Kentwood Park (Bushy Branch)
Stream Restoration
Closeout Summary Report
EEP Project # 205
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_KPC

Project ID & Status	
Project Name:	Kentwood Park (Bushy Branch)
EEP ID:	205
County:	Wake
Project Type:	Stream Restoration
Current Status:	5 Years of Monitoring Complete

Project Setting & Background	
Basin	Neuse
Physiographic Region	Piedmont
Ecoregion	Northern Outer Piedmont
USGS 8-digit HUC	03020201
NCDWQ Subbasin	03-04-02
Drainage Area	1.4 mi^2 (Bushy Branch)
	0.06 mi^2 (UT Bushy Branch)
Impervious Cover	45%
Thermal Regime	warm
Trout Water	no
Designer	Arcadis
Stream/Veg Maintenance	EcoScience
Monitoring Firm	KCI Assoc. of NC

Project Timeline	
Milestone	**Date**
Restoration Plan	Mar 2002
Construction Completed	2002
Stream/Veg Maintenance Plan	Feb 2004
Stream/Veg Maintenance	2004
As-Built Report	Feb 2005
Monitoring Year-1	Jul 2005
Monitoring Year-2	Jun 2006
Monitoring Year-3	Nov 2007
Monitoring Year-4	Oct 2008
Monitoring Year-5	Nov 2009

Table 1. Project Restoration Components and Mitigation Assets
Project Number and Name: 205 - Kentwood Park (Bushy Branch)

Hydrology Component	Restoration Component	Asset Map #	Approach	Level	Ratio	Ratio Multiplier	Total Linear Feet	Creditable Linear Feet	SMU	P/I/E	Comments
Bushy Branch	Reach 1	1	P2/3	R	1.0	1.00	1,070	965	965	P	See Project Background and Summary narrative.
UT Bushy Branch	Reach 2	2	P3	EI	1.5	0.67	358	338	225	I	

P2/3 = Combination of Priorities 1, 2, and 3
R = Restoration
SMU = Stream Mitigation Units
EI = Enhancement I
P/I/E = Perennial / Intermittent / Ephemeral

Table 2. Asset Summary
Project Number and Name: 205 - Kentwood Park (Bushy Branch)

Level	Feet	SMU
Restoration	965	965
Enhancement I	338	225
Total	**1,303**	**1,190**

Project Background and Summary

The Kentwood Park Mitigation Site was developed by the North Carolina Wetlands Restoration Program / Ecosystem Enhancement Program (EEP) in cooperation with the City of Raleigh. The project is located on Bushy Branch and an Unnamed Tributary to Bushy Branch, totaling 1,420 linear feet. These streams are located in an urban park and are surrounded by a residential area. These two streams are the primary hydrologic features of the project. The existing channel exhibited varying degrees of instability, with Bushy Branch and its tributary classified as C-E4/1 and G4 stream types, respectively prior to restoration.

The restoration and enhancement of Bushy Branch and the Unnamed Tributary were based on the relationships in the rural piedmont regional curves and survey data from the project stream and reference reaches. The channel design for Bushy Branch utilized a variety of techniques. The first 400 feet of Bushy Branch are in the same location, but the profile and dimension have been adjusted and in-stream structures were installed. Along the remainder of Bushy Branch, the dimension, pattern, and profile were adjusted, increasing sinuosity and stream length. The Unnamed Tributary to Bush Branch (UTBB) was enhanced using a Priority Level III approach. Based on a stable B4/1 reference reach, a step-pool channel was designed for UTBB.

Following construction, poor survivability of the planted vegetation and safety concerns from the City of Raleigh prompted the EEP to contract with EcoScience Corporation to design a maintenance planting plan (Appendix A) along portions of Bushy Branch and UTBB a and stream maintenance plan for UTBB. This maintenance was completed in 2004. Due to its small drainage, the EEP requested the NC Division of Water Quality (DWQ) to provide an official determination as to whether UTBB is an ephemeral, intermittent, or perennial stream. This determination concluded that UTBB is an intermittent stream. These DWQ documents are included in Appendix B entitled UT Bushy Branch Stream Determination. Due to this uncertainty, this tributary was classified in prior monitoring reports as an Enhancement II asset for the purposes of being conservative, but given that the project was constructed before the 2003 guideline definitions were in place, and both dimension and profile were modified to enhance this heavily damaged feature it has been adjusted to Enhancement I.

After reviewing site conditions and previous project documents the EEP has decided not to claim mitigation credit for the first 105’ of Bushy Branch. There are two primary reasons for this. The first is that in order to avoid impacting some large oak trees that were in place, little to no work was actually done in this area, part of which is in the NCDOT right-of-way for Kaplan Road. The latter takes precedence over the conservation easement. Twenty feet of UTBB has also been excluded from the creditable footage for this reach due to crossings or playover areas from the disc golf course that will continue to be impacted from the intense foot traffic associated with this highly utilized park feature.

Goals

- Stabilize the project streams.
- Enhance the riparian corridor.
- Improve water quality and aquatic habitat.

Objectives

- Installation of in-stream structures to define additional bed features.
- Relocate a section of stream in order to restore stream pattern.
- Grade severely eroding banks and excavate new bankfull benches.
- Install root wads to promote bank stability.
- Revegetate the adjacent banks to promote the establishment of native plant communities.

Success Criteria

Morphological

- Monitoring data will demonstrate that the stream reaches make up a functioning and stable stream system.
- The channel configuration will be compared to the as-built plans and previous geometry data to track changes in channel geometry, profile, or substrate. These data will be utilized to assist in determining the success of restoring stream channel stability. Specifically, there shall be no significant or detrimental change in channel geometry from the as-built channel. Therefore, pool and riffle depths and widths should remain consistent with the constructed geometry; the profile should continue to show the development of bed features, and channel aggradation or degradation should be within the limits of natural stream sediment patterns.

Hydrological

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

Vegetation

- The vegetation development should be observed to show progressive growth over the five-year monitoring period. Vegetation success will be determined by the survival of Character Tree Species. An average density of 320 stems per acre of Character Tree Species must be surviving in the first year of monitoring. Subsequently, 290 character tree stems per acre must be surviving in year 3, and 260 character tree stems per acre in year 5. A minimum of five Character Tree Species should be present in the sample.

DIRECTIONS TO KENTWOOD PARK SITE:
From Interstate 440 take exit 2A to Western Boulevard. From Western Boulevard, turn right (south) onto Kent Street. At a traffic light at the end of Kent Street, turn right (west) onto Kaplan Drive. Kentwood Park parking will be on the left (south) side of Kaplan Drive.

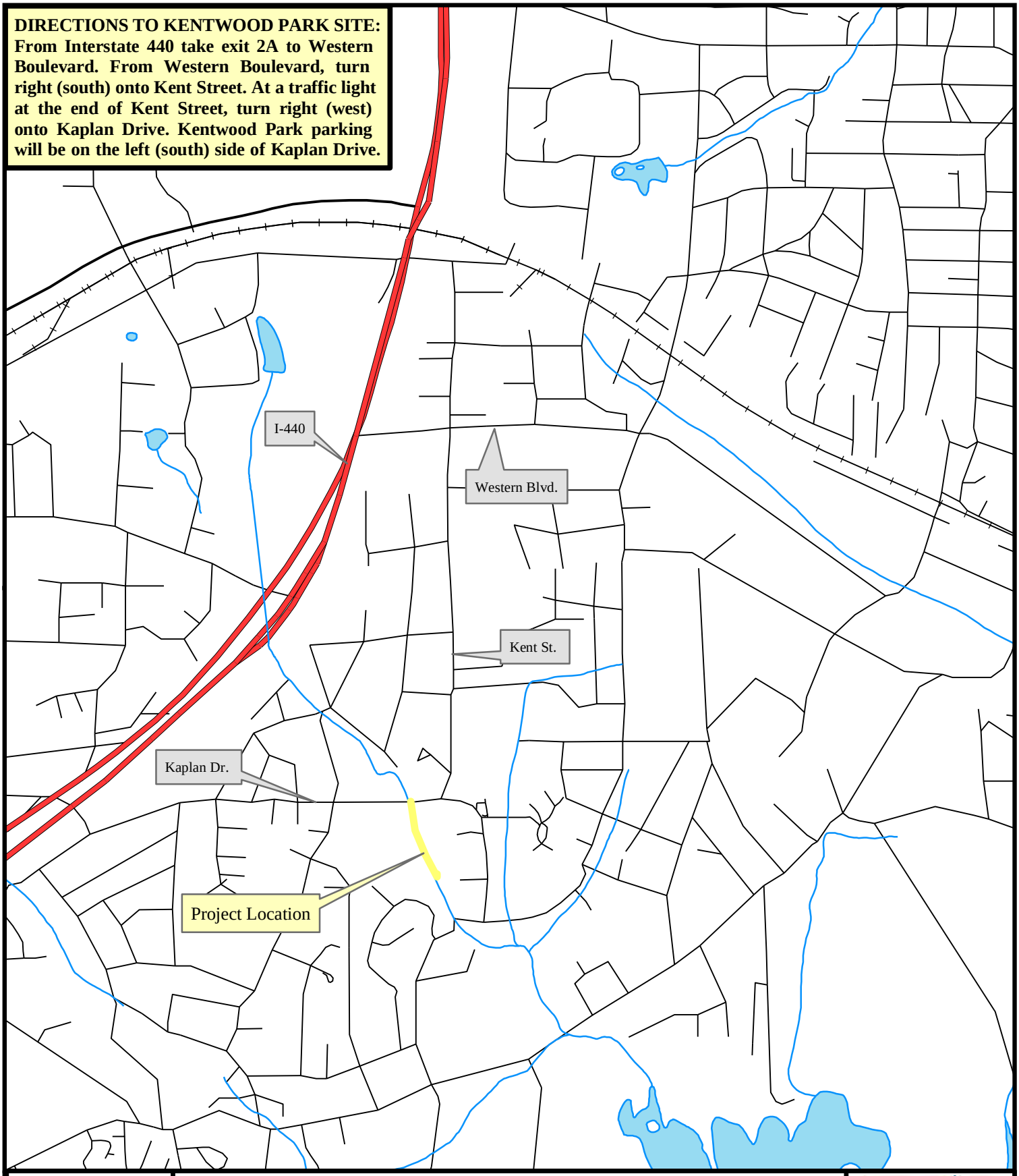


Figure 1. Site Vicinity Map
Kentwood Park, Wake County, EEP Project # 205

0.25 0.125 0 0.25 0.5 Miles

Ecosystem Enhancement Program

KCI ASSOCIATES OF NC

Figure 2. Asset Map
Kentwood Park, Wake County, EEP Project 205

40 20 0 40 80
Feet

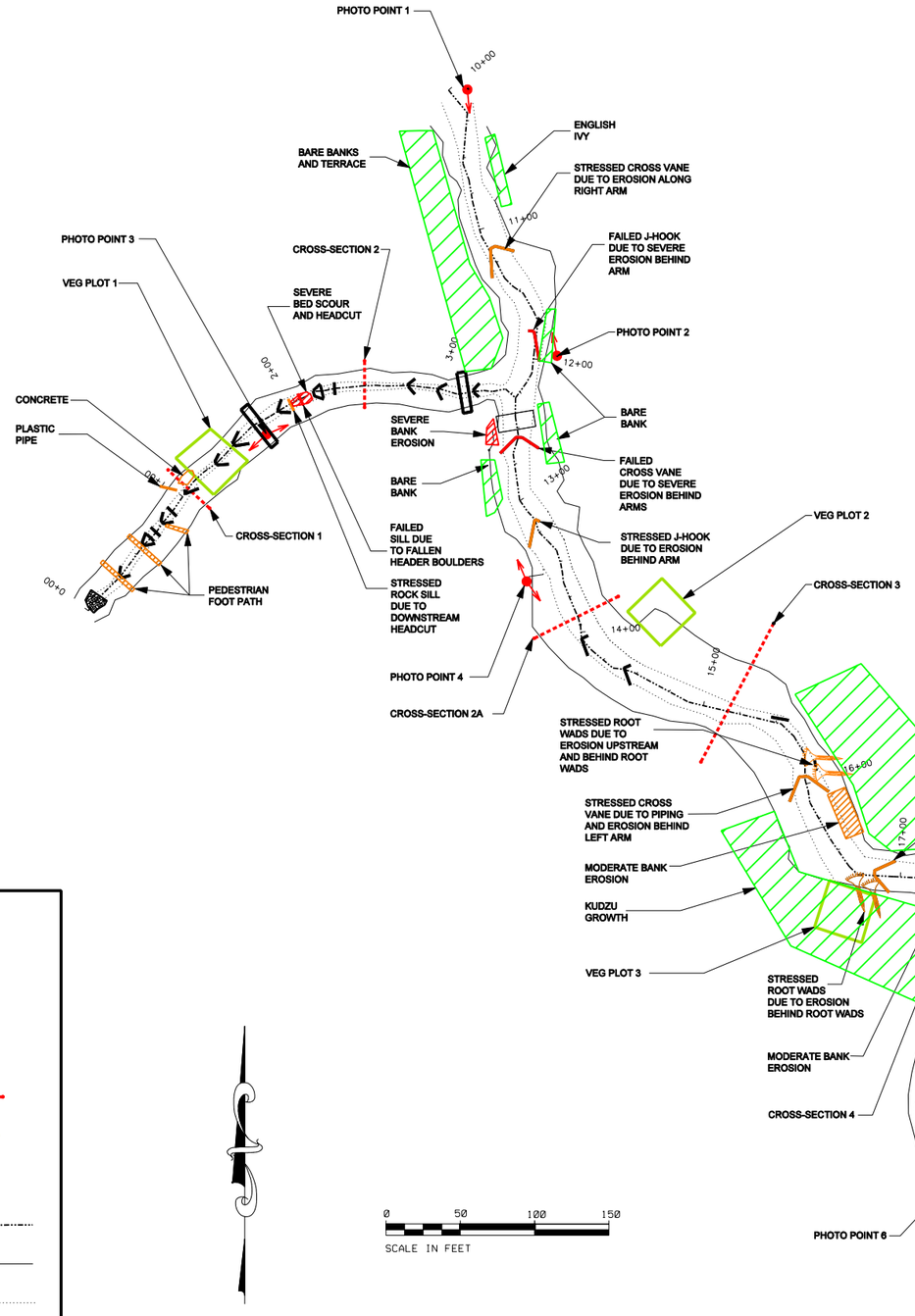
1 in = 80 ft

Source: USGS High Resolution Orthoimage, Wake County, NC, 2006.

8/2/2010

Ecosystem Enhancement Program

KCI Associates of NC



MONITORING FEATURE COORDINATES

(ASSUMED COORDINATE SYSTEM FROM MONITORING SURVEY)

		NORTHING	EASTING
CROSS-SECTION #1	LB	4926.60	4867.91
	RB	4900.65	4895.52
CROSS-SECTION #2	LB	5000.00	5000.00
	RB	4968.67	5000.00
CROSS-SECTION #2A	LB	4841.45	5170.71
	RB	4813.25	5114.21
CROSS-SECTION #3	LB	4820.56	5259.23
	RB	4723.49	5219.47
CROSS-SECTION #4	LB	4651.82	5430.88
	RB	4611.46	5389.46
VEGETATION PLOT #1		4931.15	4873.69
		4954.36	4896.34
		4909.86	4898.86
		4932.60	4921.73
VEGETATION PLOT #2		4819.84	5161.42
		4823.76	5206.52
		4844.74	5182.31
		4798.86	5185.63
VEGETATION PLOT #3		4619.82	5305.75
		4651.83	5312.74
		4644.35	5344.63
		4612.48	5338.48

LEGEND

- AS-BUILT STRUCTURE
- AS-BUILT ROOT WAD
- RIP RAP
- CROSS-SECTION
- VEGETATION PLOT
- PHOTO POINT
- AS-BUILT THALWEG
- AS-BUILT TOP OF BANK
- AS-BUILT CHANNEL BOUNDARY

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

Ecosystem Enhancement Program

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

KENTWOOD PARK (BUSHY BRANCH)
WAKE COUNTY, NORTH CAROLINA
EEP PROJECT NUMBER 205 - MY05

DATE: DECEMBER 2009
SCALE: SEE SHEET

CURRENT CONDITION PLAN VIEW

Pre-Construction Site Photos

Photograph 3. Bank erosion along Bushy Branch at northeast corner at frisbee golf course

Photograph 4. Bank erosion along Bushy Branch just upstream of confluence of Bushy Branch and its unnamed tributary

Photograph 5. Looking downstream along Bushy Branch at eroded bank at pedestrian access point just downstream of second sanitary sewer line crossing

Photograph 6. Looking downstream along Bushy Branch at eroded left bank near middle of Kentwood Park reach

Photograph 7. Debris jam along Bushy Branch at southeast corner of Kentwood Park

Photograph 8. Beginning of reference reach along Bushy Branch just downstream of Kentwood Park

Photograph 11. Unnamed tributary of Bushy Branch looking upstream from just downstream of western Kentwood Park property line

Photograph 12. Bank erosion along unnamed tributary of Bushy Branch looking downstream from culvert at concession stand

Photograph 13. Bank erosion along unnamed tributary of Bushy Branch at pedestrian access point

Photograph 14. Bank erosion and pedestrian bridge at unnamed tributary of Bushy Branch looking downstream from just upstream of confluence with Bushy Branch

Monitoring Year 05 Site Photos

Photo Point#2 – MY05 – 11/5/09

Photo Point#3, UTBB, upstream – MY05 – 11/5/09

Photo Point#4, downstream – MY05 – 11/5/09

Photo Point#5, upstream – MY05 – 11/5/09

Photo Point#5, downstream – MY05 – 11/5/09

Photo Point#6, upstream – MY05 – 11/5/09

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. Initially two permanent cross-sections were established on both Bushy Branch and UTBB. Then an additional riffle cross-section was established on Bushy Branch in Monitoring Year 2. These surveyed cross-sections have exhibited minimal change over the monitoring period (see page 13). The cross-sectional data do not show significant change in the cross-sections over the course of the monitoring period. Some small areas of aggradation and degradation are present, but this is a natural process that frequently occurs as restored streams achieve a balance in sediment transport.

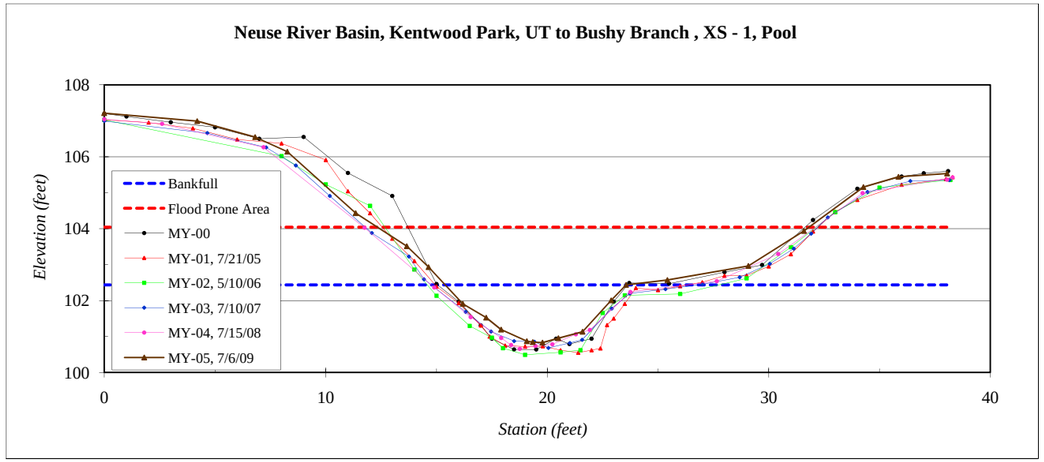
The profile has maintained its elevation and a consistent riffle-pool pattern over the past five years of monitoring. The as-built profile data could not be obtained from the designer in an electronic format that would facilitate overlay. The cross-sections, subsequent long profiles and field observations indicate a stable bed. The two riffle cross-sections surveyed in the reach also demonstrated bankfull areas and widths that matched the design targets well. The in-stream structures are holding grade and stable. Several structures that did exhibit some back arm scour at some point in the monitoring history represent remnant, localized areas of instability, which have advanced little or not at all in recent years. In addition, the majority of the project is surrounded by extremely dense woody vegetation and canopy, which is uncommon for an urban system. The associated stabilizing root mass from the buffer is extensive.

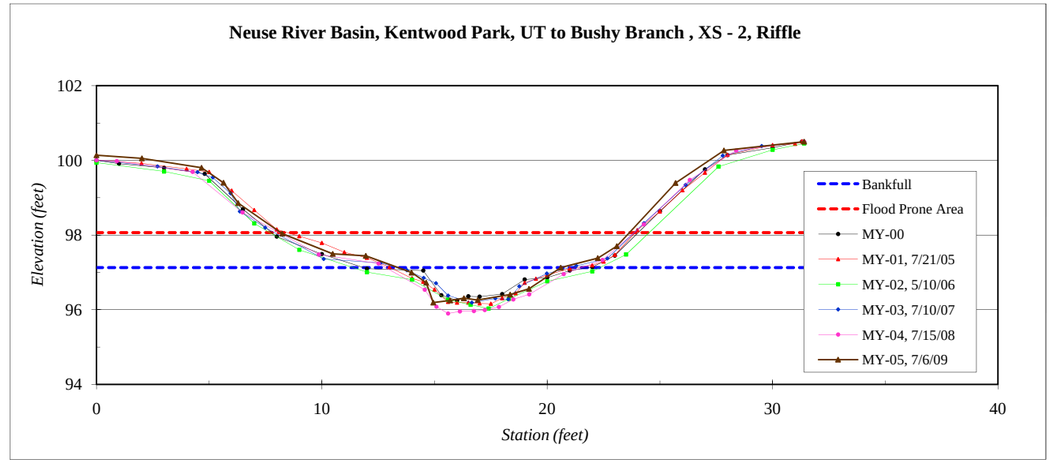
The sediment data from the cross-section pebble counts show that the material distribution has not changed significantly over the course of monitoring.

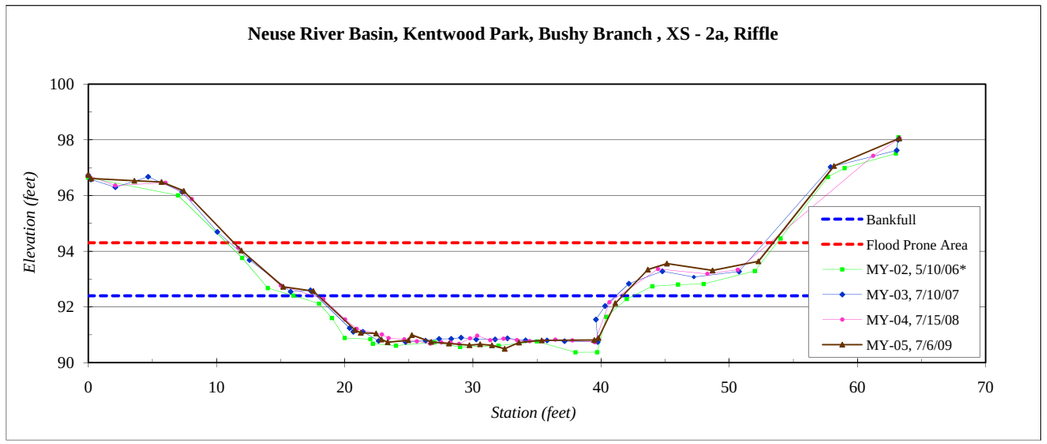
The site has experienced five verified bankfull events. It is likely that there have been more bankfull events than those listed below.

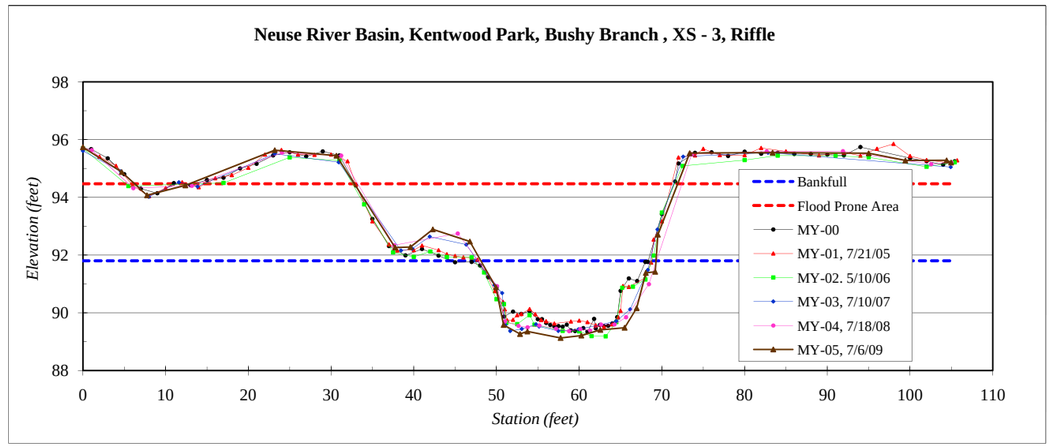
Table 3. Verification of Bankfull Events
Project Number and Name: 205 – Kentwood Park (Bushy Branch)

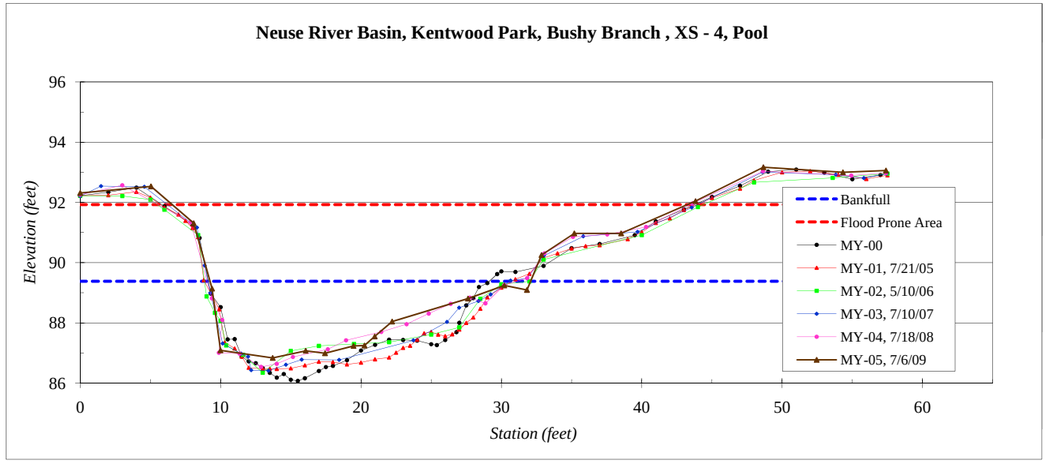
Date of Data Collection	Date of Occurrence	Method
6/15/2006	6/14/2006	Site visit to evaluate stage indicators after storm event.
7/11/2007	6/3/2007	Crest gauge
11/12/2007	7/17/2007	Crest gauge
10/28/2008	9/7/2008	Crest gauge
6/16/2009	11/9/2009	Evaluation of rainfall data, and site visit to evaluate stage indicators after storm event.


Neuse River Basin, Kentwood Park, UT to Bushy Branch , XS - 1, Pool
Elevation (feet)
Station (feet)
Bankfull
Flood Prone Area
MY-00
MY-01, 7/21/05
MY-02, 5/10/06
MY-03, 7/10/07
MY-04, 7/15/08
MY-05, 7/6/09


Neuse River Basin, Kentwood Park, UT to Bushy Branch , XS - 2, Riffle
Elevation (feet)
Station (feet)
Bankfull
Flood Prone Area
MY-00
MY-01, 7/21/05
MY-02, 5/10/06
MY-03, 7/10/07
MY-04, 7/15/08
MY-05, 7/6/09

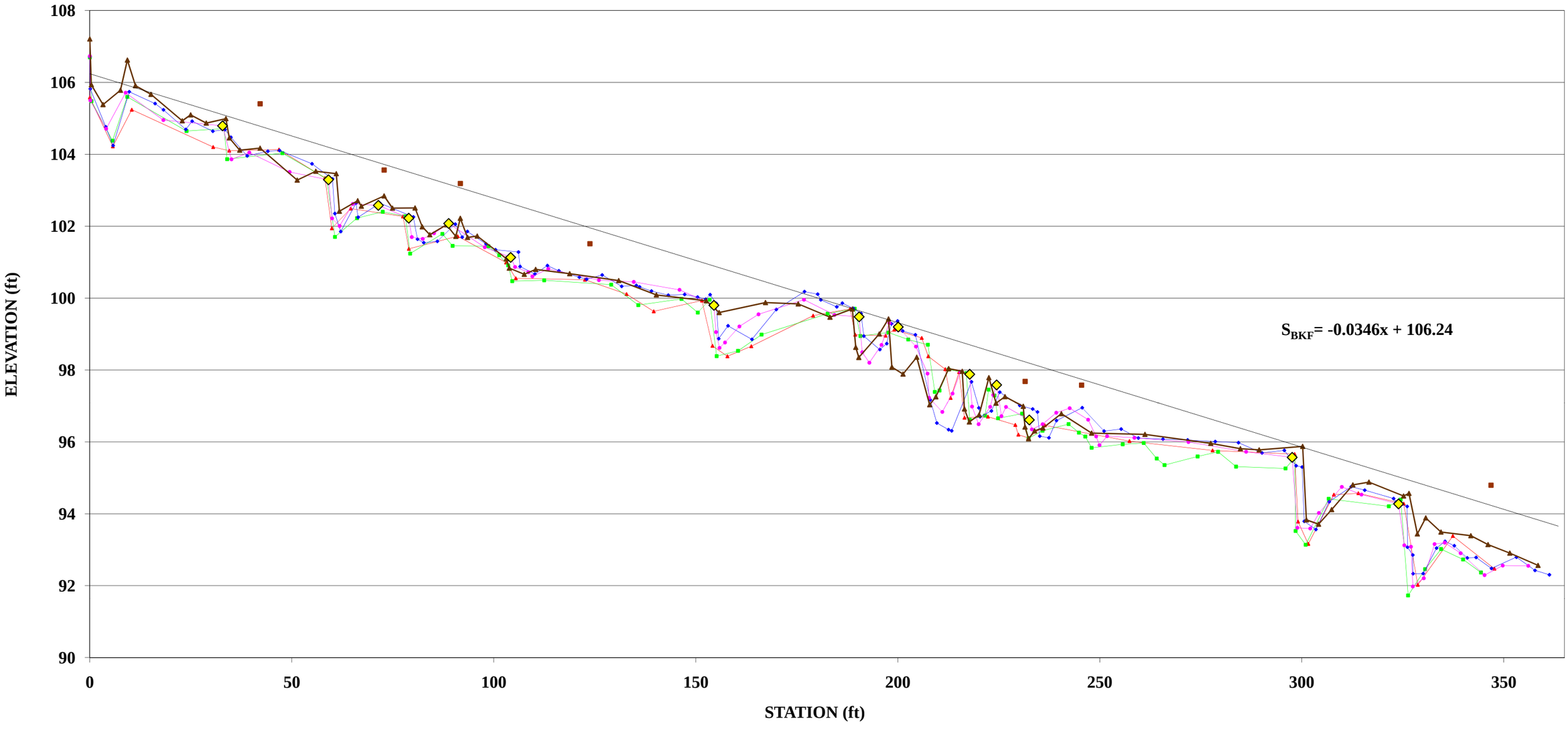

Neuse River Basin, Kentwood Park, Bushy Branch , XS - 2a, Riffle
Elevation (feet)
Station (feet)
Bankfull
Flood Prone Area
MY-02, 5/10/06*
MY-03, 7/10/07
MY-04, 7/15/08
MY-05, 7/6/09


Neuse River Basin, Kentwood Park, Bushy Branch , XS - 3, Riffle
Elevation (feet)
Station (feet)
Bankfull
Flood Prone Area
MY-00
MY-01, 7/21/05
MY-02. 5/10/06
MY-03, 7/10/07
MY-04, 7/18/08
MY-05, 7/6/09


Neuse River Basin, Kentwood Park, Bushy Branch , XS - 4, Pool
Elevation (feet)
Station (feet)
Bankfull
Flood Prone Area
MY-00
MY-01, 7/21/05
MY-02, 5/10/06
MY-03, 7/10/07
MY-04, 7/18/08
MY-05, 7/6/09

Longitudinal Profile for Bushy Branch
Kentwood Park, Wake County
EEP Project Number 205 - MY05

Longitudinal Profile for UT to Bushy Branch
Kentwood Park, Wake County
EEP Project Number 205 - MY05



Vegetation Data

The remedial vegetation was planted at a density of 4,840 stems per acre in the streamside community and 680 stems per acre in the bottomland hardwood community. See Appendix A for the maintenance planting details. Three vegetation monitoring plots were established during the as-built survey. The fifth year of monitoring calculated an average of 1,740 planted stems/acre in the streamside community based on Plots 1 and 2 and 1,200 stems/acre in the bottomland hardwood community based on plot 3. The use of the park's disc golf course has had an effect on the vegetation along the west side of the upper 200 feet of Bushy Branch. There are large, mature trees along this bank, but the impacts from frequent trampling have suppressed understory vegetation and led to compaction and poor cover in the near bank region. EEP implemented a supplemental planting effort earlier in the project's history that included this area, but foot traffic has remained frequent even with subsequent signage installed later. While the aesthetic and vegetation density of the near bank region in this area is clearly not as good as that further downstream, the large hardwood trees are providing a significant stabilizing root mass. The initial post-construction condition of the banks in this area, which were somewhat steep in large part because these trees were saved, experienced some erosion from the outset, but have not changed significantly over the monitoring period. Recently, the EEP met with the City of Raleigh and, in 2010, the city installed a closely-spaced line of boulders on this boundary interspaced with additional EEP signage. Microstegium (*Microstegium vimineum*) and kudzu (*Pueraria montana*) are present and are scattered throughout the project with a more concentrated area of kudzu near Vegetation Plot 3 at the lower end of the site. EEP has established a contract to control/suppress the kudzu during the spring/summer of 2010 with a follow-up treatment in 2011. Aside from these invasive populations, the fifth year of monitoring found that the vegetation component of the project had met the success criteria.

Table 4. Vegetation History
Project Number and Name: 205 – Kentwood Park (Bushy Branch)

Streamside Plots	Density (planted stems/acre)					
	MY00	MY01	MY02	MY03	MY04	MY05
1	2,440	2,186	2,267	2,186	1,960	1,880
2	3,440	2,267	1,902	1,781	1,720	1,600
Streamside Average	2,940	2,227	2,085	1,984	1,840	1,740

Bottomland Plot	Density (planted stems/acre)					
	MY00	MY01	MY02	MY03	MY04	MY05
3	1,440	1,377	1,255	1,255	1,240	1,200

Vegetation Plot Photos

Veg Plot #1 – MY01 – 10/27/05

Veg Plot #1 – MY05 – 7/9/09

Veg Plot #2 – MY01 – 10/27/05

Veg Plot #2 – MY05 – 7/9/09

Veg Plot #3 – MY01 – 7/20/05

Veg Plot #3 – MY05 – 7/9/09

Summary

The channel has maintained stability throughout the monitoring period since construction and maintenance. Isolated areas of bank erosion have been documented, but these have stabilized over time and are minimal today. The surveyed cross-sections have exhibited minimal change over the monitoring period. The profile reveals that the stream has maintained the riffle-pool sequence measured during the as-built survey. The site experienced at least five 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 and the invasive species will be treated/suppressed in 2010 and 2011. The project has met the stated goals and as such the project is submitted for regulatory closure.

Appendix A

Supplemental Planting

Final Species Planted at Kentwood Park in Fall of 2004

Scientific Name	Common Name	No. and Size of Material
Quercus alba	White Oak	45 (2"C)
Nyssa sylvatica	Black Gum	10 (2"C), 150 (1G)
Cornus florida	Flowering Dogwood	45 (2"C)
Quercus falcata	Spanish Oak	30 (2"C)
Liriodendron tulipifera	Yellow Poplar	50 (3G), 100 (1G)
Carya cordiformis	Bitternut Hickory	20 (3G)
Quercus michauxi	Swamp Chestnut Oak	60 (3G)
Ulmus americana	American Elm	60 (3G)
Fraxinus pennsylvanica	Green Ash	50 (3G), 300 BR
Oxydendron arboreum	Sourwood	150 (1G)
Ilex verticillata	Common Winterberry	100 (1G)
Hamamelis virginiana	Witch Hazel	50 (1G)
Euonymus americana	American Strawberry Bush	200 (1G)
Arundinara gigantea	Giant Cane	1250 BR
Salix nigra	Black Willow	1000 LS
Viburnum nudum	Southern Wild Raisin	300 BR
Platanus occidentalis	Sycamore	400 BR
Carpinus caroliniana	Ironwood	400 BR
Alnus serrulata	Tag Alder	500 BR
Cornus amomum	Silky Dogwood	750 BR
Acer negundo	Box Elder	200 BR
Betula nigra	River Birch	400 BR
Lindera benzoin	Spice Bush	400 BR
Sambucus canadensis	Canada Elder	200 BR

BR = Bare Root
LS = Live Stakes
1G = one gallon
C = Caliper

PLANTING LEGEND

		acres
	STREAM-SIDE ASSEMBLAGE (BRUSHY BRANCH)	0.59±
	BOTTOMLAND HARDWOOD FOREST (RIPPING TREATMENT)	0.36±
	SCARIFICATION AND TURF ESTABLISHMENT	0.34±
	Total	1.29±

GENERAL LEGEND

- CONSERVATION EASEMENT BOUNDARY
- EXISTING TOP OF BANK
- SS — SANITARY SEWER
- PROJECTED BANKFULL
- EXISTING CROSS-VANE
- MH — SANITARY SEWER MAN HOLE
- STREAM CHANNEL THALWEG
- DIRECTION OF FLOW
- PROPERTY BOUNDARY
- EXISTING ROOTWAD

R/W 60' R/W

40' SANITARY SEWER EASEMENT

50' GREENWAY

40'

50'

MH

SS

SANITARY SEWER

FOR TRIBUTARY PLANTING, SEE SHEET B

CONSERVATION EASEMENT BOUNDARY

SITE LAYOUT

60 0 60

SCALE IN FEET

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
NCDENR

ECOSYSTEM ENHANCEMENT PROGRAM

Project:
KENTWOOD PARK PLANTING AND MAINTENANCE PLAN

WAKE COUNTY, NORTH CAROLINA

Title:
SITE PREPARATION AND PLANTING PLAN

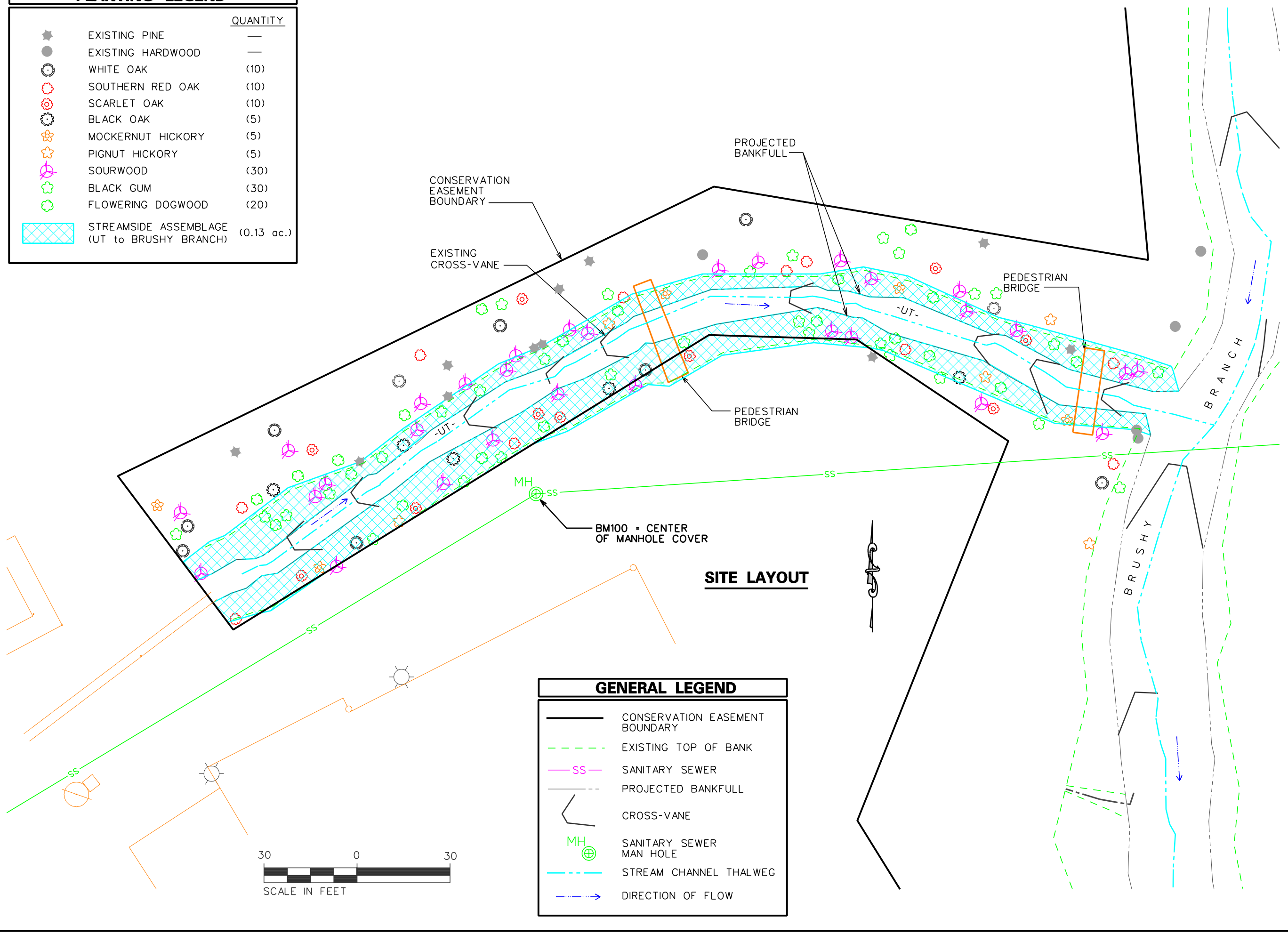
Dwn By:	Date:
MAF	FEB 2004
Ckd By:	Scale:
JG	1"= 60'

ESC Project No.: 04-178

FIGURE
5

PLANTING LEGEND

	QUANTITY
EXISTING PINE	—
EXISTING HARDWOOD	—
WHITE OAK	(10)
SOUTHERN RED OAK	(10)
SCARLET OAK	(10)
BLACK OAK	(5)
MOCKERNUT HICKORY	(5)
PIGNUT HICKORY	(5)
SOURWOOD	(30)
BLACK GUM	(30)
FLOWERING DOGWOOD	(20)
STREAMSIDE ASSEMBLAGE (UT to BRUSHY BRANCH)	(0.13 ac.)



SITE LAYOUT

GENERAL LEGEND

	CONSERVATION EASEMENT BOUNDARY
	EXISTING TOP OF BANK
SS	SANITARY SEWER
	PROJECTED BANKFULL
	CROSS-VANE
MH	SANITARY SEWER MAN HOLE
	STREAM CHANNEL THALWEG
	DIRECTION OF FLOW

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
NCDENR

ECOSYSTEM ENHANCEMENT PROGRAM

Project:
KENTWOOD PARK PLANTING AND MAINTENANCE PLAN

WAKE COUNTY, NORTH CAROLINA

Title:
PLANTING PLAN

UT TO BRUSHY BRANCH

Dwn By:	Date:
MAF	FEB 2004
Ckd By:	Scale:
JG	1"= 30'

ESC Project No.: 04-178

FIGURE
6

North Carolina Department of Environment and Natural Resources
Division of Water Quality

Beverly Eaves Perdue
Governor

Coleen H. Sullins
Director

Dee Freeman
Secretary

March 22, 2010

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

NBRRO#10-042
Wake County

BASIN:

☒ Neuse (15A NCAC 2B .0233) ☐ Tar-Pamlico (15A NCAC 2B .0259)

☐ Ephemeral/Intermittent/Perennial Determination ☐ Isolated Wetland Determination

Project Name: Kentwood Park Raleigh

Location/Directions: Subject property is a city park located on Kaplan Drive in Raleigh

Subject Stream: UT to Lake Raleigh

Date of Determination: January 26, 2010

Feature	E/I/P*	Not Subject	Subject	Start@	Stop@	Stream Form Pts.	Soil Survey	USGS Topo
A	I		X	Crossing behind bathroom building		26.5	X	
B	P		X	Throughout			X	X

**E/I/P = Ephemeral/Intermittent/Perennial*

Explanation: The feature(s) listed above has or have been located on the Soil Survey of Wake County, North Carolina or the most recent copy of the USGS Topographic map at a 1:24,000 scale. Each feature that is checked "Not Subject" has been determined not to be a stream or is not present on the property. Features that are checked "Subject" have been located on the property and possess characteristics that qualify it to be a stream. There may be other streams located on your property that do not show up on the maps referenced above but, still may be considered jurisdictional according to the US Army Corps of Engineers and/or to the Division of Water Quality.

This on-site determination shall expire five (5) years from the date of this letter. Landowners or affected parties that dispute a determination made by the DWQ or Delegated Local Authority may request a determination by the Director. An appeal request must be made within sixty (60) days of date of this letter or from the date the affected party (including downstream and/or adjacent owners) is notified of this letter. A request for a determination by the Director shall be referred to the Director in writing c/o Ian McMillan, DWQ Wetlands/401 Unit, 2321 Crabtree Blvd., Raleigh, NC 27604-2260.