Benbow Park
Stream Restoration Monitoring Report
EEP Project # 29
Monitoring Year – 05
2009

Submitted to:

NCDENR-EEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

December 2009

Monitoring Firm

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Design Firm

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY / PROJECT ABSTRACT

In 2004, the North Carolina Ecosystem Enhancement Program (EEP) conducted stream restoration at Benbow Park within the Buffalo Creek Watershed in Greensboro, North Carolina. The 0.7 mi^2 project watershed is located within the USGS 14-digit HUC 03030002020050 and the NCDWQ Sub-basin 03-06-02 of the Cape Fear River Basin. The project restored approximately 2,060 linear feet of channel, 780 feet upstream of South Benbow Road and 1,280 feet downstream of South Benbow Road. Project construction occurred in 2004. The project goals and objectives are listed below.

- Restore unstable stream channels to natural stable forms by modifying dimension, pattern, and/or profile based on reference reach parameters.
- Improve floodplain functionality by matching bankfull stage with floodplain elevation.
- Establish native floodplain vegetation through a forested riparian buffer.
- Improve the natural aesthetics of the stream corridor.
- Obtain mitigation credits for unavoidable impacts to streams within the same Hydrologic Unit Code (HUC).

The riparian buffer was planted with seven different species of bare root trees and four different species of live stakes. Three vegetation monitoring plots were established during the as-built survey, two buffer plots and one live stake plot. These plots were monitored during the first year of monitoring. In 2006, the EEP requested that the site be monitored using the new Carolina Vegetation Survey (CVS) vegetation monitoring protocol. Five new plots were established for the second monitoring year, and the previous monitoring plots were discontinued. The fifth year of monitoring produced an average planted stem count of 591 stems per acre (Range: 324 – 1,052) with the totals inclusive of native volunteers ranging from 1,093 – 5,059 stems per acre. The number of native tree and shrub species ranged from 10 to 17 across the 5 plots. In late 2008, KCI observed that the city trimmed the understory for much of the project. EEP informed KCI that the city had arranged this with EEP in order to facilitate invasives control. Many of the trees on the site have attained a substantial size and the intent of this maintenance was to continue to promote their growth and success while trying to thin out the dense understory to gain access for invasive plant control. The dense herbaceous layer was trimmed so invasives could be targeted and the lower limbs of the larger trees were pruned to limit attachment opportunities by invasive climbing vine species. As per EEP, this pruning activity is to be a one-time effort to serve as an initial point for invasive plant control by the city, while still permitting the development of a sufficiently dense assemblage of robust native trees. Subsequent invasives control will be performed by the city at a maintenance level without widespread pruning, promoting native woody, shrubs and trees. KCI did a visual evaluation of the site in November 2009 and determined the areas outside the veg plots still maintained adequate stem densities, but the herb layer and low brush were less dense than in prior observations. EEP has indicated that this is part of a maintenance strategy that permits a herb and shrub layer, but with some trimming of these strata earlier in the successional history of the buffer, invasives are in turn isolated for more manageable treatment and native trees are provided with a competitive advantage over all other buffer constituents. Over its history the project buffer has exhibited the development of many invasive plants that typify disturbed urban watersheds, most notably mimosa (*Albizia julibrissin*), ornamental pear (*Pyrus calleryana*), and kudzu (*Pueraria montana*). All of these invasive species have been and will continue to be targeted for long-term control by the City of Greensboro moving into stewardship. The fifth year of monitoring found the vegetation component of the project to be on track to meeting the success criteria.

The fifth year of monitoring found the stream to be functioning and stable throughout the project. Channel dimensions have not changed significantly from the as-built conditions over the course of the stream monitoring. The stream has experienced localized erosion, but many of these eroding banks have stabilized. Some channel narrowing and aggradation has continued, specifically between Stations 19+50 to 20+50 and 21+30 to 21+80. Several structures that did exhibit some back arm scour at some point in the monitoring history represent modest, remnant, localized areas of instability, which have advanced little or not at all in recent years. In addition, the majority of the projects longitudinal extent is surrounded

by extremely dense woody vegetation and canopy, especially for an urban system. The associated stabilizing root mass from the buffer is extensive.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the mitigation and restoration plan documents available on the EEPs website. All raw data supporting the tables and figures in the appendices are available upon request.

2.0 METHODOLOGY

The CVS-EEP protocol (http://cvs.bio.unc.edu/methods.htm) was used to collect vegetation data from Benbow Park this year, the fifth year of monitoring. This methodology was incorporated during the second year of monitoring. The method used before that time was the EEP 2004 Stem Counting Protocol.

3.0 REFERENCES

Lee, M. T., R. K. Peet, S. D. Roberts, and T. R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0 (http://cvs.bio.unc.edu/methods.htm)

Weakley, A. S. 2006. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas. (http://www.herbarium.unc.edu/FloraArchives/WeakleyFlora_2006-Jan.pdf)

Appendix A

General Figures and Plan Views

DIRECTIONS TO BENBOW PARK SITE:
From I-40, take exit 128 to NC 6 N. Bear right onto E. Lee St. ramp and go 2.2 miles. Turn left onto S. Benbow Road. Follow S. Benbow Road to the restoration site at the intersection with S. Side Boulevard.

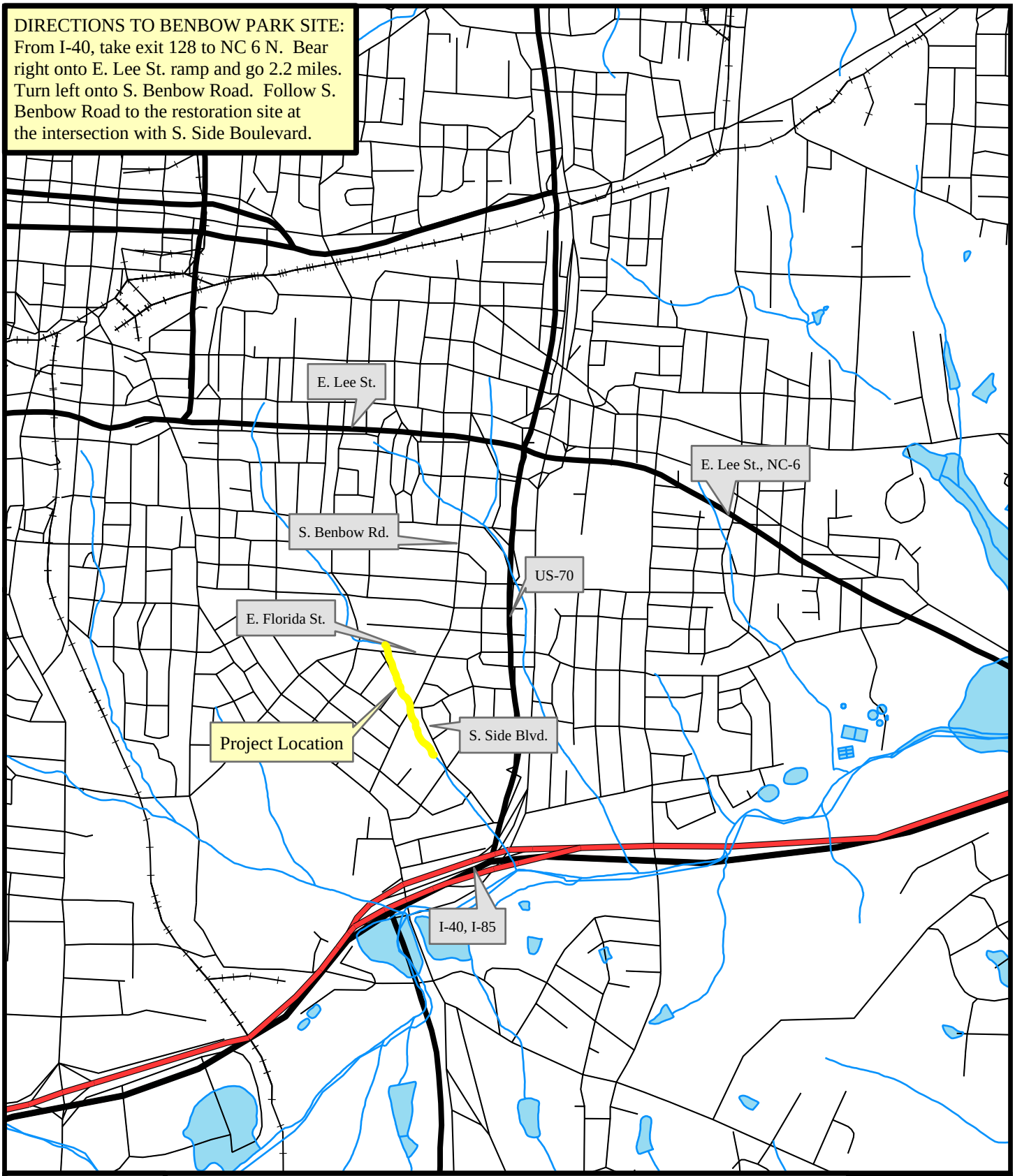


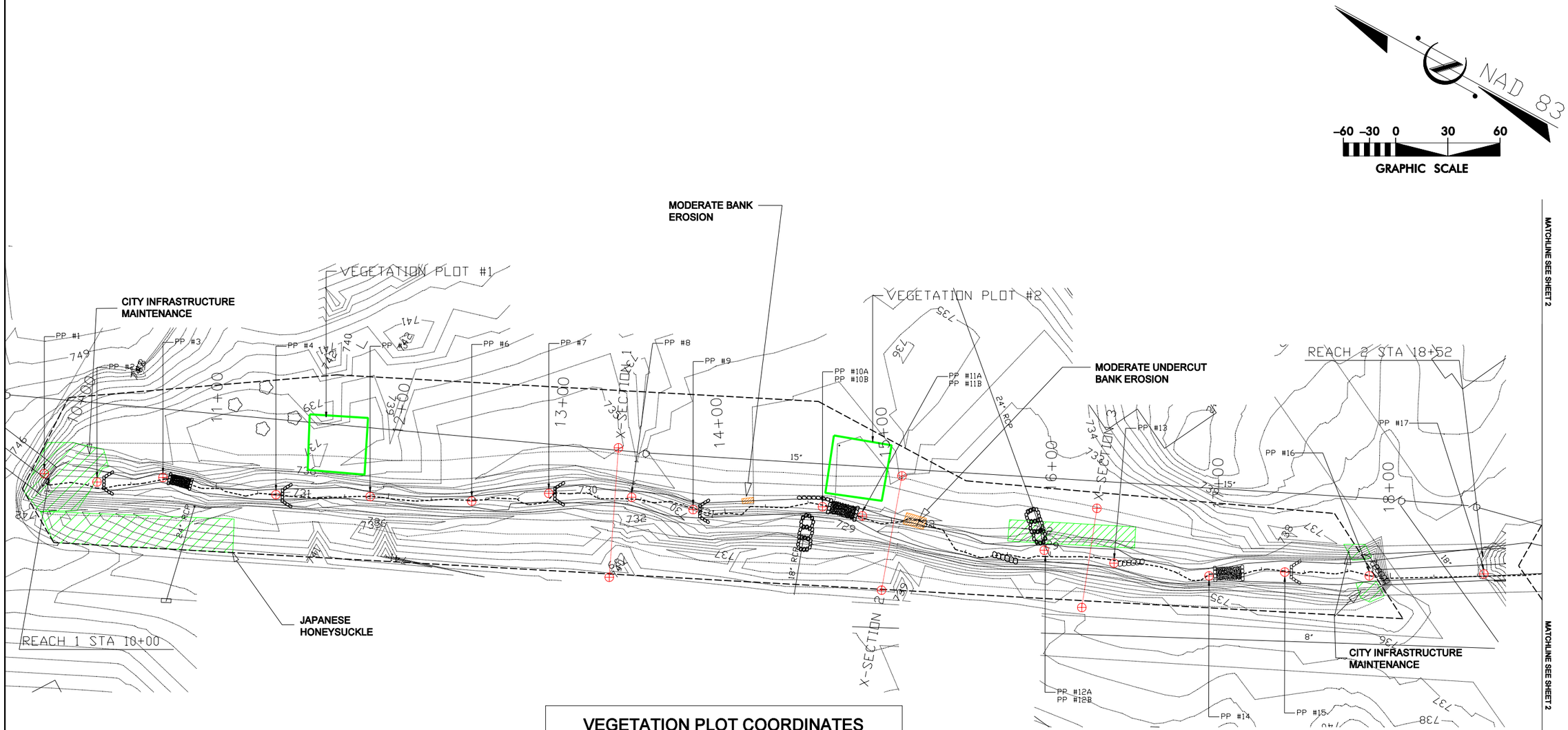
Figure 1. Site Vicinity Map
Benbow Park, Guilford County, EEP Project # 29

0.25 0.125 0 0.25 0.5 Miles

N

Ecosystem Enhancement Program

KCI ASSOCIATES OF NC



CROSS-SECTION COORDINATES

	NORTHING	EASTING	ELEVATION
CROSS-SECTION 1 LB	839329.34	1771033.91	736.61
RB	839298.26	1770966.16	740.00
CROSS-SECTION 2 LB	839178.72	1771097.96	734.05
RB	839157.49	1771034.75	738.95
CROSS-SECTION 3 LB	839071.52	1771135.40	733.47
RB	839051.78	1771081.27	737.82
CROSS-SECTION 4 LB	838397.44	1771299.45	728.30
RB	838425.07	1771246.95	729.70
CROSS-SECTION 5 LB	838314.09	1771418.26	732.10
RB	838288.35	1771353.07	727.80
CROSS-SECTION 6 LB	838180.94	1771418.13	727.84
RB	838133.24	1771409.06	728.95

VEGETATION PLOT COORDINATES

	NORTHING	EASTING
VEGETATION PLOT #1	839494.17	1770965.66
	839463.78	1770979.87
	839449.92	1770950.34
	839479.83	1770937.07
VEGETATION PLOT #2	839224.18	1771099.58
	839192.34	1771110.54
	839182.02	1771079.85
	839212.61	1771068.29
VEGETATION PLOT #3	838517.75	1771228.98
	838457.49	1771256.77
	838452.01	1771240.74
	838513.04	1771214.85
VEGETATION PLOT #4	838320.18	1771302.21
	838296.75	1771363.84
	838282.01	1771356.20
	838305.37	1771294.46
VEGETATION PLOT #5	838188.65	1771391.60
	838180.41	1771458.03
	838172.03	1771389.36
	838164.44	1771454.45

LEGEND

- PHOTO POINT
- THALWEG
- AS-BUILT VEGETATIVE BUFFER BOUNDARY
- CROSS-SECTION
- ROOT WAD
- ROCK CROSS VANE
- CONSTRUCTED RIFFLE
- STEP POOL STRUCTURE
- DOUBLE DROP CROSS VANE
- J-HOOK

REVISIONS

Ecosystem Enhancement Program

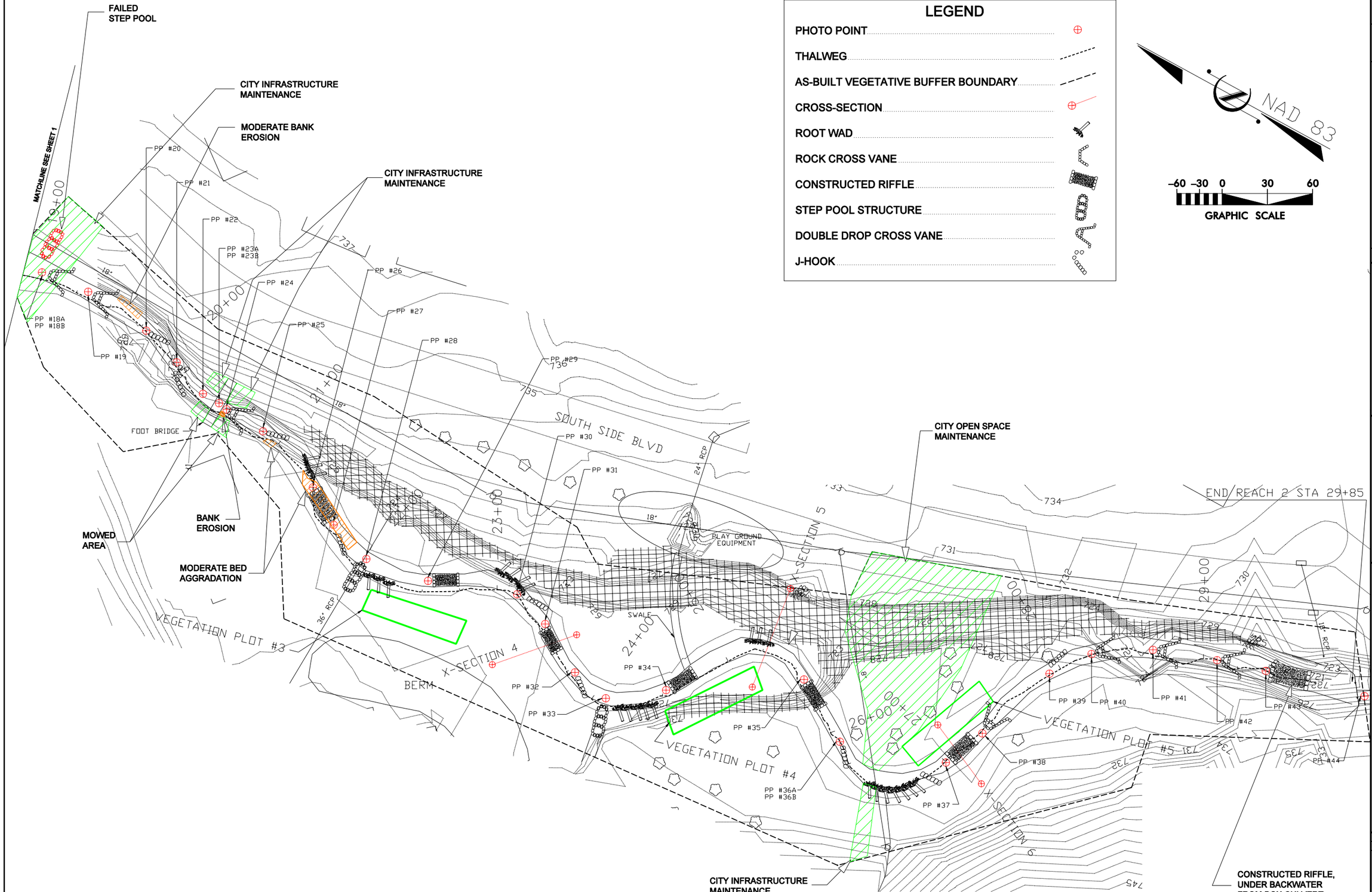
KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

BENBOW PARK
GUILFORD COUNTY, NORTH CAROLINA
EEP PROJECT NUMBER 29 - MY05

STATION 10+00 TO STATION 18+87

DATE: DECEMBER 2009
SCALE: SEE SHEET

CURRENT CONDITION PLAN VIEW



LEGEND

- PHOTO POINT
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- DOUBLE DROP CROSS VANE
- J-HOOK

NAD 83

–60 –30 0 30 60

GRAPHIC SCALE

REVISIONS

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RALEIGH, NORTH CAROLINA 27609

BENBOW PARK

GUILFORD COUNTY, NORTH CAROLINA
EEP PROJECT NUMBER 29 - MY05

STATION 18+87 TO STATION 29+85

DATE: DECEMBER 2009
SCALE: SEE SHEET

CURRENT CONDITION PLAN VIEW

Appendix B

General Project Tables

Table 1. Project Restoration Components Project Number and Name: 29 - Benbow Park						
Segment/ Reach ID	**Existing Linear Feet**	**Type**	**Approach**	**Linear Feet**	**Stationing**	**Comment**
Reach 1	780	R	P2/3	780	10+00 - 17+80	
Reach 2	972	R	P1	1,280	18+50 - 31+30	

R = Restoration P1 = Priority 1

P2/3 = Combination of Priority 2 and 3

Table 2. Project Activity and Reporting History Project Number and Name: 29 - Benbow Park		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan		Jun 02
Final Design - 90%		
Construction		Aug 04
Stream Repair and Maintenance Seeding		Apr 05
As-Built Report	2005	Jun 05
Year 1 Monitoring	Nov 05	Jan 06
Adjustments to the Location of the Conservation Easement		Oct 06
Year 2 Monitoring	Sep 06	Jan 07
Year 3 Monitoring	Sep 07	Jan 08
Year 4 Monitoring	Oct 08	Jan 09
Year 5 Monitoring	Nov 09	Dec 09

Table 3. Project Contacts Table Project Number and Name: 29 - Benbow Park	
Design Firm	Buck Engineering 8000 Regency Parkway, Suite 200 Cary, North Carolina 27511 Contact: Mr. Mike Rooney Phone: (919) 463-5488 Fax: (919) 463-5490
Construction Contractor	Shamrock Construction P.O. Box 14987 Greensboro, North Carolina 27415 Contact: Mr. Bill Wright Phone: (336) 375-1989 Fax: (336) 375-1801
Monitoring Performers	
MY-01	Buck Engineering 8000 Regency Parkway, Suite 200 Cary, North Carolina 27511 Contact: Mr. Mike Rooney Phone: (919) 463-5488 Fax: (919) 463-5490
MY-02, 03, 04, 05	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 278-2514 Fax: (919) 783-9266

Table 4. Project Attribute Table **Project Number and Name: 29 – Benbow Park**	
Project County	Guilford County
Drainage Area	0.7 mi^2
Drainage Impervious Cover Estimate (%)	61%
Stream Order	Second Order
Physiographic Region	Piedmont
Ecoregion	Southern Outer Piedmont
Rosgen Classification of As-built	B5c (Reach 1)
	E5 (Reach 2)
Dominant Soil Types	Enon - Urban Land Complex (Benbow Stream)
Reference Site ID	N/A
USGS HUC for Project and Reference	03030002020050 (Benbow Stream)
NCDWQ Sub-basin for Project and Reference	03-06-02 (Benbow Stream)
NCDWQ Classification for Project and Reference	N/A (Benbow Stream)
Any portion of the project segment 303d listed?	No - not rated
Any portion of the project segment upstream of a 303d listed segment?	Project stream is approx. 0.4 mile upstream of the listed stream, S. Buffalo Creek.
Reasons for 303d Listing or Stressor	S. Buffalo Creek is listed for impaired biological integrity and turbidity violation.
% of Project Easement Fenced	0%
% of Project Easement Demarcated with Bollards	approx. 75% - many bollards have been knocked over

Appendix C

Vegetation Assessment Data

Table 5. Vegetation Plot Mitigation Success Summary Table Project Number and Name: 29 - Benbow Park		
Vegetation Plot ID	**Monitoring Year 05 Planted Stem Density (stems/acre)**	**Vegetation Survival Threshold Met?**
1	324	Yes
2	445	Yes
3	324	Yes
4	809	Yes
5	1,052	Yes

Table 6. Vegetation Metadata Table
Project Number and Name: 29 – Benbow Park

Report Prepared By	Brian Roberts
Date Prepared	8/19/2009 9:44
Database Name	KCI-2008-cvs-eep-entrytool-v2.2.7-MTL.mdb
Database Location	C:\Users\broberts\Desktop\KCI_2008-entrytool-v2.2.7

PROJECT SUMMARY----------

Project Code	Project Name	Description	Length (ft)	Stream-to-Edge Width (ft)	Area (sq m)	Required Plots (calculated)	Sampled Plots
29	Benbow Park	Stream restoration site in Greensboro, NC.	2,000	40	14,863	5	5

Table 7. Stem Count Total and Planted by Plot and Species
Project Number and Name: 29 – Benbow Park

			Current Plot Data (MY5 2009)														Annual Means											
			029-01-0001			029-01-0002			029-01-0003			029-01-0004			029-01-0005			MY5 (2009)			MY4 (2008)			MY3 (2007)			MY2 (2006)		
Scientific Name	Common Name	Species Type	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T
Acer rubrum	red maple	Tree												8			2			10								
Acer saccharinum	silver maple	Tree			4			2												6								
Albizia julibrissin	silktree	Shrub Tree						3												3								
Baccharis	baccharis	Shrub Tree			1															1								
Betula nigra	river birch	Tree								1	1					1	1		2	2		3	3		3	3		3	3
Celtis laevigata	sugarberry	Shrub Tree			1												11			12								
Cornus amomum	silky dogwood	Shrub			4	2	2	3	1	1	1	4	4	5	5	5	9	12	12	22	12	12	12	13	13	13	15	15	15
Elaeagnus pungens	thorny olive	Shrub									2									2								
Fraxinus pennsylvanica	green ash	Tree		5	6		2	3					6	7		1	1		14	17		15	15		16	16		16	16
Hamamelis virginiana	American witchhazel	Shrub Tree		2	2		4	4		1	1				1	6	6	1	13	13		14	14		14	14		14	14
Juglans nigra	black walnut	Tree			1			2			3									6								
Juniperus virginiana	eastern redcedar	Tree									1									1								
Ligustrum sinense	Chinese privet	Shrub Tree			1												4			5								
Liquidambar styraciflua	sweetgum	Tree			11						7			19			3			40								
Liriodendron tulipifera	tuliptree	Tree															9			9								
Morus rubra	red mulberry	Tree			2						1			10			4			17								
Nyssa sylvatica	blackgum	Tree						1		2	2		4	14		2	3		8	20		8	8		8	8		8	8
Ostrya virginiana	hophornbeam	Shrub Tree						2			1			2						5								
Pinus taeda	loblolly pine	Tree			1															1								
Platanus occidentalis	American sycamore	Tree								2	2			48		2	42		4	92		4	4		4	4		4	4
Prunus	plum	Shrub Tree			2						2						4			8								
Quercus phellos	willow oak	Tree		1	9			2											1	11		1	1		1	1		1	1
Rhus	sumac							12												12								
Robinia pseudoacacia	black locust	Tree															4			4								
Salix nigra	black willow	Tree							1	1	2	1	1	2	3	3	3	5	5	7	5	5	5	5	5	5	5	5	5
Salix sericea	silky willow	Shrub Tree				3	3	3			1	5	5	10	6	6	9	14	14	23	17	17	17	17	17	17	15	15	15
Sambucus canadensis	Common Elderberry	Shrub Tree															2			2								
Ulmus alata	winged elm	Tree															3			3								
	Stem count		0	8	45	5	11	37	2	8	27	10	20	125	15	26	120	32	73	354	34	79	79	35	81	81	35	81	81
	size (ares)		1			1			1			1			1			5			5			5			5		
	size (ACRES)		0.02			0.02			0.02			0.02			0.02			0.12			0.12			0.12			0.12		
	Species count		0	3	13	2	4	11	2	6	14	3	5	10	4	8	18	4	9	28	3	9	9	3	9	9	3	9	9
	Stems per ACRE		0	323.75	1821.1	202.34	445.15	1497.3	80.937	323.75	1092.7	404.69	809.37	5058.6	607.03	1052.2	4856.2	259	590.84	2865.2	275.19	639.4	639.4	283.28	655.59	655.59	283.28	655.59	655.59

Pw/o LS – Planted Stems without Live Stakes P-all – Planted Stems Total (with Live Stakes) T – Total (Planted Including Live Stakes and Volunteers)

Vegetation Monitoring Plot Photos

Plot 1 Photo – Taken looking south from the northern corner. 8/13/09 - MY 05

Plot 2 Photo – Taken looking south from the northern corner. 8/13/09 - MY 05

Plot 3 Photo – Taken looking north from the southern corner. 8/13/09 - MY 05

Plot 4 Photo – Taken looking northwest from the southeastern corner. 8/13/09 - MY 05

Plot 5 Photo – Taken looking east from the western corner. 8/13/09 - MY 05

Appendix D

Stream Assessment Data

Stream Station Photos

PP#1 – MY05 – 11/3/09

PP#2 – MY05 – 11/3/09

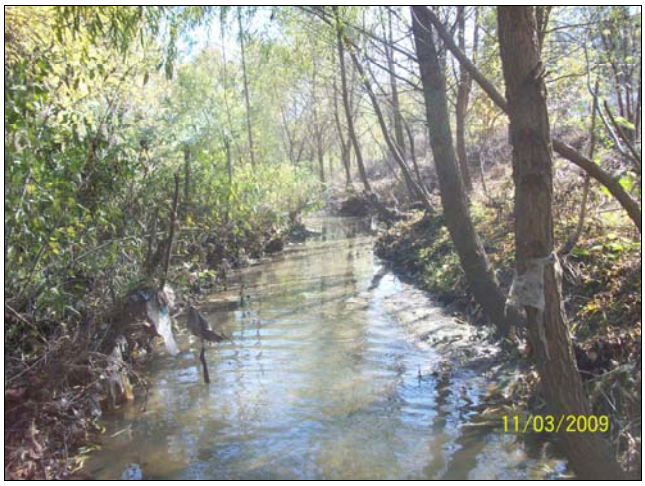
PP#3 – MY05 – 11/3/09

PP#4 – MY05 – 11/3/09

PP#5 – MY05 – 11/3/09

PP#6 – MY05 – 11/3/09

PP#7 – MY05 – 11/3/09



PP#8 – MY05 – 11/3/09

PP#9 – MY05 – 11/3/09

PP#10A – MY05 – 11/3/09

PP#10B – MY05 – 11/3/09

PP#11A – MY05 – 11/3/09

PP#11B – MY05 – 11/3/09

PP#12A – MY05 – 11/3/09

PP#12B – MY05 – 11/3/09

PP#13 – MY05 – 11/3/09

PP#14 – MY05 – 11/3/09

PP#15 – MY05 – 11/3/09

PP#16 – MY05 – 11/3/09

PP#17 – MY05 – 11/3/09

PP#18A – MY05 – 11/3/09

PP#18B – MY05 – 11/3/09

PP#19 – MY05 – 11/3/09

PP#20 – MY05 – 11/3/09

PP#21 – MY05 – 11/3/09

PP#22 – MY05 – 11/3/09

PP#23A – MY05 – 11/3/09

PP#23B – MY05 – 11/3/09

PP#24 – MY05 – 11/3/09

PP#25 – MY05 – 11/3/09

PP#26 – MY05 – 11/3/09

PP#27 – MY05 – 11/3/09

PP#28 – MY05 – 11/3/09

PP#29 – MY05 – 11/3/09

PP#30 – MY05 – 11/3/09

PP#31A – MY05 – 11/3/09

PP#31B – MY05 – 11/3/09

PP#32 – MY05 – 11/3/09

PP#33 – MY05 – 11/3/09

PP#34 – MY05 – 11/3/09

PP#35 – MY05 – 11/3/09

PP#36A – MY05 – 11/3/09

PP#36B – MY05 – 11/3/09

PP#37 – MY05 – 11/3/09

PP#38 – MY05 – 11/3/09

PP#39 – MY05 – 11/3/09

PP#40 – MY05 – 11/3/09

PP#41 – MY05 – 11/3/09

PP#42 – MY05 – 11/3/09

PP#43 – MY05 – 11/3/09

PP#44 – MY05 – 11/3/09

Table 8a. Visual Morphological Stability Assessment
Project Number and Name: 29 – Benbow Park
Segment/Reach: Reach 1 (780 ft.)

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total Number per As-built *	Total Number / feet in unstable state	% Perform. in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	9	7		129%	
	2. Armor stable (e.g. no displacement)?	9	7		129%	
	3. Facet grade appears stable?	9	7		129%	
	4. Minimal evidence of embedding/fining?	9	7		129%	
	5. Length appropriate?	9	7		129%	**129%****
B. Pools	1. Present? (e.g. no severe aggradation)	14	10		140%	
	2. Sufficiently deep (Dmax pool:Mean Bkf > 1.6?)	14	10		140%	
	3. Length appropriate?	14	10		140%	**140%****
C. Thalweg #	1. Upstream of meander bend centering?					
	2. Downstream of meander centering?					
D. Meanders #	1. Outer bend in state of limited/controlled erosion?					
	formation?					
	3. Apparent Rc within spec?					
	4. Sufficient floodplain access and relief?					
E. Bed General	1.General channel bed aggradation areas (bar formation)			0/0	100%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting?			0/0	100%	**100%**
F. Bank	1.Actively eroding, wasting, or slumping bank			2/15	99%	**99%**
G. Vanes	1. Free of back or arm scour?	6	6		100%	
	2. Height appropriate?	6	6		100%	
	3. Angle and geometry appear appropriate?	6	6		100%	
	4. Free of piping or other structural failures?	6	6		100%	**100%**

*Total number of features per as-built estimated from as-built profile and planview sheets.

** The total number of features for Monitoring Year 5 is greater than the number of features in the as-built profile.

Reach 1 is not a meandering channel.

Table 8b. Qualitative Visual Stability Assessment
Project Number and Name: 29 – Benbow Park
Segment/Reach: Reach 2 (1,135 ft.)

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total Number per As-built *	Total Number / feet in unstable state	% Perform. in Stable Condition	Feature Perform. Mean or Total
A. Riffles**	1. Present?	9	7		129%	
	2. Armor stable (e.g. no displacement)?	8	7		114%	
	3. Facet grade appears stable?	5	7		71%	
	4. Minimal evidence of embedding/fining?	5	7		71%	
	5. Length appropriate?	9	7		129%	**103%**
B. Pools**	1. Present? (e.g. no severe aggradation)	23	14		164%	
	2. Sufficiently deep (Dmax pool:Mean Bkf > 1.6?)	23	14		164%	
	3. Length appropriate?	20	14		143%	**157%**
C. Thalweg	1. Upstream of meander bend centering?	4	6		67%	
	2. Downstream of meander centering?	4	6		67%	**67%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	7	7		100%	
	2. Of those eroding, # w/ concomitant point bar formation?				100%	
	3. Apparent Rc within spec?[#]		7			
	4. Sufficient floodplain access and relief?	6	7		86%	**95%**
E. Bed General	1.General channel bed aggradation areas (bar formation)			4/65	94%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting?			0/0	100%	**97%**
F. Bank	1.Actively eroding, wasting, or slumping bank			2/35	98%	**98%**
G. Vanes	1. Free of back or arm scour?	16	16		100%	
	2. Height appropriate?	16	16		100%	
	3. Angle and geometry appear appropriate?	16	16		100%	
	4. Free of piping or other structural failures?	16	16		100%	**100%**
H. Wads / Boulders	1. Free of scour?	6	6		100%	
	2. Footing stable?	6	6		100%	**100%**

*Total number of features per as-built estimated from as-built profile and planview sheets.

** The total number of features for monitoring year 5 is greater than the number of features in the as-built profile.

No design data is available to compare to current values.

Table 9. Verification of Bankfull Events
Project Number and Name: 29 - Benbow Park

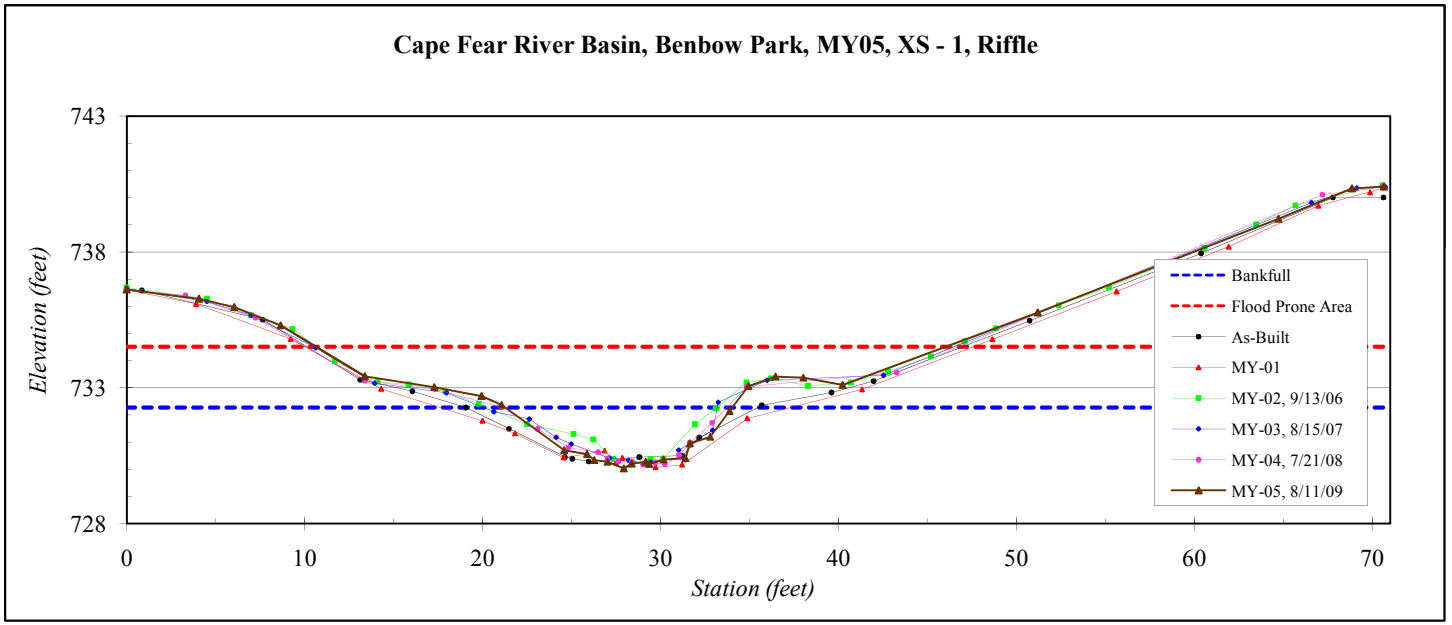
Date of Data Collection	Date of Occurence	Method	Photo Number
9/19/2006	9/18/2006	Site visit to evaluate indicators of stage after storm events	N/A
7/23/2008	4/29/2008	Crest Gauge	N/A
11/9/2009	8/29/2009	Evaluation of rainfall data	N/A
11/9/2009	6/5/2009	Evaluation of rainfall data	N/A

Cross-Section Plots

River Basin:	Cape Fear
Watershed:	Benbow Park, MY05
XS ID	XS - 1, Riffle
Drainage Area (sq mi):	0.7
Date:	8/11/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	736.62
4.1	736.28
6.0	735.97
8.6	735.29
13.4	733.43
17.3	733.02
19.9	732.70
21.1	732.37
24.6	730.70
25.9	730.57
26.3	730.33
27.0	730.28
27.9	730.03
28.4	730.21
29.2	730.28
29.4	730.19
30.2	730.36
31.4	730.41
31.6	730.95
32.8	731.20
33.9	732.14
34.9	733.06
36.5	733.41
38.0	733.38
40.2	733.10
51.2	735.77
64.7	739.22
68.9	740.34
70.6	740.41

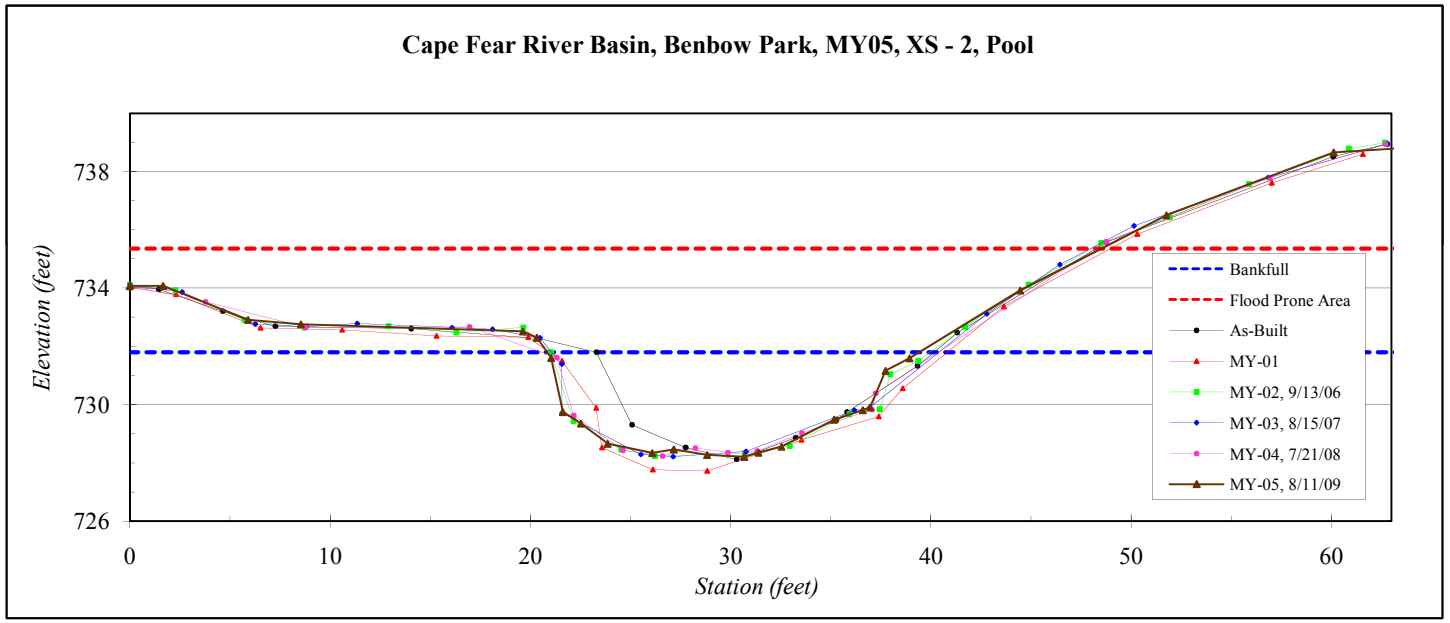
SUMMARY DATA	
Bankfull Elevation:	732.3
Bankfull Cross-Sectional Area:	18.5
Bankfull Width:	12.8
Flood Prone Area Elevation:	734.5
Flood Prone Width:	36
Max Depth at Bankfull:	2.2
Mean Depth at Bankfull:	1.4
W / D Ratio:	8.9
Entrenchment Ratio:	2.8
Bank Height Ratio:	1.0



River Basin:	Cape Fear
Watershed:	Benbow Park, MY05
XS ID	XS - 2, Pool
Drainage Area (sq mi):	0.7
Date:	8/11/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	734.08
1.7	734.08
5.9	732.92
8.5	732.76
19.6	732.52
20.3	732.30
21.0	731.61
21.6	729.75
22.5	729.36
23.9	728.66
26.1	728.34
27.2	728.47
28.8	728.27
30.7	728.21
31.4	728.36
32.5	728.56
35.2	729.49
36.6	729.81
37.0	729.91
37.7	731.16
38.9	731.60
44.5	733.92
51.8	736.51
60.1	738.66
66.7	738.95

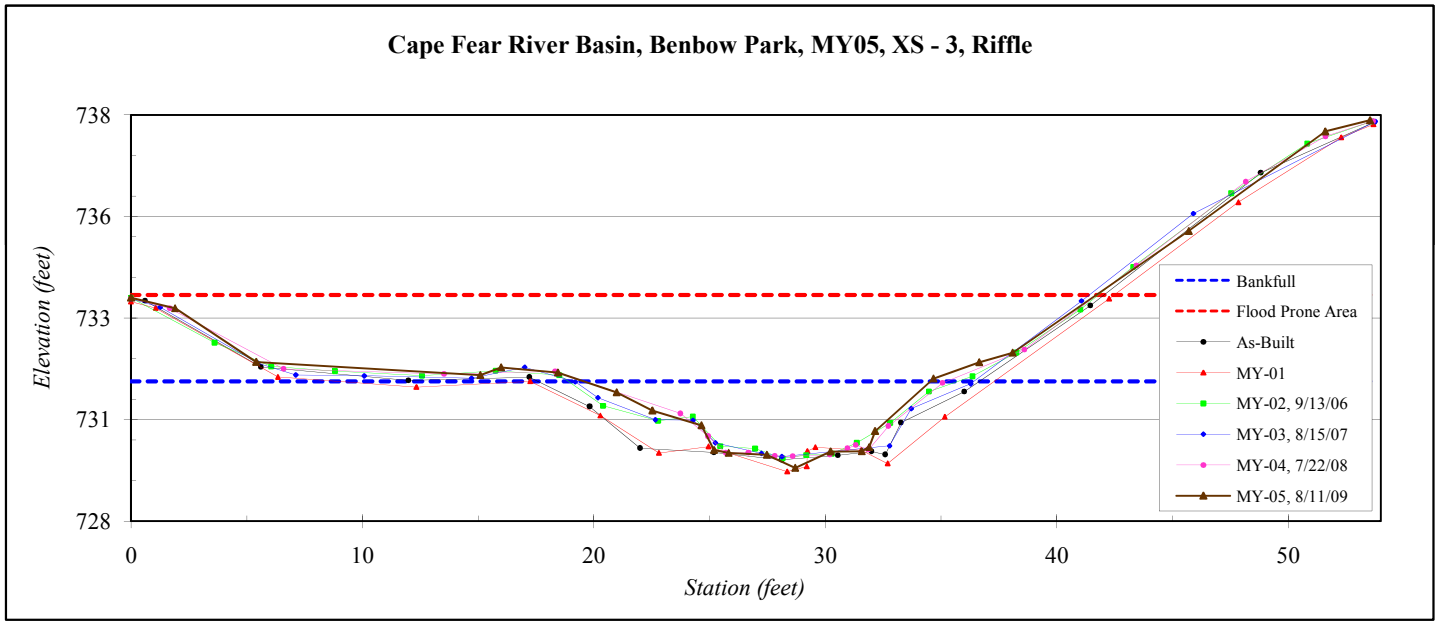
SUMMARY DATA	
Bankfull Elevation:	731.8
Bankfull Cross-Sectional Area:	48.7
Bankfull Width:	18.6
Flood Prone Area Elevation:	735.4
Flood Prone Width:	>50
Max Depth at Bankfull:	3.6
Mean Depth at Bankfull:	2.6
W / D Ratio:	7.1
Entrenchment Ratio:	>2.5
Bank Height Ratio:	1.2



River Basin:	Cape Fear
Watershed:	Benbow Park, MY05
XS ID	XS - 3, Riffle
Drainage Area (sq mi):	0.7
Date:	8/11/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	733.50
1.9	733.24
5.4	731.92
15.1	731.60
16.0	731.79
18.4	731.66
21.0	731.17
22.5	730.72
24.6	730.36
25.2	729.75
25.8	729.68
27.5	729.63
28.7	729.31
30.2	729.72
31.6	729.72
31.9	729.82
32.1	730.22
34.7	731.51
36.7	731.91
38.1	732.15
45.7	735.14
51.6	737.60
53.5	737.87

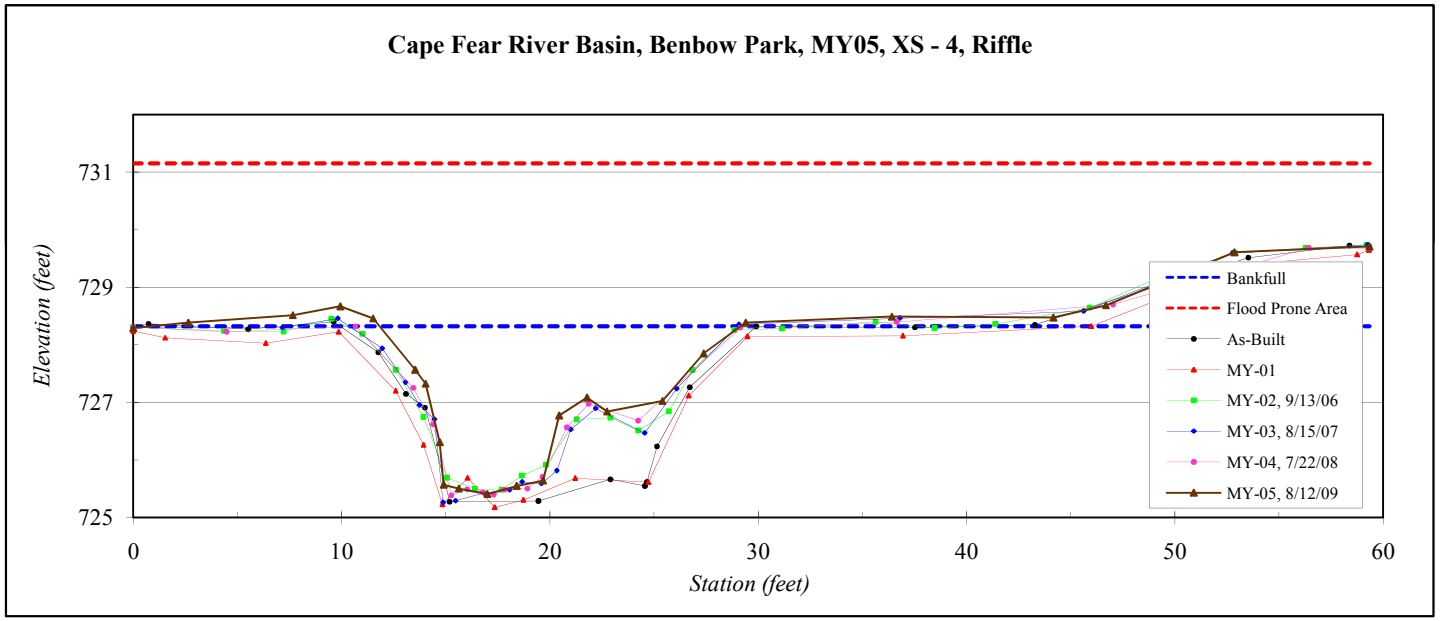
SUMMARY DATA	
Bankfull Elevation:	731.4
Bankfull Cross-Sectional Area:	17.7
Bankfull Width:	14.9
Flood Prone Area Elevation:	733.6
Flood Prone Width:	40
Max Depth at Bankfull:	2.1
Mean Depth at Bankfull:	1.2
W / D Ratio:	12.5
Entrenchment Ratio:	2.7
Bank Height Ratio:	1.0



River Basin:	Cape Fear
Watershed:	Benbow Park, MY05
XS ID	XS - 4, Riffle
Drainage Area (sq mi):	0.7
Date:	8/12/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	728.29
2.6	728.38
7.7	728.51
9.9	728.67
11.5	728.46
13.5	727.57
14.0	727.33
14.7	726.31
14.9	725.57
15.6	725.51
17.0	725.41
18.4	725.55
19.7	725.64
20.4	726.77
21.8	727.08
22.7	726.84
25.4	727.03
27.4	727.85
29.4	728.38
36.4	728.49
44.2	728.47
46.7	728.69
52.9	729.61
59.3	729.71

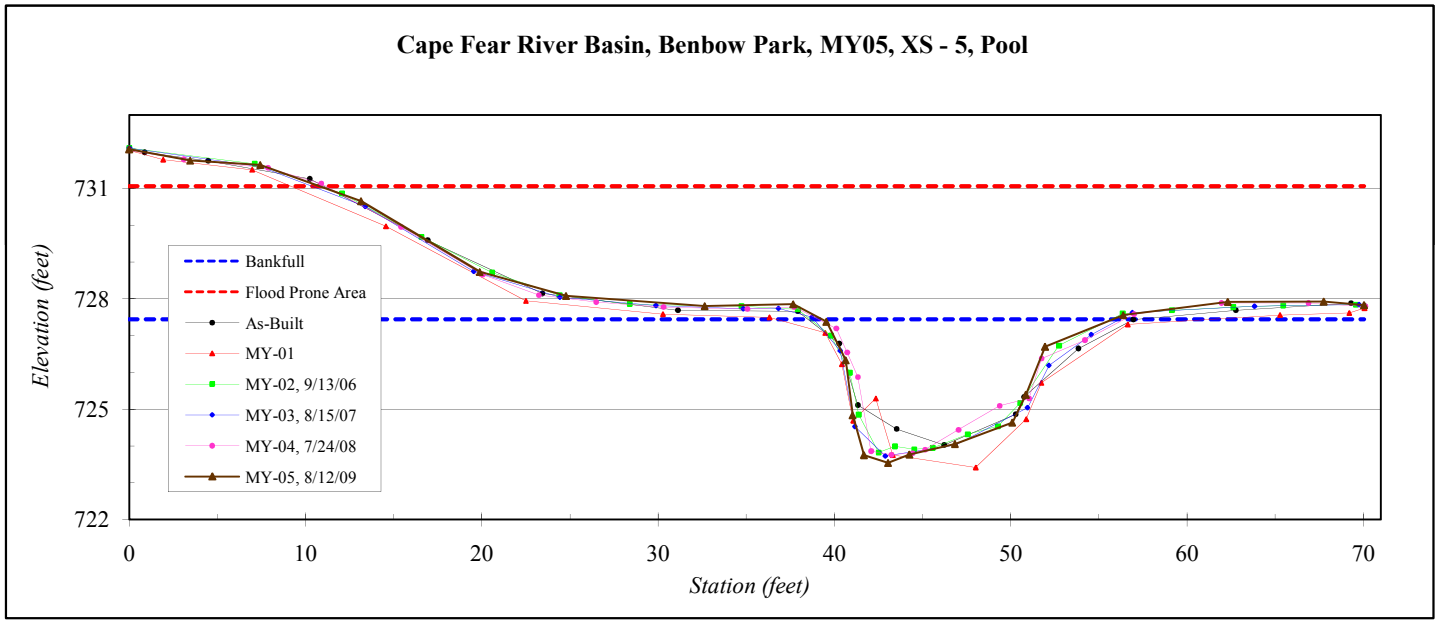
SUMMARY DATA	
Bankfull Elevation:	728.3
Bankfull Cross-Sectional Area:	26.6
Bankfull Width:	17.3
Flood Prone Area Elevation:	731.2
Flood Prone Width:	>60
Max Depth at Bankfull:	2.9
Mean Depth at Bankfull:	1.5
W / D Ratio:	11.3
Entrenchment Ratio:	>3.4
Bank Height Ratio:	1.0



River Basin:	Cape Fear
Watershed:	Benbow Park, MY05
XS ID	XS - 5, Pool
Drainage Area (sq mi):	0.7
Date:	8/12/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	732.07
3.5	731.76
7.4	731.64
13.1	730.66
19.9	728.73
24.8	728.08
32.6	727.81
37.7	727.85
39.5	727.38
40.6	726.33
41.0	724.84
41.7	723.76
43.0	723.54
44.3	723.77
46.8	724.06
50.1	724.64
50.9	725.39
52.0	726.70
56.4	727.56
62.3	727.92
67.8	727.93
70.0	727.83

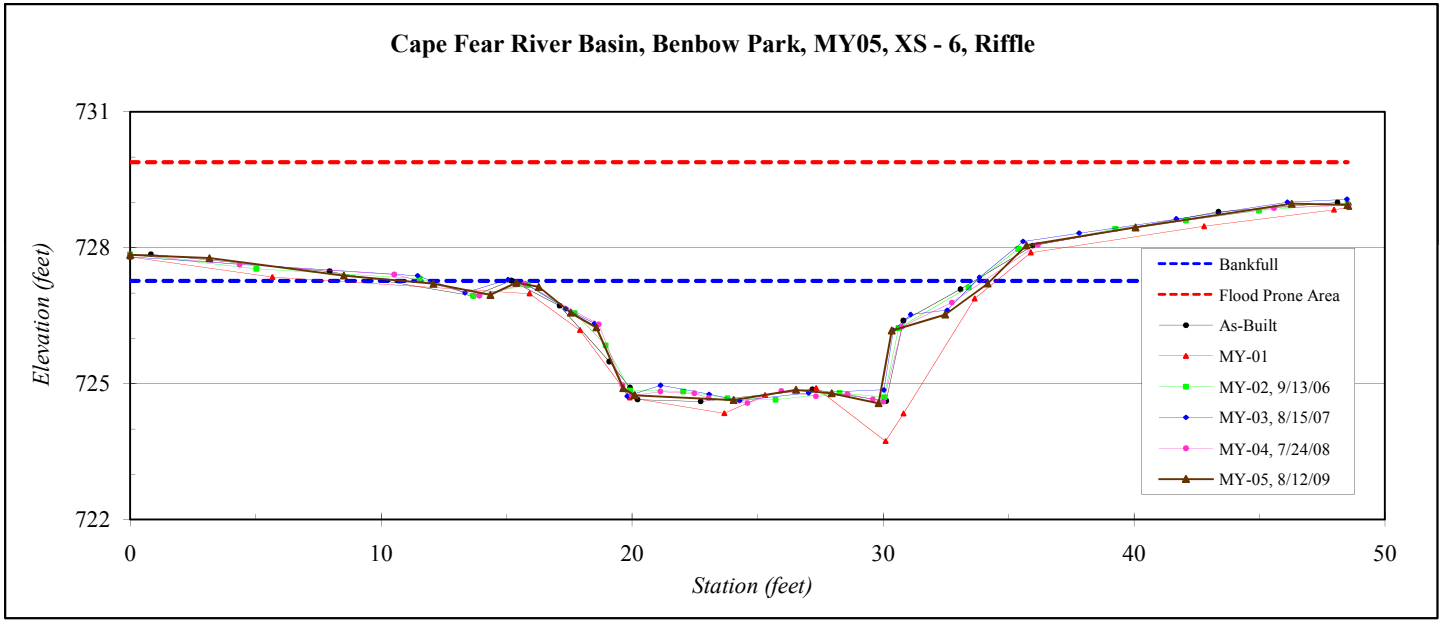
SUMMARY DATA	
Bankfull Elevation:	727.4
Bankfull Cross-Sectional Area:	37.1
Bankfull Width:	16.5
Flood Prone Area Elevation:	731.1
Flood Prone Width:	>60
Max Depth at Bankfull:	3.9
Mean Depth at Bankfull:	2.2
W / D Ratio:	7.3
Entrenchment Ratio:	>3.6
Bank Height Ratio:	1.0



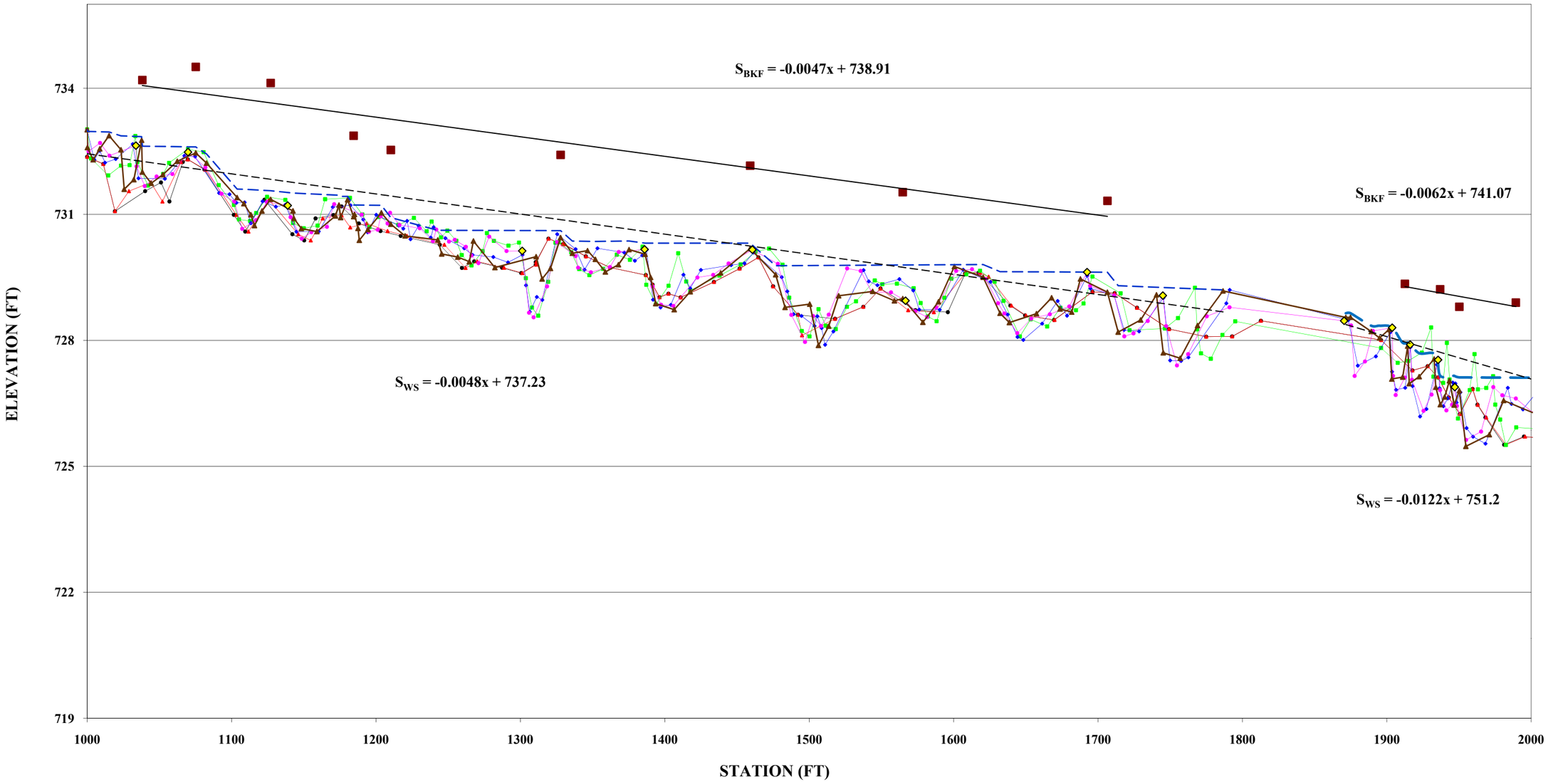
River Basin:	Cape Fear
Watershed:	Benbow Park, MY05
XS ID	XS - 6, Riffle
Drainage Area (sq mi):	0.7
Date:	8/12/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	727.84
3.2	727.77
8.5	727.39
12.1	727.21
14.4	726.96
15.4	727.23
16.3	727.14
17.6	726.57
18.6	726.24
19.7	724.90
20.1	724.75
24.0	724.64
26.5	724.87
28.0	724.79
29.8	724.57
30.4	726.17
32.5	726.53
34.2	727.21
35.7	728.06
40.1	728.45
46.3	728.97
48.5	728.94

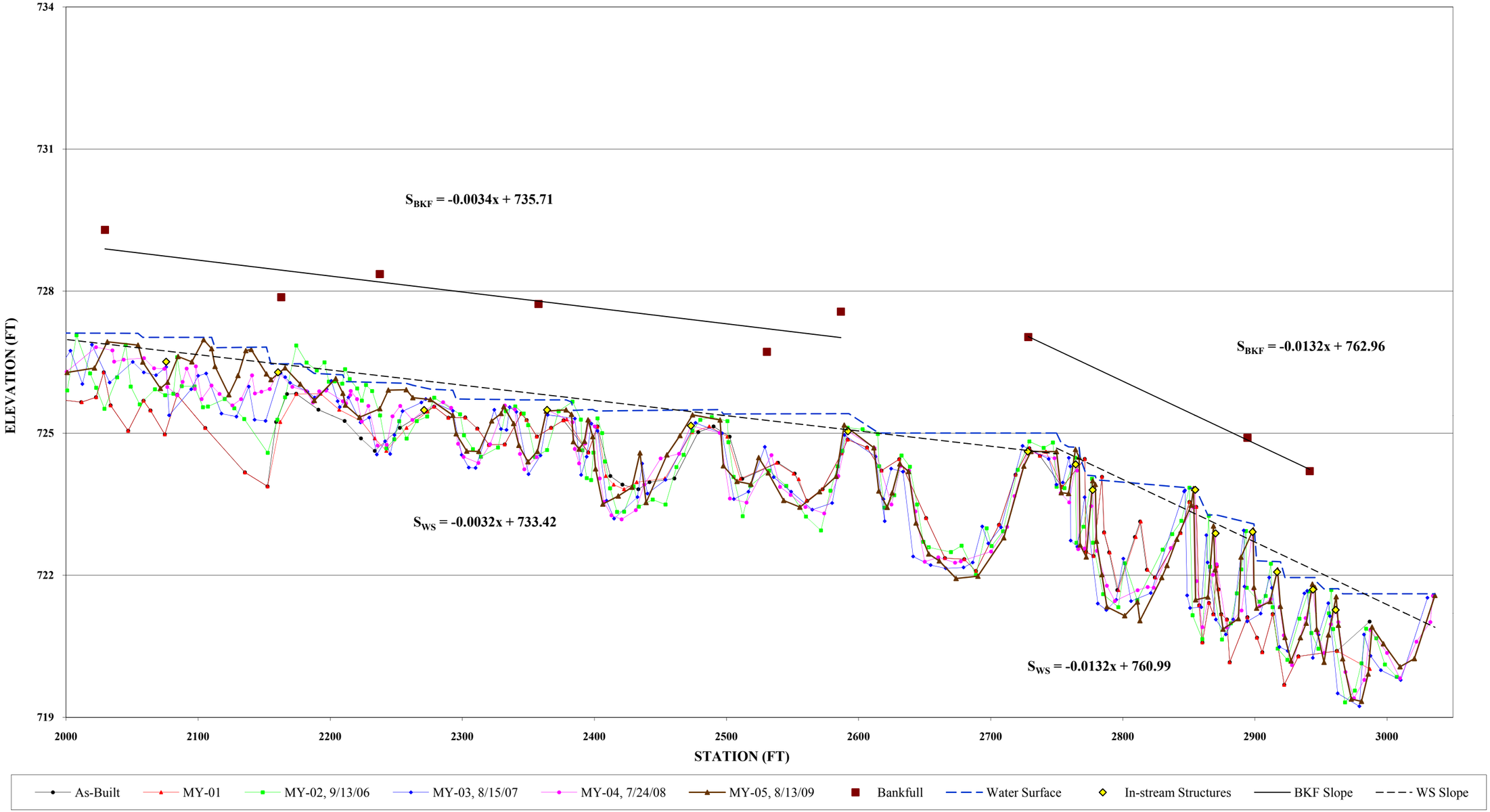
SUMMARY DATA	
Bankfull Elevation:	727.3
Bankfull Cross-Sectional Area:	32.8
Bankfull Width:	18.9
Flood Prone Area Elevation:	729.9
Flood Prone Width:	>50
Max Depth at Bankfull:	2.7
Mean Depth at Bankfull:	1.7
W / D Ratio:	10.9
Entrenchment Ratio:	>2.5
Bank Height Ratio:	1.0



Longitudinal Profile
Benbow Park
EEP Project Number 29 - MY05
Stations 10+00 - 20+00



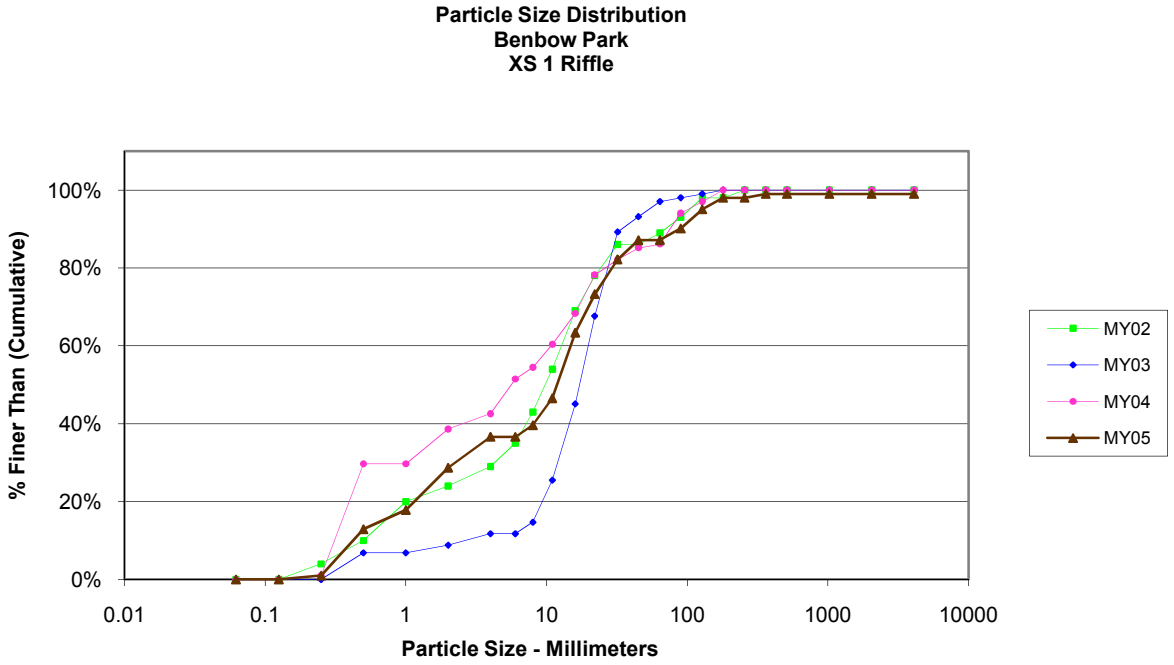
Longitudinal Profile
Benbow Park
EEP Project Number 29 - MY05
Stations 20+00 - 30+50



Pebble Count Plots

Cross-Section 1 Riffle - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	1
Medium	.25 - .50	N	12
Coarse	.50 - 1	D	5
Very Coarse	1 - 2	S	11
Very Fine	2 - 4		8
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	3
Medium	8 - 11.3	A	7
Medium	11.3 - 16	V	17
Coarse	16 - 22.6	E	10
Coarse	22.6 - 32	L	9
Very Coarse	32 - 45	S	5
Very Coarse	45 - 64		
Small	64 - 90	C	3
Small	90 - 128	O	5
Large	128 - 180	B	3
Large	180 - 256	L	
Small	256 - 362	B	1
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	100

Note:



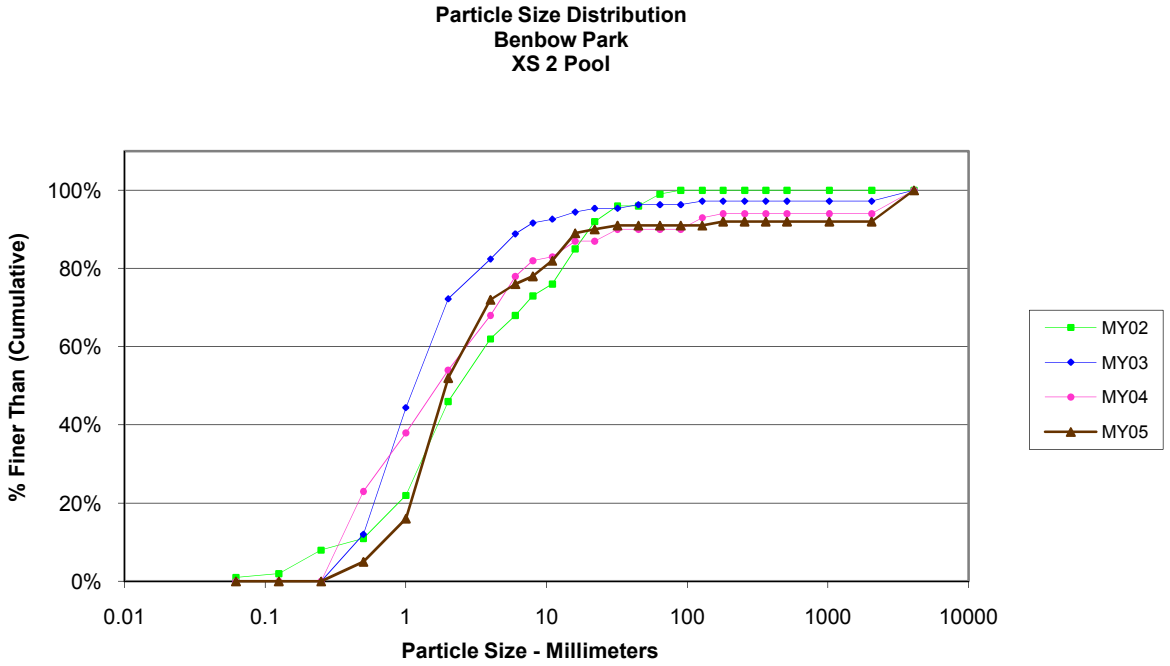
Size (mm)	
D16	0.76
D35	3.4
D50	12
D65	17
D84	34
D95	120

Size Distribution	
mean	5.1
dispersion	9.3
skewness	-0.29

Type	
silt/clay	0%
sand	29%
gravel	59%
cobble	11%
boulder	1%
bedrock	
hardpan	
wood/det	
artificial	

Cross-Section 2 Pool - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	5
Coarse	.50 - 1	D	11
Very Coarse	1 - 2	S	36
Very Fine	2 - 4		20
Fine	4 - 5.7	G	4
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	4
Medium	11.3 - 16	V	7
Coarse	16 - 22.6	E	1
Coarse	22.6 - 32	L	1
Very Coarse	32 - 45	S	
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	1
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	8
		Total	100

Note:



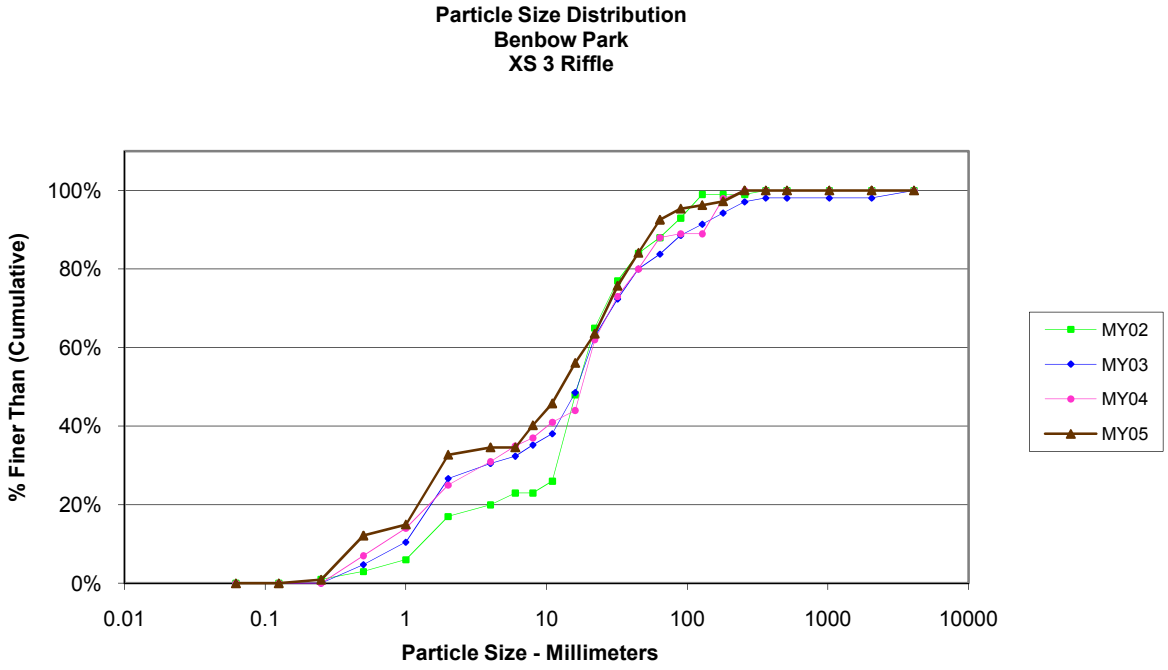
Size (mm)	
D16	0.92
D35	1.4
D50	1.8
D65	2.6
D84	7.2
D95	15

Size Distribution	
mean	2.6
dispersion	3.0
skewness	0.16

Type	
silt/clay	0%
sand	52%
gravel	39%
cobble	1%
boulder	0%
bedrock	8%
hardpan	
wood/det	
artificial	

Cross-Section 3 Riffle - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	1
Medium	.25 - .50	N	12
Coarse	.50 - 1	D	3
Very Coarse	1 - 2	S	19
Very Fine	2 - 4		2
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	6
Medium	8 - 11.3	A	6
Medium	11.3 - 16	V	11
Coarse	16 - 22.6	E	8
Coarse	22.6 - 32	L	13
Very Coarse	32 - 45	S	9
Very Coarse	45 - 64		9
Small	64 - 90	C	3
Small	90 - 128	O	1
Large	128 - 180	B	1
Large	180 - 256	L	3
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	107

Note:



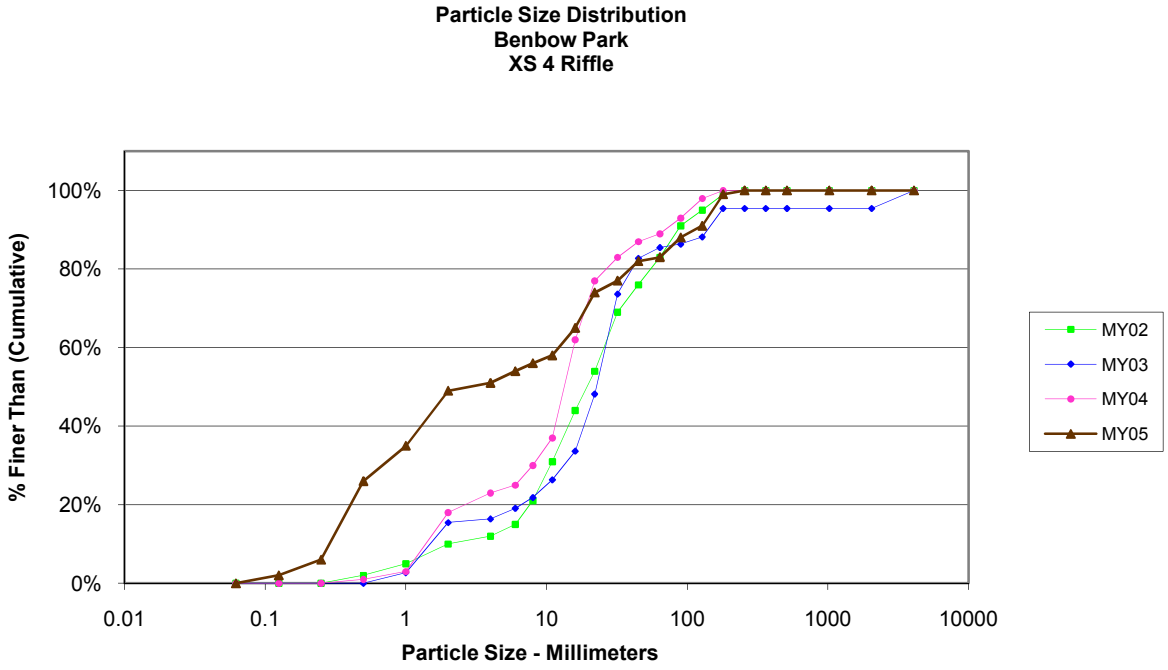
Size (mm)	
D16	1
D35	6.1
D50	13
D65	23
D84	45
D95	86

Size Distribution	
mean	6.7
dispersion	8.2
skewness	-0.22

Type	
silt/clay	0%
sand	33%
gravel	60%
cobble	7%
boulder	0%
bedrock	
hardpan	
wood/det	
artificial	

Cross-Section 4 Riffle - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	2
Fine	.125 - .25	A	4
Medium	.25 - .50	N	20
Coarse	.50 - 1	D	9
Very Coarse	1 - 2	S	14
Very Fine	2 - 4		2
Fine	4 - 5.7	G	3
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	2
Medium	11.3 - 16	V	7
Coarse	16 - 22.6	E	9
Coarse	22.6 - 32	L	3
Very Coarse	32 - 45	S	5
Very Coarse	45 - 64		1
Small	64 - 90	C	5
Small	90 - 128	O	3
Large	128 - 180	B	8
Large	180 - 256	L	1
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	100

Note:



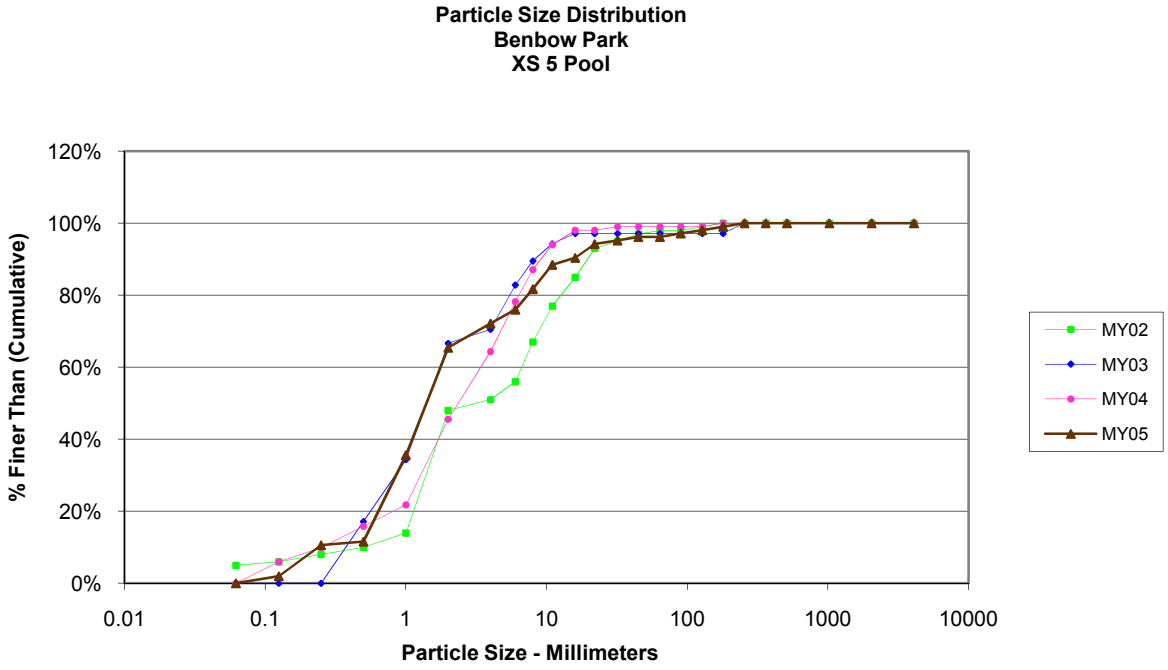
Size (mm)	
D16	0.35
D35	1
D50	2.8
D65	16
D84	69
D95	150

Size Distribution	
mean	4.9
dispersion	16.3
skewness	0.16

Type	
silt/clay	0%
sand	49%
gravel	34%
cobble	17%
boulder	0%
bedrock	
hardpan	
wood/det	
artificial	

Cross-Section 5 Pool - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	2
Fine	.125 - .25	A	9
Medium	.25 - .50	N	1
Coarse	.50 - 1	D	25
Very Coarse	1 - 2	S	31
Very Fine	2 - 4		7
Fine	4 - 5.7	G	4
Fine	5.7 - 8	R	6
Medium	8 - 11.3	A	7
Medium	11.3 - 16	V	2
Coarse	16 - 22.6	E	4
Coarse	22.6 - 32	L	1
Very Coarse	32 - 45	S	1
Very Coarse	45 - 64		
Small	64 - 90	C	1
Small	90 - 128	O	1
Large	128 - 180	B	1
Large	180 - 256	L	1
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	104

Note:



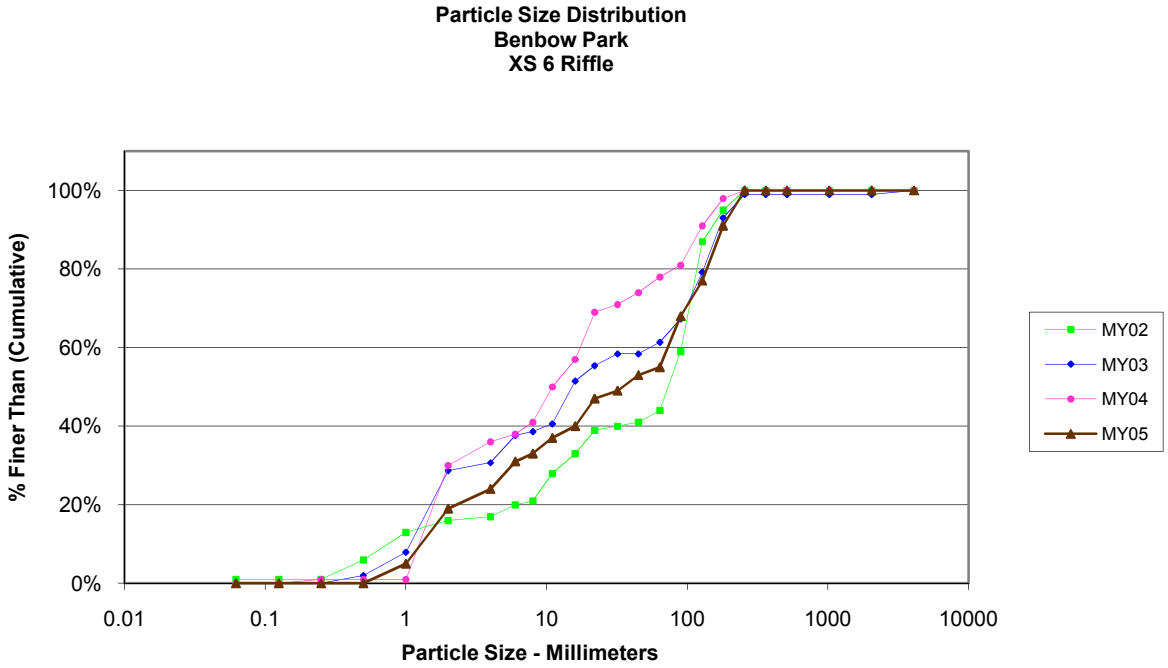
Size (mm)	
D16	0.57
D35	0.98
D50	1.4
D65	2
D84	8.9
D95	30

Size Distribution	
mean	2.3
dispersion	4.4
skewness	0.19

Type	
silt/clay	0%
sand	65%
gravel	31%
cobble	4%
boulder	0%
bedrock	
hardpan	
wood/det	
artificial	

Cross-Section 6 Riffle - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	
Coarse	.50 - 1	D	5
Very Coarse	1 - 2	S	14
Very Fine	2 - 4		5
Fine	4 - 5.7	G	7
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	4
Medium	11.3 - 16	V	3
Coarse	16 - 22.6	E	7
Coarse	22.6 - 32	L	2
Very Coarse	32 - 45	S	4
Very Coarse	45 - 64		2
Small	64 - 90	C	13
Small	90 - 128	O	9
Large	128 - 180	B	14
Large	180 - 256	L	9
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	100

Note:



Size (mm)	
D16	1.7
D35	9.4
D50	35
D65	83
D84	150
D95	210

Size Distribution	
mean	16.0
dispersion	12.4
skewness	-0.24

Type	
silt/clay	0%
sand	19%
gravel	36%
cobble	45%
boulder	0%
bedrock	
hardpan	
wood/det	
artificial	