Benbow Park
Stream Restoration
Closeout Summary Report
EEP Project # 29
2010

Submitted to:

Ecosystem Enhancement PROGRAM

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

April 2010

Prepared By

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KCI Project No: 12071067B_BP

Project ID & Status	
Project Name and Number:	Benbow Park
EEP ID:	29
County:	Guilford
Project Type:	Stream Restoration
Current Status:	5 Years of Monitoring Complete

Project Setting & Background	
Basin	Cape Fear
Physiographic Region	Piedmont
Ecoregion	Southern Outer Piedmont
USGS 8-digit HUC	03030002
NCDWQ Subbasin	03-06-02
Drainage Area	0.7 mi^2
Impervious Cover	61%
Thermal Regime	warm
Trout Water	no
Designer	Buck Engineering
Monitoring Firm	KCI Assoc. of NC

Project Timeline	
Milestone	**Date**
Restoration Plan	Jun 2002
Permits	Jun 2002
Construction Completed	Aug 2004
As-Built Report	Jun 2005
Monitoring Year-1	Dec 2005
Monitoring Year-2	Sep 2006
Monitoring Year-3	Aug 2007
Monitoring Year-4	Jul 2008
Monitoring Year-5	Aug 2009

Table 1. Project Restoration Components and Mitigation Assets
Project Number and Name: 29 - Benbow Park

Hydrology Component	Restoration Component	Asset Map #	Approach	Level	Ratio	Ratio Multiplier	Linear Feet	SMU	P/I/E
UT South Buffalo Creek	Reach 1	1	P2/3	R	1.0	1.00	780	780	P
	Reach 2	2	P1	R	1.0	1.00	1,098	1,098	P

P1 = Priority 1
P2/3 = Combination of Priority 2 and 3
SMU = Stream Mitigation Units
R = Restoration
P/I/E = Perennial / Intermittent / Ephemeral

Note: The project restored a total of 1,913 feet, 780 feet above South Benbow Road (Reach 1) and 1,133 feet below the road (Reach 2). This excludes any footage that exists in a culverted crossing. The creditable footage for Reach 2 was reduced by 35 feet to 1,098 to account for utility crossings and city infrastructure maintenance zones that require the buffer to be managed to the top of bank. These areas were the subject of stream work and total approximately 70 feet. The buffer and the stream were each considered half the asset value and due to the absence of buffer in these areas the total creditable footage (70 feet) was cut in half and subtracted from the reach total (1,133 – 35 = 1,098) for crediting.

Table 2. Asset Summary
Project Number and Name: 29 - Benbow Park

Level	Feet	SMU
Restoration	1,878	1,878
Total	**1,878**	**1,878**

Project Background and Summary

The Benbow Park Mitigation Site was developed by the North Carolina Wetlands Restoration Program / Ecosystem Enhancement Program in cooperation with the City of Greensboro. The early project documents (Restoration Plan and As-Built Report) were grouped with three other stream restoration projects (Brown Bark Park, Gillespie Golf Course, and Hillsdale Park) as a part of the Buffalo Creek Watershed Restoration. The project is located on an Unnamed Tributary to South Buffalo Creek. The project restored a total of 1,913 feet, 780 feet above South Benbow Road (Reach 1) and 1,133 feet below the road (Reach 2). This excludes any footage that exists in a culverted crossing. The creditable footage for Reach 2 was reduced by 35 feet to 1,098 to account for utility crossings and city infrastructure maintenance zones that require the buffer to be managed to the top of bank. These areas were the subject of stream work and total approximately 70 feet. The buffer and the stream were each considered half the asset value and due to the absence of buffer in these areas the total creditable footage (70 feet) was cut in half and subtracted from the reach total (1,133 – 35 = 1,098) for crediting. Prior monitoring reports indicated that Reach 1 was Enhancement I, which was the result of applying the 2003 Stream Guidelines to the sections for which pattern was not altered. However, given the B stream target for these areas and the fact that these projects were permitted prior to the guidelines, Reach 1 is offered as restoration for closure.

Except for piped stormwater outfalls, this stream is the only hydrologic feature of the project. The existing channel exhibited varying degrees of incision (Bank Height Ratios of 1.2 to 1.8), had been historically channelized, and was actively widening. The stormwater outfalls were unstable and contributed to channel and bank instability. The project design utilized reference data from three reference reaches in the North Carolina Piedmont physiographic province. The restoration of Reach 1 aimed to create a stable channel at the existing stream elevation by creating a bankfull bench feature and installing stream structures to maintain grade, protect bank, and provide improved riffle/pool habitat. The restoration along Reach 2 used similar methods while also realigning the formerly channelized stream, creating distinct meanders and the appropriate bedform for the restored channel pattern. The elevation of the stream was also set to partially reconnect the stream to the historical floodplain. A series of grade control cross vanes lower the stream to the culvert elevation at the end of the project. Throughout the project stormwater outlets were stabilized with structures to eliminate channel erosion. The existing vegetation along the stream was mixed; some areas had no vegetation, while others had narrow riparian buffers comprised of mostly invasive species. The buffers of the project have since been planted with native trees and shrubs in order to provide bank stabilization, riparian habitat and shade for the channel.

Goals and 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).

Success Criteria

Morphological

- There should be little to no change in as-built cross-sections. If changes do take place they should be evaluated to determine if they represent a movement toward a more unstable condition or are minor changes that represent an increase in stability.
- The longitudinal profiles should show that the bedform features are remaining stable (not aggrading or degrading). Short term aggradation/degradation may occur, depending on the peak annual discharge. The gravel bed pools should remain deep with flat water surface slopes and the riffles should remain steeper and shallower than the pools. Bedforms observed should be consistent with those observed in "E" type channels. The pattern should not change and there should be no change in sinuousity. The pool/riffle sequence should also remain constant.

Hydrological

- At least two bankfull events occurring in separate years during the monitoring period.

Vegetation

- Native woody stem densities of at least 260 stems/acre. In addition, the presence of facultative softwood species such as red maple, sweetgum, and loblolly pine will be limited to less than 10% each of the total number of trees utilized to determine success. These trees may contribute more than 10% of the total trees on the site, but they will not constitute more than 10% each of the 260 stems/acre.

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.

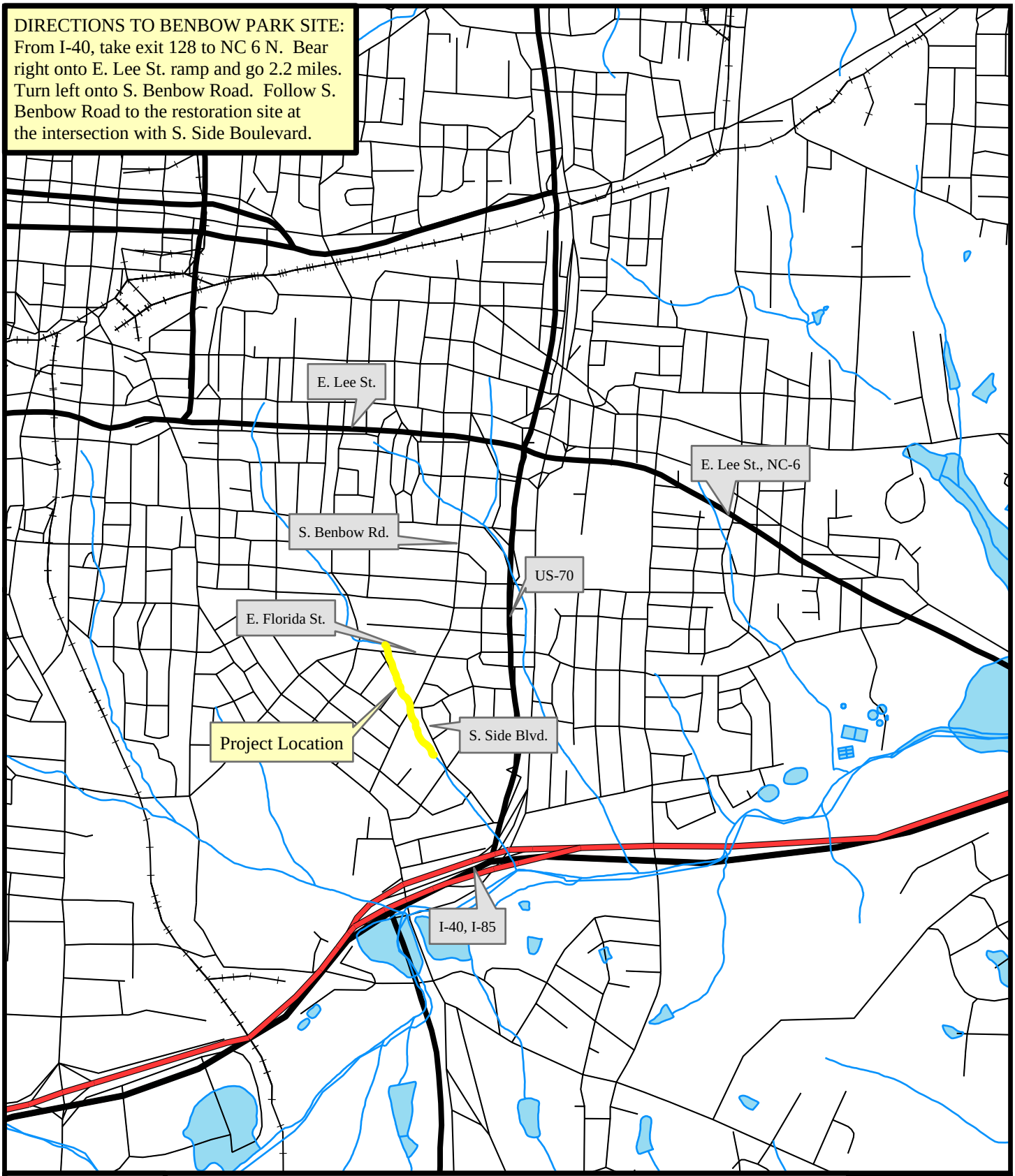

Figure 1. Site Vicinity Map
Benbow Park, Guilford County, EEP Project # 29

0.25 0.125 0 0.25 0.5 Miles

N

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E. Florida Street

New Castle Road

S. Benbow Road

S. Side Boulevard

Asset Legend

- Conservation Easement Boundary
- Other Streams
- Asset #1 (Reach 1)
- Asset #2 (Reach 2)
- Sanitary Sewer and Manholes
- Managed Open Park Land (Mown Grass)
- Utility Right of Way

Figure 2. Asset Map
Benbow Park, Guilford County, EEP Project 29

1:1,440
1 inch = 120 feet
120 60 0 120 Feet

N
W E
S

Source: USGS High Resolution Orthoimagery, Guilford County, NC, 2008

3/25/2010

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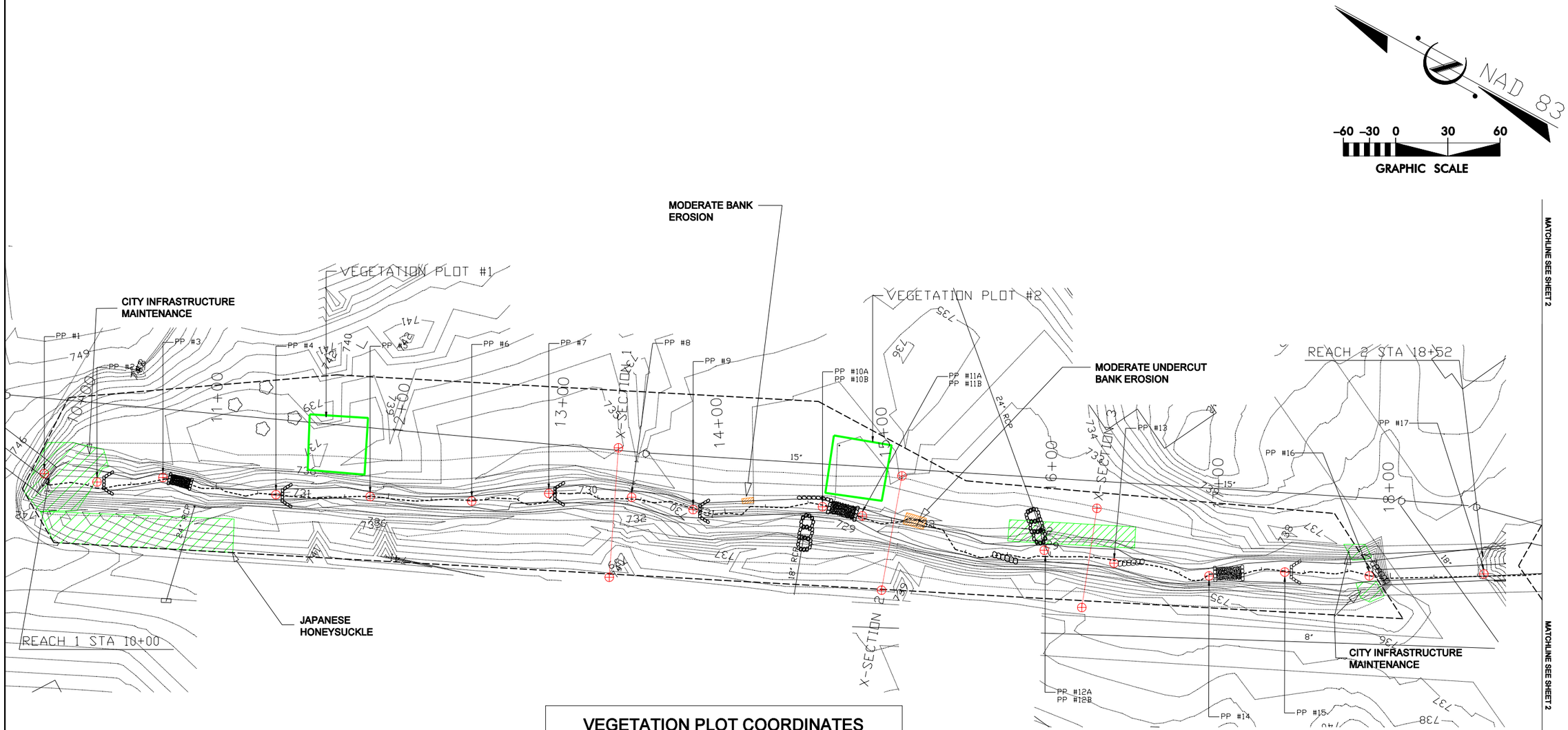


CROSS-SECTION COORDINATES

	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

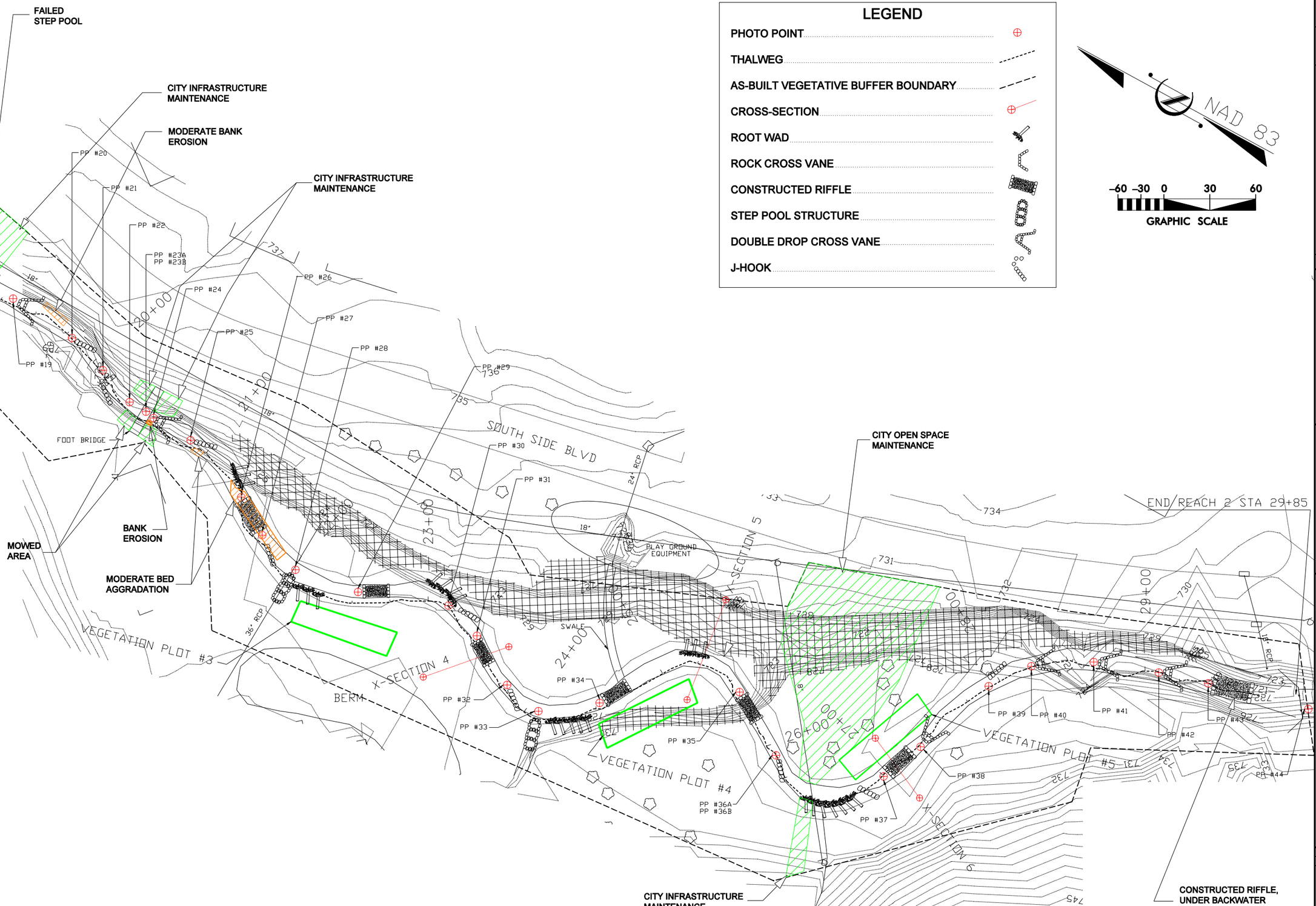
KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

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

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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

Pre-Restoration Site Photos

Momintoring Year 05 Site Photos

Photo Point#3 – MY05 – 11/3/09

Photo Point#6 – MY05 – 11/3/09

Photo Point#19 – MY05 – 11/3/09

Photo Point#30 – MY05 – 11/3/09

Photo Point#35 – MY05 – 11/3/09

Photo Point#41 – MY05 – 11/3/09

Morphology and Substrate Data

The stream assessment completed during the fifth year of monitoring found the stream to be functioning as designed and holding grade for the majority of the project. Surveyed cross-sections have exhibited minimal change over the monitoring period (see page 10). The cross-sectional data show a gradual trend in decreased cross-sectional area. From examining the cross-section plots, the changes in the cross-sections are primarily due to the building of inner berms or the slight building of the banks in general. The decreasing size that has occurred in the cross-sections is from fine sand and silt that has washed into the stream from the watershed. Most of these changes occurred between monitoring years 01 and 02. This is a natural process and in most of these cases, vegetation has become established and the banks have not changed significantly over the last three monitoring years. This sequence of events was also the case with Cross-Section 2, a pool which experienced erosion on the left bank in monitoring years 01 and 02, but has not changed significantly since then. Most instances of isolated bank erosion that were identified during the first few years of monitoring have now stabilized, with currently 99% of the Reach 1 banks and 98% of the Reach 2 banks stable. Currently there are few areas of erosion and those that still exist are minimal and do not have an effect on the stability of the stream as a whole.

The profile has maintained its elevation, although a section of the stream immediately after the S. Benbow Road culvert has less well-defined bed features, while the remainder of the stream has maintained a riffle-pool pattern similar to the as-built survey. The in-stream structures are holding grade and stable. Almost all of the project structures are intact and have not been structurally compromised in any way.

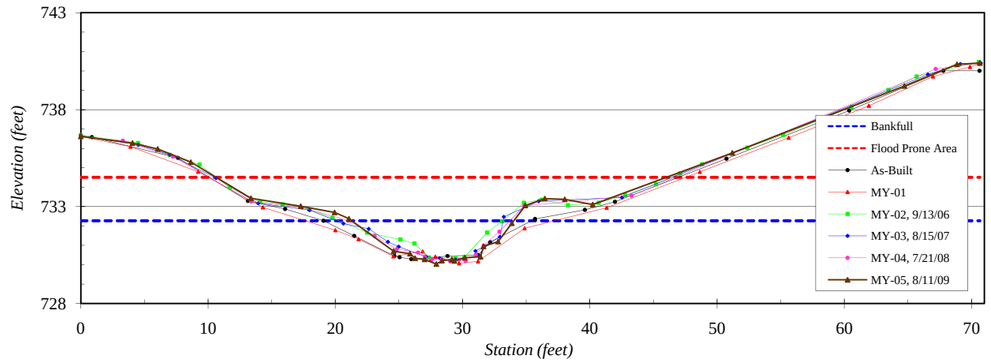
The sediment data from the cross-section pebble counts show that the material distribution has not changed dramatically over the last four years of monitoring. Cross-Section 4 shows some fining in the pebble count from Monitoring Year 5. This is likely due to isolated deposition in the riffle, and is not indicative of any system-wide changes.

The site has experienced four verified bankfull events. It is likely that there have been more bankfull events than those listed below.

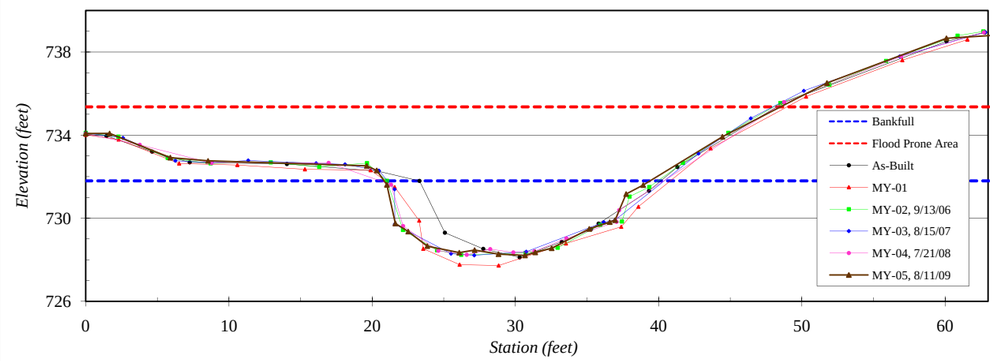
Table 3. Verification of Bankfull Events
Project Number and Name: 29 - Benbow Park

Date of Data Collection	Date of Occurence	Method
9/19/2006	9/18/2006	Site visit to evaluate indicators of stage after storm events
7/23/2008	4/29/2008	Crest gauge
11/9/2009	8/29/2009	Evaluation of rainfall data and a site visit to evaluate indicators of stage after storm events
11/9/2009	6/5/2009	Evaluation of rainfall data and a site visit to evaluate indicators of stage after storm events

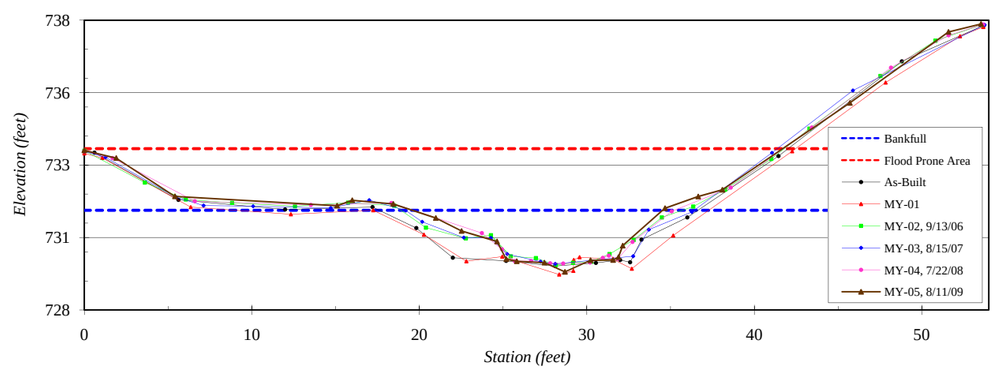
Cape Fear River Basin, Benbow Park, MY05, XS - 1, Riffle



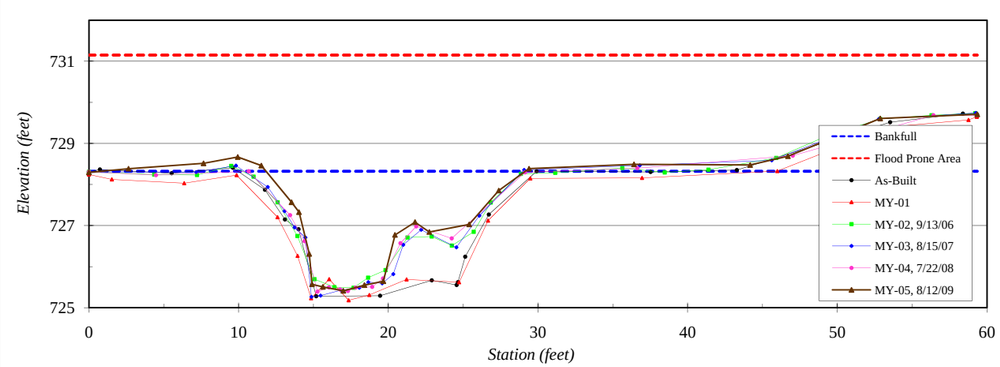
Cape Fear River Basin, Benbow Park, MY05, XS - 2, Pool



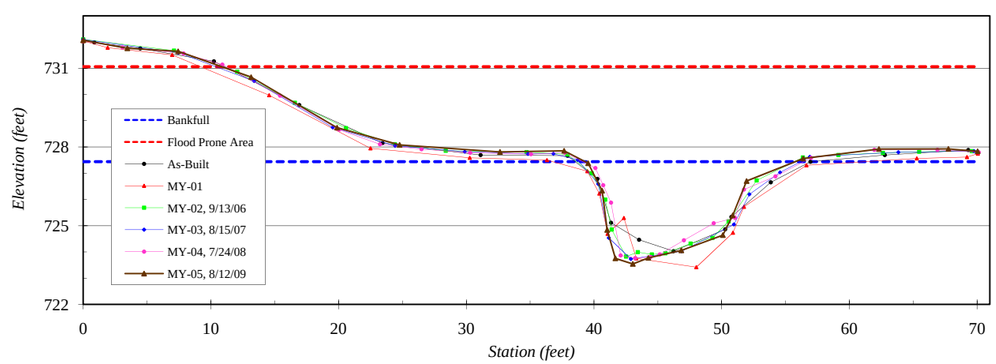
Cape Fear River Basin, Benbow Park, MY05, XS - 3, Riffle



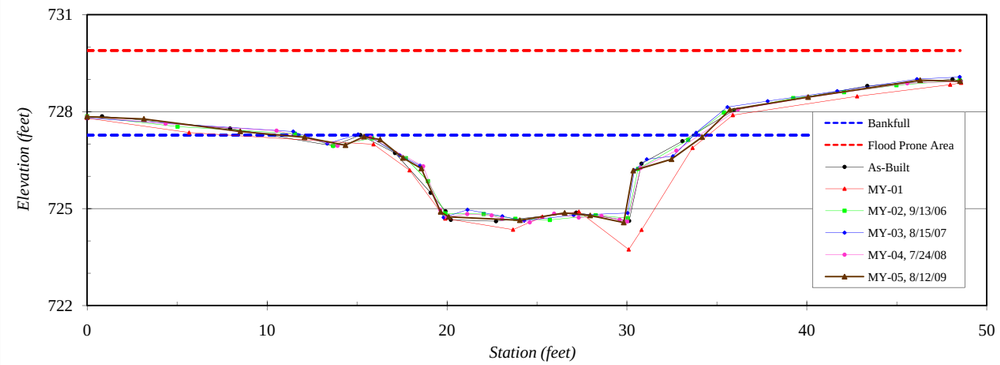
Cape Fear River Basin, Benbow Park, MY05, XS - 4, Riffle



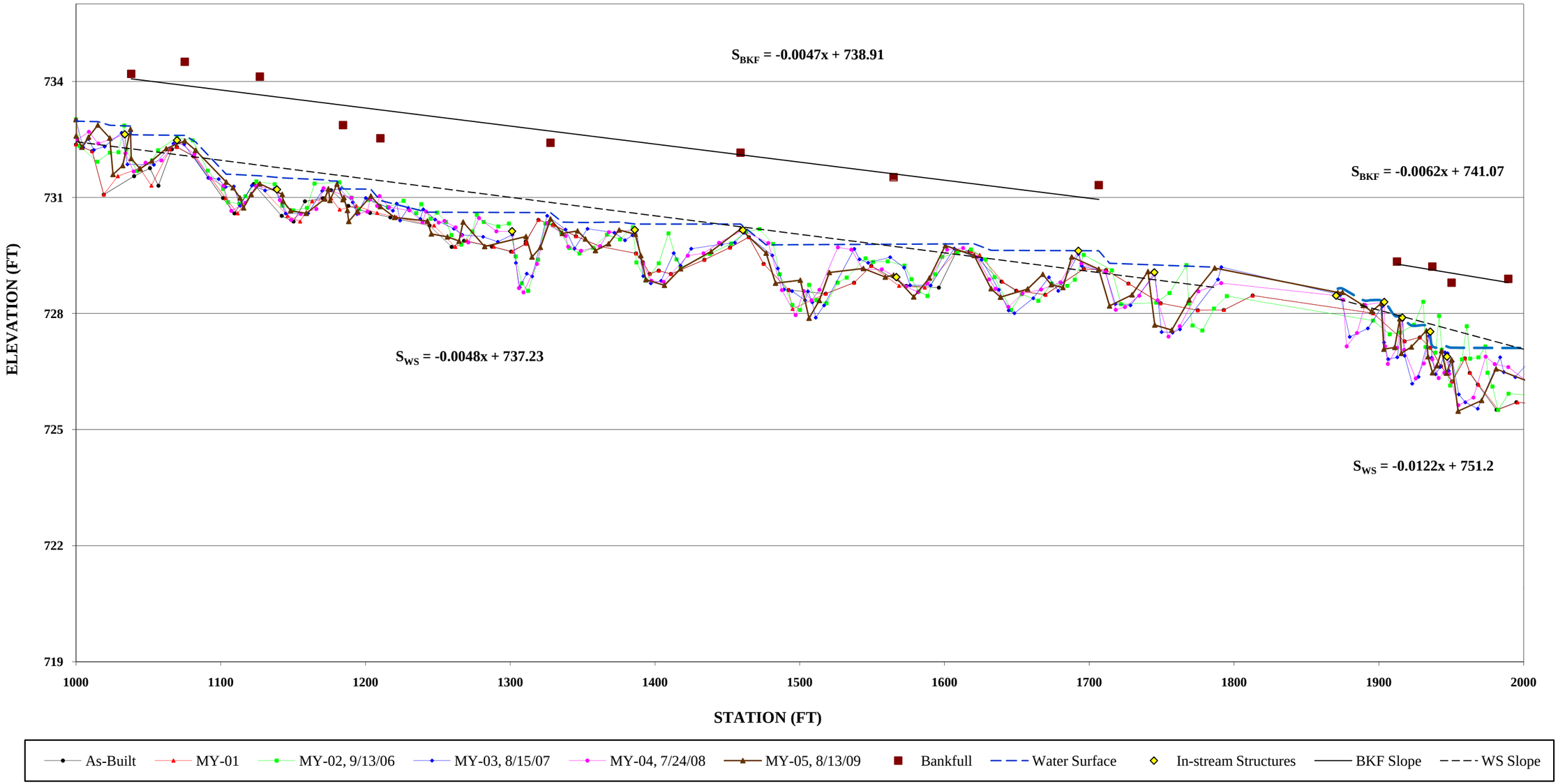
Cape Fear River Basin, Benbow Park, MY05, XS - 5, Pool



Cape Fear River Basin, Benbow Park, MY05, XS - 6, Riffle



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

Vegetation Data

The riparian buffer was planted with seven different species of bare root trees and four different species of live stakes. Some portions of the easement are maintained as managed grass in keeping with the City of Greensboro agreements necessary for utility easements and one community access area. These areas generally coincide with the locations of the sanitary sewer lines. 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 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 five 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 the 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 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 any widespread pruning, promoting native, woody shrubs and trees. Because the vegetation plots were flagged, the planted stems in the plots were not subjected to the trimming in 2008. KCI did a visual evaluation of the site in November 2009 and determined that the areas outside the vegetation plots still maintained adequate stem densities, but the herb layer and low brush were less dense than in prior observations. The 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 early in the successional history of the buffer, invasive species are in turn isolated for more manageable treatment and native trees are provided with a competitive advantage over all other buffer constituents. The invasive species at the site will continue to be targeted for long-term control by the City of Greensboro. In March 2010 the EEP added larger caliper stems (three year old trees) to a small area (<0.1 acres) adjacent to the playground on the west side of Reach 2, due to low woody stem densities. Table 4 below shows the vegetation history of the site.

Table 4. Vegetation History
Project Number and Name: 29 - Benbow Park

	Density (stems/acre)									
	MY02		MY03		MY04		MY05			
Plot Number	Total Planted	Total w/out Live Stakes	Total Planted	Total w/out Live Stakes	Total Planted	Total w/out Live Stakes	Total Planted	Total w/out Live Stakes	Total Planted and Volunteers	Total Planted and Volunteers w/out Live Stakes
029-01-0001	404	404	404	404	404	404	323	323	1,821	1,821
029-01-0002	485	283	485	283	445	242	445	242	1,497	1,294
029-01-0003	404	283	404	283	404	283	323	242	1,092	1,011
029-01-0004	809	404	809	404	809	404	809	404	5,058	4,653
029-01-0005	1,173	485	1,173	485	1,133	485	1,052	445	4,856	4,249
Site Average	655	372	655	372	639	364	590	331	2,865	2,606

Sample Vegetation Plot Photos

Veg Plot #1 – MY02 – 9/12/06

Veg Plot #1 – MY05 – 8/13/10

Veg Plot #2 – MY02 – 9/12/06

Veg Plot #2 – MY05 – 8/13/10

Veg Plot#5 – MY02 – 9/13/06

Veg Plot #5 – MY05 – 8/13/10

Summary

The channel has maintained stability throughout the monitoring period since construction. Isolated areas of bank erosion have been documented, but these have stabilized over time or are not likely to decline further. The surveyed cross-sections have exhibited minimal change over the monitoring period. Although the area after the culvert has less well-defined bed features, the profile reveals that the remainder of the stream has maintained the riffle-pool sequence measured during the as-built survey. The site experienced at least four bankfull events during monitoring. The in-stream structures are structurally intact and have maintained grade control throughout the project. The riparian buffer is sufficiently dense. The City of Greensboro will continue to monitor for and control invasive species. The project has met the stated goals of the project and as such the project is submitted for regulatory closure.