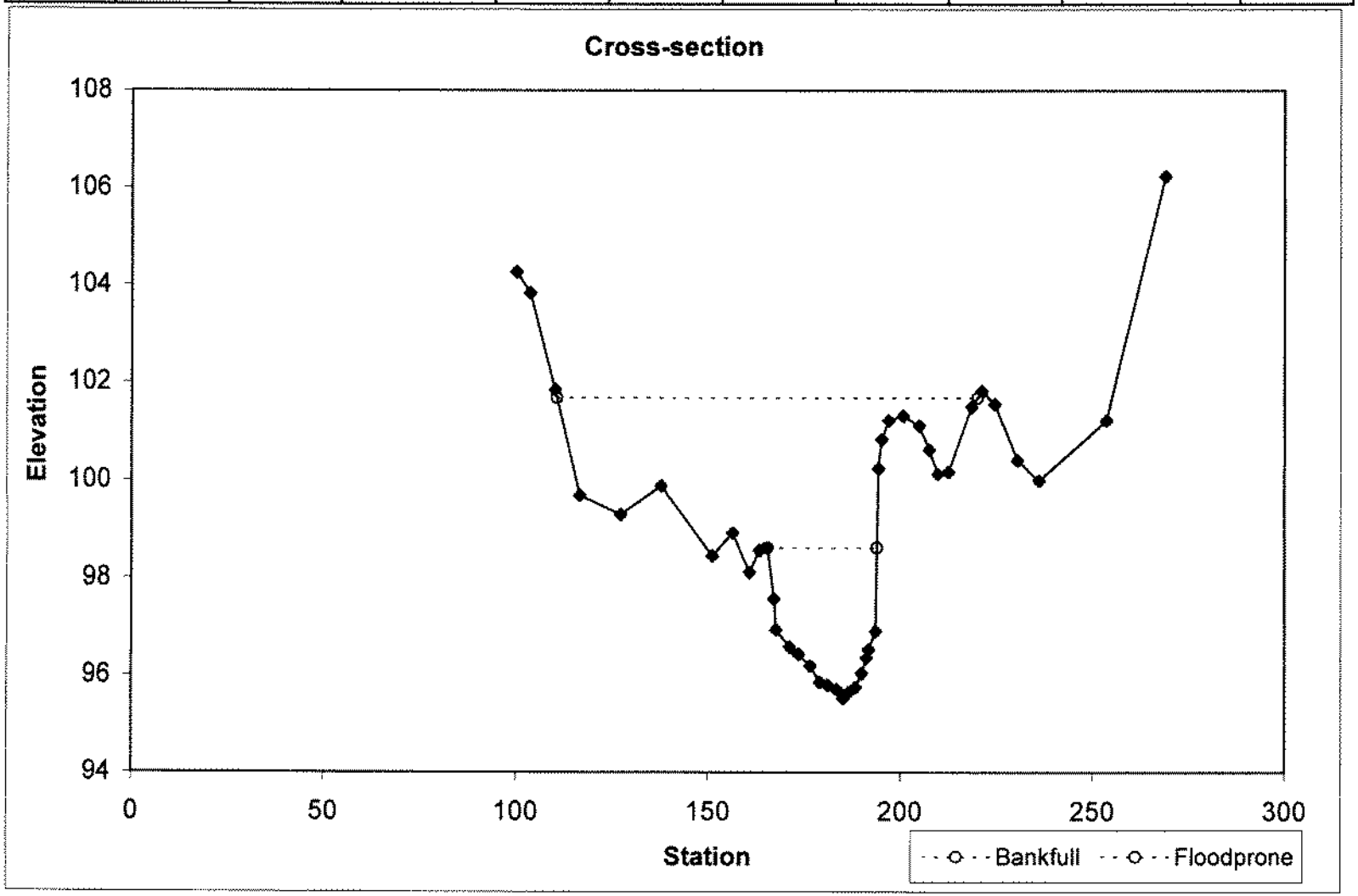
ClarkMorph
XSEC (1)

Riffle @ Station 2+34

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	WBI	BH Ratio	ER	BKF Elev	TOB Elev
Riffle		65.8	28.43	2.31	3.08	12.29	1.4	3.9	98.61	99.88



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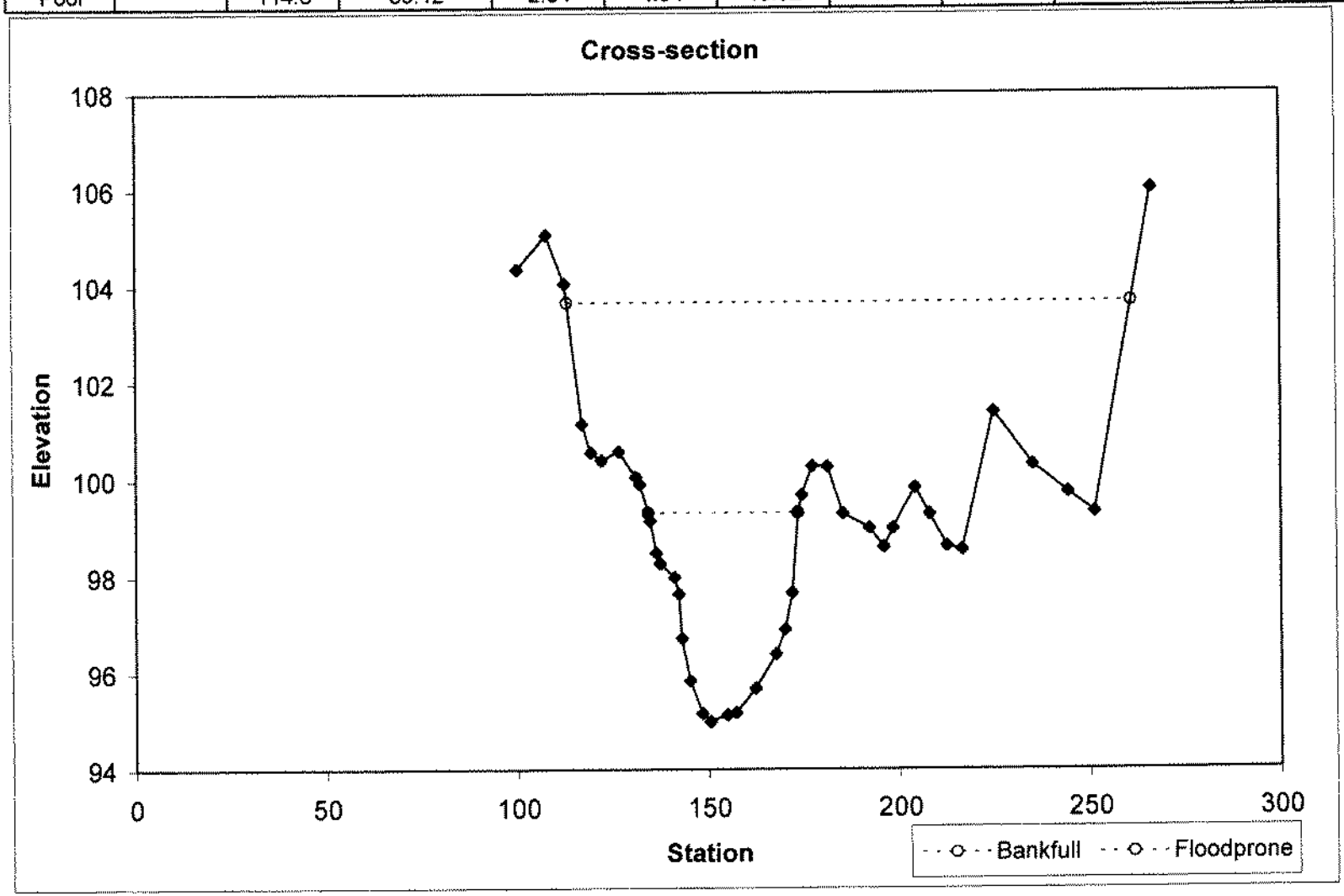
ClarkMorph
XSEC (2)

Pool @ Station 3+19

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		114.8	39.12	2.94	4.34	13.32	1.1	3.8	99.33	99.91



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PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	Dead River
REACH/LOCATION:	Clark
DATE COLLECTED:	11-Oct-04
FIELD COLLECTION BY:	SRB
DATA ENTERED BY:	SRB

SEDIMENT ANALYSIS DATA SHEET

MATERIAL	PARTICLE	SIZE (mm)	PARTICLE CLASS			Reach Summary		Riffle Summary		Pool Summary	
			Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063					0.00		0.00		0.00
SAND	Very Fine	.063 - .125	10	4	14	13.21	13.21	13.16	13.16	13.33	13.33
	Fine	.125 - .25	5	1	6	5.66	18.87	6.58	19.74	3.33	16.67
	Medium	.25 - .50	7	2	9	8.49	27.36	9.21	28.95	6.67	23.33
	Coarse	.50 - 1.0	1	2	3	2.83	30.19	1.32	30.26	6.67	30.00
	Very Coarse	1.0 - 2.0	1		1	0.94	31.13	1.32	31.58		30.00
GRAVEL	Very Fine	2.0 - 2.8					31.13		31.58		30.00
	Very Fine	2.8 - 4.0	1		1	0.94	32.08	1.32	32.89		30.00
	Fine	4.0 - 5.6					32.08		32.89		30.00
	Fine	5.6 - 8.0	2		2	1.89	33.96	2.63	35.53		30.00
	Medium	8.0 - 11.0	1		1	0.94	34.91	1.32	36.84		30.00
	Medium	11.0 - 16.0					34.91		36.84		30.00
	Coarse	16 - 22.6					34.91		36.84		30.00
	Coarse	22.6 - 32	2	1	3	2.83	37.74	2.63	39.47	3.33	33.33
	Very Coarse	32 - 45	9	1	10	9.43	47.17	11.84	51.32	3.33	36.67
	Very Coarse	45 - 64	6	3	9	8.49	55.66	7.89	59.21	10.00	46.67
COBBLE	Small	64 - 90	7	3	10	9.43	65.09	9.21	68.42	10.00	56.67
	Small	90 - 128	10	3	13	12.26	77.36	13.16	81.58	10.00	66.67
	Large	128 - 180	10	3	13	12.26	89.62	13.16	94.74	10.00	76.67
	Large	180 - 256	2	2	4	3.77	93.40	2.63	97.37	6.67	83.33
BOULDER	Small	256 - 362	1	4	5	4.72	98.11	1.32	98.68	13.33	96.67
	Small	362 - 512	1	1	2	1.89	100.00	1.32	100.00	3.33	100.00
	Medium	512 - 1024					100.00		100.00		100.00
	Large-Very Large	1024 - 2048					100.00		100.00		100.00
BEDROCK	Bedrock	> 2048					100.00		100.00		100.00
			76	30	106			100	100	100	100

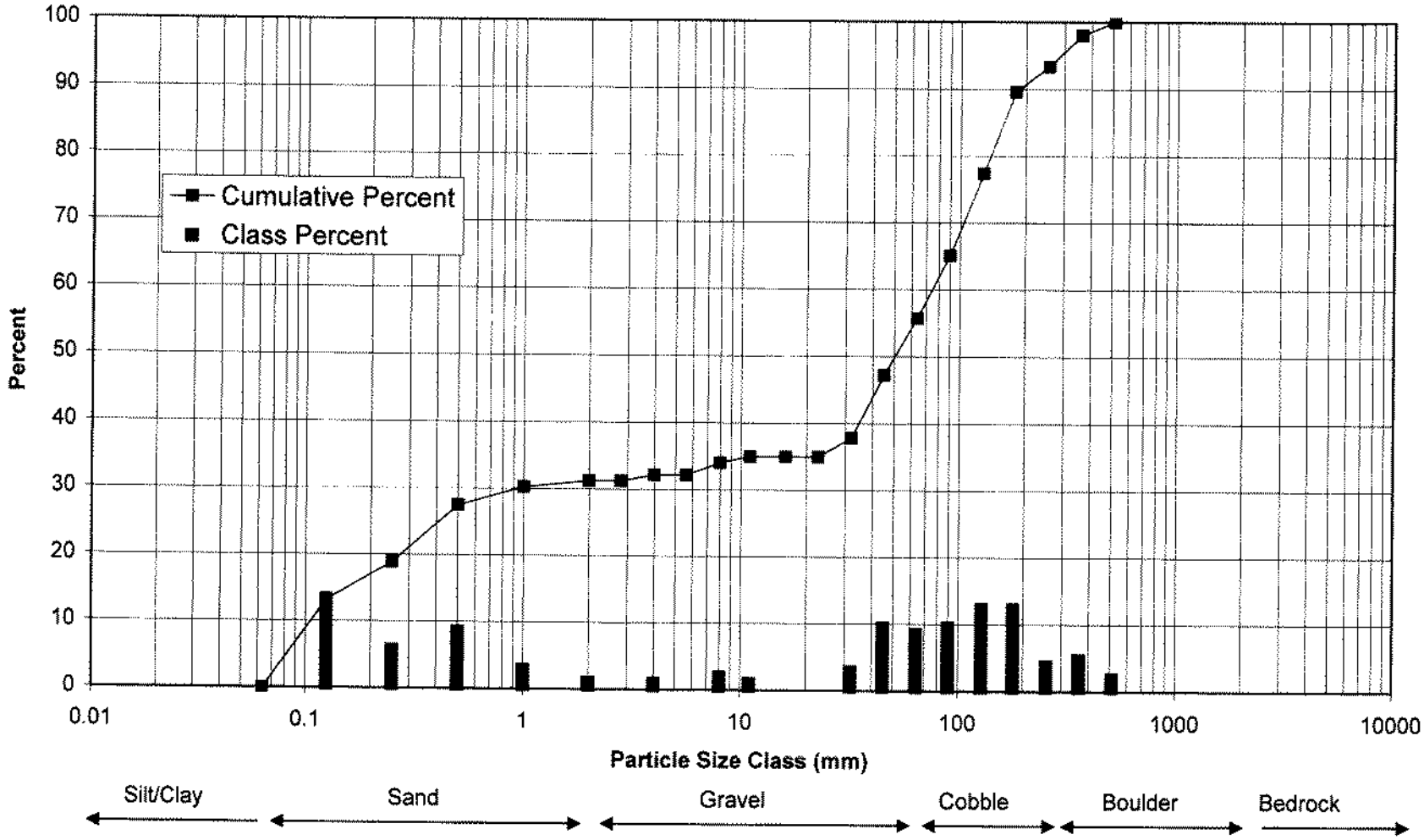
Cummulative	
Channel materials	
D_{16} =	0.18
D_{35} =	22.86
D_{50} =	50.61
D_{84} =	153.95
D_{95} =	288.00
D_{100} =	362 - 512

Riffle	
Channel materials	
D_{16} =	0.17
D_{35} =	7.45
D_{50} =	43.33
D_{84} =	136.29
D_{95} =	186.45
D_{100} =	362 - 512

Pool	
Channel materials	
D_{16} =	0.22
D_{35} =	37.95
D_{50} =	71.70
D_{84} =	260.47
D_{95} =	346.66
D_{100} =	362 - 512

Sediment Distribution

Dead River - Clark



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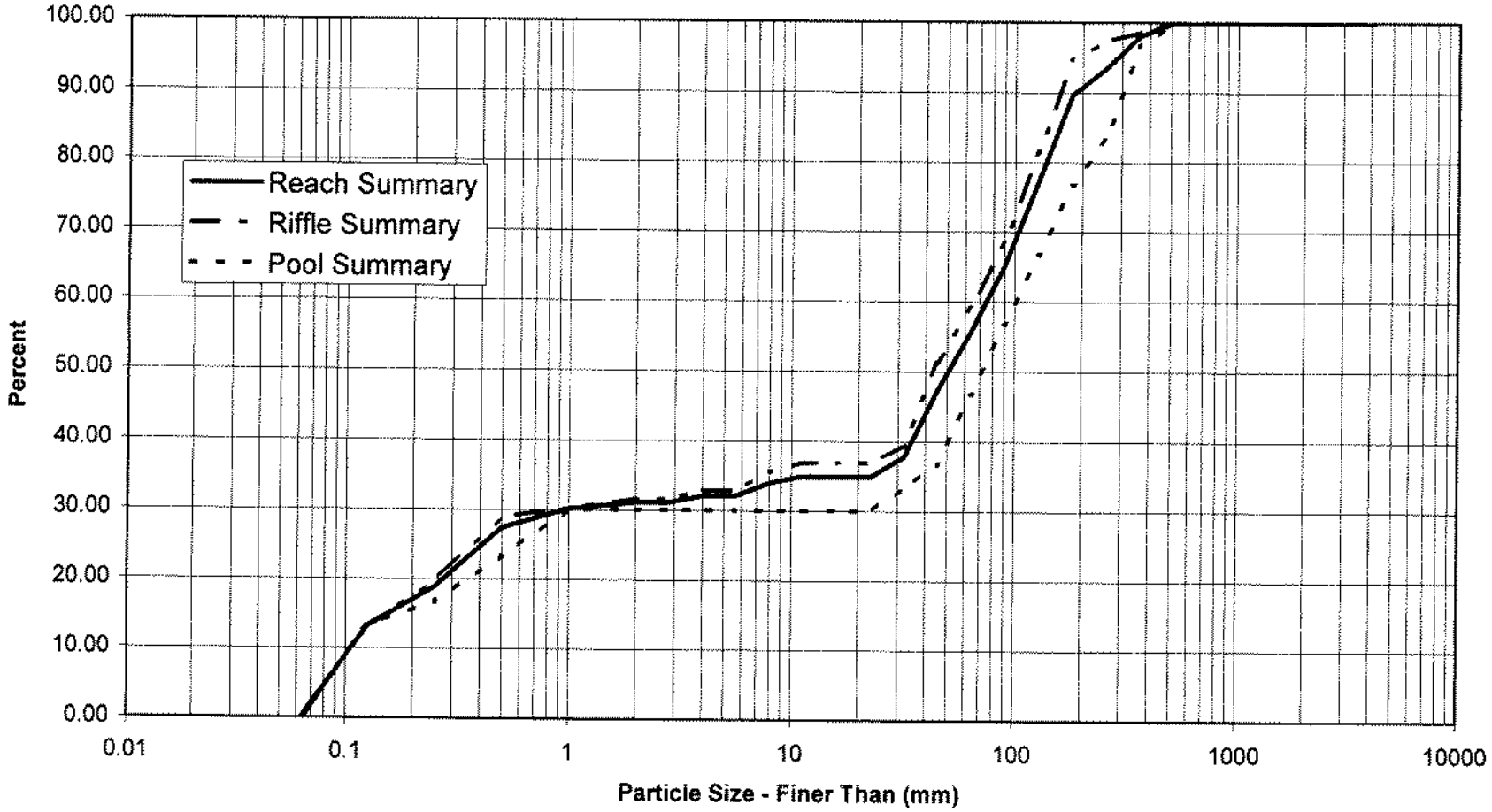
ClassificationSediment Distribution
LogHistogram

Sediment Distribution by Feature

Dead River - Clark



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ClassificationSediment Distribution
Feature Summary

PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	**Dead River**
REACH/LOCATION:	**Clark-Wetted**
DATE COLLECTED:	**11-Oct-04**
FIELD COLLECTION BY:	**SRB**
DATA ENTERED BY:	**SRB**

SEDIMENT ANALYSIS DATA SHEET

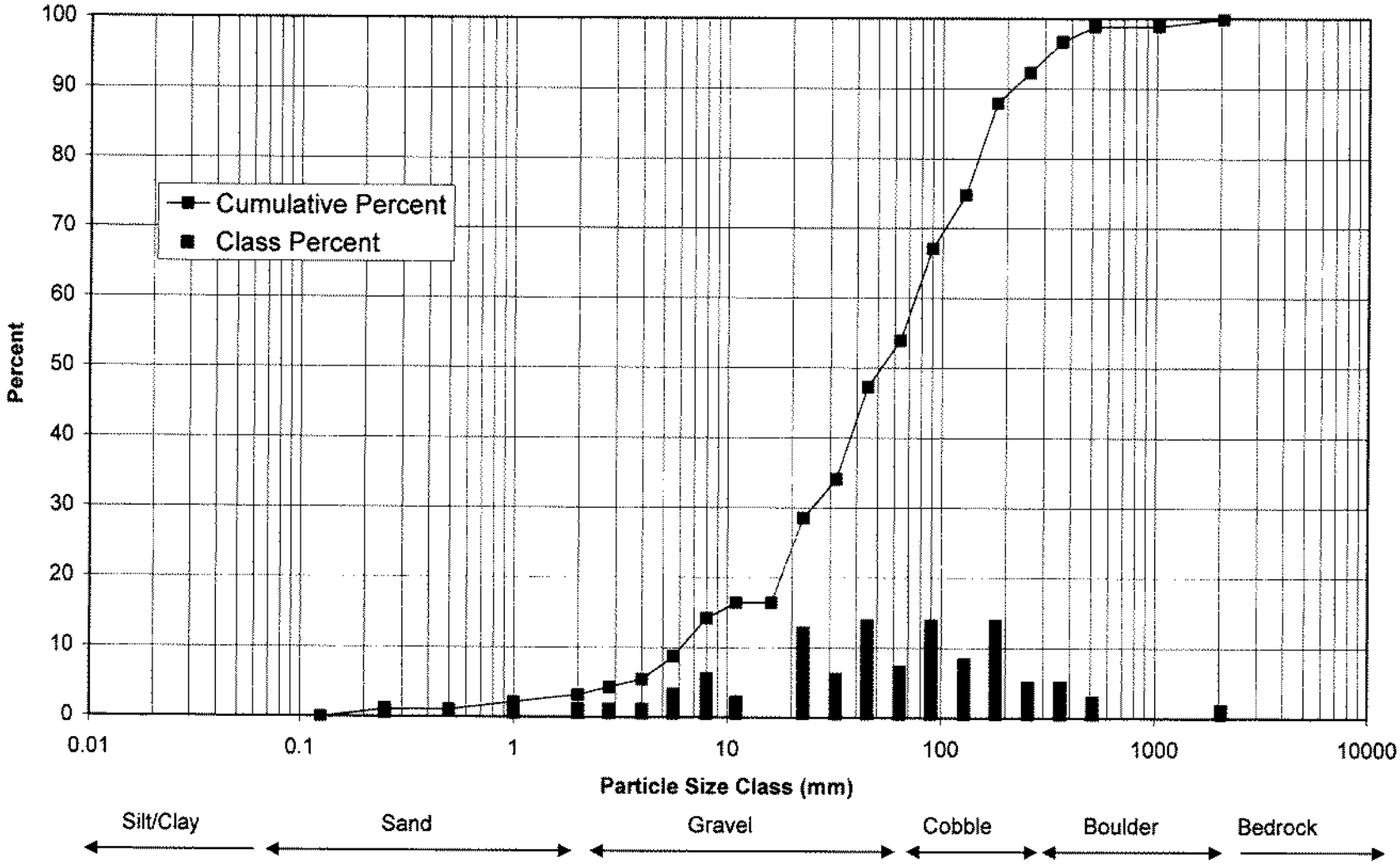
			PARTICLE CLASS			Reach Summary		Riffle Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063					0.00		0.00
SAND	Very Fine	.063 - .125					0.00		0.00
	Fine	.125 - .25	1		1	1.10	1.10	1.10	1.10
	Medium	.25 - .50					1.10		1.10
	Coarse	.50 - 1.0	1		1	1.10	2.20	1.10	2.20
	Very Coarse	1.0 - 2.0	1		1	1.10	3.30	1.10	3.30
GRAVEL	Very Fine	2.0 - 2.8	1		1	1.10	4.40	1.10	4.40
	Very Fine	2.8 - 4.0	1		1	1.10	5.49	1.10	5.49
	Fine	4.0 - 5.6	3		3	3.30	8.79	3.30	8.79
	Fine	5.6 - 8.0	5		5	5.49	14.29	5.49	14.29
	Medium	8.0 - 11.0	2		2	2.20	16.48	2.20	16.48
	Medium	11.0 - 16.0					16.48		16.48
	Coarse	16 - 22.6	11		11	12.09	28.57	12.09	28.57
	Coarse	22.6 - 32	5		5	5.49	34.07	5.49	34.07
	Very Coarse	32 - 45	12		12	13.19	47.25	13.19	47.25
	Very Coarse	45 - 64	6		6	6.59	53.85	6.59	53.85
COBBLE	Small	64 - 90	12		12	13.19	67.03	13.19	67.03
	Small	90 - 128	7		7	7.69	74.73	7.69	74.73
	Large	128 - 180	12		12	13.19	87.91	13.19	87.91
	Large	180 - 256	4		4	4.40	92.31	4.40	92.31
BOULDER	Small	256 - 362	4		4	4.40	96.70	4.40	96.70
	Small	362 - 512	2		2	2.20	98.90	2.20	98.90
	Medium	512 - 1024					98.90		98.90
	Large-Very Large	1024 - 2048	1		1	1.10	100.00	1.10	100.00
BEDROCK	Bedrock	> 2048					100.00		100.00
			91	0	91			100	100

Cummulative Channel materials	
D_{16} =	10.26
D_{35} =	32.78
D_{50} =	52.11
D_{84} =	162.68
D_{95} =	316.52
D_{100} =	1024 - 2048

Riffle Channel materials	
D_{16} =	10.26
D_{35} =	32.78
D_{50} =	52.11
D_{84} =	162.68
D_{95} =	316.52
D_{100} =	1024 - 2048

Sediment Distribution

Dead River - Clark-Wetted



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WettedSediment Distribution
LogHistogram

Pavement/Subpavement Analysis

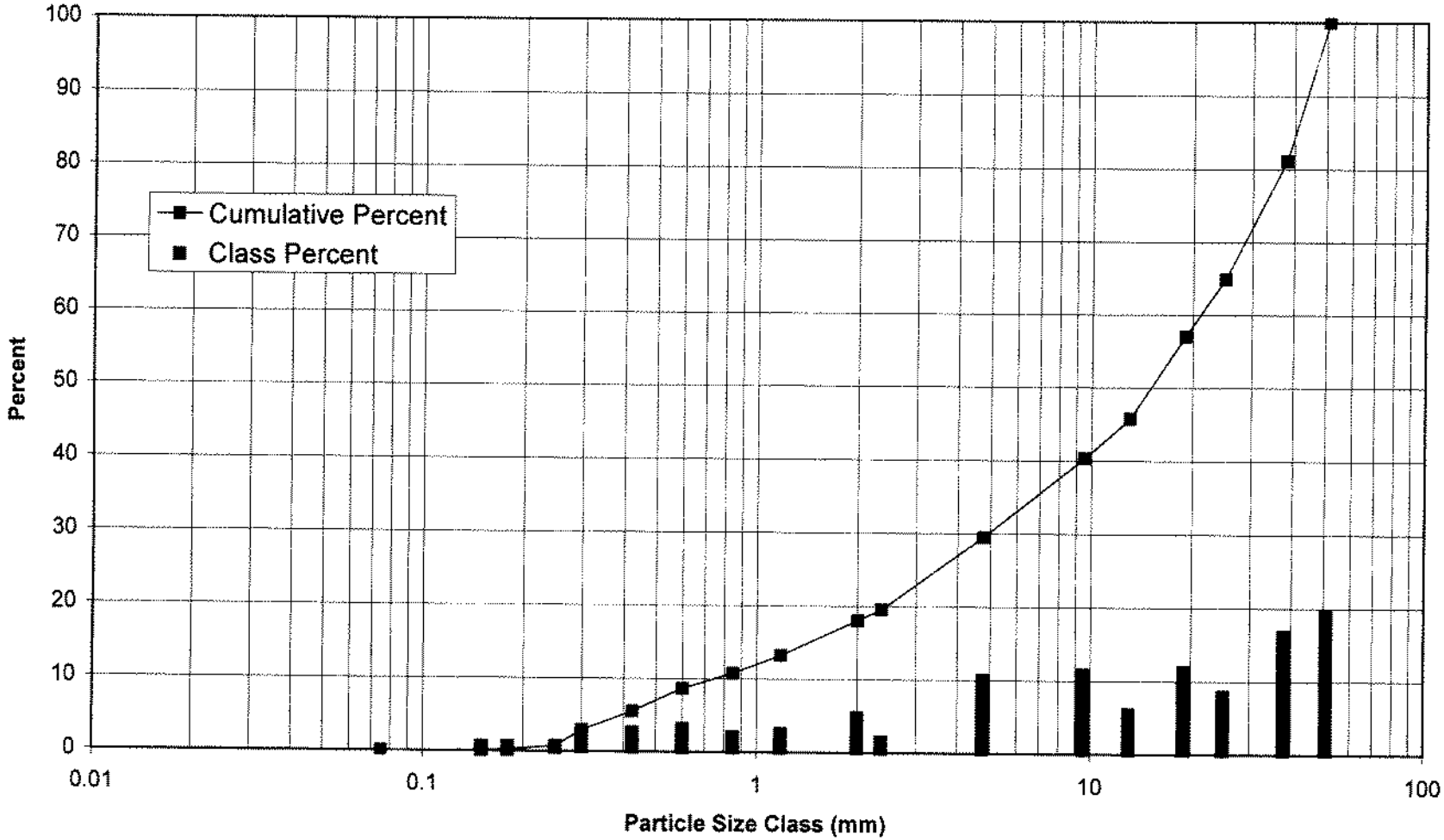
SITE OR PROJECT:	Dead R. Limited Use Curves
REACH/LOCATION:	Clark Sub
DATE COLLECTED:	10/13/04
FIELD COLLECTION BY:	SRB
DATA ENTERED BY:	STS/SRB

SEDIMENT ANALYSIS DATA SHEET

MATERIAL	PARTICLE	SIZE (mm)	Sample 1 (g)		Pavement Class %	Pavement % Cum	Subpavement Class %	Subpavement % Cum
	Silt / Clay	< .075				0.00		
SAND	Very Fine	.075 - .15	8.5		0.07	0.07		
	Fine	.15 - .18	19		0.15	0.22		
	Fine	.18 - .25	59.1		0.48	0.70		
	Fine	0.25 - 0.3	275.8		2.24	2.94		
	Medium	0.3 - 0.425	322.3		2.61	5.56		
	Medium	0.425 - 0.6	386.7		3.14	8.69		
	Medium	0.6 - 0.85	257.9		2.09	10.79		
	Medium	0.85 - 1.18	307.7		2.50	13.28		
	Medium	1.18 - 2.0	591.9		4.80	18.08		
	Coarse	2.0 - 2.36	180.5		1.46	19.55		
	Coarse	2.36 - 4.75	1228.7		9.97	29.52		
GRAVEL	Small	4.75 - 9.5	1329.3		10.79	40.30		
	Small	9.5 - 13	668.3		5.42	45.72		
	Fine	13 - 19	1392.9		11.30	57.03		
	Large	19 - 25	971		7.88	64.90		
	Large	25 - 38	1990.6		16.15	81.05		
	Large	38 - 51	2335.1		18.95	100.00		
	Large	51 - 64				100.00		
COBBLE	Small	64 - 75				100.00		
	Medium	75 - 90				100.00		
	Medium	90 - 128				100.00		
	Medium	128 - 180				100.00		
	Large	180 - 256				100.00		
BOULDER	Small	256 - 362				100.00		
	Medium	362 - 512				100.00		
	Medium	512 - 1024				100.00		
	Large-Very Large	1024 - 2048				100.00		
BEDROCK	Bedrock	> 2048				100.00		
			12325	0	100	100	0	

Channel materials	Sample 1	
D_{16} =	1.59	
D_{35} =	6.76	
D_{50} =	15.01	
D_{84} =	39.78	
D_{95} =	47.19	
D_{100} =	51.00	

Dead R. Limited Use Curves - Clark Sub



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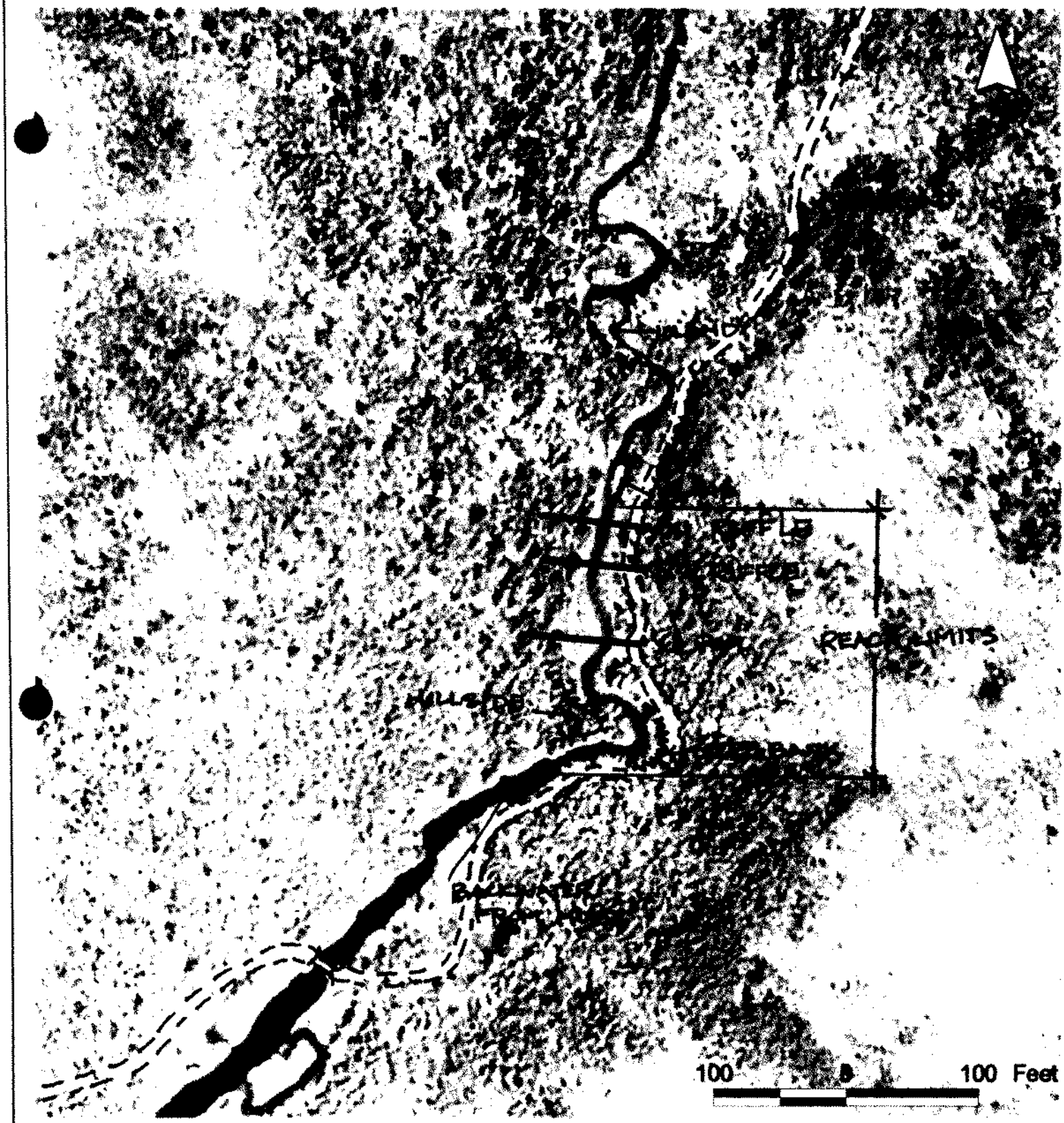
ClarkSTSPavement Sub Pavement
LogHistogramDetail



LEGEND

DIRT ROAD

XSECTION LOCATION

BUCK

1347 Harding Place
Suite 100
Charlotte, North Carolina 28204
Phone: 704.334.4454
Fax: 704.334.4492
www.buckengineering.com

Sheet 1 of 1

Clark Creek Sketch

Dead *River Post-Event Additional Environmental Assessment*

Work Plan Photograph Key

Dead River Recovery Post-Event Additional Environmental Assessment: Survey of Morphological Stream Parameters Using Rosgen Method

Number [1]	Subject	Location [2]
1	Bankfull stage indicator	location that best depicts indicator (Rosgen, 1996)
2	Stream downstream of the cross-section	standing mid-stream at the tape
3	Stream upstream of the cross-section	standing mid-stream at the tape
4	Cross-section photo	downstream of the cross-section facing upstream
5	Cross-section photo	upstream of the cross-section facing downstream
6	Right floodplain	right top of bank at the cross-section
7	Left floodplain	left top of bank at the cross-section
8	Stream upstream of the reach	standing mid-stream at the start of the longitudinal profile
9	Stream downstream of the reach	standing mid-stream at the end of the longitudinal profile
10	A sufficient number of photographs to provide a continuous visual documentation of the survey reach	facing downstream

Notes:

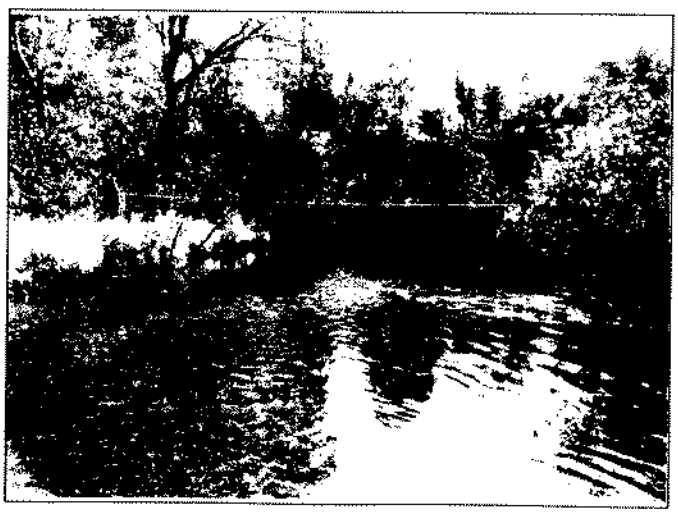
1. A letter designation is used in addition to the photo number (e.g. 10A, 10B, 10C, etc.) if more than one photograph was taken of a particular subject or from a single location.
2. Location from which photograph was taken.

CLARK POOL XS #1

CLARK POOL XS #2

CLARK POOL XS #3

CLARK POOL XS #4



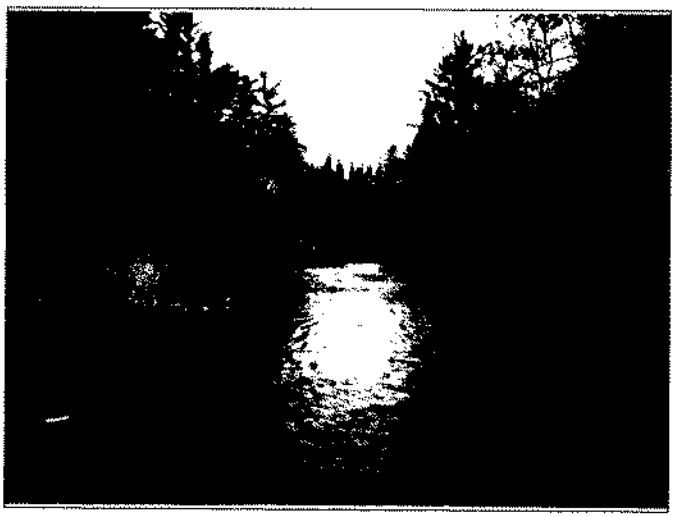
CLARK POOL XS #5

CLARK POOL XS #6

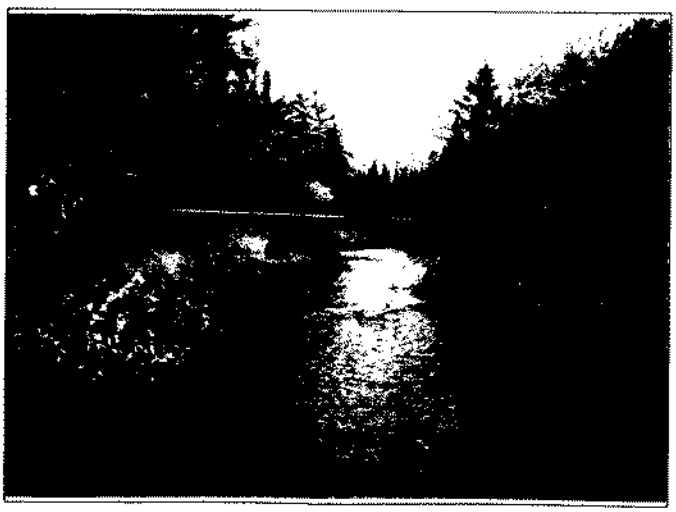
CLARK POOL XS #7

CLARK RIFFLE XS1 #1

CLARK RIFFLE XS1 #2



CLARK RIFFLE XS1 #3



CLARK RIFFLE XS1 #4

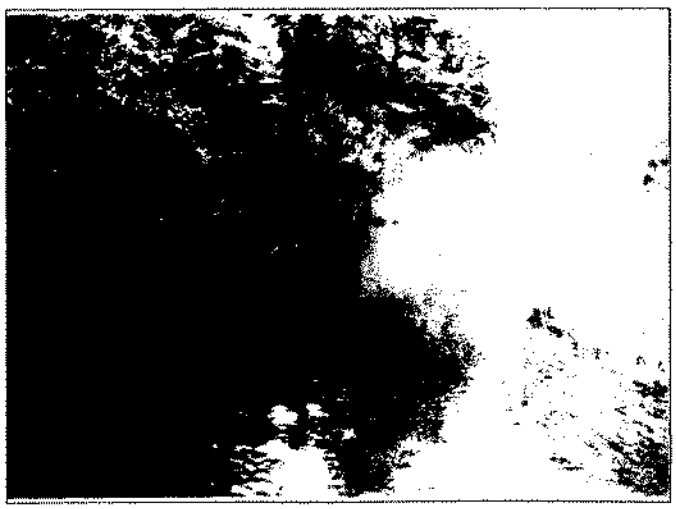
CLARK RIFFLE XS1 #5

CLARK RIFFLE XS1 #6

CLARK RIFFLE XS1 #7

CLARK RIFFLE XS2 #1

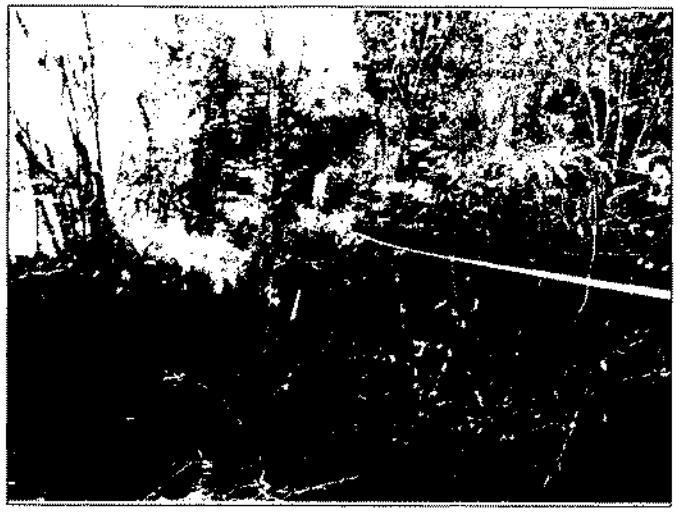
CLARK RIFFLE XS2 #2



CLARK RIFFLE XS2 #3

CLARK RIFFLE XS2 #4

CLARK RIFFLE XS2 #5

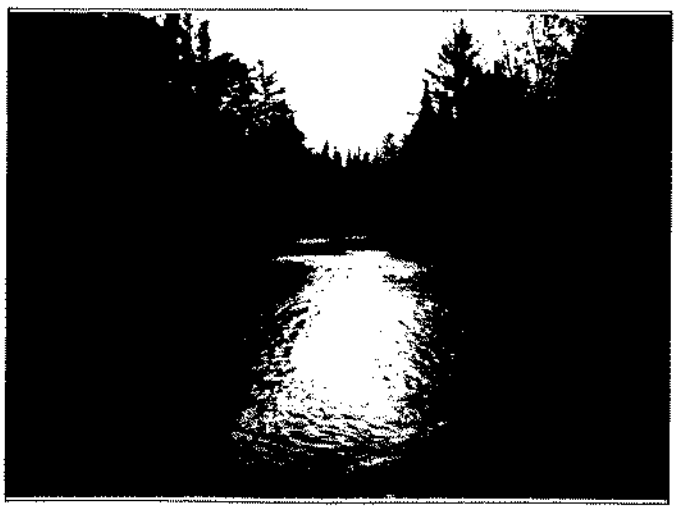


CLARK RIFFLE XS2 #6

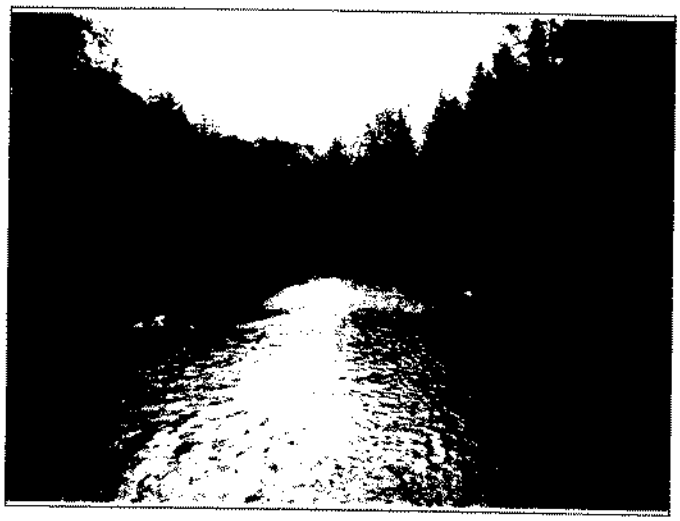
CLARK RIFFLE XS2 #7

CLARK #8

CLARK #9



CLARK #10A



CLARK #10B

CLARK #10C

CLARK #10D

CLARK #10E

CLARK #10F

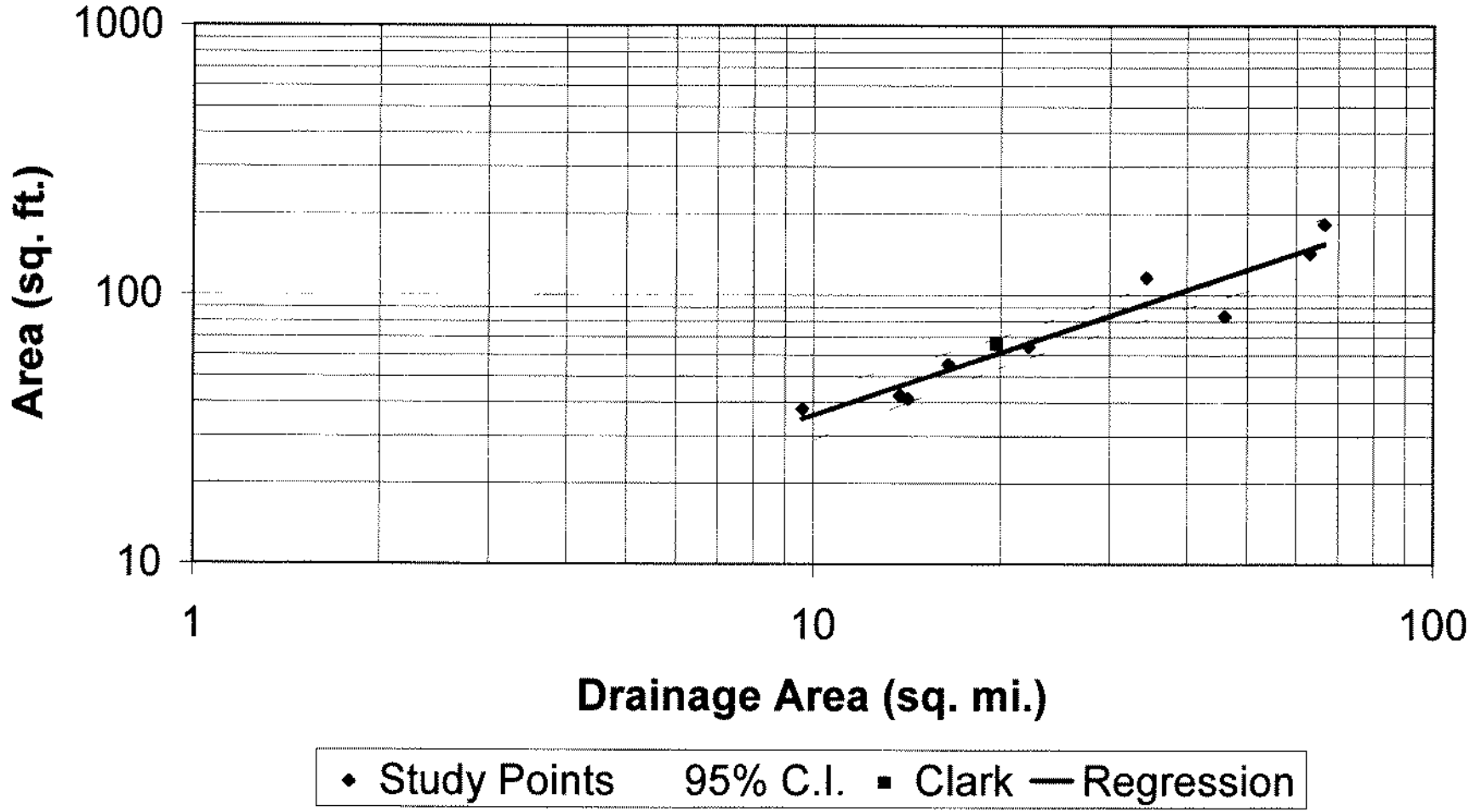
CLARK #10G

CLARK #10H

CLARK #10I

Cross Sectional Area vs. Drainage Area

$y = 6.0x^{0.77}$, $r^2 = 0.91$



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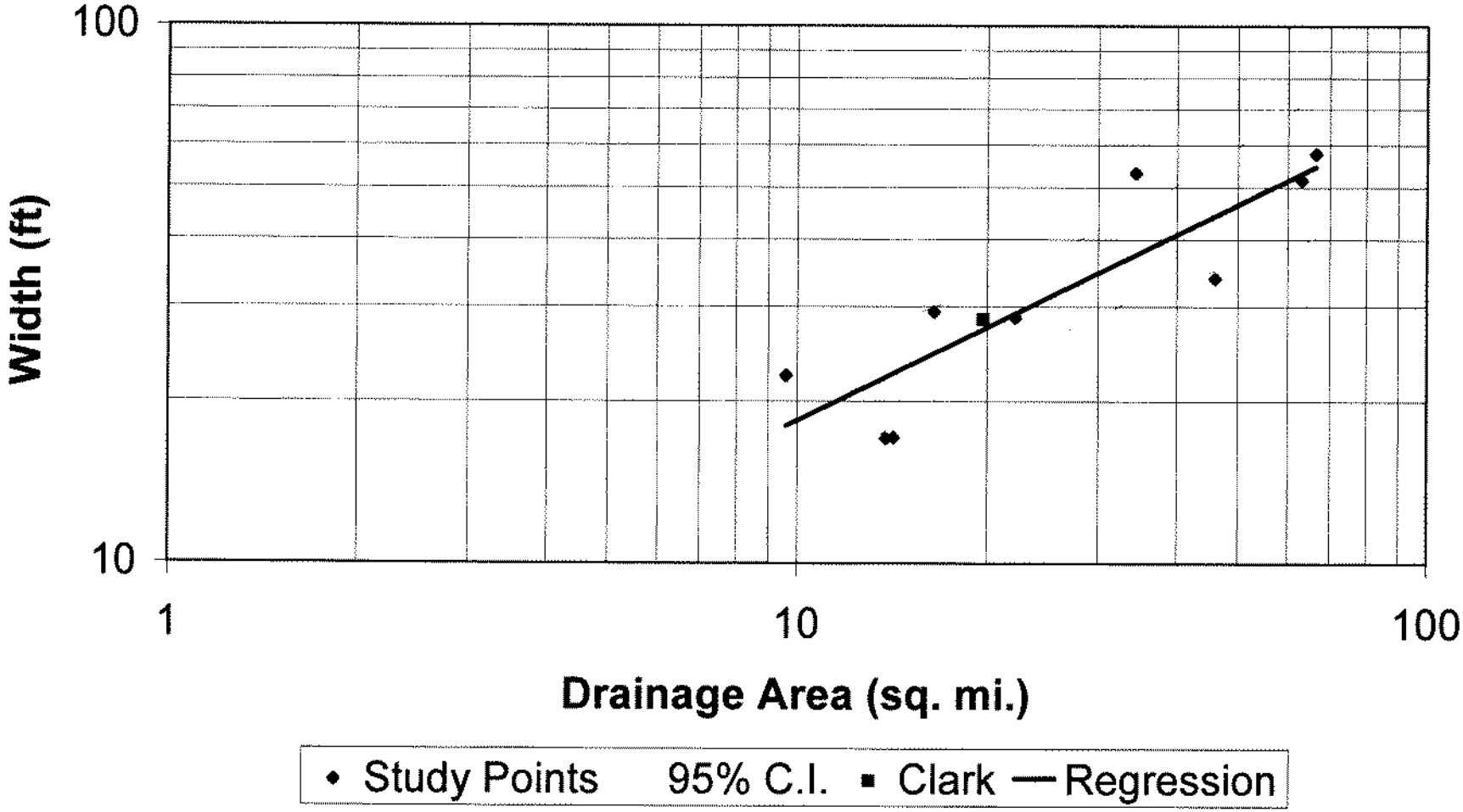
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Clark
Curves Chart 1

Bankfull Width vs. Drainage Area

$y = 4.9x^{0.57}$, $r^2 = 0.76$



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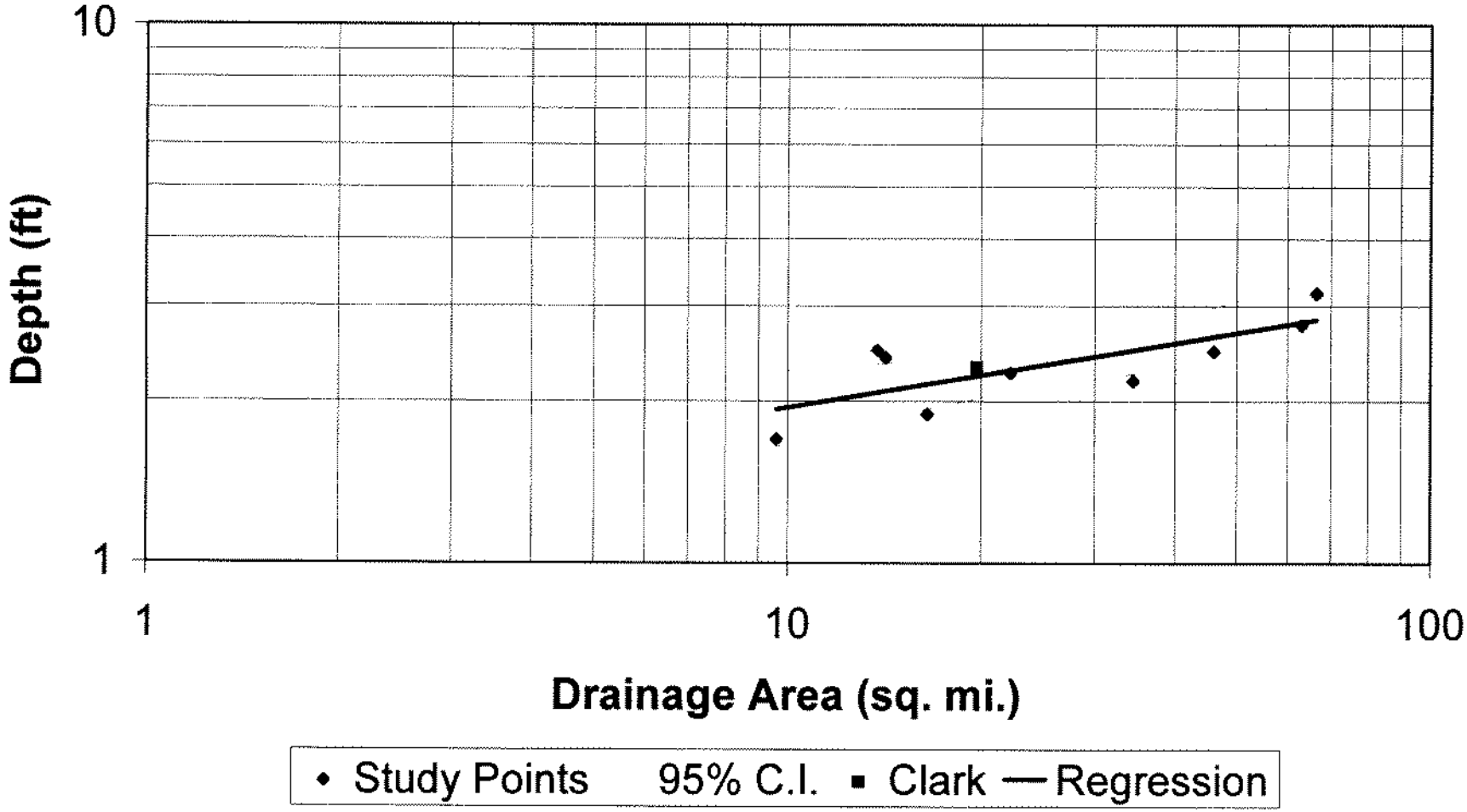
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Clark
Curves Chart 2

Bankfull Mean Depth vs. Drainage Area

$y = 1.2x^{0.20}$, $r^2 = 0.57$



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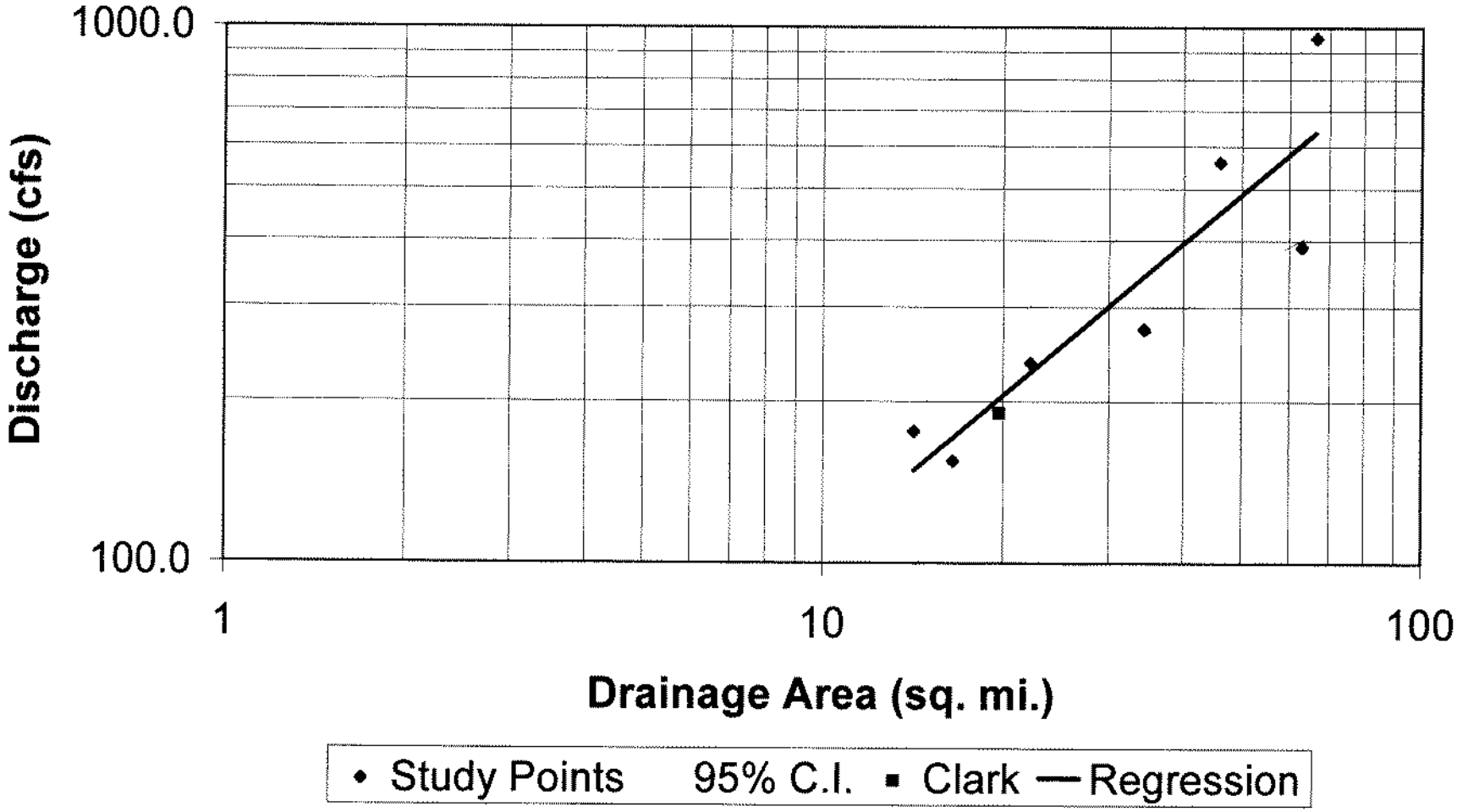
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Clark
Curves Chart 3

Bankfull Discharge vs. Drainage Area

$y = 12.2x^{0.94}$, $r^2 = 0.82$



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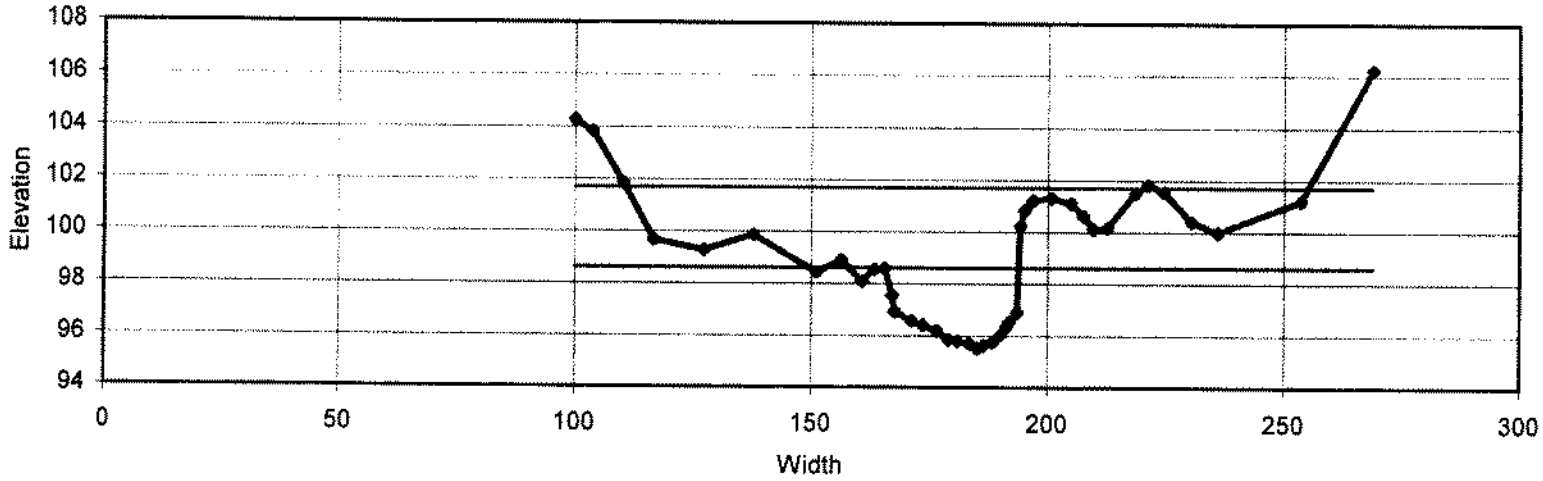
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Clark
Curves Chart 6

Cross Section X2

2 + 34 Riffle



Bankfull Dimensions	
67.4	x-section area (ft.sq.)
39.0	width (ft)
1.7	mean depth (ft)
3.1	max depth (ft)
41.3	wetted parimeter (ft)
1.6	hyd radi (ft)
22.6	width-depth ratio

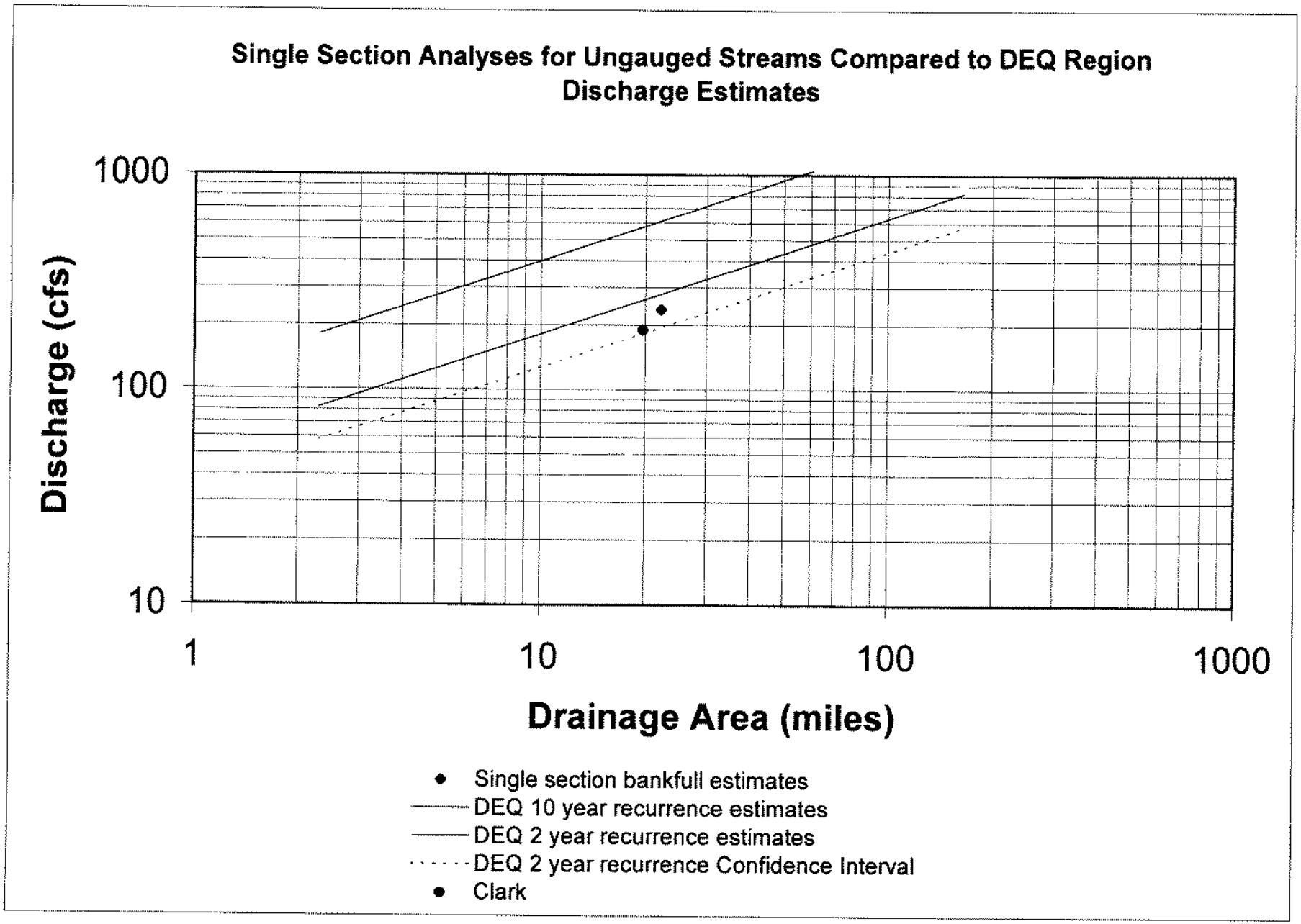
Flood Dimensions	
141.5	W flood prone area (ft)
3.6	entrenchment ratio
3.1	low bank height (ft)
1.0	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
14	threshold grain size (mm):

Bankfull Flow	
2.8	velocity (ft/s)
190.2	discharge rate (cfs)
0.39	Froude number

Flow Resistance	
0.038	Manning's roughness
0.14	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.27	channel slope (%)
0.27	shear stress (lb/sq.ft.)
0.38	shear velocity (ft/s)
0.82	unit strm power (lb/ft/s)



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StatewideRural v3_Clark
StatewideRural Chart 2

Harlow Creek

Initials	Work Item
LB	Collect the following data at a minimum for each reference reach.

Reach ID: **Harlow Creek**

- ✓ Identify bankfull per Harrelson et al., 1994
- ✓ Survey longitudinal profile for a distance of at least 20 times bankfull width
- ✓ Survey a minimum of two (2) cross-sections (one each at a riffle and pool)
- ✓ Measure plan form features:
  - ✓ Sinuosity
  - ✓ Meander length
  - ✓ Radius of curvature
  - ✓ Belt width
- ✓ Sample bed material using Wolman pebble count procedure
- ✓ Sample pavement/sub-pavement per Rosgen, 1996
- ✓ Sketch site per Harrelson et al., 1994
- ✓ Photograph site

Initials	Work Item
AB	Collect the following data at a minimum for each LUC reach.

Reach ID: **Harlow (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☐ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☑ Photograph site.

Initials	Work Item
SPP	Provide the following items for each reference reach in electronic and hard copy format.

Reach ID: **Harlow Creek**

- ☑ Morphological Data Table
- ☑ Plot of longitudinal profile
- ☑ Plot of cross-sections
- ☑ Grain size distribution
  - ☑ Bed material
  - ☑ Pavement/sub-pavement material
- ☑ Site sketch
- ☑ Photographs and photo log
- ☑ GIS data layer depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)

Initials	Work Item
_____	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Harlow (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

☑ Limited Use Curves

- DA versus Wbkf
- DA versus Dbkf
- DA versus CSA
- DA versus Qbkf

☑ Plot of longitudinal profile

☑ Plot of cross-section

☑ Grain size distribution for bed material

☑ Site sketch

☑ Photographs and photo log.

☑ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)

- Reach
  - Reach limits (line shape)
  - Reach ID (name or number)
  - Stream Type
  - DA
- Survey Locations
  - Location ID (i.e. – X1, X2, X3, etc.)
  - Location type (pool, riffle)

☑ Calculations (single section analysis)

☑ Plot of Single Section Analysis versus Regression Equation

MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

Assessment Site (Name of stream and location) Harlow Creek
Marquette, MI

	Variables	Existing Channel		
1	Stream Type		C3	
2	Drainage Area, mi2		22.30	
3	Bankfull Width, ft (Wbkf)	Mean	30.545	
		Range	28.61	32.48
4	Bankfull Mean Depth, ft (dbkf)	Mean	2.245	
		Range	2.24	2.25
5	Width/Depth Ratio (Wbkf/dbkf)	Mean	13.61	
		Range	12.74	14.48
6	Bankfull Cross-Sectional Area, ft2 (Abkf)	Mean	68.6	
		Range	64.3	72.9
7	Bankfull Mean Velocity, ft/s (Ubkf)	Mean	3.83	
		Range	2.96	4.71
8	Banfull Discharge, ft3/s (Qbkf)		236.1	
9	Bankfull Maximum Depth, ft (dmbkf)	Mean	2.94	
		Range	2.74	3.13
10	Max Riffle Depth/Mean Riffle Depth (dmbkf/dbkf)	Mean	1.25	
		Range	1.2	1.3
11	Low Bank Height to Max Riffle Depth (LBH/dmbkf)	Mean	1.05	
		Range	1	1.1
12	Width of Floodprone Area, ft (Wfpa)	Mean	108.7	
		Range	91.3	126.1
13	Entrenchment Ratio (Wfpa/Wbkf)	Mean	3.55	
		Range	3.20	3.90
14	Meander Length, ft (Lm)	Mean	275	
		Range	227	324
15	Meander Length Ratio, (Lm/Wbkf)	Mean	9.0	
		Range	7.4	10.6
16	Radius of Curvature, ft (Rc)	Mean	72	
		Range	40	80
17	Ratio of Radius of Curvature to Bankfull Width (Rc/Wbkf)	Mean	2.0	
		Range	1.3	2.6
18	Belt Width, ft (Wblt)	Mean	322	
		Range	257	386
19	Meander Width Ratio (Wblt/Wbkf)	Mean	10.53	
		Range	8.43	12.64
20	Sinuosity (K)		1.47	
21	Valley Slope (VS)		0.0041	
22	Average Water Surface Slope (S) = (VS/K)		0.0028	
23	Pool Slope (water surface facet slope) (Sp)	Mean	0.0005	
		Range	0.0002	0.0007
24	Ratio of Pool Slope/Average Water Surface Slope (Sp/S)	Mean	0.16	
		Range	0.08	0.25
25	Riffle Slope (water surface facet slope) (Srif)	Mean	0.0156	
		Range	0.0073	0.0239

MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

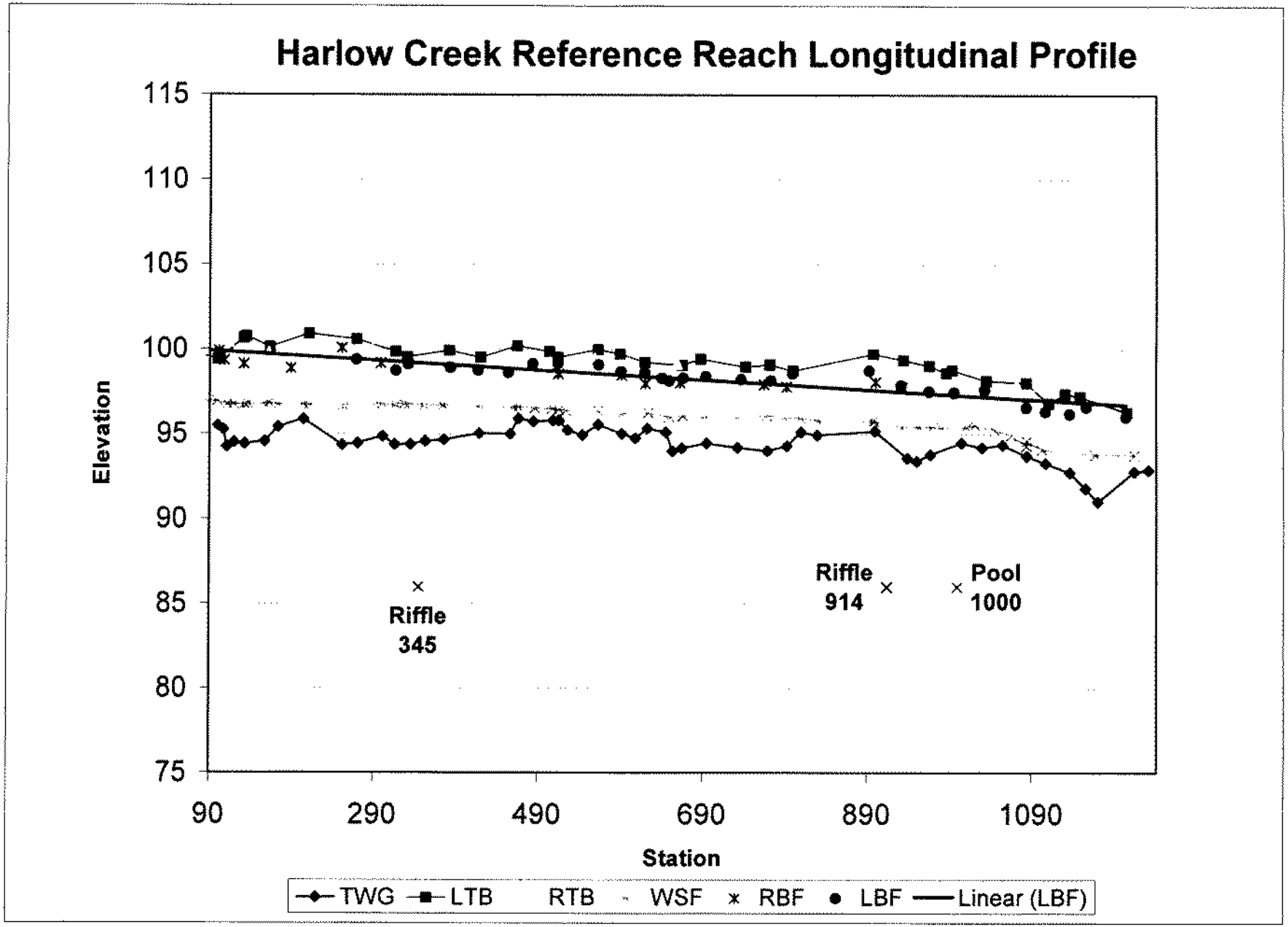
Assessment Site (Name of stream and location) Harlow Creek
Marquette, MI

	Variables	Existing Channel		
26	Ratio Riffle Slope to Average Water Surface Slope (Srif/S)	Mean	5.56	
		Range	2.60	8.53
27	Run Slope (water surface facet slope) (Srun)	Mean	0.00438	
		Range	0.00297	0.00549
28	Ratio Run Slope/Average Water Surface Slope (Srun/S)	Mean	1.51	
		Range	1.06	1.96
29	Glide Slope (water surface facet slope) (Sg)	Mean	0.0005	
		Range	0.0002	0.0007
30	Ratio Glide Slope/Average Water Surface Slope (Sg/S)	Mean	0.16	
		Range	0.07	0.25
31	Max Pool Depth, ft (dmbfkp)	Mean	5.58	
		Range	5.58	5.58
32	Ratio Max Pool Depth/Bankfull Mean Depth (dmbfkp/dbkf)	Mean	2.49	
		Range	2.48	2.49
33	Max Run Depth, ft (drun)	Mean	3.90	
		Range	3.70	4.10
34	Ratio Max Run Depth/Bankfull Mean Depth (drun/dbkf)	Mean	1.74	
		Range	1.64	1.83
35	Max Glide Depth, ft (dg)	Mean	4.01	
		Range	3.91	4.10
36	Ratio Max Glide Depth/Bankfull Mean Depth (dg/dbkf)	Mean	1.78	
		Range	1.74	1.83
37	Pool Width, ft (Wbkfp)	Mean	38.15	
		Range	38.15	38.15
38	Ratio of Pool Width to Bankfull Width (Wbkfp/Wbkf)	Mean	1.29	
		Range	1.25	1.33
	Pool Area	Mean	113.8	
		Range	113.8	113.8
39	Ratio of Pool Area to Bankfull Area	Mean	1.71	
		Range	1.66	1.77
40	Point Bar Slope	Mean	0.10	
		Range	0.10	0.10
41	Pool to Pool Spacing, ft (p-p)	Mean	275.1329	
		Range	226.58	323.6857
42	Ratio of p-p Spacing to Bankfull Width (p-p/Wbkf)	Mean	9.37	
		Range	7.42	11.31
	MATERIALS			
43	Particle Size Distribution of Channel Material (active bed)			
	D16 (mm)		55.5	
	D35 (mm)		98.6	
	D50 (mm)		141.3	
	D84 (mm)		321.0	
	D95 (mm)		Bedrock	

MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL WITH GAGE STATION AND REFERENCE REACH DATE (Rosgen, 1996)

Assessment Site (Name of stream and location) Harlow Creek
Marquette, MI

	MATERIALS			
44	Particle Size Distribution of Bar Material			
	D16 (mm)		2.3	
	D35 (mm)		12.7	
	D50 (mm)		26.3	
	D84 (mm)		44.7	
	D95 (mm)		48.9	
	Largest size particle at the toe (lower third) of bar (mm)		73.0	
45	Particle Size Distribution of Channel Material (Pavement)			
	D16 (mm)		55.5	
	D35 (mm)		98.6	
	D50 (mm)		141.3	
	D84 (mm)		321.0	
	D95 (mm)		Bedrock	
46	Particle Size Distribution of Subpavement			
	D16 (mm)		2.3	
	D35 (mm)		12.7	
	D50 (mm)		26.3	
	D84 (mm)		44.7	
	D95 (mm)		48.9	
	Largest size particle at the toe (lower third) of bar (mm)		73.0	
47	Reach Wide Particle Size Distribution			
	D16 (mm)		0.4	
	D35 (mm)		2.0	
	D50 (mm)		29.0	
	D84 (mm)		172.5	
	D95 (mm)		256.0	
	D100(mm)		Bedrock	



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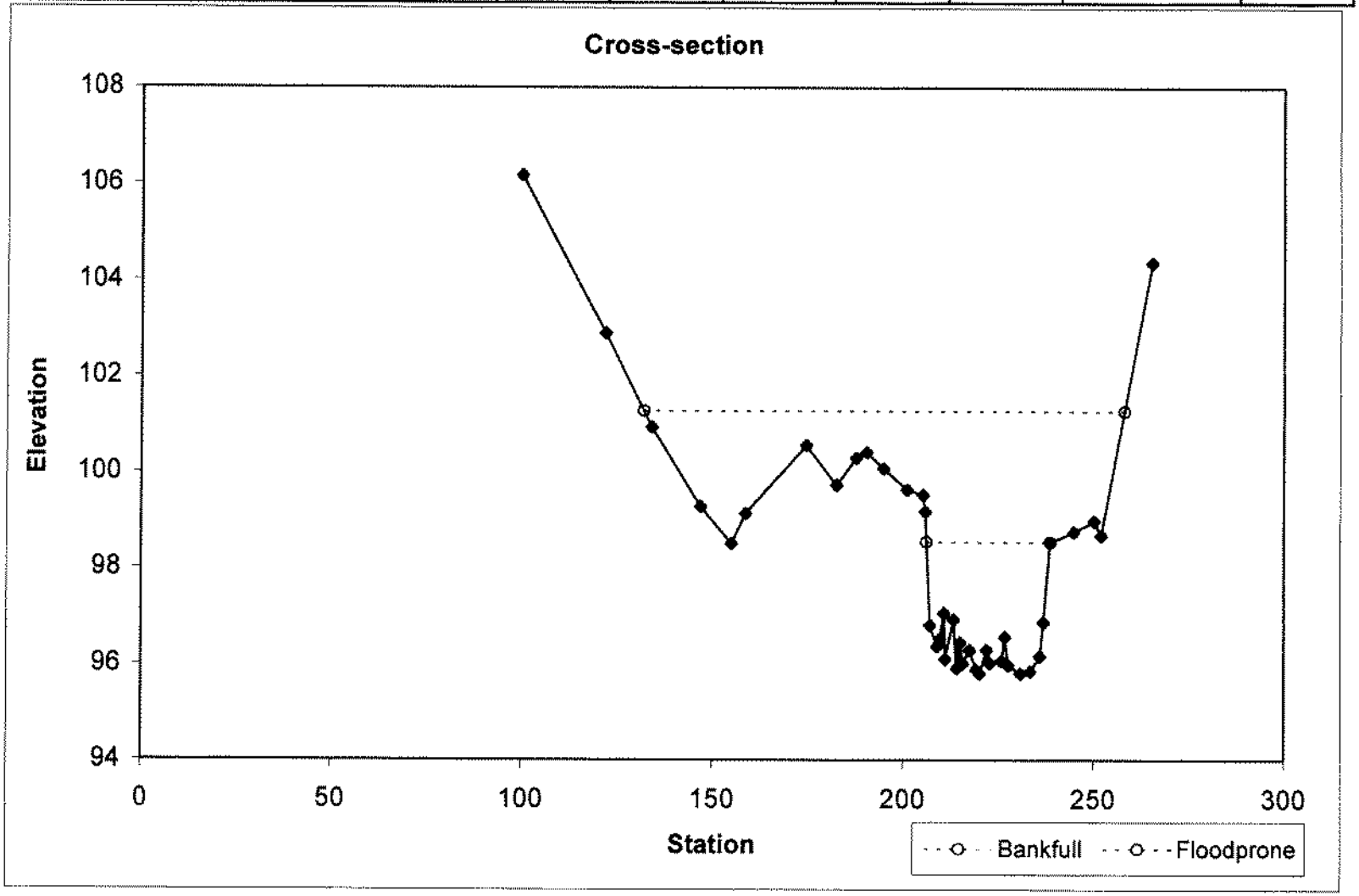
HarlowMorph v2
Profile Chart 1

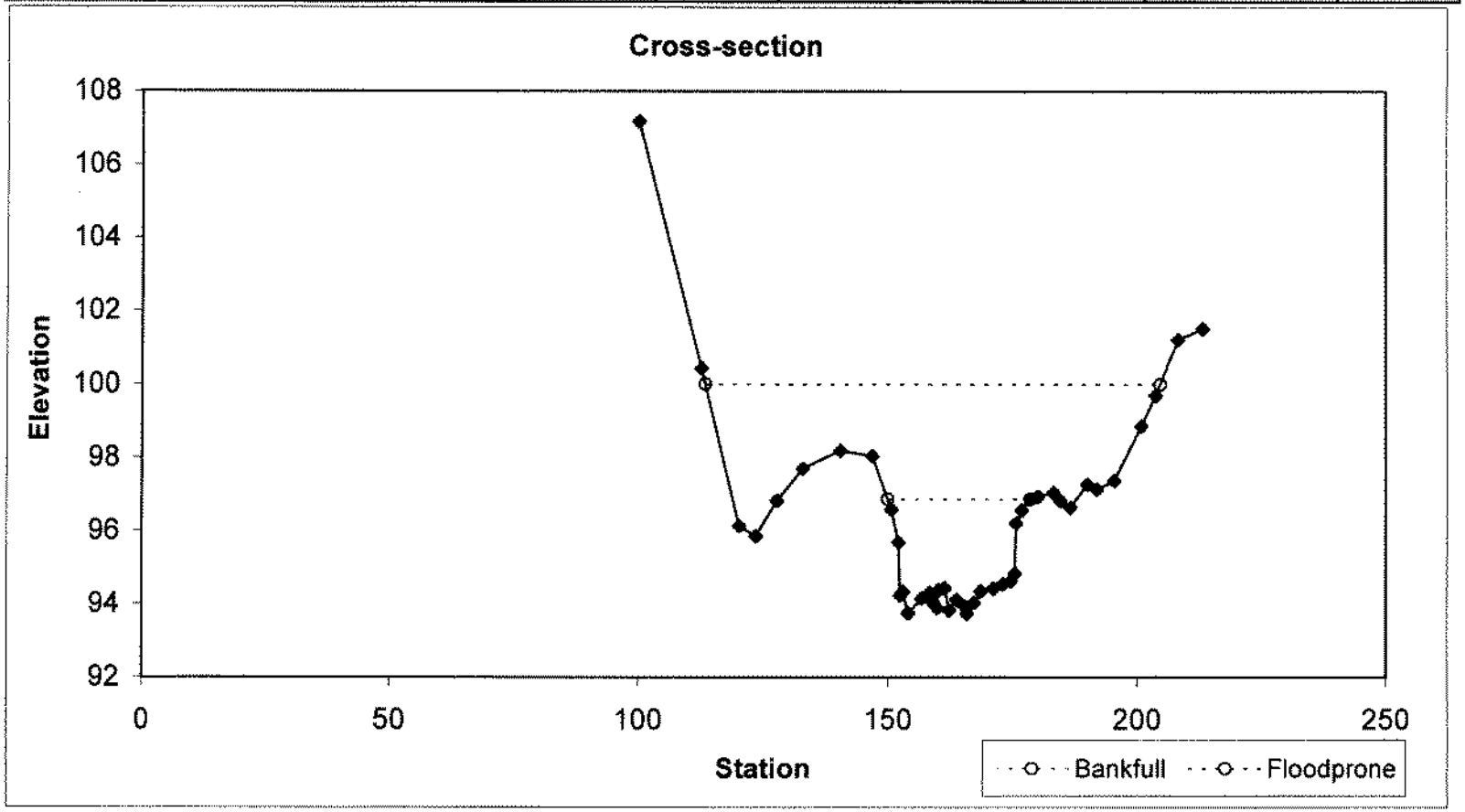
Riffle @ Station 3+45

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BR Ratio	ER	BKF Elev	TOB Elev
Riffle		72.9	32.48	2.24	2.74	14.48	1	3.9	98.55	98.55



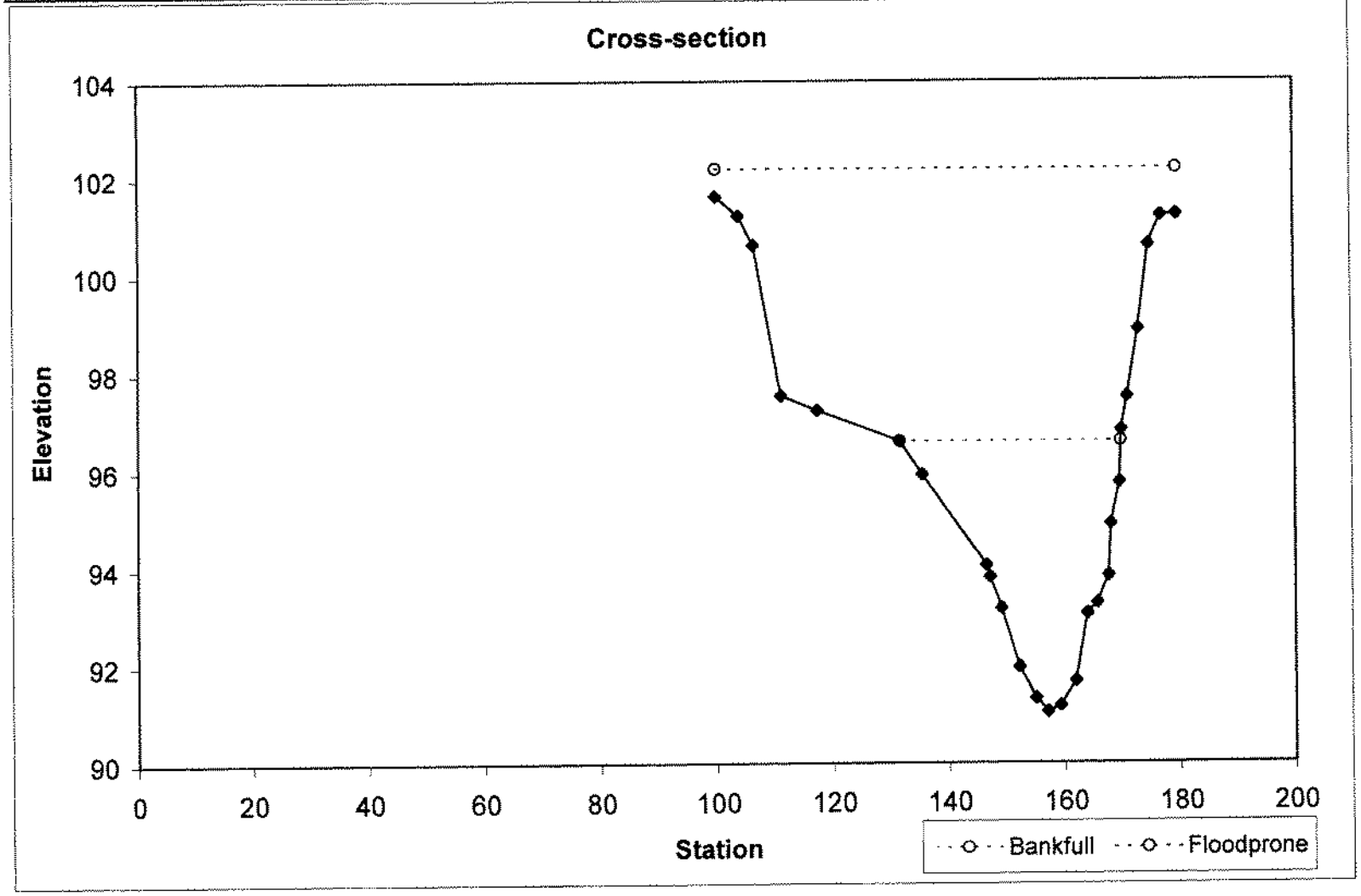
Riffle @ Station 9+14

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle		64.3	28.61	2.25	3.13	12.74	1.1	3.2	96.88	97.28



Pool @ Station 10+00

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		113.8	38.15	2.98	5.58	12.79	1.1	2.1	96.63	97.26



PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	Dead River
REACH/LOCATION:	Harlow
DATE COLLECTED:	11-Oct-04
FIELD COLLECTION BY:	SRB
DATA ENTERED BY:	SRB

SEDIMENT ANALYSIS DATA SHEET

			PARTICLE CLASS			Reach Summary		Riffle Summary		Pool Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063					0.00		0.00		0.00
SAND	Very Fine	.063 - .125					0.00		0.00		0.00
	Fine	.125 - .25	7	3	10	10.00	10.00	10.00	10.00	10.00	10.00
	Medium	.25 - .50	6	6	12	12.00	22.00	8.57	18.57	20.00	30.00
	Coarse	.50 - 1.0	4	5	9	9.00	31.00	5.71	24.29	16.67	46.67
	Very Coarse	1.0 - 2.0	1	3	4	4.00	35.00	1.43	25.71	10.00	56.67
GRAVEL	Very Fine	2.0 - 2.8	1		1	1.00	36.00	1.43	27.14		56.67
	Very Fine	2.8 - 4.0	1	1	2	2.00	38.00	1.43	28.57	3.33	60.00
	Fine	4.0 - 5.6					38.00		28.57		60.00
	Fine	5.6 - 8.0					38.00		28.57		60.00
	Medium	8.0 - 11.0	2	1	3	3.00	41.00	2.86	31.43	3.33	63.33
	Medium	11.0 - 16.0	1		1	1.00	42.00	1.43	32.86		63.33
	Coarse	16 - 22.6	3		3	3.00	45.00	4.29	37.14		63.33
	Coarse	22.6 - 32	7		7	7.00	52.00	10.00	47.14		63.33
	Very Coarse	32 - 45	4		4	4.00	56.00	5.71	52.86		63.33
	Very Coarse	45 - 64	6		6	6.00	62.00	8.57	61.43		63.33
COBBLE	Small	64 - 90	5	2	7	7.00	69.00	7.14	68.57	6.67	70.00
	Small	90 - 128	7	1	8	8.00	77.00	10.00	78.57	3.33	73.33
	Large	128 - 180	5	3	8	8.00	85.00	7.14	85.71	10.00	83.33
	Large	180 - 256	8	2	10	10.00	95.00	11.43	97.14	6.67	90.00
BOULDER	Small	256 - 362	1	1	2	2.00	97.00	1.43	98.57	3.33	93.33
	Small	362 - 512		1	1	1.00	98.00		98.57	3.33	96.67
	Medium	512 - 1024		1	1	1.00	99.00		98.57	3.33	100.00
	Large-Very Large	1024 - 2048					99.00		98.57		100.00
BEDROCK	Bedrock	> 2048	1		1	1.00	100.00	1.43	100.00		100.00
			70	30	100			100	100	100	100

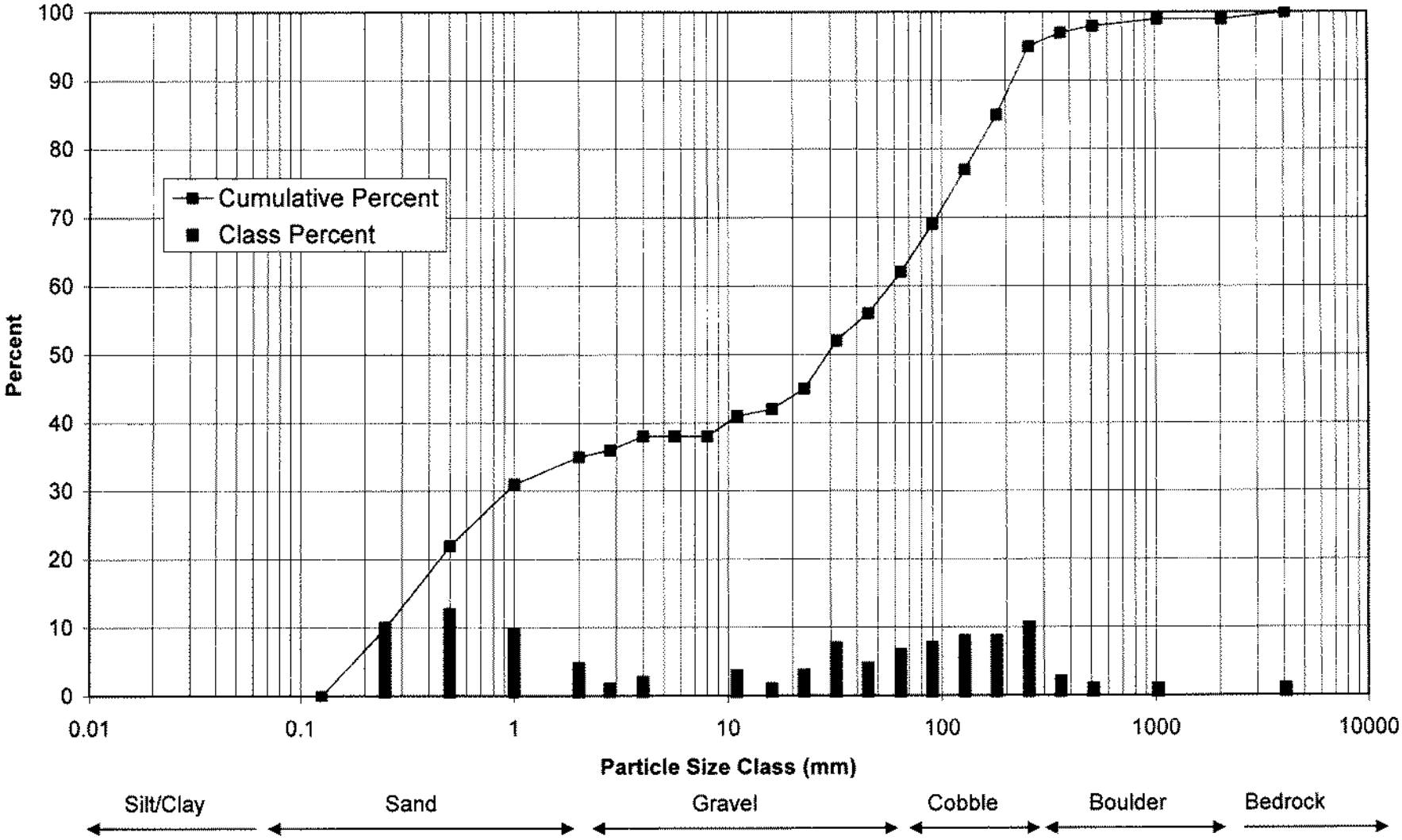
Cummulative	
Channel materials	
D_{16} =	0.35
D_{35} =	2.00
D_{50} =	28.97
D_{84} =	172.49
D_{95} =	256.00
D_{100} =	> 2048

Riffle	
Channel materials	
D_{16} =	0.41
D_{35} =	19.02
D_{50} =	37.95
D_{84} =	165.86
D_{95} =	239.64
D_{100} =	> 2048

Pool	
Channel materials	
D_{16} =	0.31
D_{35} =	0.62
D_{50} =	1.26
D_{84} =	186.45
D_{95} =	430.52
D_{100} =	512 - 1024

Sediment Distribution

Dead River - Harlow



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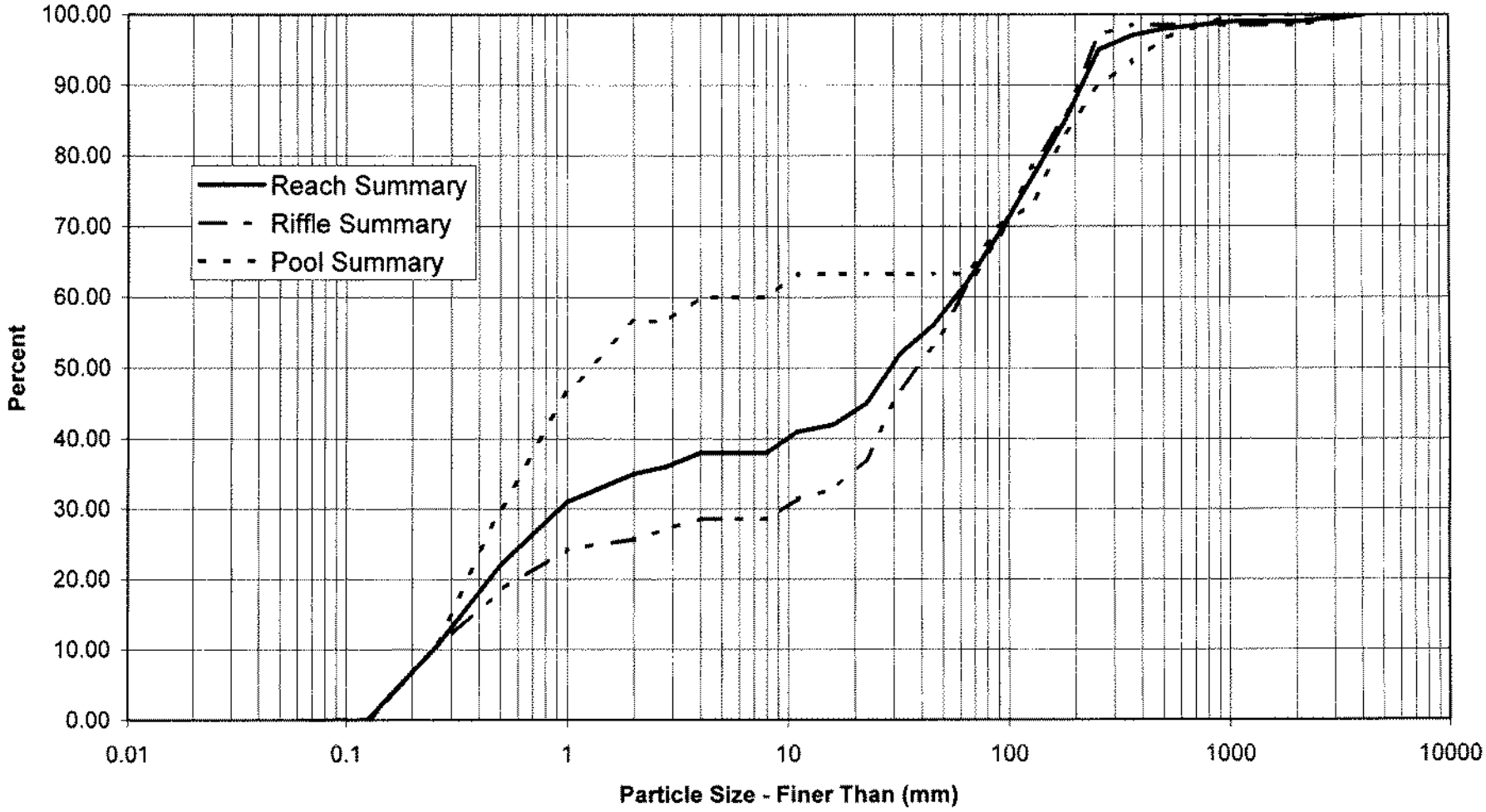
ClassificationSediment Distribution
LogHistogram

Sediment Distribution by Feature

Dead River - Harlow



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ClassificationSediment Distribution
Feature Summary

PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	**Dead River**
REACH/LOCATION:	Harlow - Wetted Surface
DATE COLLECTED:	**11-Oct-04**
FIELD COLLECTION BY:	**SRB**
DATA ENTERED BY:	**SRB**

SEDIMENT ANALYSIS DATA SHEET

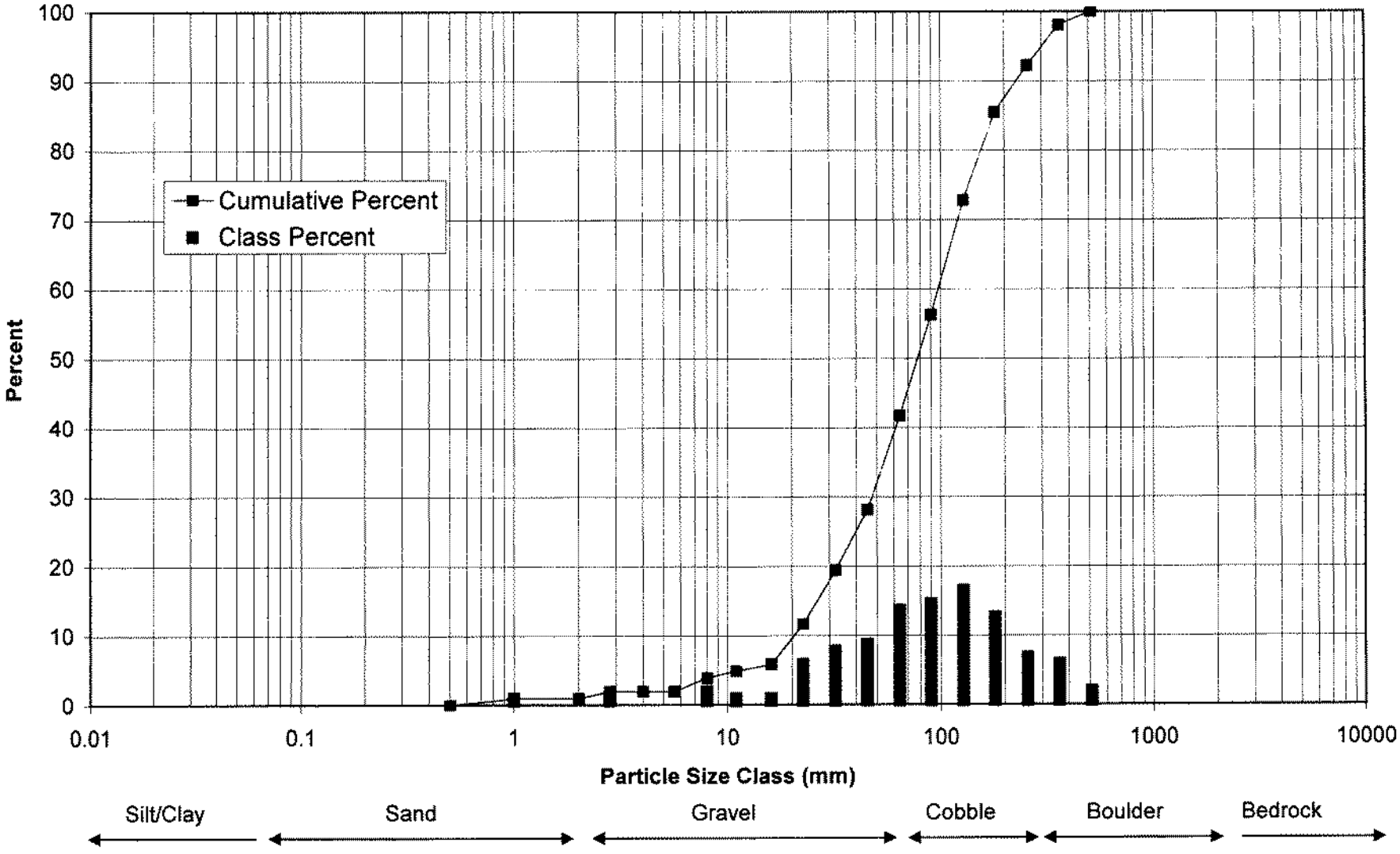
			PARTICLE CLASS			Reach Summary		Riffle Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063					0.00		0.00
SAND	Very Fine	.063 - .125					0.00		0.00
	Fine	.125 - .25					0.00		0.00
	Medium	.25 - .50	1		1	0.99	0.99	0.99	0.99
	Coarse	.50 - 1.0	1		1	0.99	1.98	0.99	1.98
	Very Coarse	1.0 - 2.0					1.98		1.98
GRAVEL	Very Fine	2.0 - 2.8	1		1	0.99	2.97	0.99	2.97
	Very Fine	2.8 - 4.0					2.97		2.97
	Fine	4.0 - 5.6	1		1	0.99	3.96	0.99	3.96
	Fine	5.6 - 8.0	1		1	0.99	4.95	0.99	4.95
	Medium	8.0 - 11.0					4.95		4.95
	Medium	11.0 - 16.0	1		1	0.99	5.94	0.99	5.94
	Coarse	16 - 22.6					5.94		5.94
	Coarse	22.6 - 32					5.94		5.94
	Very Coarse	32 - 45	3		3	2.97	8.91	2.97	8.91
	Very Coarse	45 - 64	12		12	11.88	20.79	11.88	20.79
COBBLE	Small	64 - 90	11		11	10.89	31.68	10.89	31.68
	Small	90 - 128	13		13	12.87	44.55	12.87	44.55
	Large	128 - 180	19		19	18.81	63.37	18.81	63.37
	Large	180 - 256	13		13	12.87	76.24	12.87	76.24
BOULDER	Small	256 - 362	12		12	11.88	88.12	11.88	88.12
	Small	362 - 512	3		3	2.97	91.09	2.97	91.09
	Medium	512 - 1024	1		1	0.99	92.08	0.99	92.08
	Large-Very Large	1024 - 2048					92.08		92.08
BEDROCK	Bedrock	> 2048	8		8	7.92	100.00	7.92	100.00
			101	0	101			100	100

Cummulative Channel materials	
D_{16} =	55.52
D_{35} =	98.55
D_{50} =	141.28
D_{84} =	321.03
D_{95} =	2644.45
D_{100} =	> 2048

Riffle Channel materials	
D_{16} =	55.52
D_{35} =	98.55
D_{50} =	141.28
D_{84} =	321.03
D_{95} =	2644.45
D_{100} =	> 2048

Sediment Distribution

Dead River - Harlow - Wetted Surface



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Wetted SurfcaeSediment Distribution
LogHistogram

Pavement/Subpavement Analysis

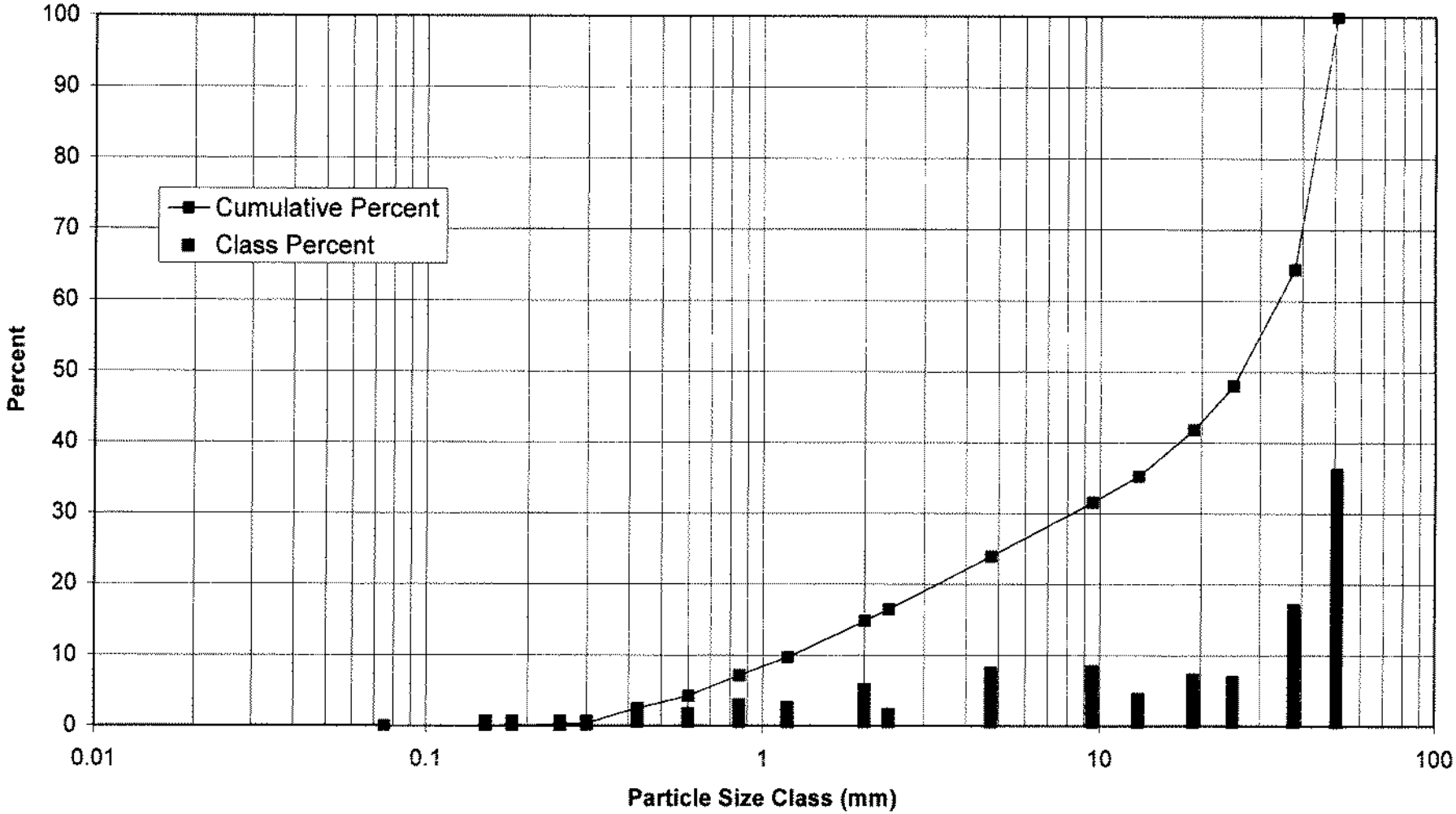
SITE OR PROJECT:	Dead R. Limited Use Curves
REACH/LOCATION:	Harlow Sub
DATE COLLECTED:	10/12/04
FIELD COLLECTION BY:	SRB
DATA ENTERED BY:	STS/SRB

SEDIMENT ANALYSIS DATA SHEET

MATERIAL	PARTICLE	SIZE (mm)	Sample 1 (g)		Pavement Class %	Pavement % Cum
	Silt / Clay	< .075				0.00
SAND	Very Fine	.075 - .15	3.4		0.03	0.03
	Fine	.15 - .18	2.3		0.02	0.06
	Fine	.18 - .25	12.8		0.13	0.18
	Fine	0.25 - 0.3	19.6		0.19	0.37
	Medium	0.3 - 0.425	217.2		2.12	2.49
	Medium	0.425 - 0.6	175.8		1.72	4.21
	Medium	0.6 - 0.85	298.7		2.92	7.13
	Medium	0.85 - 1.18	260.0		2.54	9.67
	Medium	1.18 - 2.0	523.2		5.11	14.79
	Coarse	2.0 - 2.36	169.2		1.65	16.44
	Coarse	2.36 - 4.75	762.5		7.45	23.89
GRAVEL	Small	4.75 - 9.5	784.2		7.66	31.55
	Small	9.5 - 13	382.4		3.74	35.29
	Fine	13 - 19	671.4		6.56	41.85
	Large	19 - 25	637.7		6.23	48.08
	Large	25 - 38	1675.9		16.38	64.46
	Large	38 - 51	3636.8		35.54	100.00
	Large	51 - 64				100.00
COBBLE	Small	64 - 75				100.00
	Medium	75 - 90				100.00
	Medium	90 - 128				100.00
	Medium	128 - 180				100.00
	Large	180 - 256				100.00
BOULDER	Small	256 - 362				100.00
	Medium	362 - 512				100.00
	Medium	512 - 1024				100.00
	Large-Very Large	1024 - 2048				100.00
BEDROCK	Bedrock	> 2048				100.00
			10233	0	100	100

Channel materials	Sample 1	
D_{16} =	2.26	
D_{35} =	12.69	
D_{50} =	26.26	
D_{84} =	44.67	
D_{95} =	48.93	
D_{100} =	51.00	

Dead R. Limited Use Curves - Harlow Sub



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HarlowSTSPavement Sub Pavement
LogHistogramDetail

LEGEND

.... FOOT TRAILS

BEDROCK

BUCK ENGINEERING

1347 Harding Place
Suite 100
Charlotte, North Carolina 28204
Phone: 704.334.4454
Fax: 704.334.4492
www.buckengineering.com

Sheet 1 of 1

Harlow Creek Sketch

Dead *River Post-Event Additional Environmental Assessment*

Work Plan Photograph Key

Dead River Recovery Post-Event Additional Environmental Assessment: Survey of Morphological Stream Parameters Using Rosgen Method

Number [1]	Subject	Location [2]
1	Bankfull stage indicator	location that best depicts indicator (Rosgen, 1996)
2	Stream downstream of the cross-section	standing mid-stream at the tape
3	Stream upstream of the cross-section	standing mid-stream at the tape
4	Cross-section photo	downstream of the cross-section facing upstream
5	Cross-section photo	upstream of the cross-section facing downstream
6	Right floodplain	right top of bank at the cross-section
7	Left floodplain	left top of bank at the cross-section
8	Stream upstream of the reach	standing mid-stream at the start of the longitudinal profile
9	Stream downstream of the reach	standing mid-stream at the end of the longitudinal profile
10	A sufficient number of photographs to provide a continuous visual documentation of the survey reach	facing downstream

Notes:

1. A letter designation is used in addition to the photo number (e.g. 10A, 10B, 10C, etc.) if more than one photograph was taken of a particular subject or from a single location.
2. Location from which photograph was taken.

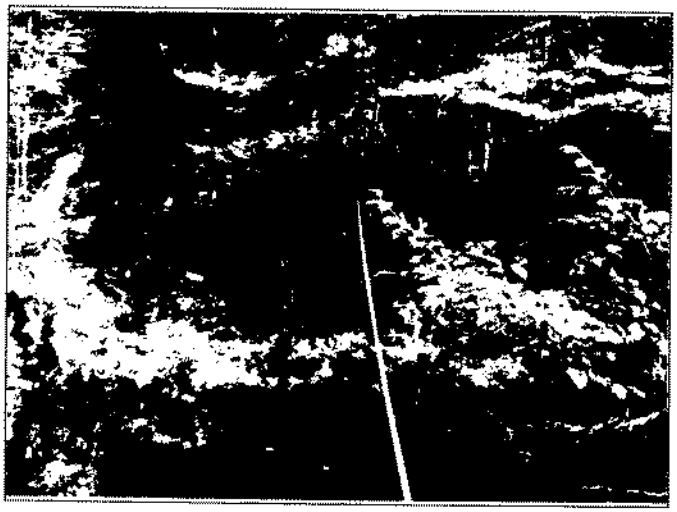
HARLOW POOL XS #1

HARLOW POOL XS #2

HARLOW POOL XS #3

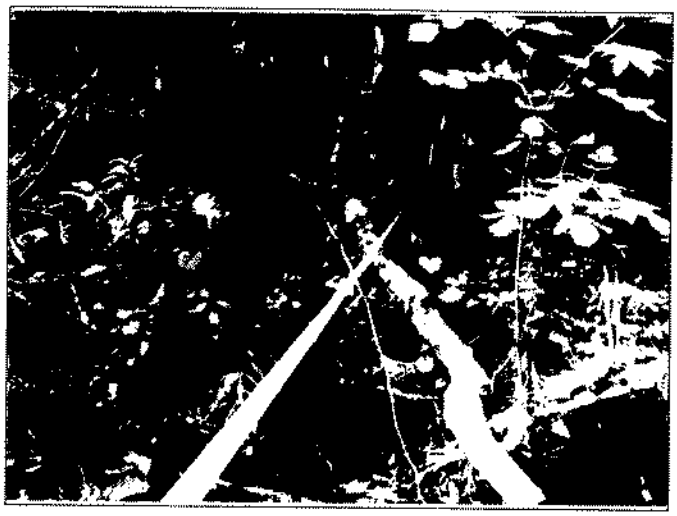
HARLOW POOL XS #4

HARLOW POOL XS #5

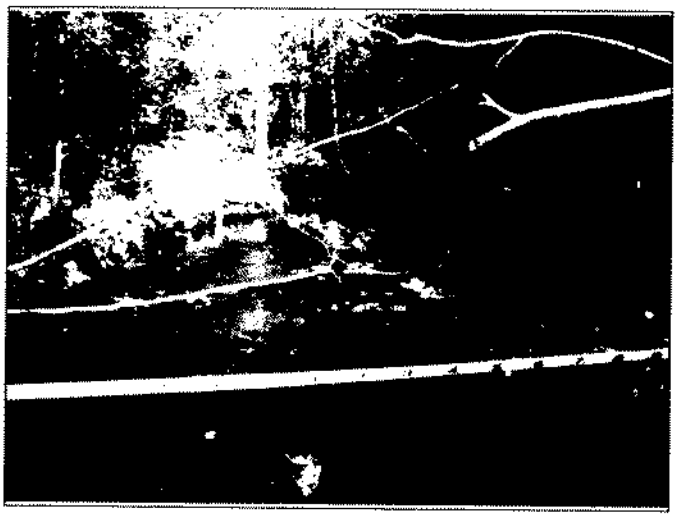


HARLOW POOL XS #6

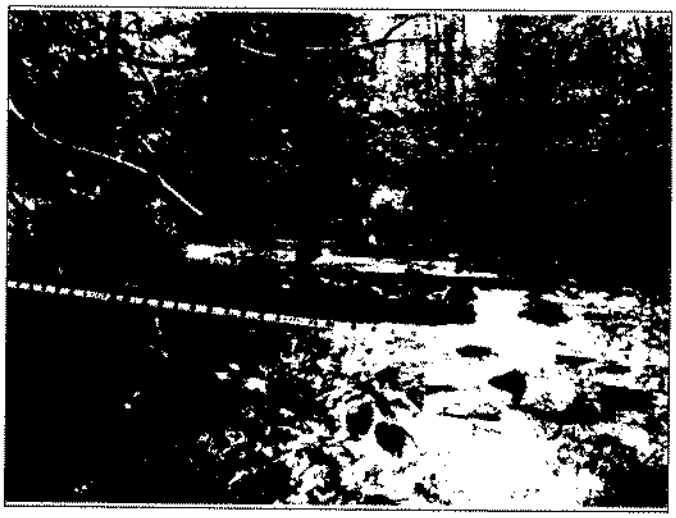
HARLOW POOL XS #7



HARLOW RIFFLE XS1 #1



HARLOW RIFFLE XS1 #2



HARLOW RIFFLE XS1 #3

HARLOW RIFFLE XS1 #4

HARLOW RIFFLE XS #5

HARLOW RIFFLE XS1 #6

HARLOW RIFFLE XS1 #7

HARLOW #8

HARLOW #9

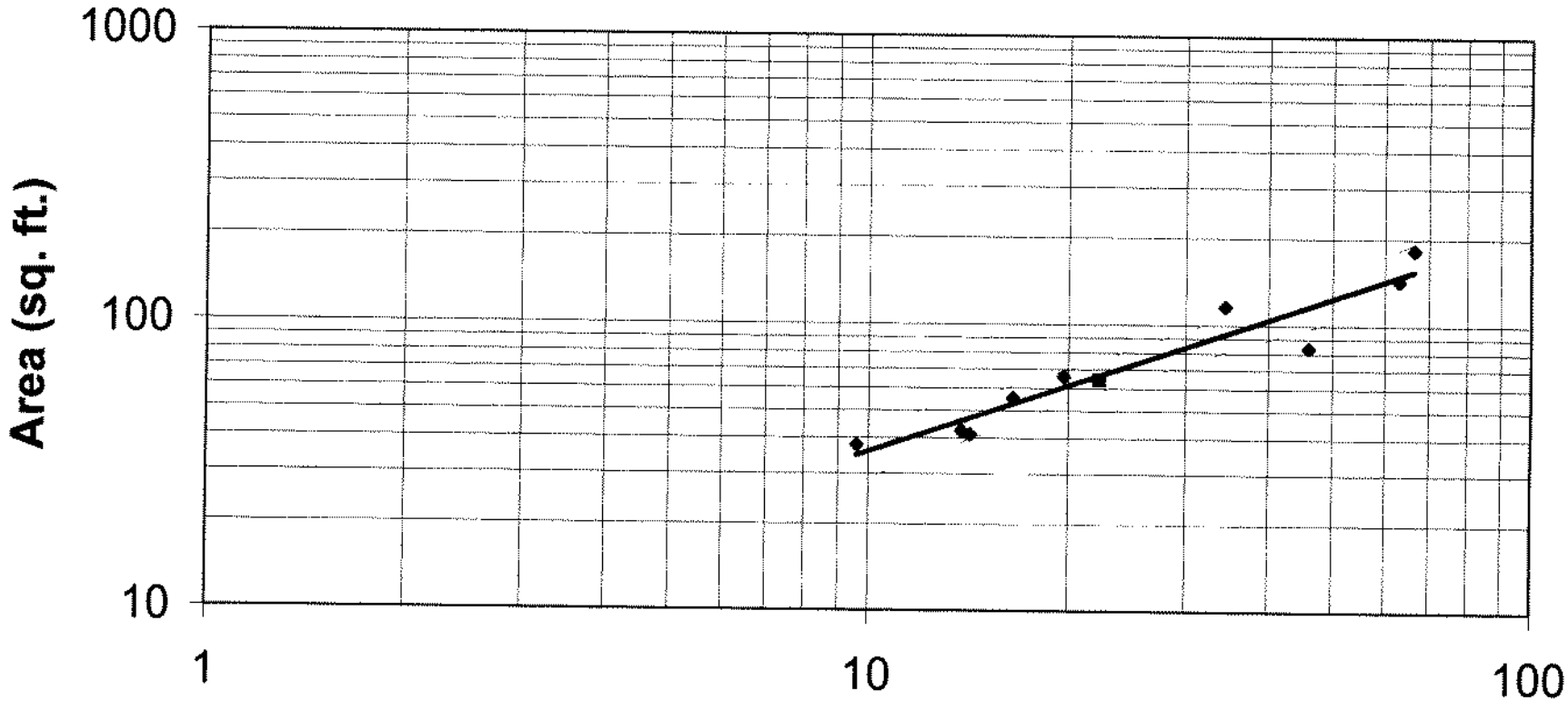
HARLOW RIFFLE XS #10A

HARLOW RIFFLE XS #10B

HARLOW #10C

Cross Sectional Area vs. Drainage Area

$y = 6.0x^{0.77}$, $r^2 = 0.91$



◆ Study Points 95% C.I. ▪ Harlow — Regression

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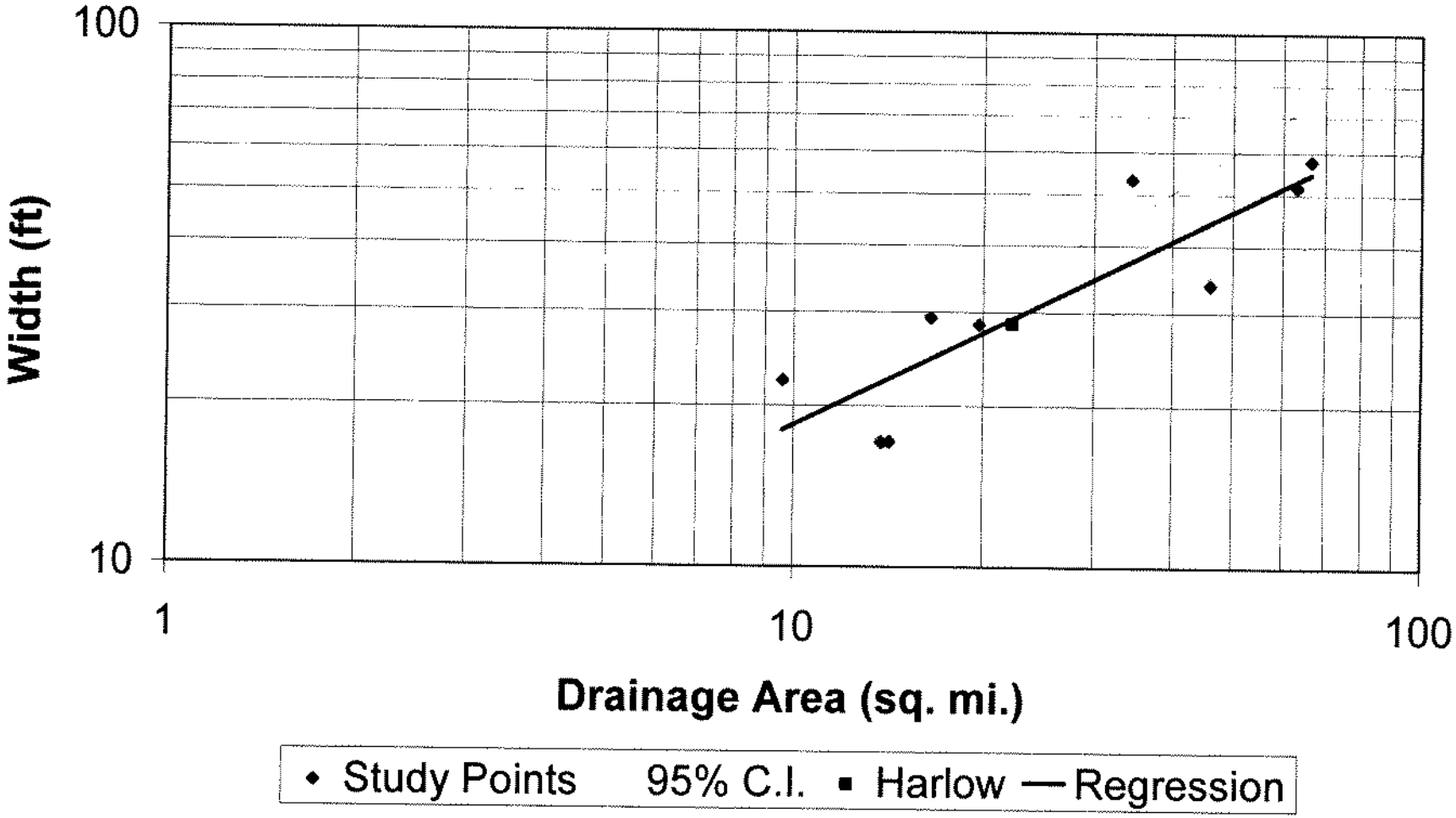
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Harlow
Curves Chart 1

Bankfull Width vs. Drainage Area

$y = 4.9x^{0.57}$, $r^2 = 0.76$



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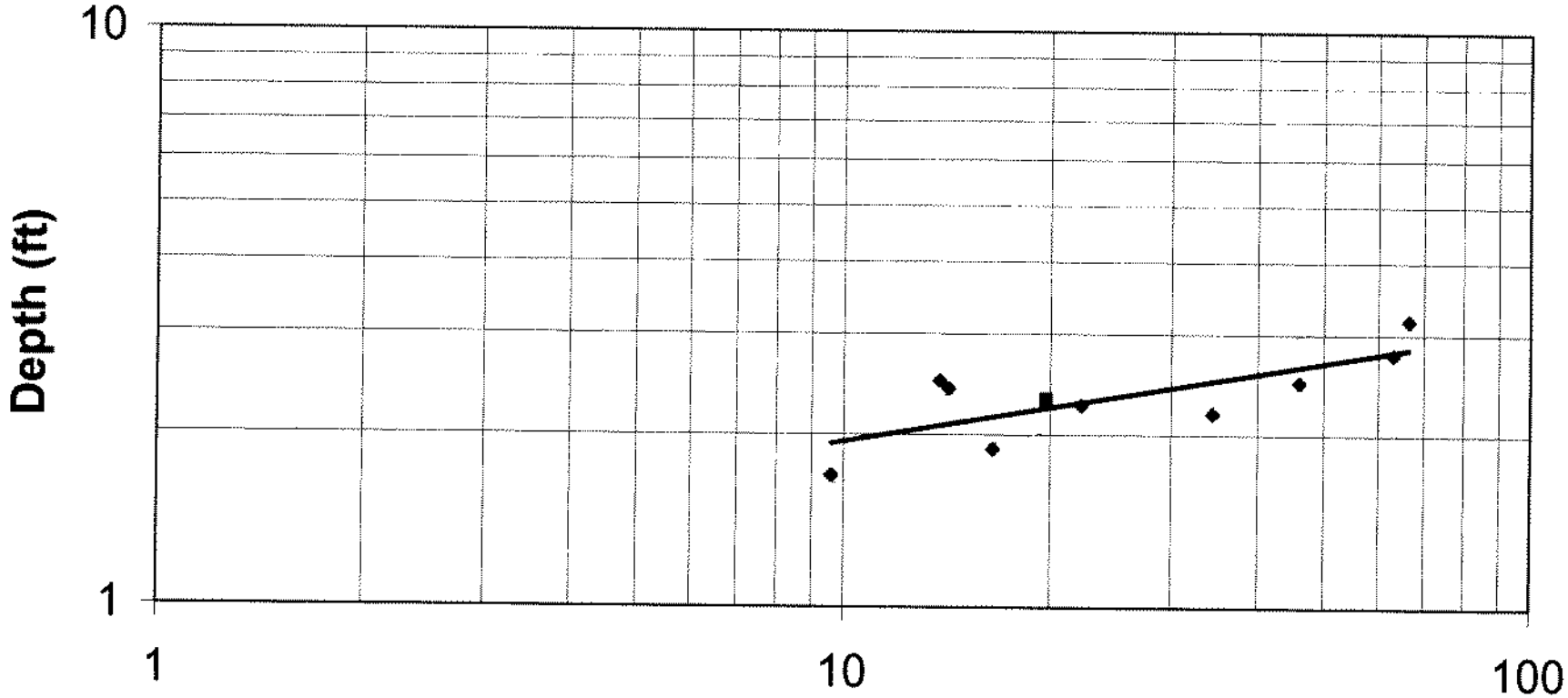
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Harlow
Curves Chart 2

Bankfull Mean Depth vs. Drainage Area

$y = 1.2x^{0.20}$, $r^2 = 0.57$



◆ Study Points 95% C.I. ▪ Clark — Regression

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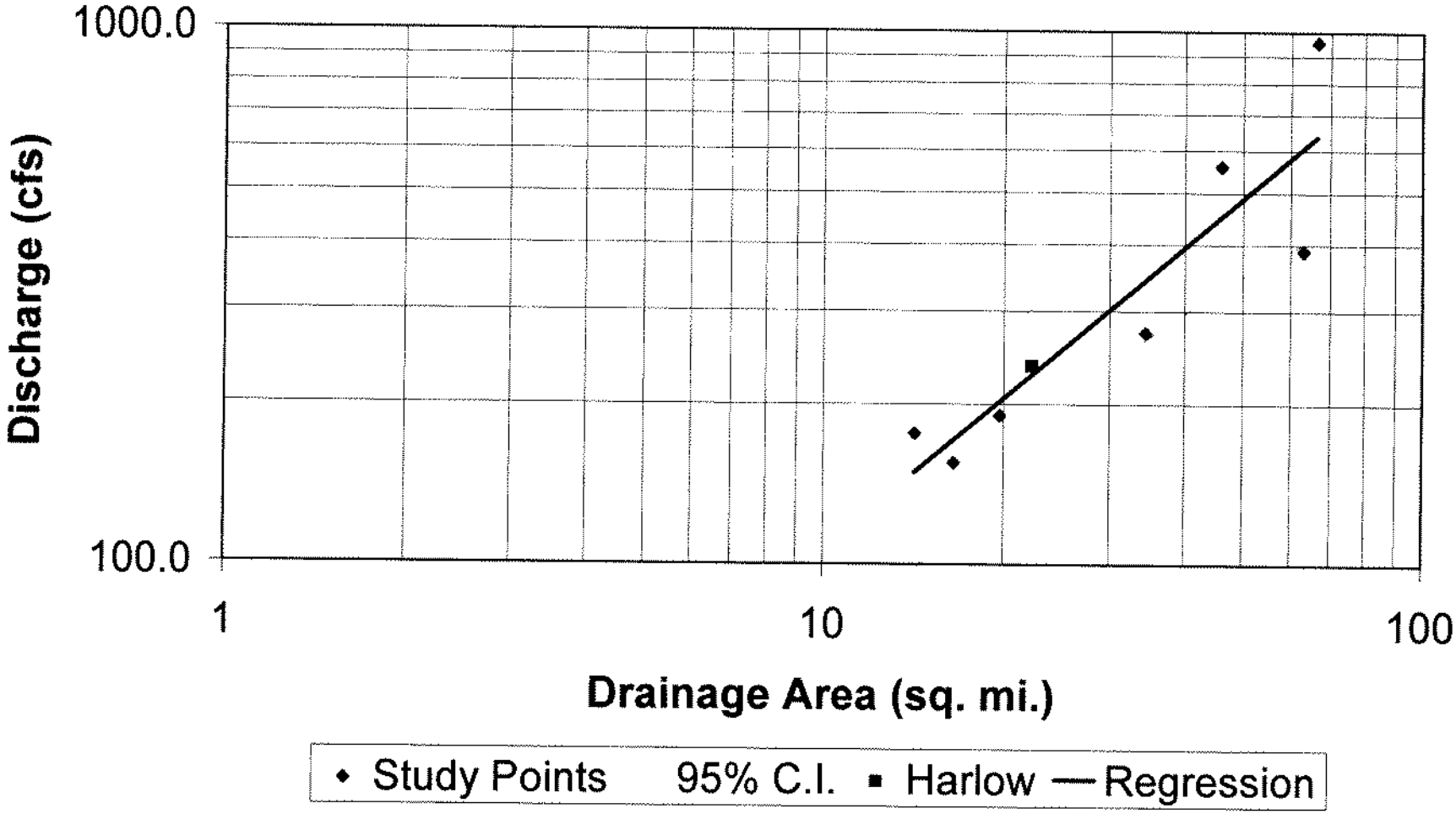
4:23 PM

NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Harlow
Curves Chart 3

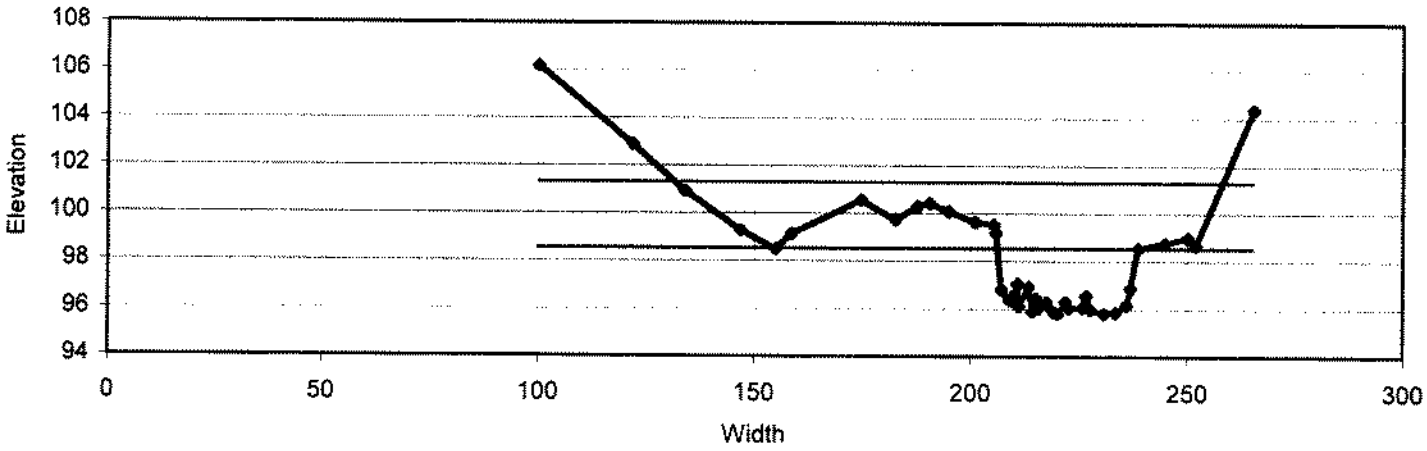
Bankfull Discharge vs. Drainage Area

$y = 12.2x^{0.94}$, $r^2 = 0.82$



Cross Section X1

3 + 45 Riffle



Bankfull Dimensions	
73.0	x-section area (ft.sq.)
33.2	width (ft)
2.2	mean depth (ft)
2.7	max depth (ft)
37.5	wetted parimeter (ft)
1.9	hyd radi (ft)
15.1	width-depth ratio

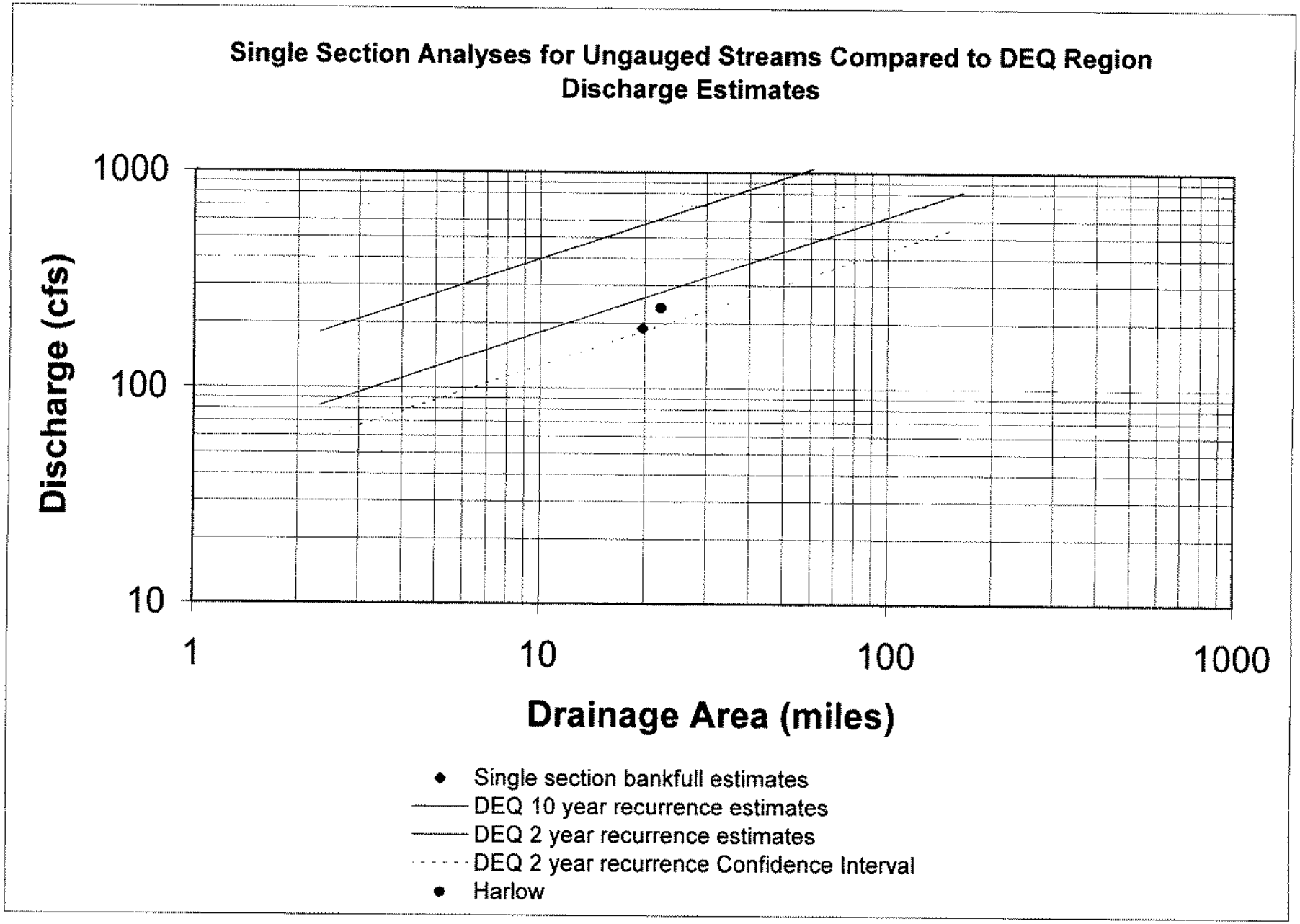
Flood Dimensions	
126.2	W flood prone area (ft)
3.8	entrenchment ratio
2.7	low bank height (ft)
1.0	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
17	threshold grain size (mm):

Bankfull Flow	
3.2	velocity (ft/s)
236.1	discharge rate (cfs)
0.41	Froude number

Flow Resistance	
0.038	Manning's roughness
0.13	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.28	channel slope (%)
0.34	shear stress (lb/sq.ft.)
0.42	shear velocity (ft/s)
1.24	unit strm power (lb/ft/s)



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StatewideRural v3
StatewideRural Chart 2

Appendix 8

Detailed LUC Site Methods

1.1 Dimension, Profile, and Pattern Measurements

At each site, a Total Station with a survey card was used to complete a longitudinal profile and three cross-sections along a reach length of approximately 20 times the bankfull width. The survey was tied to the USGS reference marks and water surface elevation at the gage.

Cross-sections were surveyed at two representative riffles or crossover sections and one pool. Moving left to right looking downstream, morphological features were surveyed including top of bank, bankfull stage, edge of channel, edge of water, thalweg, and channel bottom (Harrelson et al., 1994; U.S. Geological Survey, 1969). Permanent pins were not established; however, the cross-sections were tied to the longitudinal profile station. A distance and azimuth to the bridge or culvert was also determined. Therefore, from the bridge or culvert, the approximate location of the cross-section can be recovered. The data were downloaded from the Total Station and the following bankfull dimensions were calculated: width, cross-sectional area, maximum depth, mean depth, ratio of width/mean depth, bank height ratio, and entrenchment ratio (riffles only). The data were then exported to Microsoft Excel for graphing and regional curve development. Additional statistics were completed using CoStat statistical software.

A longitudinal survey was completed over a stream length of approximately 20 bankfull widths. Measurements were collected at most bed feature (heads of riffles and maximum depth of pools). Due to the presence of heavy riparian vegetation and limited trespass permission, full details of stream profile were not collected. However sufficient detail was collected to estimate channel and water surface slope throughout each study reach with particular detail collected surrounding the gage station. Thalweg, water surface, bankfull stage, and top of bank were recorded at regular intervals. The slope of a line fitted through the bankfull stage indicators was compared to a line of best fit through the water surface points. The longitudinal survey was carried through the gage plate to obtain the bankfull stage and corresponding discharge. The data were processed in the same manner as the cross-section data and the following values were calculated: valley slope and average channel slope.

Channel pattern was determined from the survey points and verified on aerial photographs. Stream sinuosity, belt width and meander length were measured for each study site.

1.2 Bed Material Measurements

One hundred count pebble samples were recorded reach wide. Where sand dominated bed material the Wolman pebble count procedure did not apply (Bunte and Abt, 2001). Instead, bulk samples were taken of the bed material at two cross-sections stratified by riffles and pools. The samples were returned to the STS soils lab and sieved.

1.3 Stream Classification

Each project reach was classified using the Rosgen (1994, 1996) method. The width of the floodprone area was measured from survey data or topographic maps (where survey data were insufficient due to wide, heavily vegetated floodplains). In cases where clear shots could be collected across the valley, a complete cross-section was surveyed across the floodplain and the floodprone area width was taken from the cross-section.

1.4 Bankfull Discharge and Flood Frequency for Gaged Streams

The bankfull discharge was determined using the USGS stage-discharge rating table and the longitudinal survey of bankfull stage (discussed above). The return interval was determined through Log-Pearson Type III distributions of annual peak discharge data. Procedures are outlined in USGS Bulletin #17B, "Guidelines for Determining Flood Flow Frequency" (USGS, 1982). The annual exceedence probability was calculated as the inverse of the recurrence interval. Exceedence probabilities were plotted as functions of corresponding calculated discharge measurements on log-probability paper and a regression line was fit to the data. The bankfull discharge recurrence interval was then estimated from the graph.

Appendix 9

Limited Use Curve Data and Deliverables

Task 1.2.2 from original Work Plan
(reference Section 2.2.2 from Report)

Develop "Limited Use" Curve (LUC)

PM: Ed D. Ahr

Date: 12/14/2004

QA/QC: J. Rock Parker

Date: 12/14/2004

Initials	Work Item
SRO	Perform a minimum of eight (8) reach surveys. List reach names below in the appropriate category:

Sites with DA less than Dead River DA below the post-event Silver Lake confluence:

Site #1: Green Ck. (13.8 SM)

Site #2: Warner Ck. (14.2 SM)

Site #3: Carp Ck. (16.5 SM)

Sites with DA greater than Dead River DA below the post-event Silver Lake confluence:

Site #4: Perch Rvr. (63.1 SM)

Site #5: Escanaba-MBr (46 SM)

Site #6: Black Rvr. (34.4 SM)

Others:

Site #7: Harlow Ck. (22.2 SM)

Site #8: Clark Ck. (19.69 SM)

#9 Peshekee Rvr. (66.5 SM)

Initials	Work Item
JB	Collect the following data at a minimum for each LUC reach.

Reach ID: **Green**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☐ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☐ Photograph site.

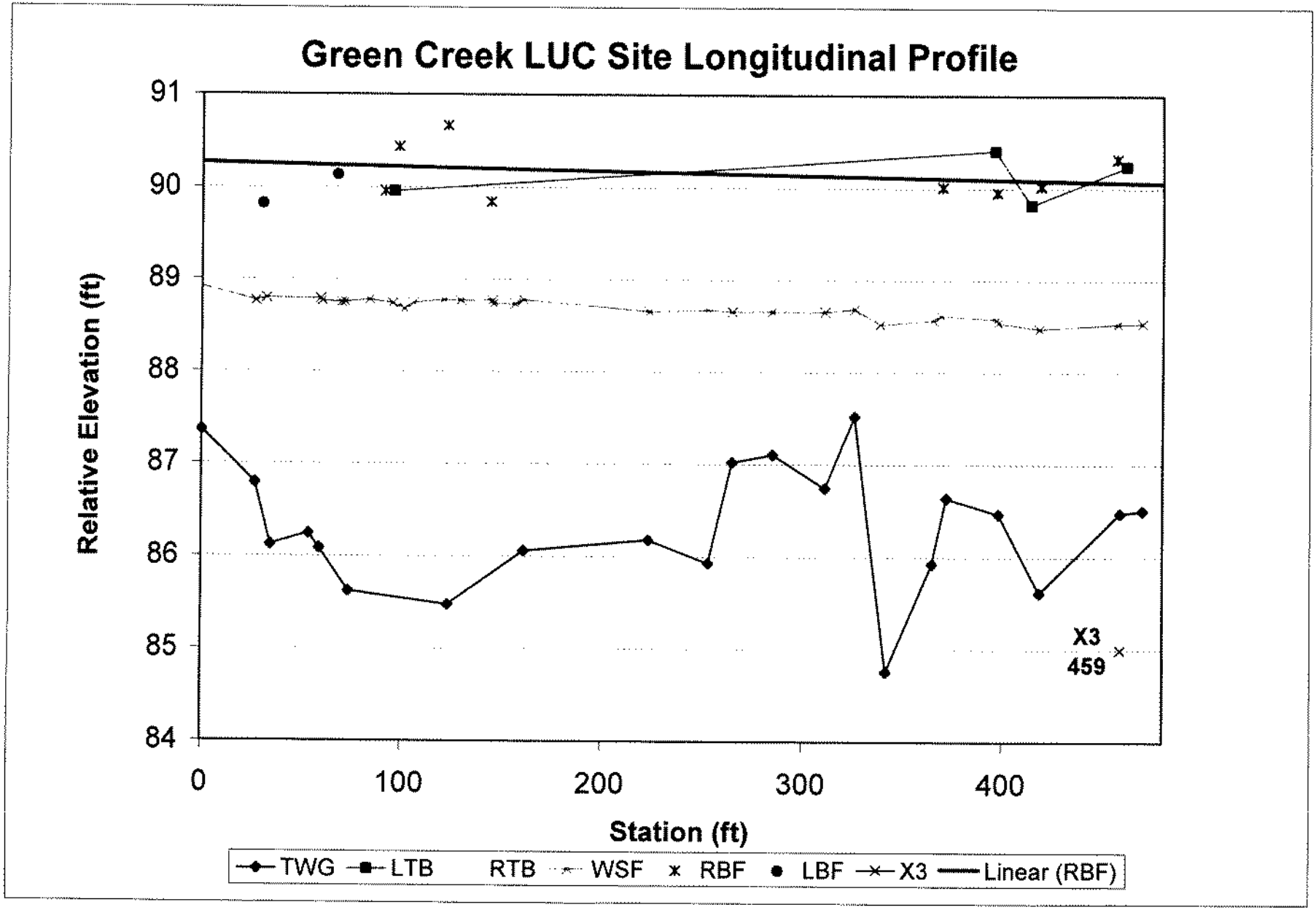
Initials	Work Item
SRB	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Green**

- ☑ Limited Use Curves
  - ☑ DA versus Wbkf
  - ☑ DA versus Dbkf
  - ☑ DA versus CSA
  - ☒ DA versus Qbkf Gage records @ Green incomplete
- ☑ Plot of longitudinal profile
- ☑ Plot of cross-section
- ☑ Grain size distribution for bed material
- ☑ Site sketch
- ☑ Photographs and photo log.
- ☑ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)

n/a ☐ Calculations (single section analysis)

n/a ☐ Plot of Single Section Analysis versus Regression Equation } gauge data available.



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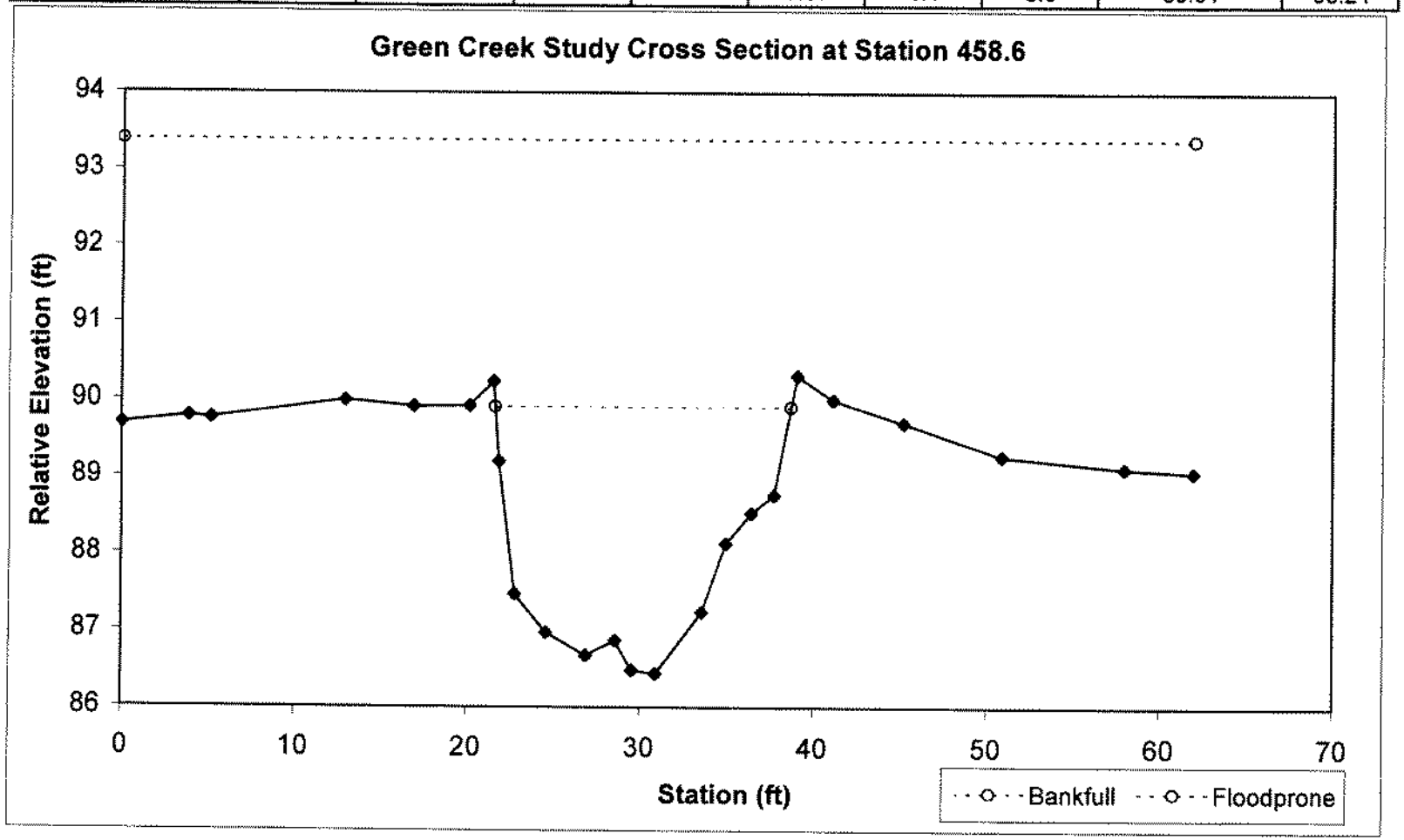
Green Xsecs and Profile
Profile Chart 1

Riffle @ Station 4+59

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	Width	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E5	42.4	17.06	2.48	3.47	6.87	1.1	3.6	89.91	90.24



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Green Xsecs and Profile
XSEC 458.6

Pavement/Subpavement Analysis

SITE OR PROJECT:	Dead R. Limited Use Curves
REACH/LOCATION:	Green Creek
DATE COLLECTED:	08/31/04
FIELD COLLECTION BY:	SRB
DATA ENTERED BY:	STS/SRB

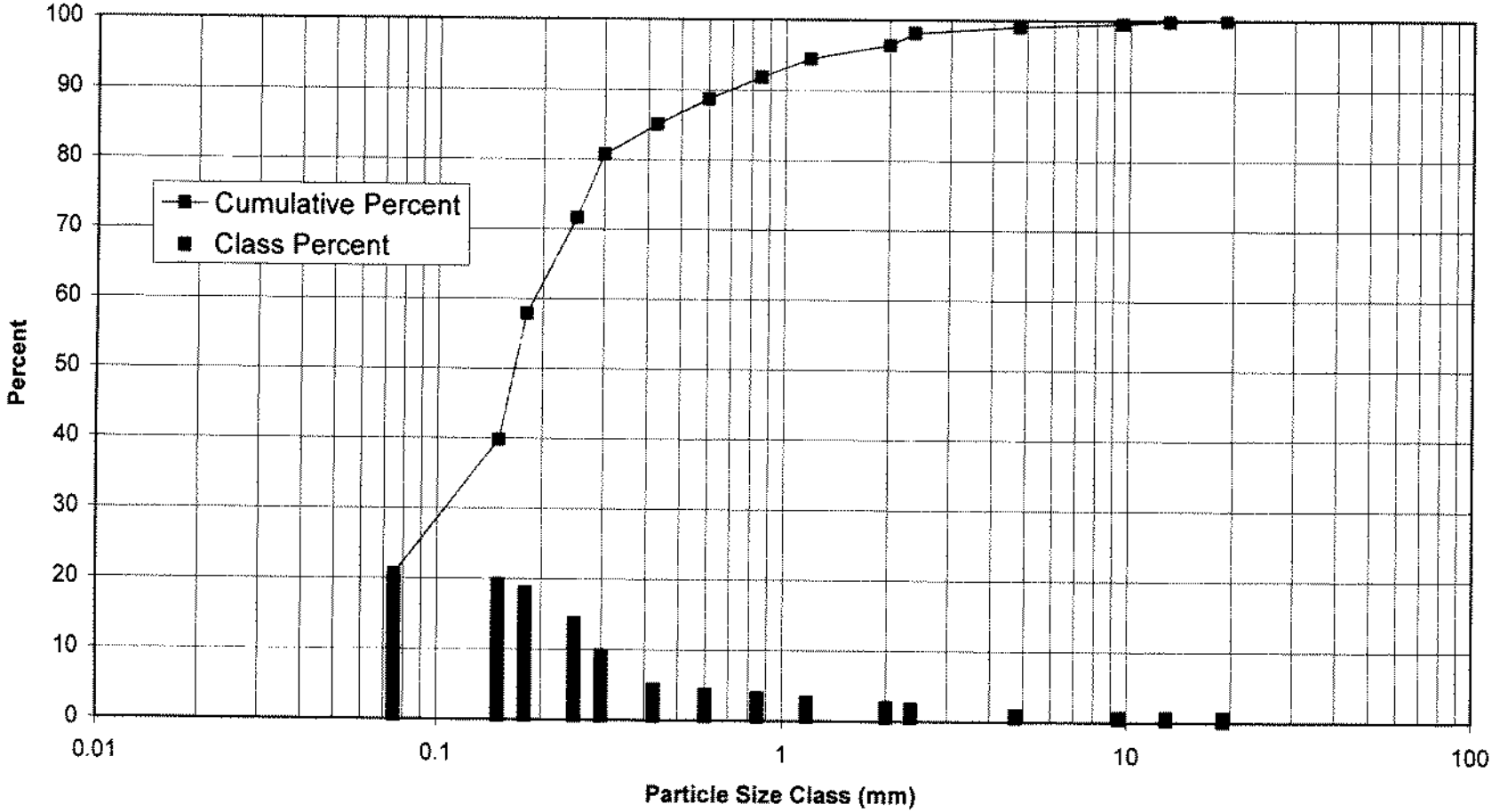
SEDIMENT ANALYSIS DATA SHEET

MATERIAL	PARTICLE	SIZE (mm)	Sample 1 (g)		Pavement Class %	Pavement % Cum
	Silt / Clay	< .075	2338.6		20.68	20.68
SAND	Very Fine	.075 - .15	2167.2		19.16	39.84
	Fine	.15 - .18	2039.3		18.03	57.88
	Fine	.18 - .25	1552.8		13.73	71.61
	Fine	0.25 - 0.3	1027.8		9.09	80.69
	Medium	0.3 - 0.425	486.8		4.30	85.00
	Medium	0.425 - 0.6	411.4		3.64	88.64
	Medium	0.6 - 0.85	357.0		3.16	91.79
	Medium	0.85 - 1.18	300.4		2.66	94.45
	Medium	1.18 - 2.0	221.7		1.96	96.41
	Coarse	2.0 - 2.36	197.7		1.75	98.16
	Coarse	2.36 - 4.75	101.5		0.90	99.06
GRAVEL	Small	4.75 - 9.5	52.4		0.46	99.52
	Small	9.5 - 13	35.9		0.32	99.84
	Fine	13 - 19	18.5		0.16	100.00
	Large	19 - 25				100.00
	Large	25 - 38				100.00
	Large	38 - 51				100.00
	Large	51 - 64				100.00
COBBLE	Small	64 - 75				100.00
	Medium	75 - 90				100.00
	Medium	90 - 128				100.00
	Medium	128 - 180				100.00
	Large	180 - 256				100.00
BOULDER	Small	256 - 362				100.00
	Medium	362 - 512				100.00
	Medium	512 - 1024				100.00
	Large-Very Large	1024 - 2048				100.00
BEDROCK	Bedrock	> 2048				100.00
			11309	0	100	100

Channel materials	Sample 1	
D_{16} =	< .075	
D_{35} =	0.13	
D_{50} =	0.17	
D_{84} =	0.39	
D_{95} =	1.37	
D_{100} =	19.00	

Green Creek Pavement Particle Distribution

Dead R. Limited Use Curves - Green Creek



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GreenSedimentDist
LogHistogramDetail

LEGEND:

- Green Creek reference reach
- ▲ USGS gage 4058130
- O Green cross sections
- ● Green sediment sample site

250 125 0 250 500 Feet

BUCK ENGINEERING

Green Creek Reach for
Limited Use Curve Development

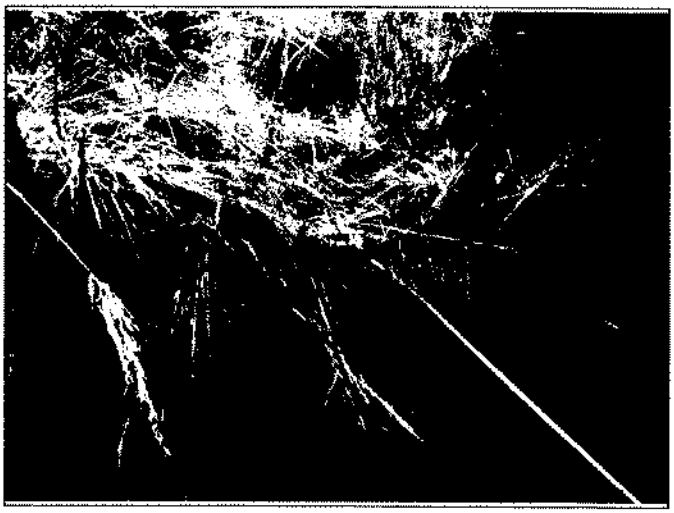
Work Plan Photograph Key

Dead River Recovery Post-Event Additional Environmental Assessment: Survey of Morphological Stream Parameters Using Rosgen Method

Number [1]	Subject	Location [2]
1	Bankfull stage indicator	location that best depicts indicator (Rosgen, 1996)
2	Stream downstream of the cross-section	standing mid-stream at the tape
3	Stream upstream of the cross-section	standing mid-stream at the tape
4	Cross-section photo	downstream of the cross-section facing upstream
5	Cross-section photo	upstream of the cross-section facing downstream
6	Right floodplain	right top of bank at the cross-section
7	Left floodplain	left top of bank at the cross-section
8	Stream upstream of the reach	standing mid-stream at the start of the longitudinal profile
9	Stream downstream of the reach	standing mid-stream at the end of the longitudinal profile
10	A sufficient number of photographs to provide a continuous visual documentation of the survey reach	facing downstream

Notes:

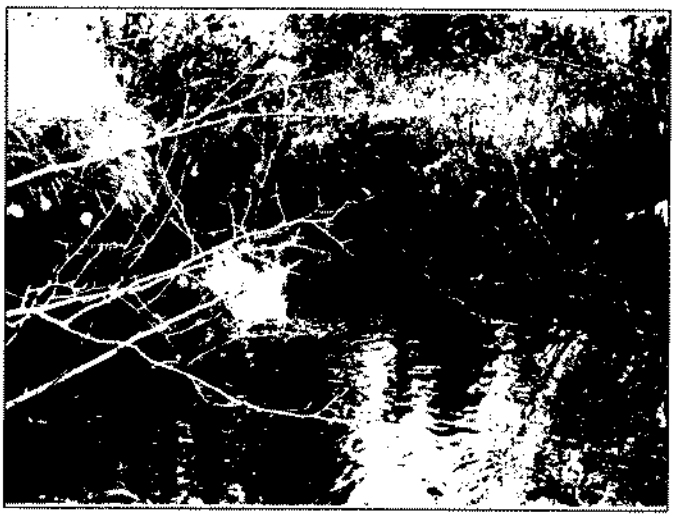
1. A letter designation is used in addition to the photo number (e.g. 10A, 10B, 10C, etc.) if more than one photograph was taken of a particular subject or from a single location.
2. Location from which photograph was taken.



GREEN RIFFLE XS #1A

GREEN RIFFLE XS #1B

GREEN RIFFLE XS #2



GREEN RIFFLE XS #3

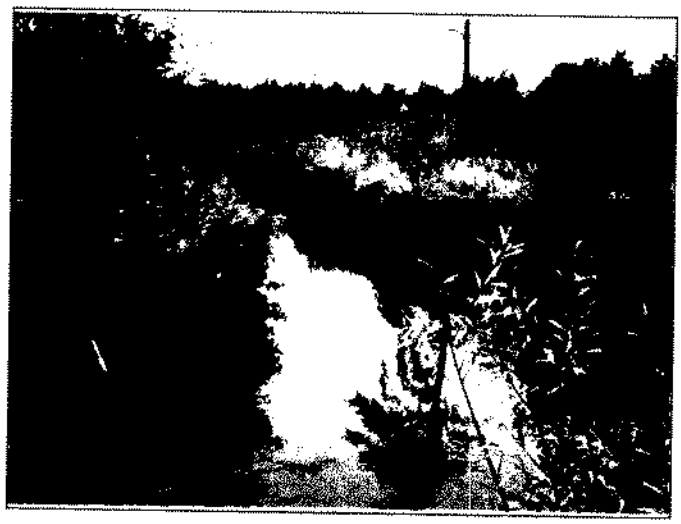
GREEN RIFFLE XS #4

GREEN RIFFLE XS #5

GREEN RIFFLE XS #6

GREEN RIFFLE XS #7

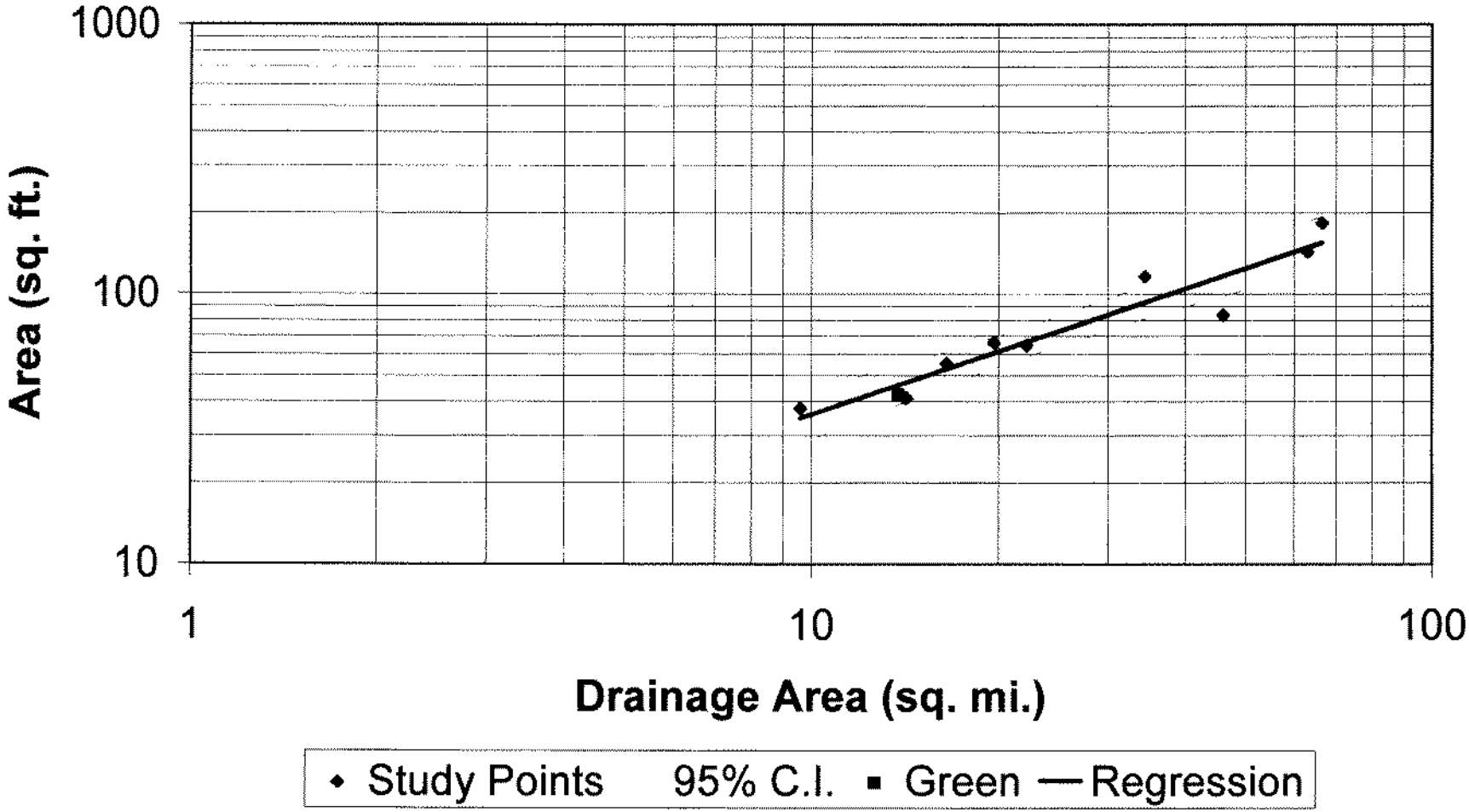
GREEN #8



GREEN #9

Cross Sectional Area vs. Drainage Area

$y = 6.0x^{0.77}$, $r^2 = 0.91$



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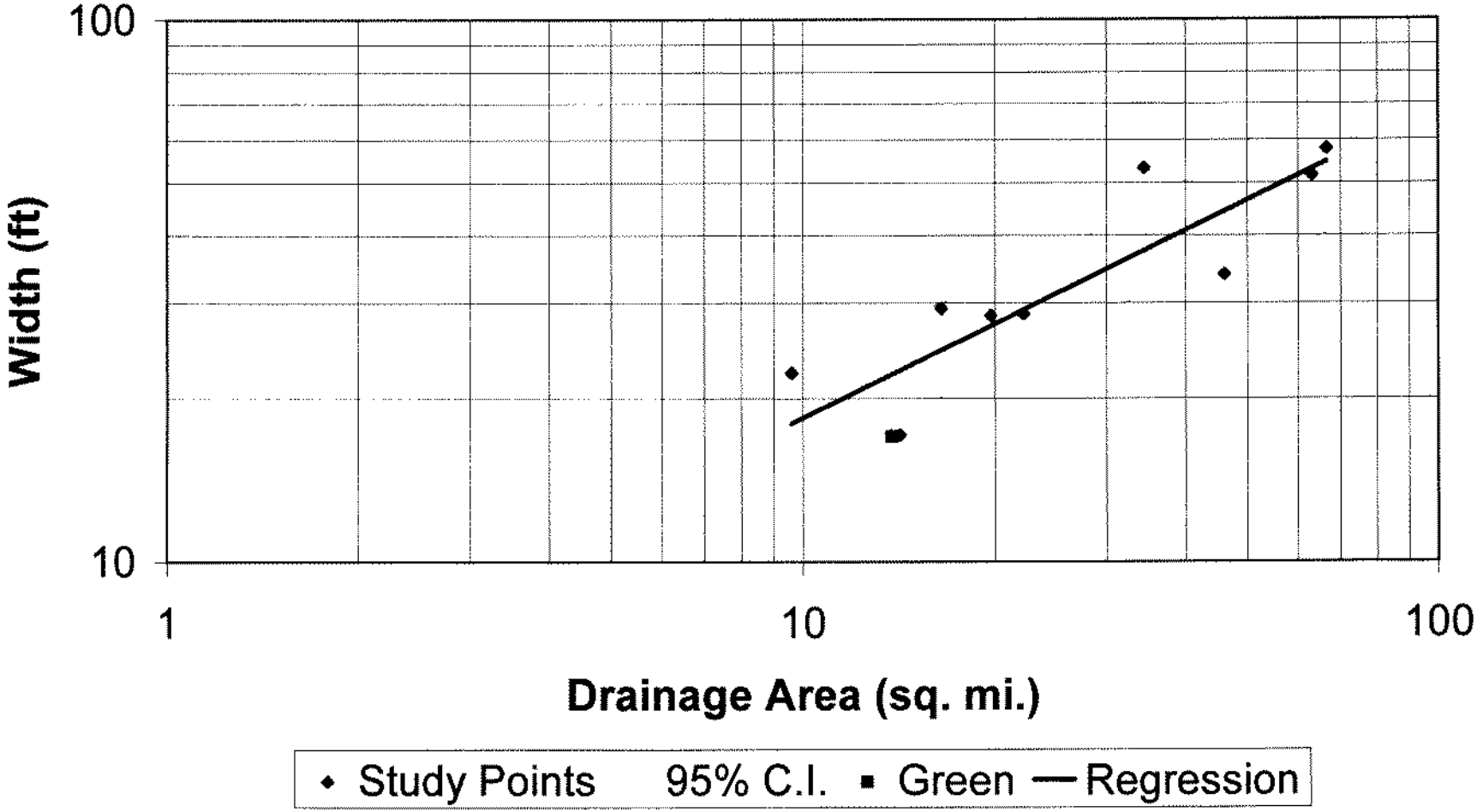
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Green
Curves Chart 1

Bankfull Width vs. Drainage Area

$y = 4.9x^{0.57}$, $r^2 = 0.76$



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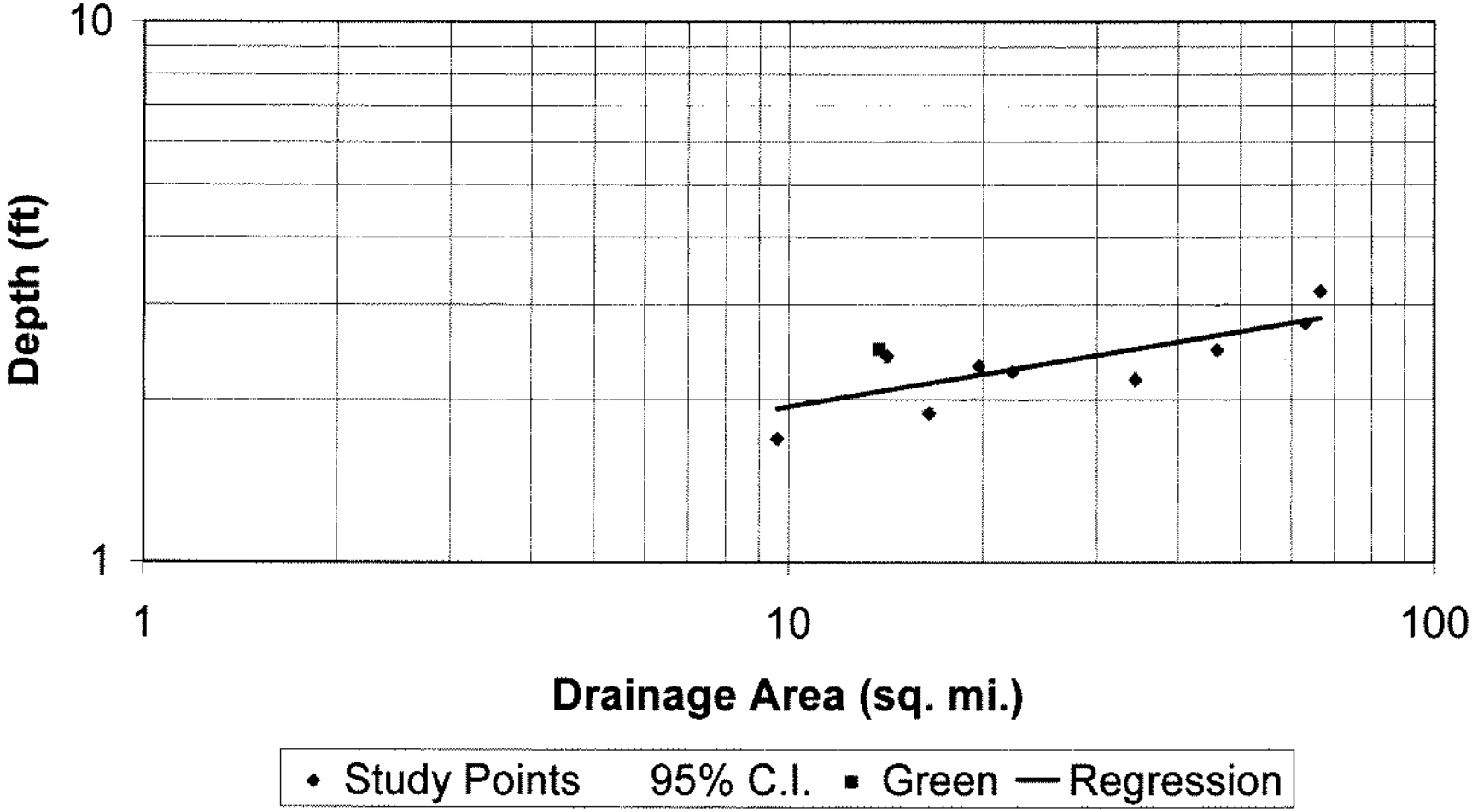
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Green
Curves Chart 2

Bankfull Mean Depth vs. Drainage Area

$y = 1.2x^{0.20}$, $r^2 = 0.57$



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NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Green
Curves Chart 3

Warner Creek

Initials	Work Item
AB	Collect the following data at a minimum for each LUC reach.

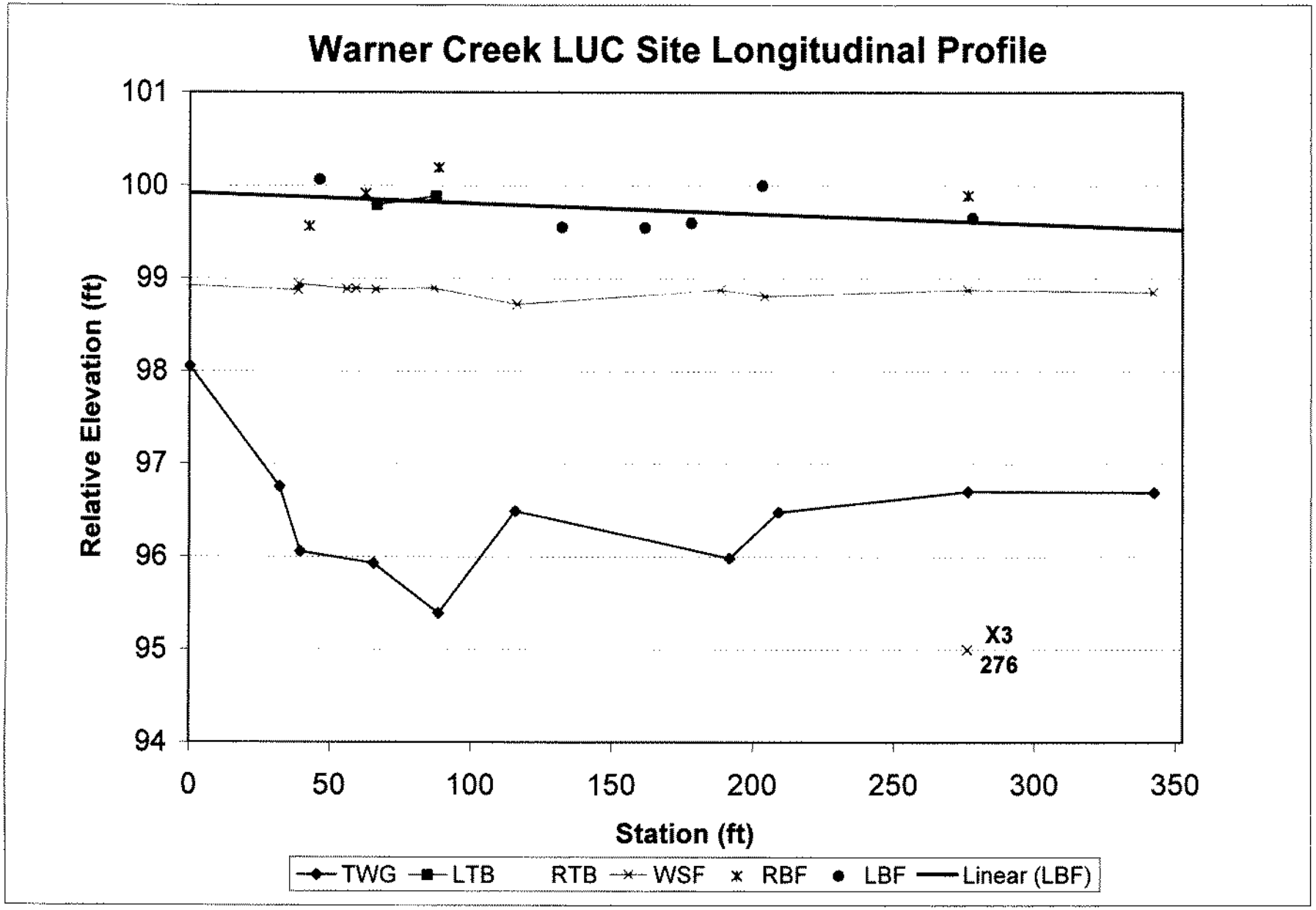
Reach ID: **Warner**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☑ Photograph site.

Initials	Work Item
SPB	Provide the following items for each LUC reach in electronic and hard copy format.

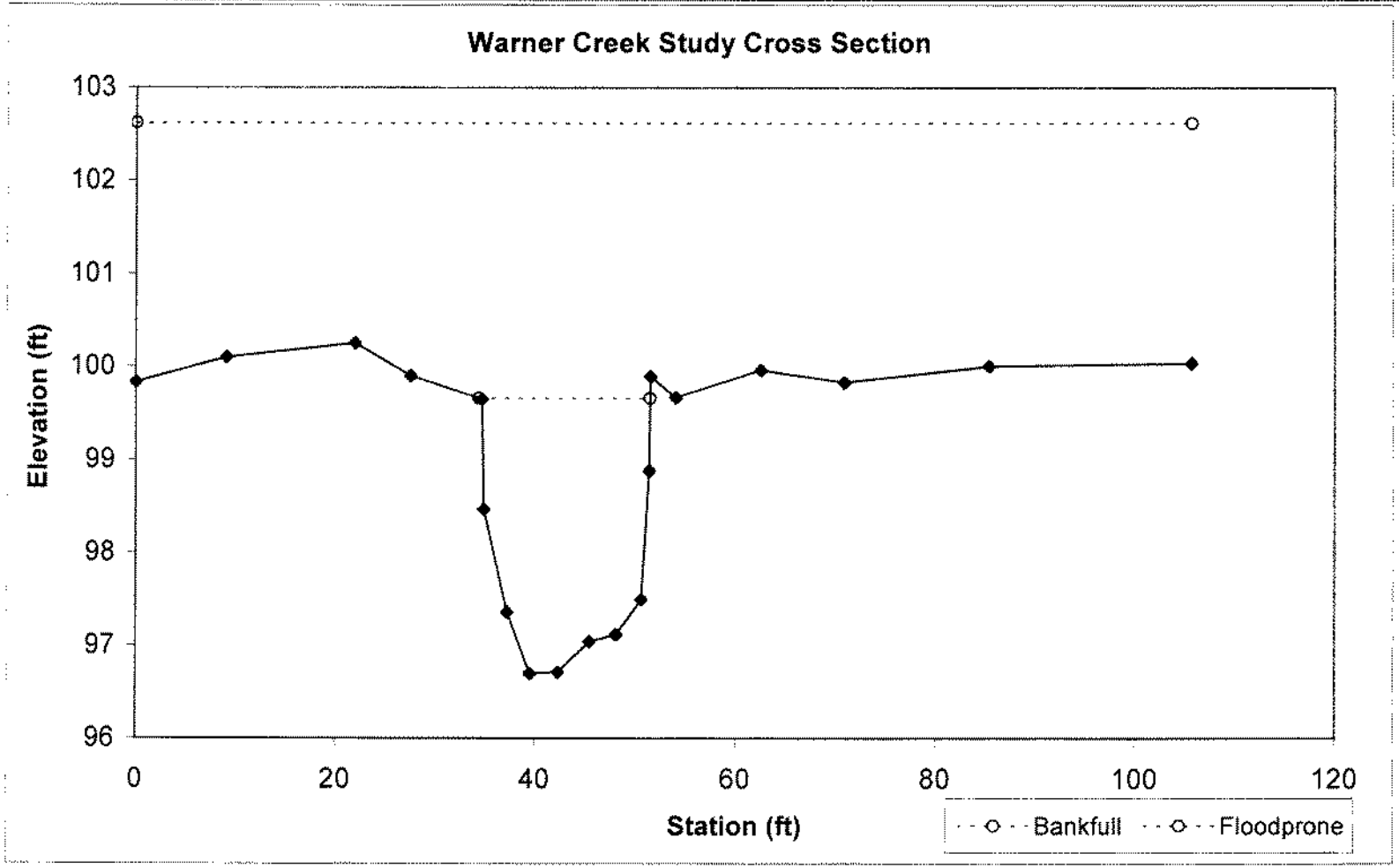
Reach ID: **Warner**

- ☑ Limited Use Curves
  - -- DA versus Wbkf
  - -- DA versus Dbkf
  - -- DA versus CSA
  - -- DA versus Qbkf
- ☑ Plot of longitudinal profile
- ☑ Plot of cross-section
- ☑ Grain size distribution for bed material
- ☑ Site sketch
- ☑ Photographs and photo log.
- ☑ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)
- n/a ☑ Calculations (single section analysis)
- n/a ☑ Plot of Single Section Analysis versus Regression Equation } gauge data available



Riffle @ Station 2+76

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E5	41.2	17.13	2.41	2.96	7.12	1.1	6.2	99.66	99.89



Pavement/Subpavement Analysis

SITE OR PROJECT:	Dead R. Limited Use Curves
REACH/LOCATION:	Warner Creek
DATE COLLECTED:	08/31/04
FIELD COLLECTION BY:	SRB
DATA ENTERED BY:	STS/SRB

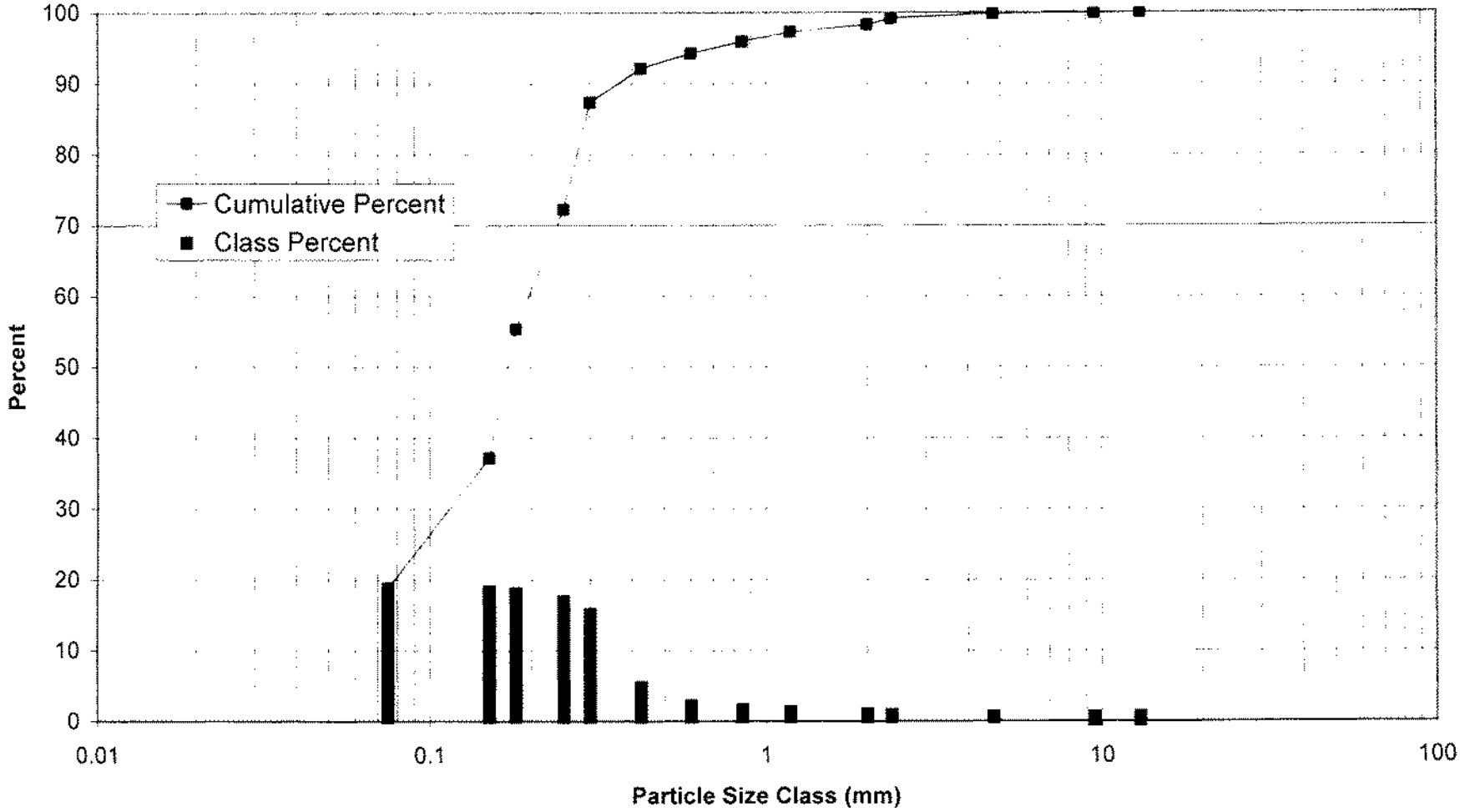
SEDIMENT ANALYSIS DATA SHEET

MATERIAL	PARTICLE	SIZE (mm)	Sample 1 (g)		Pavement Class %	Pavement % Cum
	Silt / Clay	< .075	1418.0		18.84	18.84
SAND	Very Fine	.075 - .15	1382.2		18.36	37.20
	Fine	.15 - .18	1362.0		18.09	55.30
	Fine	.18 - .25	1276.6		16.96	72.26
	Fine	0.25 - 0.3	1140.5		15.15	87.41
	Medium	0.3 - 0.425	358.5		4.76	92.17
	Medium	0.425 - 0.6	163.4		2.17	94.34
	Medium	0.6 - 0.85	124.6		1.66	96.00
	Medium	0.85 - 1.18	102.2		1.36	97.36
	Medium	1.18 - 2.0	74.7		0.99	98.35
	Coarse	2.0 - 2.36	67.8		0.90	99.25
	Coarse	2.36 - 4.75	44.0		0.58	99.83
GRAVEL	Small	4.75 - 9.5	10.9		0.14	99.98
	Small	9.5 - 13	1.6		0.02	100.00
	Fine	13 - 19	0.0		0.00	100.00
	Large	19 - 25	0.0		0.00	100.00
	Large	25 - 38				100.00
	Large	38 - 51				100.00
	Large	51 - 64				100.00
COBBLE	Small	64 - 75				100.00
	Medium	75 - 90				100.00
	Medium	90 - 128				100.00
	Medium	128 - 180				100.00
	Large	180 - 256				100.00
	Small	256 - 362				100.00
	Medium	362 - 512				100.00
BOULDER	Medium	512 - 1024				100.00
	Large-Very Large	1024 - 2048				100.00
BEDROCK	Bedrock	> 2048				100.00
			7527	0	100	100

Channel materials	Sample 1	
D_{16} =	< .075	
D_{35} =	0.14	
D_{50} =	0.17	
D_{84} =	0.29	
D_{95} =	0.69	
D_{100} =	25.00	

Pavement Particle Distribution

Dead R. Limited Use Curves - Warner Creek



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WarnerPavementDist
LogHistogramDetail

LEGEND:

- Warner Creek reference reach
- ▲ USGS gage 4058300
- ○ Warner cross sections
- ● Warner sediment sampling site

250 125 0 250 500 Feet

BUCK

Warner Creek Reach for Limited Use Curve Development

Work Plan Photograph Key

Dead River Recovery Post-Event Additional Environmental Assessment: Survey of Morphological Stream Parameters Using Rosgen Method

Number [1]	Subject	Location [2]
1	Bankfull stage indicator	location that best depicts indicator (Rosgen, 1996)
2	Stream downstream of the cross-section	standing mid-stream at the tape
3	Stream upstream of the cross-section	standing mid-stream at the tape
4	Cross-section photo	downstream of the cross-section facing upstream
5	Cross-section photo	upstream of the cross-section facing downstream
6	Right floodplain	right top of bank at the cross-section
7	Left floodplain	left top of bank at the cross-section
8	Stream upstream of the reach	standing mid-stream at the start of the longitudinal profile
9	Stream downstream of the reach	standing mid-stream at the end of the longitudinal profile
10	A sufficient number of photographs to provide a continuous visual documentation of the survey reach	facing downstream

Notes:

1. A letter designation is used in addition to the photo number (e.g. 10A, 10B, 10C, etc.) if more than one photograph was taken of a particular subject or from a single location.
2. Location from which photograph was taken.

WARNER POOL XS #7

WARNER RIFFLE XS #1

WARNER RIFFLE XS #2

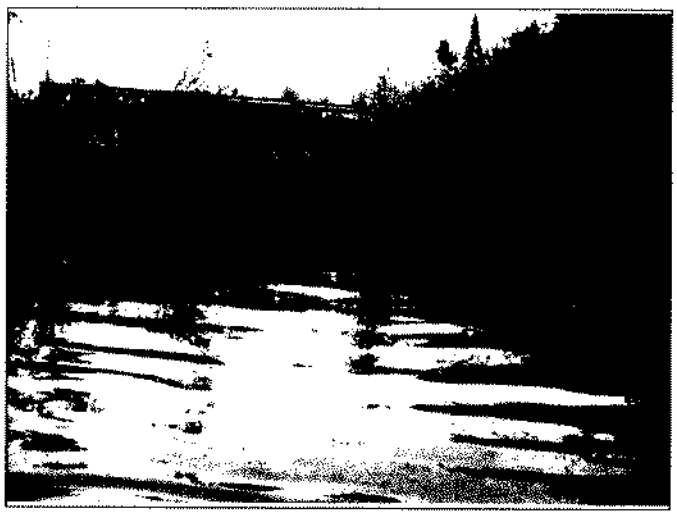
WARNER RIFFLE XS #3

WARNER RIFFLE XS #4

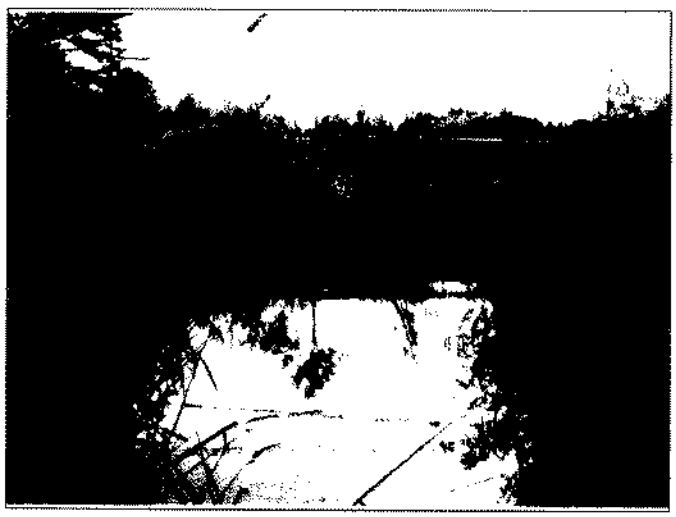
WARNER RIFFLE XS #5

WARNER POOL XS #1

WARNER POOL XS #2



WARNER POOL XS #3



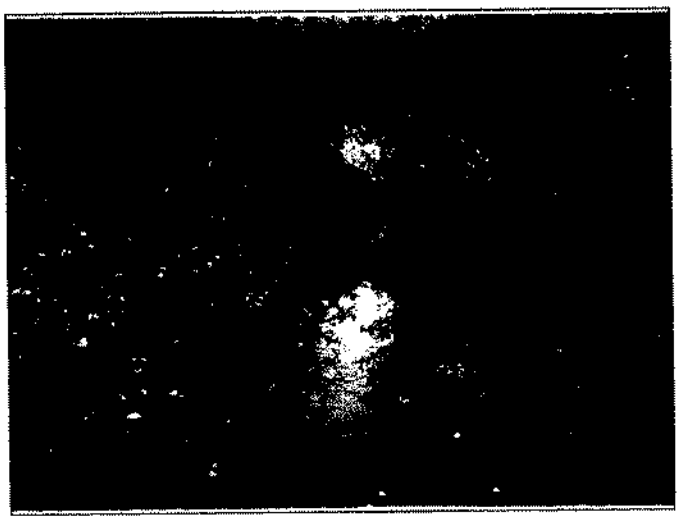
WARNER POOL XS #4

WARNER POOL XS #5

WARNER POOL XS #6

WARNER RIFFLE XS #6

WARNER RIFFLE XS #7



WARNER #8

WARNER#9

WARNER #10A

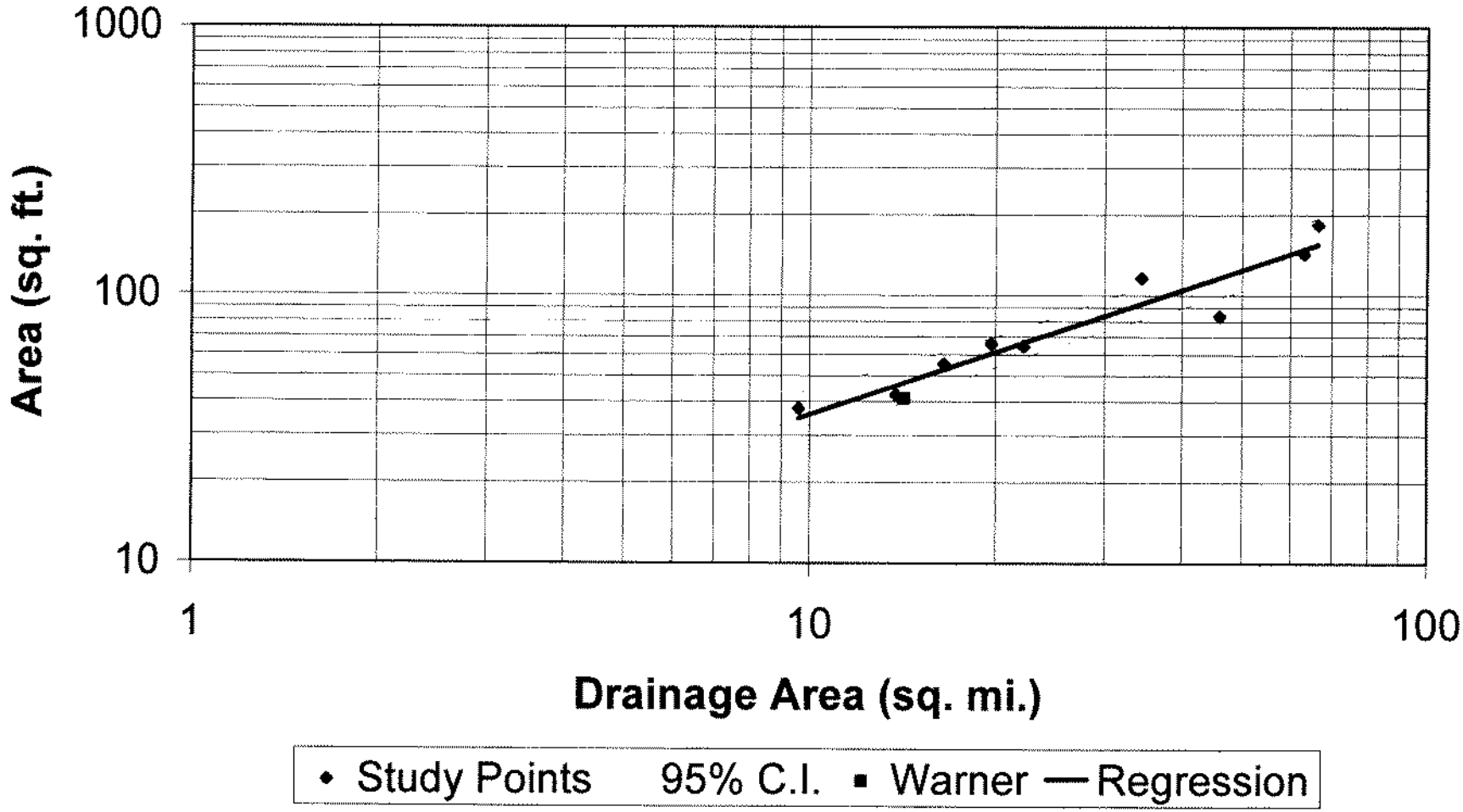
WARNER #10B

WARNER #10C

WARNER #10D

Cross Sectional Area vs. Drainage Area

$y = 6.0x^{0.77}$, $r^2 = 0.91$



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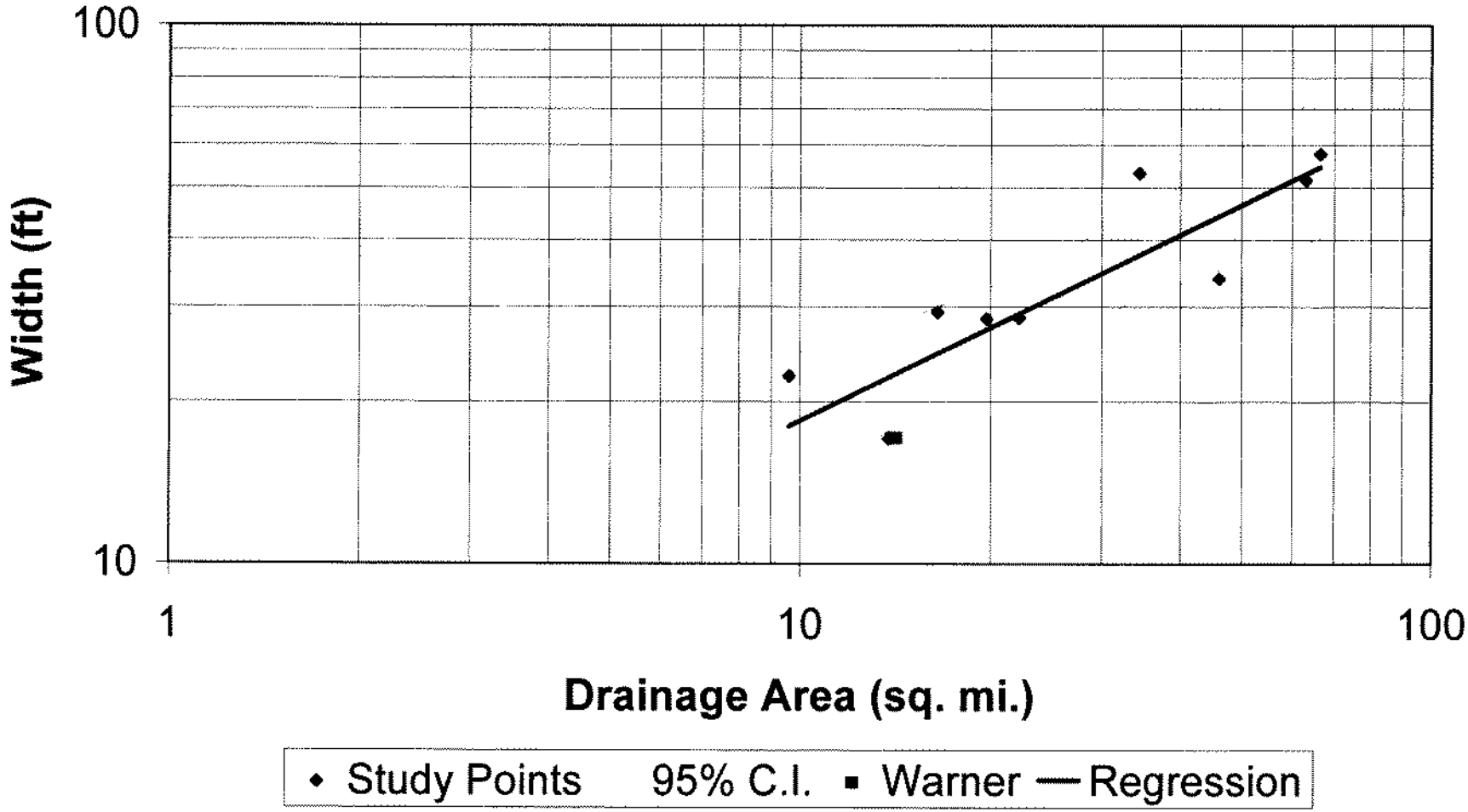
4:10 PM

NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Warner
Curves Chart 1

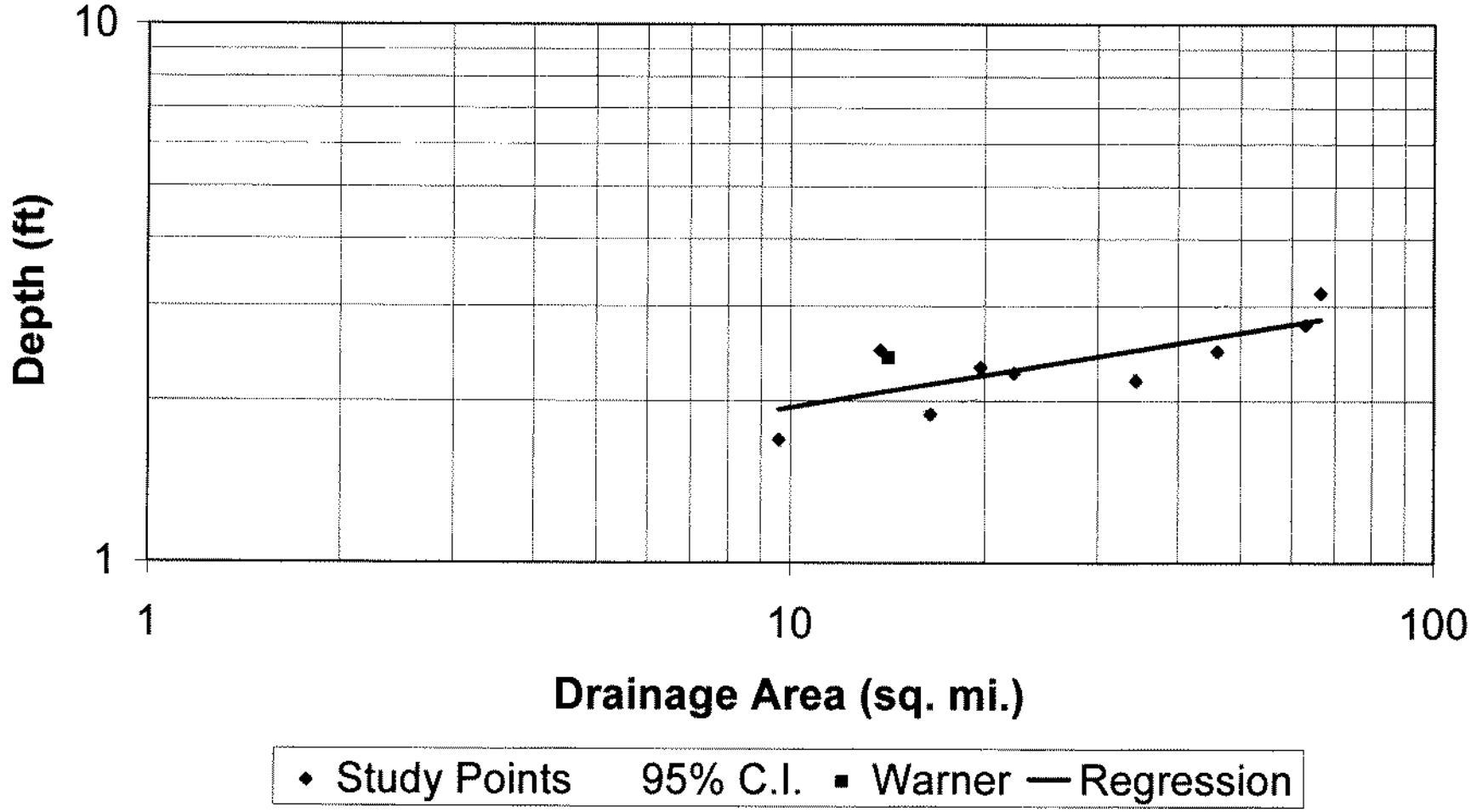
Bankfull Width vs. Drainage Area

$y = 4.9x^{0.57}$, $r^2 = 0.76$



Bankfull Mean Depth vs. Drainage Area

$y = 1.2x^{0.20}$, $r^2 = 0.57$



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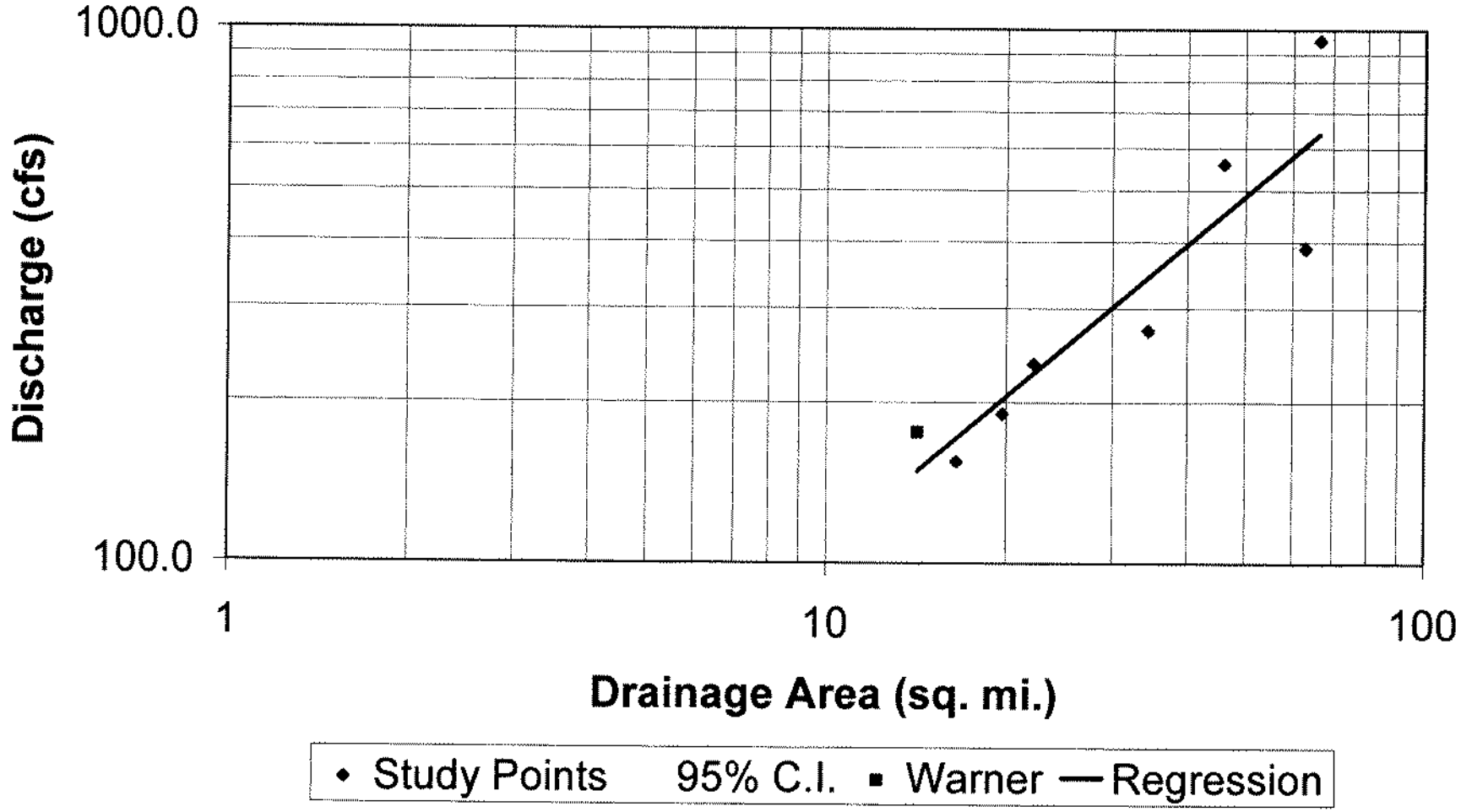
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Warner
Curves Chart 3

Bankfull Discharge vs. Drainage Area

$y = 12.2x^{0.94}$, $r^2 = 0.82$



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4:11 PM

NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Warner
Curves Chart 6

Carp River

Initials	Work Item
JB	Collect the following data at a minimum for each LUC reach.

Reach ID: **Carp**

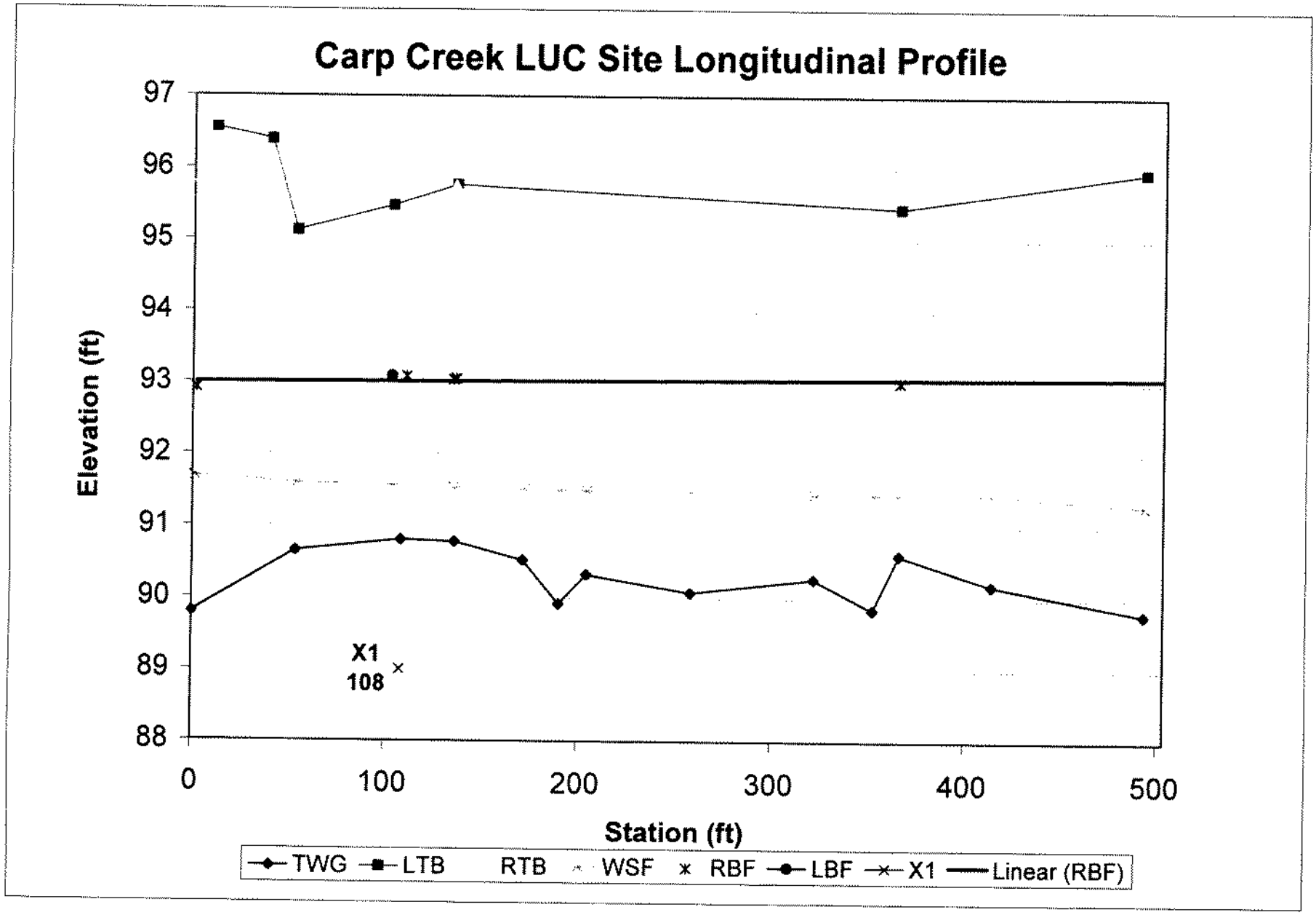
- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☑ Photograph site.

Initials	Work Item
SPB	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Carp**

- ☑ Limited Use Curves
  - -- DA versus Wbkf
  - -- DA versus Dbkf
  - -- DA versus CSA
  - -- DA versus Qbkf
- ☑ Plot of longitudinal profile
- ☑ Plot of cross-section
- ☑ Grain size distribution for bed material
- ☑ Site sketch
- ☑ Photographs and photo log.
- ☑ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)
- n/a ☑ Calculations (single section analysis)
- n/a ☑ Plot of Single Section Analysis versus Regression Equation

} gauge data available



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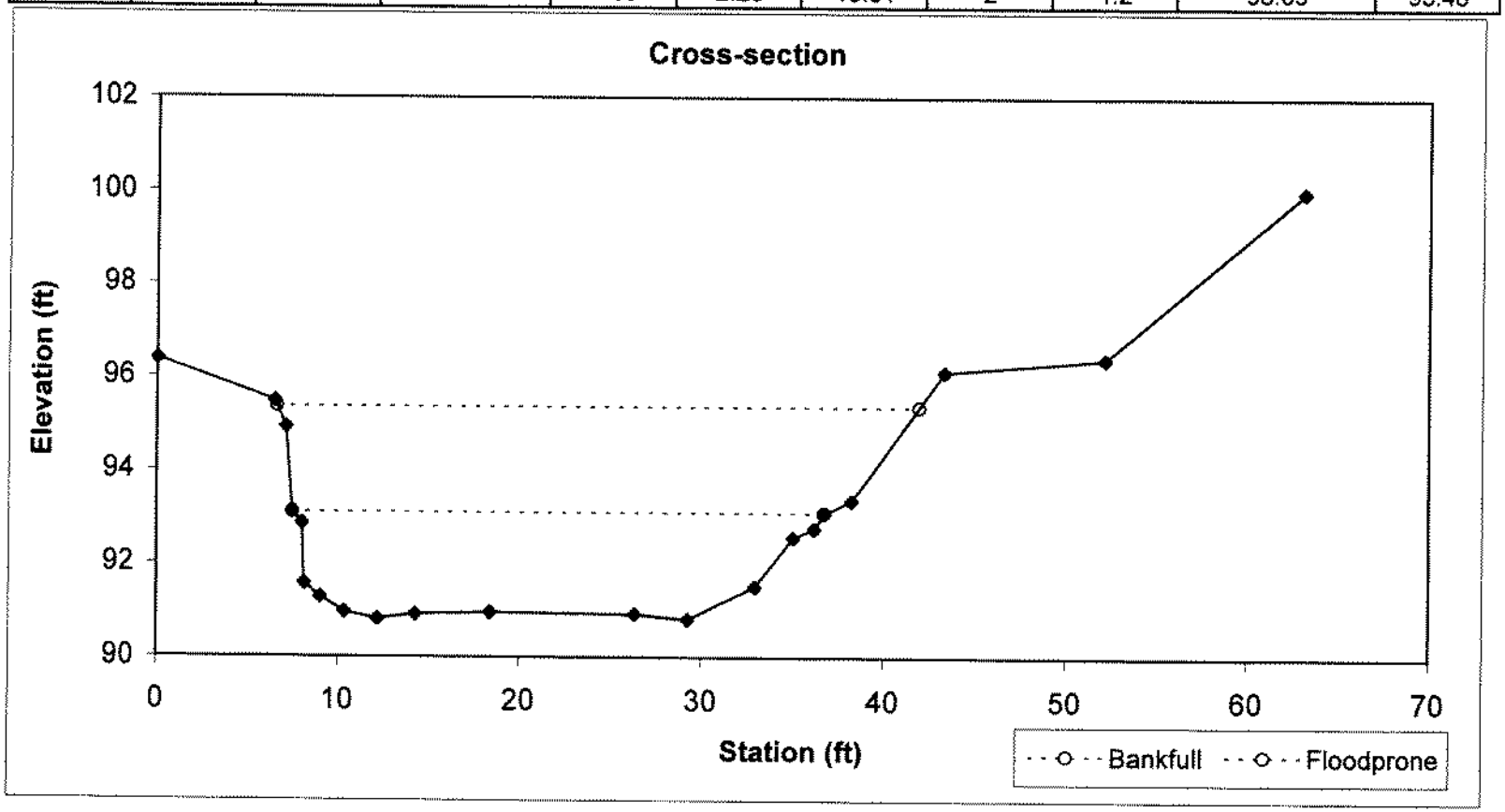
Carp Xsecs and Profile
Profile Chart 1

Run @ Station1+08

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	WRI	BH Ratio	ER	BKF Elev	TOB Elev
Run	F4	55.2	29.27	1.89	2.28	15.51	2	1.2	93.09	95.48



Pavement/Subpavement Analysis

SITE OR PROJECT:	Dead R. Limited Use Curves
REACH/LOCATION:	Carp Creek
DATE COLLECTED:	08/31/04
FIELD COLLECTION BY:	SRB
DATA ENTERED BY:	STS/SRB

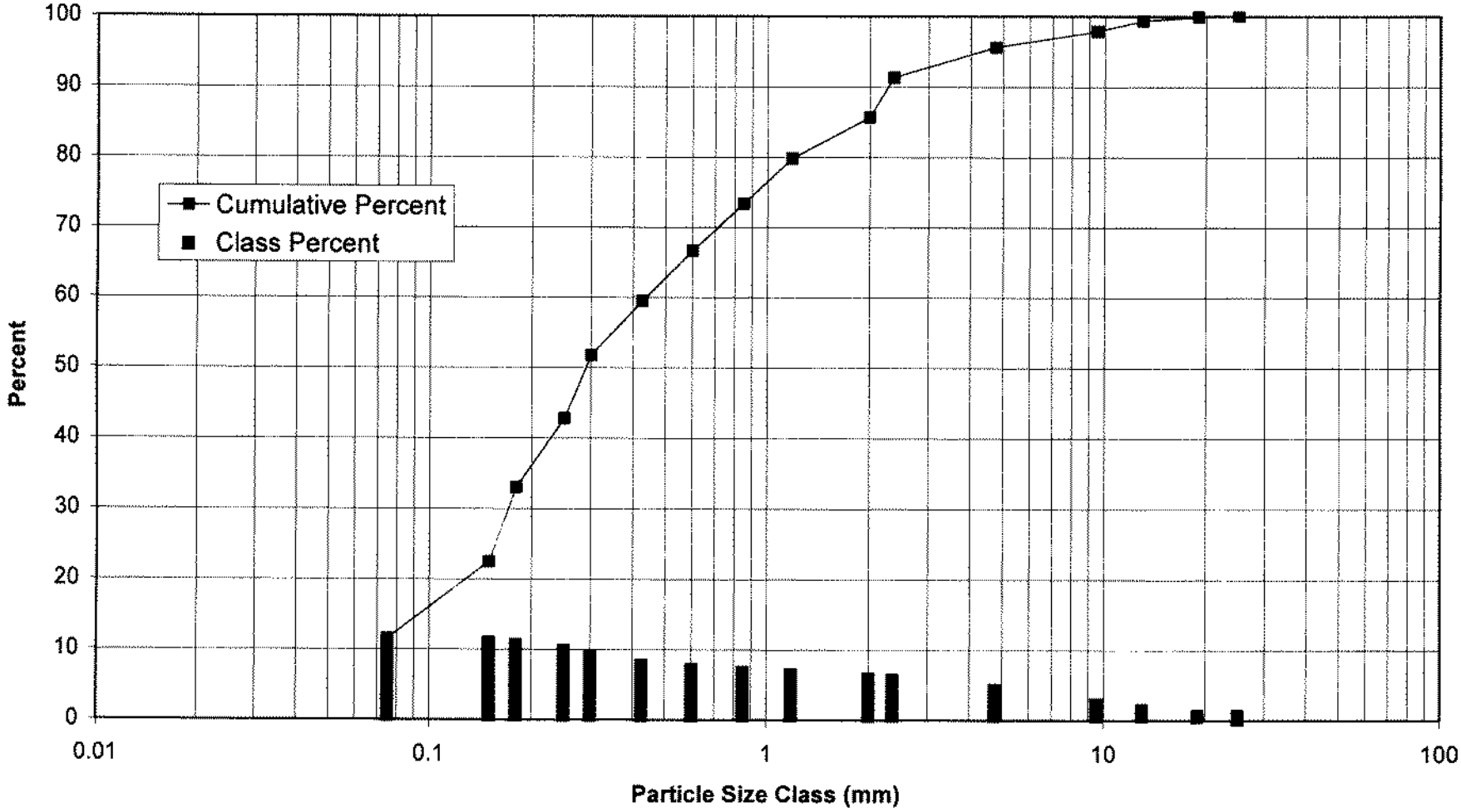
SEDIMENT ANALYSIS DATA SHEET

MATERIAL	PARTICLE	SIZE (mm)	Sample 1 (g)		Pavement Class %	Pavement % Cum
	Silt / Clay	< .075	4431.0		11.49	11.49
SAND	Very Fine	.075 - .15	4204.5		10.91	22.40
	Fine	.15 - .18	4088.2		10.61	33.01
	Fine	.18 - .25	3759.5		9.75	42.76
	Fine	0.25 - 0.3	3491.3		9.06	51.82
	Medium	0.3 - 0.425	2976.0		7.72	59.54
	Medium	0.425 - 0.6	2737.4		7.10	66.64
	Medium	0.6 - 0.85	2600.3		6.75	73.38
	Medium	0.85 - 1.18	2477.4		6.43	79.81
	Medium	1.18 - 2.0	2260.7		5.86	85.67
	Coarse	2.0 - 2.36	2185.5		5.67	91.34
	Coarse	2.36 - 4.75	1650.5		4.28	95.62
GRAVEL	Small	4.75 - 9.5	856.4		2.22	97.85
	Small	9.5 - 13	570.9		1.48	99.33
	Fine	13 - 19	206.4		0.54	99.86
	Large	19 - 25	53.4		0.14	100.00
	Large	25 - 38				100.00
	Large	38 - 51				100.00
	Large	51 - 64				100.00
COBBLE	Small	64 - 75				100.00
	Medium	75 - 90				100.00
	Medium	90 - 128				100.00
	Medium	128 - 180				100.00
	Large	180 - 256				100.00
BOULDER	Small	256 - 362				100.00
	Medium	362 - 512				100.00
	Medium	512 - 1024				100.00
	Large-Very Large	1024 - 2048				100.00
BEDROCK	Bedrock	> 2048				100.00
			38549	0	100	100

Channel materials	Sample 1	
D_{16} =	0.10	
D_{35} =	0.19	
D_{50} =	0.29	
D_{84} =	1.72	
D_{95} =	4.29	
D_{100} =	25.00	

Pavement Particle Distribution

Dead R. Limited Use Curves - Carp Creek



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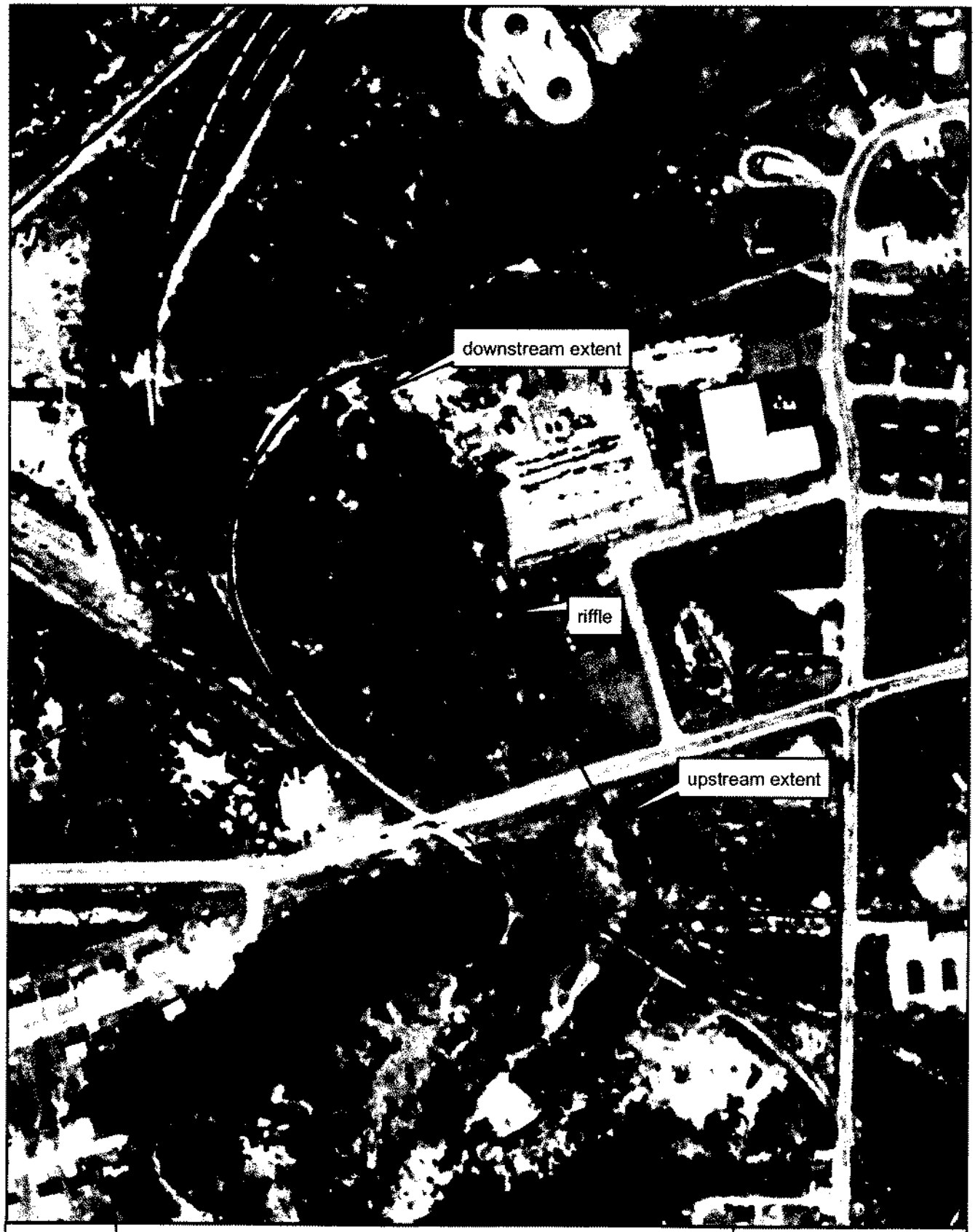
CarpPavementDist
LogHistogramDetail



LEGEND:

- Carp Creek reference reach
- ▲ USGS gage 4044200
- ○ Carp cross sections
- ● Carp sediment sample site

250 125 0 250 500 Feet

BUCK

Carp Creek Reach for
Limited Use Curve Development

Work Plan Photograph Key

Dead River Recovery Post-Event Additional Environmental Assessment: Survey of Morphological Stream Parameters Using Rosgen Method

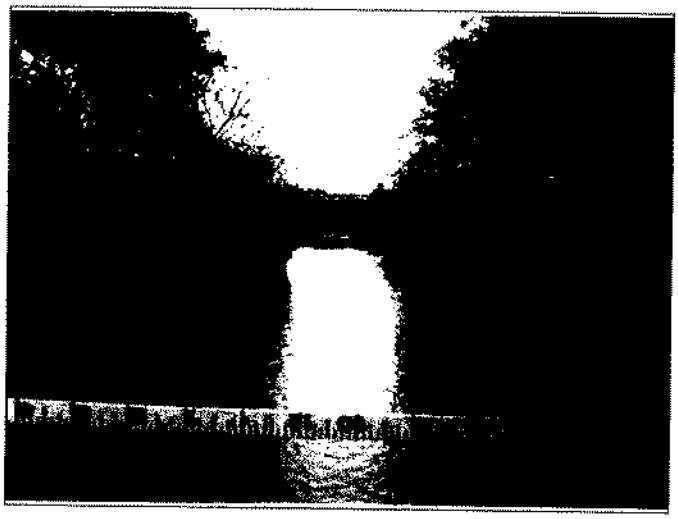
Number [1]	Subject	Location [2]
1	Bankfull stage indicator	location that best depicts indicator (Rosgen, 1996)
2	Stream downstream of the cross-section	standing mid-stream at the tape
3	Stream upstream of the cross-section	standing mid-stream at the tape
4	Cross-section photo	downstream of the cross-section facing upstream
5	Cross-section photo	upstream of the cross-section facing downstream
6	Right floodplain	right top of bank at the cross-section
7	Left floodplain	left top of bank at the cross-section
8	Stream upstream of the reach	standing mid-stream at the start of the longitudinal profile
9	Stream downstream of the reach	standing mid-stream at the end of the longitudinal profile
10	A sufficient number of photographs to provide a continuous visual documentation of the survey reach	facing downstream

Notes:

1. A letter designation is used in addition to the photo number (e.g. 10A, 10B, 10C, etc.) if more than one photograph was taken of a particular subject or from a single location.
2. Location from which photograph was taken.

CARP RIFFLE XS #1

CARP RIFFLE XS #2



CARP RIFFLE XS #3

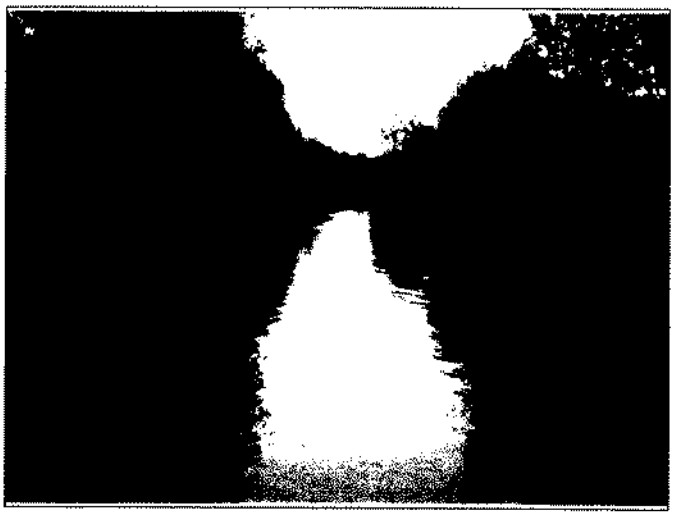
CARP RIFFLE XS #4

CARP RIFFLE XS #5

CARP RIFFLE XS #6

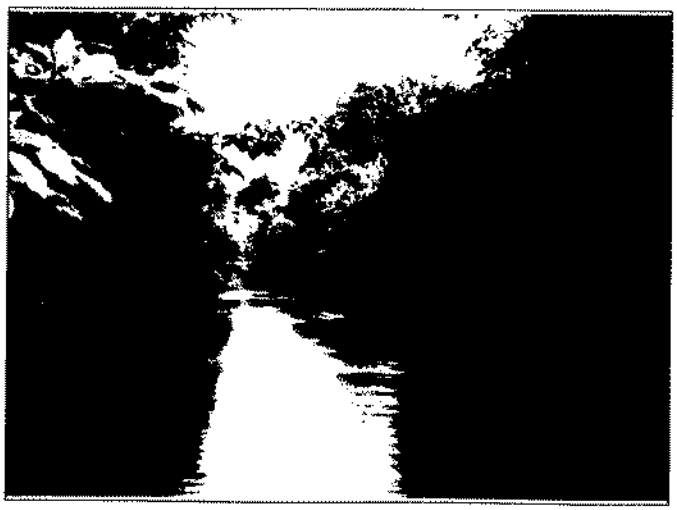
CARP RIFFLE XS #7

CARP #8



CARP #9

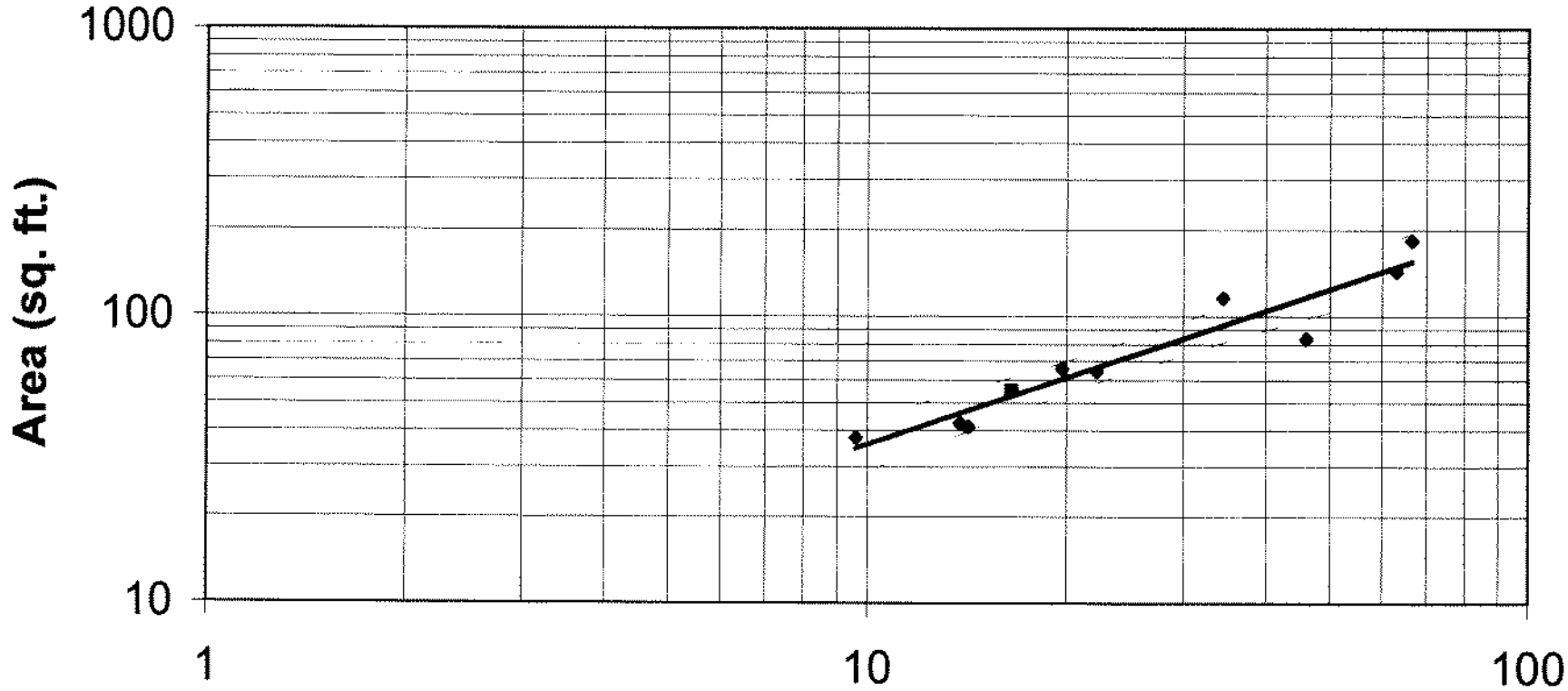
CARP #10A



CARP #10B

Cross Sectional Area vs. Drainage Area

$y = 6.0x^{0.77}$, $r^2 = 0.91$

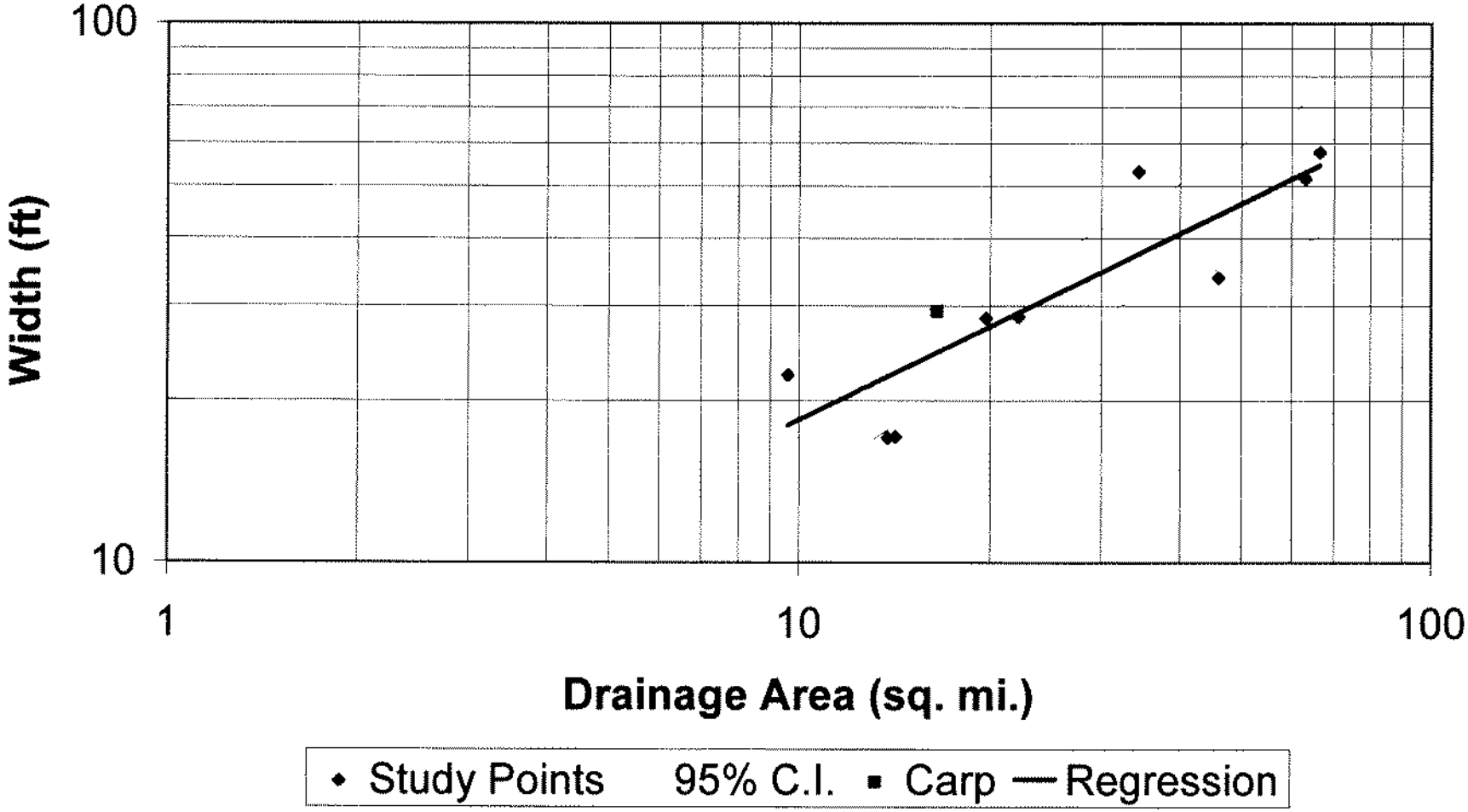


12/14/2004
4:18 PM

NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Carp
Curves Chart 1

Bankfull Width vs. Drainage Area

$y = 4.9x^{0.57}$, $r^2 = 0.76$



12/14/2004
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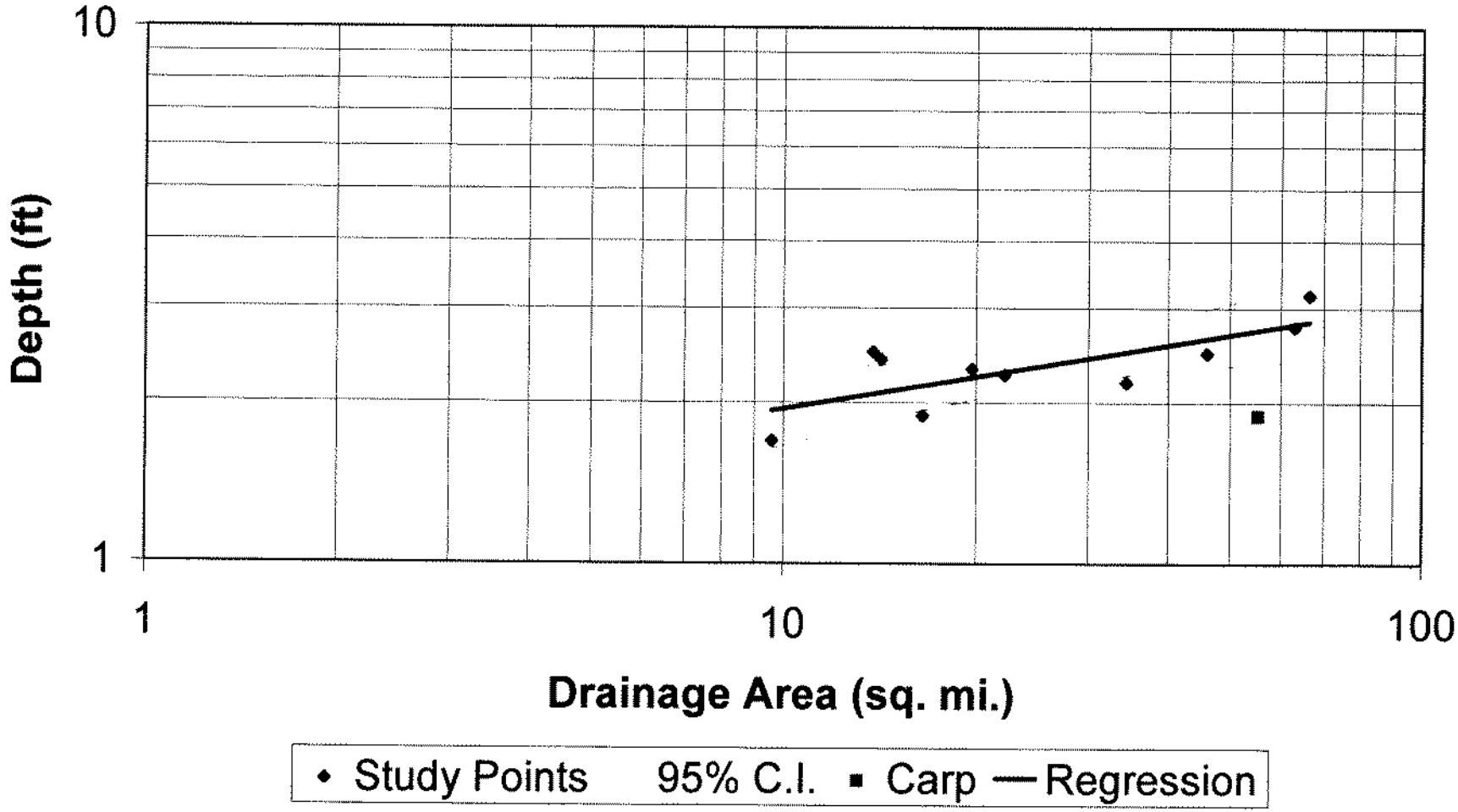
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Carp
Curves Chart 2

Bankfull Mean Depth vs. Drainage Area

$y = 1.2x^{0.20}$, $r^2 = 0.57$



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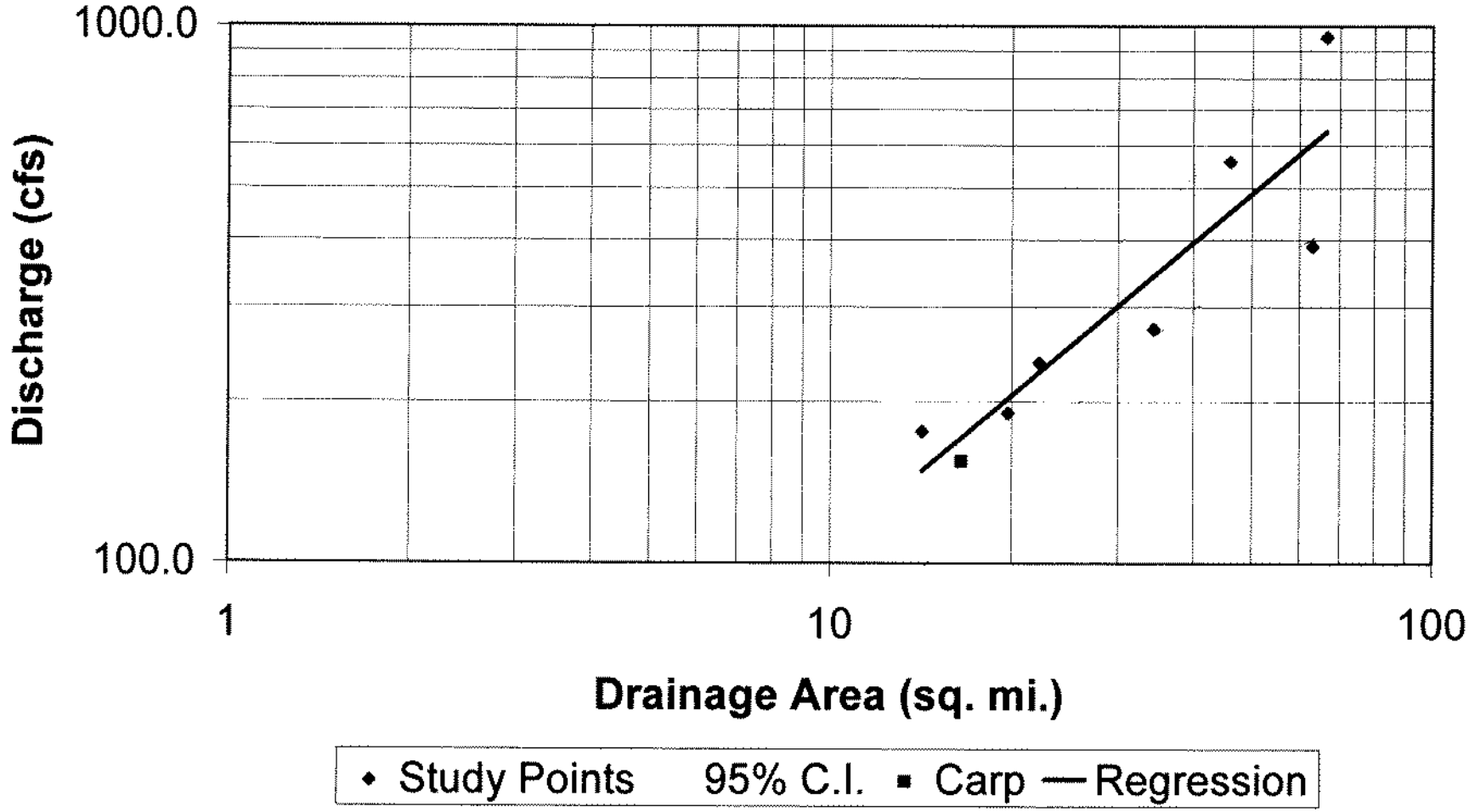
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Carp
Curves Chart 3

Bankfull Discharge vs. Drainage Area

$y = 12.2x^{0.94}$, $r^2 = 0.82$



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4:18 PM

NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Carp
Curves Chart 6

Perch River

Initials	Work Item
_____	Collect the following data at a minimum for each LUC reach.

Reach ID: **Perch (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end) .
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☑ Photograph site.

Initials	Work Item
_____	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Perch (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☑ Limited Use Curves
  - ☑ DA versus Wbkf
  - ☑ DA versus Dbkf
  - ☑ DA versus CSA
  - ☑ DA versus Qbkf
- ☑ Plot of longitudinal profile
- ☑ Plot of cross-section
- ☑ Grain size distribution for bed material
- ☑ Site sketch
- ☑ Photographs and photo log.
- ☑ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)
- ☑ n/a Calculations (single section analysis)
- ☑ n/a Plot of Single Section Analysis versus Regression Equation

Middle Branch Escanaba River

Initials	Work Item
SB	Collect the following data at a minimum for each LUC reach.

Reach ID: **Middle Branch of the Escanaba**

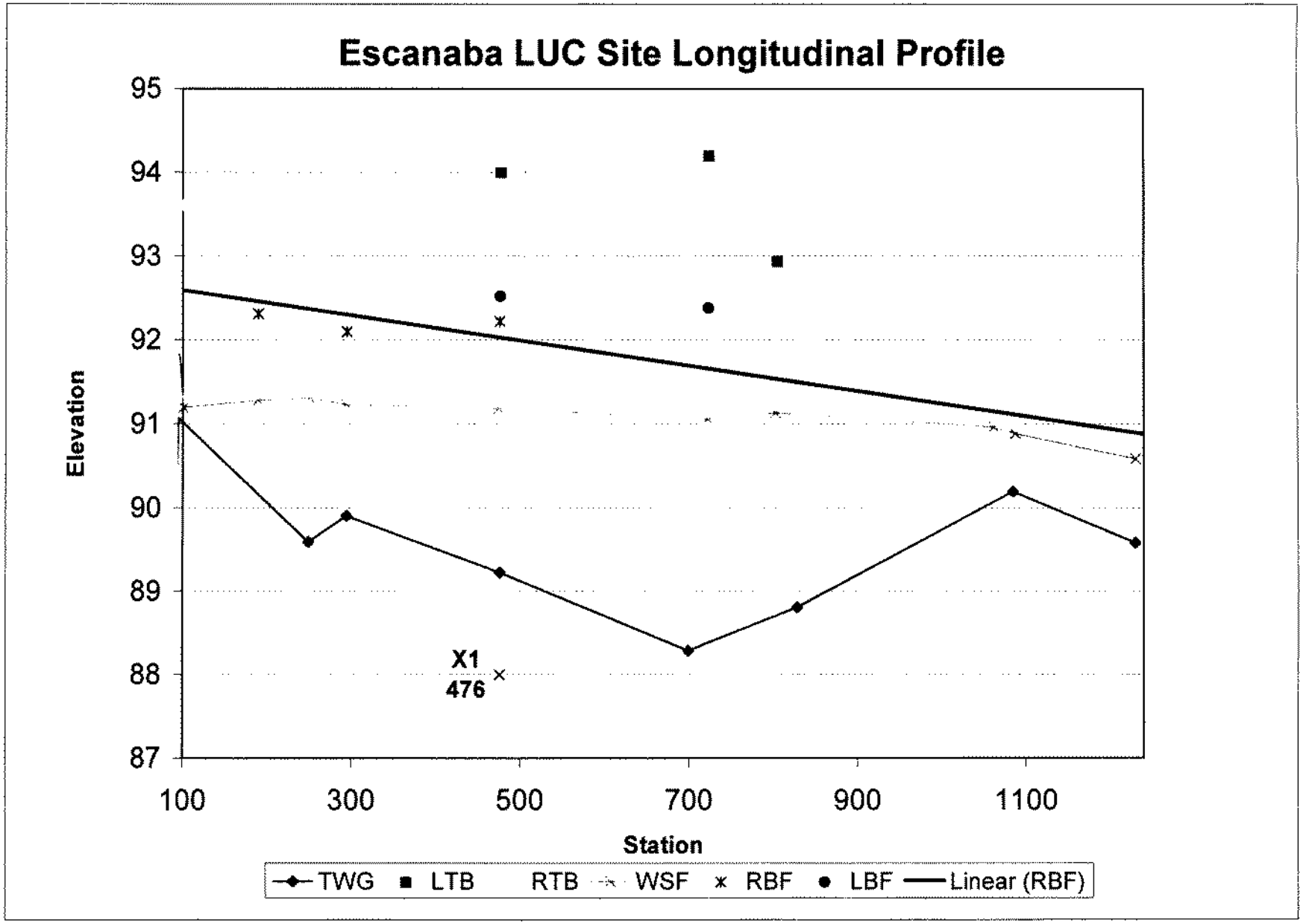
- ☐ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☑ Photograph site.

Initials	Work Item
SPP	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Middle Branch of the Escanaba**

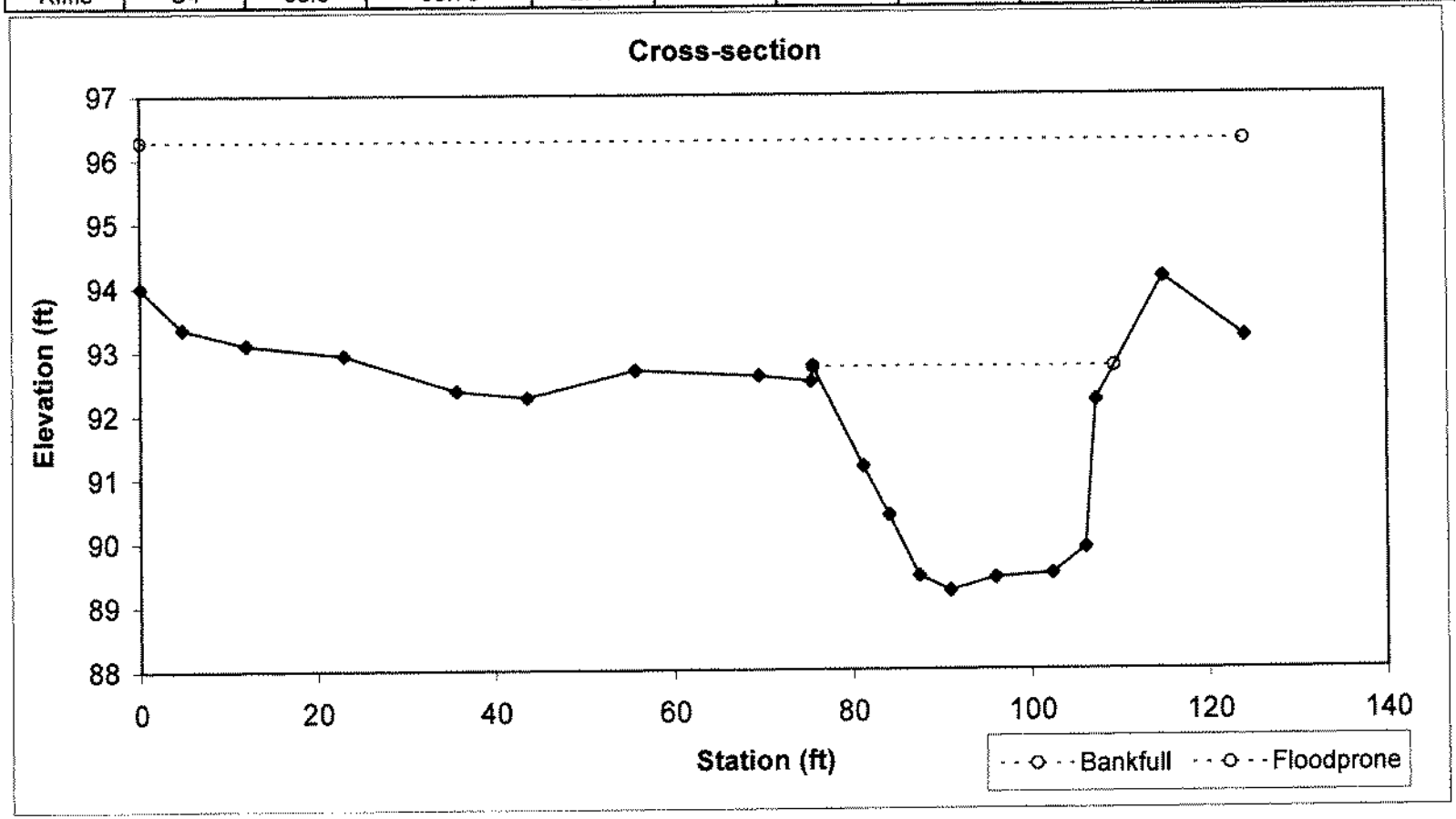
- ☑ Limited Use Curves
  - -- DA versus Wbkf
  - -- DA versus Dbkf
  - -- DA versus CSA
  - -- DA versus Qbkf
- ☑ Plot of longitudinal profile
- ☑ Plot of cross-section
- ☑ Grain size distribution for bed material
- ☑ Site sketch
- ☑ Photographs and photo log.
- ☑ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)
- n/a ☑ Calculations (single section analysis)
- n/a ☑ Plot of Single Section Analysis versus Regression Equation

} gauge data available



Riffle @ Station 4+76

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C4	83.5	33.78	2.47	3.53	13.66	1.4	3.7	92.75	94



PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	**Dead River**
REACH/LOCATION:	**Escanaba @ Gauge**
DATE COLLECTED:	**26-Jul-04**
FIELD COLLECTION BY:	**SRB**
DATA ENTERED BY:	**SDC**

SEDIMENT ANALYSIS DATA SHEET

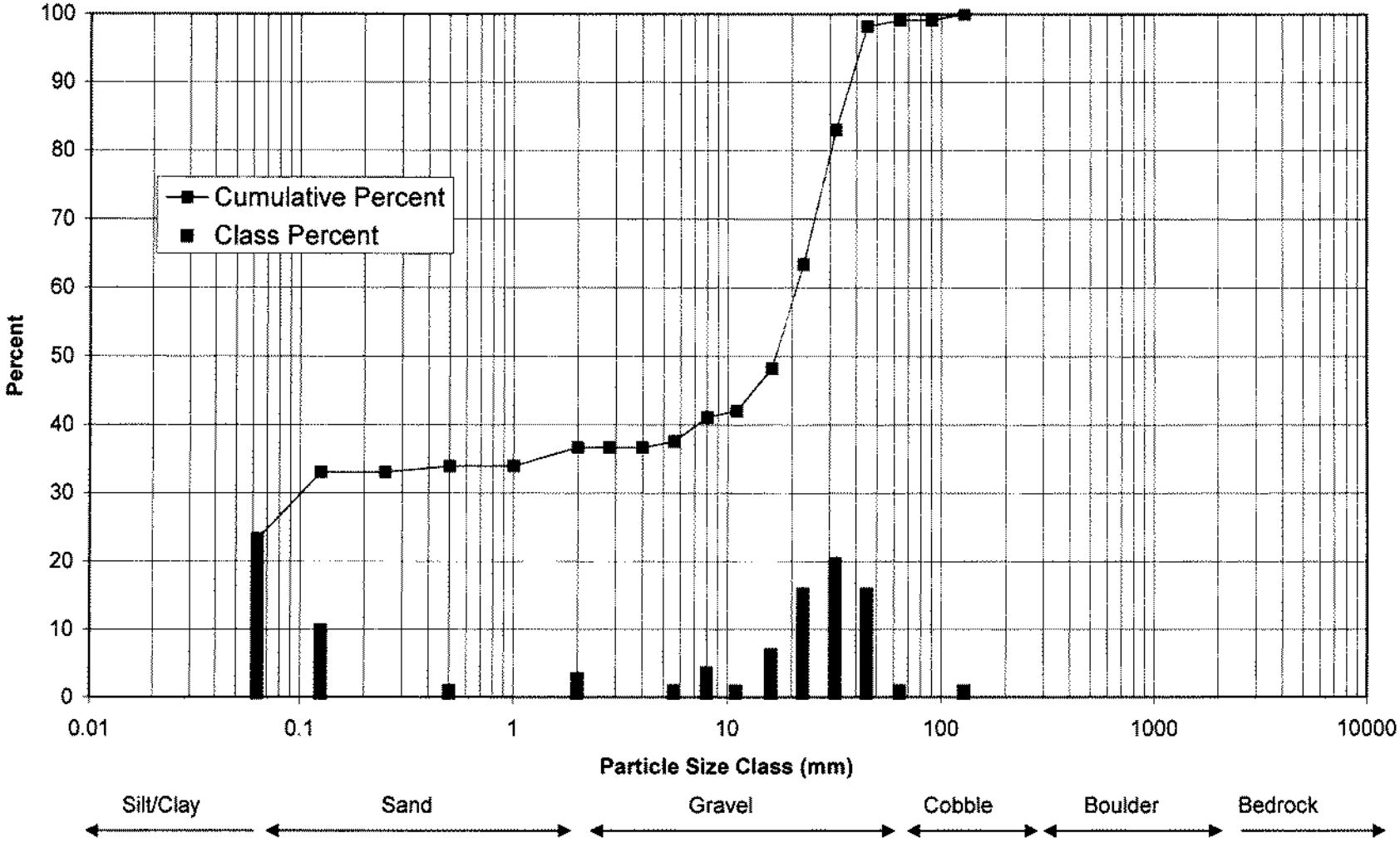
			PARTICLE CLASS			Reach Summary		Riffle Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063	26		26	23.21	23.21	23.21	23.21
SAND	Very Fine	.063 - .125	11		11	9.82	33.04	9.82	33.04
	Fine	.125 - .25	0				33.04	0.00	33.04
	Medium	.25 - .50	1		1	0.89	33.93	0.89	33.93
	Coarse	.50 - 1.0	0				33.93	0.00	33.93
	Very Coarse	1.0 - 2.0	3		3	2.68	36.61	2.68	36.61
GRAVEL	Very Fine	2.0 - 2.8	0				36.61	0.00	36.61
	Very Fine	2.8 - 4.0	0				36.61	0.00	36.61
	Fine	4.0 - 5.6	1		1	0.89	37.50	0.89	37.50
	Fine	5.6 - 8.0	4		4	3.57	41.07	3.57	41.07
	Medium	8.0 - 11.0	1		1	0.89	41.96	0.89	41.96
	Medium	11.0 - 16.0	7		7	6.25	48.21	6.25	48.21
	Coarse	16 - 22.6	17		17	15.18	63.39	15.18	63.39
	Coarse	22.6 - 32	22		22	19.64	83.04	19.64	83.04
	Very Coarse	32 - 45	17		17	15.18	98.21	15.18	98.21
	Very Coarse	45 - 64	1		1	0.89	99.11	0.89	99.11
COBBLE	Small	64 - 90	0				99.11	0.00	99.11
	Small	90 - 128	1		1	0.89	100.00	0.89	100.00
	Large	128 - 180	0				100.00	0.00	100.00
	Large	180 - 256	0				100.00	0.00	100.00
BOULDER	Small	256 - 362	0				100.00	0.00	100.00
	Small	362 - 512					100.00		100.00
	Medium	512 - 1024					100.00		100.00
	Large-Very Large	1024 - 2048					100.00		100.00
BEDROCK	Bedrock	> 2048	0				100.00	0.00	100.00
			112	0	112			100	100

Cummulative Channel materials	
D_{16} =	#N/A
D_{35} =	1.32
D_{50} =	16.66
D_{84} =	32.70
D_{95} =	41.87
D_{100} =	90 - 128

Riffle Channel materials	
D_{16} =	#N/A
D_{35} =	1.32
D_{50} =	16.66
D_{84} =	32.70
D_{95} =	41.87
D_{100} =	> 2048

Sediment Distribution

Dead River - Escanaba @ Gauge



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ClassificationSediment Distribution_escanaba
LogHistogram

LEGEND:

- Middle Escanaba reference reach
- ▲ USGS gage 4057800
- O Middle Escanaba cross sections
- ● Middle Escanaba sediment site

250 125 0 250 500 Feet

BUCK ENGINEERING

Middle Br. Escanaba R. Reach for Limited Use Curve Development

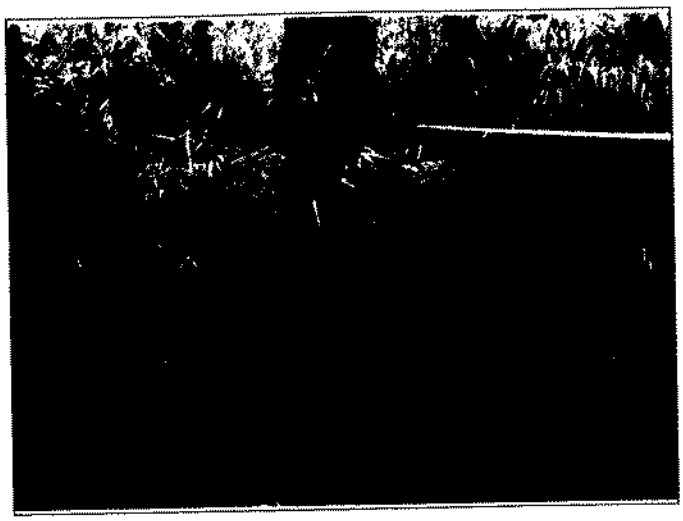
Work Plan Photograph Key

Dead River Recovery Post-Event Additional Environmental Assessment: Survey of Morphological Stream Parameters Using Rosgen Method

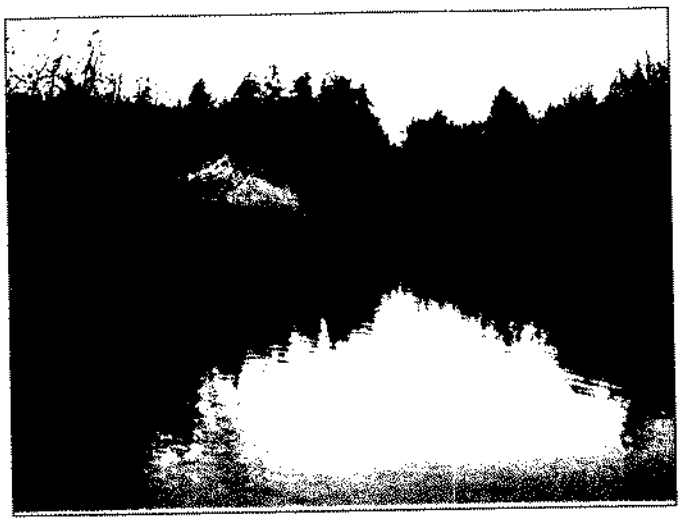
Number [1]	Subject	Location [2]
1	Bankfull stage indicator	location that best depicts indicator (Rosgen, 1996)
2	Stream downstream of the cross-section	standing mid-stream at the tape
3	Stream upstream of the cross-section	standing mid-stream at the tape
4	Cross-section photo	downstream of the cross-section facing upstream
5	Cross-section photo	upstream of the cross-section facing downstream
6	Right floodplain	right top of bank at the cross-section
7	Left floodplain	left top of bank at the cross-section
8	Stream upstream of the reach	standing mid-stream at the start of the longitudinal profile
9	Stream downstream of the reach	standing mid-stream at the end of the longitudinal profile
10	A sufficient number of photographs to provide a continuous visual documentation of the survey reach	facing downstream

Notes:

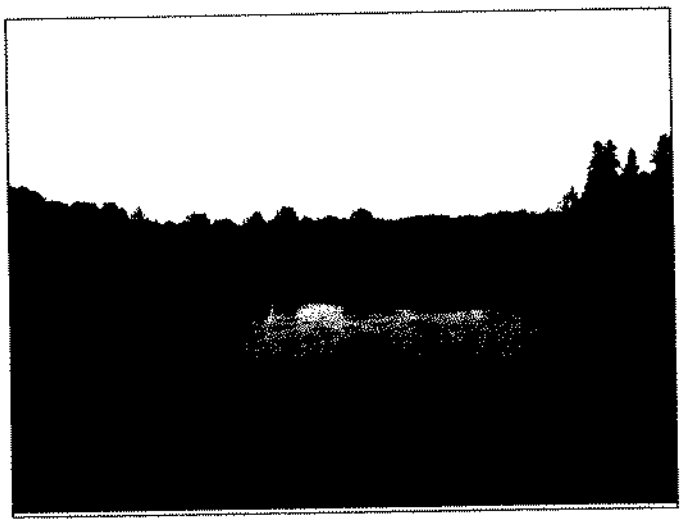
1. A letter designation is used in addition to the photo number (e.g. 10A, 10B, 10C, etc.) if more than one photograph was taken of a particular subject or from a single location.
2. Location from which photograph was taken.



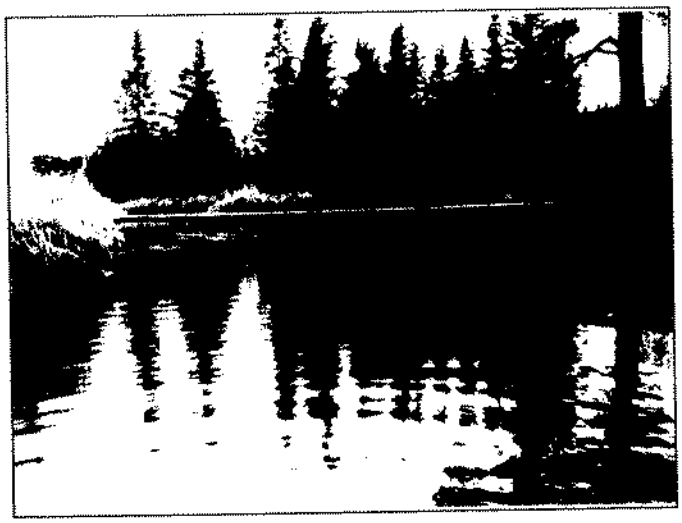
MIDDLE BRANCH ESCANABA POOL XS #1



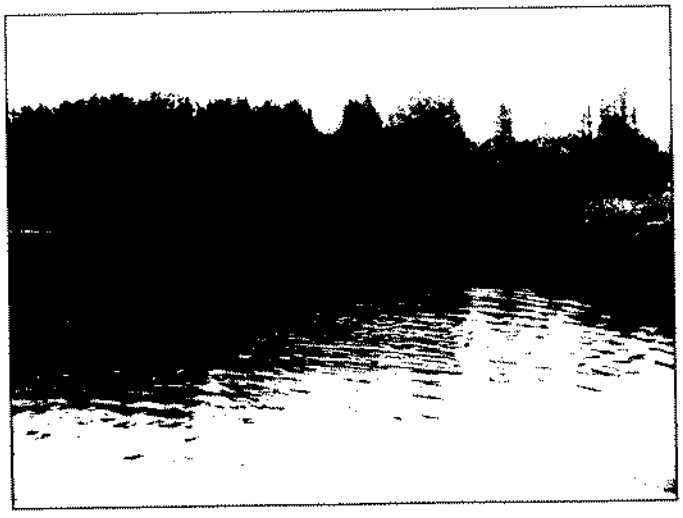
MIDDLE BRANCH ESCANABA POOL XS #2



MIDDLE BRANCH ESCANABA POOL XS #3



MIDDLE BRANCH ESCANABA POOL XS #4

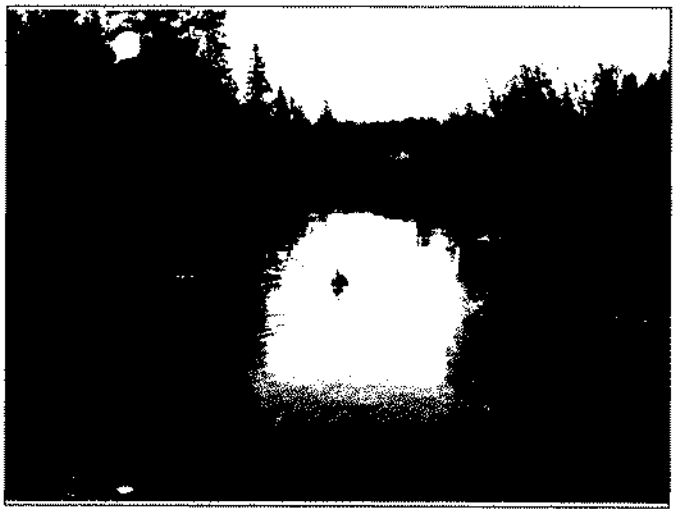


MIDDLE BRANCH ESCANABA POOL XS #5

MIDDLE BRANCH ESCANABA POOL XS #6

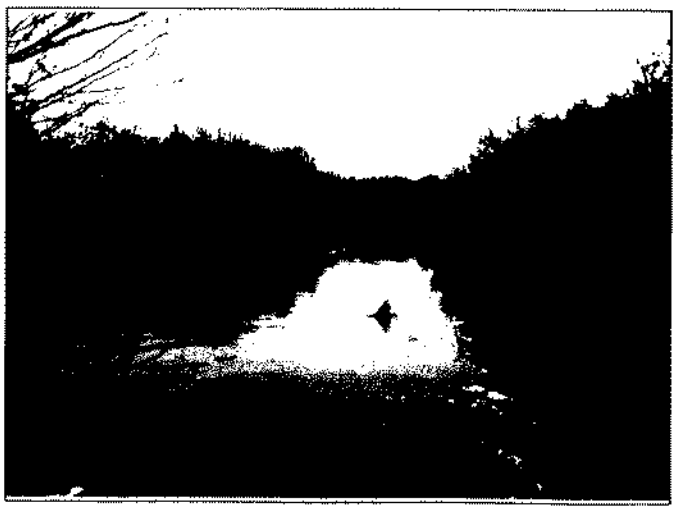
MIDDLE BRANCH ESCANABA POOL XS #7

MIDDLE BRANCH ESCANABA RIFFLE XS #1

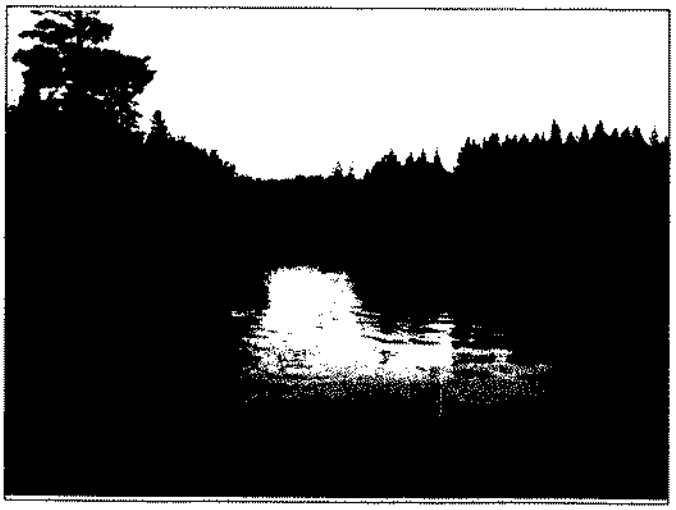


MIDDLE BRANCH ESCANABA RIFFLE XS #2

MIDDLE BRANCH ESCANABA RIFFLE XS #3



MIDDLE BRANCH ESCANABA RIFFLE XS #4

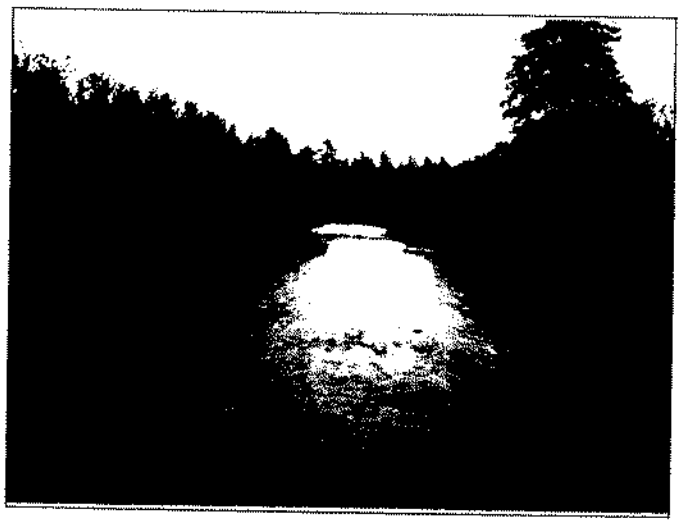


MIDDLE BRANCH ESCANABA RIFFLE XS #5

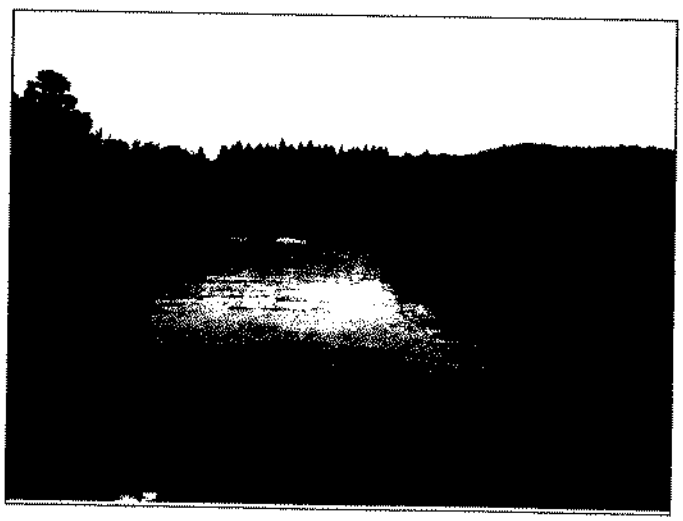
MIDDLE BRANCH ESCANABA RIFFLE XS #6

MIDDLE BRANCH ESCANABA RIFFLE XS #7

MIDDLE BRANCH ESCANABA #8



MIDDLE BRANCH ESCANABA #9



MIDDLE BRANCH ESCANABA #10A

MIDDLE BRANCH ESCANABA #10B

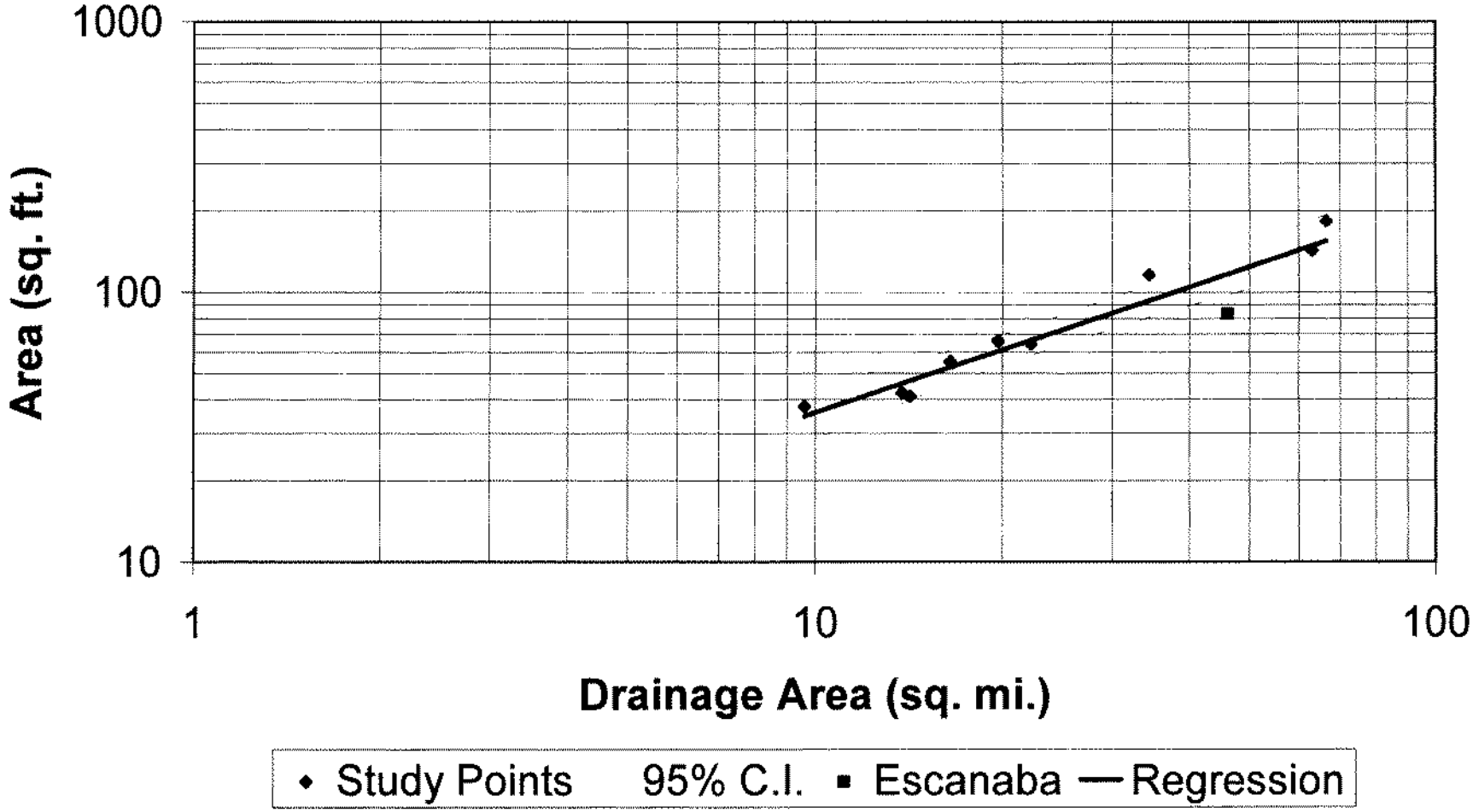
MIDDLE BRANCH ESCANABA #10C

MIDDLE BRANCH ESCANABA #10D

MIDDLE BRANCH ESCANABA #10E

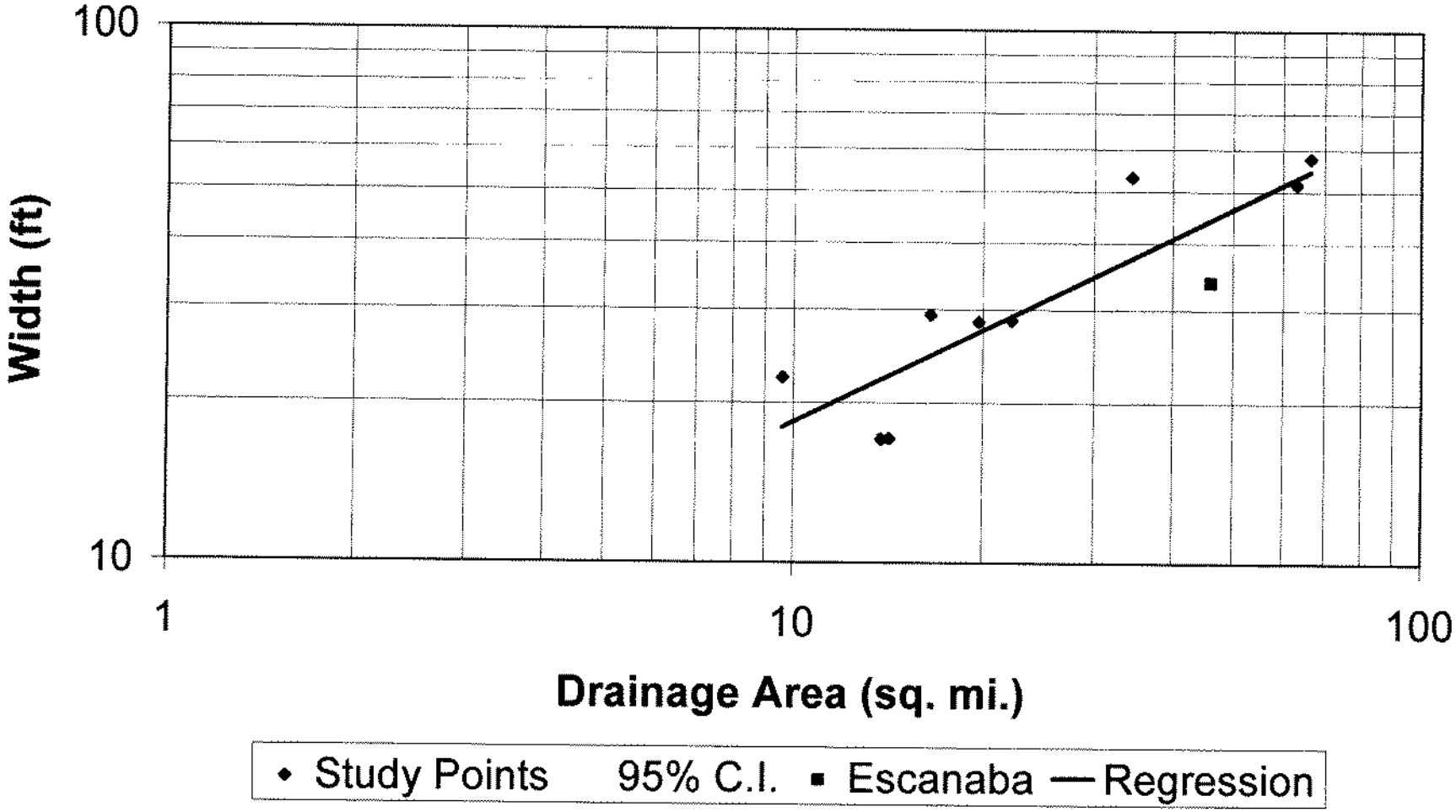
Cross Sectional Area vs. Drainage Area

$y = 6.0x^{0.77}$, $r^2 = 0.91$



Bankfull Width vs. Drainage Area

$y = 4.9x^{0.57}$, $r^2 = 0.76$



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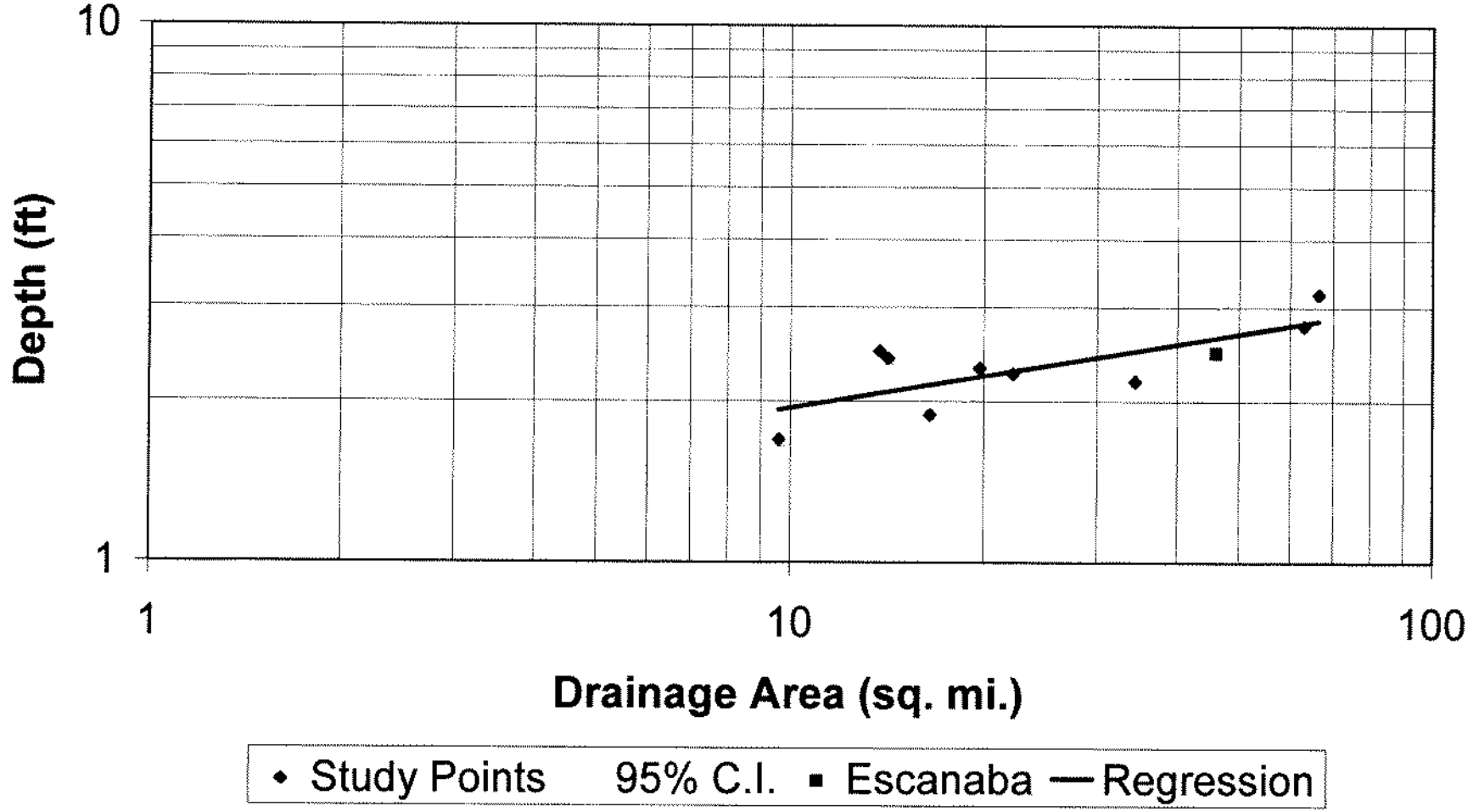
4:28 PM

NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Escanaba
Curves Chart 2

Bankfull Mean Depth vs. Drainage Area

$y = 1.2x^{0.20}$, $r^2 = 0.57$



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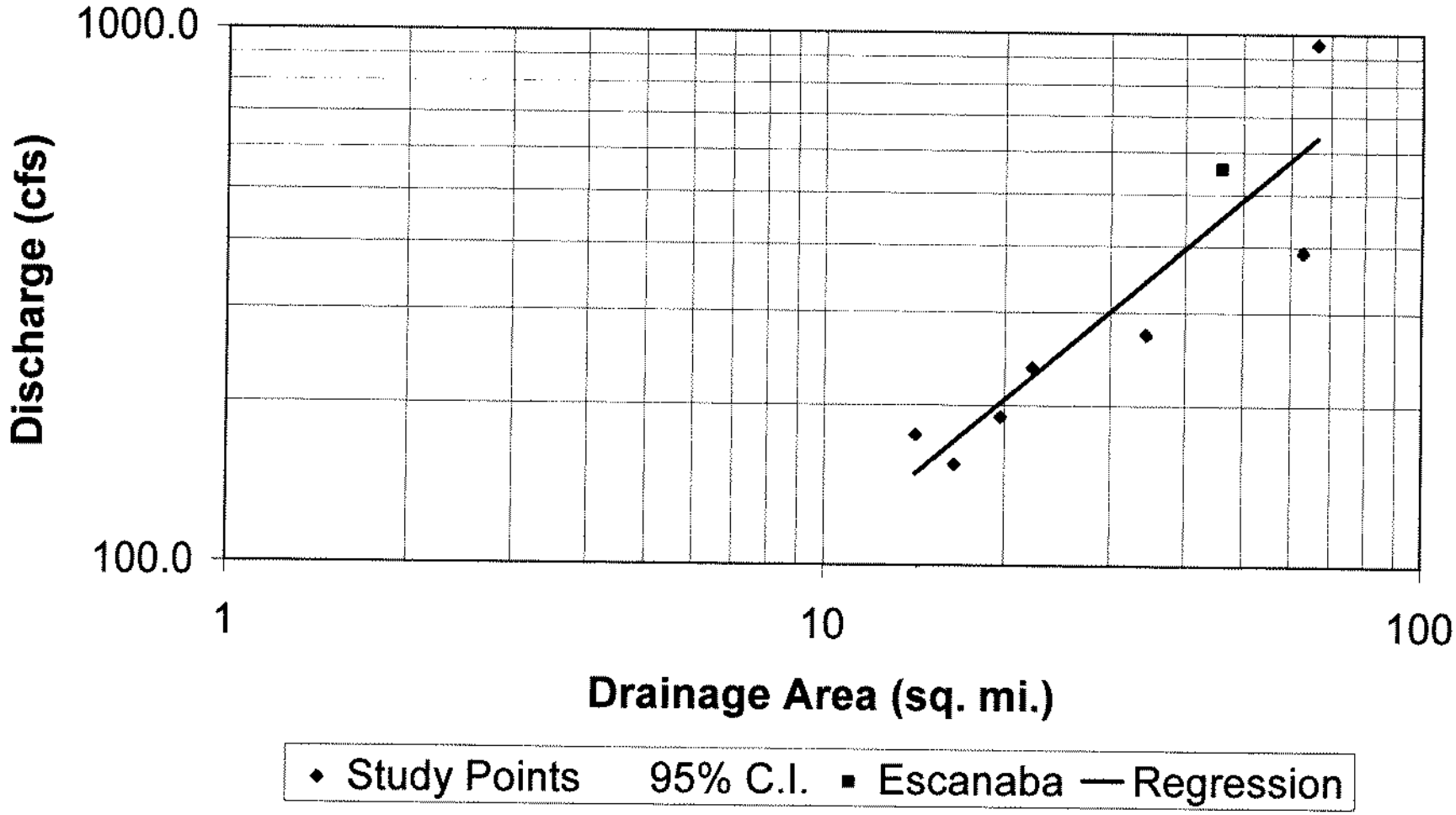
NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Escanaba
Curves Chart 3

Bankfull Discharge vs. Drainage Area

$y = 12.2x^{0.94}$, $r^2 = 0.82$



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NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Escanaba
Curves Chart 6

Black River

Initials	Work Item
SB	Collect the following data at a minimum for each LUC reach.

Reach ID: **Black**

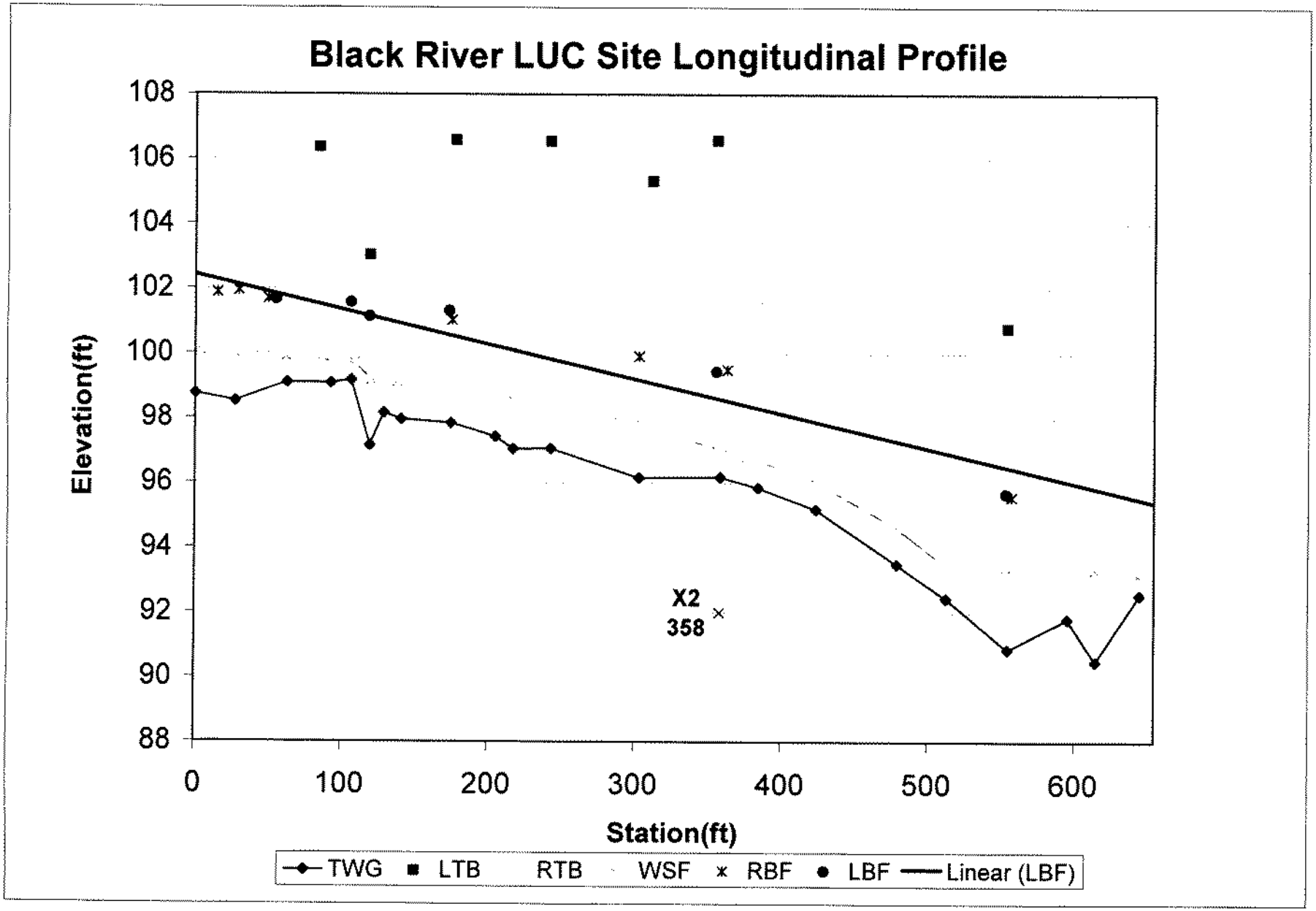
- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☑ Photograph site.

Initials	Work Item
SPB	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Black**

- ☑ Limited Use Curves
  - -- DA versus Wbkf
  - -- DA versus Dbkf
  - -- DA versus CSA
  - -- DA versus Qbkf
- ☑ Plot of longitudinal profile
- ☑ Plot of cross-section
- ☑ Grain size distribution for bed material
- ☑ Site sketch
- ☑ Photographs and photo log.
- ☑ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)
- N/A ☑ Calculations (single section analysis)
- N/A ☑ Plot of Single Section Analysis versus Regression Equation

gauge data available.

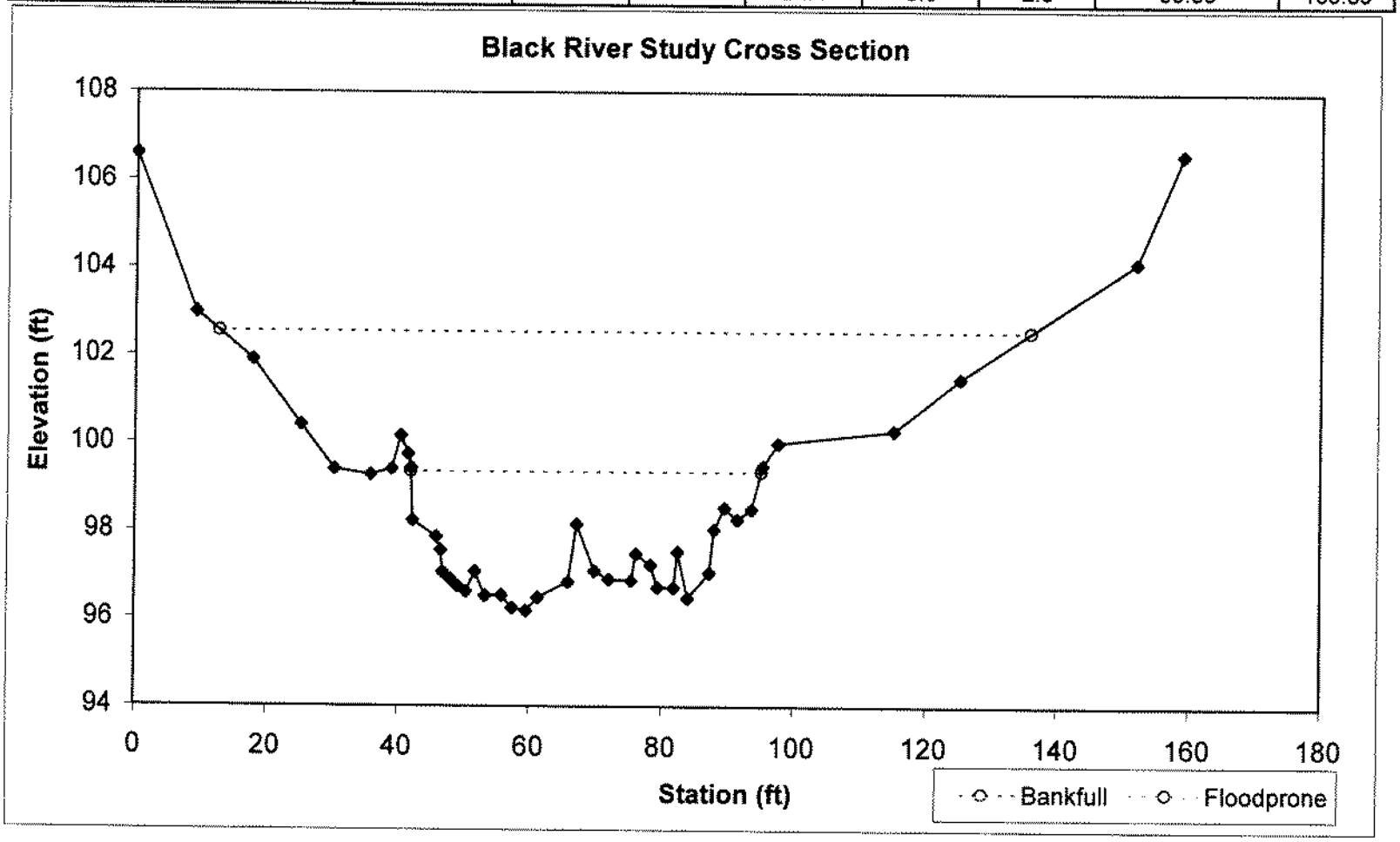


12/15/2004
12:19 AM

Black Xsecs and Profile
Profile Chart 1

Riffle @ Station 3+58

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Bc2	115.9	53.19	2.18	3.18	24.4	3.3	2.3	99.36	106.59



12/15/2004
12:21 AM

Black Xsecs and Profile
XSEC 358.4

PEBBLE COUNT DATA SHEET

SITE OR PROJECT:	Dead River
REACH/LOCATION:	Black @ Gauge
DATE COLLECTED:	29-Jul-04
FIELD COLLECTION BY:	SRB
DATA ENTERED BY:	SDC

SEDIMENT ANALYSIS DATA SHEET

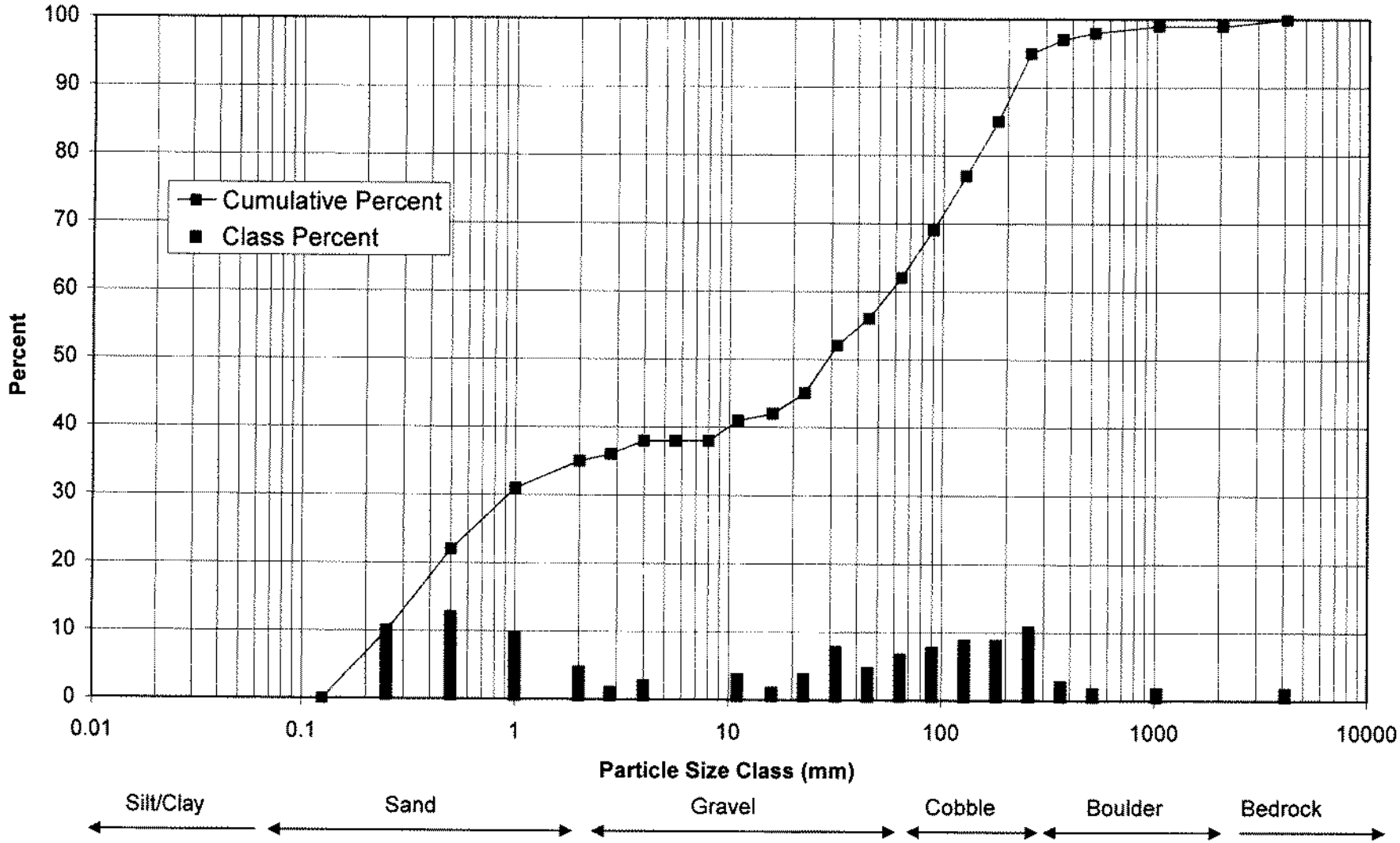
			PARTICLE CLASS			Reach Summary		Riffle Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063	10		10	10.00	10.00	10.00	10.00
SAND	Very Fine	.063 - .125					10.00		10.00
	Fine	.125 - .25	2		2	2.00	12.00	2.00	12.00
	Medium	.25 - .50	4		4	4.00	16.00	4.00	16.00
	Coarse	.50 - 1.0	3		3	3.00	19.00	3.00	19.00
	Very Coarse	1.0 - 2.0					19.00		19.00
GRAVEL	Very Fine	2.0 - 2.8					19.00		19.00
	Very Fine	2.8 - 4.0					19.00		19.00
	Fine	4.0 - 5.6					19.00		19.00
	Fine	5.6 - 8.0					19.00		19.00
	Medium	8.0 - 11.0					19.00		19.00
	Medium	11.0 - 16.0	1		1	1.00	20.00	1.00	20.00
	Coarse	16 - 22.6	1		1	1.00	21.00	1.00	21.00
	Coarse	22.6 - 32					21.00		21.00
	Very Coarse	32 - 45	1		1	1.00	22.00	1.00	22.00
	Very Coarse	45 - 64	2		2	2.00	24.00	2.00	24.00
COBBLE	Small	64 - 90	4		4	4.00	28.00	4.00	28.00
	Small	90 - 128	7		7	7.00	35.00	7.00	35.00
	Large	128 - 180	16		16	16.00	51.00	16.00	51.00
	Large	180 - 256	15		15	15.00	66.00	15.00	66.00
BOULDER	Small	256 - 362	9		9	9.00	75.00	9.00	75.00
	Small	362 - 512	8		8	8.00	83.00	8.00	83.00
	Medium	512 - 1024	12		12	12.00	95.00	12.00	95.00
	Large-Very Large	1024 - 2048	4		4	4.00	99.00	4.00	99.00
BEDROCK	Bedrock	> 2048	1		1	1.00	100.00	1.00	100.00
			100	0	100			100	100

Cummulative Channel materials	
D_{16} =	0.50
D_{35} =	128.00
D_{50} =	176.21
D_{84} =	542.45
D_{95} =	1024.00
D_{100} =	> 2048

Riffle Channel materials	
D_{16} =	0.50
D_{35} =	128.00
D_{50} =	176.21
D_{84} =	542.45
D_{95} =	1024.00
D_{100} =	> 2048

Sediment Distribution

Dead River - Black @ Gauge



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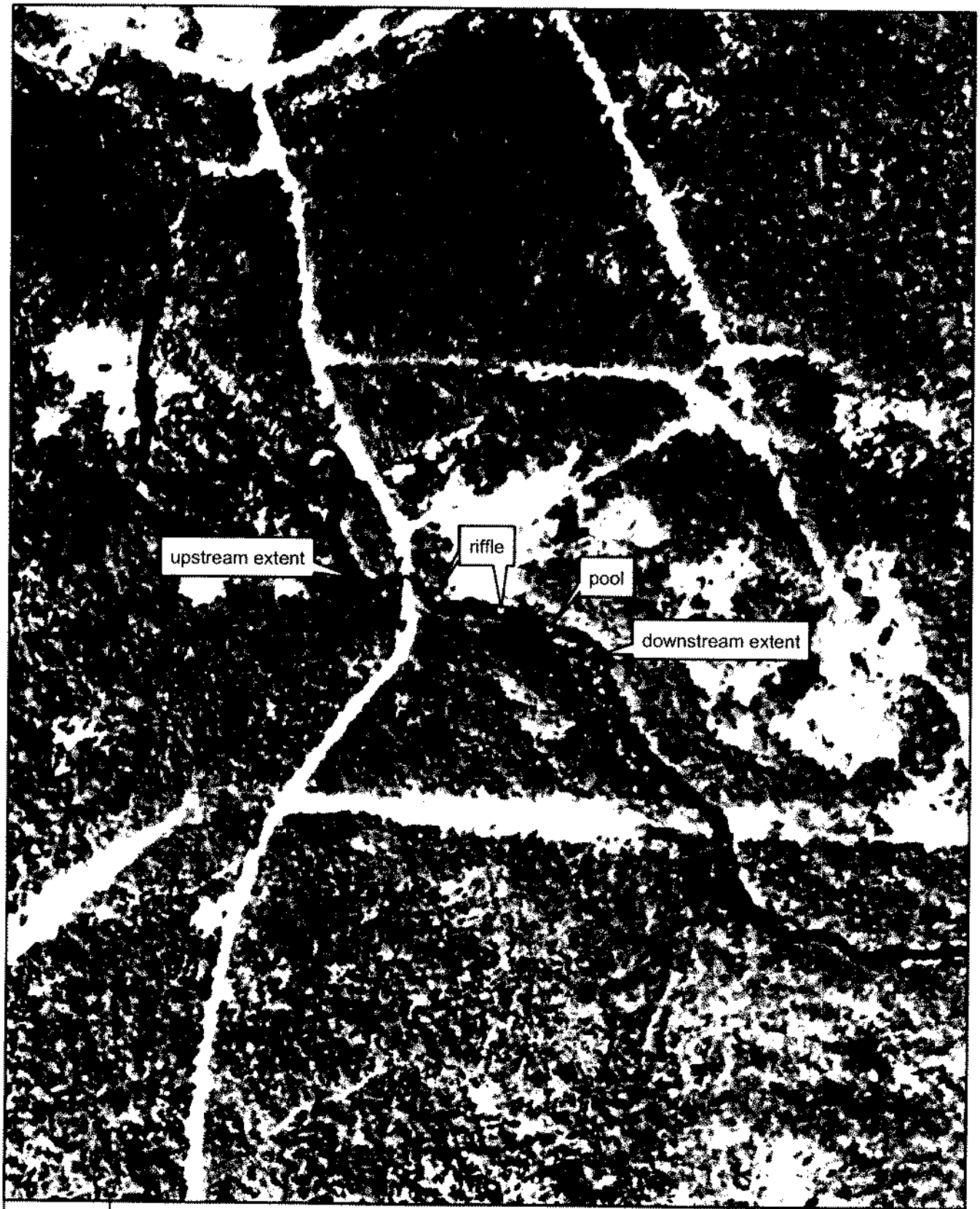
ClassificationSediment Distribution v2
LogHistogram



LEGEND:

- Black River reference reach
- ▲ USGS gage 4057900
- ○ Black cross sections
- ● Black sediment sample site

250 125 0 250 500 Feet

BUCK

Black River Reach for Limited Use Curve Development

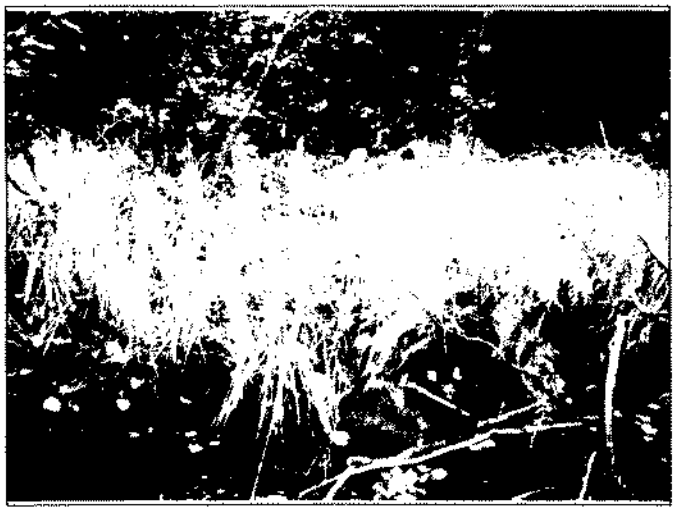
Work Plan Photograph Key

Dead River Recovery Post-Event Additional Environmental Assessment: Survey of Morphological Stream Parameters Using Rosgen Method

Number [1]	Subject	Location [2]
1	Bankfull stage indicator	location that best depicts indicator (Rosgen, 1996)
2	Stream downstream of the cross-section	standing mid-stream at the tape
3	Stream upstream of the cross-section	standing mid-stream at the tape
4	Cross-section photo	downstream of the cross-section facing upstream
5	Cross-section photo	upstream of the cross-section facing downstream
6	Right floodplain	right top of bank at the cross-section
7	Left floodplain	left top of bank at the cross-section
8	Stream upstream of the reach	standing mid-stream at the start of the longitudinal profile
9	Stream downstream of the reach	standing mid-stream at the end of the longitudinal profile
10	A sufficient number of photographs to provide a continuous visual documentation of the survey reach	facing downstream

Notes:

1. A letter designation is used in addition to the photo number (e.g. 10A, 10B, 10C, etc.) if more than one photograph was taken of a particular subject or from a single location.
2. Location from which photograph was taken.



BLACK POOL XS #1

BLACK POOL XS #2

BLACK POOL XS #3

BLACK POOL XS #4

BLACK POOL XS #5

BLACK POOL XS #6

BLACK POOL XS #7

BLACK RIFFLE XS1 #1

BLACK RIFFLE XS1 #2

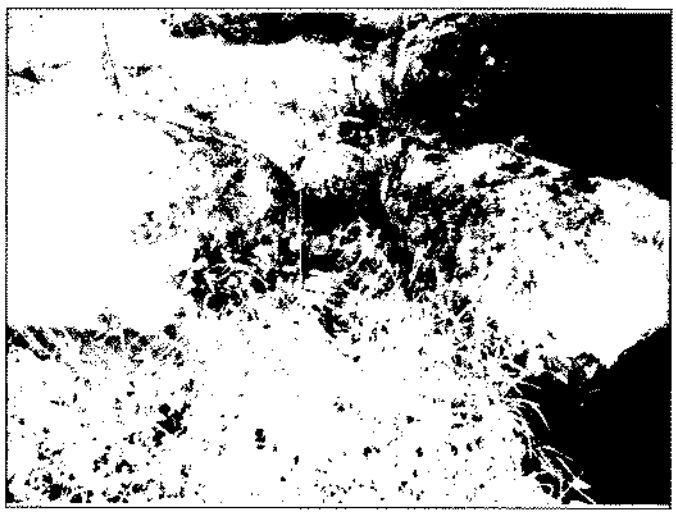
BLACK RIFFLE XS1 #3

BLACK RIFFLE XS1 #4

BLACK RIFFLE XS1 #5

BLACK RIFFLE XS1 #6

BLACK RIFFLE XS1 #7



BLACK RIFFLE XS2 #1

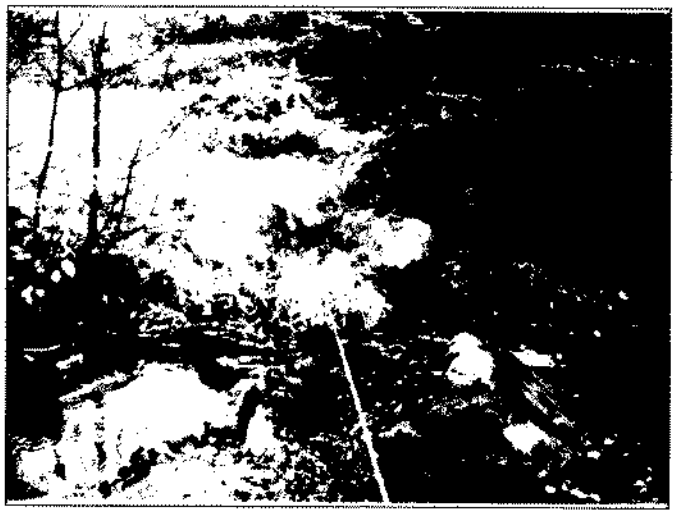
BLACK RIFFLE XS2 #2

BLACK RIFFLE XS2 #3

BLACK RIFFLE XS2 #4

BLACK RIFFLE XS2 #5

BLACK RIFFLE XS2 #6



BLACK RIFFLE XS2 #7

BLACK #8

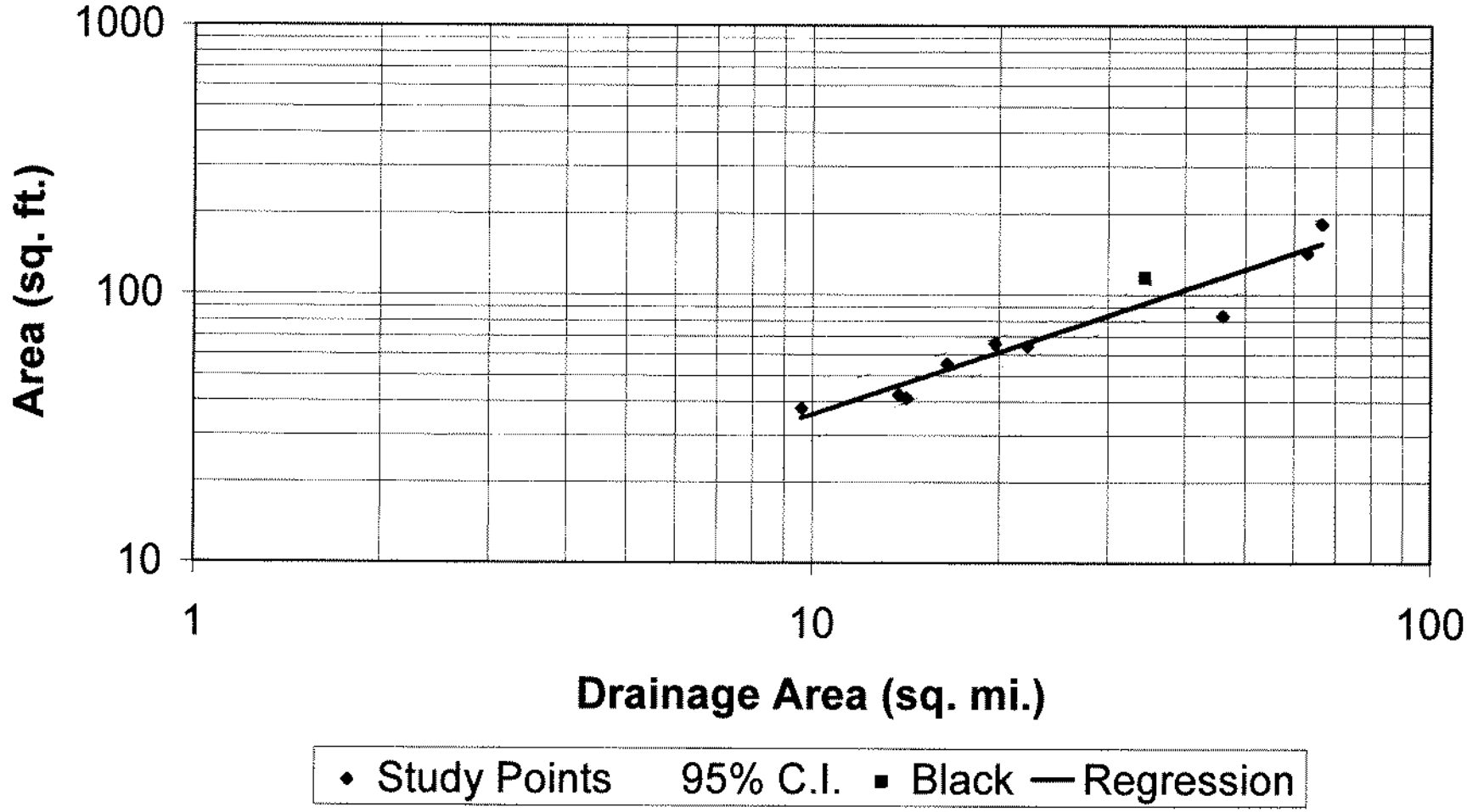
BLACK #9

BLACK #10A

BLACK #10B

Cross Sectional Area vs. Drainage Area

$y = 6.0x^{0.77}$, $r^2 = 0.91$

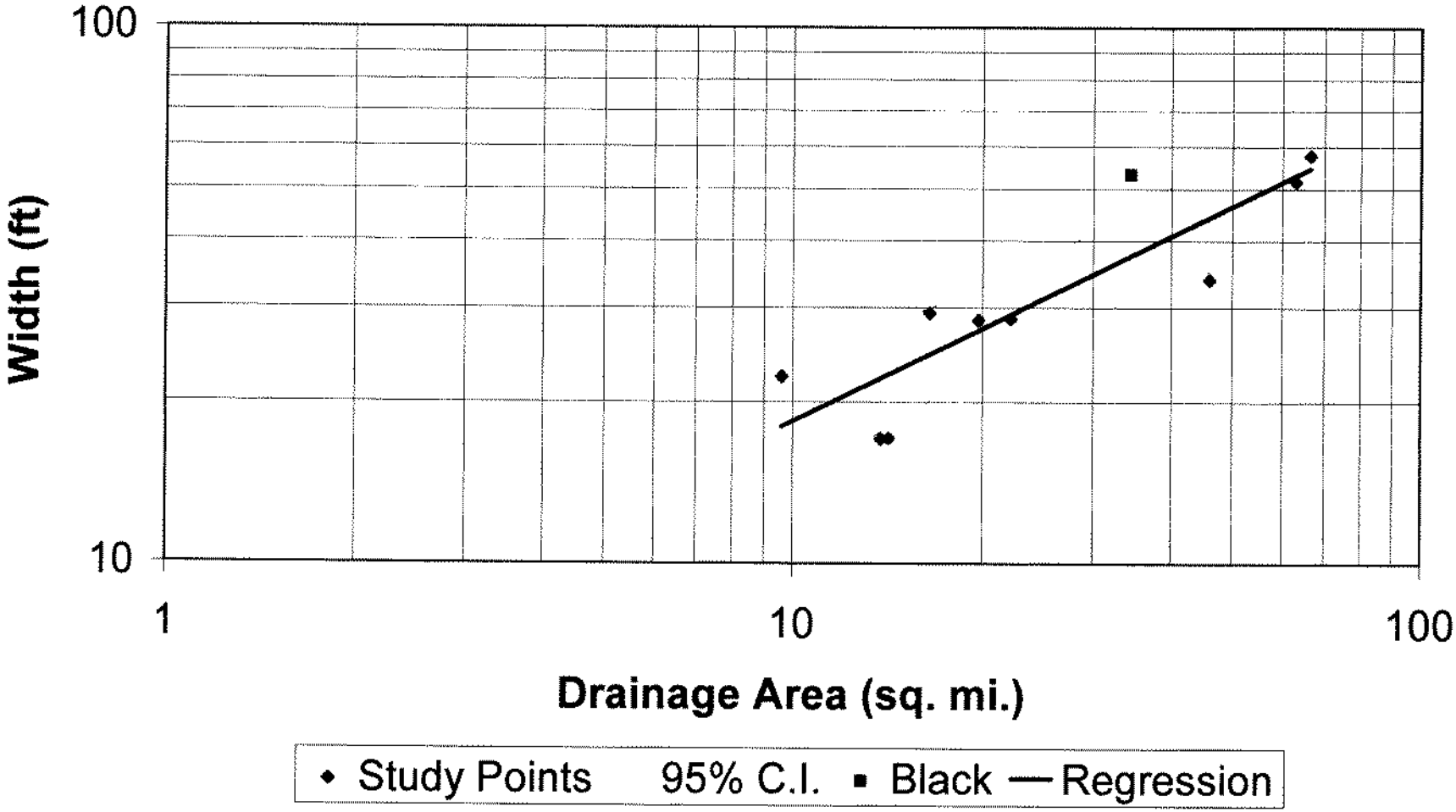


12/14/2004
4:26 PM

NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Black
Curves Chart 1

Bankfull Width vs. Drainage Area

$y = 4.9x^{0.57}$, $r^2 = 0.76$

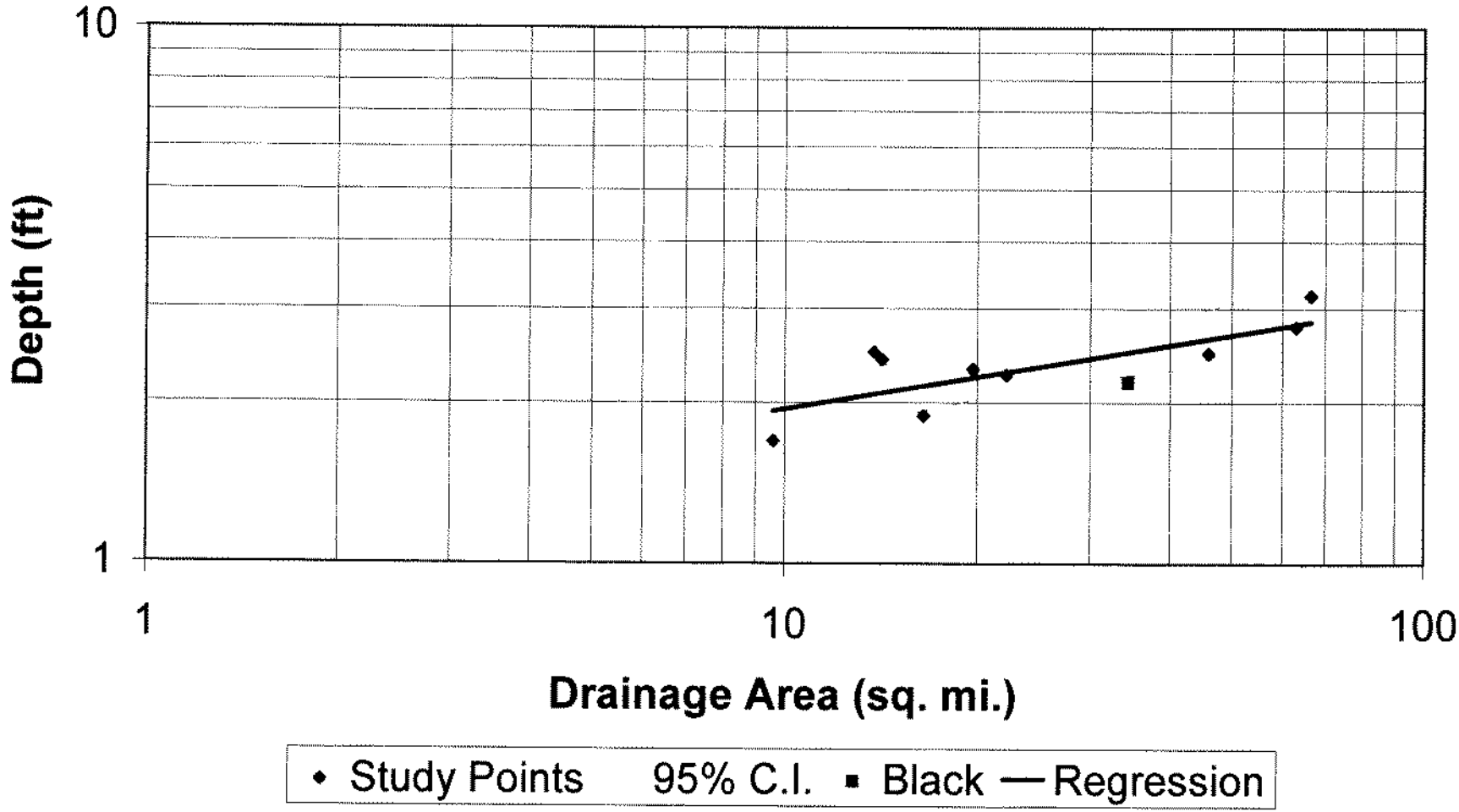


12/14/2004
4:26 PM

NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Black
Curves Chart 2

Bankfull Mean Depth vs. Drainage Area

$y = 1.2x^{0.20}$, $r^2 = 0.57$

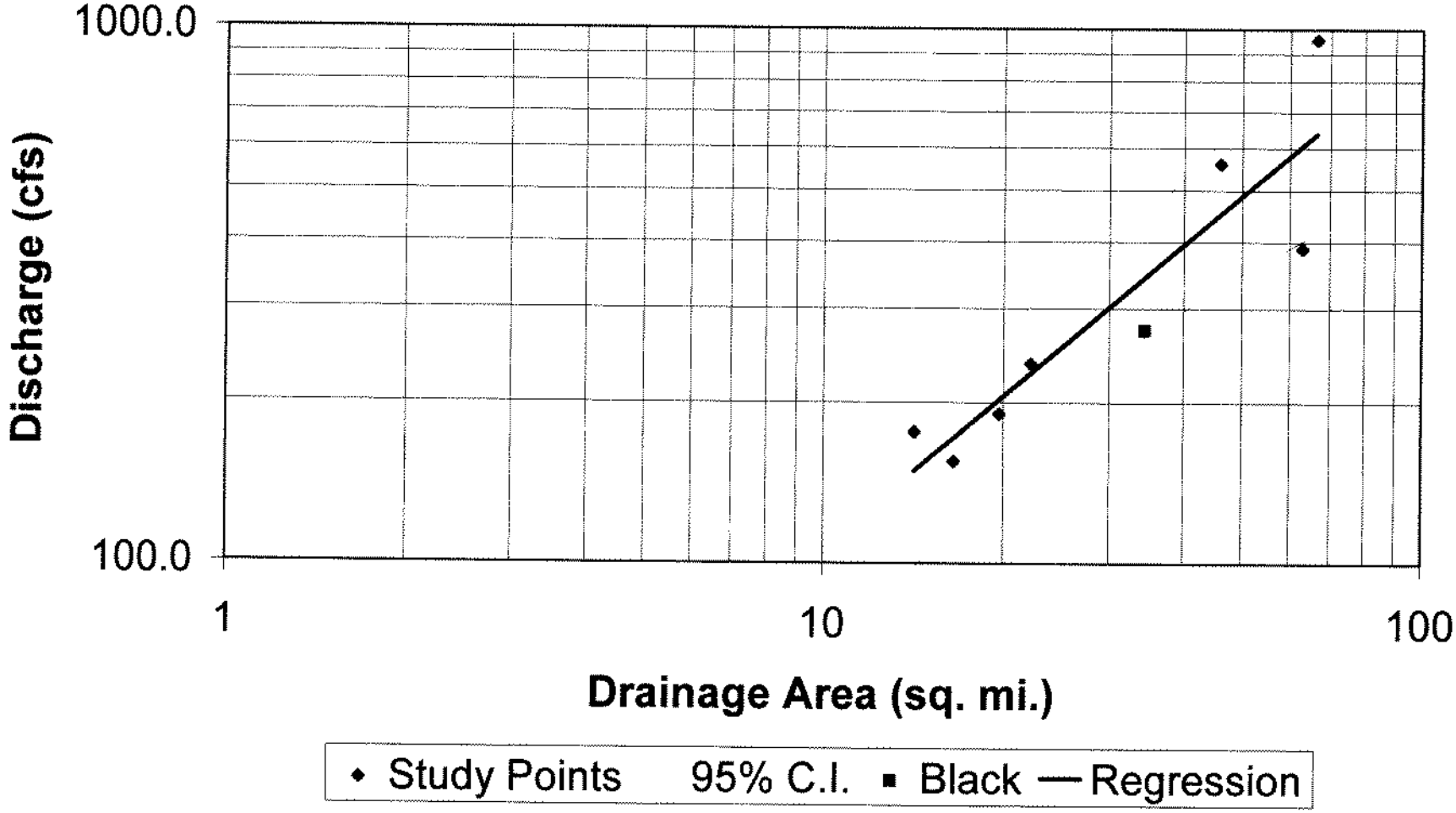


12/14/2004
4:26 PM

NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Black
Curves Chart 3

Bankfull Discharge vs. Drainage Area

$y = 12.2x^{0.94}$, $r^2 = 0.82$



12/14/2004
4:26 PM

NewCopy of CurvesLog-Log90and95ConfidenceIntervals_Black
Curves Chart 6

Harlow Creek

Initials	Work Item
_____	Collect the following data at a minimum for each LUC reach.

Reach ID: **Harlow (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☐ Identify bankfull per Harrelson et al., 1994
- ☐ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☐ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☐ Sample bed material using Wolman pebble count procedure
- ☐ Sketch site per Harrelson et al., 1994.
- ☐ Photograph site.

Initials	Work Item
_____	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Harlow (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☐ Limited Use Curves
  - DA versus Wbkf
  - DA versus Dbkf
  - DA versus CSA
  - DA versus Qbkf
- ☐ Plot of longitudinal profile
- ☐ Plot of cross-section
- ☐ Grain size distribution for bed material
- ☐ Site sketch
- ☐ Photographs and photo log.
- ☐ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - Reach
    - Reach limits (line shape)
    - Reach ID (name or number)
    - Stream Type
    - DA
  - Survey Locations
    - Location ID (i.e. – X1, X2, X3, etc.)
    - Location type (pool, riffle)
- ☐ Calculations (single section analysis)
- ☐ Plot of Single Section Analysis versus Regression Equation

Clark Creek

Initials	Work Item
_____	Collect the following data at a minimum for each LUC reach.

Reach ID: **Clark (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☑ Identify bankfull per Harrelson et al., 1994
- ☑ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☑ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☑ Sample bed material using Wolman pebble count procedure
- ☑ Sketch site per Harrelson et al., 1994.
- ☑ Photograph site.

Initials	Work Item
_____	Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Clark (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

☐ Limited Use Curves

-- DA versus Wbkf
-- DA versus Dbkf
-- DA versus CSA
-- DA versus Qbkf

☑ Plot of longitudinal profile

☐ Plot of cross-section

☐ Grain size distribution for bed material

☐ Site sketch

☐ Photographs and photo log.

☐ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)

- Reach
  - Reach limits (line shape)
  - Reach ID (name or number)
  - Stream Type
  - DA
- Survey Locations
  - Location ID (i.e. – X1, X2, X3, etc.)
  - Location type (pool, riffle)

☐ Calculations (single section analysis)

☐ Plot of Single Section Analysis versus Regression Equation

Peshekee River

Initials	Work Item
_____	Collect the following data at a minimum for each LUC reach.

Reach ID: **Peshekee (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☐ Identify bankfull per Harrelson et al., 1994
- ☐ Survey longitudinal profile for a distance of at least 5 riffles (one at beginning, three in middle, one at end).
- ☐ Survey a minimum of one (1) cross-section (at mid-riffle within the reach limits).
- ☐ Sample bed material using Wolman pebble count procedure
- ☐ Sketch site per Harrelson et al., 1994.
- ☐ Photograph site.

Initials	Work Item

_____ Provide the following items for each LUC reach in electronic and hard copy format.

Reach ID: **Peshekee (also used as a reference reach; see the Reference Reach data Appendix for detailed information)**

- ☐ Limited Use Curves
  - -- DA versus Wbkf
  - -- DA versus Dbkf
  - -- DA versus CSA
  - -- DA versus Qbkf
- ☐ Plot of longitudinal profile
- ☐ Plot of cross-section
- ☐ Grain size distribution for bed material
- ☐ Site sketch
- ☐ Photographs and photo log.
- ☐ GIS data layers depicting reach location with associated attribute data (in ESRI shapefile format and MI State Plane Coordinates)
  - ▪ Reach
    - o Reach limits (line shape)
    - o Reach ID (name or number)
    - o Stream Type
    - o DA
  - ▪ Survey Locations
    - o Location ID (i.e. – X1, X2, X3, etc.)
    - o Location type (pool, riffle)
- n/a ☐ Calculations (single section analysis)
- n/a ☐ Plot of Single Section Analysis versus Regression Equation