

**Benbow Park Stream Restoration
Monitoring Report
EEP Project # 29
Monitoring Year – 02
2006**



Submitted to:



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

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Monitoring Firm



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EXECUTIVE SUMMARY

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 mi² watershed is located within USGS 14-digit HUC 03030002020050 and NCDWQ Sub-basin 03-06-02 of the Cape Fear River Basin. The initial planning proposed to restore approximately 2,060 linear feet of channel, 780 feet upstream of South Benbow Road and 1,280 feet downstream of South Benbow Road. The design was developed to address vertical instability (incision) problems and lack of bed variability. The restoration plan called for correcting these problems by stabilizing stream banks, installing in-stream structures, adjusting stream planform, and clearing and replanting the riparian areas with native vegetation. Project construction occurred in 2004. This report is a description of the findings of the second year monitoring that took place in 2006.

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 monitoring period. The EEP requested that the site be monitored using the new vegetation protocol. Five new plots were established for the second monitoring year, and the previous monitoring plots were discontinued. The five plots were surveyed and the corners marked with metal conduit for future monitoring. The second year monitoring counted an average of 647 stems per acre. The buffer along Reach 1 has numerous mimosa (*Albizia julibrissin*) and ornamental pear (*Pyrus calleryana*) volunteers, which may warrant manual control if the prolific growth continues. The second year monitoring found the vegetation component of the project to be successful.

The stream assessment completed during the first year monitoring found the stream to be functioning for the majority of the project. Channel dimensions have not changed drastically from the designed conditions over the course of the stream. The stream has experienced localized widening between stations 14+80 to 15+20 and 21+10 to 21+30. This widening is a product of eroding banks in these areas. Some channel narrowing has occurred where the stream has aggraded; specifically between stations 21+30 to 21+80, 22+50 to 22+80, and 23+45 to 23+75. These aggradation/bank erosion issues are detailed in the following report and should be monitored to determine if repairs are warranted. The majority of the in-stream structures are functioning with minimal problems.

1.0 PROJECT BACKGROUND

1.1 Project Objectives

- 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).

1.2 Project Structure, Restoration Type, and Approach

A previously incised channel through Benbow Park was restored using channel dimension, pattern, and profile modifications and the establishment of a vegetated riparian zone adjacent to the creek. Channel profile is maintained through the use of rock cross vanes and constructed riffles. Channel pattern is maintained through the use of cross vanes, single vanes, root wads, J-hooks, and vegetation along the channel banks.

1.3 Location and Setting

Benbow Park is located within the city limits of Greensboro, North Carolina. The landuse of the 0.7-mi² watershed is urban residential with small pockets of industrial/commercial development. The watershed is completely built out with little potential for future development.

1.4 Project History and Background

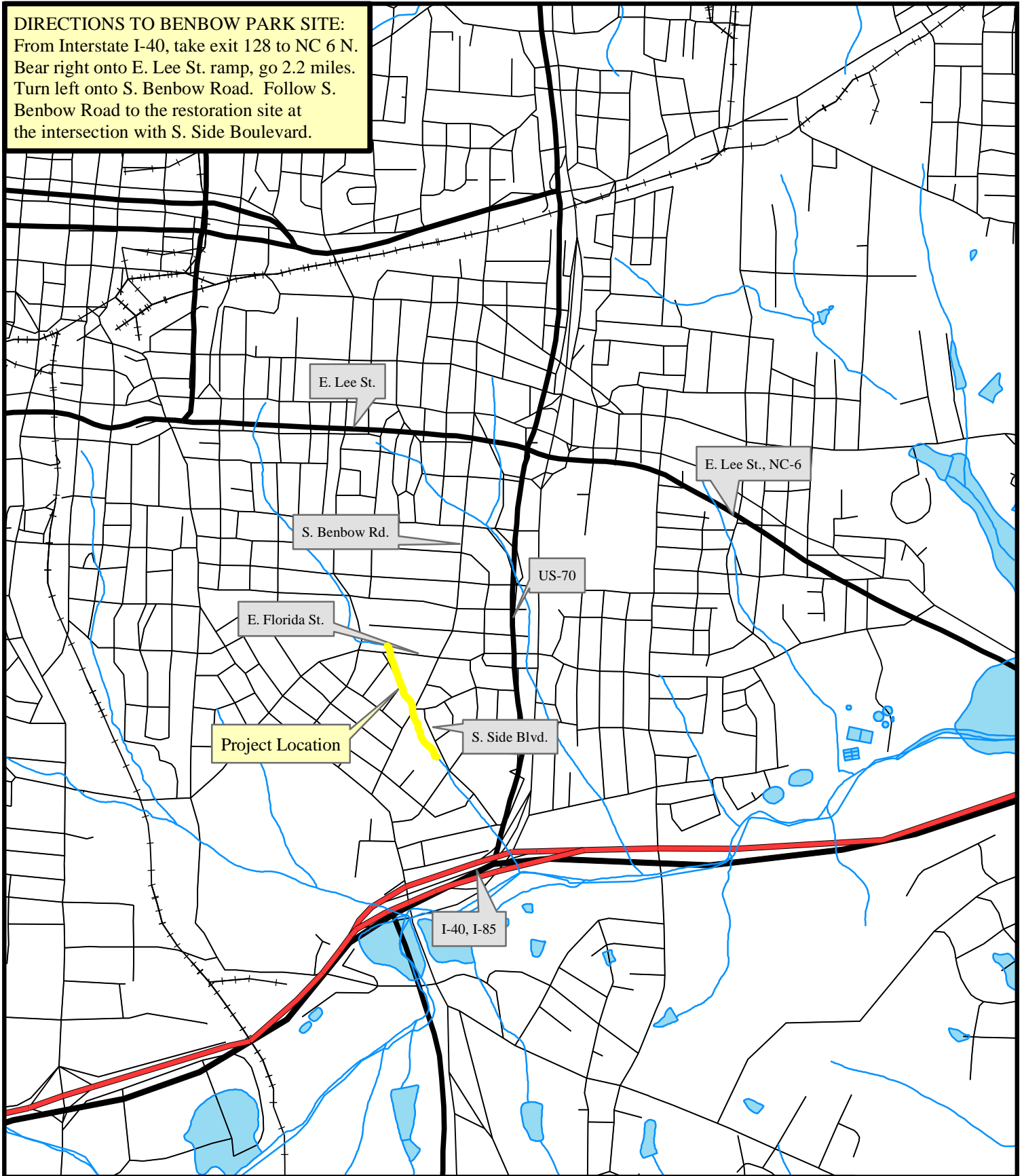
Table 1. Project Mitigation Structure and Objectives								
Project Number and Name: 29 - Benbow Park								
Segment/ Reach ID	Existing Linear Feet	Type	Approach	Linear Feet	Mitigation Ratio	Mitigation Units	Stationing	Comment
Reach 1	780	R	P2/3	780	1.0	780	10+00 - 17+80	
Reach 2	972	R	P1	1,280	1.0	1,280	18+50 - 31+30	
Mitigation Unit Summations								
Stream (lf)	Riparian Wetland (Ac)	Nonriparian Wetland (Ac)	Total Wetland (Ac)	Buffer (Ac)	Comment			
2,060								

R = Restoration

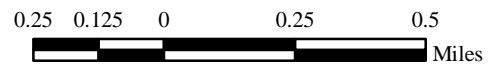
P2/3 = Combination of Priority II and III

P1 = Priority I

DIRECTIONS TO BENBOW PARK SITE:
From Interstate I-40, take exit 128 to NC 6 N.
Bear right onto E. Lee St. ramp, 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 - MY02**



Date: 01/02/07



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		
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 07
Year 2 Monitoring	Sep 06	Jan 07

Table 3. Project Contact 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	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 783-9214 Fax: (919) 783-9266

Table 4. Project Background Table	
Project Number and Name: 29 – Benbow Park	
Project County	Guilford County
Drainage Area	0.7 mi ²
Drainage Impervious Cover Estimate (%)	N/A
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 miles upstream of the listed stream, S. Buffalo Creek.
Reasons for 303d Listing or Stressor	S. Buffalo Creek 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 and are no longer in the proper positions

2.0 PROJECT CONDITIONS AND MONITORING RESULTS

2.1 Vegetation Assessment

See vegetation assessment in Appendix A.

2.1.1 Vegetative Problem Areas

See Table A6. Vegetative Problem Areas in Appendix A.

2.1.2 Vegetative Problem Area Plan View

See Vegetative Problem Area Plan View in Appendix A.

2.2 Stream Assessment

2.2.1 Bankfull Event and Stability Assessment

2.2.1.a Verification of Bankfull Events Table

Table 5. Verification of Bankfull Events			
Project Number and Name: 29 - Benbow Park			
Date of Data Collection	Date of Occurance	Method	Photo Number
9/19/06	9/18/06	Site visit to evaluate indicators of stage after storm event	

2.2.1.b BEHI and Sediment Export Table

Table 6. BEHI and Sediment Export Estimates
Project Number and Name: 29 - Benbow Park
To Be Conducted During Monitoring Year 05

2.2.2 Stream Problem Areas

See Stream Problem Areas Table, Plan View, and Photos in Appendix B.

2.2.3 Stability Assessment Table

Table 7a. Categorical Stream Feature Visual Stability Assessment						
Project Number and Name: 29 – Benbow Park						
Segment/Reach: Reach 1 (780 ft.)						
Feature	Initial	MY - 01	MY - 02	MY - 03	MY - 04	MY - 05
A. Riffles	100%	N/A	109%			
B. Pools	100%	N/A	133%			
C. Thalweg*	N/A	N/A	N/A			
D. Bed General	100%	N/A	96%			
E. Bank Condition	100%	N/A	87%			
F. Vanes / J Hooks etc	100%	N/A	100%			

*Reach 1 is not a meandering channel

Table 7b. Categorical Stream Feature Visual Stability Assessment						
Project Number and Name: 29 – Benbow Park						
Segment/Reach: Reach 2 (1,135 ft.)						
Feature	Initial	MY - 01	MY - 02	MY - 03	MY - 04	MY - 05
A. Riffles	100%	N/A	80%			
B. Pools	100%	N/A	102%			
C. Thalweg	100%	N/A	67%			
D. Meanders	100%	N/A	53%			
E. Bed General	100%	N/A	96%			
F. Bank Condition	100%	N/A	96%			
G. Vanes / J Hooks etc.	100%	N/A	100%			
H. Wads and Boulders	100%	N/A	92%			

2.2.4 Quantitative Measures Summary Tables

Table 8a. Baseline Morphology and Hydraulic Summary																			
Project Number and Name: 29 – Benbow Park																			
Segment Reach: Reach 1 (780 ft.)																			
Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built			
	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	
Bankfull Width (ft)																16.4	20.3	18.4	
Floodprone Width (ft)																35	38	36.5	
Bankfull Cross Sectional Area (ft ²)																20.3	20.5	20.4	
Bankfull Mean Depth (ft)																1.2	1.3	1.25	
Bankfull Maximum Depth (ft)																2.0	1.7	1.85	
Width/Depth Ratio																13.1	15.1	14.1	
Entrenchment Ratio																2.2	2.2	2.2	
Bank Height Ratio																1.0	1.0	1.0	
Wetted Perimeter (ft)																			
Hydraulic Radius (ft)																			
Pattern																			
Channel Beltwidth (ft)																			
Radius of Curvature (ft)																			
Meander Wavelength (ft)																			
Meander Width Ratio																			
Profile																			
Riffle Length (ft)																			
Riffle Slope (ft/ft)																			
Pool Length (ft)																			
Pool Spacing (ft)																			
Substrate																			
d50 (mm)																			
d84 (mm)																			
Additional Reach Parameters																			
Valley Length (ft)																			
Channel Length (ft)																			
Sinuosity																			
Water Surface Slope (ft/ft)																			
BF Slope (ft/ft)																			
Rosgen Classification																		B5c	

Table 8b. Baseline Morphology and Hydraulic Summary

Project Number and Name: 29 – Benbow Park

Segment Reach: Reach 2 (1,135 ft.)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Dimension																		
Bankfull Width (ft)																18.5	20	19.3
Floodprone Width (ft)																49	59	54
Bankfull Cross Sectional Area (ft ²)																33.2	38.1	35.7
Bankfull Mean Depth (ft)																1.8	1.9	1.85
Bankfull Maximum Depth (ft)																2.7	3.0	2.85
Width/Depth Ratio																10.3	10.4	10.4
Entrenchment Ratio																2.7	3.0	2.85
Bank Height Ratio																1.0	1.0	1.0
Wetted Perimeter (ft)																		
Hydraulic Radius (ft)																		
Pattern																		
Channel Beltwidth (ft)																		
Radius of Curvature (ft)																		
Meander Wavelength (ft)																		
Meander Width Ratio																		
Profile																		
Riffle Length (ft)																		
Riffle Slope (ft/ft)																		
Pool Length (ft)																		
Pool Spacing (ft)																		
Substrate																		
d50 (mm)																		
d84 (mm)																		
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		
Sinuosity																		
Water Surface Slope (ft/ft)																		
BF Slope (ft/ft)																		
Rosgen Classification																		E5

Table 9a. Morphology and Hydraulic Monitoring Summary**Project Number and Name: 29 – Benbow Park****Segment Reach: Reach 1 (780 ft.)**

Parameter	Cross Section 1 Riffle						Cross Section 2 Pool						Cross Section 3 Riffle					
	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	15.4	12.9					18.7	18.9					20	16.8				
Floodprone Width (ft)	35	34					49	48					39	40.7				
Bankfull Cross Sectional Area (ft ²)	16.7	13.6					47.4	49.8					26.9	18.4				
Bankfull Mean Depth (ft)	1.1	1.1					2.5	2.6					1.3	1.1				
Bankfull Maximum Depth (ft)	1.8	1.9					3.8	3.6					2.2	1.9				
Width/Depth Ratio	14.1	12.2					7.4	7.2					14.9	15.3				
Entrenchment Ratio	2.1	2.6					2.6	2.5					2.1	2.4				
Bank Height Ratio	1.0	1.0					1.0	1.0					1.0	1.0				
Wetted Perimeter (ft)		13.8						21.8						15.4				
Hydraulic Radius (ft)		1.0						2.3						1.0				
Substrate																		
d50 (mm)		9.8						2.4						16.6				
d84 (mm)		29						15						45				

Table 9b. Morphology and Hydraulic Monitoring Summary**Project Number and Name: 29 – Benbow Park****Segment Reach: Reach 2 (1,135 ft.)**

Parameter	Cross Section 4 Riffle						Cross Section 5 Pool						Cross Section 6 Riffle					
	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	20.0	20.9					18.9	17.2					18.5	17.9				
Floodprone Width (ft)	59	59.5					59	59.1					49	48.5				
Bankfull Cross Sectional Area (ft ²)	36.1	29.9					40.0	36.4					35.0	32.2				
Bankfull Mean Depth (ft)	1.9	1.4					2.1	2.1					1.9	1.8				
Bankfull Maximum Depth (ft)	2.9	2.8					3.9	3.6					3.3	2.6				
Width/Depth Ratio	10.4	14.6					8.9	8.1					9.3	10.0				
Entrenchment Ratio	3.1	2.8					3.3	3.4					2.7	2.7				
Bank Height Ratio	1.0	1.0					1.0	1.0					1.0	1.0				
Wetted Perimeter (ft)		22.3						19.6						19.9				
Hydraulic Radius (ft)		1.3						1.9						1.6				
Substrate																		
d50 (mm)		19.4						3.2						73.4				
d84 (mm)		67						15						123				

Table 9c. Morphology and Hydraulic Monitoring Summary continued																
Project Number and Name: 29 - Benbow Park																
Segment Reach: Reach 1 (780 ft.)																
Parameter	MY - 01 (2005)			MY - 02 (2006)			MY - 03 (2007)			MY - 04 (2008)			MY - 05 (2009)			
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	
Channel Beltwidth (ft)				17	37	25										
Radius of Curvature (ft)				-	-	-										
Meander Wavelength (ft)				-	-	-										
Meander Width Ratio				1.1	2.5	1.7										
Profile																
Riffle Length (ft)				9	53	19										
Riffle Slope (ft/ft)				0.001	0.030	0.014										
Pool Length (ft)				12	55	19										
Pool Spacing (ft)				28	117	47										
Additional Reach Parameters																
Valley Length (ft)					772											
Channel Length (ft)					800											
Sinuosity					1.01											
Water Surface Slope (ft/ft)					0.006											
Rosgen Classification					B5c											

Table 9d. Morphology and Hydraulic Monitoring Summary continued																
Project Number and Name: 29 - Benbow Park																
Segment Reach: Reach 2 (1,135 ft.)																
Parameter	MY - 01 (2005)			MY - 02 (2006)			MY - 03 (2007)			MY - 04 (2008)			MY - 05 (2009)			
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	
Channel Beltwidth (ft)				36	111	82										
Radius of Curvature (ft)				36	120	47										
Meander Wavelength (ft)				151	228	183										
Meander Width Ratio				1.8	5.6	4.1										
Profile																
Riffle Length (ft)				9	23	13										
Riffle Slope (ft/ft)				0.001	0.033	0.018										
Pool Length (ft)				3	118	25										
Pool Spacing (ft)				10	187	43										
Additional Reach Parameters																
Valley Length (ft)					934											
Channel Length (ft)					1150											
Sinuosity					1.23											
Water Surface Slope (ft/ft)					0.006											
Rosgen Classification					E5											

Click on the Desired Link Below

Appendix A

Appendix B1

Appendix B2