Privateer Farms
Wetland and Stream Restoration Project
Annual Monitoring Report for 2005 (Year 1)
Cumberland and Bladen Counties, North Carolina

Prepared for North Carolina Ecosystem Enhancement Program

Design Report Prepared by Buck Engineering PC

8000 Regency Parkway
Suite 200
Cary, North Carolina 27511
Phone: 919.463.5488
Fax: 919.463.5490
www.buckengineering.com

Kevin Tweedy, PE
Project Engineer

Jim Buck, PE
Principal in Charge

November 2005

EXECUTIVE SUMMARY

The Privateer Farms site was restored through a full-delivery contract with the North Carolina Department of Transportation (NCDOT). Administrative management of the project has since been transferred to the North Carolina Ecosystem Enhancement Program (NCEEP). The goals and objectives of this project are as follows:

1. Restore riverine wetlands through stream restoration, filling of agricultural drainage ditches, restoration of a natural topography, and planting.
2. Enhance riverine wetlands through stream restoration and supplemental planting.
3. Increase stream length across Privateer Farms Restoration Project from 25,000 feet to approximately 34,005 feet through dimension, pattern and profile adjustments.
4. Restore floodplain and other low-lying areas to their historic wetland ecosystem.

Construction of this project was completed in April 2005. Stability of the project must be annually monitored and documented during a five-year period following construction completion. This report documents the monitoring data collected at the project site during the 2005 growing season (Year 1 of the 5-year monitoring period).

Table 1
Background Information.

Project Name	Privateer Farms
Designer's Name	Buck Engineering 8000 Regency Parkway, Cary, NC, 27511 (919) 463-5488
Contractor's Name	River Works, Inc.
Project County	Bladen and Cumberland Counties
Directions to Project Site	From Raleigh, follow I-40 east to exit 328 (I- 95). Merge onto I-95 south and proceed to exit 49 (Route 53). Take NC 53 south approximately 12.4 miles to the site. Turn right into site at a blue sign labeled "Privateer Farms Road." From Elizabethtown, follow NC 53 north. Travel through the town of White Oak. From White Oak, travel approximately 5.0 miles to entrance of farm. Turn left into site at a blue sign labeled "Privateer Farms Road."
Drainage Area	6.0 sq. mi. (End of Reach 5-end of the project)
USGS Hydro Unit	03030005
NCDWQ Subbasin	03-06-15 and 03-06-16
Project Length	34,005 Linear feet (Restoration)
Restoration Approach	34,005 feet of dimension, pattern, and profile
	402.5 acres of riverine wetland restoration
	25 acres of riverine wetland enhancement
Date of Completion	April 2005
Monitoring Dates	Monthly through each growing season for 5 years.

Table of Contents

Tables and Figures

Appendices (<u>Appendix materials are located on the enclosed CD</u>)

1.0 Background Information

The Privateer Farms Restoration Project is located in Bladen and Cumberland Counties, North Carolina, approximately fourteen miles southeast of Fayetteville (Figure 1). Land use for the restoration site over the past 20 years had been primarily row crop agriculture. Stream and riparian functions on the site had been severely impacted as a result of agricultural conversion. Harrison Creek had historically meandered through the site, but was channelized in the early 1980s to reduce flooding and provide a drainage outlet for the extensive network of ditches carved across the site. Subsequent to channelization, Harrison Creek existed as a large canal running straight through the project site.

Restoration activities for this site involved moving the stream channel back to its historic location and elevation, and filling drainage ditches to raise the local water table and restore wetland and stream hydrology on the site. The plan also included scarification of the fields and breaking of the local plow pan to increase surface water storage and provide a range of hydrologic conditions suitable for a variety of native wetland plant species. The restoration plan for the site predicted the restoration of 405 acres of riverine wetlands, 25 acres of riverine wetland enhancement, and 33,985 feet of stream restoration. Following construction, the as-built data indicated that the total area of restored riverine wetlands was 402.5 acres (excluding 2.5 acres for road accesses), with 25 acres of enhanced riverine wetlands, and 34,005 feet of restored stream channel.

This Annual Monitoring Report presents data from 30 hydrologic monitoring stations and 15 vegetation monitoring stations placed throughout the site, in addition to stream monitoring data, as required by the approved Restoration Plan for the site.

1.1 Goals and Objectives

The goals and objectives of this project are as follows:

- Restore 402.5 acres of riverine wetlands.
- Enhance 25 acres of riverine wetlands.
- Increase stream length across Privateer Farms Restoration Project from 25,000 feet to approximately 34,005 feet through dimension, pattern and profile adjustments.
- Restore Harrison Creek's floodplain and other low lying areas to their historic wetland ecosystem.
- Monitor success of the restored and enhanced features during a five-year period following construction.

1.2 Project Location

This project is located approximately fourteen miles southeast of Fayetteville in Bladen and Cumberland Counties. From Raleigh, follow Interstate I-40 east to exit 328 (I-95). Merge onto I-95 south and proceed to exit 49 (NC 53). Take NC 53 south approximately 12.4 miles to the entrance of the site. Turn right into site at a blue road sign that says "Privateer Farms Road."

From Elizabethtown, follow NC 53 north. Travel through the town of White Oak.

From White Oak, travel approximately 5.0 miles to entrance of farm. Turn left at a blue road sign that says "Privateer Farms Road."

1.3 Project Description

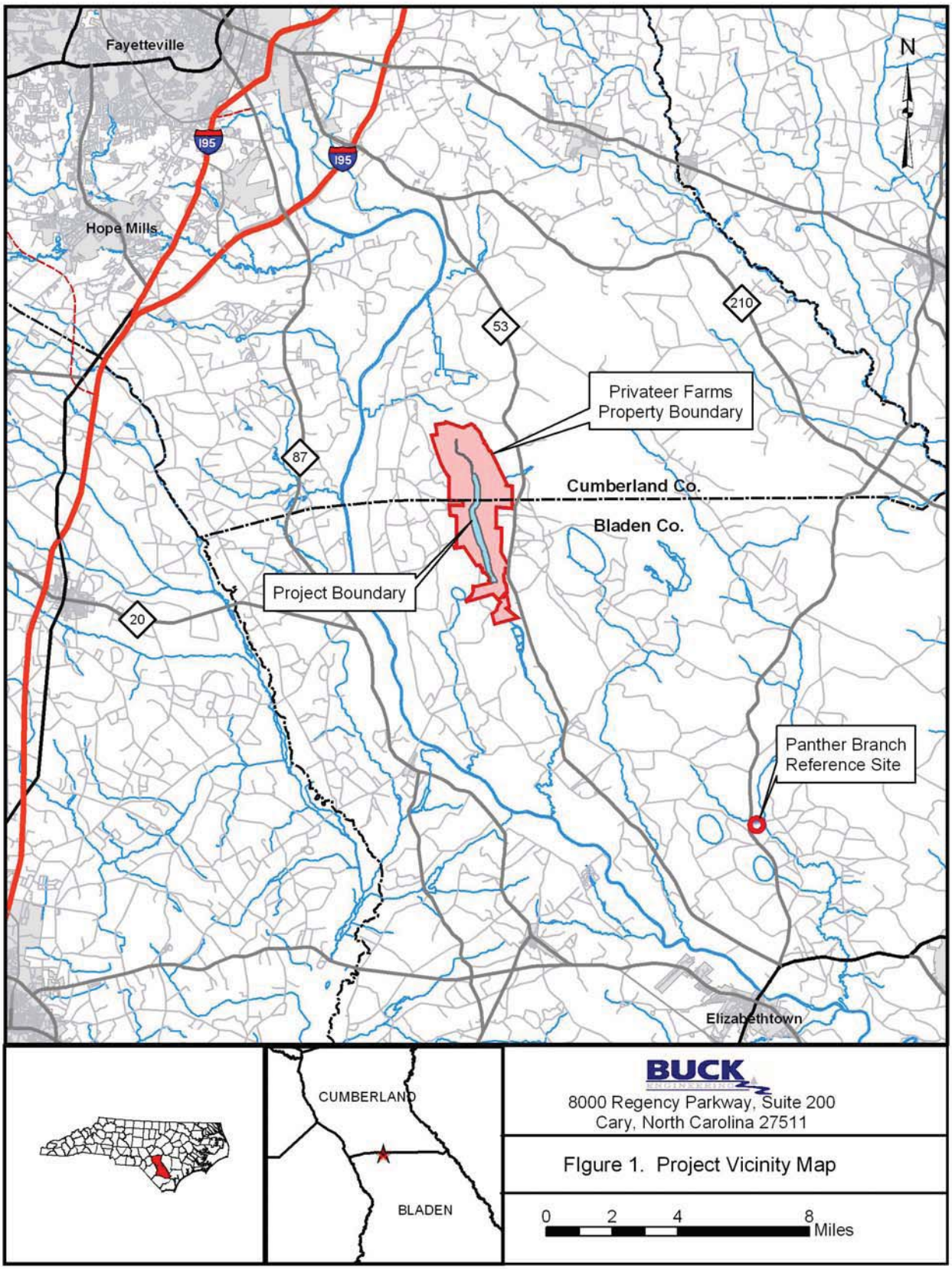
Restoration of site hydrology involved the restoration of natural stream and wetland systems on the site. The stream system that historically flowed through the site was channelized and, as a result, was highly incised ("Gc" type stream – Rosgen classification) prior to restoration. The natural channel design for the restored stream involved the construction of a new meandering channel across the agricultural fields. The furthest upstream portion of the project used sections of the remnant historic channel for Harrison Creek that were still visible within the existing wetland areas. The remaining portion of the restored channel was constructed as a Rosgen "C" stream type with design dimensions based on historic reference parameters for Harrison Creek. These reference parameters were discerned from historic aerial photographs, the topography of the valley, and local reference reach information. The total stream length across the Privateer Farms site was increased from approximately 25,000 to 34,005 feet.

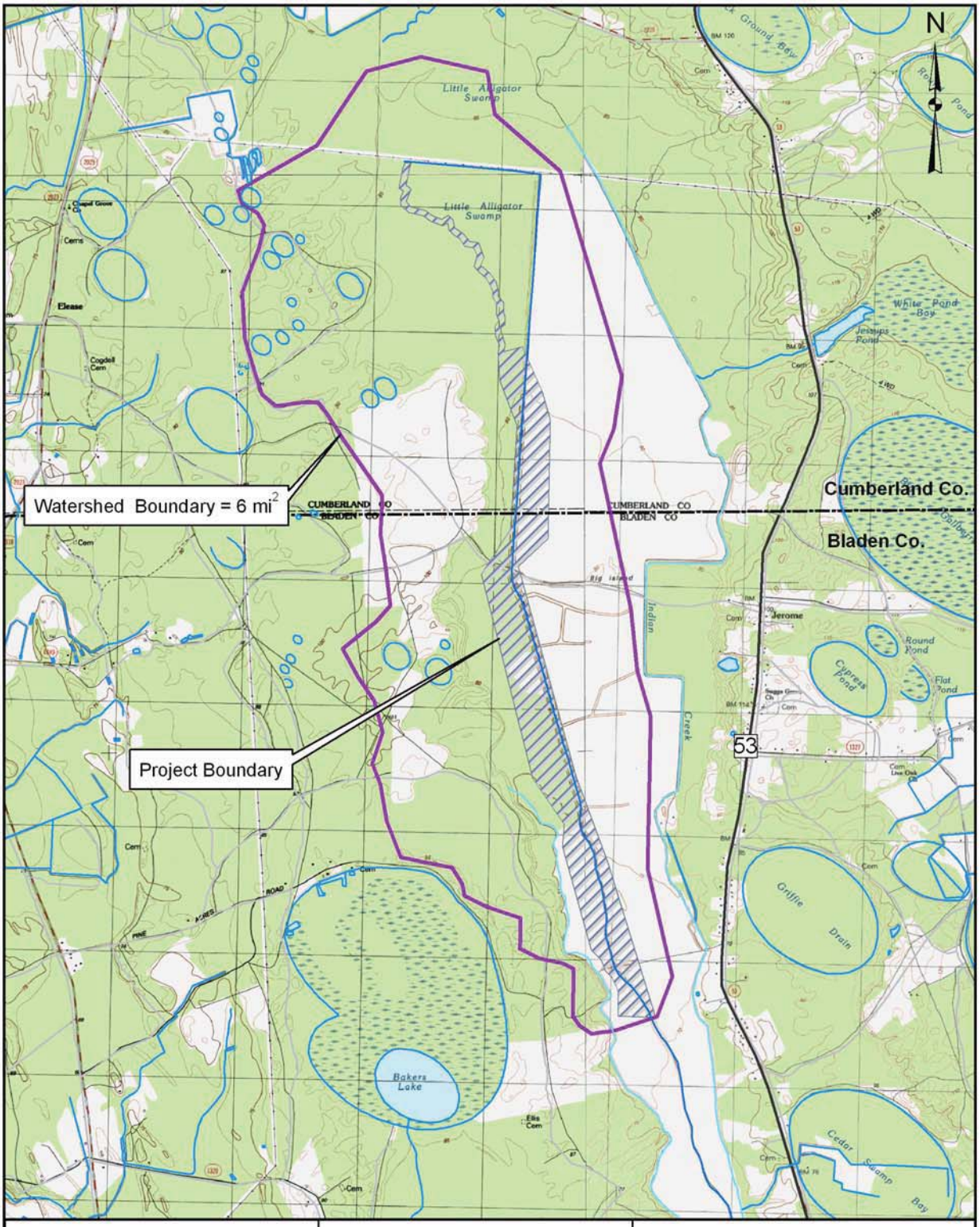
The channel design allows discharges greater than bankfull flows to spread onto the floodplain, dissipating flow energies and reducing stress on streambanks. In-stream structures were used to control streambed grade, reduce stresses on streambanks, and promote bedform sequences and habitat diversity. The in-stream structures consisted of root-wads, log vanes, and log weirs that promote a diversity of habitat features in the restored channel. Where grade control was a consideration, constructed riffles were installed to provide long-term stability. Streambanks were stabilized using a combination of erosion control matting, bare-root planting, and transplants. Transplants provided immediate shading to the restored stream, as well as living root mass to increase streambank stability and create holding areas for fish and aquatic biota.

While restoration of the stream channel followed the historic pattern of Harrison Creek, the restored stream would most appropriately be considered a tributary to Harrison Creek. Flow from the headwaters of Harrison Creek has been channelized around the perimeter of the farm. Due to elevation differences between the restored stream and the channelized stream around the perimeter of the farm, flow from the headwaters of Harrison Creek could not be diverted back into the restoration channel without causing significant hydrologic trespass issues beyond the property boundary of Privateer Farms. The restored channel functions as a headwater tributary to Harrison Creek. It has a drainage area of approximately one square mile at the upper limits of the project, increasing to six square miles at the downstream end of the project (Figure 2).

Due to the extensive length of stream restoration and changes in drainage area from the beginning to the end of the project, the project was divided into five stream reaches. Design ratios were the same for each design reach and were based on reference reach information; however, the size of each restored channel reach increased from upstream to downstream to reflect the increasing drainage area.

The large road that ran from north to south through the middle of the project area was graded down to floodplain level to allow spreading of flood flows over the restored floodplain. The excavated road material was used to fill the road-side canals. The two roads that crossed the project area from east to west were left in place to allow access across the restoration site to other parts of the farm.


Fayetteville
I95
I95
Hope Mills
N
210
53
Privateer Farms
Property Boundary
87
Cumberland Co.
Bladen Co.
Project Boundary
20
Panther Branch
Reference Site
Elizabethtown
CUMBERLAND
BLADEN
BUCK
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
FIgure 1. Project Vicinity Map
0 2 4 8 Miles



BUCK ENGINEERING
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511

0 2,000 4,000 Feet

Figure 2. Watershed Map

2.0 Monitoring Results – Year 1 (2005) Data

The five-year monitoring plan for the Privateer Farms site includes criteria to evaluate the success of the wetland hydrology, vegetation components of the project, and stream components of the project. The specific locations of vegetation plots, monitoring wells, permanent cross-sections, crest gauges, and rainfall gauge are shown on the as-built drawing sheets included in Appendix 1 of this report, and in Figures 3a through 3d. Photo points are located at each of the monitoring wells, and at each of the grade control structures along the restored stream channel. Site photographs are included in Appendix 2.

2.1 Vegetation

Bare root trees were planted within all areas of the conservation easement. A minimum 50-foot buffer was established along all restored stream reaches. In most areas, the final buffer area was more than several hundred feet wide and included restored wetland areas. In general, bare-root vegetation was planted at a target density of 680 stems per acre, or an 8-foot by 8-foot grid. Planting of bare-root trees was conducted during the dormant season, with all trees installed prior to March 20, 2005.

Observations were made during construction of the site regarding the relative wetness of areas to be planted. Planting zones were determined based on these assessments, and planted species were matched according to their wetness tolerance and the anticipated wetness of the planting area. Species planted are summarized in Table 2.

Table 2
Bare-root Tree Species Planted Across the Restoration Site.

Common Name	Scientific Name	Percent Planted by Species	Total Number of Stems	Wetness Tolerance [1]
Willow oak	*Quercus phellos*	8.6%	23,300	weak – moderate
Swamp chestnut	*Quercus michauxii*	8.6%	23,300	weak
Laurel oak	*Quercus laurifolia*	6.0%	16,200	moderate – weak
Overcup oak	*Quercus lyrata*	6.3%	17,000	moderate
Swamp tupelo	*Nyssa biflora*	7.9%	21,300	tolerant
Water tupelo	*Nyssa aquatica*	8.2%	22,000	tolerant
Bald cypress	*Taxodium distichum*	11.6%	31,200	tolerant
Water oak	*Quercus nigra*	8.6%	23,300	weak – moderate
Sycamore	*Platanus occidentalis*	10.8%	29,200	moderate
Green ash	*Fraxinus pennsylvanica*	10.8%	29,200	moderate
Shumard oak	*Quercus shumardii*	6.5%	17,500	weak
Cherrybark oak	*Quercus pagoda*	5.9%	15,900	weak –intolerant

Notes:
1. Based on information from US Army Corps of Engineers (USACE) Wetland Research Program (WRP) Technical Note VN-RS-4.1 (1997).
2. Based on information from other literature sources.

PROJECT: 0157 PRIVATEER FARMS

STATE	PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	0157	1	34

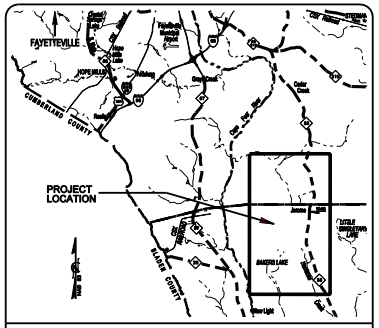
STATE PROJ. NO.	F. A. PROJ. NO.	DESCRIPTION

AS–BUILT

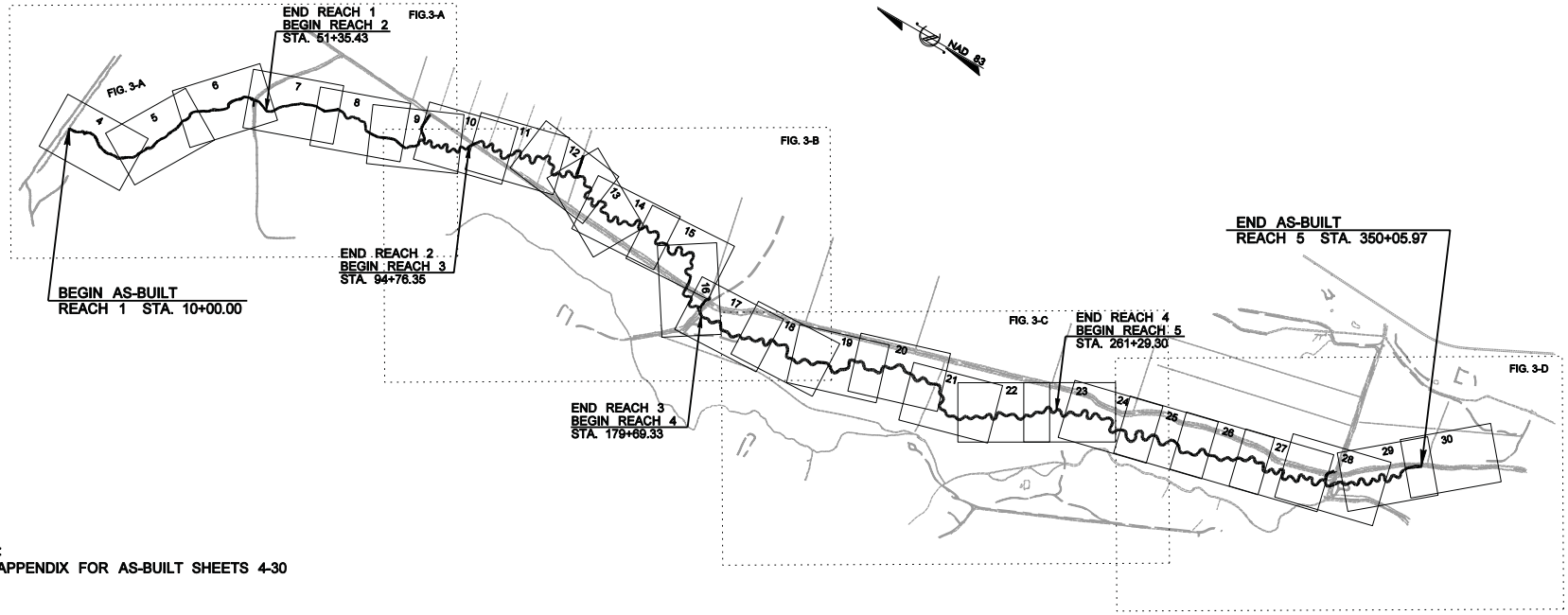
BLADEN /CUMBERLAND COUNTY

LOCATION: *OFF NC 53 NEAR JEROME*
SOUTHEAST OF FAYETTEVILLE

TYPE OF WORK: *WETLAND AND STREAM RESTORATION*



VICINITY MAP



NOTE:
SEE APPENDIX FOR AS-BUILT SHEETS 4-30

GRAPHIC SCALES

50 25 0 50 100
PLANS

50 25 0 50 100
PROFILE (HORIZONTAL)

5 0 5 10
PROFILE (VERTICAL)

PROJECT SUMMARY

PROPOSED DESIGN REACH 1 LENGTH	=	4,135.43 FEET
PROPOSED DESIGN REACH 2 LENGTH	=	4,340.92 FEET
PROPOSED DESIGN REACH 3 LENGTH	=	8,492.98 FEET
PROPOSED DESIGN REACH 4 LENGTH	=	8,159.97 FEET
PROPOSED DESIGN REACH 5 LENGTH	=	8,855.70 FEET
TOTAL DESIGN LENGTH	=	33,985.00 FEET
TOTAL AS–BUILT LENGTH	=	34,005.97 FEET
PROPOSED RESTORED WETLAND AREA	=	402.5 ACRES
PROPOSED ENHANCED WETLAND AREA	=	25 ACRES

PREPARED FOR THE OFFICE OF:

NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

1652 MAIL SERVICE CENTER
RALEIGH, NORTH CAROLINA 27699

CONTACT:

KRISTIN MIGUEZ
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

JULY 2004
CONSTRUCTION BEGAN:

MARCH 2005
END OF CONSTRUCTION:

KEVIN L. TWEEDY, PE
PROJECT ENGINEER

PROJECT ENGINEER

THIS DOCUMENT ORIGINALLY ISSUED AND SEALED BY:

KEVIN L. TWEEDY
027337
JUNE 27, 2005

THIS MEDIA SHALL NOT BE CONSIDERED A CERTIFIED DOCUMENT

P.E.
SIGNATURE:

VEGETATION PLANTING AND MONITORING AS-BUILT PLAN

PROJECT REFERENCE NO.	SHEET NO.
0157	31

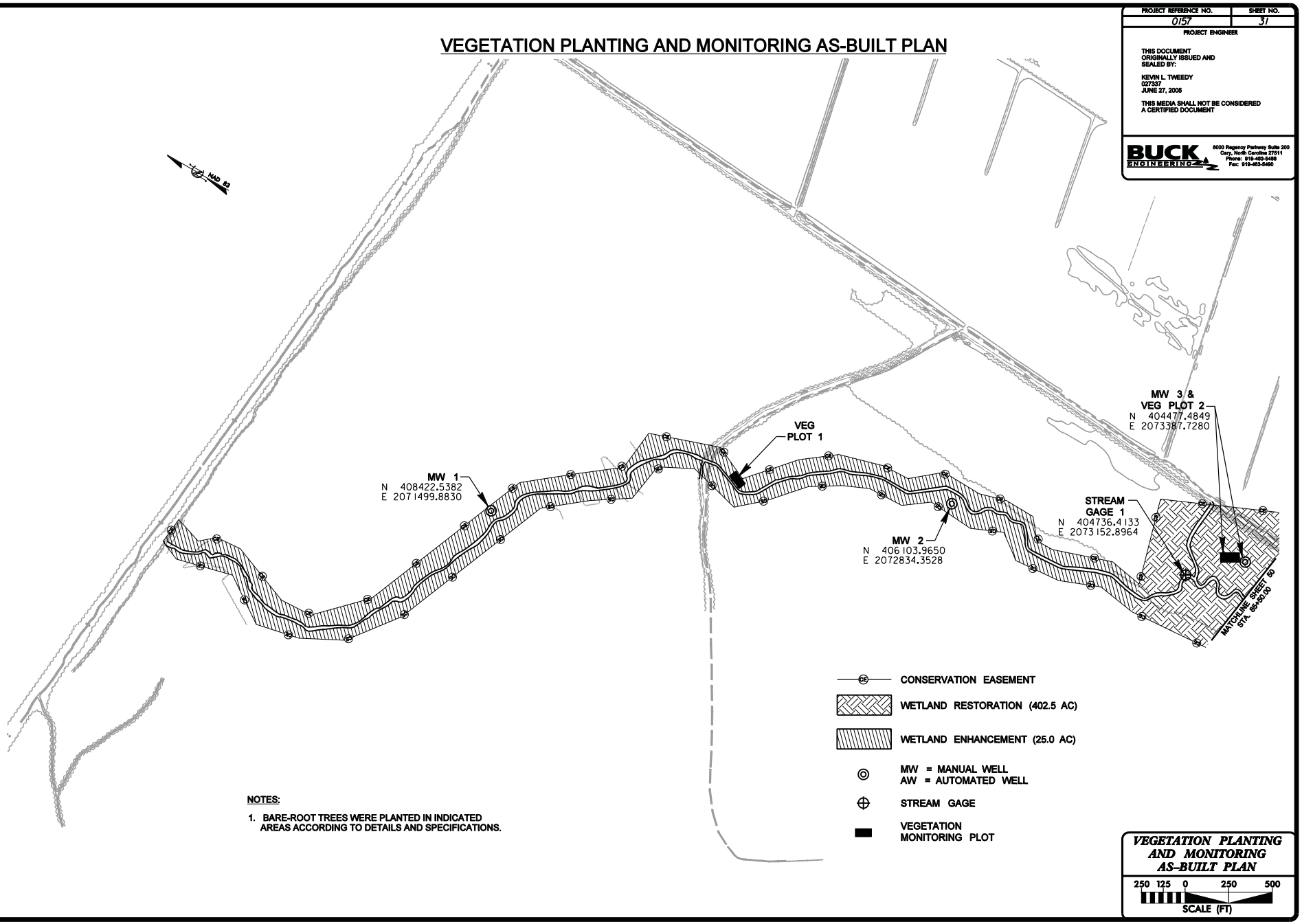
PROJECT ENGINEER

THIS DOCUMENT ORIGINALLY ISSUED AND SEALED BY:

KEVIN L. TWEEDY
027357
JUNE 27, 2005

THIS MEDIA SHALL NOT BE CONSIDERED A CERTIFIED DOCUMENT

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



NOTES:

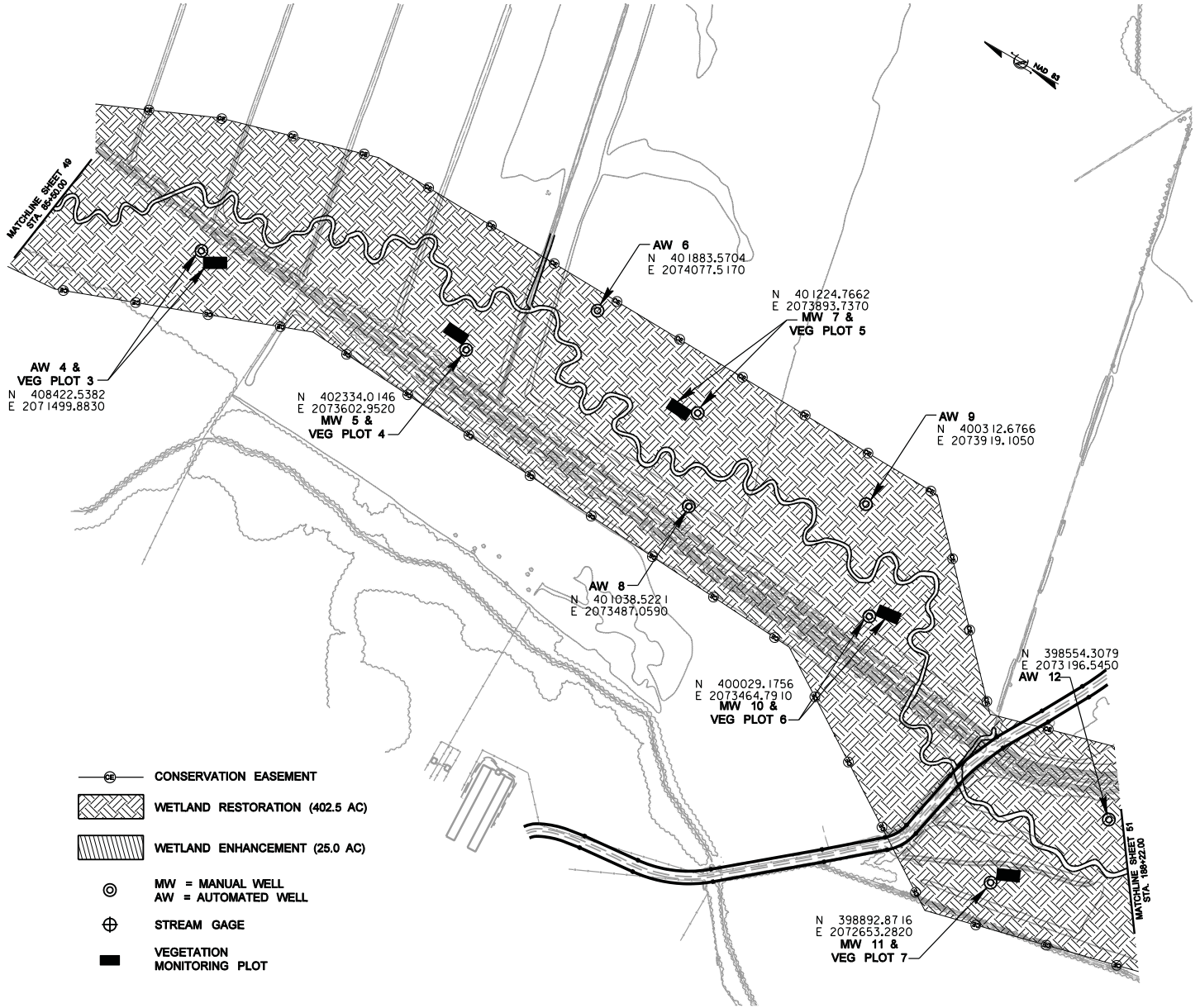
1. BARE-ROOT TREES WERE PLANTED IN INDICATED AREAS ACCORDING TO DETAILS AND SPECIFICATIONS.

VEGETATION PLANTING AND MONITORING AS-BUILT PLAN

250 125 0 250 500
SCALE (FT)

2/26/03
11/10/2005
n:\0157R\Design\Plans\0157R_BUCK_PSH_eb_31veg.dgn

VEGETATION PLANTING AND MONITORING AS-BUILT PLAN



PROJECT REFERENCE NO.	SHEET NO.
0157	32

PROJECT ENGINEER

THIS DOCUMENT
ORIGINALLY ISSUED AND
SEALED BY:

KEVIN L. TWEEDY
027357
JUNE 27, 2005

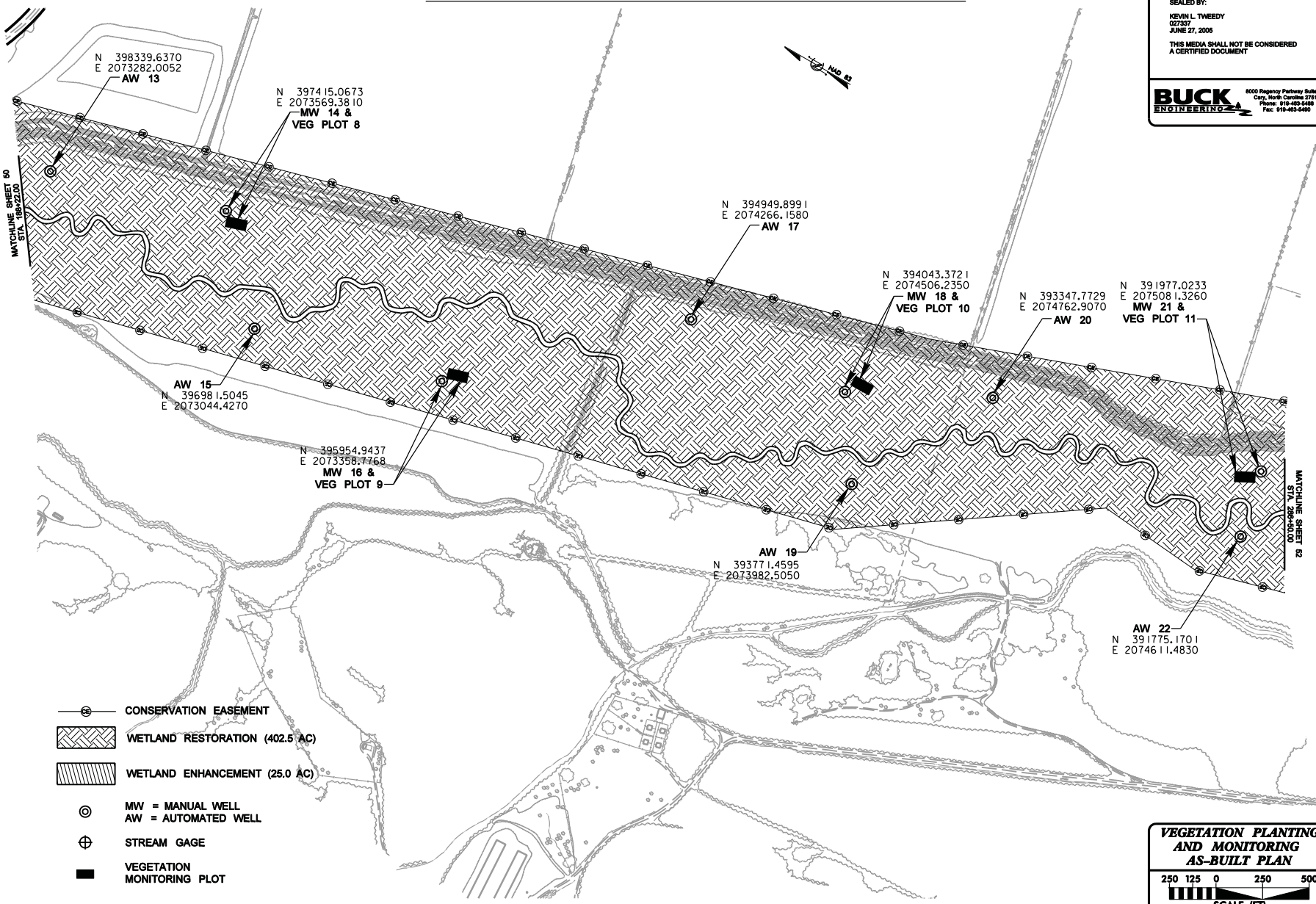
THIS MEDIA SHALL NOT BE CONSIDERED
A CERTIFIED DOCUMENT

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

VEGETATION PLANTING AND MONITORING AS-BUILT PLAN

250 125 0 250 500
SCALE (FT)

VEGETATION PLANTING AND MONITORING AS-BUILT PLAN



PROJECT REFERENCE NO.	SHEET NO.
0157	33

PROJECT ENGINEER

THIS DOCUMENT ORIGINALLY ISSUED AND SEALED BY:

KEVIN L. TWEEDY
027357
JUNE 27, 2005

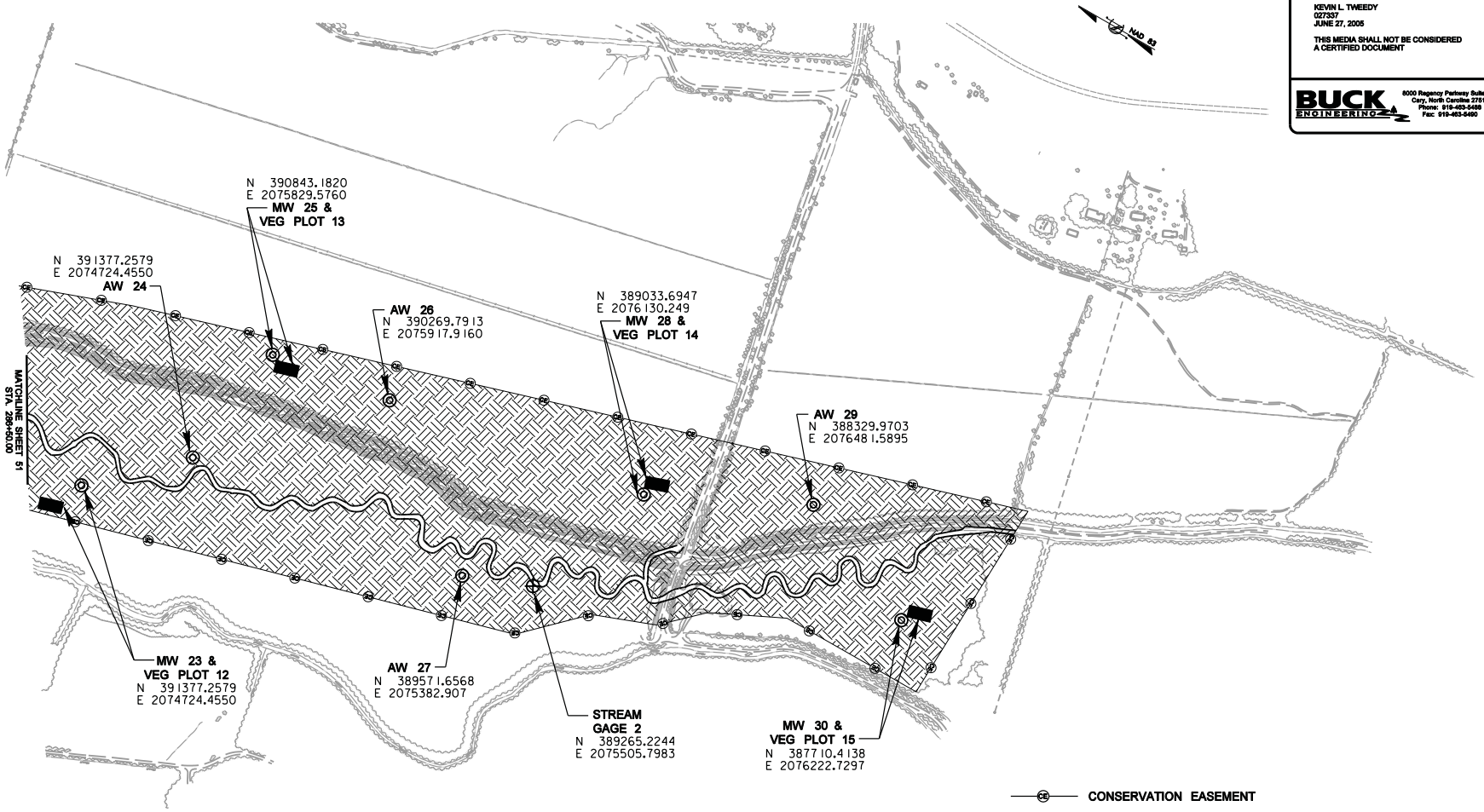
THIS MEDIA SHALL NOT BE CONSIDERED A CERTIFIED DOCUMENT

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

VEGETATION PLANTING AND MONITORING AS-BUILT PLAN

250 125 0 250 500
SCALE (FT)

VEGETATION PLANTING AND MONITORING AS-BUILT PLAN



CONSERVATION EASEMENT

WETLAND RESTORATION (402.5 AC)

WETLAND ENHANCEMENT (25.0 AC)

MW = MANUAL WELL
AW = AUTOMATED WELL

STREAM GAGE

VEGETATION
MONITORING PLOT

PROJECT REFERENCE NO.	SHEET NO.
0157	34

PROJECT ENGINEER

THIS DOCUMENT
ORIGINALLY ISSUED AND
SEALED BY:

KEVIN L. TWEEDY
027357
JUNE 27, 2005

THIS MEDIA SHALL NOT BE CONSIDERED
A CERTIFIED DOCUMENT

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

VEGETATION PLANTING AND MONITORING AS-BUILT PLAN

250 125 0 250 500
SCALE (FT)

2/26/03

11/10/2005
r:\0157R\Design\Plans\0157R_BUCK_PSH_sb_34veg.dgn

The restoration plan for the Privateer Farms site specified that 15 vegetation plots, each 25 by 100 feet in size would be established across the restored site. The initial planted density within each of the vegetation monitoring plots is given in Table 3. The average initial density of planted bare root stems, based on the data from the 15 monitoring plots, was 670 stems/ acre. The data from the end of the first growing season are presented in Table 3. The locations of the vegetation plots are shown on the as-built plan sheets.

Table 3
Initial Planted Density of Trees for the 15 Vegetation Sampling Plots.

Sampling Plot No.	Counted Stems per Plot		Stems per Acre (extrapolated)	
	Initial	Year 1	Initial	Year 1
1	38	29	662	519
2	40	31	697	527
3	39	35	680	610
4	33	18	575	371
5	42	34	732	551
6	37	26	645	478
7	43	29	749	459
8	31	28	540	614
9	35	27	610	525
10	35	24	610	466
11	39	19	680	331
12	36	30	627	567
13	35	16	610	311
14	49	20	854	278
15	45	37	784	478

2.1.1 Results and Discussion

Fifteen monitoring plots 0.1 acre in size were used to predict survivability of the woody vegetation planted on-site. The vegetation monitoring for 2005 (Year 1) indicated an average survivability of over 478 stems per acre, which is on a trajectory to achieve an average vegetation survival criteria of 320 stems per acre surviving after the fifth growing season.

2.1.2 Areas of Concern

Four monitoring plots had lower than expected survivability rates for Year 1. The survivability rates for Plots 4, 11, 13, and 14 ranged from 40 to 54 percent and densities ranging from 278 to 371. The lower than expected results for these plots are most likely the result of below average rainfall. Many stems were called dead that actually were green at the base of the stem. If normal conditions and saturation levels occur next year, it is anticipated that many of these stems will re-sprout from the roots and grow. Therefore, no remedial action is proposed until more data can be collected during the next growing season.

2.2 Morphology

Drainage area strongly influences channel morphology. Watershed area for the reconstructed channel increases from 1.0 square mile at the beginning of the project to 6.0 square miles at its downstream end (southern limit of the project site). The project was divided into five stream reaches, and the size of each restored channel reach was increased from upstream to downstream to reflect the increasing drainage area. Design ratios were kept the same for each design reach and were based on reference reach information.

Year 1 monitoring data for stream stability of each channel reach were collected during June 2005 to set a baseline for stream monitoring to occur in subsequent years. This included data on 68 permanent cross-sections, and data from two streamflow gauges installed at the site: one near the upstream limit of the project (stream gauge # 1) and one near the downstream limit of the project (stream gauge # 2). The location of the permanent cross-sections and the stream gauges are shown on the as-built plan sheets included in Appendix 1 and as Figures 3a though 3d.

Permanent cross-sections are used to monitor channel dimension and bank erosion over time. Two permanent cross-sections were established per 1,000 linear feet of restored stream, with equal proportion of sections across riffles and pools. Each cross-section was marked on both banks with permanent pins and they were all survey-located relative to a common benchmark. This ensures use of the same transects through the entire monitoring period, facilitating easy comparison of year-to-year data. In addition, a complete longitudinal survey was completed for the restored stream channel to provide a base-line for evaluating changes in bed conditions over time. This longitudinal profile will subsequently be re-surveyed every two years during the five-year monitoring period.

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. The longitudinal profile includes the elevations of all grade control structures. The permanent cross-section and longitudinal profile data are provided in Appendices 3 and 4, respectively.

The stream gauges were installed to document continuous water level in the restored channel and record the occurrence of bankfull events. The gauges automatically record water depth every six (6) hours, and have a continuous period of record extending from end of construction to present. The gauges are inspected and their water level data is retrieved every month.

Photographs were taken to visually document restoration success during Year 1 of monitoring. Each reference photograph station was marked with wooden stakes and GPS coordinates. Reference photos of both streambanks were taken at each permanent cross-section. On each streambank photograph, the survey tape is centered and the water line is located along the lower edge of the frame, showing as much of the bank as possible.

2.2.1 Morphology Success Criteria

The stream restoration success criteria for the site include the following:

- *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 “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 “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. Longitudinal photos should indicate the absences of developing bars within the channel or of excessive increase in channel depth.

2.2.2 Results and Discussion

On-site streamflow gauges documented the occurrence of at least two bankfull flow events during the first year of the monitoring period (2005). The largest stream flow documented by the onsite crest gauge occurred during the end of the month of July 2005 and was approximately 0.9 feet above the bankfull stage at stream gauge #2. The on-site streamflow gauges also registered a continuous out-of-bank flow through the site for a period of at least 48 hours, from July 29 to August 1, 2005.

Visual evidence of the out-of-bank flows observed during a subsequent site visit helped confirm the bankfull flow gauge readings. Based on observations of ponded water, debris lines, and deposited sediment on the floodplain, this bankfull event spread over a substantial portion of the restored wetland areas adjacent to the stream.

In-stream structures installed within the restored stream included constructed riffles, log vanes, log weirs, and root wads. Visual observations of structures throughout the past growing season have indicated that the structures are functioning as designed. Low flow conditions, due to lack of rainfall throughout much of the year, have allowed the channel banks to stabilize with vegetation through the year.

Photographs have been taken throughout the Year 1 (2005) growing season to document the evolution of the restored stream channel (see Appendix 2). Restored pools have maintained a variety of depths and habitat qualities, depending on the location and type of scour features (logs, root wads, etc.). Permanent vegetation seeded on the restored streambanks established quickly during the first half of the growing season.

2.2.3 Areas of Concern

No areas of concern have been identified for the restored stream channel segments.

2.3 Hydrology

The restoration plan for the Privateer Farms site specified that 30 monitoring wells (15 automated and 15 manual) would be established across the restored site. Thirty wells (15 automated and 15 manual) were installed initially during mid-March 2005 to document water table hydrology in all required monitoring locations throughout the site. The locations of monitoring wells are shown on the as-built plan sheets in Appendix 1, and in Figures 3a through 3d. Data spreadsheets for each well are provided in Appendix 5.

The reference wetland site identified for this project and described in the Monitoring Plan is also being monitored. Three (3) automated monitoring wells were installed at the reference site during late April 2005 to document variation in water table depth across the reference site. Data from these wells provide a base of comparison for water table hydrology between the project site and the established wetland area.

Monthly photographs were taken during the Year 1 (2005) growing season to document vegetation growth throughout the restored wetland area (see Appendix 2). The monitoring well locations will serve as the reference points from which photographs of vegetation growth will be taken over time.

As per the approved Privateer Farms Monitoring Plan, historic rainfall for Cumberland County was used to determine average rainfall and growing season dates for the site. The automated weather station William O. Huske L&D (UCAN: 14405, COOP: 319427) in Bladen County, located within five (5) miles of the project site, was used to determine rainfall over the site during the 2005 growing season. Missing data were supplemented with data from the next closest weather station, Elizabethtown Lock 2 gauge (UCAN: 14082, COOP: 312732) in Bladen County.

A manual rainfall gauge on the Privateer Site was used to validate observations made at the automated weather stations. However, the manual rain gauge malfunctioned during the month of July 2005, the wettest month of the 2005 growing season. For this reason, total rainfall depth for the 2005 growing season collected by the manual onsite gauge and by the nearby automated weather stations do not correlate well.

2.3.1 Success Criteria

Successful restoration of wetland hydrology is defined in the project's Restoration Plan as achieving continuous inundation of the site or continuous saturation of its soil within 12 inches of soil surface for a minimum of 12.5 percent of the growing season, or 30 consecutive days. The day counts are based on the growing season for Cumberland County, which is 242 days long, beginning on March 18 and ending November 15, as calculated from National Weather Service Wetlands Determination Tables (WETS) for Johnston County. Data on inundation height or depth of soil saturation line were obtained from the 15 automated monitoring wells and 15 manual monitoring wells in place throughout the site. Data defining successful hydrologic conditions must demonstrate that wetland conditions are present in normal or dryer than normal conditions.

If rainfall data for any given year during the monitoring period are not normal, and if the desired hydrology for the project site is not on a trajectory to achieve success, then data from the pre-defined reference wetland site for this project can be assessed to determine if there is a positive correlation between the underperformance of the restoration site and the natural hydrology of the reference site.

If the restored site is inundated or saturated within 12 inches of the soil surface for less than 12.5 percent of the growing season, but the post-restoration monitoring data reflect that the site meets applicable USACE criteria for wetlands and the site is performing with similar hydrology as the monitored reference site, then the regulatory agencies may consider the site for mitigation of in-kind impacts on a case-by-case basis.

2.3.2 Results and Discussion

The spring months of the 2005 growing season were unusually dry, with total monthly rainfall noticeably below the approximated long-term average for the area. The months of June and July 2005 experienced wetter conditions, with monthly rainfall depths over an inch above the estimated long-term average for these months. Rainfall total were again below the long-term average in August 2005, while moderately wetter conditions returned during September 2005. Conditions were dry again for the month of October 2005, with rainfall substantially below long-term average during this period.

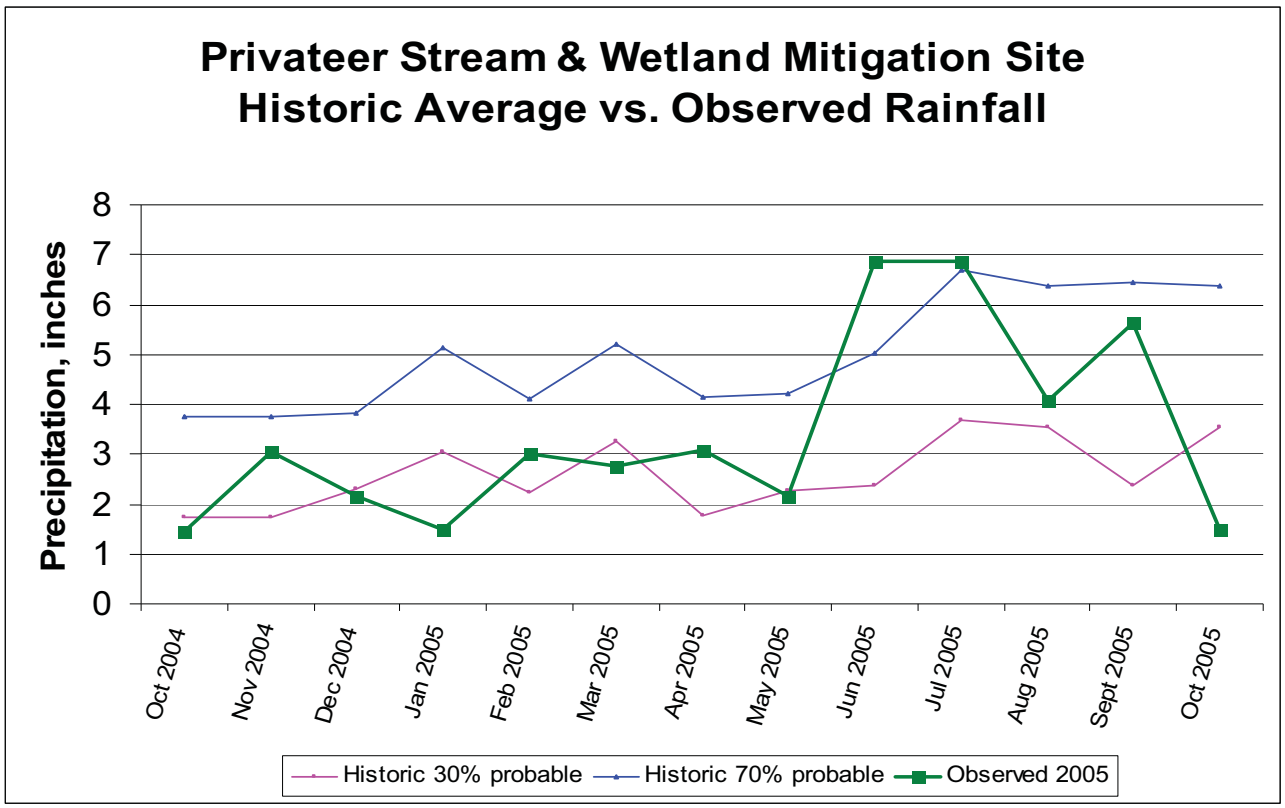
Total rainfall for the 2005 growing season was only three inches below the long-term average for total growing season rainfall; however the distribution of rainfall throughout the growing season did not follow the average rainfall pattern for the area. Most rain fell during the hottest summer months when evapotranspiration leads to significant losses of water to the atmosphere. Year 1 may be considered a relatively dry year, since monthly total rainfall fell below the long term average for half of the growing season. Table 2 and Figure 4 compare historic rainfall over the area with those observed during the 2005 growing season.

Data collected during the 2005 growing season by the fifteen automatic monitoring well gauges at the Privateer site showed that groundwater levels met hydrologic success criteria for nine of the wells. Data from a total of thirteen of the onsite automatic well gauges exhibited occurrence of a continuous hydroperiod greater than 5 percent of the growing season. None of the automatic monitoring well gauges installed at the reference site met hydrologic success criteria, and none showed occurrence of a continuous hydroperiod for more than 5 percent of the growing season, reflecting the usually dry conditions for the year. Data collected from onsite gauges are summarized in Table 5.

Table 4
Comparison of Historic Average Rainfall to Observed Rainfall (Inches).

Month	Average	30%	70%	Observed 2005 Precipitation
January	4.16	3.06	5.13	1.47
February	3.43	2.22	4.11	3.00
March	4.37	3.24	5.22	2.75
April	3.06	1.77	4.13	3.08
May	3.29	2.25	4.2	2.17
June	4.18	2.36	5.02	6.87
July	5.21	3.69	6.7	6.85
August	5.21	3.54	6.36	4.08
September	4.77	2.36	6.46	5.62
October	3.15	1.73	3.76	1.49
November	2.88	1.75	3.76	N/A
December	3.24	2.3	3.81	N/A

Figure 4. Comparison of Observed Rainfall and Historic Average Rainfall.



Monitoring well data are shown in Figures 5 through 11. A separate graph is presented for monitoring wells in each of the five reaches into which the project is subdivided, except for data from Reach 1 which is included with Reach 2 data. Wherever there were more than 5 monitoring wells in

a single reach, data for that reach are presented in two separate graphs: one for the upstream half of the reach and another for the downstream half of the same reach. Reference site well data are presented in Figure 12.

Table 5
Hydrologic Monitoring Results for 2005 (Year 1).

Monitoring Station	Most Consecutive Days Meeting Criteria[1]	Cumulative Days Meeting Criteria[2]	Number of Instances Meeting Criteria[3]
MW1[4]	20 (8.3%)	57 (23.6%)	6
MW2[5]	90 (37.2%)	154 (63.6%)	5
MW3[5]	90 (37.2%)	154 (63.6%)	5
AW4	90 (37.2%)	154 (63.6%)	5
MW5[5]	90 (37.2%)	154 (63.6%)	5
AW6	20 (8.3%)	57 (23.6%)	6
MW7[6]	45 (18.6%)	131 (54.1%)	8
AW8	96 (39.7%)	198 (81.8%)	6
AW9	45 (18.6%)	131 (54.1%)	8
MW10[6]	45 (18.6%)	131 (54.1%)	8
MW11[7]	36 (14.9%)	120 (49.6%)	9
AW12	36 (14.9%)	120 (49.6%)	9
AW13	34 (14.0%)	96 (39.7%)	9
MW14[8]	34 (14.0%)	96 (39.7%)	9
AW15	18 (7.4%)	57 (23.6%)	9
MW16[7]	36 (14.9%)	120 (49.6%)	9
AW17	19 (7.9%)	54 (22.3%)	8
MW18[9]	18 (7.4%)	59 (24.4%)	6
AW19	18 (7.4%)	59 (24.4%)	6
AW20	39 (16.1%)	93 (38.4%)	4
MW21[9]	18 (7.4%)	59 (24.4%)	6
AW22	28 (11.6)	60 (24.8%)	7
MW23[9]	18 (7.4%)	59 (24.4%)	6
AW24	13 (5.4%)	36 (14.9%)	8
MW25[9]	18 (7.4%)	59 (24.4%)	6
AW26	17 (7.0%)	52 (21.5%)	5
AW27	9 (3.7%)	34 (14.0%)	8
MW28[9]	18 (7.4%)	59 (24.4%)	6
AW29	22 (9.1%)	68 (28.1%)	6
MW30[10]	22 (9.1%)	68 (28.1%)	6

REF1	3 (1.2%)	12 (3.7%)	4
REF2	5 (2.1%)	12 (5.0%)	3
REF3	9 (3.7%)	60 (24.8%)	10

[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] Groundwater gauge MW1 is a manual gauge. Hydrologic parameters are estimated based on data from gauge AW6.

[5] Groundwater gauges MW2, MW3, and MW5 are manual gauges. Hydrologic parameters are estimated based on data from gauge AW4.

[6] Groundwater gauges MW7 and MW10 are manual gauges. Hydrologic parameters are estimated based on data from gauge AW9.

[7] Groundwater gauges MW11 and MW16 are manual gauges. Hydrologic parameters are estimated based on data from gauge AW12.

[8] Groundwater gauge MW14 is a manual gauge. Hydrologic parameters are estimated based on data from gauge AW13.

[9] Groundwater gauges MW18, MW21, MW23, MW25, and MW28 are manual gauges. Hydrologic parameters are estimated based on data from gauge AW19.

[10] Groundwater gauge MW30 is a manual gauge. Hydrologic parameters are estimated based on data from gauge AW29.

Figure 5. Well Data for Reach 1 and Reach 2 of the Privateer Restoration Project.

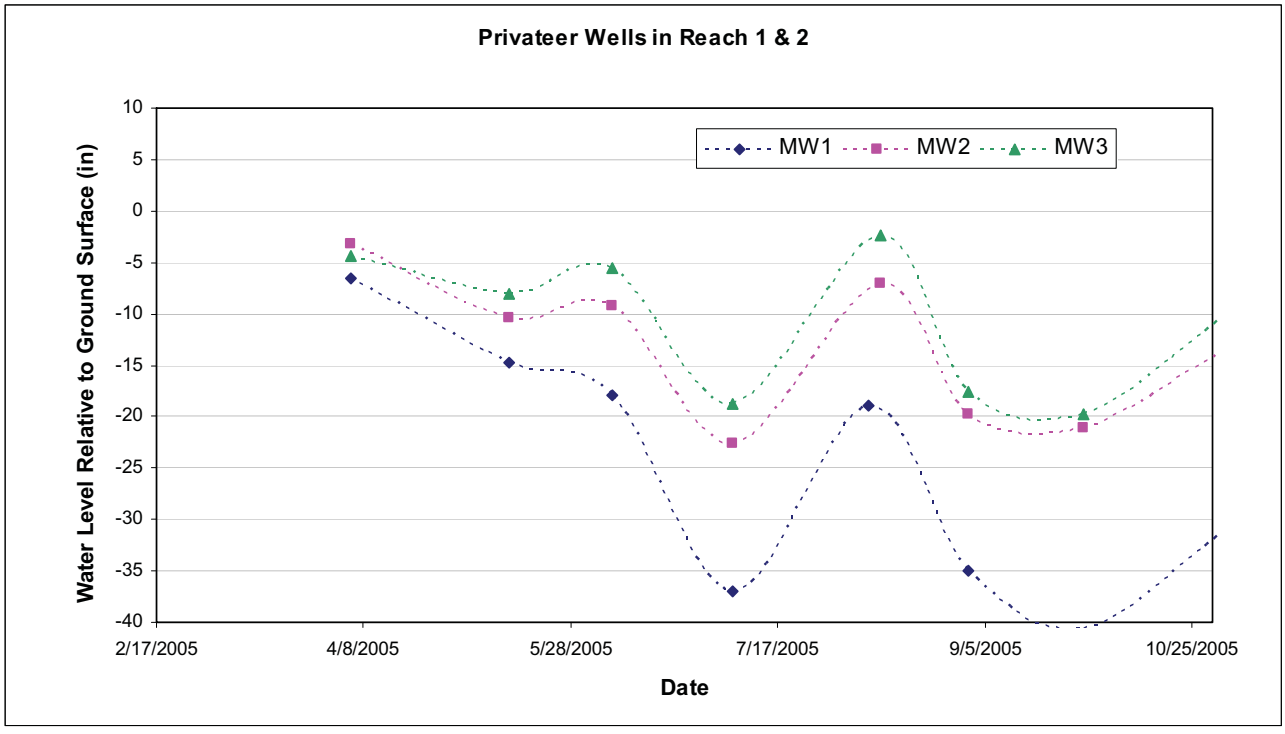


Figure 6. Well Data for Upstream Half of Reach 3 of the Privateer Restoration Project.

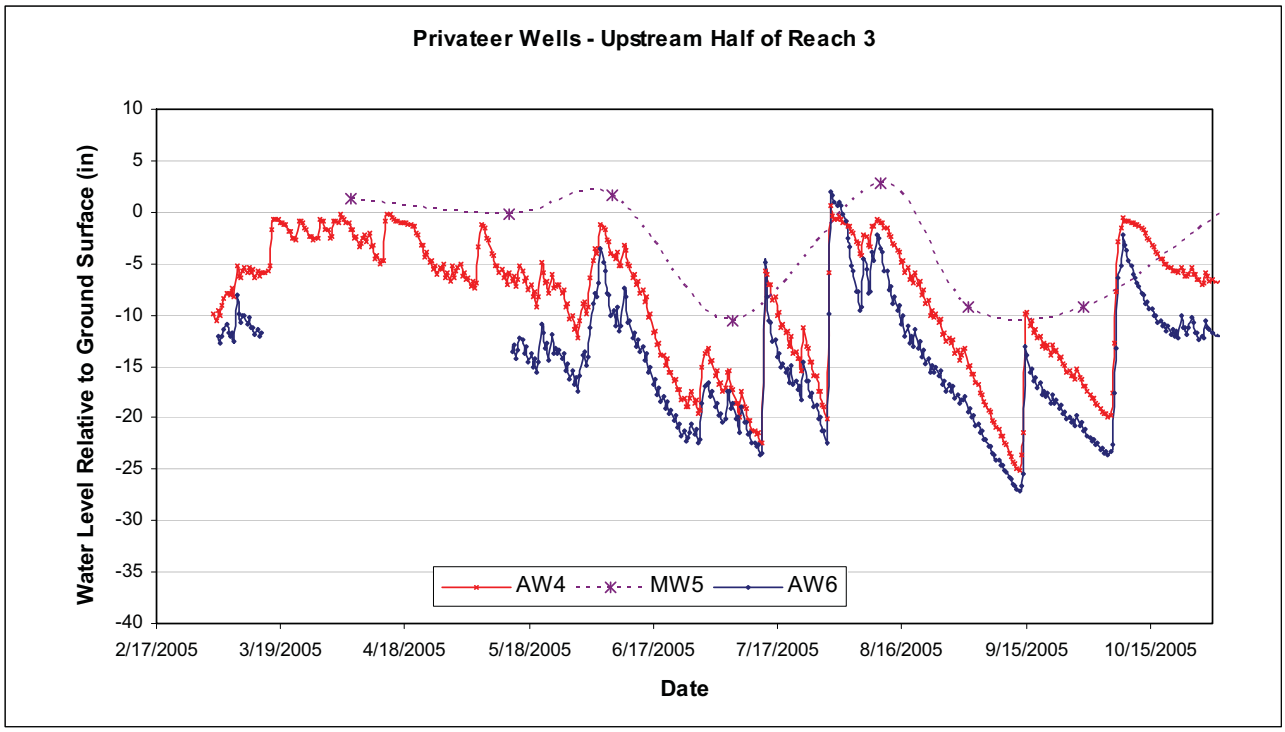


Figure 7. Well Data for Downstream Half of Reach 3 of the Privateer Restoration Project.

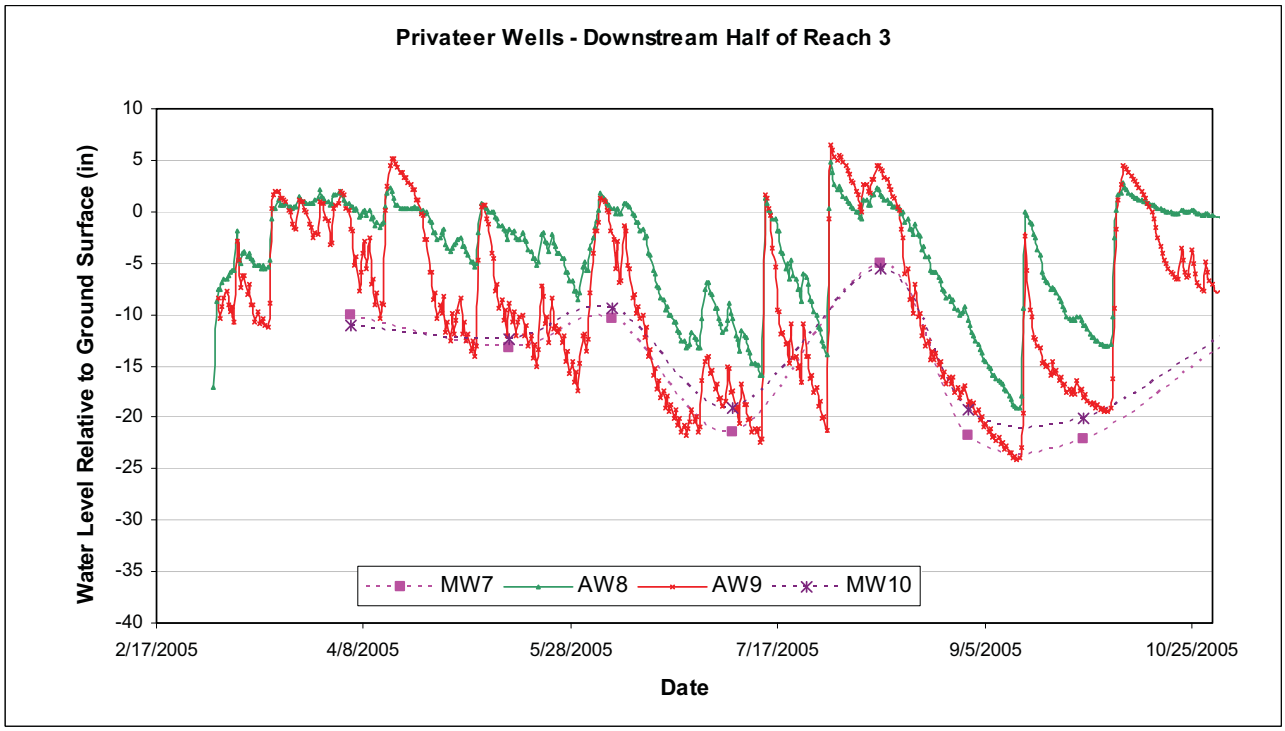


Figure 8. Well Data for Upstream Half of Reach 4 of the Privateer Restoration Project.

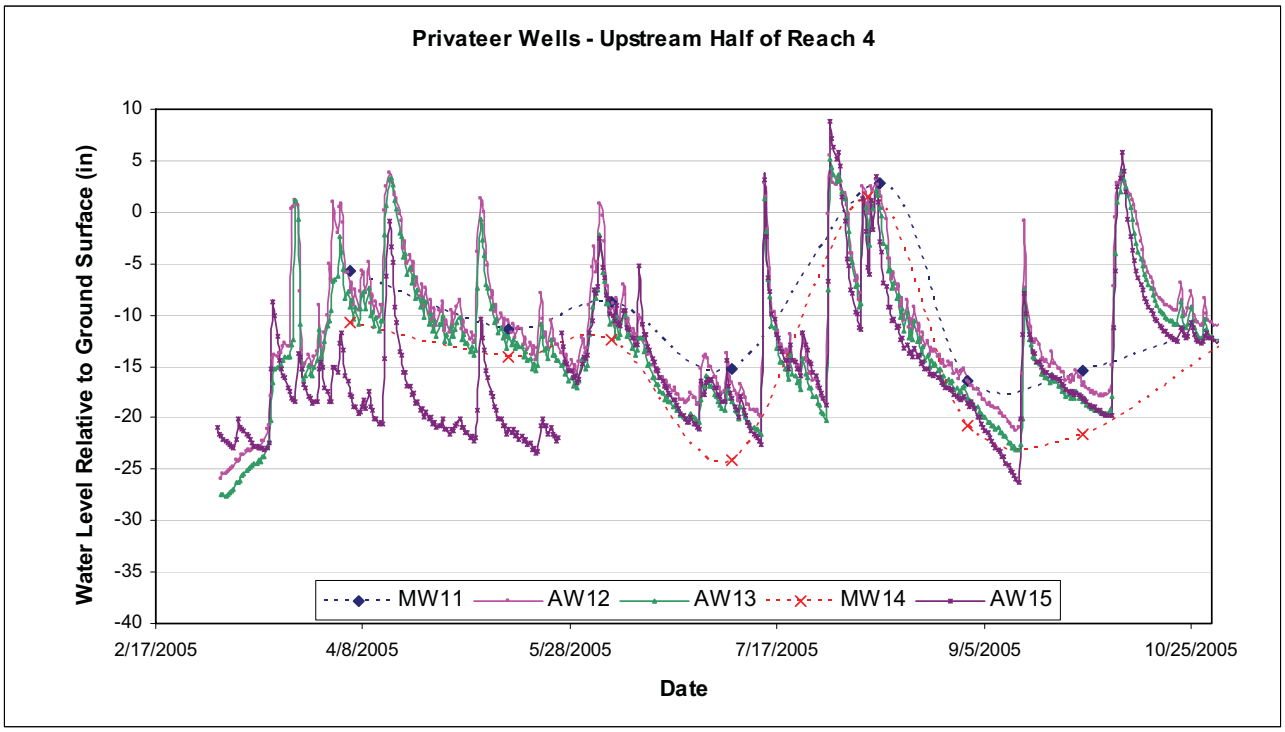


Figure 9. Well Data for Downstream Half of Reach 4 of the Privateer Restoration Project.

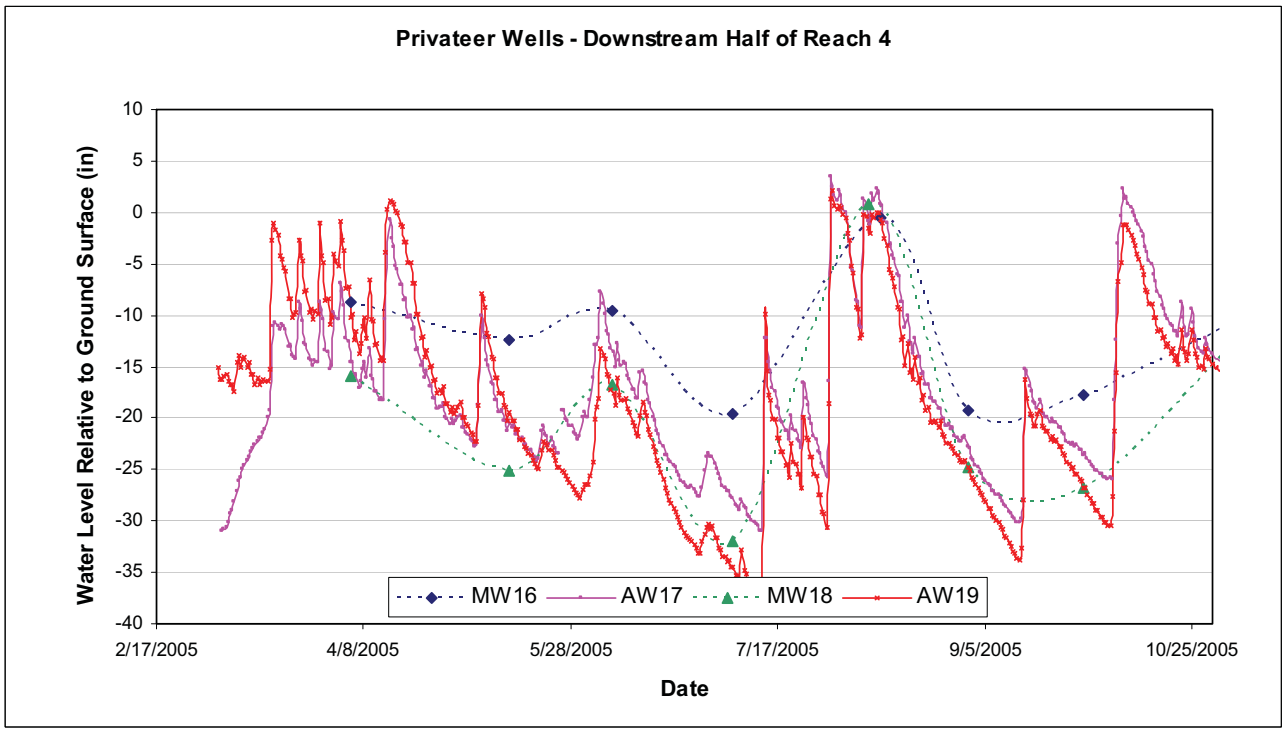


Figure 10. Well Data for Upstream Half of Reach 5 of the Privateer Restoration Project.

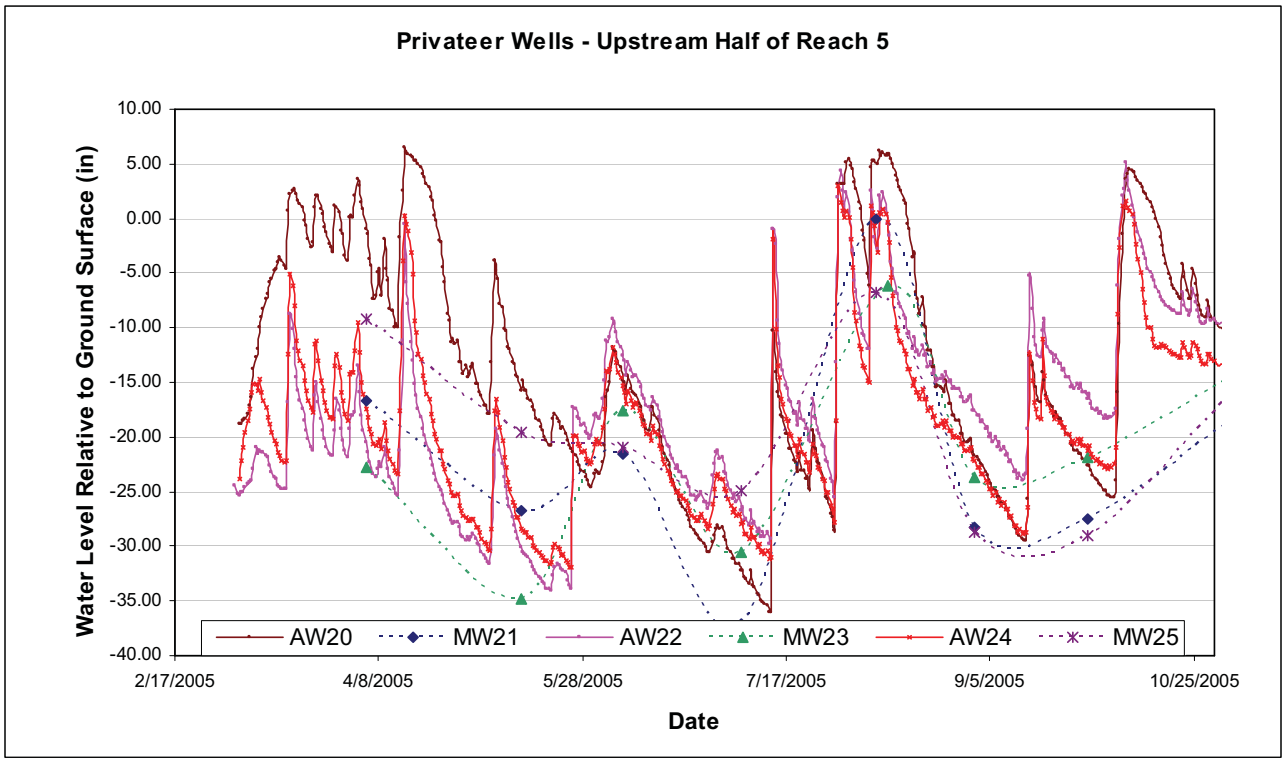


Figure 11. Well Data for Downstream Half of Reach 5 of the Privateer Restoration Project.

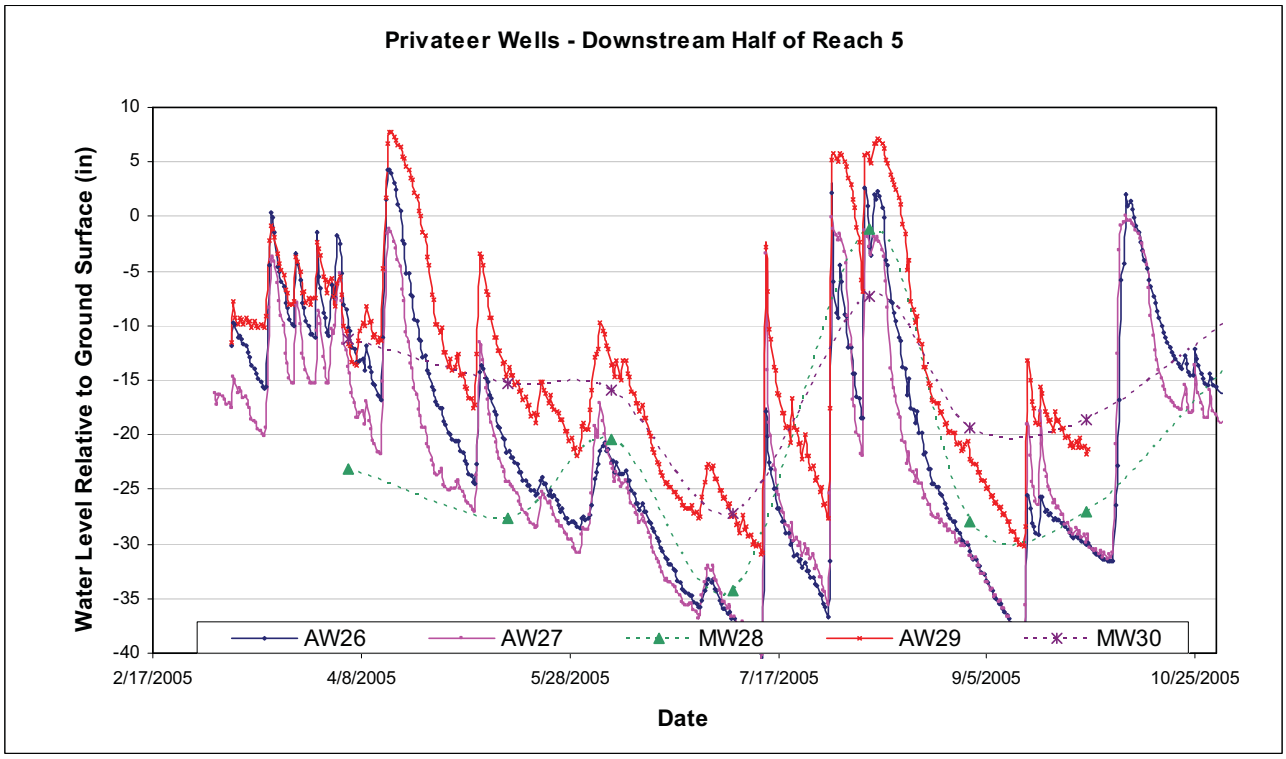
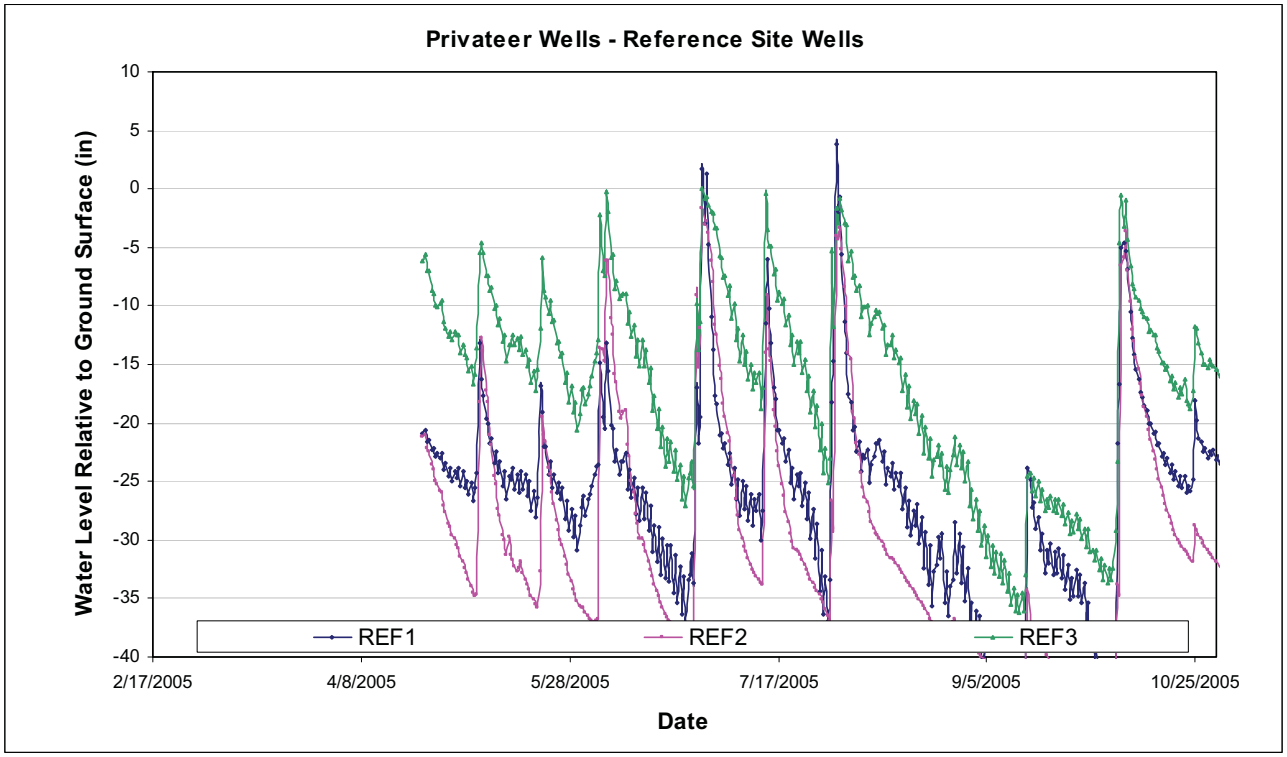


Figure 12. Well Data for Reference Site Wells - Privateer Restoration Project.



Although hydrologic success criteria was not met for all wells at the site, the data show that 2005 hydrologic conditions at the site were more favorable than those occurring at the reference site for the same year, even during a relatively dry year. These data correlate well with the type of wetland systems that are targeted in this project. Based on these results, it was concluded that most of the site is performing as designed and conditions are expected to improve as normal rainfall pattern return.

Monitoring data from the reference site demonstrate positive correlations between the restoration site and the natural hydrology of the target system.

2.3.3 Areas of Concern

While the conditions documented for some well locations were drier than expected, rainfall for the year was below normal. The overall lack of rain in the early part of the growing season could indicate that the site is still rebounding hydrologically following restoration. It is anticipated that once normal rainfall conditions return, the site will perform as expected hydrologically.

2.4 Site Observations

Many different animal species were observed throughout the site. White tail deer, wild turkey, blue herons, many other birds, turtles, and small fish in the stream were commonly observed on-site. Occasionally, black bear and several snake species were observed throughout the site. Bobcat tracks were also commonly observed.

Thick, herbaceous vegetation covered nearly the entire site. Observed species included rush (*Juncus* sp.), goldenrod (*Solidago* sp.), switchgrass (*Panicum virgatum*), lespedeza (*Lespedeza*), fennel (*Foeniculum vulgare*), tearthumb (*Polygonum sagittatum*), and various other grasses.