Gillespie Golf Course (Mile Run Creek) Stream Restoration
Greensboro, North Carolina

Annual Monitoring Report

Monitoring Year 2007

NCDENR EEP
1619 Mail Service Center
Raleigh, NC 27699-1619

Monitoring Year: 2007
Measurement Year 4
As-Built Date: 2004
NCEEP Project Number 144

March 2008

Submitted by:

WK Dickson and Co., Inc.
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GILLESPIE GOLF COURSE (MILE RUN CREEK) STREAM RESTORATION
2007 MONITIORING REPORT

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I. EXECUTIVE SUMMARY/PROJECT ABSTRACT

The Gillespie Golf Course Stream Restoration Site includes 2,634 linear feet of Mile Run Creek and 3,436 linear feet of a tributary within the City of Greensboro, Guilford County, North Carolina. The site was constructed between February and March 2004. The following report provides the Year 4, 2007 Monitoring information.

Overall, the project is doing well with a few minor areas of erosion and several sections where coir fiber matting has pulled away from the bank. Previously, there had been a beaver dam constructed on Mile Run Creek but it has since been eliminated and is no longer creating a problem along the restoration reach. Problem areas should be monitored and remediation options developed if they worsen.

Vegetation monitoring of the site documented an average tree density of 248 trees per acre. This average is below the minimum criteria of at least 260 stems per acre after 5 years. The low density can be attributed to mowing of portions of the vegetation plots by golf course personnel. Seedlings from natural recruitment are very low. Additional plantings are needed to restore the density to at least 260 stems per acre to meet mitigation requirements.

II. PROJECT BACKGROUND

A. Project Objectives

The objectives of the restoration of Mile Run Creek that flows through Gillespie Golf Course were to:

- 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).

B. Project Restoration Components

Mile Run Creek and its unnamed tributary are located on Gillespie Golf Course, a public golf course in the City of Greensboro. The stream channel has low sinuosity and varying levels of incision due to historic channelization. The alternative of creating a stable meandering channel with bankfull stage located at the existing floodplain elevation was evaluated. However, in these streams, topographic and development restrictions did not allow for a new channel pattern to be established. The existing incised channels were enhanced by excavating new floodplain benches at the bankfull stage and installing structures to improve bed features and control channel grade.

The restoration project was divided into one main stem (GR1) and four small unnamed tributaries (GR2, GR3, GR4, and GR5) that flow into Mile Run Creek. The design was based on a Rosgen Priority 3 restoration approach. Bankfull benches were constructed along both banks. In-stream structures, including root wads, double wing deflectors, and rock vanes were used to stabilize eroding streambanks and improve channel profile and bedform. Cross vanes were installed upstream and downstream of the golf cart bridges to prevent near bank scour at the bridges. A cross vane was constructed upstream of the box culverts to decrease the width of the low flow

channel. Reach GR1 from station 0+00 to 24+34 was converted from an incised E5/C5 to a C5. Managed and unmanaged forested buffers consisting of herbaceous perennials, shrubs, and bare roots were planted along the banks to provide stabilization.

Reach GR2 was designed using a Rosgen Priority 3 restoration approach. Reach GR2 is an unnamed tributary that drains off the city maintenance yard and flows into Reach 1 at station 17+00. Seven rock vanes were used to stabilize the streambanks and improve bedform diversity. A forested buffer 25 feet wide was painted to provide additional bank stabilization.

Restoration of GR3 was based on a Rosgen Priority 3 restoration approach. Reach GR3 is an unnamed tributary that is 450 feet long. A forested buffer, varying in width from 50 to 55 feet, was planted for additional stabilization.

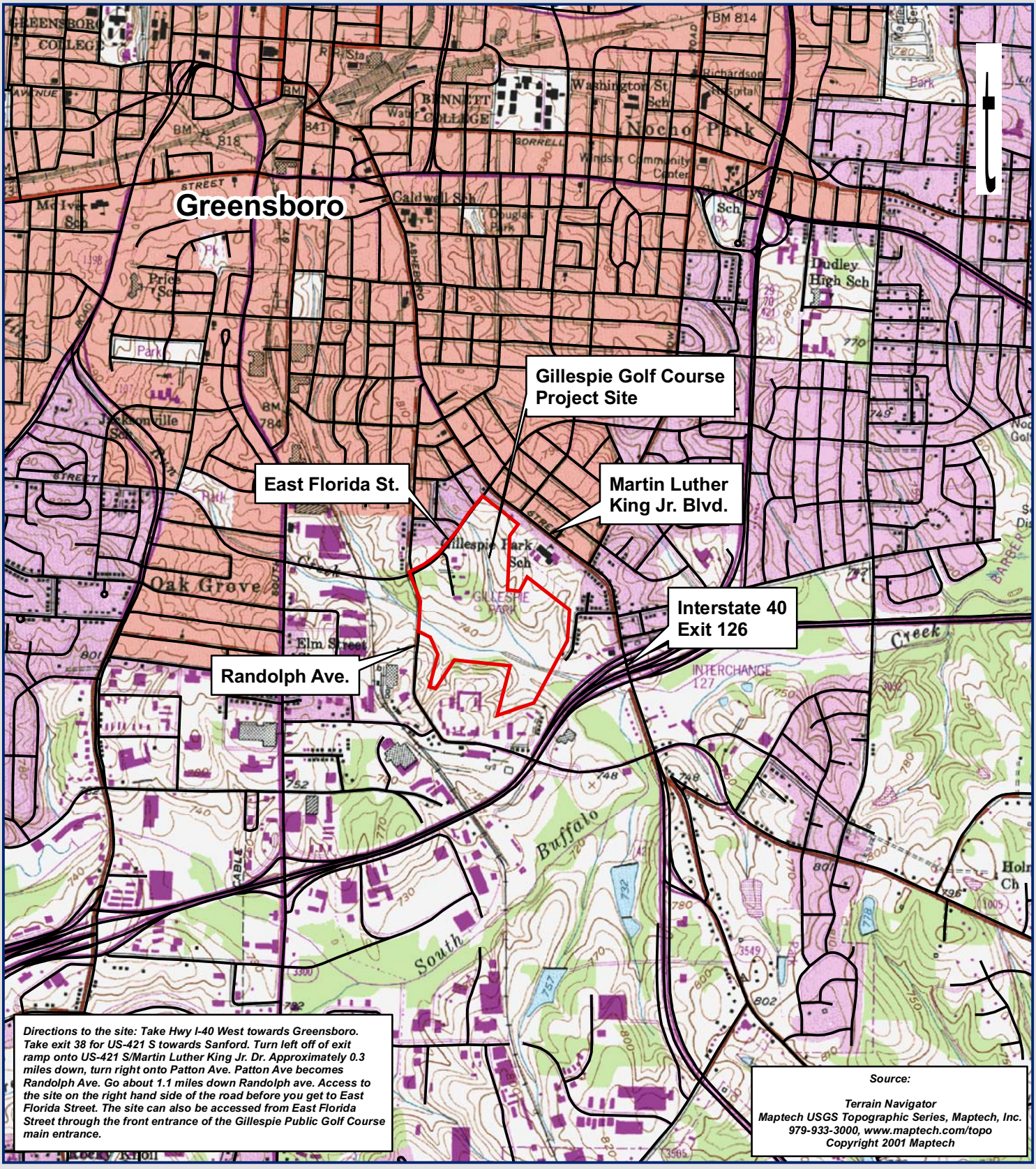
Reach GR4 was designed based on a bank stabilization restoration approach. Reach GR4 is an unnamed tributary that runs 1,300 feet before it intersects with Reach GR5 and then runs 300 feet into Mile Run Creek. Forested and herbaceous buffers, varying in width from 20 to 50 feet were planted along the reach to provide stability.

Reach GR5 of Mile Run Creek was based on a bank stabilization approach. Reach GR5 is an unnamed tributary that runs 800 feet before it intersects with Reach GR4 and then runs 300 feet into Mile Run Creek. Forested and herbaceous buffers, varying in width from 20 to 50 feet, were planted along the reach to provide stability.

Additional details regarding the restoration components of the project are provided in Table I.

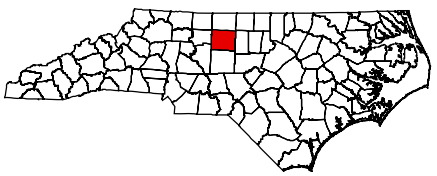
C. Location and Setting

The Gillespie Golf Course Stream Restoration Site includes 2,634 linear feet of Mile Run Creek and 3,436 linear feet of an unnamed tributary. The site is located in the City of Greensboro near the intersection of Interstate 85 and North Carolina Highway 22 (NC-22) in Guilford County, North Carolina (See Figure 1).



Ecosystem Enhancement PROGRAM

Figure 1.
Gillespie Golf Course
Stream Restoration Site
Vicinity Map
Guilford County, NC



0 1,000 2,000 4,000 Feet

Table I. Project Restoration Components Gillespie Golf Course Stream Restoration/Project No. 144					
Project Segment or Reach ID	**Mitigation Type**	**Approach**	**Existing Feet/Acres**	**Stationing**	**Comment**
Mile Run Crk., Reach GR1	Enhancement	Priority 3	2634 lf	0+00 to 26+34.26	In-stream Structures and Buffers
UT Reach GR2	Enhancement	Priority 3	250 lf	17+00 of Mile Run	In-stream Structures and Buffers
UT Reach GR3a	Stabilization	Bank Stabilization	461 lf	NA	In-stream Structures and Buffers
UT Reach GR3b	Enhancement	Priority 3	225 lf	NA	In-stream Structures and Buffers
UT Reach GR4	Stabilization	Bank Stabilization	1,425 lf	NA	20 to 50 foot buffer
UT Reach GR5	Stabilization	Bank Stabilization	800 lf	NA	20 to 50 foot buffer

NA - No stationing was provided for these reaches

D. Project History and Background

The construction of Mile Run Creek was completed in early 2004 with the As-Built survey occurred in February 2005. Year 1 monitoring took place in April 2005 and Year 2 monitoring occurred in October 2005. Additional details regarding the timeline of the project are provided in Table II below.

Table II. Project Activity and Reporting History Gillespie Golf Course Stream Restoration/Project No. 144		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	NA	February 2005
Final Design-90%	NA	NA
Construction	NA	March 15, 2004
Temporary S&E mix**	NA	NA
Permanent seed mix applied to reach/segments 1&2	NA	NA
Woody plantings for reach/segments 1&2	NA	March 15, 2004
Mitigation Plan /As-Built (Year 0 Monitoring-baseline)	NA	February 2005
Year 1 Monitoring	April 2005	April 2005
Year 2 Monitoring	October 2005	December 2005
Year 3 Monitoring	October 2006	December 2006
Year 4 Monitoring	October 2007	December 2007
Year 5 Monitoring		

*Historical project documents necessary to provide this data were unavailable at the time of this report submission
**Seed and mulch is added as each section of construction is completed.

The project was designed by Buck Engineering. Construction was performed by LJ, Incorporated. Monitoring activities for Year 4 were performed by WK Dickson and Co., Inc. Additional information regarding contractors is shown in Table III.

Table III. Project Contact Table Gillespie Golf Course Stream Restoration/Project No. 144	
Designer POC	Buck Engineering
	Mr. Mike Rooney
	8000 Regency Parkway, Suite 200
	Cary, NC 27511
	(919) 463-5490
Construction Contractor POC	LJ, Incorporated
	Mr. Arden Reiser
	PO Box 3188
	Mooresville, North Carolina 28117
	(704) 799-2670
Planting Contractor POC	NA
Seeding Contractor POC	NA
Seed Mix Sources	NA
Nursery Stock Suppliers	NA
Monitoring POC	WK Dickson and Co., Inc.
	Mr. Daniel Ingram
	3101 John Humphries Wynd
	Raleigh, NC 27612
	(919) 782-0495

NA-Historical project documents necessary to provide this data were unavailable at the time of this report submission

The project is located within Guilford County, within the Southern Outer Piedmont of the Piedmont physiographic province of North Carolina. The site is located within a highly urbanized area. Additional information regarding this stream is included in Table IV.

Table IV. Project Background Table Gillespie Golf Course Stream Restoration/Project No. 144	
Project County	Guilford
Drainage Area	
Mile Run Creek	2.2 sq. mi.
Tributary GR2	0.002 sq. mi.
Tributary GR3	0.04 sq. mi.
Tributary GR4	0.13 sq. mi.
Tributary GR5	0.04 sq. mi.
Drainage impervious cover estimate (%)	>20%
Stream Order	
Mile Run Creek	2nd order
Tributary GR2	1st order
Tributary GR3	1st order
Tributary GR4	1st order/2nd order
Tributary GR5	1st order
Physiographic Region	Piedmont
Ecoregion	Southern Outer Piedmont
Rosgen Classification of As-Built	C5
Cowardian Classification	NA
Dominant Soil Types	Chewacla sandy loam, Enon fine sandy loam
Reference Site ID	E5, Ut Lake Jeanette (Guilford), McClintock 1 & 2 (Mecklenburg); B4c, DuHart (Gaston), Silas (Forsyth), Morgan (Orange)
USGS HUC for Project	03030002 (Cape Fear)
USGS HUC for Reference	Ut Lake Jeanette 03030002, McClintock 03050103, DuHart 03050102, Silas 03040101, Morgan 03030002
NCDWQ Sub-basin for Project	030602
NCDWQ Sub-basin for Reference	Ut Lake Jeanette 030602, McClintock 030834, DuHart 030836, Silas 030704, Morgan 030606
NCDWQ Classification for Project	C, NSW
NCDWQ Classification for Reference	Ut Lake Jeanette-WSIII, NSW; McClintock-C, DuHart-WS-V, Silas-C, Morgan-WS-II, HQW, NSW, CA
Any Portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	Yes, Mile Run Creek is upstream of South Buffalo Creek
Reasons for 303d listing or stressor	Impaired biological stressor, stressor not identified, Urban runoff-storm sewers
% of project easment fenced	None

E. Monitoring Plan View

A series of monitoring points have been installed on site. A total of six (6) individual cross-sections were located. Cross-sections were plotted from left to right facing downstream. Each cross-section is also a designated photographic point that will be photographed annually. There are thirty-four (34) permanent photo points located at various points along the length of the channel. Four (4) vegetation-monitoring plots were randomly located within the riparian buffer of the Gillespie Golf Course Stream Restoration project. The locations of all monitoring installations are shown on the Monitoring Plan View (Figures 2a and 2b).

LEGEND

- STREAM TOP OF BANK
- STREAM CENTERLINE
- VEG PLOT
- SINGLE-ARM DEFLECTOR
- OUTLET BASIN
- DROP CROSS-VANE
- CONSTRUCTED RIFFLE
- DOUBLE-WING DEFLECTOR
- J-HOOK
- BOULDER CLUSTER
- BEDROCK
- PHOTO POINT

Gillespie
Figure 2a

100 50 0 100 200
SCALE (FT)

PROJECT MANAGER	DPI
DRAWN BY	TRS
APPROVED BY	
DRAWING SCALE	1"=100'
SURVEY DATE	
MAP DATE	
PROJECT NUMBER	5045700RA

WK DICKSON
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Office Locations:
North Carolina
South Carolina
Georgia
Florida

Ecosystem Enhancement Program

PREPARED FOR:

NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

TITLE:

YEAR 4 MONITORING PLAN VIEW
GILLESPIE GOLF COURSE
GREENSBORO
NORTH CAROLINA

LEGEND

- STREAM TOP OF BANK
- STREAM CENTERLINE
- VEG PLOT
- SINGLE-ARM DEFLECTOR
- OUTLET BASIN
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- CONSTRUCTED RIFFLE
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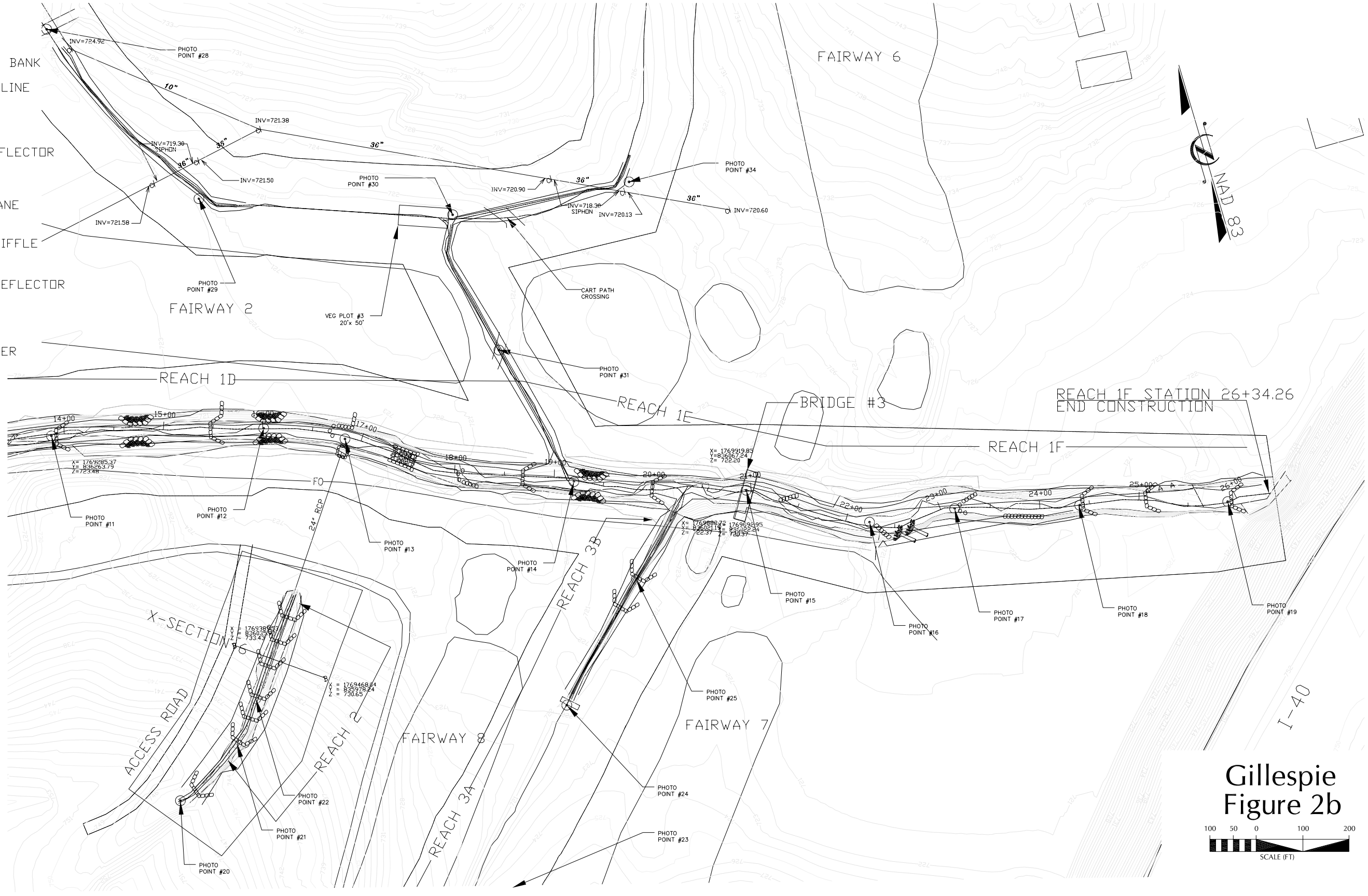

Gillespie
Figure 2b

100 50 0 100 200
SCALE (FT)

PROJECT MANAGER	DRAWING SCALE
DPI	1"=100'
DRAWN BY	SURVEY DATE
TRS	
APPROVED BY	MAP DATE
PROJECT NUMBER	
5045700RA	

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III. PROJECT CONDITION AND MONITORING RESULTS

Monitoring results are discussed below. An initial visual survey was conducted on March 22, 2007 with a more detailed monitoring survey (evaluation of vegetation plots) conducted in August 2007.

A. Vegetation Assessment

Planted zones related to the stream restoration consist of the riparian buffer zone and the stream banks. The riparian buffer zone begins at the top of the bank and continues out perpendicular from the stream. The planted stream bank initiates at the normal base flow elevation and extends to the top of bank or interface with the floodplain.

1. Soil Data

Soils present in the riparian areas adjacent to Mile Run Creek are characteristic of those found in alluvial landforms in the Southern Outer Piedmont. However, extensive grading and dredging has likely modified much of the naturally occurring soils on site.

Chewacla soils (*Fluvaquentic Dystrudepts*) are the prevalent map unit along the channel. Formed in recent alluvial sediments, they are very deep, moderately well and somewhat poorly drained soils with moderate permeability.

Other soil series found along the stream corridor are Enon soils. Enon soils (*Ultic Hapludalfs*) are very deep, well drained, slowly permeable soils found on ridgetops and side slopes in the Piedmont.

2. Vegetative Problem Areas

Mowing has been a problem at all vegetation plots since the implementation of the restoration project. Plot 4 was reported as completely mowed in the April 2005 Year 1 Monitoring Report. This plot had apparently recovered as of the Year 2 vegetation monitoring site visit and was back to its original state in Year 3 and Year 4 monitoring. The right bank is dominated by giant ragweed (*Ambrosia trifida*). Many shrubs were multi-stemmed, and invasive coral berry (*Symphoricarpos orbiculatus)* appears to be spreading throughout Plot 4. Mowing did not occur in Plots 1 and 2, but all of the vegetation in Plot 3 was mowed, with few plants re-sprouting. The vegetation problem area is depicted in Figure 2 and described in Appendix A, Table A.2, which lists the vegetation problem areas, their approximate station numbers, and the probable cause of the problem.

3. Stem Counts

The complexity of the planting plan required the establishment of four vegetation survival plots that were designed to monitor varying vegetation planting types.

- Plot 1 monitors bare root trees and live stakes.
- Plot 2 monitors shrubs, live stakes, and perennial plantings.
- Plot 3 monitors live stakes and perennial plantings.
- Plot 4 monitors shrubs on both sides of the channel.

Plots 1 and 2 are each 100 feet long and 25 feet wide along the right bank of the channel. The vegetation monitored in these plots includes planted bare root trees and live stake plantings. The

remaining two plots span both channel banks. Plot 4, a shrub plot, is 50 feet long and 50 feet wide, and Plot 3 is 50 feet long and 25 feet wide. All plots are adjacent to the golf course fairways and greenways.

The plots were originally marked with wooden stakes. The original corner stakes were often missing or found lying within the buffer. It appears that some corners are now within the maintained fairway by approximately two feet, with the portion of the plot furthest from the stream having been mowed.

- Plot 1 has not changed since Year 3 and is still approximately the same dimension as previously observed. The un-mowed portion of the vegetation plot is still 23 feet x 100 feet.
- Plot 2 has not changed since Year 3 and is still approximately the same dimension as previously observed. The un-mowed portion of the vegetation plot is still 23 feet x 100 feet.
- Plot 3 has been entirely mowed. Shrubs have been mowed, and few plants have re-sprouted. WK Dickson was not able to count any stems.
- Plot 4 had been previously mowed, but for the Year 4 monitoring season live stems were present, and several species were thriving throughout the plot.

In addition to percentage survival of planted stems, an estimate of total stems per acre is provided. The number of stems per acre is based upon extrapolating the number of stems per plot to stems per acre. This allows a useful assessment of the current conditions and will help decide if further action is necessary.

Of the original 223 monitored live stakes, 32 were alive in Year 4, a 14% survival rate. Plot 3 was entirely mowed, and few plants have re-sprouted. The issue of mowing beyond the vegetation plot boundary needs to be addressed. Of the original 162 shrubs that were planted, only 21, or 13% remain. In general, the mortality of over 25% of the original plantings of live stakes and shrubs necessitates additional plantings according to the guidelines set forth in the mitigation plan of February 2005.

The vegetation monitoring of the site revealed an average tree density of 227 trees per acre in Plot 1, and 87 trees per acre in Plot 2. The total number of trees per acre in both of these plots has already dropped below the 260 trees per acre required after 5 years to meet mitigation criteria. Natural recruitment of seedlings is also low. Additional plantings are needed to restore the density in these plots to at least 260 stems per acre to meet mitigation requirements according to success criteria set forth in the mitigation plan of February 2005.

The total number of shrubs has also been reduced to 13% of the original number planted. The number of shrub stems per acre is 209 in Plot 2, and 157 in Plot 4. It appears that aggressive mowing soon after planting has been the main contributor to the low survival of shrubs.

Volunteer species are abundant in Plots 1 and 2, and some are found in Plot 4. Common volunteer species found in Plot 1 are ashleaf maple (*Acer negundo*), silver maple (*Acer saccharinum*), sweet gum (*Liquidambar styraciflua*), mimosa (*Albizia jullibrisin*), slippery elm (*Ulmus rubra*), and sycamore saplings (*Platanus* sp.). Common volunteer species found in Plot 2 are silver maple, mimosa, and coral berry. Black cherry (*Prunus serotina*) is the most common volunteer species found in Plot 4. No volunteer species were found in Plot 3.

On September 5, 2007, WK Dickson conducted vegetation counts within each established plot as described above. The results of this survey are shown in Appendix A.

4. Vegetation Plot Photos

Photos of the vegetation plots are located in Section A-3 of Appendix A.

B. STREAM ASSESSMENT

WK Dickson and Co., Inc personnel performed an initial site visit at Gillespie Golf Course on August 14th to 17th, 2007. During the field visit, qualitative observations were recorded regarding the condition of the stream restoration project. Cross section and longitudinal surveys were also performed at the time of this visit. Six cross sections and approximately 3,000 linear feet of stream profiles were surveyed. Photographs were taken at all permanent photo points. A pebble count was performed for Year 4. The photographs show that vegetation is generally growing well and is a good combination of woody and herbaceous growth, although aggressive mowing has killed some of the trees and shrubs, thereby narrowing the buffer and reducing the vegetative height and diversity. Overall, the project is doing well with a few minor areas of erosion or areas of minimal vegetation. At this time, no repairs are recommended. The problem areas should be monitored over time; if the problems worsen, solutions should be discussed to assess the reasons for the problems and potential options to fix them. Vegetative problem areas are described in Appendix A, Table A.2, and stream problem areas are described in Appendix B, Table B.1.

Hydrologic Assessment

No crest gauges are installed at this site to document bankfull flow events. The following USGS stream gauge data had been used in past reports to verify bankfull events (Figure 3). Although this technique has been used to establish the occurrence of bankfull events for the history of this project, it is not scientifically valid. The accepted USGS procedure would be to transfer the discharge to the project reach from the gauge site, and then run a step-backwater or other flow model to predict slope and water surface elevation. Given the substantial short-comings in this method, our recommendation is that a crest gauge be installed at the project site.

Figure 3. USGS Stream Gauge Discharge Data for South Buffalo Creek at US 220.

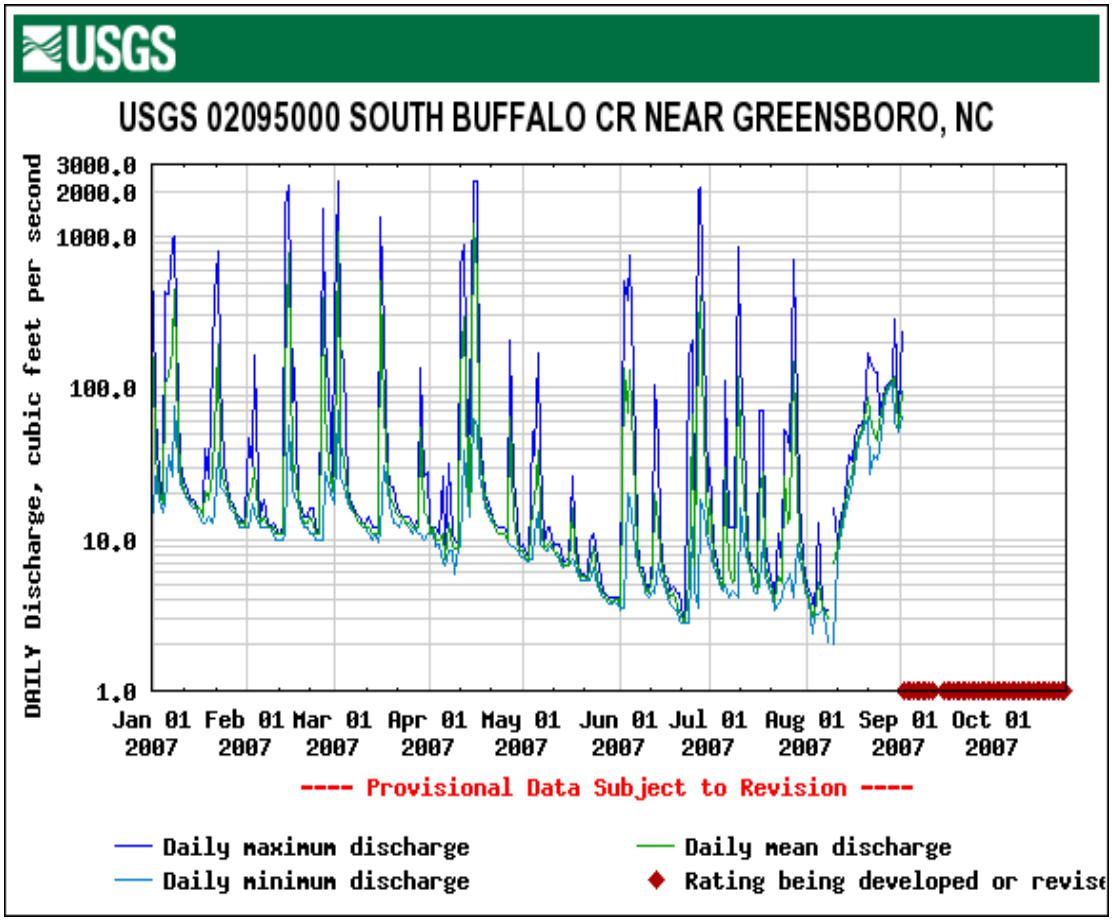

Table V lists bankfull events as they occurred in 2007.

Table V. Verification of Bankfull Events Gillespie Golf Course Stream Mitigation Site/Project No. 144				
Date of Data Collection	**Date of Occurrence**	**Maximum Discharge (cfs)**	**Method**	**Photo # (if available)**
2007	February 13, 2007	1560	Proximal USGS gauge resource	NA
2007	February 14, 2007	2170	Proximal USGS gauge resource	NA
2007	February 25, 2007	1550	Proximal USGS gauge resource	NA
2007	March 2, 2007	2340	Proximal USGS gauge resource	NA
2007	April 15, 2007	2320	Proximal USGS gauge resource	NA
2007	April 16, 2007	2350	Proximal USGS gauge resource	NA
2007	June 27, 2007	1990	Proximal USGS gauge resource	NA
2007	June 28, 2007	2130	Proximal USGS gauge resource	NA

1. Problem Areas Plan View

An assessment of the channel stability was preformed on April 27, 2007 by WK Dickson and Co., Inc. Several areas of concern were observed and documented, including localized bank scour, aggradation, and failure occurring with the engineered structures. These problem areas are shown in Figure 2.

2. Problem Areas Table Summary

The Problem Areas Summary Table is located in Appendix B, Table B.1.

3. Representative Stream Problem Areas Photos

Representative photos of each category of stream problem area were taken and are shown in Appendix B, Section B-3.

4. Fixed Photo Station Photos

Photos from established photo stations were collected on August 14, 2007 during the stream survey. These photos are included in Appendix B, Section B-4.

5. Stability Assessment

A visual qualitative assessment was performed to inspect channel facets, meanders, bed, banks, and installed structures. This visual assessment was confirmed and enhanced with a quantitative assessment of the physical stream survey. The goal of this assessment is to provide a percentage of the features listed in Table VI that are stable.

Table VI. Categorical Stream Feature Visual Stability Assessment
Gillespie Golf Course Stream Restoration/Project No. 144

Reach GR1/ (2,634 feet)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	100%	98%	96.20%	82%	82%	
B. Pools	100%	95%	NA	90%	90%	
C. Thalweg	100%	100%	NA	NA	NA	
D. Meanders	100%	100%	NA	NA	NA	
E. Bed General	100%	100%	NA	98%	98%	
F. Bank Condition	NA	NA	NA	98%	96%	
F. Vanes/J-Hooks etc.	100%	100%	95.80%	96%	96%	
G. Wads and Boulders	100%	100%	100%	86%	86%	

Note: Year 1 estimates are based upon review of text within the Buck Engineering Year 1 Monitoring Report.

6. Quantitative Morphology

The following tables (Table VII and Table VIII) summarize the quantitative data collected from the cross-sectional and longitudinal stream survey. These data were analyzed and summarized, and then compared with baseline data (i.e. as-built and previous year's data) available for this

project. The SRI urban Piedmont curve was used to determine an average bankfull cross-sectional area, and bankfull was placed at the elevation that would yield this area (for 2007 cross-sections). When the elevations chosen for bankfull were plotted on the longitudinal profile, the points formed a reasonably uniform slope that was consistent with the water surface slope. The baseline that has been chosen for 2007 is consistent with the regional curve and will provide accurate illustrations of departure if bankfull is located in the same manner for future years of monitoring. The Quantitative Morphology Tables illustrate the degree of departure, if any, of the current channel from the baseline data. Tables VII and VIII were compiled from the cross-section and profile raw data and plots located in Appendix B of this report.

Table VII. Baseline Morphology and Hydraulic Summary
Gillespie Golf Course Stream Restoration/Project No. 144
Reach GR1 (2,634 feet)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-Built		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)				27	35.9	31.6	27.2	44.4	29.2	9.1	12.6	10.6	*	*	27	24	28.5	26.3
BF Cross Sectional Area (ft2)				96	106	101	61.5	112.8	88	14.2	21.8	20.5	*	*	74	49.9	85.5	52.3
BF Mean Depth (ft)				2.7	3.6	3.1	1.9	3.9	2.9	1.6	2	1.6	*	*	2.7	1.9	3.4	2.2
BF Max Depth (ft)							3.8	5.4	4.7	*	*	*	*	*	3.4	2.9	5.7	3.4
Width/Depth Ratio							7.2	19.3	9.9	5	8	6	*	*	10	7.3	13.9	11.15
Entrenchment Ratio							>2.5	>3.9	>3.1	*	*	*	3	3.6	*	2.1	9.4	3.75
Wetted Perimeter (ft)							34.6	49	35	*	*	*	*	*	*	28.4	34.3	30.7
Hydraulic Radius (ft)							1.72	3.05	2.42	*	*	*	*	*	*	1.66	2.7	1.83
Pattern																		
Channel Beltwidth (ft)							*	*	*	32	45	*	*	*	*	*	*	*
Radius of Curvature (ft)							*	*	*	18	30	*	*	*	*	*	*	*
Meander Wavelength (ft)							*	*	*	35	69	*	*	*	*	*	*	*
Meander Width Ratio							*	*	*	2.7	5.7	*	*	*	*	*	*	*
Profile																		
Riffle Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Riffle Slope (ft)							*	*	*	0.0066	0.011	*	*	*	*	*	*	*
Pool Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Pool -to-Pool Spacing (ft)							*	*	*	*	*	*	54	108	*	*	*	*
Substrate																		
d50 (mm)							*	*	1	0.28	0.5	0.4	*	*	*	*	*	*
d84 (mm)							*	*	20	2.5	10	3.5	*	*	*	*	*	*
Additional Reach Parameters																		
Valley Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Channel Length (ft)							*	*	2877	*	*	*	*	*	1867	*	*	*
Sinuosity							*	*	1.09	1.3	2.4	*	*	*	1.1	*	*	*
Water Surface Slope (ft/ft)							*	*	0.0028	*	*	*	*	*	0.0028	*	*	*
BF Slope (ft/ft)							*	*	*	*	*	*	*	*	0.0025	*	*	*
Rosgen Classification							*	*	E5/C5	E5	E5	E5	*	*	E5	*	*	*
*Habitat Index							*	*	*	*	*	*	*	*	*	*	*	*
*Macrobenthos							*	*	*	*	*	*	*	*	*	*	*	*

*Historical documents necessary to provide this information were unavailable at the time of the report submission

Table VII Continued. Baseline Morphology and Hydraulic Summary
Gillespie Golf Course Stream Restoration/Project No. 144
Reach GR2 (250 feet)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-Built		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)							*	*	*	*	*	*	*	*	*	7.2	7.2	7.2
BF Cross Sectional Area (ft2)							*	*	*	*	*	*	*	*	*	4.6	4.6	4.6
BF Mean Depth (ft)							*	*	*	*	*	*	*	*	*	0.6	0.6	0.6
BF Max Depth (ft)							*	*	*	*	*	*	*	*	*	0.8	0.8	0.8
Width/Depth Ratio							*	*	*	*	*	*	*	*	*	11.2	11.2	11.2
Entrenchment Ratio							*	*	*	*	*	*	*	*	*	3.1	3.1	3.1
Wetted Perimeter (ft)							*	*	*	*	*	*	*	*	*	8.4	8.4	8.4
Hydraulic Radius (ft)							*	*	*	*	*	*	*	*	*	0.55	0.55	0.55
Pattern																		
Channel Beltwidth (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Radius of Curvature (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Meander Wavelength (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Meander Width Ratio							*	*	*	*	*	*	*	*	*	*	*	*
Profile																		
Riffle Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Riffle Slope (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Pool Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Pool -to-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							*	*	*	*	*	*	*	*	*	E5b	E5b	E5b
*Habitat Index							*	*	*	*	*	*	*	*	*	*	*	*
*Macrobenthos							*	*	*	*	*	*	*	*	*	*	*	*

*Historical documents necessary to provide this information were unavailable at the time of the report submission

Table VIII. Morphology and Hydraulic Monitoring Summary
Gillespie Golf Course Stream Mitigation Site/Project No. 144
Reach GR1 CS 1-5 (2,634 feet)
Tributary CS 6 (250 feet)

Parameter	Cross-Section 1					Cross-Section 2					Cross-Section 3					Cross-Section 4					Cross-Section 5					Cross-Section 6				
	2+09 Pool					5+86 Riffle					7+31 Riffle					9+65 Pool					12+76 Riffle					Trib 2 Riffle				
Dimension	MY0	MY1	MY2	MY3	MY4	MY0	MY1	MY2	MY3	MY4	MY0	MY1	MY2	MY3	MY4	MY0	MY1	MY2	MY3	MY4	MY0	MY1	MY2	MY3	MY4	MY0	MY1	MY2	MY3	MY4
BF Width (ft)	24.9	25.4	25.9	34.3	33.6	26.7	26.3	24.2	25.9	24.7	24	26.8	36.9	26.1	25.8	28.5	30.1	29.8	26.1	24.3	26.3	27.1	25	25.2	22.6	7.2	7.4	7.3	6.9	8.4
Floodprone Width (ft)	235	235	235	**	**	56	66	>60	>90	65	52	63	>90	>80	80	262	262	262	**	**	115	115	>185	>185	>185	22	22	18.2	22	22
BF Cross Sectional Area (ft2)	85.5	91	87.3	87.5	95.8	52.3	61.4	46.3	45.7	46.8	51.9	79.6	87.1	58.7	61.4	82.6	79.7	99	84.2	73.2	49.9	51.6	55	58.8	66	4.6	2.8	3.3	3.4	4.8
BF Mean Depth (ft)	3.4	3.6	3.4	2.6	2.8	2	2.3	1.9	1.8	1.9	2.2	3	2.4	2.2	2.4	2.9	2.7	3.3	3.2	3	1.9	1.9	2.2	2.3	2.9	0.6	0.4	0.5	0.5	0.5
BF Max Depth (ft)	5.7	5.3	5.2	5.2	5.7	3.1	3.8	3.4	3.4	3.7	3.4	4.6	4.3	4.2	4.3	4.4	4	5.4	4.8	4.3	2.9	3.1	5.1	5.4	5.7	1	0.8	0.9	1	0.9
Width/Depth Ratio	7.3	7.1	7.6	13.4	11.8	13.6	11.3	12.7	14.6	13	11.1	9	15.6	11.6	10.9	9.8	11.3	9	8.1	8.1	13.9	14.2	11.4	10.8	7.7	12	18.5	14.6	14.3	17.7
Entrenchment Ratio	9.4	9.2	9.1	**	**	2.1	2.5	>2.5	>2.5	2.6	2.2	2.4	>2.4	3.1	3.1	9.2	8.7	8.8	**	**	4.4	4.2	>7.4	7.3	8.2	3.1	3	2.5	3.2	2.6
Wetted Perimeter (ft)	31.7	36	32.64	38.0	37.0	30.7	30.9	28.05	27.1	27.9	28.4	32.8	41.64	28.1	28.2	34.3	35.5	36.45	28.7	27	30.1	30.9	29.4	28.8	26.4	8.4	8.2	8.19	7.4	8.7
Hydraulic Radius (ft)	2.7	2.53	2.67	2.3	2.6	1.7	1.99	1.91	1.7	1.7	1.83	2.43	2.09	2.1	2.2	2.41	2.25	2.72	2.9	2.7	1.66	1.67	1.87	2	2.5	0.55	0.34	0.41	0.5	0.5
Substrate																														
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	MY-01 (2005)					MY-02 (2005)					MY-03 (2006)					MY-04 (2007)					MY-05 (2008)					MY+ (2009)				
Pattern	Min	Max	Med			Min	Max	Med			Min	Max	Med			Min	Max	Med			Min	Max	Med			Min	Max	Med		
Channel Beltwidth (ft)	*	*	*			*	*	*			8	34	25			4	40	30												
Radius of Curvature (ft)	*	*	*			*	*	*			2	17	8			5	41	13												
Meander Wavelength (ft)	*	*	*			*	*	*			8	45	30			5	49	35												
Meander Width Ratio	*	*	*			*	*	*			0.33	1.41	1.04			0.80	1.23	1.17												
Profile																														
Riffle Length (ft)	*	*	*			5	79	24			15	65	37			2	106	36												
Riffle Slope (ft)	*	*	*			0	0.066	0.0025			0	0.041	0.023			0	0.038	0.010												
Pool Length (ft)	*	*	*			19.41	98.53	33.76			36.2	146.1	74.14			16.9	140.9	51.5												
Pool -to-Pool Spacing (ft)	*	*	*			19.41	292.7	100.18			38.7	203.5	107.4			24.0	222.6	107.6												
Additional Reach Parameters																														
Valley Length (ft)	2648					2648					2648					2648														
Channel Length (ft)	2642					2642					2642					2642														
Sinuosity	0.99					0.99					0.99					1.0														
Water Surface Slope (ft/ft)	0.00267					0.00296					0.00275					0.0027														
BF Slope (ft/ft)	NA					0.002835					0.0029					0.003														
Rosgen Classification	E/C					E/C					E/C					E/C														
*Habitat Index	NA					NA					NA					NA														
*Macrobenthos	NA					NA					NA					NA														

C. Wetland Assessment

There is no wetland restoration associated with this site. Table X is not applicable to this project.

IV. METHODOLOGY SECTION

No deviations from the established procedures were performed in collecting data for this report.

RECOMMENDATIONS

It is recommended that an invasive species control plan be developed and implemented. It is recommended that mowing in Plot 3 should be stopped and additional plantings are needed to restore the density in Plots 1 and 2 to at least 260 stems per acre to meet mitigation requirements according to success criteria set forth in the mitigation plan of February 2005.

References:

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Rosgen, D.L. (1996) *Applied River Morphology*. Wildland Hydrology Books, Pagosa Springs, Co.

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Appendix A

Appendix B