STREAM MITIGATION
AS-BUILT REPORT

Jefferson Pilot
Guilford County, North Carolina

N.C. Wetlands Restoration Program
_____NCDENR_DWQ

June 2002

Prepared by:

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(919) 854-6200

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1.0 INTRODUCTION

The North Carolina Wetlands Restoration Program (WRP) requested that Earth Tech conduct an as-built study on the Jefferson Pilot Stream Restoration in Guilford County, North Carolina.

The objective of this study was to establish a post-construction assessment of site conditions, to establish permanent reference points for future monitoring, and compile a photographic log of current stream and site conditions.

This report is broken into five main components:

1) Detailed establishment of study plots and monument points
2) Assessment of the stream channel and structures
3) Assessment of the vegetation in the riparian buffer
4) Development of a baseline photographic log showing post-construction conditions
5) A summary of findings

1.1 Project Description

This site is located on the west side of Greensboro off New Garden Road. The stream reach is located at the entrance to Price Park on land that is held by the City of Greensboro (Figure 1). The stream is situated in the Upper Cape Fear River Basin (8-digit hydrologic code: 03030002). Jefferson Elementary is located to the west, Price Park to the east, and Guilford College is located south of the site. Local residents use the area surrounding the stream for walking, biking, and other recreational activities.

The stream is the unnamed tributary to Horsepen Creek, henceforth referred to as the Jefferson Pilot stream. This stream drains into a private pond that backs up the lower portion of the channel. The pond elevation was raised after the restoration construction was completed. From a review of historical aerial photographs, this second order stream appears to have been straightened prior to 1937 for agricultural purposes. The drainage area is approximately 1.0 square mile (Figure 1).

Prior to the restoration, a narrow riparian corridor existed along much of the stream banks and the channel was deeply incised with active erosion and undercutting. Within this buffer, the vegetation was relatively weedy and scrubby with only approximately 10 trees with a basal diameter greater than 10 inches. Development pressures continue to increase the urbanization in the Jefferson Pilot watershed and adjacent watersheds.

The Priority I restoration involved converting the 1436 ft straightened channel into a sinuous channel that meanders for a total of 1646 ft as measured along the centerline or 1776 along the thalweg (Appendix A). Cross-vanes and rootwads were incorporated for aquatic habitat enhancement and bed and bank stability. A 50-foot riparian buffer on either side of the stream was planted with native vegetation. In addition, an aerial sanitary sewer line was re-aligned to be perpendicular to the stream flow and a gas line was re-routed under the stream channel.

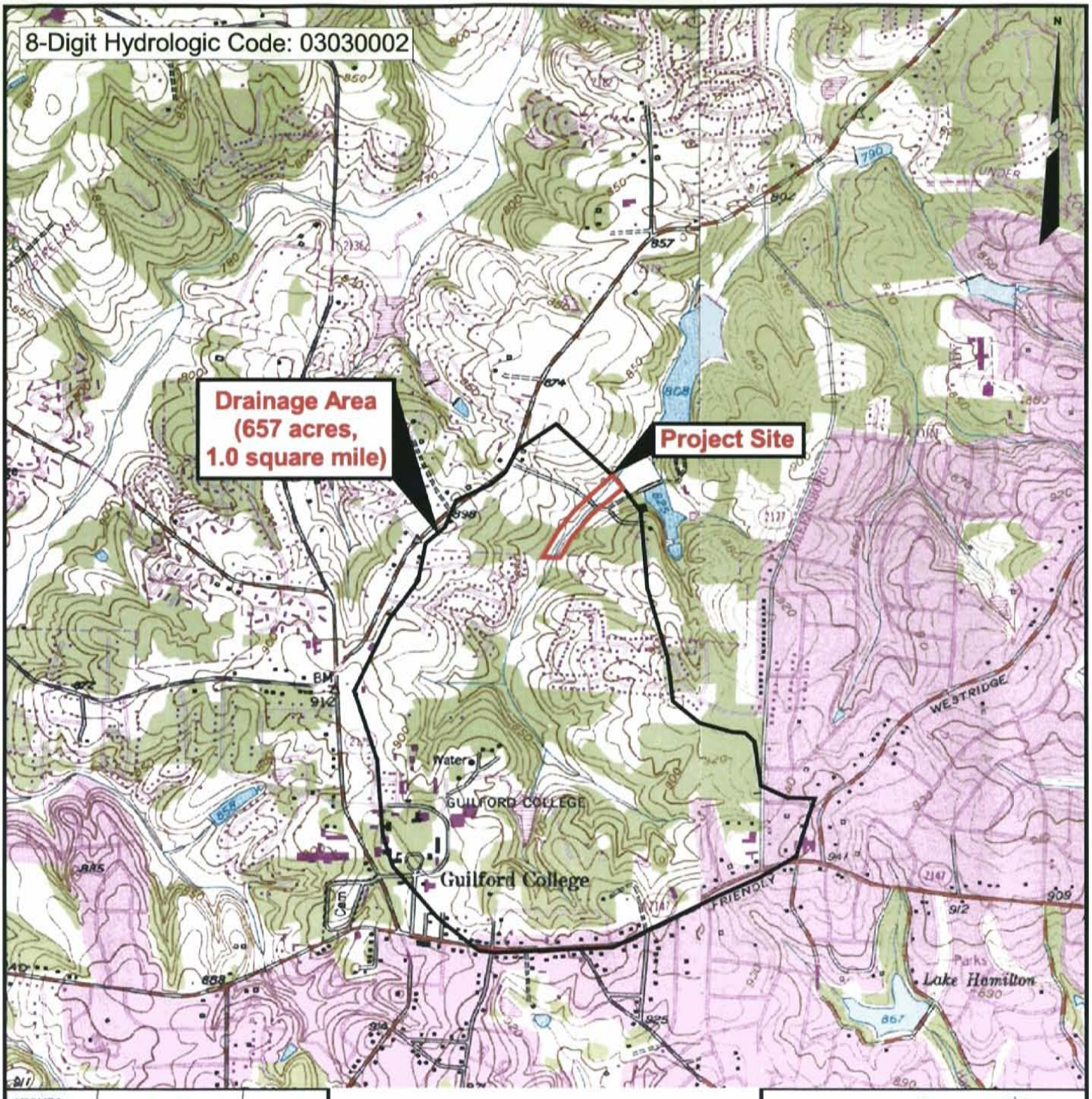


FIGURE 1
Site Map

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina

Table 1 contains a schedule of events for the construction of the Jefferson Pilot stream.

Table 1. Schedule of Construction Events

Construction Event	Date
Channel construction	June-August 2001
Additional structure construction	February 25-28, 2002
Temporary Seeding	July-August 2001 February 2002 (limited to disturbed areas after construction of additional structures)
Permanent Seeding	August 2001
Planting of bare-root stock	February 18-19, 2002 & March 7, 2002
As-built Stream Survey	April 11, 2002
As-built Vegetation Survey	June 6, 2002

1.2 Methodology

Post-construction monitoring of geomorphic and vegetative conditions was performed on the Jefferson Pilot Stream Restoration project. Methodologies used are detailed in the following sections.

1.2.1 Reference Point Establishment

The establishment of permanent markers are needed to document post-construction conditions and for future evaluation of any changes in the site. Documentation is necessary to evaluate any changes and determine the success of this stream restoration project. Benchmark elevation points have been established near each end of the project. The first is located on top of a sanitary sewer manhole cover. This manhole is near the southern end of the project and to the west of the channel. This manhole is identified on the mapping as TBM#1. The second benchmark, TBM#2, is located at the northern end of the project, on top of the culvert beneath Hobbs Road. See Figure 2 for more precise locations.

Four cross-sections were established along the stream to document channel conditions. Permanent markers were installed to locate the ends of the cross-section. The permanent markers are metal pins consisting of approximately 2-foot lengths of re-bar driven flush with the ground surface. Wooden stakes were driven in the ground at each rebar pin and marked with the cross-section identifier.

Ten belt transects perpendicular to the channel were established to document vegetation conditions. Permanent markers (2-foot length of rebar) with wooden stakes identifying transects are located at each end. A tape was stretched between the markers to locate the area within each zone.

1.2.2 Longitudinal Profile

A longitudinal profile of the stream began at the fence that crosses the stream near the property boundary and ends at the culvert beneath Hobbs Road. Standard differential leveling techniques and equipment were employed to measure the elevations of thalweg, water surface, bankfull, and build-out. These measurements were taken at the head of each riffle, max pool, and at each cross-vane. In addition, max pool depth and water surface were taken below each cross-vane to monitor the change in the scour pool depth.

1.2.3 Cross-Sections

Four cross-sections were surveyed to establish the dimensions of the channel using standard differential leveling techniques and equipment (Figure 2). These cross-sections were tied to the longitudinal profile and were assigned station identification numbers based on the longitudinal survey. Of the four cross-sections, three were riffles and one was a pool. Cross-sections are 100 feet wide with one permanent marker on each side of the channel. Data was analyzed using the methods recommended by Dave Rosgen (1996). From the field data, the bankfull cross-sectional area, width, depth, and entrenchment ratio were determined. Appendix A contains the data for each cross-section including pictures of each cross-section.

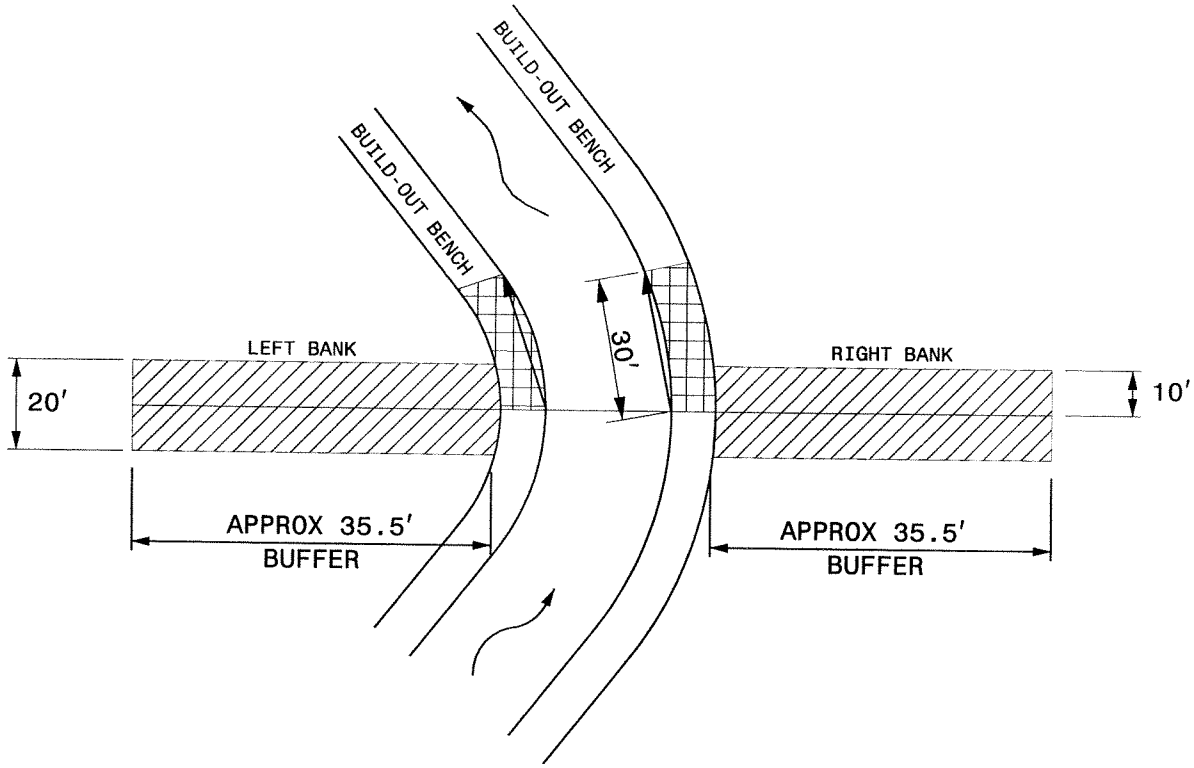
1.2.4 Pebble Count

A pebble count was taken at each cross-section to determine the size distribution of the channel materials. The Modified Wolman Pebble Count was used to account for both bed and bank materials. Fifty counts were randomly taken beginning at the left bankfull station and proceeding down the bank into the bed and back up to the right bankfull station. Only fifty counts were taken due to the narrow width of the bankfull channel. The data was analyzed using methods recommended by Dave Rosgen (1996). A spreadsheet was developed to calculate the cumulative percent by particle size class. These values were plotted on log-normal scale. Due to the fineness of the samples, the D50 and the D84 particle sizes were calculated from the data and not the graph. These values are listed on the graphs contained in Appendix A.

1.2.5 Vegetation

Ten vegetative belt transects (BT-1 through BT-10) were established, six at runs and four at pools. The general locations of the transects are shown in Figure 2. The belt transects were pulled perpendicular to the channel. Within each transect there are two zones: bankfull to build-out (called build-out bench) and build-out to the edge of the buffer (called buffer) (Figure 3). The build-out bench vegetation zone was measured beginning at the intersection of the belt transect with the top of bank feature and extends downstream for 30 feet. The width of this vegetation zone is variable due to structures, root wads and the sinuosity of the channel, varying from 8 to 13 feet. The buffer zone vegetation was measured beginning at the top of the build-out bench for a distance of

POOL BELT TRANSECT - PLAN VIEW



POOL BELT TRANSECT - CROSS SECTION VIEW

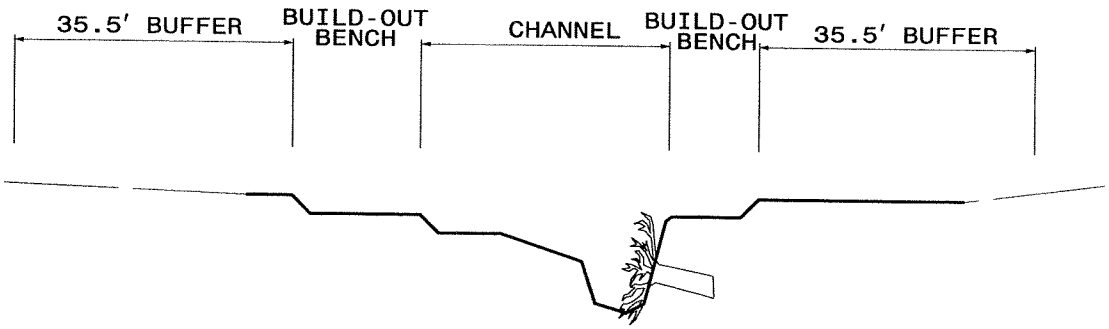


FIGURE 3

EXAMPLE BELT TRANSECT
FOR VEGETATION MONITORING

35.5 feet, ending approximately to the buffer extents. This vegetation plot extends for 10 feet on either side of the belt transect creating a 20 feet wide by 35.5 feet long transect on either side of the stream.

Within the two planting zones bare-root seedlings were evaluated for density and height. Estimates of the target planting density within the build-out zone are based upon a linear 7-foot spacing of seedlings. Estimates of the target planting density for the buffer zone are based upon 10 x10-foot spacing. See Appendix B for a summary of the post-construction findings with regard to the vegetation.

All seedlings planted within plots were counted and their height measured. Identification to species was made when possible. Because of the small seedling size and damage from planting, identification of some seedlings was uncertain. Accurate determination of diversity was therefore not possible during this monitoring event. Obvious damage to planted bare-root stock was noted at the time of the survey. Some damage has occurred after planting because of continuing site work and the high use of the park area by local citizens.

The initial planting plan specified 440 stems per acre with a minimum accepted survival of 80% or 352 stems per acre at the end of the one-year warranty period. Less than 80% survival would require the contractor to replant to achieve 440 stems per acre at the end of a warranty period. The goal of 440 (rounded up from 436) stems per acre is based on a recommendation from Smith (2001) to provide 320 trees per acre at the end of 5 years. Since the Contractor finished planting the trees on March 7, 2002, the warranty will expire on March 7, 2003.

1.2.6 Photograph Log

Photographs were taken to depict existing conditions for the stream channel, cross-sections, structures, and vegetation. To document channel conditions, a photograph was taken looking upstream and downstream from the back of each meander bend. This was done to eliminate individual staking that is typically required at each photo point. Photo reference point staking was eliminated since this is a heavily used park and stakes are easily pulled up or kicked over making successive monitoring unreliable. Since the cross-vanes are located immediately downstream of the meanders, this serves not only as a representative view of the stream, but also each cross-vane. Photographs are labeled using the meander number and direction of the photo (Figure 2). For example, a photograph taken looking upstream from the third meander would have an identification number as follows: M3-US. The stream channel photo log is included in Appendix C. Additional photos are included with the cross-section data in Appendix A to depict the existing conditions of the cross-sections. To document existing vegetative conditions, a photograph was taken looking upstream and downstream to show the bench zone and looking toward right bank and toward left bank, to show the buffer zone. The vegetation photo log is included in Appendix C.

1.3 Project Contacts

WRP Project Manager:	Jeff Jurek 1619 Mail Service Center Raleigh, NC 27699-1619 Phone: (919)733-5316
Design Firm:	Earth Tech of North Carolina, INC. 701 Corporate Center Drive, Suite 475 Raleigh, NC 27607 Phone: (919)854-6200
Contractor:	SEI Environmental, INC. 5100 North I-85, Suite 7 Charlotte, NC 28206 Phone: 1-800-873-1250

2.0 SUCCESS CRITERIA

The following success criteria are recommended for the Jefferson Pilot Stream Restoration Project. These criteria are suggested based on past projects and guidance from NCWRP.

2.1 Dimension, Pattern and Profile

The dimension, pattern, and profile of the stream should show no radical change during the 5-year monitoring period. To determine this, a longitudinal profile and cross-sections should be surveyed annually as described in Section 2.2. Cross-sections should be overlaid to verify no significant change in the dimension from year to year. Similarly, the longitudinal profile should be overlaid to confirm a stable bed profile. Due to the number of rootwads located in the majority of the meanders, the pattern should be confirmed through visual observation. If a rootwad has washed out or there are signs of erosion, the radius of curvature should be measured and compared to the as-built mapping.

2.2 Materials

A Modified Wolman Pebble Count should be taken at each cross-section to determine the change in the surface material below bankfull as described in Section 2.2. The pools should contain a finer material than the riffles, which should show coarsening over the 5-year monitoring period. The pebble count should be taken once a year during the annual monitoring period. The consecutive pebble counts should be plotted on the same graph. In addition, the D50 and D84 should be compared to determine changes in the surface material of the cross-section.

2.3 Photograph Points

Photographs should be taken standing in the back of each meander looking upstream and then downstream as described in Section 2.2. A qualitative assessment should be made with regard to the vegetation, cross-vanes, rootwads, and the general stability of the reach. Any significant changes should be discussed and highlighted in the report.

2.4 Vegetation

The success criteria for tree seedlings in the riparian buffer zones are defined by the Division of Water Quality to be 320 stems/acre after five years. Vegetation should be monitored annually as described in Section 1.2.5.

The initial planting plan specified 440 stems per acre with a minimum accepted survival of 80% or 352 stems per acre at the end of the one-year warranty. Less than 80% survival will require the contractor to replant to achieve 440 stems per acre at the end of the warranty period. The goal of 440 (rounded up from 436) stems per acre is based on a recommendation from Smith (2001) to provide 320 trees per acre at the end of 5 years. Since the Contractor finished planting the trees on March 7, 2002, the warranty will expire on March 7, 2003.

3.0 MONITORING

Future monitoring of the site is necessary to determine if the success criteria for mitigation have been met. The monitoring shall fulfill the requirements of the NC Division of Water Quality. The duration of the monitoring shall be 5 years from the end of construction, which includes channel modifications and vegetation planting. On this project, the channel construction was completed in August 2001. However, due to drought conditions, the vegetation planting was not completed until March 7, 2002. Therefore, the one-year vegetation warranty will expire on March 7, 2003. The vegetation will need to be assessed prior to this date to determine a need for the Contractor to replant. The annual monitoring of the site should be conducted during the late fall or early winter of each year beginning in 2002 as indicated by Table 2. Earth Tech has provided the as-built conditions as outlined in this report and will provide the Year 1 monitoring. A separate firm, to be announced at a later date, will monitor the site during Years 2-5.

Table 2. 5-Year Monitoring Schedule

Monitoring Year	Monitoring Date	Monitoring Firm
Year 1*	Late Fall/Early Winter 2002	Earth Tech
Year 2	Late Fall/Early Winter 2003	TBA
Year 3*	Late Fall/Early Winter 2004	TBA
Year 4	Late Fall/Early Winter 2005	TBA
Year 5*	Late Fall/Early Winter 2006	TBA

*These monitoring reports should be sent to USACOE and NCDWQ, 401-Wetlands Unit at the end of the yearly monitoring period.

This monitoring will be conducted using the methodologies described in Section 2.2 for longitudinal profile, cross-sections, pebble counts, vegetation monitoring, and photo reference points.

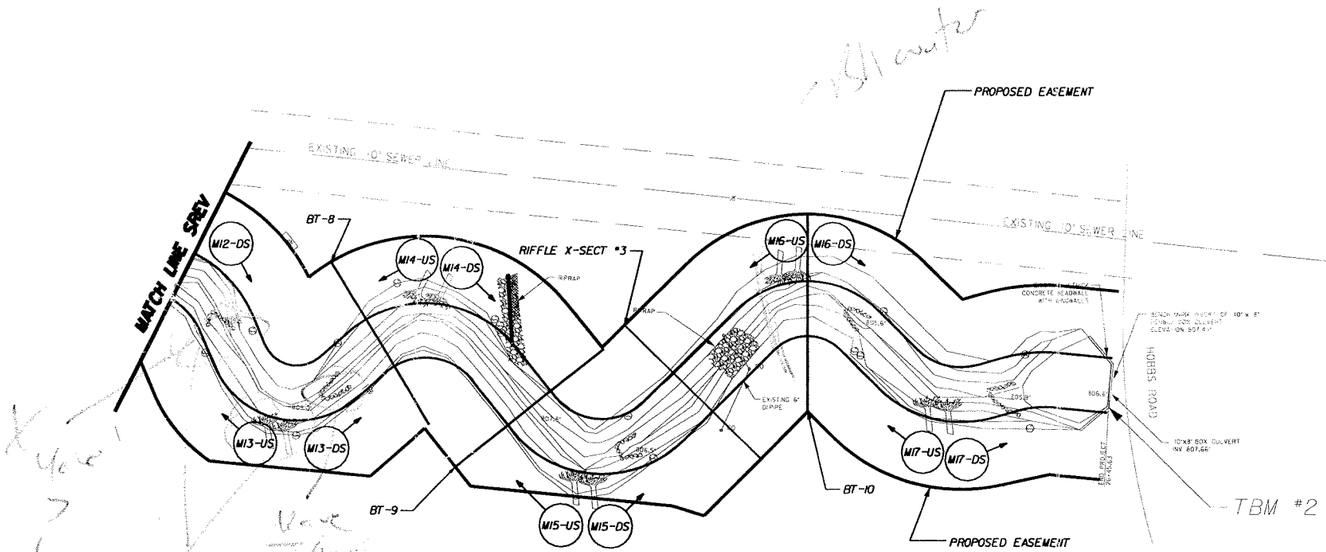
4.0 MITIGATION

This project consisted of taking a 1436 linear foot channelized urban stream and converting it into 1646 linear feet of Priority I stream restoration (Rosgen, 1997) as measured along the centerline, or 1776 feet along the thalweg. Included in this restoration was the installation of 13 cross-vanes, 40 rootwads, re-aligning an aerial sanitary sewer line, and re-routing a gas line under the stream. A 50-ft riparian buffer was established along either side of the stream channel for the entire length of channel. A dedicated easement will contain the vegetative buffer and stream channel.

The plan sheets in Figure 4 contain the As-Built Plans for the project. These plans depict the stream restoration in plan view along the centerline of the project post-construction.

5.0 MAINTENANCE AND CONTINGENCY PLANS

AS-BUILT SURVEY MAPPING
PROVIDED BY:
THE ROSE GROUP
104 GILLESPIE STREET
FAYETTEVILLE, NC 28301
(910) 323-3400



NOTES:

BT = BELT TRANSECTS

○—• = PHOTO POINTS

SCALE
40 0 40 80

NO	REVISIONS	DRN	CHK	DATE

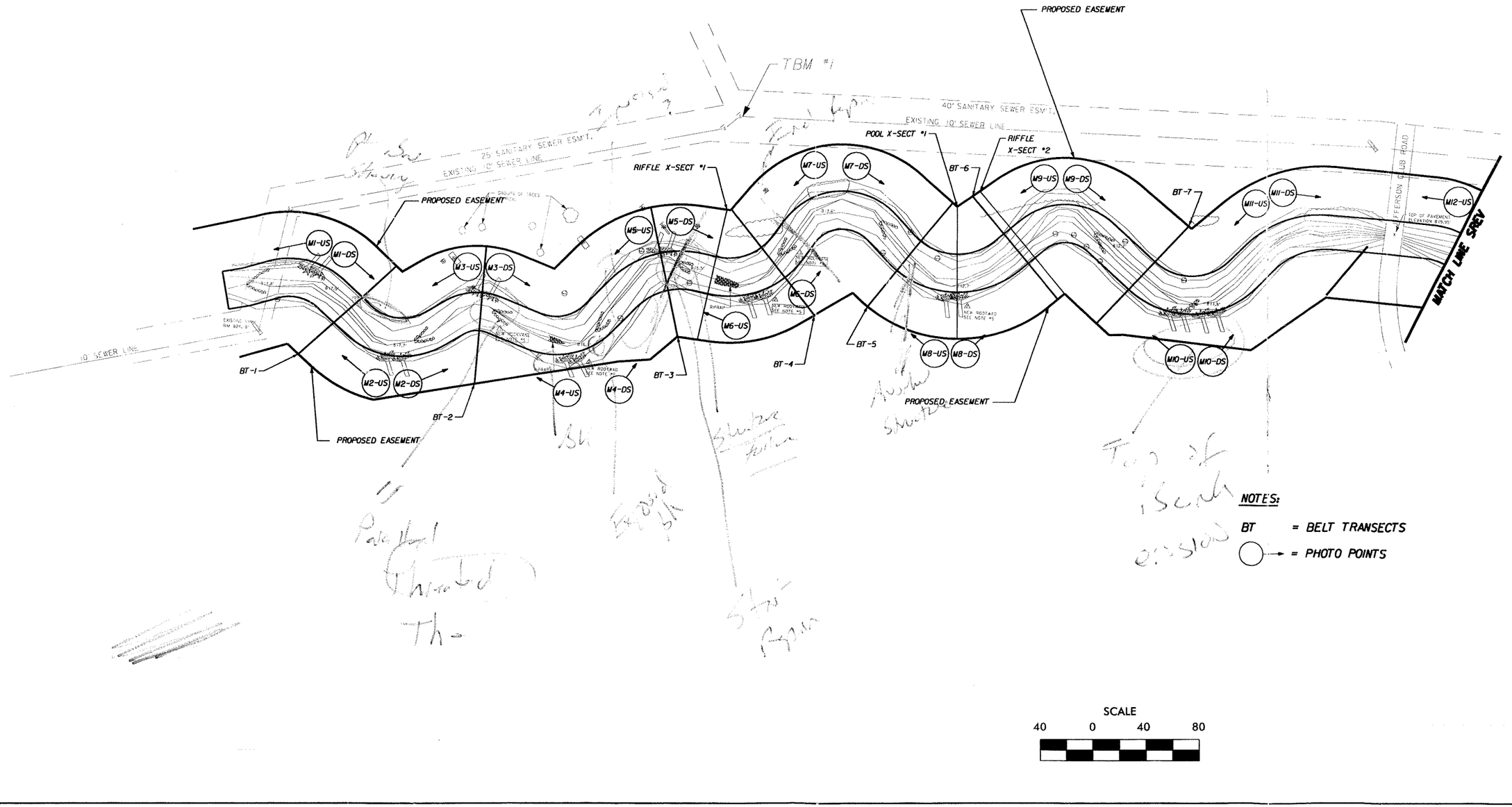
EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

FIGURE 2
SITE PLAN

DATE	APRIL 03, 2001
PROJECT NO	40361
FILENAME	
SHEET NO	C-4
DRAWING NO	

AS-BUILT SURVEY MAPPING
PROVIDED BY:
THE ROSE GROUP
104 GILLESPIE STREET
FAYETTEVILLE, NC 28301
(910) 323-3400



NO	REVISIONS	DRN	CHK	DATE

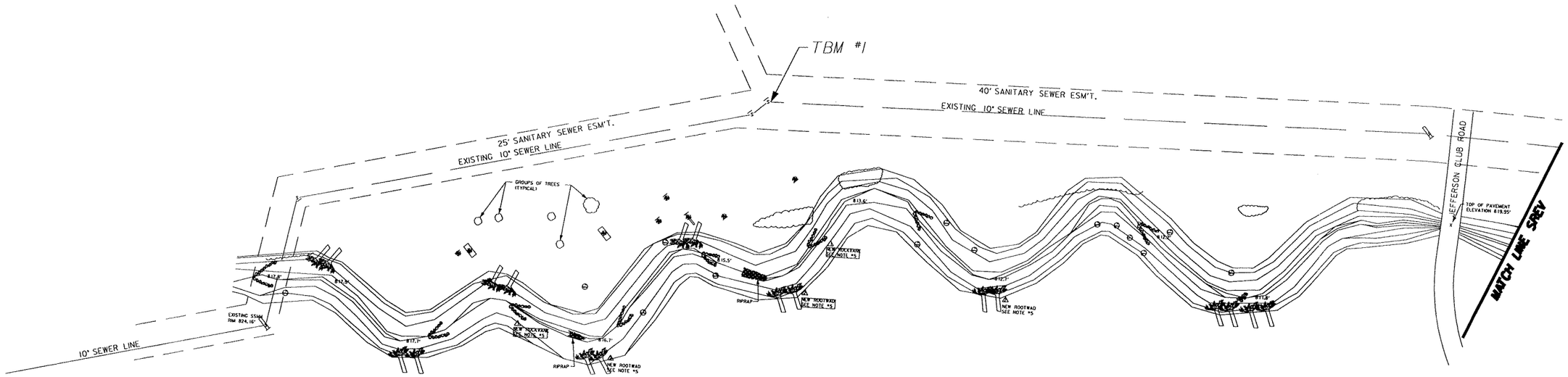
EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

FIGURE 2
SITE PLAN

DATE	APRIL 03, 2001
PROJECT NO	40361
FILENAME	
SHEET NO	C-3
DRAWING NO	

AS-BUILT SURVEY MAPPING
PROVIDED BY:
THE ROSE GROUP
104 GILLESPIE STREET
FAYETTEVILLE, NC 28301
(910) 323-3400



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NO	REVISIONS	DRN	CHK	DATE

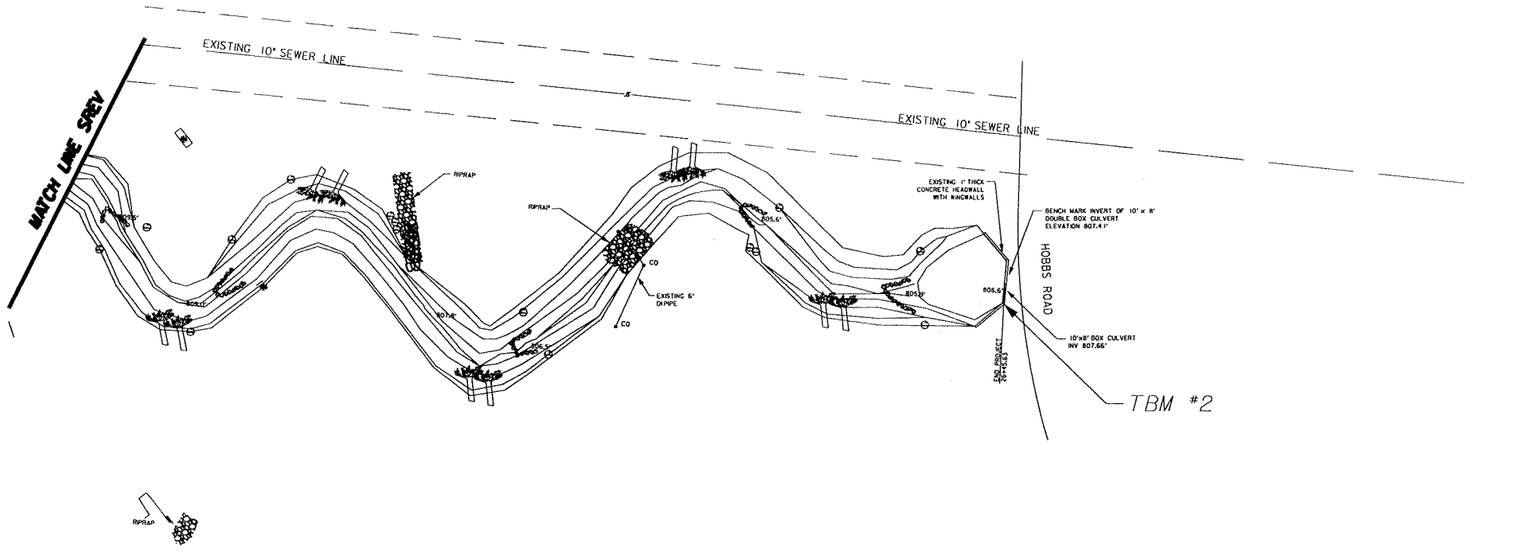
EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

FIGURE 4
AS-BUILTS

DATE	APRIL 03, 2001
PROJECT NO	40361
FILENAME	
SHEET NO	C-3
DRAWING NO	

AS-BUILT SURVEY MAPPING
PROVIDED BY:
THE ROSE GROUP
104 GILLESPIE STREET
FAYETTEVILLE, NC 28301
(910) 323-3400



SCALE
40 0 40 80

NO	REVISIONS	DRN	CHK	DATE

EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

FIGURE 4
AS-BUILTS

DATE	APRIL 03, 2001
PROJECT NO	40361
FILENAME	
SHEET NO	C-4
DRAWING NO	

6.0 REFERENCES

Radford, A.E., H.E. Ahles and G.R. Bell. 1968. *Manual of the Vascular Flora of the Carolinas.* The University of North Carolina Press, Chapel Hill, North Carolina.

Rosgen, D. L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Rosgen, D. L. 1997. "A Geomorphological Approach to Restoration of Incised Rivers." Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision. Edited by S. S. Y. Wang, E. J. Langendoen, and F. D. Shields, Jr.

Schafale, M.P. and A.S. Weakley. 1990. *Classification of the Natural Communities of North Carolina, Third Approximation.* North Carolina Natural Heritage Program, Division of Parks and Recreation, NCDENR, Raleigh, NC.

Smith, C. L. 2001. "Guidelines for Riparian Buffer Restoration." Prepared for the Department of Environment and Natural Resources, Division of Water Quality, Wetlands Restoration Program. Raleigh, North Carolina.

APPENDIX A
AS-BUILT STREAM CONDITIONS

Profile

The longitudinal profile was modified from the design after the initial construction period due to bed degradation. During construction, loose clay soils were encountered in the streambed that became easily suspended once in contact with water. These soils washed away, contributing to the bed degradation. Two additional cross-vanes were installed in the stream to hold the grade immediately upstream. The longitudinal profile was taken after the degradation and after the addition of the two cross-vanes.

Bedrock was encountered in the streambed in several locations during construction. This also contributed to profile adjustments both during construction and after the water was turned into the channel. Immediately below meander 10 (Figure 2), bedrock was exposed during construction. Due to the bedrock, the water was directed into the right streambank causing erosion. In an effort to minimize the streambank erosion, rootwads were installed to dissipate the energy of the water flowing off of the bedrock. Bedrock was also uncovered in meander 14 (Figure 2). Due to the bedrock, the pool cross section could not be dug to the designed depth. This meander appears to be maintaining the as-built stability without erosion due to the bedrock.

The design profile was not plotted over the as-built longitudinal profile since the design profile was based on centerline lengths while the as-built profile was measured along the thalweg of the channel. A direct overlay of the 1st year monitoring profile on the as-built profile will better depict changes in the bed. Successive overlays in the 5-year monitoring period are recommended.

Cross-Sections

The channel cross-sectional area that was designed was based on an E-type channel. An E-channel was chosen due to the narrow buffer width that was available to fit the channel into after taking into account the sewer utility easements located on-site. In the future, it is recommended that a larger buffer width be obtained for urban restorations. This will allow for a higher width-to-depth ratio stream (C-type channel) to be designed, which will allow for the inclusion of an inner berm for periods of low flow. In addition, a C-type channel will have reduced shear velocities in the channel as well as enhance the growth of bank and buffer vegetation.

The following table (Table 1) contains a summary of the design and as-built cross-sectional information for comparison. The complete set of as-built data including photographs and graphs follows this write-up.

Table 1. Summary of Cross-Section Data

	CS #1-Riffle		CS #2-Pool		CS #3-Riffle		CS #4-Riffle	
	Design	As-built	Design	As-built	Design	As-built	Design	As-built
Bankfull Area (sq. ft.)	32.5	24.1	36.8	49.5	32.5	31.9	32.5	36.7
Build-Out Area (sq. ft.)	59.5	65.2	63.8	104.5	59.5	63.1	59.5	91.6
Bankfull Width (ft.)	16.4	13.3	18.0	22.2	16.4	14.0	16.4	17.2
Build-Out Width (ft.)	29	34.1	29.0	39.0	29	31.0	29	33
Bankfull Max Depth (ft.)	3.5	3.5	4.3	4.9	3.5	3.6	3.5	3.2
Build-Out Max Depth (ft.)	4.5	5.1	5.3	6.6	4.5	4.7	4.5	5.1
Bankfull Mean Depth (ft.)	2.0	1.8	2.0	2.2	2.0	2.3	2.0	2.1
Build-Out Mean Depth (ft.)	2.1	1.9	2.2	2.7	2.1	2.0	2.1	2.8
Bankfull Width/Depth	8.3	7.3	n/a	n/a	8.3	6.2	8.3	8.1
Entrenchment Ratio	>2.2	4.9	n/a	n/a	>2.2	7.1	>2.2	5.8

Pebble Count

Table 2 summarizes the pebble count data for the as-built conditions. The complete as-built pebble count data follows this write-up.

Table 2. Pebble Count Summary Data

	D50	D84
CS #1-Riffle	~0.45 mm Medium Sand	~103 mm* Small Cobble
CS #2-Pool	~0.34 mm Medium Sand	~2.0 mm Very Coarse Sand
CS #3-Riffle	~0.22 mm Fine Sand	~8.0 mm Fine Gravel
CS #4-Riffle	~0.33 mm Medium Sand	~8.0 mm Fine Gravel

***Note: This cross-section contains rip-rap which skews the pebble count.**

Other

The step-pool outfall was designed to have a much longer step length and a wider tie-in with the main channel. The initial outfall was built according to the plans. However, erosion occurred during a rain event. Eddies that were formed at the tie-in caused this erosion. Therefore, the outfall was re-built on-site to help minimize the eddy effect.

Prior to construction, there was a small wet area located near the right bank of the channel. This area contained the hydrology and the vegetation to indicate a wetland, however, the soils were questionable. After construction was completed, this wet area expanded in part due to compaction from construction traffic. At the current time, this wet area does not appear to be draining into the stream. This will need to be monitored closely to ensure channelization does not occur. Dan Maxson, with the City of Greensboro Parks and Recreation Department, commented that he did not want to see this wet area drained since it was creating wildlife habitat.

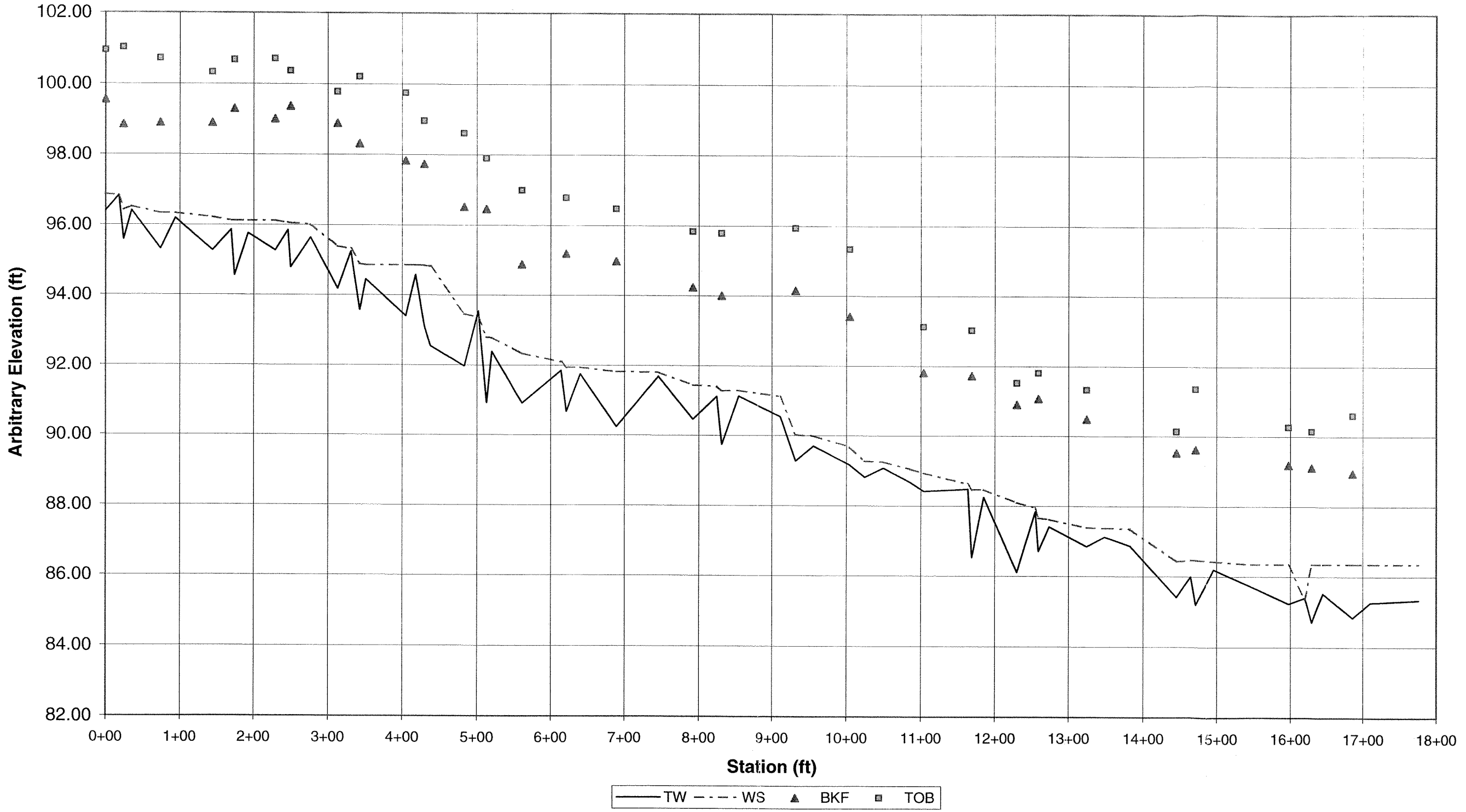
After the construction of the channel was completed and the water was diverted into the channel, the water from the downstream lake was raised due possibly to construction on the dam. This is causing a backwater effect on the lower portions of the channel. This is being investigated by the Wetlands Restoration Program to determine what should be done to remedy this problem.

Field Crew:	George Lankford, Jan Patterson
River Basin:	Cape Fear
Watershed:	**Guilford College**
Stream Reach:	Jefferson Pilot
Drainage Area:	1.00
Date:	4/11/2002
Description:	LONGITUDINAL PROFILE

Station	TW (FS)	TW	WS (FS)	WS	BKF (FS)	BKF	BOB (FS)	BOB	Notes	HI
00+00.0	8.47	96.39	8.00	96.86					Fenceline	104.86
00+18.0	8.03	96.83	8.03	96.83	5.31	99.55	3.92	100.94	XVANE	104.86
00+24.0	9.28	95.58	8.45	96.41					XVANE-Max Pool	104.86
00+35.0	8.46	96.40	8.35	96.51	6.01	98.85	3.84	101.02	Head of Riffle	104.86
00+74.0	9.55	95.31	8.54	96.32					Max Pool	104.86
00+94.0	8.68	96.18	8.54	96.32	5.96	98.90	4.15	100.71	Head of Riffle	104.86
01+44.0	9.59	95.27	8.65	96.21					Max Pool	104.86
01+69.0	9.00	95.86	8.75	96.11	5.96	98.90	4.54	100.32	XVANE	104.86
01+74.0	10.30	94.56	8.75	96.11					XVANE-Max Pool	104.86
01+92.0	9.10	95.76	8.75	96.11	5.56	99.30	4.19	100.67	Head of Riffle	104.86
02+29.0	9.59	95.27	8.75	96.11					Max Pool	104.86
02+46.0	9.01	95.85	8.80	96.06	5.85	99.01	4.16	100.70	XVANE	104.86
02+50.0	10.07	94.79	8.82	96.04					XVANE-Max Pool	104.86
02+77.0	9.22	95.64	8.85	96.01	5.49	99.37	4.50	100.36	Head of Riffle	104.86
03+13.0	10.68	94.18	9.47	95.39					Max Pool	104.86
03+31.0	9.61	95.25	9.54	95.32	5.97	98.89	5.08	99.78	XVANE	104.86
03+43.0	11.29	93.57	9.97	94.89					XVANE-Max Pool	104.86
03+51.0	10.41	94.45	10.00	94.86	6.55	98.31	4.66	100.20	Head of Riffle	104.86
04+05.0	11.46	93.40	10.00	94.86					Max Pool	104.86
04+18.0	10.28	94.58	10.00	94.86	7.03	97.83	5.11	99.75	XVANE	104.86
04+30.0	11.75	93.11	10.01	94.85					XVANE-Max Pool	104.86
04+38.0	10.50	92.54	10.04	94.82	7.13	97.73	5.90	98.96	Head of Riffle	104.86
04+83.0	12.89	91.97	11.40	93.46					Max Pool	104.86
05+02.0	11.32	93.54	11.49	93.37	8.35	96.51	6.25	98.61	XVANE	104.86
05+13.0	13.94	90.92	12.07	92.79					XVANE-Max Pool	104.86
05+20.0	12.48	92.38	12.08	92.78	8.41	96.45	6.96	97.90	Head of Riffle	104.86
05+61.0	10.23	90.91	8.81	92.33					Max Pool	101.14
06+14.0	9.29	91.85	9.05	92.09	6.26	94.88	4.15	96.99	XVANE	101.14
06+21.0	10.47	90.67	9.20	91.94					XVANE-Max Pool	101.14
06+40.0	9.39	91.75	9.20	91.94	5.95	95.19	4.36	96.78	Head of Riffle	101.14
06+89.0	10.90	90.24	9.32	91.82					Max Pool	101.14
07+46.0	9.45	91.69	9.33	91.81	6.16	94.98	4.67	96.47	Head of Riffle	101.14
07+92.0	10.68	90.46	9.70	91.44					Max Pool	101.14
08+24.0	10.02	91.12	9.73	91.41	6.90	94.24	5.30	95.84	XVANE	101.14
08+31.0	11.40	89.74	9.86	91.28					XVANE-Max Pool	101.14
08+54.0	10.01	91.13	9.85	91.29	7.14	94.00	5.35	95.79	Head of Riffle	101.14
09+11.0	10.60	90.54	10.02	91.12					Max Pool	101.14
09+32.0	11.87	89.27	11.12	90.02					Max Pool	101.14
09+56.0	11.44	89.7	11.15	89.99	6.99	94.15	5.20	95.94	Head of Riffle	101.14
10+04.0	11.98	89.16	11.46	89.68					Top Bedrock	101.14
10+24.0	12.33	88.81	11.87	89.27	7.73	93.41	5.80	95.34	Max Pool	101.14
10+49.0	12.07	89.07	11.89	89.25					Head of Riffle	101.14
10+86.0	12.48	88.66	12.1	89.04					US Box Culvert	101.14

11+04.0	8.11	88.41	7.59	88.93					DS Box Culvert	96.52
11+64.0	8.05	88.47	7.9	88.62	4.71	91.81	3.40	93.12	XVANE	96.52
11+69.0	9.99	86.53	8.06	88.46					XVANE-Max Pool	96.52
11+85.0	8.28	88.24	8.06	88.46	4.80	91.72	3.50	93.02	Head of Riffle	96.52
12+30.0	10.41	86.11	8.43	88.09					Max Pool	96.52
12+55.0	8.68	87.84	8.57	87.95	5.62	90.9	5.00	91.52	XVANE	96.52
12+59.0	9.81	86.71	8.86	87.66					XVANE-Max Pool	96.52
12+74.0	9.11	87.41	8.9	87.62	5.45	91.07	4.71	91.81	Head of Riffle	96.52
13+24.0	9.67	86.85	9.13	87.39					Max Pool	96.52
13+48.0	9.40	87.12	9.15	87.37	6.04	90.48	5.19	91.33	Head of Riffle	96.52
13+82.0	9.65	86.87	9.16	87.36					Intermediate Point	96.52
14+45.0	11.11	85.41	10.09	86.43					Max Pool	96.52
14+64.0	10.52	86.00	10.05	86.47	7.00	89.52	6.38	90.14	XVANE	96.52
14+71.0	11.32	85.20	10.05	86.47					XVANE-Max Pool	96.52
14+96.0	10.32	86.20	10.09	86.43	6.90	89.62	5.16	91.36	Head of Riffle	96.52
15+47.0	10.80	85.72	10.17	86.35					Aerial Sewer Line	96.52
15+98.0	11.29	85.23	10.17	86.35					Max Pool	96.52
16+20.0	11.12	85.40	11.17	85.35	7.34	89.18	6.25	90.27	XVANE	96.52
16+30.0	11.82	84.70	10.17	86.35					XVANE-Max Pool	96.52
16+45.0	11	85.52	10.17	86.35	7.41	89.11	6.37	90.15	Head of Riffle	96.52
16+86.0	11.69	84.83	10.17	86.35					Max Pool	96.52
17+10.0	11.26	85.26	10.17	86.35	7.58	88.94	5.92	90.60	XVANE	96.52
17+76.0	11.19	85.33	10.17	86.35					DBL 10' x 8' Box Cul	96.52

As-Built Longitudinal Profile
Jefferson Pilot Stream Restoration



Field Crew:	George Lankford, Jan Patterson
River Basin:	Cape Fear
Watershed:	**Guilford College**
Stream Reach:	Jefferson Pilot
Drainage Area:	1.00
Date:	4/11/2002
Description:	Longitudinal Station ~ 4+54
Feature:	CS#1, Riffle

STATION (Feet)	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
0+00.0	104.86	6.44	98.42	edge scrub woods
0+23.6	104.88	5.97	98.89	LT BOB
0+25.6	104.86	7.07	97.79	Toe BOB
0+27.5	104.86	7.39	97.47	
0+34.0	104.86	7.66	97.20	LBKF
0+38.6	104.86	9.80	95.06	
0+39.4	104.06	10.88	94.00	LEW/WS
0+41.4	104.88	11.11	93.75	TW
0+43.0	104.80	10.79	94.07	REW
0+43.7	104.86	9.56	95.30	
0+45.2	104.86	8.75	96.11	
0+47.3	104.88	7.66	97.20	RBW
0+49.0	104.86	6.78	98.08	
0+54.8	104.88	6.34	98.52	Toe BOB
0+57.7	104.80	5.19	Q9.67	RT BOB
0+59.7	104.88	4.80	100.06	
0+74.0	104.06	4.22	100.04	
1+00.0	104.88	4.28	100.58	
1+24.0				edge g-way

BUILDOUT BENCH
Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	2.0	1.1	1.1
	1.9	1.4	2.4
	6.5	1.7	10.1
	4.6	3.8	12.7
	0.8	4.9	3.5
	2.0	5.1	10.0
	1.6	4.8	8.0
	0.7	3.6	2.9
	1.5	2.8	4.8
	3.8	0.8	6.8
	5.6	0.4	3.4
	2.9	-0.8	-0.6
TOTALS	34.1		65.2

SUMMARY DATA (TOB)

A(BKF)	65.2
W(BKF)	34.1
Max d	5.4
Mean d	1.9

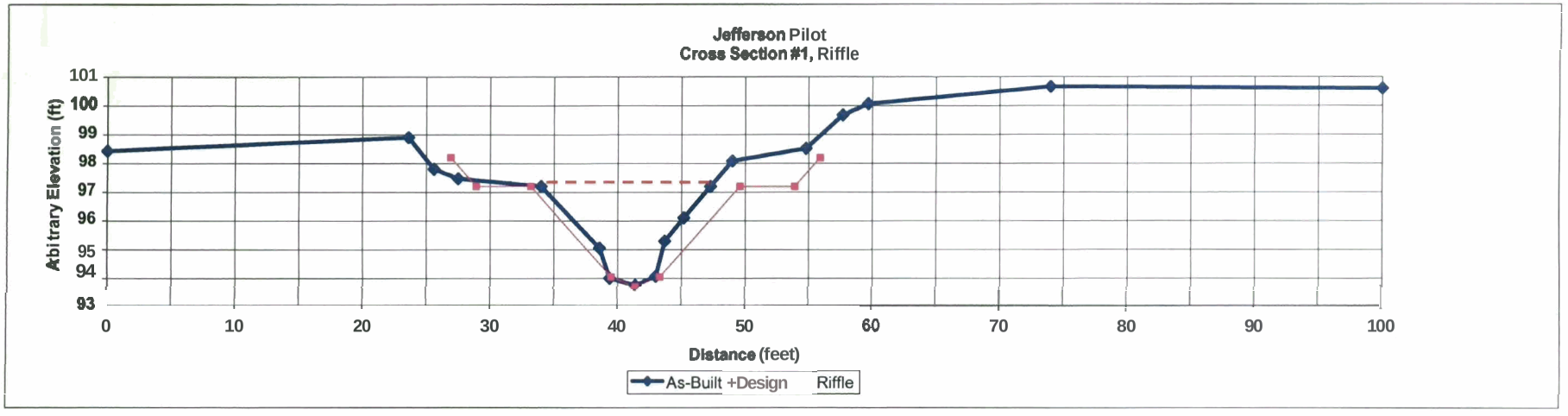
BANKFULL
Hydraulic Geometry

	Width (Feet)	Depth (Feet)	($q. Ft.,
	0.0	0.0	0.0
	4.6	2.1	4.9
	0.8	3.2	2.1
	2.0	3.5	6.7
	1.6	3.1	5.3
	0.7	1.9	1.8
	1.5	1.1	2.2
	2.1	0.0	1.1
TOTALS	13.3		24.1

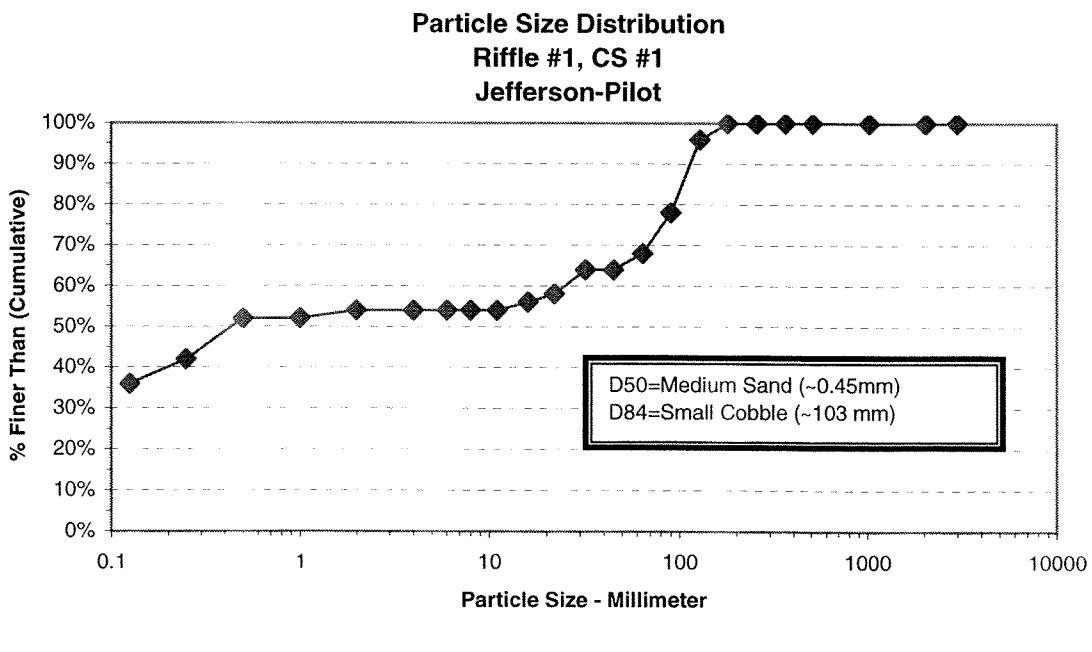
SUMMARY DATA (BANKFULL)

A(BKF)	24.1	W(FPA)	>74
W(BKF)	13.3		
Max d	3.5		
Mean d	1.8	Area=	A
W/D	7.3	Width=	W
Entrenchment	>4.9	Depth=	D
Stream Type	E	Bankfull=	BKF

Riffle (CS#1) looking in the upstream direction.



PEBBLE COUNT								
Site: Jefferson-Pilot, Greensboro, NC								Date: 4/11/02
Party: J. Patterson and G. Lankford				Reach: Riffle #1 (CS #1)				
Notes:				Particle Count				
Inches	Particle	Millimeter		Riffle		Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	18		18	36%	36%
	Very Fine	.062 - .125	S	0		0	0%	36%
	Fine	.125 - .25	A	3		3	6%	42%
	Medium	.25 - .50	N	5		5	10%	52%
	Coarse	.50 - 1.0	D	0		0	0%	52%
.04 -.08	Very Coarse	1.0 - 2.0		1		1	2%	54%
.08 - .16	Very Fine	2.0 - 4.0		0		0	0%	54%
.16 - .22	Fine	4.0 - 5.7	G	0		0	0%	54%
.22 - .31	Fine	5.7 - 8.0	R	0		0	0%	54%
.31 - .44	Medium	8.0 - 11.3	A	0		0	0%	54%
.44 - .63	Medium	11.3 - 16.0	V	1		1	2%	56%
.63 - .89	Coarse	16.0 - 22.6	E	1		1	2%	58%
.89 - 1.26	Coarse	22.6 - 32.0	L	3		3	6%	64%
1.26 - 1.77	Very Coarse	32.0 - 45.0		0		0	0%	64%
1.77 - 2.5	Very Coarse	45.0 - 64.0		2		2	4%	68%
2.5 - 3.5	Small	64 - 90	C	5		5	10%	78%
3.5 - 5.0	Small	90 - 128	O	9		9	18%	96%
5.0 - 7.1	Large	128 - 180	B	2		2	4%	100%
7.1 - 10.1	Large	180 - 256	L	0		0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0		0	0%	100%
14.3 - 20	Small	362 - 512	L	0		0	0%	100%
20 - 40	Medium	512 - 1024	D	0		0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0		0	0%	100%
	Bedrock		BDRK	0		0	0%	100%
			Totals	**50**		**50**	**100%**	**100%**



Field Crew:	George Lankford, Jan Pattersor
River Basin:	Cape Fear
Watershed:	**Guilford College**
Stream Reach:	Jefferson Pilot
Drainage Area	1.00
Date:	4/11/2002
Description:	Longitudinal Station ~ 6+86
Feature:	CS#2, Pool

STATION (Feet)	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
0+00.0	101.14	4.29	96.85	LPIN
0+21.4	101.14	4.20	96.94	
0+34.7	101.14	4.20	96.94	LT BOB
0+38.5	101.14	5.52	95.62	Toe BOB
0+44.8	101.14	5.90	95.24	LBKF
0+52.0	101.14	8.44	92.70	
0+54.5	101.14	8.74	92.40	
0+56.3	101.14	9.32	91.82	LEW/WS
0+57.1	101.14	9.73	91.41	
0+57.7	101.14	10.37	90.77	
0+59.2	101.14	10.79	90.35	TW @ rootwac
0+61.6	101.14	10.11	91.03	
0+62.7	101.14	7.16	93.98	
0+67.0	101.14	5.43	95.71	RBKF
0+71.0	101.14	5.19	95.95	Toe BOB
0+73.7	101.14	3.77	97.37	RT BOB
0+80.0	101.14	3.66	97.48	
0+87.3	101.14	3.65	97.49	
0+92.4	101.14	3.95	97.19	
1+00.0	101.14	3.85	97.29	

BUILDOUT BENCH
Hydraulic Geometry

	Width (Fee0	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	3.8	1.3	2.5
	6.3	1.7	9.5
	7.2	4.2	21.4
	2.5	4.5	11.0
	1.8	5.1	8.7
	0.8	5.5	4.3
	0.6	6.2	3.5
	1.5	6.6	9.6
	2.4	5.9	15.0
	1.1	3.0	4.9
	4.3	1.2	9.0
	4.0	1.0	4.4
	2.7	-0.4	0.8
TOTALS	39.0		104.5

SUMMARY DATA (TOB)

A(BKF)	104.5
W(BKF)	39.0
Max d	6.6
Mean d	2.7

BANKFULL
Hydraulic Geometry

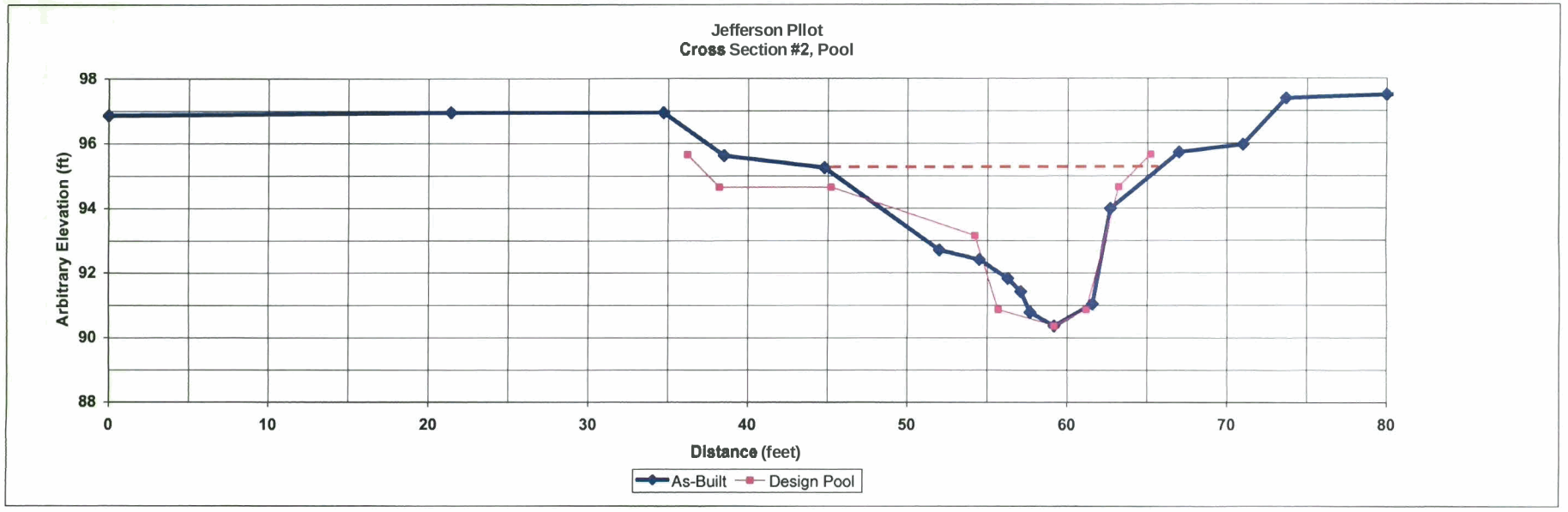
	Width (Feet)	Depth (Fee0	Area (Sq. Ft.)
	0.0	0.0	0.0
	7.2	2.5	9.1
	2.5	2.8	6.7
	1.8	3.4	5.6
	0.8	3.8	2.9
	0.6	4.5	2.5
	1.5	4.9	7.0
	2.4	4.2	10.9
	1.1	1.3	3.0
	4.3	-0.5	1.7
TOTALS	22.2		49.5

SUMMARY DATA (BANKFULL)

A(BKF)	49.5
W(BKF)	22.2
Max d	4.9
Mean d	2.2

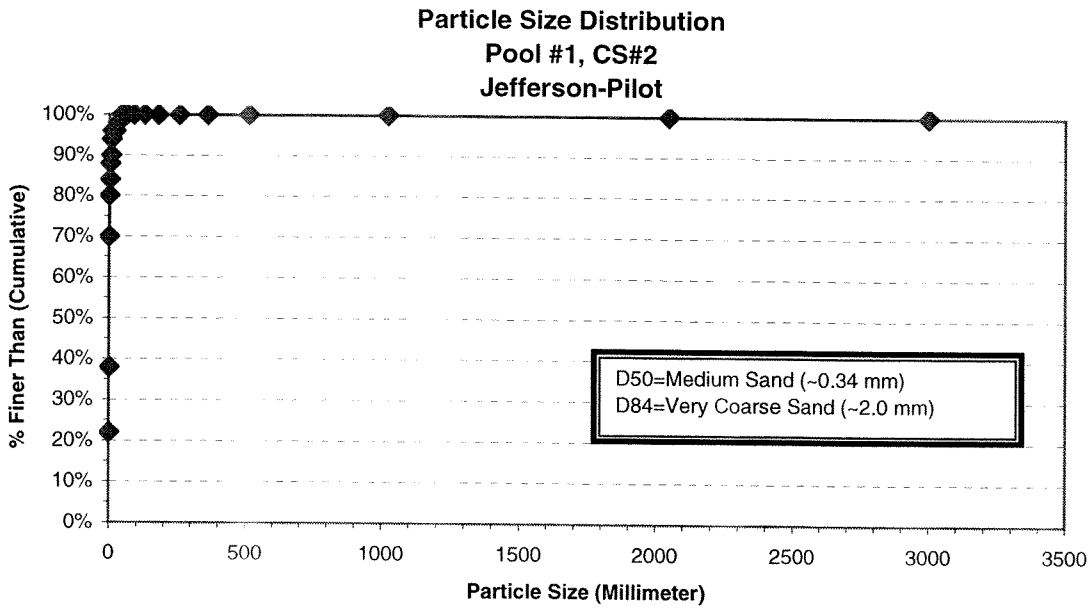
Area= A
Width= W
Depth= D
Bankfull= BKF

Pool (CS#2) looking in the downstream direction.



PEBBLE COUNT

Site: Jefferson-Pilot, Greensboro, NC							Date: 4/11/02	
Party: J. Patterson and G. Lankford					Reach: Pool #1 (CS #2)			
Notes:				Particle Count				
Inches	Particle	Millimeter			Pool	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C		5	5	10%	10%
	Very Fine	.062 - .125	S		6	6	12%	22%
	Fine	.125 - .25	A		8	8	16%	38%
	Medium	.25 - .50	N		16	16	32%	70%
	Coarse	.50 - 1.0	D		5	5	10%	80%
.04 -.08	Very Coarse	1.0 - 2.0			2	2	4%	84%
.08 - .16	Very Fine	2.0 - 4.0			2	2	4%	88%
.16 - .22	Fine	4.0 - 5.7	G		1	1	2%	90%
.22 - .31	Fine	5.7 - 8.0	R		2	2	4%	94%
.31 - .44	Medium	8.0 - 11.3	A		1	1	2%	96%
.44 - .63	Medium	11.3 - 16.0	V			0	0%	96%
.63 - .89	Coarse	16.0 - 22.6	E			0	0%	96%
.89 - 1.26	Coarse	22.6 - 32.0	L		1	1	2%	98%
1.26 - 1.77	Very Coarse	32.0 - 45.0			1	1	2%	100%
1.77 - 2.5	Very Coarse	45.0 - 64.0				0	0%	100%
2.5 - 3.5	Small	64 - 90	C			0	0%	100%
3.5 - 5.0	Small	90 - 128	O			0	0%	100%
5.0 - 7.1	Large	128 - 180	B			0	0%	100%
7.1 - 10.1	Large	180 - 256	L			0	0%	100%
10.1 - 14.3	Small	256 - 362	B			0	0%	100%
14.3 - 20	Small	362 - 512	L			0	0%	100%
20 - 40	Medium	512 - 1024	D			0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R			0	0%	100%
	Bedrock		BDRK			0	0%	100%
			Totals		50	50	100%	100%



Field Crew:	George Lankford, Jan Patterson
River Basin:	Cape Fear
Watershed:	**Guilford College**
Stream Reach:	Jefferson Pilot
Drainage Area:	1.00
Date:	4/11/2002
Description:	Longitudinal Station ~ 7+52
Feature:	CS#3, Riffle

STATION (Feet)	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
0+00.0	101.14	4.61	96.53	LPIN
0+12.5	101.14	4.42	96.72	
0+24.0	101.14	4.93	96.21	LT BOB
0+25.3	101.14	5.87	95.27	
0+32.0	101.14	6.08	95.06	LBKF
0+36.2	101.14	8.68	92.46	
0+37.0	101.14	9.26	91.88	
0+37.6	101.14	9.43	91.71	LEW/WS
0+39.3	101.14	9.65	91.49	
0+41.0	101.14	9.67	91.47	TW
0+42.4	101.14	9.46	91.68	REW
0+42.8	101.14	8.50	92.64	
0+46.0	101.14	6.23	94.91	RBKF
0+48.0	101.14	5.95	95.19	
0+52.0	101.14	5.94	95.20	
0+55.0	101.14	4.70	96.44	RT BOB
0+70.0	101.14	4.73	96.41	
1+00.0	101.14	4.60	96.54	RPIN

BUILDOUT BENCH
Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	1.3	0.9	0.6
	8.7	1.2	7.0
	4.2	3.8	10.3
	0.8	4.3	3.2
	0.6	4.5	2.6
	1.7	4.7	7.8
	1.7	4.7	8.0
	1.4	4.5	8.5
	0.4	3.6	1.6
	3.2	1.3	7.8
	2.0	1.0	2.3
	4.0	1.0	4.1
	3.0	-0.2	1.2
TOTALS	31.0		63.1

SUMMARY DATA (TOB)

A(TOB)	63.1
W(BKF)	31.0
Max d	4.7
Mean d	2.0

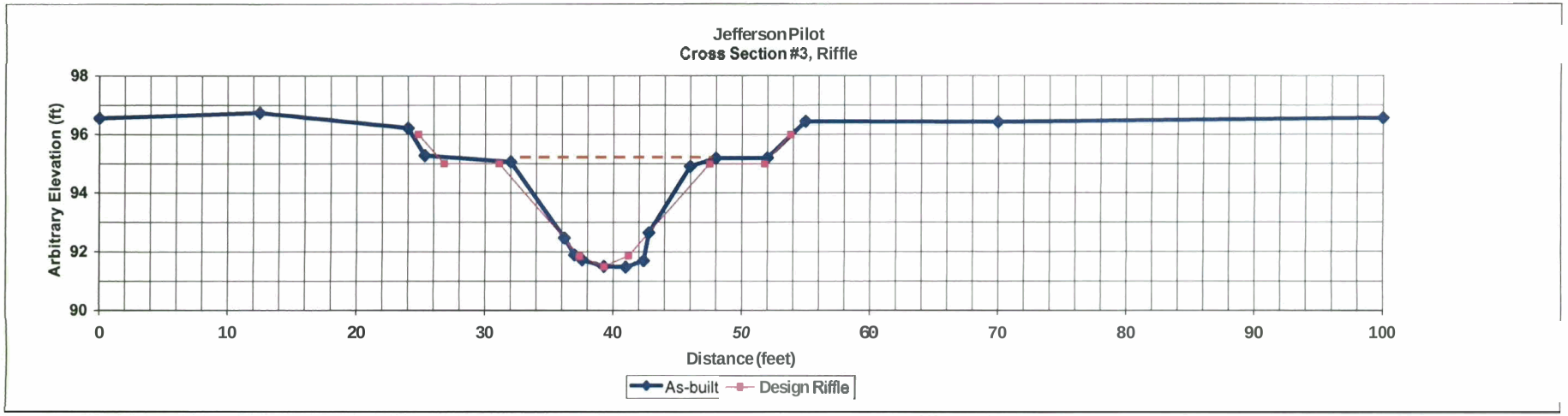
BANKFULL
Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	4.2	2.6	5.5
	0.8	3.2	2.3
	0.6	3.3	2.0
	1.7	3.6	5.9
	1.7	3.6	6.1
	1.4	3.4	4.9
	0.4	2.4	1.2
	3.2	0.2	4.1
TOTALS	14.0		31.9

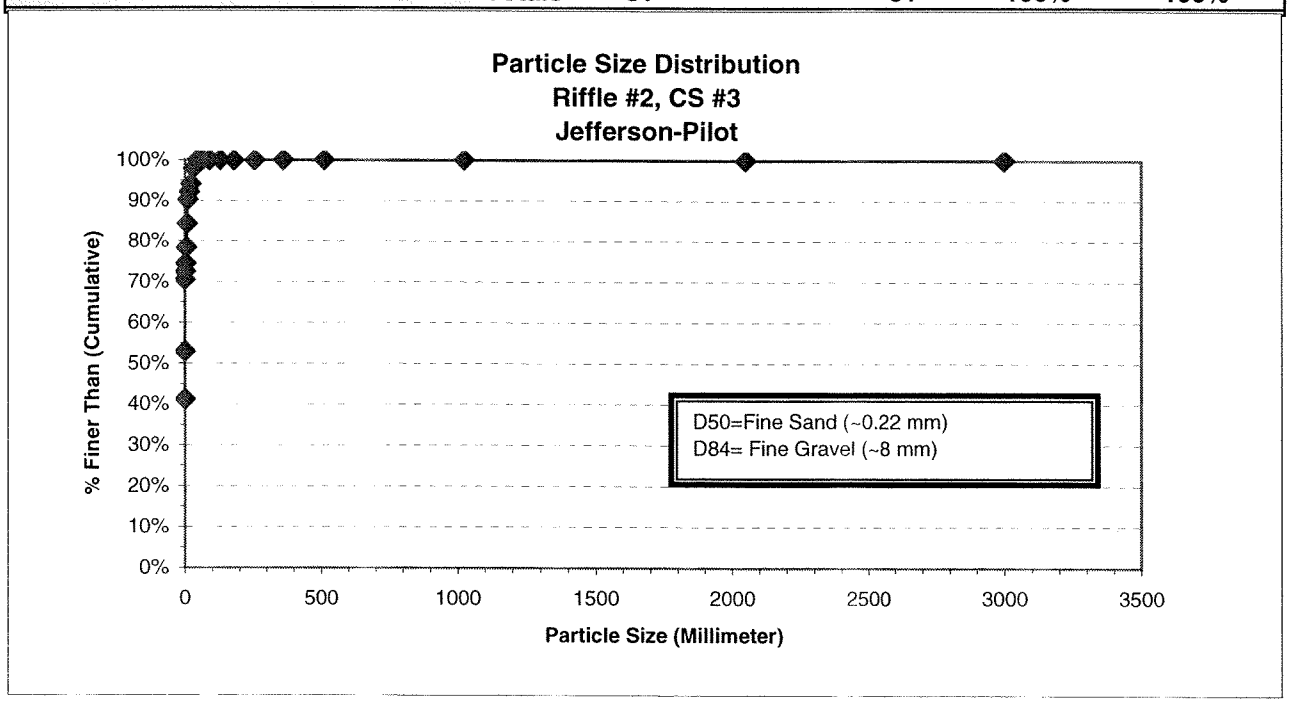
SUMMARY DATA (BANKFULL)

A(BKF)	31.9	W(FPA)	>100
W(BKF)	14.0		
Max d	3.6		
Mean d	2.3	Area=	A
W/D	6.2	Width=	W
Entrenchment	>7.1	Depth=	D
Stream T.. e	E	Bankfull=	BKF

Riffle (CS#3) looking in Me downstream direction.



PEBBLE COUNT								
Site: Jefferson-Pilot, Greensboro, NC								Date: 4/11/02
Party: J. Patterson and G. Lankford				Reach: Riffle #2 (CS #3)				
Notes:				Particle Count				
Inches	Particle	Millimeter		Riffle		Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	13		13	25%	25%
	Very Fine	.062 - .125	S	8		8	16%	41%
	Fine	.125 - .25	A	6		6	12%	53%
	Medium	.25 - .50	N	9		9	18%	71%
	Coarse	.50 - 1.0	D	1		1	2%	73%
.04 -.08	Very Coarse	1.0 - 2.0		1		1	2%	75%
.08 - .16	Very Fine	2.0 - 4.0				0	0%	75%
.16 - .22	Fine	4.0 - 5.7	G	2		2	4%	78%
.22 - .31	Fine	5.7 - 8.0	R	3		3	6%	84%
.31 - .44	Medium	8.0 - 11.3	A	3		3	6%	90%
.44 - .63	Medium	11.3 - 16.0	V	1		1	2%	92%
.63 - .89	Coarse	16.0 - 22.6	E	1		1	2%	94%
.89 - 1.26	Coarse	22.6 - 32.0	L	2		2	4%	98%
1.26 - 1.77	Very Coarse	32.0 - 45.0		1		1	2%	100%
1.77 - 2.5	Very Coarse	45.0 - 64.0				0	0%	100%
2.5 - 3.5	Small	64 - 90	C			0	0%	100%
3.5 - 5.0	Small	90 - 128	O			0	0%	100%
5.0 - 7.1	Large	128 - 180	B			0	0%	100%
7.1 - 10.1	Large	180 - 256	L			0	0%	100%
10.1 - 14.3	Small	256 - 362	B			0	0%	100%
14.3 - 20	Small	362 - 512	L			0	0%	100%
20 - 40	Medium	512 - 1024	D			0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R			0	0%	100%
	Bedrock		BDRK			0	0%	100%
			Totals	**51**		**51**	**100%**	**100%**



Field Crew:	George Lankford, Jan Patterson
River Basin:	Cape Fear
Watershed:	**Guilford College**
Reach:	Jefferson Pilot
Drainage Area:	1.00
Date:	4/11/2002
Description:	Longitudinal Station ~ 15+11
Feature:	CS#4, Riffle

STATION (Feet)	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
0+00.0	96.52	4.74	91.78	
0+20.6	96.52	4.75	91.77	
0+40.0	96.52	5.06	91.46	
0+45.5	96.52	5.20	91.32	LT BOB
0+48.0	96.52	6.39	90.13	
0+54.0	96.52	7.09	89.43	LBKF
0+59.0	96.52	9.68	86.84	
0+61.2	96.52	10.12	86.40	LEW/WS
0+65.0	96.52	10.31	86.21	TW
0+66.5	96.52	10.24	86.28	REW
0+71.2	96.52	7.10	89.42	RBKF
0+76.5	96.52	6.8	89.72	
0+78.5	96.52	5.98	90.54	RT BOB
0+94.7	96.52	5.22	91.30	
1+00.0	96.52	5.50	91.02	
0+86.0				Sewerline Cleanout

BUILDOUT BENCH
Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	2.5	1.2	1.5
	6.0	1.9	9.2
	5.0	4.5	15.9
	2.2	4.9	10.3
	3.8	5.1	19.1
	1.5	5.0	7.6
	4.7	1.9	18.3
	5.3	1.8	9.3
	2.0	0.8	2.4
TOTALS	33.0		91.6

SUMMARY DATA (TOB)

A(BKF)	91.6
W(BKF)	33.0
Max d	5.1
Mean d	2.8

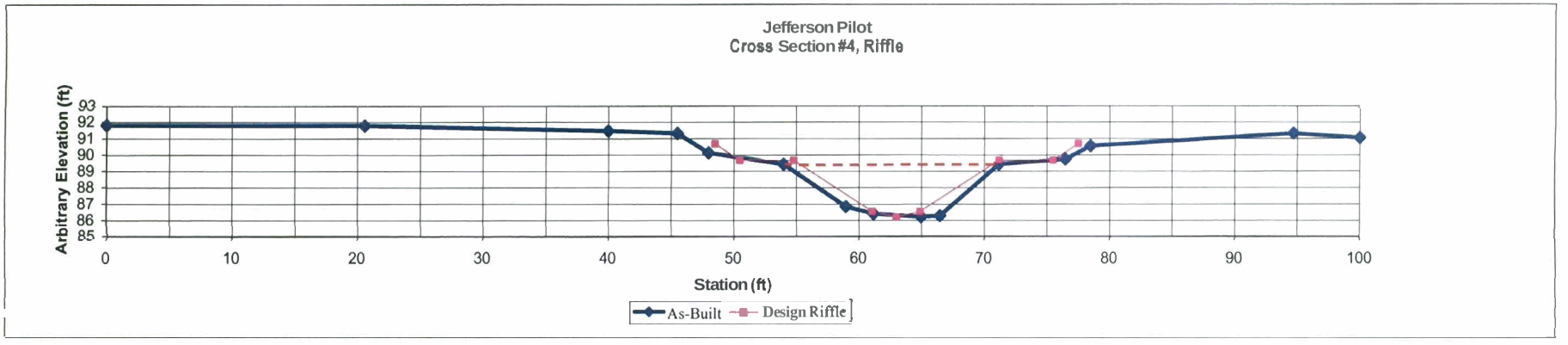
BANKFULL
Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0	0	0
	5.0	2.8	6.5
	2.2	3.0	6.2
	3.8	3.2	11.9
	1.5	3.1	4.8
	4.7	0.0	7.4
TOTALS	17.2		36.7

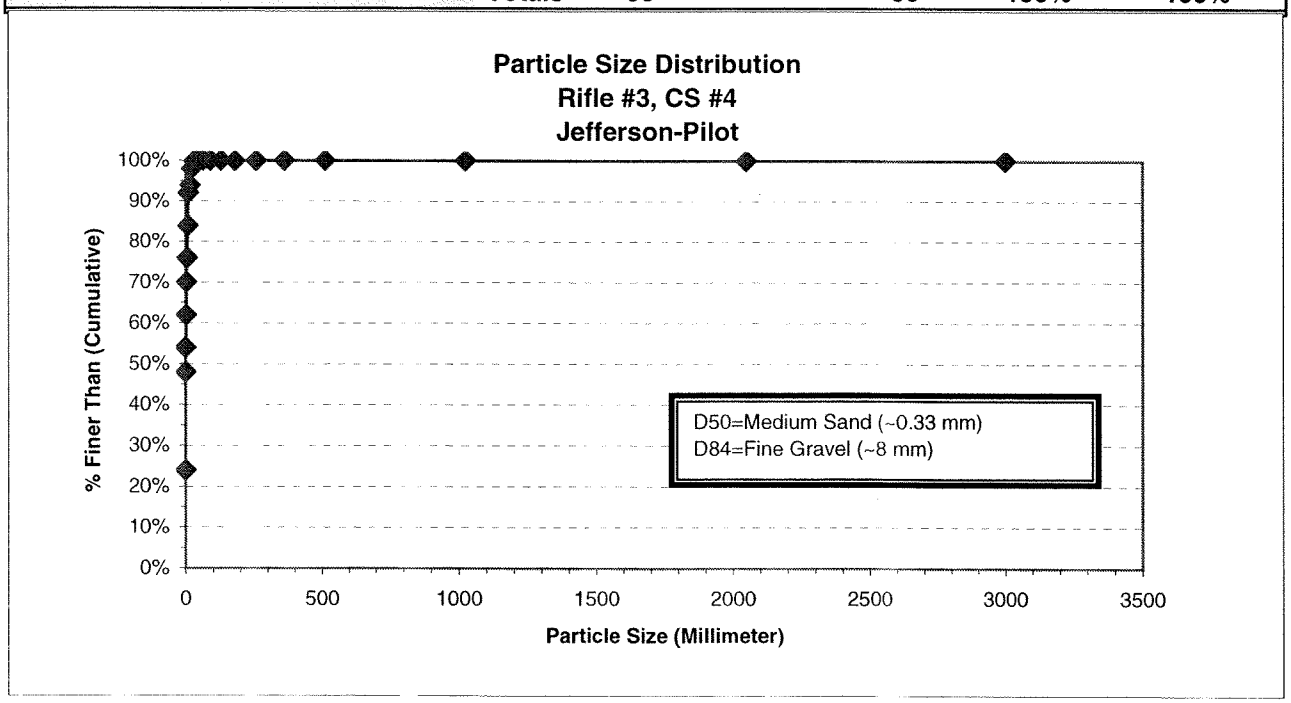
SUMMARY DATA (BANKFULL)

A(BKF)	36.7	W(FPA)	>100
W/D		Width=	W
Entrenchment	>5.8	Depth=	D
Stream T,[illegible]	–	Bankfull=	BKF

Riffle (CS#4) looking in the downstream direction.



PEBBLE COUNT								
Site: Jefferson-Pilot, Greensboro, NC								Date: 4/11/02
Party: J. Patterson and G. Lankford				Reach: Riffle #3 (CS #4)				
Notes:				Particle Count				
Inches	Particle	Millimeter		Riffle		Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	8		8	16%	16%
	Very Fine	.062 - .125	S	4		4	8%	24%
	Fine	.125 - .25	A	12		12	24%	48%
	Medium	.25 - .50	N	3		3	6%	54%
	Coarse	.50 - 1.0	D			0	0%	54%
.04 -.08	Very Coarse	1.0 - 2.0		4		4	8%	62%
.08 - .16	Very Fine	2.0 - 4.0		4		4	8%	70%
.16 - .22	Fine	4.0 - 5.7	G	3		3	6%	76%
.22 - .31	Fine	5.7 - 8.0	R	4		4	8%	84%
.31 - .44	Medium	8.0 - 11.3	A	4		4	8%	92%
.44 - .63	Medium	11.3 - 16.0	V	1		1	2%	94%
.63 - .89	Coarse	16.0 - 22.6	E	2		2	4%	98%
.89 - 1.26	Coarse	22.6 - 32.0	L	1		1	2%	100%
1.26 - 1.77	Very Coarse	32.0 - 45.0				0	0%	100%
1.77 - 2.5	Very Coarse	45.0 - 64.0				0	0%	100%
2.5 - 3.5	Small	64 - 90	C			0	0%	100%
3.5 - 5.0	Small	90 - 128	O			0	0%	100%
5.0 - 7.1	Large	128 - 180	B			0	0%	100%
7.1 - 10.1	Large	180 - 256	L			0	0%	100%
10.1 - 14.3	Small	256 - 362	B			0	0%	100%
14.3 - 20	Small	362 - 512	L			0	0%	100%
20 - 40	Medium	512 - 1024	D			0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R			0	0%	100%
	Bedrock		BDRK			0	0%	100%
			Totals	**50**		**50**	**100%**	**100%**



APPENDIX B
AS-BUILT VEGETATION CONDITIONS

Bare-root Seedlings

Bare-root seedlings were evaluated separately within two separate planting zones. These two zones are bankfull to build-out bench and build-out bench to easement limit.

Bankfull to Build-Out Elevation (Build-out Bench) - This is a bench along the stream channel that allows larger stream flows to move out of the channel. It will also provide additional capacity to the channel after the watershed reaches the phase of being completely developed.

Build-out to Easement Limits (Buffer) - This area extends beyond the build-out bankfull to the edge of the riparian zone and easement limits.

Contractor Records

The contractor was required to plant a minimum of 1638 seedlings to obtain a density of 440 stems per acre. Required density was estimated to be 1168 seedlings within the buffer zone and 470 seedlings within the build-out zone.

A total of 1840 seedlings were reported as planted by the contractor. The contractor indicated that 1300 seedlings were planted within the buffer zone and 500 seedlings were planted within the build-out zone. An additional 40 container seedlings were planted on the outside meanders.

As-Built Findings:

Findings for both stem count and stem height are reported below. These findings are summarized by planting zone.

Buffer

Approximately 12% of the total buffer area was sampled (Table B1). Based on the planting density specified in the plans the buffer area for each transect was expected to contain approximately 14 stems. The minimal acceptable number for the contractor at the end of the one-year warranty period is 80%, or approximately 11 stems per transect. Stems counted ranged from 7 to 14 per transect. Five transects contained less than 11 stems. Based on the percent of total area sampled 75% of the expected stems were counted.

Seedling height was measured. Average stem height for transect ranged from 1.4 to 2.9 feet. The average across all transects was 1.9 feet.

Build-out Bench

Approximately 18% of the total build-out bench area was sampled (Table B1). Based on the planting density specified in the plans the build-out bench zone for each transect was expected to contain approximately 8 stems. The minimal acceptable number for the

contractor at the end of the one-year warranty period is 80%, or approximately 7 stems per transect. Stems counted ranged from 2 to 11 per transect. Two transects contained less than 7 stems. Based on the percent of total area sampled 95% of the expected stems were counted.

Seedling height was measured. Average stem height for transect ranged from 1.1 to 3.3 feet. The average across all transects was 1.9 feet.

Herbaceous Vegetation

Herbaceous vegetation was only qualitatively assessed using general visual observations of coverage. No quantification of the number of individual plants was recorded. The buffer area ranges from 35 to 90 percent coverage with an average 60 percent cover. Much of the coverage is from a single species, Italian ryegrass (*Lolium multiflorum*). Across the site are scattered patches and clumps of persistent fescue grass (*Festuca* sp.). Various weeds are appearing, including horseweed (*Erigeron* sp.), tick seed (*Bidens* sp.), eastern gama grass (*Tripsacum dactyloides*), wingstem (*Verbesina alternifolia*), and wild garlic (*Allium vineale*). The build-out bench area appears to have less cover, ranging from 5 to 75 percent with an average 40 percent cover. Individual plants appear to be smaller in comparison to the buffer area. Smaller plants have less coverage although similar numbers of individual plants may be present. Herbaceous species are similar to that observed in the buffer area. The banks along the channel appeared to contain the smallest individual plants. Most of these appeared to be Italian ryegrass. Along the bottom of the channel a variety of wet herbaceous species were observed. Rushes (*Juncus effusus, J. coriaceus*) and sedges (*Carex* sp.) were the most dominate species, but other stream bank species observed included touch-me-not (*Impatiens capensis*) and beak rushes (*Rhynchospora* sp.).

In several recently disturbed areas the coverage was similar to other areas but appeared to contain more individual plants. Germination of annual grasses was higher near several recently installed structures. Coverage of weedy species in these disturbed areas was reduced.

ADDITIONAL COMMENTS AND RECOMMENDATIONS

The following is a brief summary of findings of the post-construction monitoring as well as recommendations for future monitoring.

Seedling Density and Height

The density of bare root seedlings planted at the site appears to be less than the targeted post-construction density, but generally above the 80 percent required after 1 year. The structures added in February affected some of the counts (transects 2 and 4). Replanting should bring these areas to acceptable density.

Herbaceous Species
As the herbaceous vegetation matures, it will become more difficult to find the seedlings. The initial slow growth of transplanted seedlings will make locating the smaller seedlings difficult in the tall dense herbaceous cover that will develop. Distinguishing between planted and volunteer seedlings of similar species may also be difficult. Flagging each seedling within the sample area will allow for easy identification of seedlings and will expedite the annual monitoring process.

Two species not specified in the design and planting plans were planted at the site. Sycamore (*Plantanus occidentalis*) and black gum (*Nyssa sylvatica*) seedlings were found below the bridge in Transects 8, 9 and 10. These tree species are considered appropriate for riparian buffers of Piedmont Levee Forest (Schafale, M.P. and A.S. Weakley. 1990).

Exotic and Invasive Species
A number of areas contain exotic and invasive vegetation. These areas typically are where trees were left during construction. Species include multiflora rose (*Rosa multiflora*), privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*) and bittersweet (*Celastrus orbiculata*). A few of the transplanted shrubs at the structures also contain some of these exotics. In the buffer area below the bridge and near the sewer easement Johnson grass (*Sorghum halepense*) was observed. It is recommended that a plan to eliminate or control these species be considered due to their invasive nature and ability to spread rapidly.

Species Identification
Accurate identification of small seedlings was difficult. Separation of ironwood and hop hornbeam and the separation of species as oaks are difficult in the seedling stages. Identification at the site is further compounded by small size and stress. The diversity of the seedlings planted could not be accurately determined at the time of this monitoring due to lack of confidence in correctly identifying all species.

Climatic Conditions
Local weather conditions greatly influence vegetative growth. The Greensboro area has experienced a drier than normal winter and a number of consecutively dry years. An extended wet period would significantly increase the herbaceous vegetative coverage at the site within a short period.

JEFFERSON PILOT AS-BUILT REPORT--VEGETATION PLOTS

BELT TRANSECT FIELD DATA

	BELT TRANSECT											
	BT-1	BT-2 *	BT-3	BT-4 *	BT-5	BT-6	BT-7	BT-8	BT-9	BT-10	Average	Average - Without Disturbed Transects *
Buffer Stem Count	10	7	8	10	12	10	11	13	14	11	10.6	11.1
Build-out Bench Stem Count	10	8	9	2	8	9	11	4	11	9	8.1	8.9
Buffer Average Stem Height (ft)	1.6	1.4	1.9	1.4	1.5	1.7	1.6	2.9	2.3	2.4	1.9	
Build-out Bench Average Stem Height (ft)	1.5	2.7	1.7	3.3	1.2	1.1	1.2	1.1	1.9	2.8	1.9	

SUMMARY STEM COUNT (FOR SAMPLING EFFORT)

Buffer (10' x 10' Spacing)

Estimated density = 35.5 ft x 20 ft x 2 = 1420 sq ft; 1420/100 = **14.2 Stems**

Total Area Sampled: 14200 sq ft

Total Area in Buffer Area: 116840 sq ft

Percent Buffer Sampled: 12 %

Minimum Acceptable for each Transect (80%): 11

Total Stems Estimated for Project	Total Stems Expected Within Plots	Total Stems Counted Within Plots	% of Expected
1168.4	142	106	75

Build-out Bench (7' Spacing)

Estimated density = (30 ft x 2) 7 ft = **8.6 Stems**

Total Length Sampled: 600 feet

Total Build-out Bench Length: 3292 feet

% Build-out Bench Sampled: 18 %

Minimum Acceptable for each Transect (80%): 7

Total Stems Estimated for Project	Total Stems Expected Within Plots	Total Stems Counted Within Plots	% of Expected
470	86	81	95

*Note: mechanical disturbance due to additon of new structures

= stem count/average below the acceptable 80% limit

JEFFERSON PILOT AS-BUILT REPORT--VEGETATION PLOTS

Herbaceous Vegetation

Estimated Percent Cover (%)

Belt Transect	Buffer Left	Buffer Right	Transect Average	Build-out Bench Left	Build-out Bench Right	Transect Average
BT-1	35	50	43	5	5	5
BT-2*	40	85	63	35	55	45
BT-3	45	55	50	45	30	38
BT-4*	45	40	43	75	40	58
BT-5	45	35	40	25	15	20
BT-6	90	80	85	50	50	50
BT-7	65	50	58	45	45	45
BT-8	80	80	80	70	40	55
BT-9	70	55	63	65	55	60
BT-10	60	70	65	10	10	10
Average Cover (%)	58	60	59	42.5	34.5	39
Range	35-90	35-80		5-75	5-55	

Build-out Bench Width (ft)

Belt Transect	Build-out Bench Left	Build-out Bench Right	Transect Average
BT-1	9	9.5	9
BT-2*	12	11	12
BT-3	8	9.4	9
BT-4*	11	13	12
BT-5	8	10.5	9
BT-6	12	9.5	11
BT-7	11	9	10
BT-8	9.5	8	9
BT-9	8	8	8
BT-10	13	10	12
Average Width (ft)	10.2	9.8	10
	8-13		

*Note: mechanical disturbance due to additon of new structures

Photo Log

Jefferson Pilot Stream Restoration
Guilford County, North Carolina

M1-US: Meander 1, looking in the upstream direction. Fenceline represents the beginning of the project and longitudinal profile.

MI-DS: View from Meander 1, looking downstream towards M2.

M2-US: View from Meander 2 looking in the upstream direction towards M1.

M2-DS: View from Meander 2, looking downstream at M3.

M3-US: View from Meander 3 looking upstream.

M3-DS: View from Meander 3 looking downstream towards a cross vane that was installed after the main construction period due to concerns with the grade downstream.

M4-US: View from Meander 4 looking upstream at Meander 3.

M4-DS: View from Meander 4 looking downstream towards Meander 5.

M5-US: View from Meander 5 looking upstream towards Meander 4.

M5-DS: View from Meander 5 looking downstream towards Meander 6. Note the cross rock and the boulder adjacent to it on the right have settled since construction and are below the water surface.

M6-US: View from Meander 6 looking upstream towards Meander 5. Note rip-rap was installed at the end of construction due to bed downcutting.

M6-DS: View from Meander 6 looking downstream. Note newly constructed cross-vane due to upstream degradation since the initial construction. Water is short cutting between the cross boulders on the right side.

M7-US: View from Meander 7 looking upstream.

M7-DS: View from Meander 7 looking downstream.

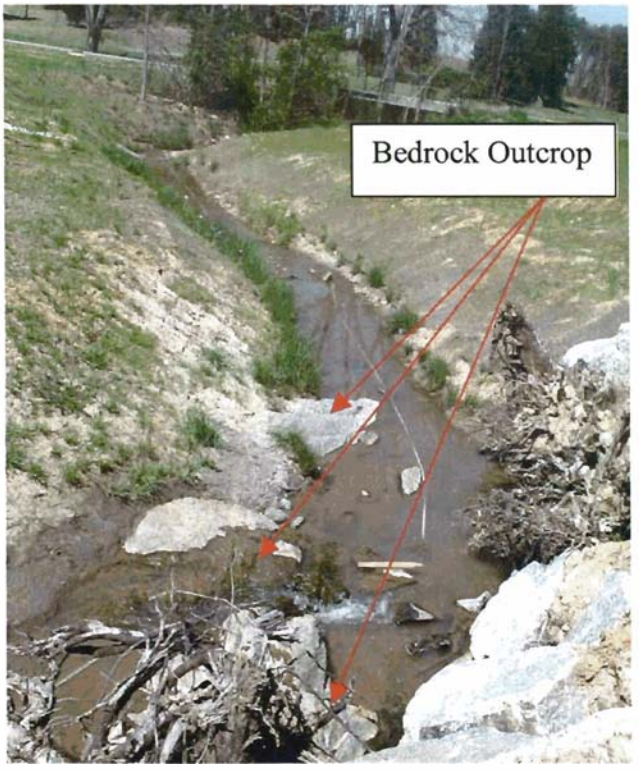
M8-US: View from Meander 8 looking upstream. Note the yellow fiberglass tape is pulled across the pool cross section in the foreground.

M8-DS: View from Meander 8 looking downstream towards Meander 9. Meander 9 does not have rootwads since the existing trees were salvaged.

M9-US: View from Meander 9 looking upstream. Note the fiberglass tape is pulled across a riffle cross section near the center of the picture.

M9-DS: View from Meander 9 looking downstream. Note the point bar formation in the lower right corner of picture.

M10-US: View from Meander 10 **looking** upstream.



M10-DS: View from Meander 10 looking downstream. Note the bedrock in the bed of the channel exposed during construction.

M11-US: View from Meander 11 looking upstream.

M11-DS: View from Meander 11 looking downstream. Jefferson Club Road crosses the stream via this 14' x 7.5 box culvert.

M12-US: View from Meander 12 looking upstream through the culvert.

M12-DS: View from Meander 12 looking downstream.

M13-US: View from Meander 13 looking upstream.

M13-DS: View from Meander 13 looking downstream.

M14-US: View from Meander 14 looking upstream.

M14-DS: View from Meander 14 looking downstream. Note stone step-pool outfall to connect roadway drainage to stream.

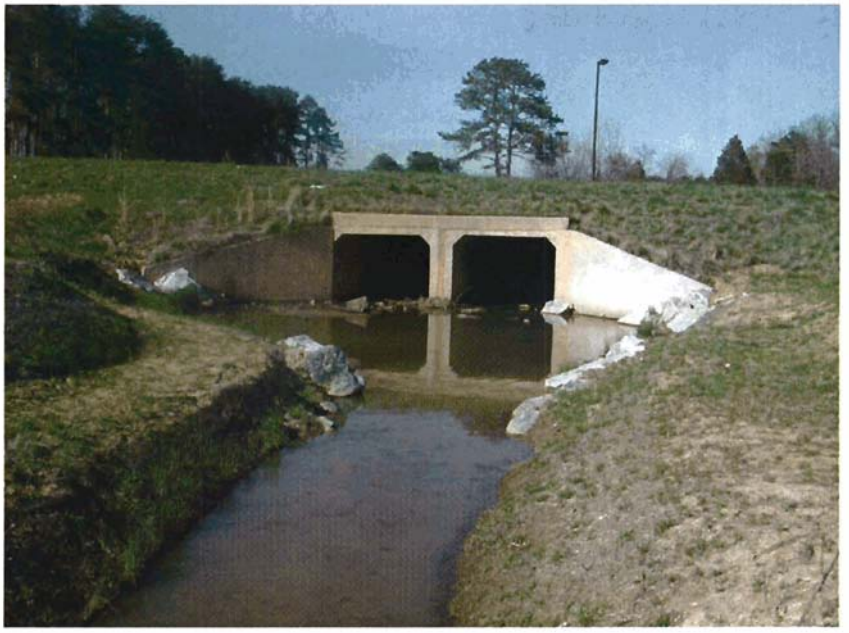
M15-US: View from Meander 15 looking upstream.

M15-DS: View from Meander 15 looking downstream. Note this cross-vane was moved upstream into the meander to avoid a gas line during construction. In effect, the upper portion of the cross vane has been covered up by the point bar since the cross vane slowed the water on the inside meander.

M16-US: View from Meander 16 looking upstream. The aerial sewer line was re-routed to make it perpendicular to the stream.

M16-DS: View from Meander 16 looking downstream. Cross-vane is drowned out due to backwater from the off-site lake downstream.

M17-US: View from Meander 17 looking upstream.

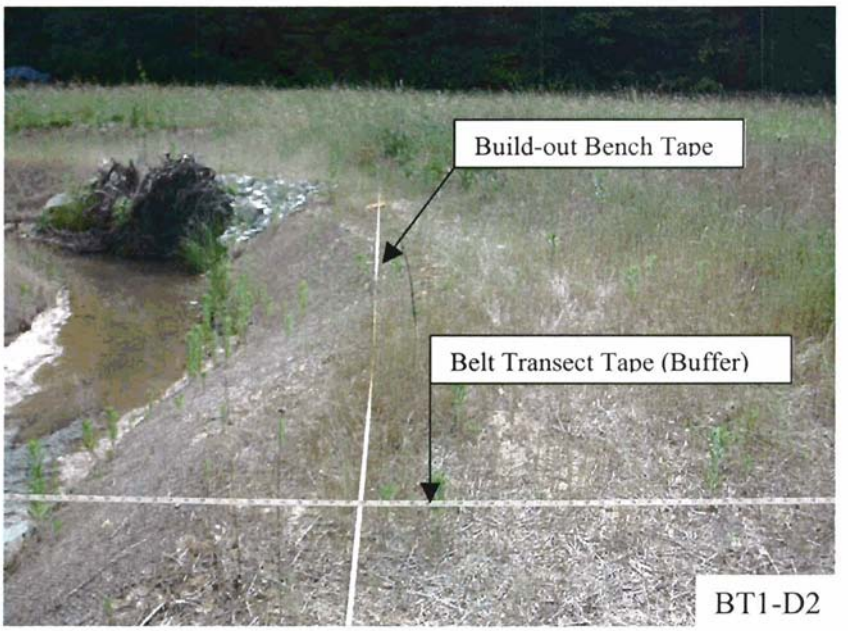


M17-DS: View from Meander 17 looking downstream towards the double 10' x 8' box culvert. Cross-vane is drowned out.

Vegetation Photo Log

Jefferson Pilot Stream Restoration – As-Built
Guilford County, North Carolina
June 6,2002

Transect 1 – Left bank. Shows build-out bench above coir matting with thin herbaceous vegetation



Transect 1 – Right build-out bench looking downstream. Shows the right side build-out bench vegetation. Transect tape in foreground, suspended above bench

BT2-L

Transect 2 – Left bank. Shows belt transect tape crossing a root wad. Tape for build-out bench plot is in the foreground.

BT3-D2

Transect 3 – View of right build-out bench looking downstream. Shows herbaceous vegetation on build-out bench and transplant above structure in background.

Transect 4 – Right build-out bench looking downstream, facing area of new structure.

Transect 4 – Left bank. Looking at area disturbed by construction of new structure.

Transect 5 – View of right build-out bench looking downstream, showing tape setup for bench plot. Note development of sedges and rushes along edge of stream on point bar above structure.

Transect 7 – Left bank in lower section below bridge. Shows significant elevation change between build-out bench and buffer elevation.

Transect 8 – Right build-out bench looking downstream. Shows relatively dense herbaceous vegetation, primarily Italian ryegrass.

Transect 9 – View of right bank, build-out bench and buffer.