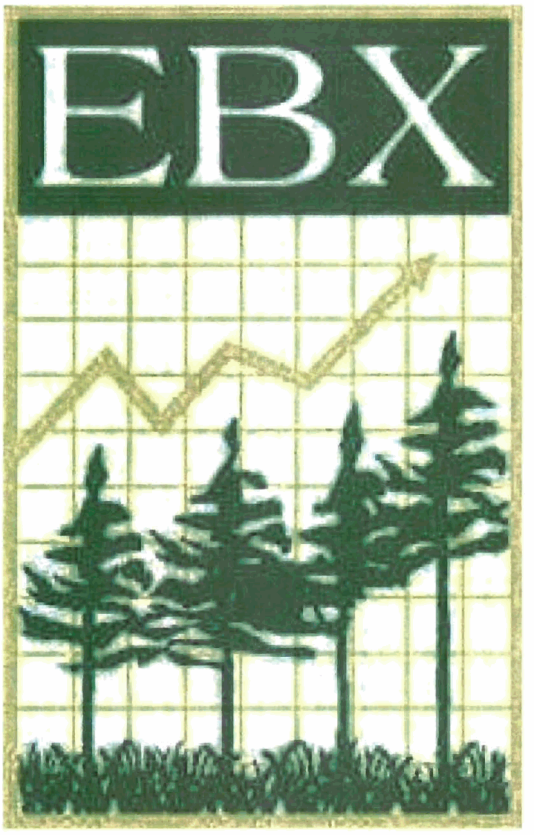
NEU-CON UMBRELLA
WETLAND AND STREAM MITIGATION BANK

WESTBROOK LOWGROUNDS WETLAND AND STREAM MITIGATION SITE
Annual Monitoring Report for 2005 (Year 3)



Environmental Banc & Exchange, LLC
Managers, Bankers, and Traders of Environmental Rights

"We Invest in the Environment."

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ANNUAL REPORT FOR 2005 (Year 3)

Westbrook Lowgrounds Mitigation Site

1.0 SUMMARY

This Annual Report details the monitoring activities during the 2005 growing season on the Westbrook Lowgrounds Mitigation Site. Construction of the site, including planting of trees, was completed in February 2003. The 2005 data represents results from the third year of hydrologic and vegetation monitoring for both wetlands and streams.

The design for the Westbrook Lowlands property involved the restoration of a Coastal Plain, small stream swamp and associated wet flats as described by Schafale and Weakley (1990). The Coastal Plain, small stream swamp communities exist as the floodplains of small blackwater streams in which separate fluvial features and associated vegetation are too small or poorly developed to distinguish. After construction, it was determined that 5,414 feet of stream and 66.2 acres of wetland hydrology were restored.

This Annual Report presents the data from 5 hydrologic monitoring stations, 13 vegetation monitoring stations, and stream monitoring, as required by the approved Mitigation Plan for the site. Two of the hydrologic stations are equipped with manual groundwater gauges and three stations are equipped with automated gauges and a manual calibration gauge. Additionally, the gauges are used as points from which photographs are taken over time.

Weather station data from the Smithfield Weather Station were used in conjunction with a manual rain gauge located on the site to document precipitation amounts. The manual gauge is used to validate observations made at the automated station. For the 2005 growing season, total rainfall during the monitoring period was much less than the long-term average (approximately 16 inches less from October 2004 through October 2005). Much of the rain that fell during the 2005 growing season fell during the months of May, June, and August when evapotranspiration losses were highest.

In 2005, four of five hydrology monitoring gauges have met the hydrologic success criteria based on field observations. The one remaining gauge that did not meet success criteria exhibited a hydroperiod less than 5 percent of the growing season. However, the gauge correlates with data collected from gauges located on the reference site that also experienced dry conditions during the 2005 growing season. Based on these results, it was concluded that the site is performing as designed, but that drier than normal conditions occurred during the 2005 monitoring year.

Thirteen monitoring plots 0.1 acre in size were used to predict survivability of the woody vegetation planted on site. The vegetation monitoring indicated an average survivability of over 528 stems per acre, which achieves the initial vegetation survival criteria of 320 stems per acre surviving after the third growing season.

2.0 INTRODUCTION

2.1 Project Description

Located in Johnston County, the entire Westbrook Lowlands Mitigation Site covers approximately 140 acres and is located approximately one mile east of the town of Bentonville, North Carolina (Figure 1). This project provides compensatory mitigation for stream and wetland impacts associated within the resident hydrologic unit. The Westbrook Lowlands site is designed to restore a Coastal Plain, small stream swamp and associated wet flats as described by Schafale and Weakley (1990). The Coastal Plain, small stream swamp communities exist as the floodplains of small, blackwater streams in which separate fluvial features and associated vegetation are too small or poorly developed to distinguish. Construction was completed in January 2003, and 66.2 acres were planted in February 2003. Groundwater, surface water, and rain gauges were functional beginning March 7, 2003. The 2005 monitoring season represents the third year of monitoring for the site.

2.2 Purpose

Monitoring of the Westbrook Lowland Site is required to demonstrate successful mitigation based on the criteria found in the Mitigation Plan, the Neu-Con Umbrella Stream and Wetland Mitigation Bank Instrument, and through a comparison to reference site conditions. Hydrologic, vegetation, and stream monitoring are conducted on an annual basis. Success criteria must be met for five consecutive years. This Annual Report details the results of the monitoring efforts for 2005 (Year 3) at the Westbrook Lowgounds Mitigation Site.

2.3 Project History

June 2001	Pre-restoration Monitoring Gauges Installed
Fall 2002	Approved Mitigation Plan
November 2002	Construction Began
January 2003	Construction Completed
February 2003	Planting Completed
March 2003	Post-restoration Monitoring Begins
November 2003	1st Annual Monitoring Report
November 2004	2nd Annual Monitoring Report
November 2005	3rd Annual Monitoring Report
November 2006 (scheduled)	4th Annual Monitoring Report
November 2007 (scheduled)	5th Annual Monitoring Report

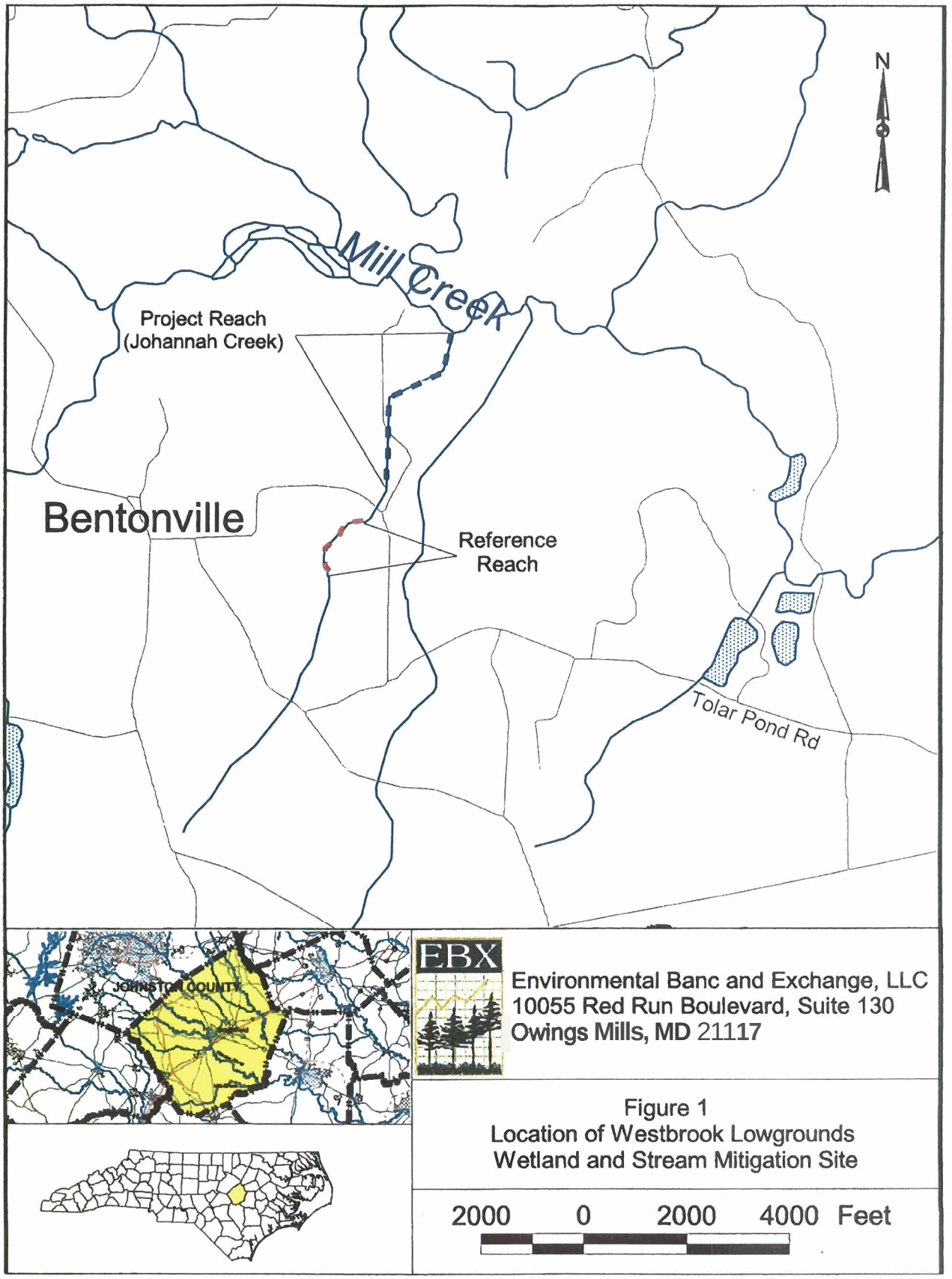


Figure 1. Location of Westbrook Lowgrounds Wetland and Stream Mitigation Site.

3.0 HYDROLOGY

3.1 Success Criteria

As stated in the approved Mitigation Plan, the hydrologic success criteria for the site are to restore the water table so that it will remain within 12 inches of the soil surface for at least 9 percent of the growing season continuously (approximately 21 days). The day counts are based on the growing season for Johnston County, which is 232 days long, beginning on March 17 and ending November 5, as calculated from National Weather Service Wetlands Determination Tables (WETS) for Johnston County. As specified in the approved Mitigation Plan, data are collected from three automated and two manual groundwater gauges.

The Mitigation Plan further specified that in order for the hydrologic data to be considered successful it must demonstrate wetland conditions are present in normal or dryer than normal conditions. During the 2005 growing season, the rainfall total over the period from October 2004 through October 2005 was approximately 16 inches below the long-term average. Further, much of the rain that fell during the 2005 growing season occurred during the months of May, June, and August when evapotranspiration losses were highest.

Monitoring data from the reference site demonstrate positive correlations between the restoration site and the natural hydrology of the target system. At the reference site, conditions were also drier than normal.

3.2 Description of Hydrologic Monitoring Efforts

Two manual groundwater gauges, three automated Remote Data Systems (RDS) WL 40 groundwater gauges, and one rain gauge were installed prior to the beginning of the first growing season (see the as-built drawing in Figure 2). Groundwater gauges, both manual and automated, were installed to a minimum depth of at least 32 inches below the ground surface. The monitoring protocol for the site specifies that automated monitoring stations will be downloaded and checked for malfunctions on a monthly basis. During monthly site visits, manual groundwater gauges are read and rainfall totals are collected from the on-site rain gauge. During the 2005 growing season a period of missing data occurred on AW2 between September 30 and October 19 due to a downloading error.

Prior to the start of the 2005 growing season, one of the RDS loggers (WB-AW2) failed and was replaced by a logger manufactured by Infinities USA, Inc. Based on past monitoring experience, the Infinities loggers have proved to be more reliable than those manufactured by RDS, and provide the same level of accuracy. Therefore, any RDS loggers that fail will be replaced by Infinities loggers.

PROJECT: 043 WESTBROOK LOWGROUNDS

STREAM AND WETLAND RESTORATION PROJECT
ENVIRONMENTAL BANC AND EXCHANGE, LLC
WESTBROOK LOWGROUNDS SITE

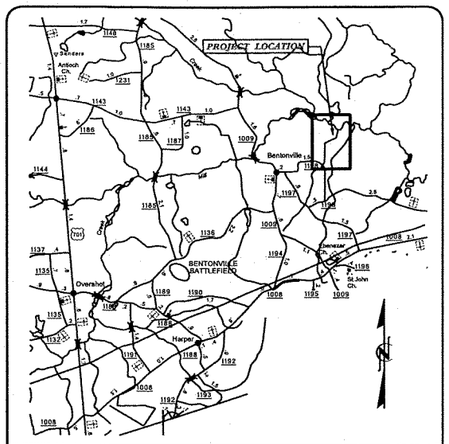
JOHNSTON COUNTY

LOCATION: WESTBROOK LOWGROUNDS ROAD (SR 1198)
NEAR BENTONVILLE, NC

TYPE OF WORK: AS-BUILT DRAWING FOR WETLAND AND STREAM MITIGATION

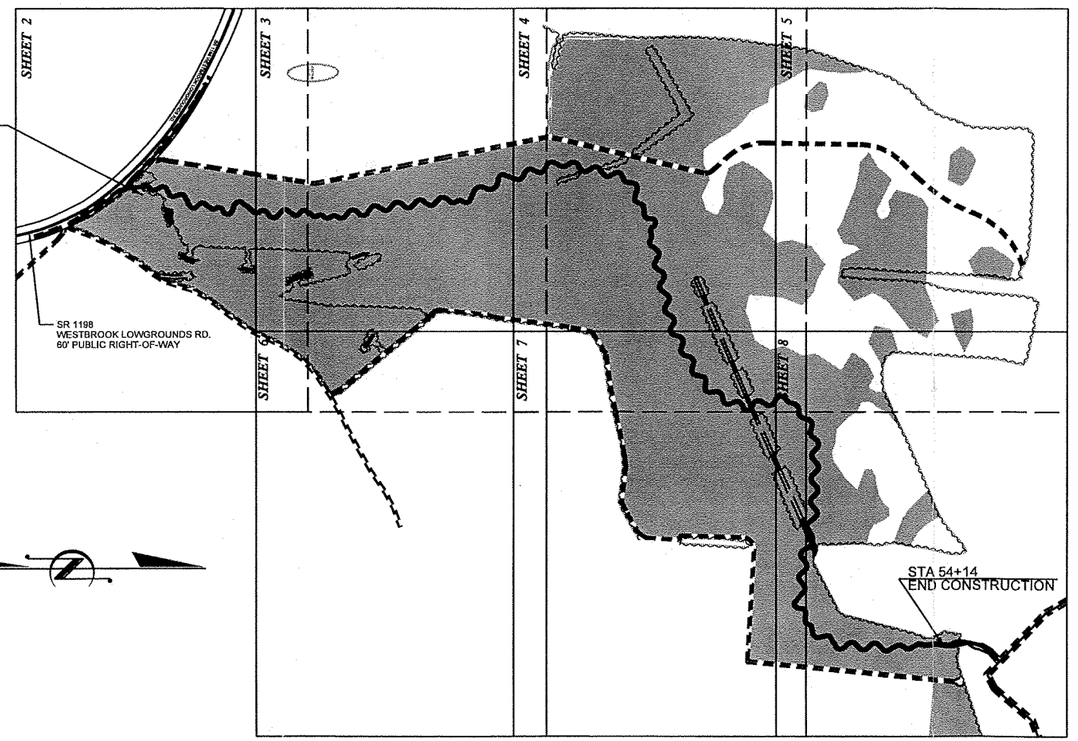
STATE	BUCK PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	043	1	8

NO.	DATE	CHECKED BY	APPROVED BY
1	28 JAN 2005	KEVIN TWEEDY	KEVIN TWEEDY



VICINITY MAP

INDEX OF SHEETS:



GRAPHIC SCALES

50 25 0 50 100
PLANS

PROJECT SUMMARY

RESTORED STREAM LENGTH = 5414 FEET
RESTORED WETLAND ACREAGE = 66.2 ACRES

PREPARED FOR THE OFFFICE OF:
ENVIRONMENTAL BANC AND EXCHANGE, LLC

10055 RED RUN BOULEVARD, SUITE 130
OWING MILLS, MD 21117

8000 REGENCY PARKWAY SUITE 200A
CARY, NORTH CAROLINA 27511

EBX CONTACT:
GEORGE KELLY
PROJECT MANAGER

PREPARED IN THE OFFICE OF:

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

APRIL 11, 2003
DATE PREPARED:

KEVIN L. TWEEDY, PE
PROJECT ENGINEER

PROJECT ENGINEER

Figure 2a.
As-Built Drawing for the Westbrook Mitigation Site

SIGNATURE: _____ *P.E.*

MATCHLINE SHEET 3

SR 1198 WESTBROOK LOWGROUNDS RD.

ROAD DITCH

X-SECTION 2
STA 2+07

X-SECTION 1
STA 1+59

VEGETATION PLOT #7

DITCH PLUG

DITCH PLUG

DITCH PLUG

DIVERSION DITCH TO ROUTE ROAD RUNOFF INTO WETLAND SITE

CULVERT #4 18" RCP
PERMANENT SITE ACCESS
LENGTH = 40 FT

STATION 0+00
BEGIN CONSTRUCTION
N=4746 7993
E=5392 6200

PROJECT REFERENCE NO.	SHEET NO.
043	2

EBX WESTBROOK LOWGROUNDS

PLAN VIEW OF
EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

Figure 2b. As-Built Drawing for the Westbrook Mitigation Site

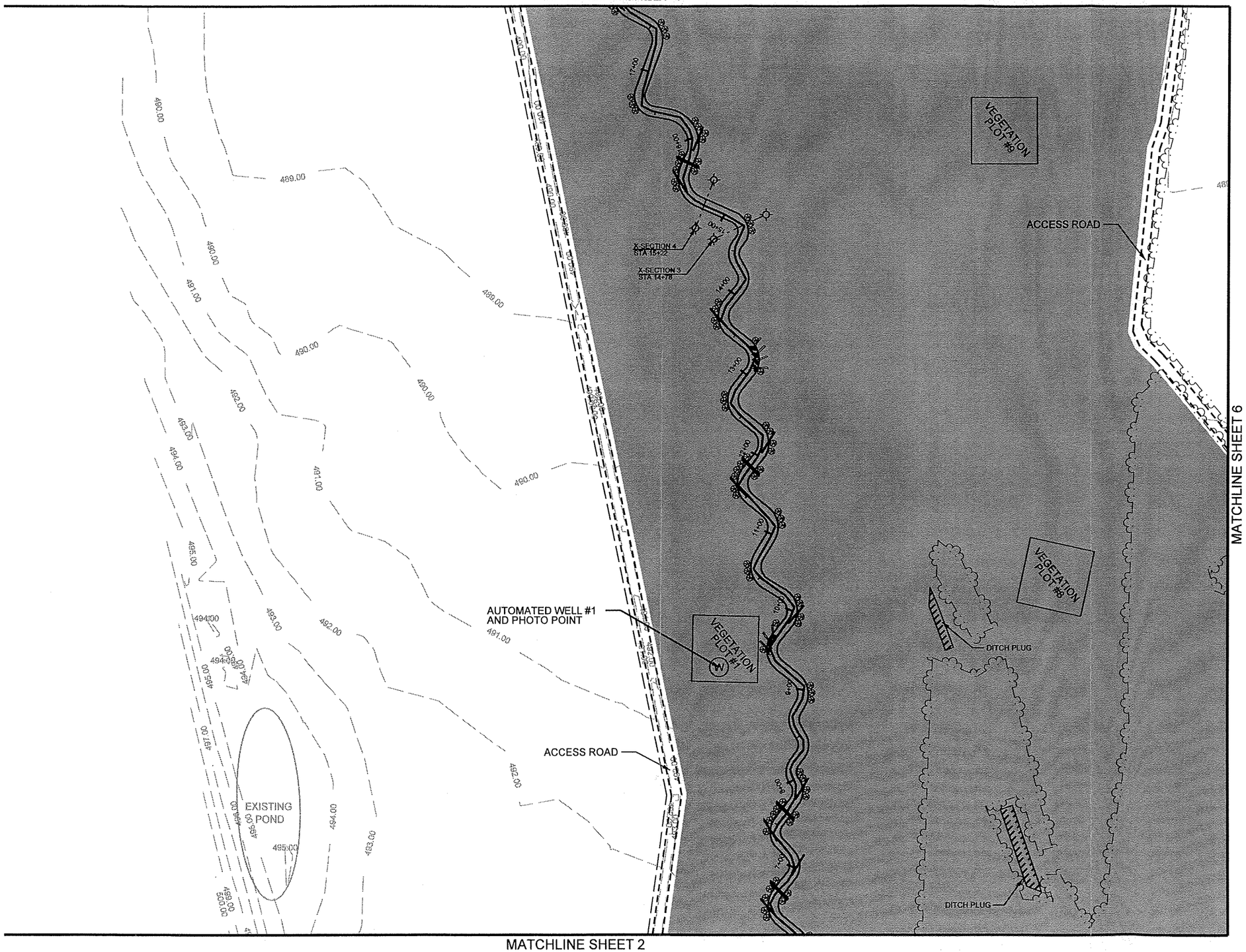
BUCK ENGINEERING
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CE CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

50 25 0 50 100
SCALE (FT)

MATCHLINE SHEET 4



MATCHLINE SHEET 6

MATCHLINE SHEET 2

PROJECT REFERENCE NO.	SHEET NO.
043	3

EBX WESTBROOK LOWGROUNDS

PLAN VIEW OF
EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

Figure 2c. As-Built Drawing for the Westbrook Mitigation Site

BUCK ENGINEERING
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CE CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

50 25 0 50 100
SCALE (FT)

PROJECT REFERENCE NO.	SHEET NO.
043	4

EBX WESTBROOK LOWGROUNDS

PLAN VIEW OF
EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

Figure 2d. As-Built Drawing for the Westbrook Mitigation Site

BUCK ENGINEERING
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

MATCHLINE SHEET 5

MATCHLINE SHEET 7

MATCHLINE SHEET 3

ACCESS ROAD

CHANNEL BLOCK

VEGETATION PLOT #5

VEGETATION PLOT #5

MANUAL WELL #1
AND PHOTO POINT

X-SECTION 5
STA 25+15

X-SECTION 6
STA 25+44

VEGETATION PLOT #2

ACCESS ROAD

AUTOMATED WELL #2
AND PHOTO POINT

VEGETATION PLOT #10

ACCESS ROAD

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CE CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

SCALE (FT)
50 25 0 50 100

PROJECT REFERENCE NO.	SHEET NO.
043	5

EBX WESTBROOK LOWGROUNDS

PLAN VIEW OF
EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

Figure 2e. As-Built Drawing for the Westbrook Mitigation Site

BUCK ENGINEERING
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CE CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

50 25 0 50 100
SCALE (FT)

MATCHLINE SHEET 7

MATCHLINE SHEET 3

489.00

489.00

489.00

490.00

490.00

490.00

490.00

490.00

490.00

490.00

490.00

490.00

EARTHEN BERM CONSTRUCTED ACROSS ABANDONED ROAD

PROJECT REFERENCE NO.	SHEET NO.
043	6

EBX WESTBROOK LOWGROUNDS

PLAN VIEW OF EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

Figure 2f. As-Built Drawing for the Westbrook Mitigation Site

BUCK ENGINEERING
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CE CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

N

50 25 0 50 100
SCALE (FT)

MATCHLINE SHEET 8

CHANNEL BLOCK

CHANNEL BLOCK

VEGETATION PLOT #12

AUTOMATED WELL #3 AND PHOTO POINT

ACCESS ROAD

VEGETATION PLOT #11

ACCESS ROAD

MATCHLINE SHEET 4

MATCHLINE SHEET 6

PROJECT REFERENCE NO.	SHEET NO.
043	7

EBX WESTBROOK LOWGROUNDS

PLAN VIEW OF EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

Figure 2g. As-Built Drawing for the Westbrook Mitigation Site

BUCK ENGINEERING
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CE CONSERVATION EASEMENT
- V TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

SCALE (FT): 50 25 0 50 100

PROJECT REFERENCE NO.	SHEET NO.
043	8

EBX WESTBROOK LONGROUNDS

PLAN VIEW OF EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

Figure 2h. As-Built Drawing for the Westbrook Mitigation Site

BUCK ENGINEERING
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CE CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

INSET "A"

MILL CREEK
(APPROX. LOCATION)

SEE INSET "A"

STATION 54+14
END CONSTRUCTION
N=7744.4772
E=7046.1261

X-SECTION 11
STA 53+08

MATCHLINE SHEET 5

VEGETATION PLOT #6

CHANNEL BLOCK

X-SECTION 8
STA 37+31

X-SECTION 7
STA 37+11

CHANNEL BLOCK

VEGETATION PLOT #12

X-SECTION 9
STA 44+94

X-SECTION 10
STA 45+22

ACCESS ROAD

VEGETATION PLOT #13

MATCHLINE SHEET 7

50 25 0 50 100
SCALE (FT)

3.3 Results of Hydrologic Monitoring

3.3.1 Site Data

The following hydroperiod statistics were calculated for each monitoring station during the growing season: 1) most consecutive days that the water table was within twelve inches of the soil surface; 2) cumulative number of days that the water table was within twelve inches of the soil surface; and 3) number of times that the water table rose to within twelve inches of the soil surface. The results of these calculations are presented in Table 1. Figure 3 provides a chart of the water depth for each of the monitoring gauges on the site. Precipitation events are shown at the top of the graph. The figure demonstrates the reaction at each monitoring location of the groundwater level to specific rainfall events. Raw hydrograph data collected from the monitoring gauges are provided in Appendix A.

The site was designed to function as a riparian wetland system with associated wet flats. Hydrology in the riparian areas is driven primarily by groundwater discharge and overbank flooding, whereas precipitation is the primary hydrologic influence in the wet flat areas. Monitoring has thus far demonstrated that the site is functioning as designed, with varying degrees of wetness and saturation across the site. Gauges A3, A2, M1, and M2 have exceeded the 9 percent hydrologic success criteria, while gauge AW1 is exhibiting saturated conditions for less than 9 percent of the 2005 growing season.

Table 1. Hydrologic Monitoring Results for 2005 (Year 3).

Monitoring Station	Most Consecutive Days Meeting Criteria[1]	Cumulative Days Meeting Criteria[2]	Number of Instances Meeting Criteria[3]
WB-AW1[4]	9 (3.9%)	42 (18.1%)	12
WB-AW2[5]	21 (9.1 %)	54 (23.3%)	13
WB-AW3	24 (10.3%)	53 (22.8%)	9
WB-M1[6]	~24 (10.3%)	~53 (22.8%)	~9
WB-M2[6]	~24 (10.3%)	~53 (22.8%)	~9

Notes:

Percentage indicates percent of the growing season.

1. Indicates the most consecutive number of days within the monitored growing season with a water table less than 12 inches from the soil surface.
2. Indicates the cumulative number of days within the monitored growing season with a water table less than 12 inches from the soil surface.
3. Indicates the number of instances within the monitored growing season when the water table rose to less than 12 inches from the soil surface.
4. During a period of 20 consecutive days, between March 17 and April 6, 2005, well readings were within 0.8 inches of the 12 inch criteria line.
5. During the period of 21 days meeting hydrologic criteria, the water table fell to 0.3 inches below the 12 inch criteria line for one and a half days. This discrepancy was deemed to be within the range of measurement error, therefore the entire 21 day period was considered to appropriately document the hydrologic conditions at gauge WB-AW2.
6. Groundwater gauges WB-M1 and WB-M2 are manual gauges. Hydrologic parameters are estimated based on data from gauge WB-AW3, however wetter conditions were documented at both M1 and M2 as compared to AW3.

The approved mitigation plan for the Westbrook Lowgrounds Site states in Section 3.5:

"*... [model] simulations indicate that, on average, the water table will be less than 30 cm [12 inches] deep continuously for approximately 9 percent of the growing season. This scenario can be assumed to represent average conditions across the site, with the majority of the restored acreage on the site being represented by this hydrologic scenario. It is probable that there will be areas slightly drier or slightly wetter than the modeled scenario within the restoration area. The modeled scenario provides a basis for estimating the average hydrologic condition over the restored site, based on the proposed restoration practices. However, it is important to note that the hydrology of the targeted restored wetland system (Coastal Plain, small stream swamp) is highly variable across a given site, supporting the ecological and functional diversity that makes these systems so valuable.*"

The model simulations performed during the design phase of the project indicated that the entire site would range from slightly higher than the minimum wetland criteria of 5 percent to more saturated areas that would exceed 12.5 percent. While most of the site is performing as described in the Mitigation Plan, the upper west corner of the site (represented by gauge AW1) displayed drier conditions during the 2005 growing season.

This area has displayed drier than expected conditions during the past two monitoring years. During January 2005, several of the log weir grade control structures were raised on the upstream side of the project to promote more frequent flooding and higher water table conditions in this area. The effort has been successful at raising the baseflow elevation of the stream by approximately 0.5 – 1.0 foot. However, especially dry conditions throughout most of 2005 have masked any positive improvements to hydrology that may become apparent under more normal rainfall conditions. Conclusions and recommendations are provided in Section 3.4.

3.3.2 Climatic Data

Table 2 provides a comparison of the 2005 monthly rainfall to historical precipitation (collected between 1961 and 1990) for Johnston County. Historic data presented were collected from an automated weather station in Smithfield. For the period when rainfall measurements were collected on-site (October 2004 – October 2005), the rainfall total from the Smithfield gauge (34.01 inches) is higher than the data collected from the onsite manual rain gauge (30.5 inches). Total rainfall recorded from October 2004 – October 2005 for the Smithfield gauge was approximately 32 percent less (16 inches) below the long-term average. More importantly, the majority of the rainfall that fell during the 2005 season fell during the summer months when evapotranspiration losses are, historically, greatest. Table 2 compares date from 2005 to long-term average rainfall data. Monthly rainfall for November and December 2005 were not available at the time this report was compiled.

Table 2. Comparison of Historic Average Rainfall to Observed Rainfall (Inches).

Month	Average	30%	70%	Observed Precipitation, P (in) Month	P
October	3.16	1.78	3.93	October 2004	0.6
November	2.95	1.93	3.76	November 2004	2.86
December	3.05	2.06	3.8	December 2004	0.64
January	4.24	3.37	5.14	January 2005	2.44
February	3.66	2.51	4.46	February 2005	1.94
March	4.57	3.54	5.54	March 2005	4.17
April	3.24	1.98	4.01	April 2005	2.82
May	4.16	2.83	4.9	May 2005	2.78
June	4.14	2.57	4.6	June 2005	3.49
July	5.13	3.48	6.34	July 2005	6.86
August	4.58	3.05	5.66	August 2005	2.02
September	4.54	2.34	5.97	September 2005	2.28
October	3.16	1.78	3.93	October 2005	1.11
November	2.95	1.93	3.76	November 2005	N/A
December	3.05	2.06	3.8	December 2005	N/A

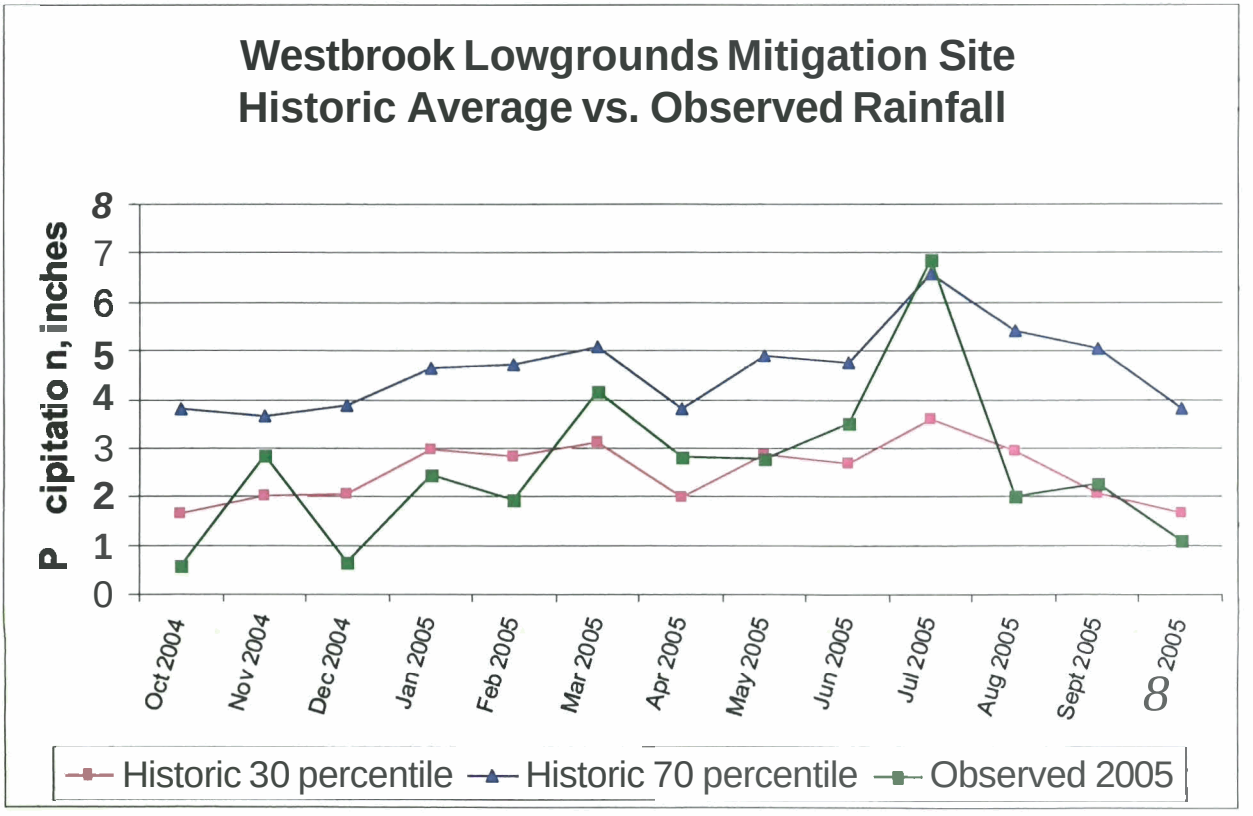


Figure 3. Historic Average vs. Observed Rainfall.

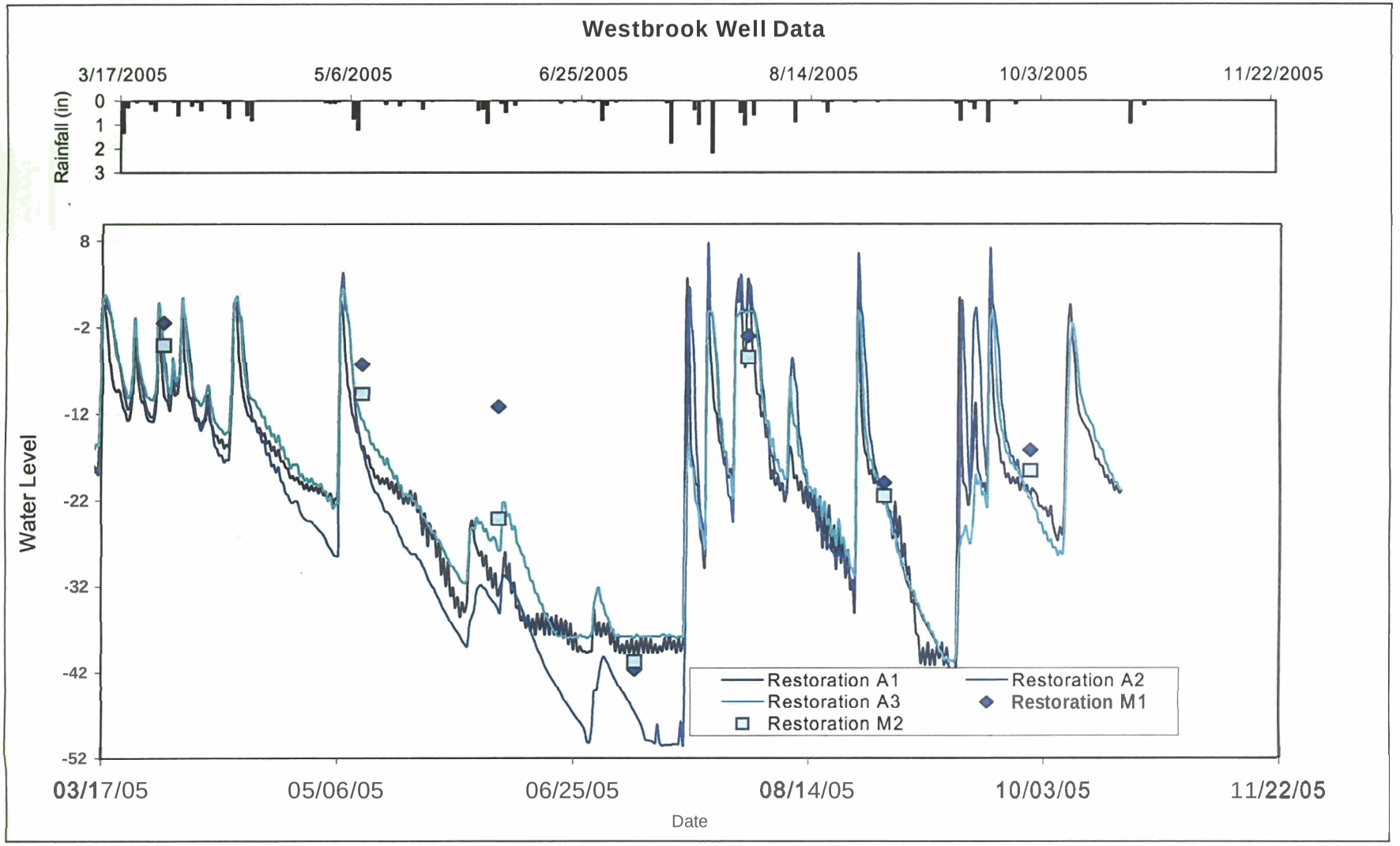


Figure 4. 2005 Groundwater Gauge Data Graph.

3.4 Hydrologic Conclusions

Data collected from all the groundwater monitoring gauges on the Westbrook Lowgrounds Mitigation Site indicate that approved hydrologic success criteria have been met during the 2005 growing season for four out of the five stations.

During January 2005, several of the log weir grade control structures near well AW1 were raised to promote more frequent flooding and higher water table conditions in this area. The effort has been successful at raising the baseflow elevation of the stream by approximately 0.5 – 1.0 foot. However, especially dry conditions throughout most of 2005 have masked any positive improvements to hydrology that may become apparent under more normal rainfall conditions.

In summary, the site is performing as designed and predicted, with varying degrees of saturation across the site. The site, in general, exhibits flashy hydrographs that appear to be indicative of the soils and hydrology of the targeted wetland system, since similar trends have been documented on the adjacent reference site (see Section 6).

4.0 VEGETATION

4.1 Success Criteria

The interim measure of vegetative success identified in the approved Mitigation Plan will be the survival of at least 320 3-year old trees per acre at the end of Year 3 of the monitoring period. The final vegetative success criteria will be the survival of 260 5-year old trees per acre at the end of the monitoring period. Up to 20 percent of the site species composition may be comprised of invaders. Remedial action may be required should these (i.e. loblolly pine, red maple, sweet gum, etc.) present a problem and exceed 20 percent composition.

Construction of the site, planting of bare root trees, and spreading of the permanent seed mixture was completed in March 2003. Approximately 45,000 trees were planted over 66.2 acres.

4.2 Description of Species and Monitoring Protocol

The following tree species were planted in the Westbrook Wetland Restoration Area:

Table 3. Tree Species Planted in the Westbrook Wetland Restoration Area.

ID	Common Name	Scientific Name	FAC Status
1	Sugarberry	*Celtis laevigata*	FACW
2	Swamp Tupelo	*Nyssa biflora*	OBL
3	Blackgum	*Nyssa sylvatica*	FAC
4	Laurel Oak	*Quercus laurifolia*	FACW
5	Swamp White Oak	*Quercus* lyrata	OBL
6	Swamp Chestnut Oak	*Quercus michauxii*	FACW-
7	Water Oak	*Quercus nigra*	FAC
8	Cherrybark Oak	*Quercus pagoda*	FAC+
9	Coastal Willow Oak	*Quercus phellos*	FACW-
10	Shumard Oak	*Quercus shumardii*	FACW-
11	Bald Cypress	*Taxodium distichum*	OBL

The following monitoring protocol was designed to predict vegetative survivability. Thirteen plots were established on the Westbrook Mitigation Site, to monitor approximately 2 percent of the site. The vegetation monitoring plots were designed to be 0.1 acre in size, or 66' x 66' dimensionally. The plots were randomly located and randomly oriented within the wetland restoration area.

Plot construction involved using metal fence posts at each of the four corners to clearly and permanently establish the area that was to be sampled. Then ropes were hung connecting all four corners to determine if trees close to the plot boundary were inside or outside of the plot. Trees immediately on the boundary, and trees just outside of the boundary that appear to have greater than 50 percent of their canopy inside the boundary were counted inside the plot. A piece of white PVC pipe ten feet tall was placed over the metal post on one corner to facilitate visual location of site throughout the five-year monitoring period.

All of the planted stems inside the plot were flagged to mark them as the planted stems (vs. any colonizers) and to help in locating them in the future. Each stem was then tagged with a permanent numbered aluminum tag.

4.3 Results of Vegetative Monitoring

Table 4 shows stem counts for each of the monitoring stations. Numbers identify planted tree species and letters identify volunteer tree species at the top row, and each plot is identified down the left column. To match the numeric Species ID with the species name, please refer to the previous table. Trees are flagged in the field on a quarterly basis before the flags degrade. Flags are utilized because they will not interfere with the growth of the tree. Volunteers are also flagged during this process.

Table 4. 2005 Vegetation Monitoring Statistics by Plot.

Plot	1	2	3	4	5	6	7	8	9	10	11	Total	Stem/ac
W1	1	5	5	6	5	0	5	4	5	3	13	52	520
W2	4	4	6	10	0	0	2	6	0	22	4	58	580
W3	6	2	5	7	1	0	2	13	2	6	12	56	560
W4	0	0	3	4	1	18	12	1	6	18	0	63	630
W5	0	1	0	1	1	9	3	4	4	35	2	60	600
W6	5	0	0	16	0	9	4	2	2	8	2	48	480
W7	2	4	7	5	3	8	3	0	10	4	7	53	530
W8	0	7	10	4	1	1	4	3	1	6	15	52	520
W9	0	3	5	1	1	10	7	10	5	5	5	52	520
W10	3	0	3	5	1	4	8	3	17	2	2	48	480
W11	1	2	11	3	0	2	12	11	3	2	0	47	470
W12	5	0	0	2	0	0	0	1	0	38	13	59	590
W13	0	1	3	4	5	3	13	2	2	1	5	39	390

Average Stems/Acre: 528

Volunteer species will also be monitored throughout the five-year monitoring period. Table 5 presents the most commonly found woody volunteer species.

Volunteer woody species were observed in most all of the vegetation plots, but were deemed too infrequent and too small to tally. Identifiable volunteers accounted for no more than 20 stems per plot; these specimens were typically less than 6 inches tall. If these trees persist into next growing season they will be flagged and added to the overall stems per acre assessment of the site. Sweetgum (*Liquidambar styraciflua*) is the most common volunteer, though Red Maple (*Acer rubrum*) and Persimmon (*Diospyros virginiana*) were also observed.

Table 5. Volunteer Tree Species Identified within the Wetland Restoration Area.

ID	Species	Common Name	FAC Status
A	*Liquidambar styraciflua*	Sweetgum	FAC+
B	*Acer rubrum*	Red Maple	FAC
C	*Diospyros virginiana*	Persimmon	FAC
D	*Taxodium distichum*	Bald Cypress	OBL

4.4 Vegetation Conclusion

Approximately 66.2 acres of this site were planted with hardwood species in March 2003. There were thirteen 0.1 acre vegetation monitoring plots established throughout the planting areas. The 2005 vegetation monitoring revealed tree density greater than the success criteria of 320 stems per acre. This site meets the minimum success interim criteria of 320 trees per acre by the end of Year 3 and is on trajectory for meeting the final success criteria of 260 trees per acre by the end of Year 5. Slightly higher statistics between years on monitoring plots appear because some saplings appear dead in one year when they may in fact be dormant or have a dead terminal bud and will re-sprout in the following spring.

5.0 STREAM MONITORING

5.1 Success Criteria

As stated in the approved Mitigation Plan, the stream restoration success criteria for the site include the following:

- *Bankfull Events:* Two bankfull flow events must be documented within the five-year monitoring period.
- *Cross-sections:* There should be little change in as-built cross-sections. Cross-sections shall be classified using the Rosgen stream classification method and all monitored cross-sections should fall within the quantitative parameters defined for "E" or "C" type channels.
- *Longitudinal Profiles:* The longitudinal profiles should show that the bedform features are remaining stable, e.g. they are not aggrading or degrading. Bedforms observed should be consistent with those observed in "E" and "C" type channels.
- *Photo Reference Stations:* Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and effectiveness of erosion control measures.
- *Benthic Macroinvertebrate and Fish Sampling:* Sampling of benthic macroinvertebrates and fish within the restored stream channel shall be conducted for the first three years of post-restoration monitoring. No success criteria are applied to the sampling data that will be collected.

5.2 Description of Stream Monitoring

To document the stated success criteria, the following monitoring program was instituted following construction completion on the Westbrook Site:

Bankfull Events: A crest gauge was installed on the site to document bankfull events. The gauge is checked each month, and records the highest out-of-bank flow event that occurred during the past month. The gauge is located near stream station 43+50 (see Figure 2h).

Cross-sections: Two permanent cross-sections were installed per 1,000 linear feet of stream restoration work, with one of the locations being a riffle cross-section and one location being a pool cross-section. A total of 11 permanent cross-sections were established across the mitigation site. Each cross-section was marked on both banks with permanent pins to establish the exact transect used. Permanent cross-section pins were surveyed and located relative to a common benchmark to facilitate easy comparison of year-to-year data. The annual cross-section surveys include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg. Riffle cross-sections are classified using the Rosgen stream classification system. Permanent cross-sections for 2003 (Year 1) were surveyed in March and April 2003. Permanent cross-sections for 2004 (Year 2) were surveyed in February 2004. Permanent cross-sections for 2005 (Year 3) were surveyed in January 2005.

Longitudinal Profiles: A complete longitudinal profile will be completed in Years one, three, and five. The profile will be conducted for a length of restored channel at least 3,000 feet in length. Measurements will include thalweg, water surface, inner berm, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature, e.g. riffle, run, pool, and

glide, and the max pool depth. A common benchmark will be used each year to facilitate comparison of year-to-year data. The longitudinal survey for 2003 (Year 1) was conducted during March and April 2003. The longitudinal survey for 2005 (Year 1) was conducted during January 2005.

Photo Reference Stations: Photographs are used to visually document restoration success. Nine reference photo stations have been established across the Westbrook Site. Reference stations are marked with wooden stakes and Global Positioning Satellite (GPS) coordinates have been determined for each location. Reference photos are taken at least once per year. Reference photos are taken at each permanent cross-section from both streambanks. The survey tape is centered in the photographs of the bank, and the water line is located in the lower edge of the frame with as much of the bank as possible included in each photo. Structure photos of each grade control structure are also taken.

Benthic Macroinvertebrates and Fish Sampling: Benthic macroinvertebrate and fish sampling data were collected from the reference reach (upstream of project reach) and within the project reach. Pre-restoration data were collected on January 17, 2002, prior to initiation of stream restoration practices. Post-restoration sampling began one year after construction activities were completed, and annually thereafter for a total of three years. Sampling is conducted each year between November and February, since the stream in the past has experienced periods of very low flow during summer months. Sample collection follows protocols described in the standard operating procedures of the Biological Assessment Unit of the North Carolina Division of Water Quality (NCDWQ). The Qual-4 collection method is used for the collection of macroinvertebrate samples, and a North Carolina-certified laboratory performs the identification of the macroinvertebrate samples. The metrics calculated include total and EPT taxa richness, EPT abundance and biotic index values.

For Year 1, biological sampling was conducted in February of 2004 (one year following completion of construction). For Year 2, biological sampling was conducted in January of 2005. Results are presented in the following sections.

5.3 Results of Stream Monitoring

During 2005, bankfull events on the site were documented during at least one site visit through the use of the onsite crest gauge and visual evidence of out-of-bank flow. The largest stream flow documented by the crest gauge on the site was a flow that occurred during the month of July and was approximately 0.46 feet above the bankfull stage at the crest gauge. Based on observations of ponded water, debris lines, and deposited sediment on the floodplain, the bankfull event spread over much of the restored wetland areas adjacent to the stream.

Year 3 cross-section monitoring data and longitudinal profile data were collected during January 2005, and compared to baseline data collected in April of 2003 and February of 2004. Permanent cross-sections document the stream dimension at eleven locations (six riffles and five pools, see Appendix C). The cross-sections show that there has been very little adjustment to stream dimension since construction. The two cross-sections on the lower end of the stream (45+22 and 53+08) show that some degradation occurred between Year 1 and Year 2. This area is subject to periodic backwater conditions from Mill Creek and, therefore, bed elevation will be dependent on the baseflow water level in Mill Creek. During the past year theses cross-sections have remained stable and relatively unchanged after some initial downcutting. Several other

pool cross-sections indicate the development of point bar features, which is expected. All monitored cross-sections fell within the quantitative parameters defined for "E" or "C" type channels.

In-stream structures installed within the restored stream included rock cross-vanes, log vanes, log weirs, and root wads. Visual observations of structures throughout the past growing season have indicated that nearly all structures are functioning as designed. Log vanes placed in meander pool areas have provided scour to keep pools deep and provide cover for fish. Log weirs placed in riffle areas have maintained riffle elevations and provided a downstream scour hole that provides habitat. Some log weirs experienced scour of the streambanks directly downstream of the weirs during the first two years after construction. This was primarily caused by high flows shortly after construction before vegetation on the banks could become well established. These areas were repaired during January 2005 when several of the log weirs on the upper end of the site were raised to increased hydrologic wetness in that area (see discussion below). Root wads placed on the outside of meander bends have provided bank stability and in-stream cover for fish and other aquatic organisms. Several boulders have shifted in the cross vanes at the downstream end of the site. Boulders in these structures are scheduled to be stabilized during the fall of 2005. This area is at the end of the site where the stream steps down to flow into Mill Swamp. An access area already exists in the area; therefore, any disturbance to the surrounding area will be minimized.

During January 2005, eight log weirs were raised by a few tenths of a foot, and two new log weirs were installed between stations 0+00 and 10+00. This was done to improve the hydrology on the northwestern area of the site. Due to less than average rainfall for the growing season, it is unknown whether the increased elevation of the log weirs was successful in increasing hydrology for this section of the site. All work was done with minimal disturbance to the site and stream.

Photographs have been taken throughout the monitored season to document the evolution of the restored stream channel (see Appendix B). The most observable change to the stream during 2005 has been the raising and installation of log weirs between station 0+00 and 10+00. Herbaceous vegetation is dense along the restored stream, making it difficult to take photographs of the stream channel itself. Pools have maintained a variety of depths and habitat qualities, depending on the location and type of scour features (logs, root wads, transplants, etc.).

5.3.1 Stream Benthic Macroinvertebrates

Benthic macroinvertebrate samples were collected at two sites within and upstream of the project area on January 7, 2005, as part of the second year of post-monitoring requirements. One sampling site (Site 1) is located within the downstream section of the project reach below SR 1198, while the other sampling site (Site 2, reference reach) is located upstream of the project reach above SR 1198 . The sampling methodology followed the Qual-4 protocol listed in the NCDWQ's Standard Operating Procedures for Benthic Macroinvertebrates. A summary of the benthic macroinvertebrate sampling results at each location is presented in Table 6, with complete results presented in Appendix C.

The components of the benthic macroinvertebrate community that are commonly used to evaluate water quality are the EPT taxa. The EPT taxa include specimens belonging to the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera

(caddisflies). These groups are generally the least tolerant to water pollution and therefore are very useful indicators of water quality. Therefore, the presence of substantial numbers of EPT taxa and individuals is considered indicative of relatively undisturbed "higher quality" streams. EPT metrics commonly used to assess water quality include EPT taxa richness, EPT biotic index, and EPT abundance, which are shown in Table 6.

Table 6. Summary of Benthic Macroinvertebrate Data for the Project Reach and the Reference Reach.

Sites	Total Taxa Richness	EPT Taxa Richness	Total Biotic Index	EPT Biotic Index	EPT Abundance
Site 1 Project Reach in 2002	30	7	6.16	4.83	45
Site 1 Project Reach in 2004	31	13	5.96	5.26	79
Site 1 Project Reach in 2005	35	18	6.1	5.08	76
Site 2 Reference Reach in 2005	35	13	5.29	4.05	62

EPT taxa richness and EPT abundance values were greater in the project reach than in the reference reach in 2005 (2nd year of post-construction monitoring). More importantly, EPT taxa richness in the project area continues to increase. The EPT taxa richness have increased steadily from 7 (pre-construction) to 13 (1st year post construction) to 18 (2nd year post construction) in the restoration area. The EPT taxa increase from 2004 to 2005 was due to the four caddisflies collected in 2005.

While the EPT taxa richness and abundance values were greater in the project reach than the reference reach in 2005, the biotic indices at the restoration site have not reached that of the reference site, suggesting that the community of the restoration site has not yet stabilized. This conclusion is supported by the lesser number of shredder organisms and higher number of tolerant baetid mayflies found at the restoration site than the reference site. However, shredders have increased at the restoration site from 2004 to 2005. It is anticipated that shredders will continue to increase as organic matter input from maturing riparian vegetation increases.

5.3.2 Fish Sampling

On February 26, 2005, the second survey of the fish community in the project reach was conducted. A fish survey conducted in November 2002 prior to the construction indicated no fish to be present; however, their absence was attributed to the effects of the prolonged drought and possibly to shallow water depths and uniformity of habitat. The first post-construction survey was conducted on March 12, 2004, and fourteen species were collected.

Three segments were surveyed in 2004 and 2005 with a backpack electroshocker. Two segments of approximately 200 yards in length were shocked within the restoration area and one segment of approximately 100 yards was shocked in the Reference Reach upstream of the restoration reach. One of the two segments in the restoration area was

the lowermost 200 yards (Downstream Site) while the other one was upstream, approximately ¼ mile below SR 1198 (Upstream Site). In 2005, due to battery problems, only about 150 yards were sampled in the upstream site. Approximately 1 hour was spent at each segment shocking all available habitats.

Water levels in both 2004 and 2005 ranged between a few inches and 3 feet in the restoration segments and up to 8 inches in the natural segment; the current was slight but noticeable. All fish were released after being identified and counted. Numerous crayfishes were noted in all segments but were not counted.

Table 7. Summary of Fish Data for the Project Reach and the Reference Reach.

	Upstream Site		Downstream Site		Reference Site	
Species	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**
American eel		1				
Eastern mudminnow	1					
Redfin pickerel	2	1	2	9	2	1
Satinfin shiner			6			
White shiner			2	3		
Golden shiner			1			
Creek chubsucker	44	1	20	1	4	
Yellow bullhead	11		4	4		2
Tadpole madtom				1		
Pirate perch			2	2		
Eastern mosquitofish	1		1	1		
Bluespotted sunfish	1		1	2		
Redbreast sunfish				5		
Green sunfish	1		1	1		
Bluegill						
Largemouth bass			8			
Tessellated darter	2		2			

Eleven species of fish were collected in the restoration segment of the stream in 2005; 14 were taken in 2004. Three of the fish species observed in 2005, American eel, tadpole madtom, and redbreast sunfish, were new for the stream. Six fish species encountered in 2004 were not observed in 2005. Four of these were represented by only 1 specimen or were seen only in the lowermost 20 yards of the stream. All of the fish species taken in both years are species typical of this part of North Carolina and in numbers similar to natural streams of a similar size. It is interesting to note how quickly the stream was re-colonized after stream restoration and a prolonged drought. The diversity and abundance of species is partly due to the heterogeneity of habitats offered in the restoration area. The variation in numbers between the years, particularly for redfin pickerel and creek chubsucker are also noteworthy. Many of the fish species taken in 2004 were juveniles and subadults, while in 2005 mostly adults were observed. There appears to be good movement of fish species between Mill Creek and Johannah Branch. This is especially

evident in the capture of the American eel, a catadromous fish that migrated from the Sargasso Sea as a larva to reside in this area. While there has been variation in numbers of species and their abundance between the two years, this is not unexpected in a stream of this small size.

5.4 Conclusions

Based on the data collected thus far, the restored channel is stable and is providing the functions intended (Figure 4). Stable riffle and pool features have developed and native vegetation has colonized the site especially the streambank areas and adjacent floodplain. It is expected that stability of the system will continue to improve in the coming years as permanent riparian vegetation becomes more established.

6.0 REFERENCE SITE CONDITIONS

The approved Mitigation Plan provides that if the rainfall data for any given year during the monitoring period is not normal, the reference wetland data can be accessed to determine if there is a positive correlation between the performance of the restoration site and the natural hydrology of the reference site.

Reference site data were compared to onsite hydrographs to compare the performance of the restored site to reference conditions. One automated groundwater gauge (WB-RA1) and one manual gauge (WB-RM1) were installed in the reference site during March 2003. When data collected from the reference site were reviewed early in the growing season of 2003, that data indicated wetter conditions than could visually be confirmed for the majority of the reference site. Gauge RA1 was installed in a depressional area near the stream channel that apparently receives significant overland runoff during rain events. Gauge RM1 was located further from the stream channel, but was also determined to be located in a depressional area. The decision was made to install three additional manual groundwater gauges (WB-RM2, WB- RM3, and WB-RM4) to document the range of conditions observed across the reference site, for comparison against the range of hydrologic conditions that were being documented on the restoration site. RM2 and RM3 were installed in areas away from the stream channel, yet well within the wetland floodplain. RM4 was installed closer to the periphery of the reference wetland to document conditions near the transition from wetland system to upland. The three additional gauges were installed on May 14, 2003.

The automated gauges on the restoration site (AW1, AW2, and AW3) were installed in areas most similar to gauges RM2 and RM3 on the reference site, and were assumed to represent average conditions across the restoration site. Data from the automated gauges on the restoration site correlate very well with reference site gauges RM2, RM3, and RM4, and indicate the same general hydrologic trends in both systems (Figure 5).

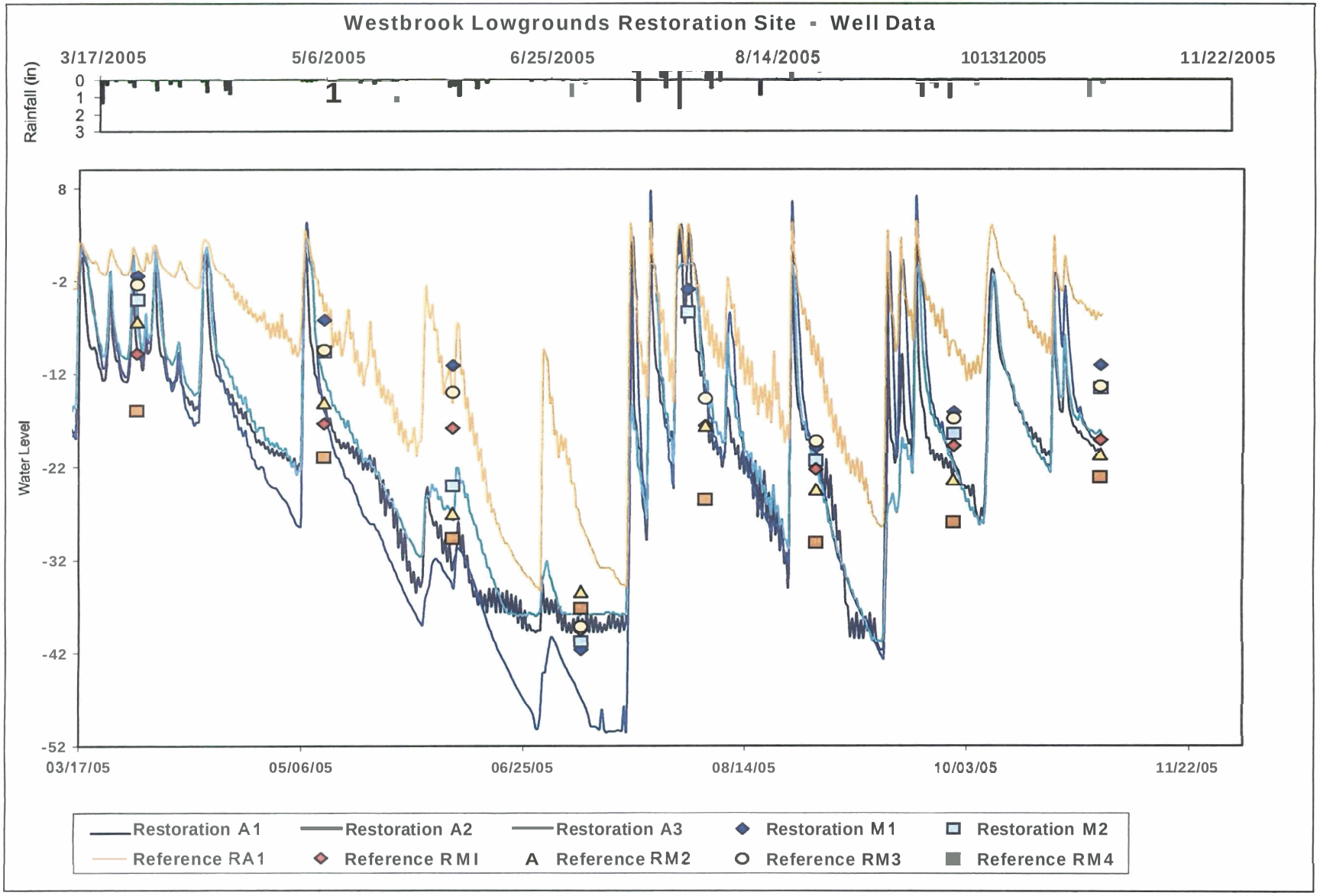


Figure 5. Comparison of Reference Site Data to Restoration Site Data.

7.0 OVERALL CONCLUSIONS AND RECOMMENDATIONS

- Third year hydrologic monitoring data have shown that the site is performing as anticipated. As is typical for wetland systems, varying hydrologic conditions were experienced across the site, and four of the five hydrologic monitoring gauges achieved the targeted success criteria. Climatic conditions over the 2005 monitoring period must be considered when evaluating overall site performance.
- The restored stream channel has remained stable and is providing the intended habitat and hydrologic functions. All monitoring cross-sections for 2005 showed very little adjustment in stream dimension.
- Vegetation monitoring efforts have calculated the average number of stems per acre on site to be 528, which is a survival rate of greater than 85 percent based on the initial planting count of 590 stems per acre. We feel that vegetation survivability should remain excellent on site and vegetative success criteria will easily be met.
- Benthic macroinvertebrate sampling indicates that the restored stream has greater EPT taxa richness and EPT abundance than those found in the reference reach in 2005 (2nd year of post-construction monitoring). More importantly, EPT taxa richness in the project area continues to increase.
- While fish sampling results show variations in the numbers of species and their abundance between the two sampling periods, this is not unexpected in a small stream. There appears to be good movement of fish species between Mill Creek and Johannah Branch.
- Monitoring of vegetation and groundwater and surface water levels will continue.

8.0 WILDLIFE OBSERVATIONS

Observations of deer and deer tracks are common on the Westbrook Lowgrounds site. During certain times of the year, frogs have been very prevalent across the site. Hog tracks are fairly common in the lower portions of the site adjacent to Mill Creek. Birds, turtles and black snakes have also been observed on the site.

9.0 VEGETATION OBSERVATIONS

After construction of the mitigation site a permanent ground cover seed mixture of Virginia wild rye (*Elymus virginicus*), switch grass (*Panicum virgatum*), and fox sedge (*Carex vulpinoidea*) was broadcast on the site at a rate of 10 pounds per acre. These species are dominant on the site, though they pose no threat to the survival or health of the planted or naturally occurring hydrophytic vegetation. Hydrophytic herbaceous vegetation is also occurring on site. Rush (*Juncus effusus*), spike-rush (*Eleocharis obtusa*), climbing hempweed (*Mikania scandens*), tearthumb (*Polygonum sagittatum*), Boxseed (*Ludwigia* sp.), and sedge (*Carex* sp.), all hydrophytic herbaceous plants, are frequently observed across the site particularly in areas of inundation. The presence of these herbaceous wetland plants helps to confirm the presence of wetland hydrology on the site.

There are zones of weedy species occurring on the site, though none seem to be posing any problems for the woody or herbaceous hydrophytic vegetation. The majority of the weedy species are annuals and believed to pose very little threat to survivability in site. Commonly seen weedy vegetation includes ragweed (*Ambrosia artemisiifolia*), dill (*Foeniclum vulgare*), and Morning Glory (*Ipomoea* sp.). Any threatening weedy vegetation found in the future will be documented and discussed.

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Appendices