RICH FORK(BODENHEIMER)
STREAM/WETLAND RESTORATION
YEAR 1 MONITORING REPORT
DECEMBER 2004

FULL DELIVERY PROJECT

EXECUTIVE SUMMARY

The Rich Fork Mitigation Project restored 21.49 acres of riverine wetland and 3,398 linear feet and preserved 1,972 linear feet of perennial stream in the Yadkin River Basin yielding 18.59 Wetland Management Units and, 3,792 Stream Management Units. The project was initiated in spring of 2000 and construction was completed in the spring of 2004. The goal of the project is to re-establish an integrated wetland-stream complex that will restore ecosystem processes, structure, and composition to mitigate for wetland functions and values that have been lost as a result of anthropogenic disturbances in this region of the Yadkin River Basin.

Activities in 2004 reflect the first year of monitoring following construction. Included in this report are analyses of both hydrologic and vegetation monitoring results, as well as local climate conditions throughout the growing season. Monitoring activities included sampling vegetation survivability at six locations, monitoring ground water elevations at six locations and documenting general site conditions at six permanent photo documentation points within the wetland restoration area.

The wetland restoration components of the project were evaluated to determine their compliance with the success criteria established for vegetation and hydrology, (soils did not require success criteria). Climatic data for the 2004 growing season was analyzed in comparison with historical data to determine whether 2004 was a normal year in terms of climate conditions, as a precursor to validating the results of the wetland monitoring. The historical data was collected from the NRCS, Water and Climate Center, Climate Analysis for Wetlands by County website. This evaluation concluded 2004 was a below normal year for rainfall during the growing season. Rainfall was within the 30th to 70th percentile thresholds as the range of normal for the months of June, and November. Rainfall was less than the 30th percentile threshold in March, April, May, August and October. Rainfall was greater than the 70th percentile threshold in July and September.

The site was planted at a density of 680 trees per acre. There were six (6) vegetation-monitoring plots established throughout the planting areas. The 2004 vegetation monitoring of the planted areas revealed an average density of 600 trees per acre, which is well above the minimum requirement of 260 trees per acre needed to meet the success criteria at the end of the five year monitoring period.

Wetland hydrology was monitored through the entire 2004 growing season with groundwater gauges. The result of this monitoring indicated that the water table is within 12 inches of the soil surface for greater than 12.5 % of the growing season all six monitoring gauges. In addition the site gauges closely mimic the hydroperiod of the reference wetland.

Soils in the restoration portion of the site have been determined to be Wehadkee and Chewacla. Since these soils are already considered hydric, no success criteria or monitoring is required.

The as built survey was completed immediately prior to relocation of active flow into the channel in June 2004. Existing conditions data was collected in November for cross sectional area, planform and profiles in four monitoring reaches and compared to the as-built condition three bankfull event occurred during this time. The permanent cross-sections, planform and profile showed no significant deviation from the as built conditions indicating that the streams are maintaining a stable form with dimensions and characteristics. Biological monitoring was conducted at upstream control site, in the main stem, tributary and below the confluence of the restored channels. Samples were collected and submitted to a laboratory for analysis. The survey, in general, found a higher density and diversity of species in the restored reaches then in the upstream control.

TABLE OF CONTENTS

Tables

Appendices

1.0 WETLANDS

The wetland restoration components of the project were evaluated to determine their compliance with the success criteria established for vegetation and hydrology, (soils did not require success criteria). Climatic data for the 2004 growing season was analyzed in comparison with historical data to determine whether 2004 was a normal year in terms of climate conditions, as a precursor to validating the results of the wetland monitoring. The historical data was collected from the NRCS, Water and Climate Center, Climate Analysis for Wetlands by County website. This evaluation concluded 2004 was a below normal year for rainfall during the growing season. Rainfall was within the 30^{th} to 70^{th} percentile thresholds as the range of normal for the months of June, and November. Rainfall was less than the 30^{th} percentile threshold in March, April, May, August and October. Rainfall was greater than the 70^{th} percentile threshold in July and September (Appendix B).

1.1 Vegetation - The 21.49-acre wetland restoration/creation/enhancement site was planted at a density of 680 trees per acre. There were six (6) vegetation-monitoring plots established throughout the planting areas. The 2004 vegetation monitoring of the planted areas revealed an average density of 600 trees per acre, which is well above the minimum requirement of 260 trees per acre (Appendix A). The average density for the Piedmont Bottomland Forest species was 600 trees per acre after one year (Table 1). A total of 6.5 trees per vegetation-monitoring plot are needed to meet the 260 trees per acre minimum requirement.

Table 1: Vegetation Monitoring Results

Plot #	Willow Oak	Swamp Chestnut Oak	Laurel Oak	Yellow Poplar	Swamp Blackgum	Black Willow	Silky Dogwood	Overcup Oak	Green Ash	Cherry bark Oak	Total (1 year)	Density (Trees/Acre)
1		12		4					2		18	720
2	1	2	5							6	14	560
3	8	2							6		16	640
4		3	2	2	1	2	1		3	3	17	680
5		1							12		13	520
6	2	7		1					2		12	480
									Total Average			**600**

1.2 Hydrology Wetland hydrology was monitored through the entire 2004 growing season with groundwater gauges(Appendix B). The result of this monitoring indicated that the water table is within 12 inches of the soil surface for greater than 12.5 % of the growing season at all six monitoring gauges (Table 2). In addition the site gauges closely mimic the hydroperiod of the reference wetland.

Table 2: Hydrologic Monitoring Results

Gauge #	5%	5% - 8%	8% -12.5%	>12.5%	No. of Days	Dates Meeting Success
1				X	58 and 40	3/14-5/11 and 9/8-10/18
2				X	87, 70, and 63	3/14-6/9, 6/26-9/4 and 9/8-11/10
3				X	53 and 63	3/14-5/6 and 9/8-11/10
4				X	58 and 63	3/14-5/11 and 9/8-11/10
5				X	62 and 63	3/14-5/15 and 9/8-11/10
6				X	62 and 63	3/14-5/15 and 9/8-11/10
Ref. Wetland				X	67 and 63	3/14-5/20 and 9/8-11/10

Table 3. Hydro-period Histories

Gauge #	Pre-Restoration	Year 1	Year 2	Year 3	Year 4	Year 5
1	>5%	>12.5%				
2	>5%	>12.5%				
3	>5%	>12.5%				
4	>5%	>12.5%				
5	>5%	>12.5%				
6	>5%	>12.5%				
Ref. Wetland	>12.5%	>12.5%				

1.3 Soils - Soils in the restoration portion of the site have been determined to be Wehadkee and Chewacla. Wehadkee is a hydric soil shown on the state and federal hydric soils list and the Chewacla soils have hydric inclusions of poorly drained soils. The overburden and fill associated with the Chewacla soils was removed during construction to restore the hydric characteristics of the soil lost from filling and over bank flooding. As both soils are already considered hydric, no success criteria or monitoring was required.

2.0 STREAMS

The streams restored on site were monitored to evaluate their compliance with the success criteria established for physical stability (cross section, planform and profile) and biological.

2.1 Physical - The as built survey was completed immediately prior to relocation of active flow into the channel in June 2004. Existing conditions data was collected in November for cross sectional area, planform and profiles in four monitoring reaches and compared to the as-built condition (appendix C) three bankfull events occurred during this time. The permanent cross-sections (table 4), planform (table 5) and profile (table 6) showed no significant deviation from the as built conditions indicating that the streams are maintaining a stable form with dimensions and characteristics.

Table 4. Bankfull Cross Sectional Area

X-Section	As-Built	Year 1	Year 2	Year 3	Year 4	Year 5
XS-1 Main Stem Up	7.28	7.34				
XS-2 Main Stem Up	2.14	2.45				
XS-3 Main Stem Down	5.88	5.72				
XS-4 Main Stem Down	4.56	4.85				
XS-1 Tributary Up	1.79	1.55				
XS-2 Tributary Up	1.18	1.14				
XS-3 Tributary Down	2.61	2.71				
XS-4 Tributary Down	1.14	1.20				

Table 5. Planform (Sinuosity/Radius of Curvature)

Reach	As-Built	Year 1	Year 2	Year 3	Year 4	Year 5
Main Stem Up	1.19/13.93	1.19/13.93				
Main Stem Down	1.20/13.00	1.20/13.08				
Tributary Up	1.24/7.39	1.24/7.39				
Tributary Down	1.35/7.27	1.35/7.27				

Table 6. Profile (Average depth in feet from control elevation)

Reach	As-Built	Year 1	Year 2	Year 3	Year 4	Year 5
Main Stem Up	1.42	1.37				
Main Stem Down	0.87	0.82				
Tributary Up	0.87	0.82				
Tributary Down	1.15	1.09				

2.2 Biological Monitoring - Biological monitoring was conducted at an upstream control site, in the main stem, tributary and below the confluence of the restored channels. Samples were collected and submitted to a laboratory for analysis. The survey, in general, found a higher density and diversity of species in the restored reaches then in the upstream control (Appendix D).

Table 7. Summary Benthic Macroinvertebrate Data

Sampling Location	Total No. of Organisms						Total Number of Taxa						Biotic Index Assigned Values					
Year	Pre	1	2	3	4	5	Pre	1	2	3	4	5	Pre	1	2	3	4	5
Upstream*	24	33					9	10					6.61	7.47				
Main Stem Up	N/A	52					N/A	17					N/A	7.63				
Tributary Up	N/A	56					N/A	18					N/A	7.45				
Confluence	N/A	27					N/A	13					N/A	6.77				

*Upstream control site monitored pre-restoration

3.0 MAINTENANCE/MANAGEMENT ACTIONS

The final relocation of the stream channel and abandonment of the existing ditched channel was conducted in June 2004. All planting had been completed in winter of 2004, however, Land Quality required herbaceous vegetation to be established on the site before redirecting flow into the new channel.

Maintenance actions conducted during the 2004 growing season were limited to removal of herbaceous vegetation in the stream channel that had become established prior to redirecting flow into the channel in June. The application of a pre-emergent is scheduled for March 2005 to decrease herbaceous competition with the trees.

4.0 CONCLUSIONS

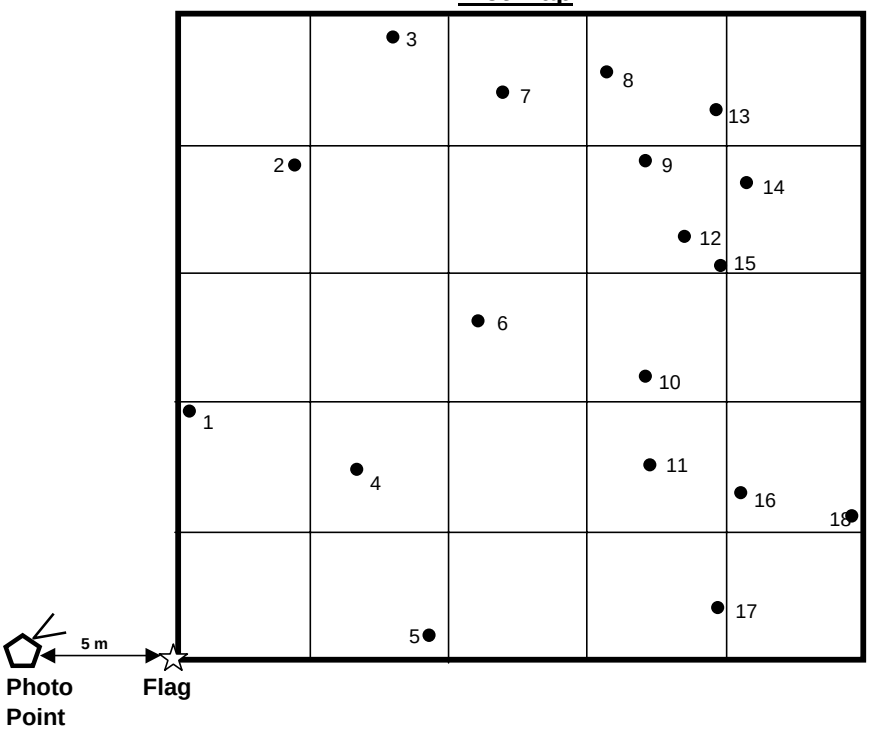
Findings from this monitoring year indicate that the project site is performing as designed. The survival of the planted species exceeds the density requirement of the success criteria and non-target species were not identified in any of the vegetation-monitoring plots. All six monitoring gauges exceeded the hydrologic success criteria of 8% of the growing season. Physical monitoring of the stream at 4 permanent monitoring reaches documented no change in the cross section, planform or profile from the as-built conditions. The stream is maintaining a stable form and accessing its floodplain. Instream structures are stable and functioning. Observations of stream bank vegetation indicate that live stake survivability is very good and the herbaceous vegetation is well developed on the stream banks. Biological diversity is higher then the upstream control site and is significantly higher then the pre-restoration monitoring.

Appendix A
Vegetation Monitoring Plot Data Sheets

Vegetation Monitoring Worksheet

Site: Richfork **Plot:** 1 **Date:** 7/22/2004

Plot Map



ID	Species	Height (m)	Collar Diameter (cm)	Comments (insect damage, disease, browsing)
1	Yellow Poplar (*Liriodendron tulipifera*)	1.0	0.8	healthy
2	Yellow Poplar (*Liriodendron tulipifera*)	0.6	0.8	black spots on leaves
3	Swamp Chestnut Oak (*Quercus michauxii*)	0.5	0.5	healthy
4	Swamp Chestnut Oak (*Quercus michauxii*)	0.7	0.7	healthy
5	Swamp Chestnut Oak (*Quercus michauxii*)	0.7	0.5	healthy
6	Yellow Poplar (*Liriodendron tulipifera*)	0.7	1.0	healthy
7	Yellow Poplar (*Liriodendron tulipifera*)	0.6	0.7	healthy
8	Swamp Chestnut Oak (*Quercus michauxii*)	0.5	0.5	healthy
9	Swamp Chestnut Oak (*Quercus michauxii*)	0.6	0.6	healthy
10	Swamp Chestnut Oak (*Quercus michauxii*)	0.9	0.7	some insect damage
11	Green Ash (*Fraxinus pennsylvanica*)	1.0	0.9	healthy
12	Swamp Chestnut Oak (*Quercus michauxii*)	0.8	0.7	healthy
13	Swamp Chestnut Oak (*Quercus michauxii*)	0.8	0.7	some insect damage
14	Swamp Chestnut Oak (*Quercus michauxii*)	0.8	0.6	healthy
15	Swamp Chestnut Oak (*Quercus michauxii*)	0.6	0.4	healthy
16	Swamp Chestnut Oak (*Quercus michauxii*)	0.6	0.6	some insect damage
17	Green Ash (*Fraxinus pennsylvanica*)	0.6	0.7	healthy
18	Swamp Chestnut Oak (*Quercus michauxii*)	1.1	1.5	healthy

Species	Percent of Total
Swamp Chestnut Oak (*Quercus michauxii*)	67
Yellow Poplar (*Liriodendron tulipifera*)	22
Green Ash (*Fraxinus pennsylvanica*)	11

Density:

Total Number of Trees **18** / **0.025 acres** = **720** **trees / acre**

Survivability:

Total Number of Trees **18** / **18 trees** x **100** = **100** **% survivability**

Number of New Recruits : _____

Note : Flag located N 38° E, 27' from monitoring well

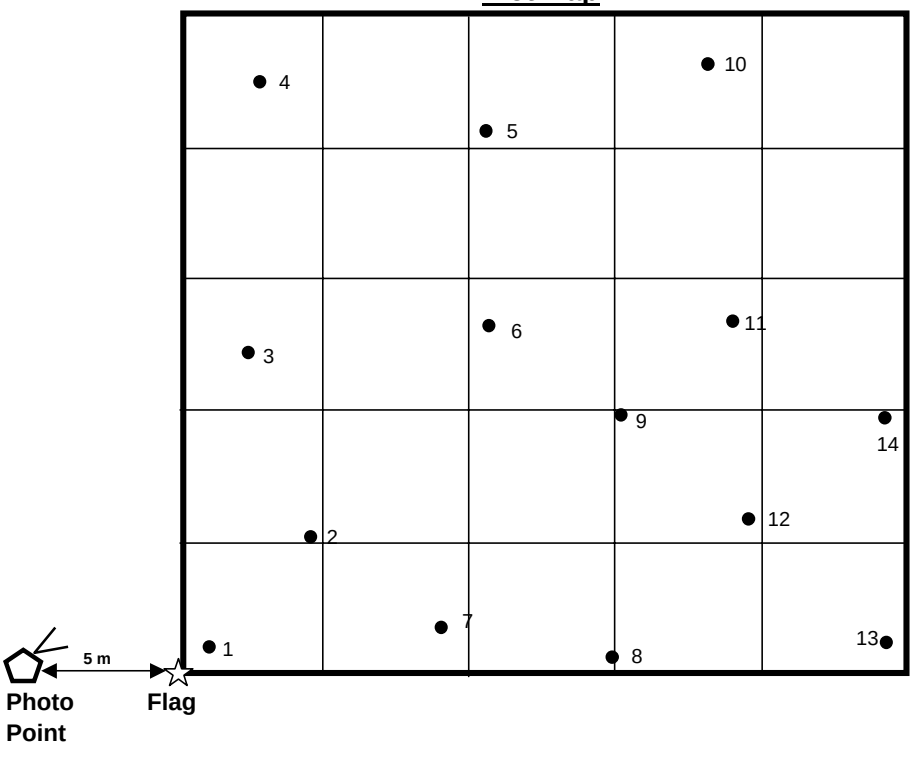
Previous

Current

Vegetation Monitoring Worksheet

Site: Richfork **Plot:** 2 **Date:** 7/22/2004

Plot Map



ID	Species	Height (m)	Collar Diameter (cm)	Comments (insect damage, disease, browsing)
1	Laurel Oak (*Quercus laurifolia*)	0.51	0.64	healthy
2	Laurel Oak (*Quercus laurifolia*)	0.51	0.64	rootstock healthy
3	Cherrybark Oak (*Quercus falcata*)	0.36	0.64	healthy
4	Swamp Chestnut Oak (*Quercus michauxii*)	0.64	1.27	healthy
5	Cherrybark Oak (*Quercus falcata*)	0.43	0.64	healthy
6	Willow Oak (*Quercus phellos*)	0.36	0.64	healthy original stem
7	Cherrybark Oak (*Quercus falcata*)	0.51	0.64	healthy
8	Cherrybark Oak (*Quercus falcata*)	0.15	0.32	rootstock healthy
9	Cherrybark Oak (*Quercus falcata*)	0.46	0.64	healthy
10	Laurel Oak (*Quercus laurifolia*)	0.53	0.64	healthy
11	Cherrybark Oak (*Quercus falcata*)	0.46	0.64	healthy
12	Laurel Oak (*Quercus laurifolia*)	0.79	1.27	healthy multistemed
13	Swamp Chestnut Oak (*Quercus michauxii*)	1.17	1.27	healthy
14	Laurel Oak (*Quercus laurifolia*)	0.56	0.64	healthy

Species	Percent of Total
Swamp Chestnut Oak (*Quercus michauxii*)	14
Cherrybark Oak (*Quercus falcata*)	43
Laurel Oak (*Quercus laurifolia*)	36
Willow Oak (*Quercus phellos*)	7

Density:

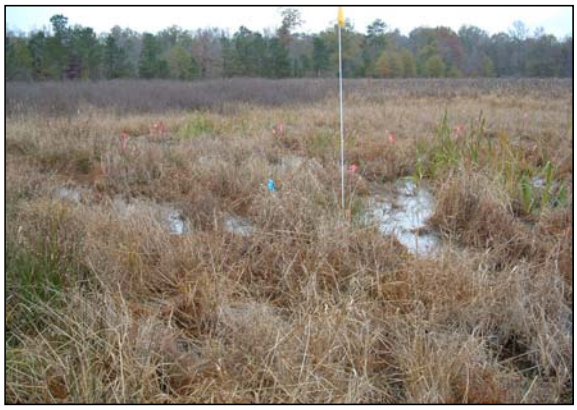
Total Number of Trees **14** / **0.025 acres** = **560** **trees / acre**

Survivability:

Total Number of Trees **14** / **14 trees** x **100** = **100** **% survivability**

Number of New Recruits : _____

Note : Flag located W 270° N, 126' from monitoring well



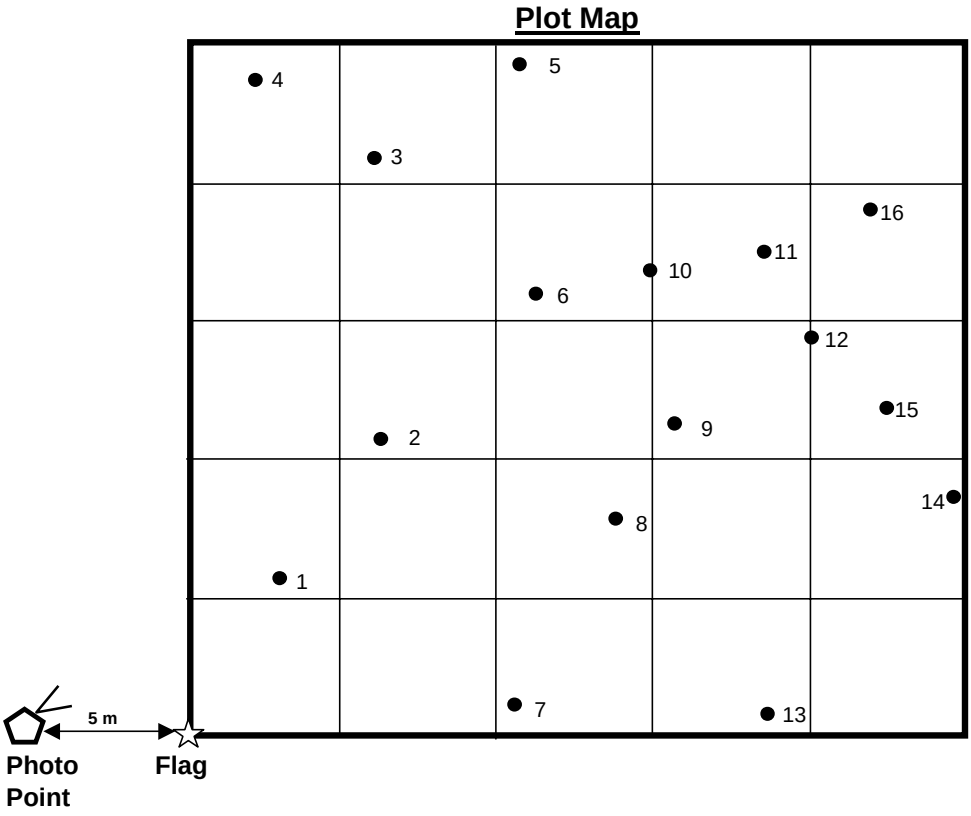
Previous

Current

Vegetation Monitoring Worksheet

Site: Richfork **Plot:** 3 **Date:** 7/22/2004

Plot Map



ID	Species	Height (m)	Collar Diameter (cm)	Comments (insect damage, disease, browsing)
1	Willow Oak (*Quercus phellos*)	0.5	1.0	healthy
2	Willow Oak (*Quercus phellos*)	0.6	0.7	Re growth after dieback
3	Willow Oak (*Quercus phellos*)	0.7	0.7	Re growth after dieback
4	Willow Oak (*Quercus phellos*)	0.7	0.6	healthy
5	Swamp Chestnut Oak (*Quercus michauxii*)	0.9	0.6	healthy
6	Willow Oak (*Quercus phellos*)	0.4	0.5	healthy
7	Green Ash (*Fraxinus pennsylvanica*)	1.0	1.1	black spots on leaves
8	Green Ash (*Fraxinus pennsylvanica*)	0.7	0.7	black spots on leaves
9	Green Ash (*Fraxinus pennsylvanica*)	0.8	0.9	healthy
10	Willow Oak (*Quercus phellos*)	0.7	0.8	healthy
11	Willow Oak (*Quercus phellos*)	0.5	0.6	healthy
12	Green Ash (*Fraxinus pennsylvanica*)	0.6	1.0	healthy
13	Green Ash (*Fraxinus pennsylvanica*)	1.0	1.2	black spots on leaves
14	Swamp Chestnut Oak (*Quercus michauxii*)	0.6	0.8	healthy
15	Green Ash (*Fraxinus pennsylvanica*)	0.7	0.9	healthy
16	Willow Oak (*Quercus phellos*)	0.4	0.7	healthy

Species	Percent of Total
Swamp Chestnut Oak (*Quercus michauxii*)	13
Willow Oak (*Quercus phellos*)	50
Green Ash (*Fraxinus pennsylvanica*)	38

Density:

Total Number of Trees **16** / **0.025 acres** = **640** **trees / acre**

Survivability:

Total Number of Trees **16** / **16 trees** x **100** = **100** **% survivability**

Number of New Recruits : _____

Note : Flag located N 38° E, 27' from monitoring well

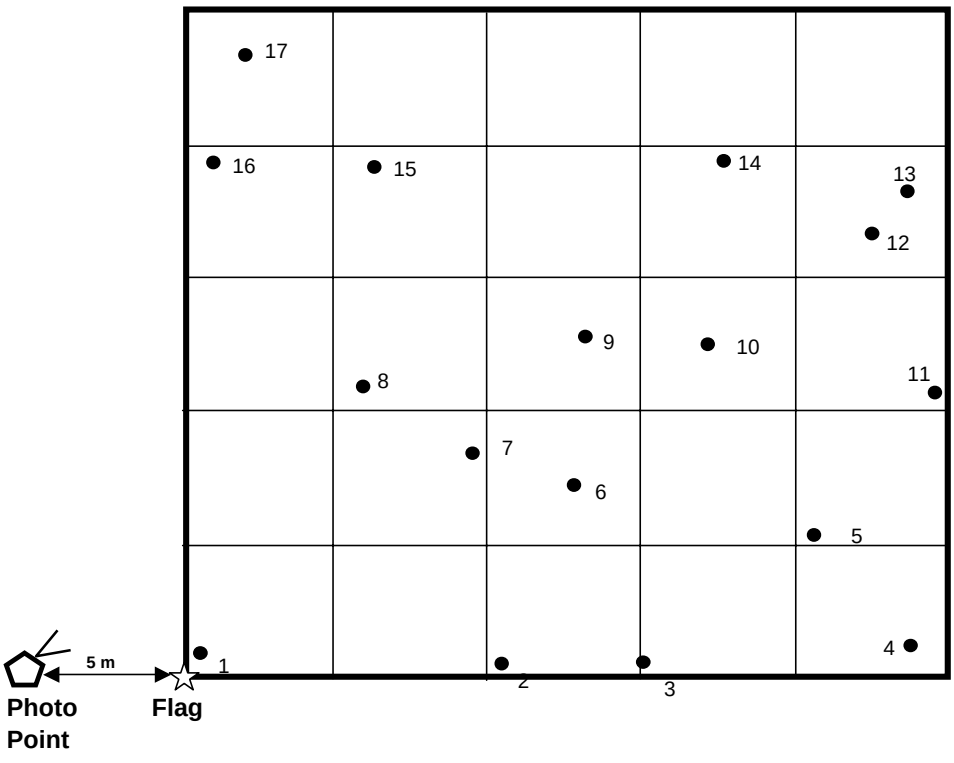
Previous

Current

Vegetation Monitoring Worksheet

Site: Richfork **Plot:** 4 **Date:** 11/11/2004

Plot Map



ID	Species	Height (m)	Collar Diameter (cm)	Comments (insect damage, disease, browsing)
1	Swamp Black Gum (*Nyssa sylvatica*)	0.50	0.64	dead
2	Laurel Oak (*Quercus laurifolia*)	0.34	0.32	healthy two stems
3	Cherrybark Oak (*Quercus falcata*)	0.43	0.64	healthy
4	Black Willow (*Salix nigra*)	0.94	0.64	healthy multistem
5	Swamp Chestnut Oak (*Quercus michauxii*)	0.64	1.27	healthy
6	Laurel Oak (*Quercus laurifolia*)	0.36	0.32	healthy
7	Swamp Chestnut Oak (*Quercus michauxii*)	0.67	1.27	healthy
8	Swamp Chestnut Oak (*Quercus michauxii*)	0.74	0.95	healthy
9	Yellow Poplar (*Liriodendron tulipifera*)	0.48	2.22	healthy
10	Yellow Poplar (*Liriodendron tulipifera*)	0.41	1.27	healthy
11	Cherrybark Oak (*Quercus falcata*)	0.38	0.64	healthy
12	Silky Dogwood (*Cornus amomum*)	0.53	1.27	healthy multistem
13	Green Ash (*Fraxinus pennsylvanica*)	1.17	1.91	healthy
14	Green Ash (*Fraxinus pennsylvanica*)	0.74	1.27	no leaves, has buds, appears healthy
15	Cherrybark Oak (*Quercus falcata*)	0.46	0.32	healthy
16	Green Ash (*Fraxinus pennsylvanica*)	0.79	1.27	no leaves, has buds, appears healthy
17	Black Willow (*Salix nigra*)	1.75	2.54	healthy

Species	Percent of Total
Swamp Chestnut Oak (*Quercus michauxii*)	18
Green Ash (*Fraxinus pennsylvanica*)	18
Cherrybark Oak (*Quercus falcata*)	18
Swamp Black Gum (*Nyssa sylvatica*)	6
Silky Dogwood (*Cornus amomum*)	6
Black Willow (*Salix nigra*)	12
Yellow Poplar (*Liriodendron tulipifera*)	12
Laurel Oak (*Quercus laurifolia*)	12

Density:

Total Number of Trees **16** / **0.025 acres** = **640** **trees / acre**

Survivability:

Total Number of Trees **16** / **16 trees** x **100** = **100** **% survivability**

Number of New Recruits : _____

Note : Flag located E 158° S, 76' from monitoring well

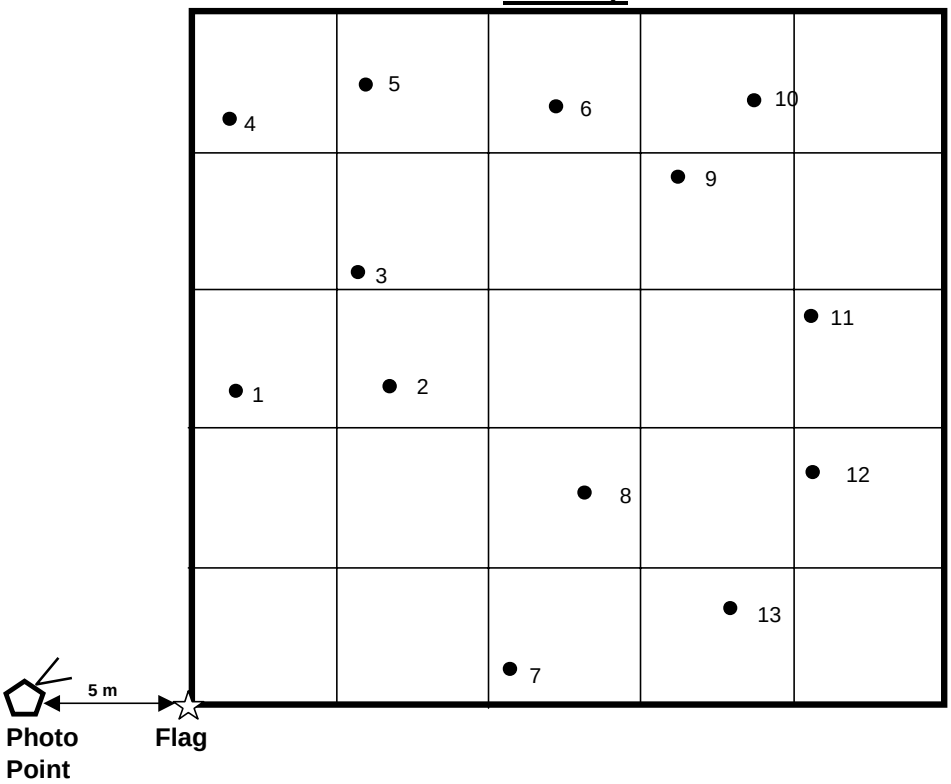
Previous

Current

Vegetation Monitoring Worksheet

Site: Richfork **Plot:** 5 **Date:** 7/22/2004

Plot Map



ID	Species	Height (m)	Collar Diameter (cm)	Comments (insect damage, disease, browsing)
1	Green Ash (*Fraxinus pennsylvanica*)	0.5	0.9	healthy
2	Green Ash (*Fraxinus pennsylvanica*)	0.5	0.8	healthy
3	Green Ash (*Fraxinus pennsylvanica*)	0.7	0.9	healthy
4	Green Ash (*Fraxinus pennsylvanica*)	0.5	0.6	healthy
5	Green Ash (*Fraxinus pennsylvanica*)	0.6	0.7	healthy
6	Green Ash (*Fraxinus pennsylvanica*)	0.5	0.7	healthy
7	Green Ash (*Fraxinus pennsylvanica*)	0.8	1.1	healthy
8	Green Ash (*Fraxinus pennsylvanica*)	0.4	0.7	healthy
9	Green Ash (*Fraxinus pennsylvanica*)	0.9	1.0	black spots on leaves
10	Swamp Chestnut Oak (*Quercus michauxii*)	0.6	0.8	healthy
11	Green Ash (*Fraxinus pennsylvanica*)	0.6	0.9	healthy
12	Green Ash (*Fraxinus pennsylvanica*)	0.7	1.0	black spots on leaves
13	Green Ash (*Fraxinus pennsylvanica*)	0.3	0.4	healthy

Species	Percent of Total
Swamp Chestnut Oak (*Quercus michauxii*)	8
Green Ash (*Fraxinus pennsylvanica*)	92

Density:

Total Number of Trees **13** / **0.025 acres** = **520** **trees / acre**

Survivability:

Total Number of Trees **13** / **13 trees** x **100** = **100** **% survivability**

Number of New Recruits : _____

Note : Flag located N 38° E, 27' from monitoring well

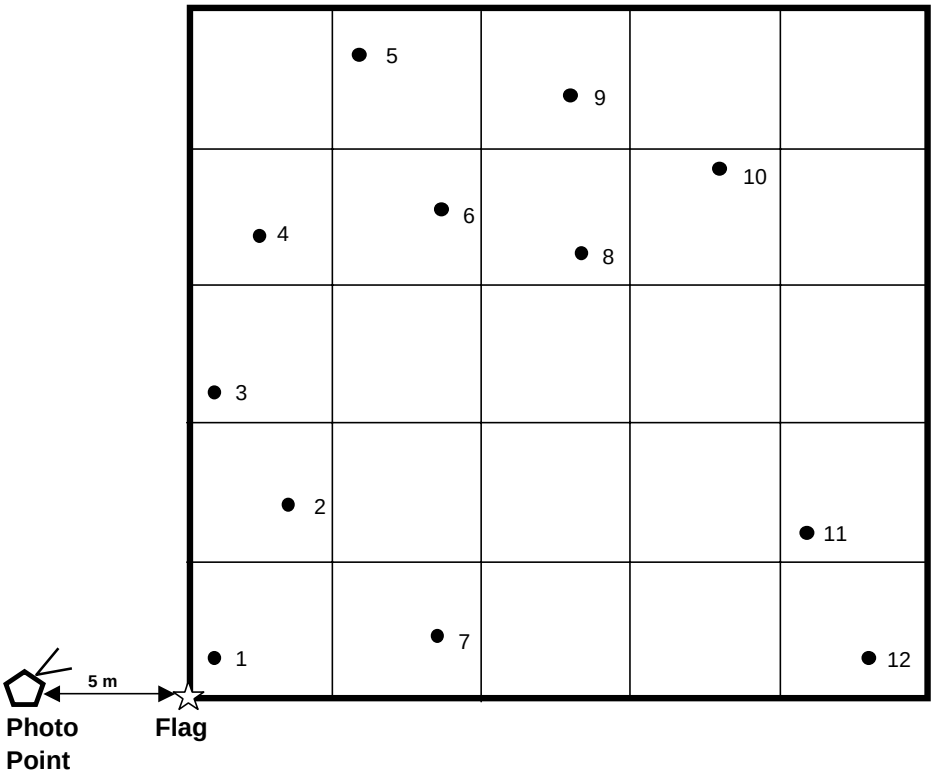
Previous

Current

Vegetation Monitoring Worksheet

Site: Richfork **Plot:** 6 **Date:** 7/22/2004

Plot Map



ID	Species	Height (m)	Collar Diameter (cm)	Comments (insect damage, disease, browsing)
1	Swamp Chestnut Oak (*Quercus michauxii*)	1.0	1.0	healthy
2	Swamp Chestnut Oak (*Quercus michauxii*)	0.8	0.4	healthy
3	Swamp Chestnut Oak (*Quercus michauxii*)	0.9	0.6	healthy
4	Swamp Chestnut Oak (*Quercus michauxii*)	1.1	0.6	healthy
5	Swamp Chestnut Oak (*Quercus michauxii*)	0.7	0.7	healthy
6	Willow Oak (*Quercus phellos*)	0.5	0.7	healthy
7	Swamp Chestnut Oak (*Quercus michauxii*)	1.1	0.8	healthy
8	Green Ash (*Fraxinus pennsylvanica*)	0.9	1.1	healthy
9	Yellow Poplar (*Liriodendron tulipifera*)	0.4	0.6	healthy
10	Swamp Chestnut Oak (*Quercus michauxii*)	0.9	0.9	healthy
11	Green Ash (*Fraxinus pennsylvanica*)	1.1	1.4	healthy
12	Willow Oak (*Quercus phellos*)	0.5	0.6	healthy

Species	Percent of Total
Swamp Chestnut Oak (*Quercus michauxii*)	58
Green Ash (*Fraxinus pennsylvanica*)	17
Yellow Poplar (*Liriodendron tulipifera*)	8
Willow Oak (*Quercus phellos*)	17

Density:

Total Number of Trees **12** / **0.025 acres** = **480** **trees / acre**

Survivability:

Total Number of Trees **12** / **12 trees** x **100** = **100** **% survivability**

Number of New Recruits : _____

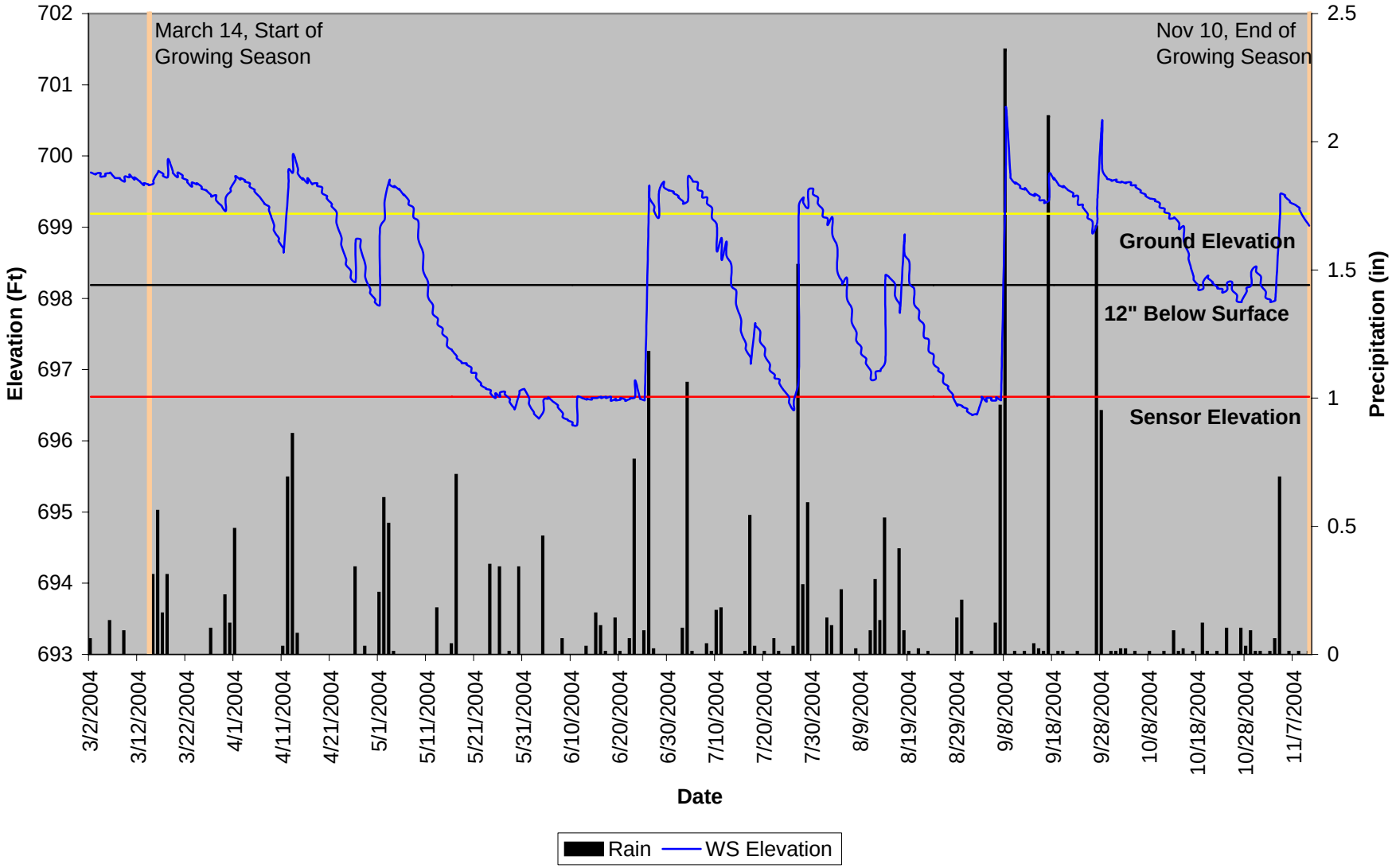
Note : Flag located N 38° E, 27' from monitoring well

Previous

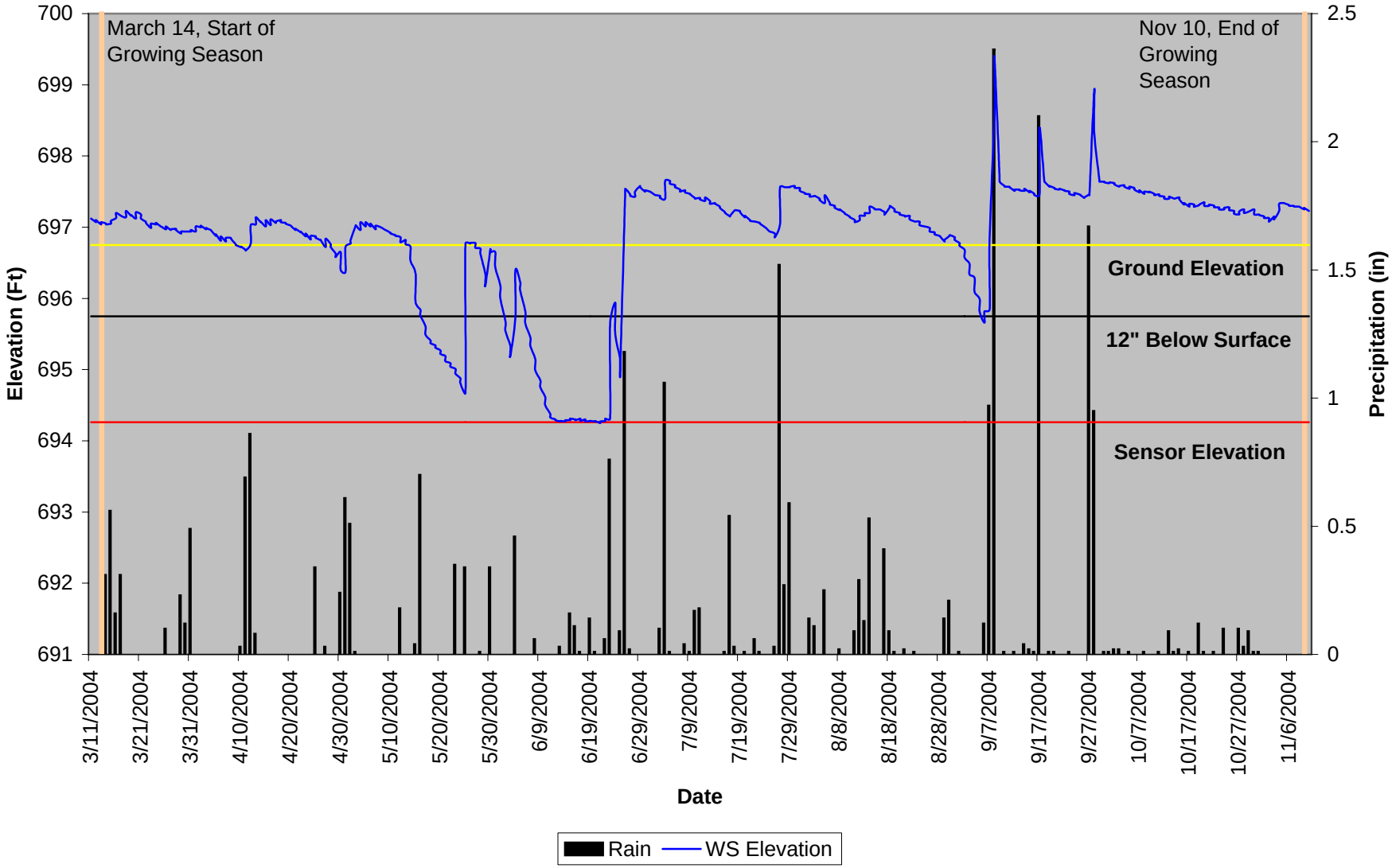
Current

Appendix B
Hydrologic Monitoring and Hydroperiod

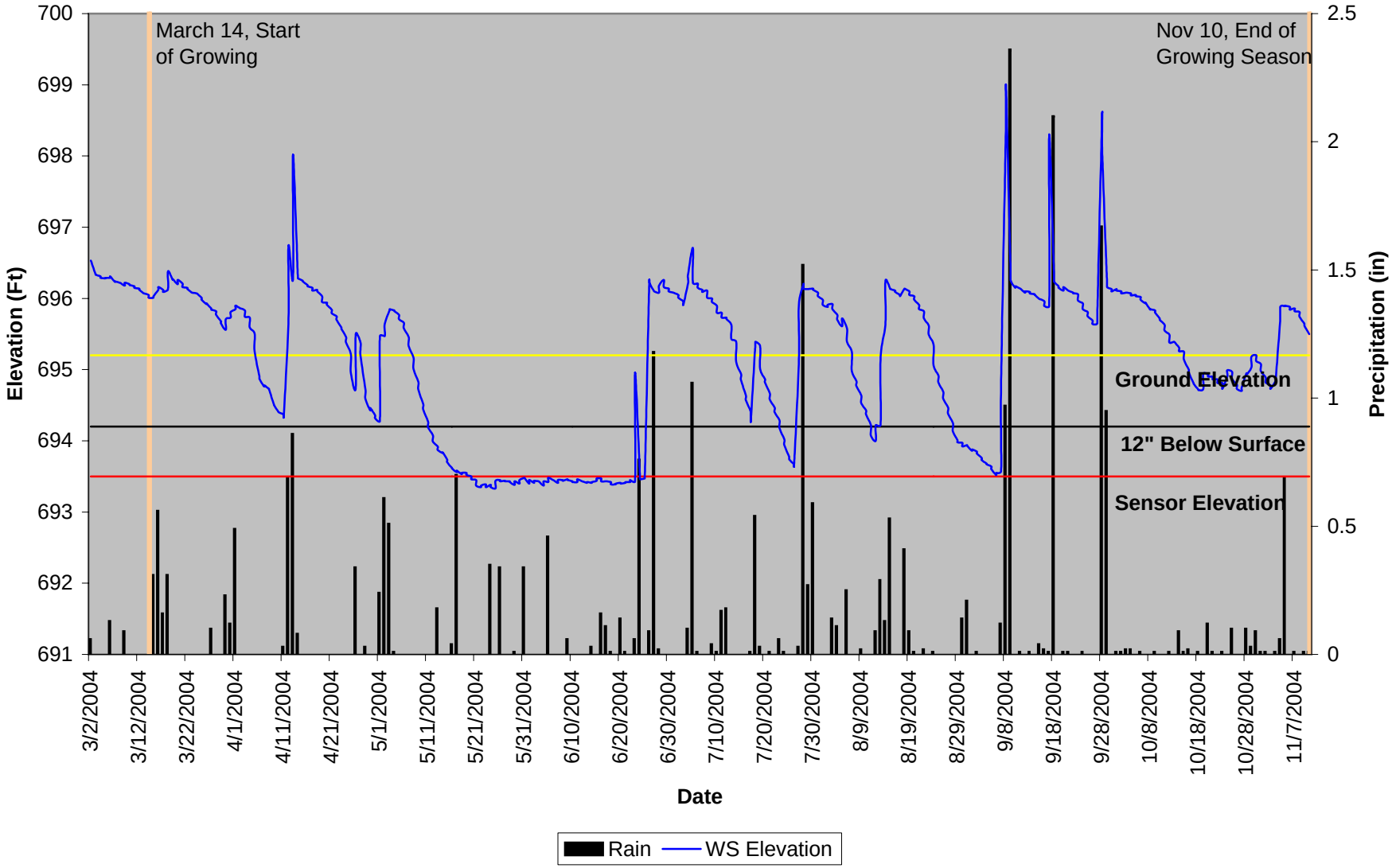
Rich Fork-Gauge 1



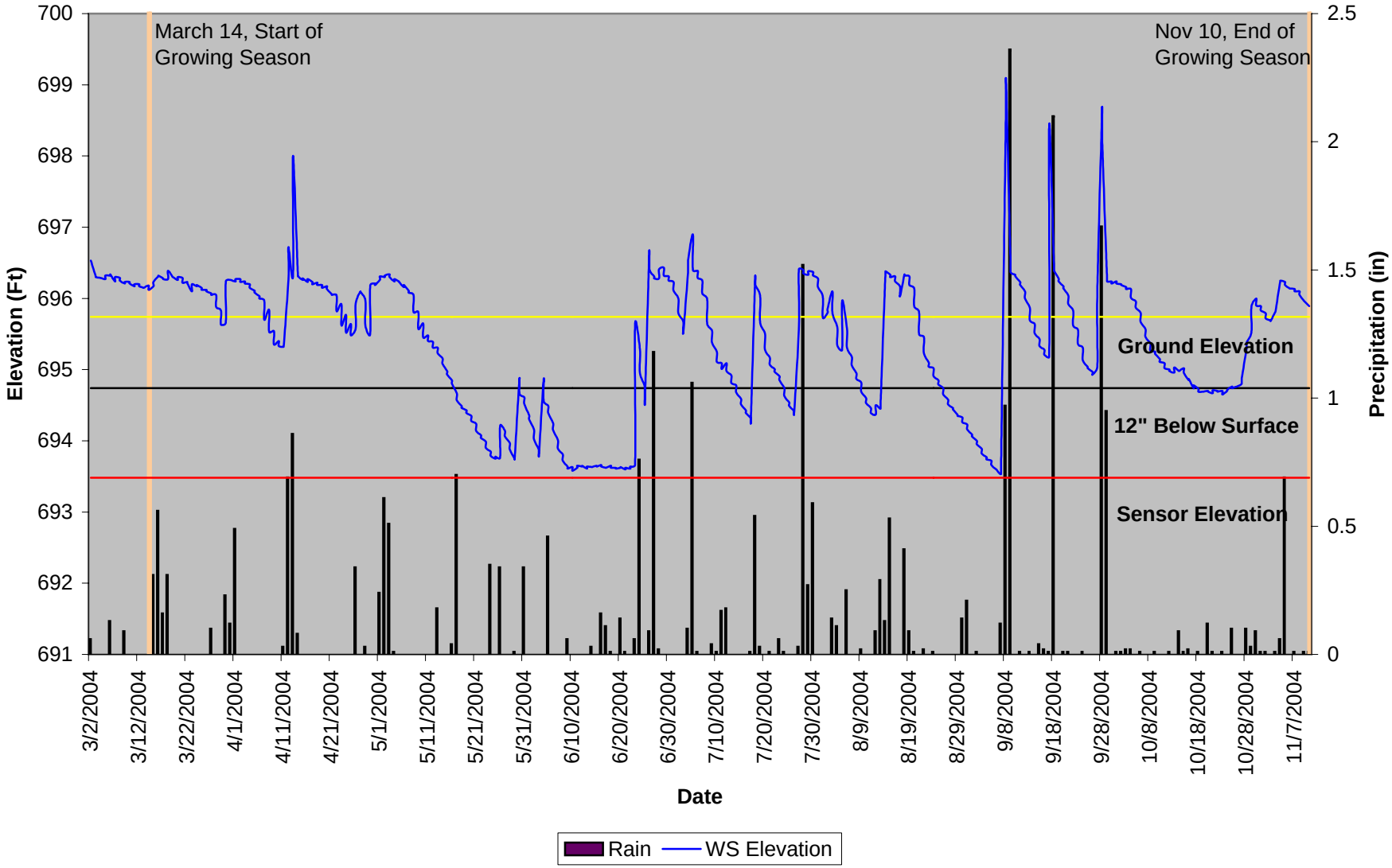
Rich Fork-Gauge 2



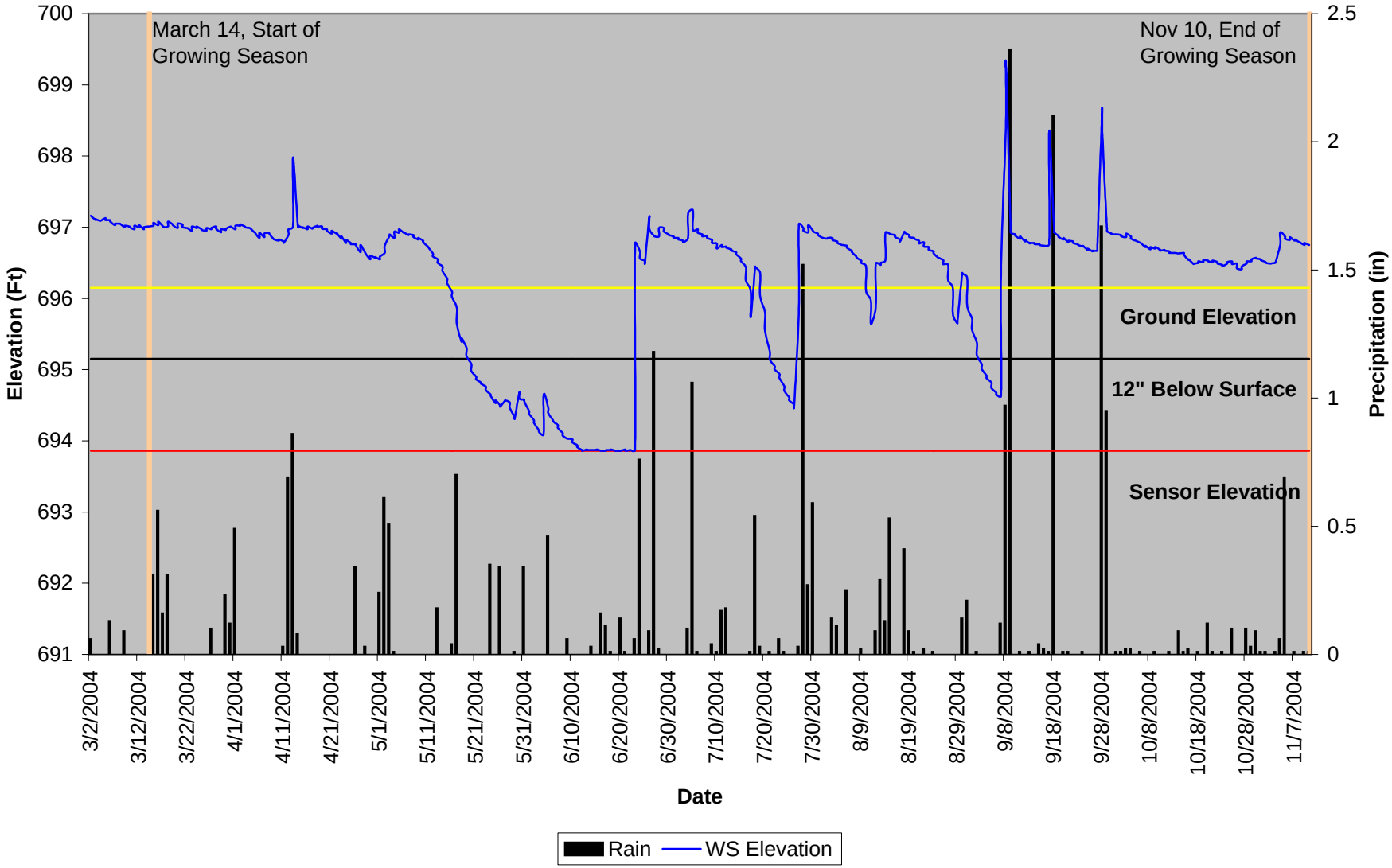
Rich Fork-Gauge 3



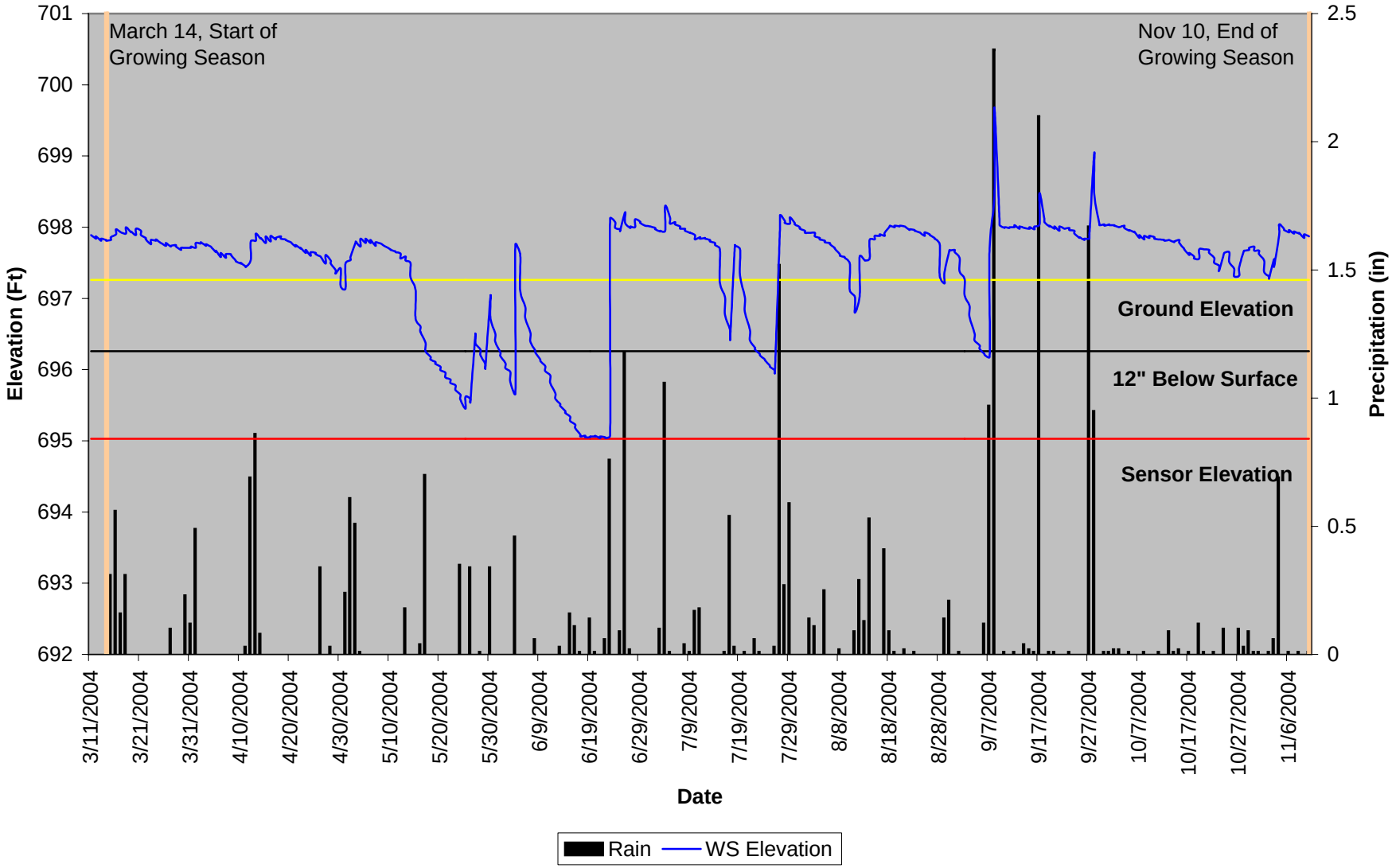
Rich Fork-Gauge 4



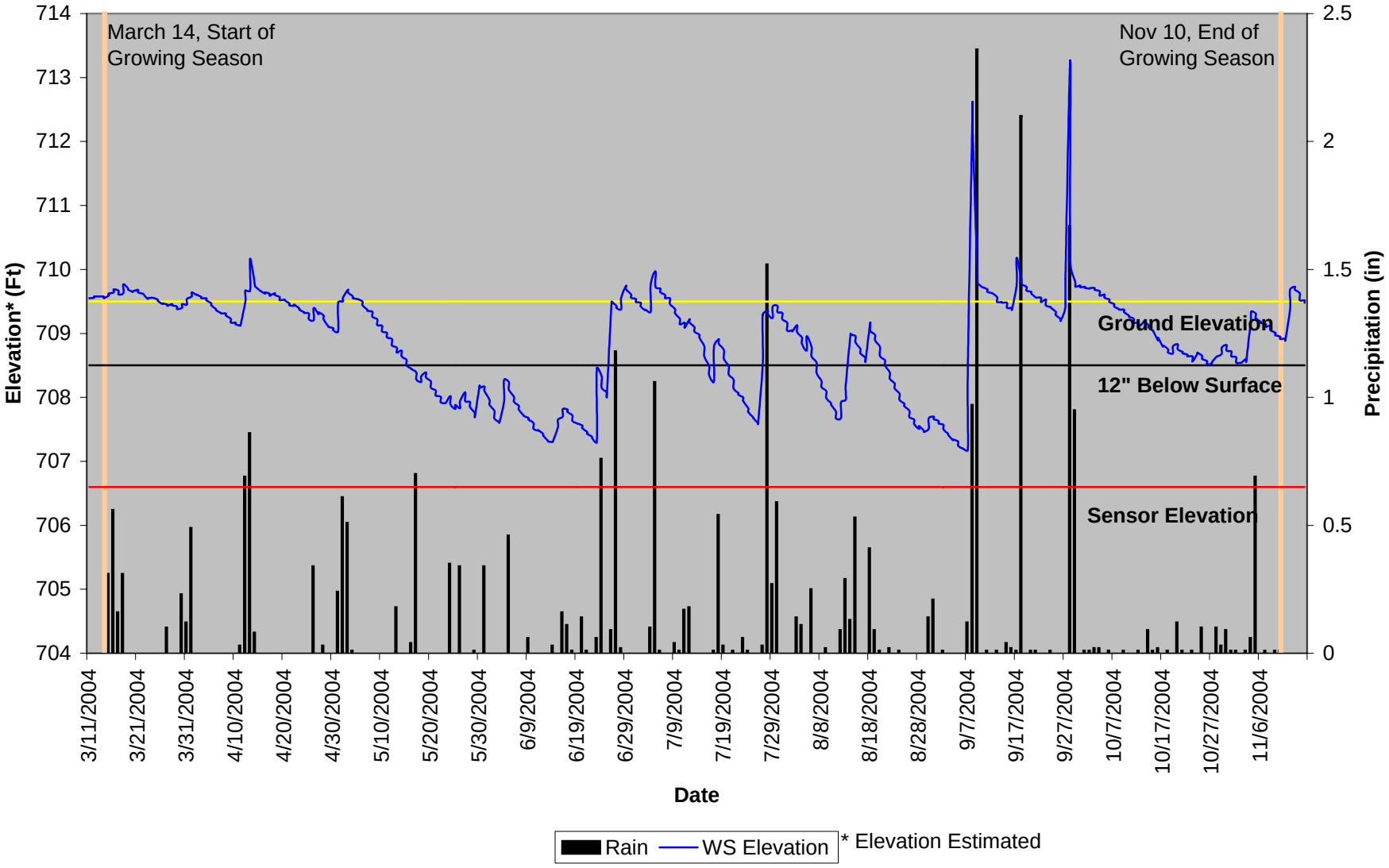
Rich Fork-Gauge 5



Rich Fork-Gauge 6



Rich Fork-Reference



Appendix C
Stream Morphology

Rich Fork Creek Stream Monitoring

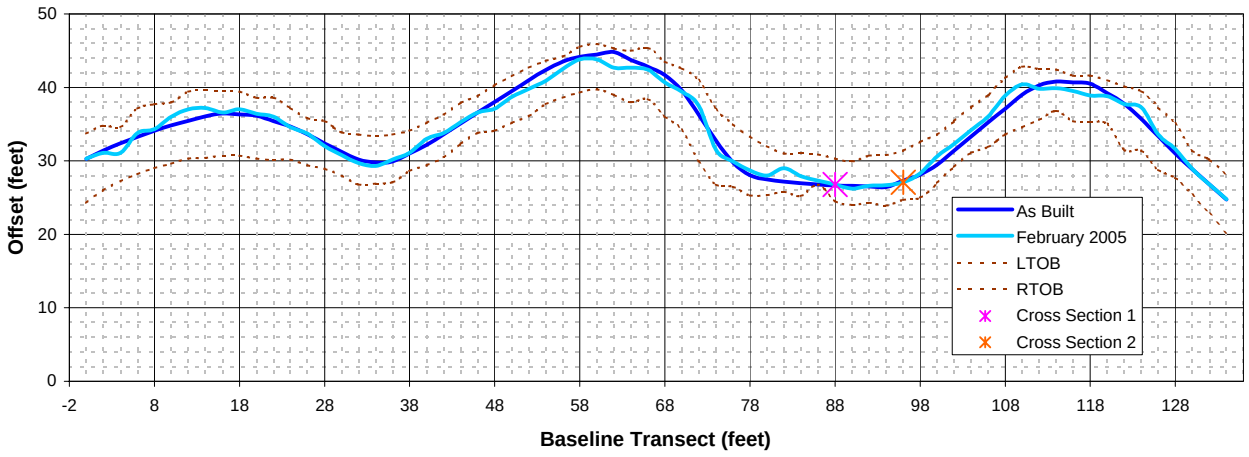
River Basin:	Yadkin
Watershed:	Rich Fork
Planform ID	Main Up
Date:	2/15/2005
Field Crew:	AS, MC

SUMMARY DATA	
Stream Segment Length:	160.00
Distance Between Survey Points:	134.00
Distance Between Stations:	2.00
Sinuosity:	1.19
Mean Radius of Curvature:	13.93
Belt Width:	19.00

View of mainstem upstream planform section looking downstream

Stream Type:	E5

Stream Segment Planform



Comments:

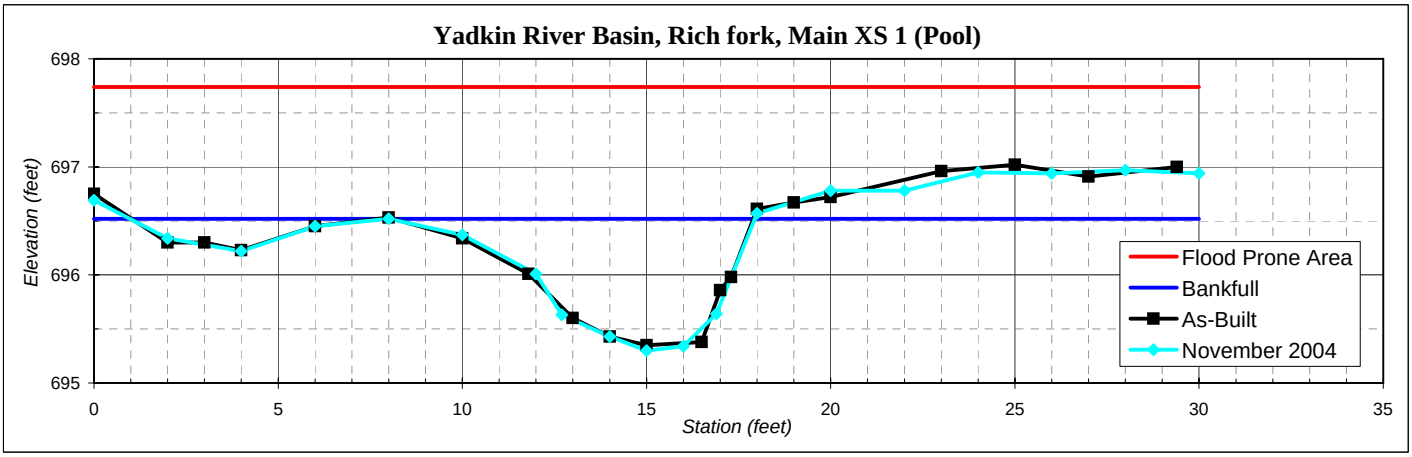
Rich Fork Creek Stream Monitoring

River Basin:	Yadkin
Watershed:	Rich fork
XS ID	Main XS 1 (Pool)
Reach:	Main Upstream
Date:	11/12/2004
Field Crew:	BH

SUMMARY DATA	
Bankfull Elevation:	696.52
Bankfull Cross-Sectional Area:	7.34
Bankfull Width:	16.97
Flood Prone Area Elevation:	697.74
Flood Prone Width:	240.00
Max Depth at Bankfull:	1.22
Mean Depth at Bankfull:	0.43
W / D Ratio:	39.2
Entrenchment Ratio:	14.14
Bank Height Ratio:	1.21
Slope (ft/ft):	0.004
Discharge (cfs)	13

View of cross-section #1 looking upstream

Stream Type:	E5c



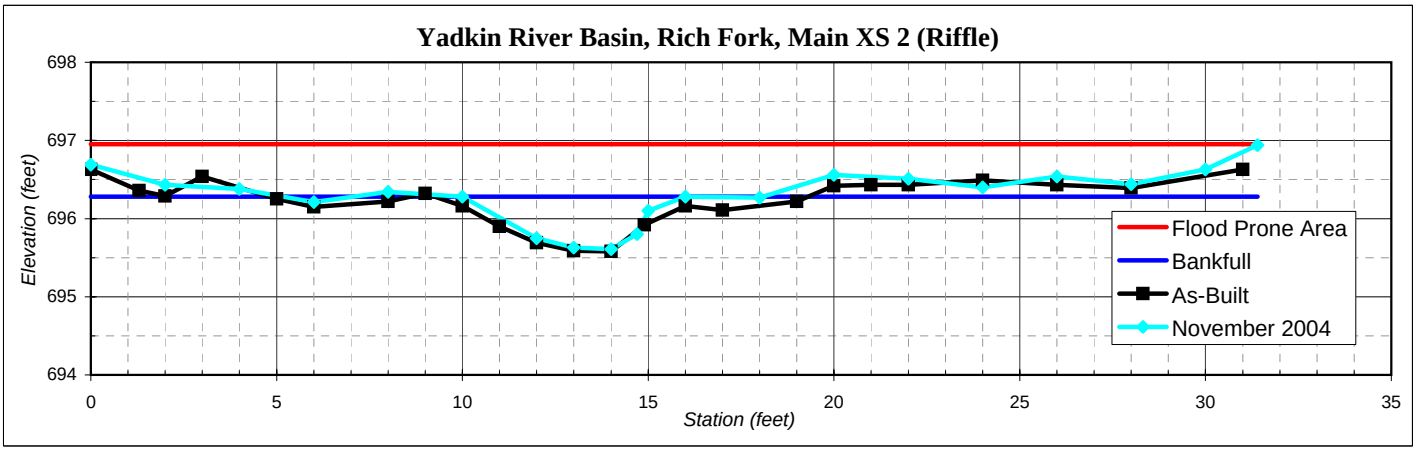
Rich Fork Creek Stream Monitoring

River Basin:	Yadkin
Watershed:	Rich Fork
XS ID	Main XS 2 (Riffle)
Reach:	Main Upstream
Date:	11/12/2004
Field Crew:	BH

SUMMARY DATA	
Bankfull Elevation:	696.28
Bankfull Cross-Sectional Area:	2.45
Bankfull Width:	9.97
Flood Prone Area Elevation:	696.95
Flood Prone Width:	240.00
Max Depth at Bankfull:	0.67
Mean Depth at Bankfull:	0.25
W / D Ratio:	40.6
Entrenchment Ratio:	24.07
Bank Height Ratio:	1.00
Slope (ft/ft):	0.004
Discharge (cfs)	3

View of cross-section #2 looking upstream

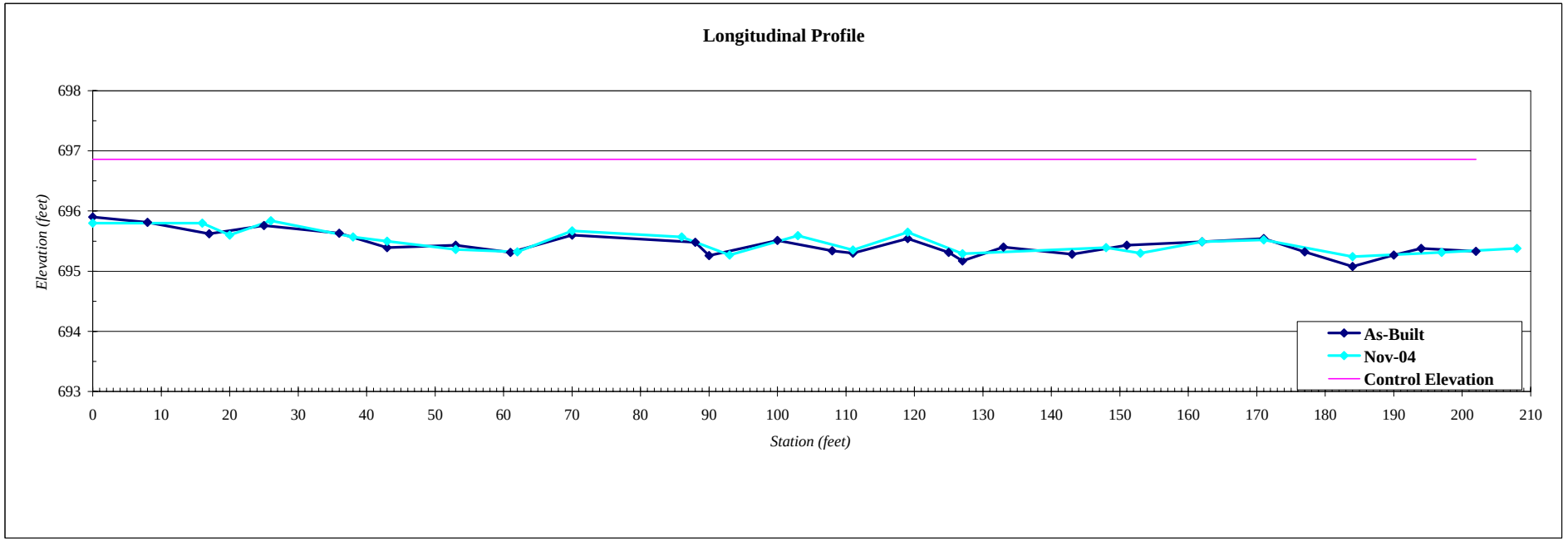
Stream Type:	E5c



Rich Fork Stream Restoration Project
Longitudinal Profile

River Basin:	Yadkin
Watershed:	Rich Fork Creek
Reach:	Mainstem
Profile ID:	Upstream
Date:	November-04
Field Crew:	Hayes
Control Elevation:	696.86

Average Slope:	0.003
As-Built Avg. Depth:	1.42
November Avg. Depth:	1.37

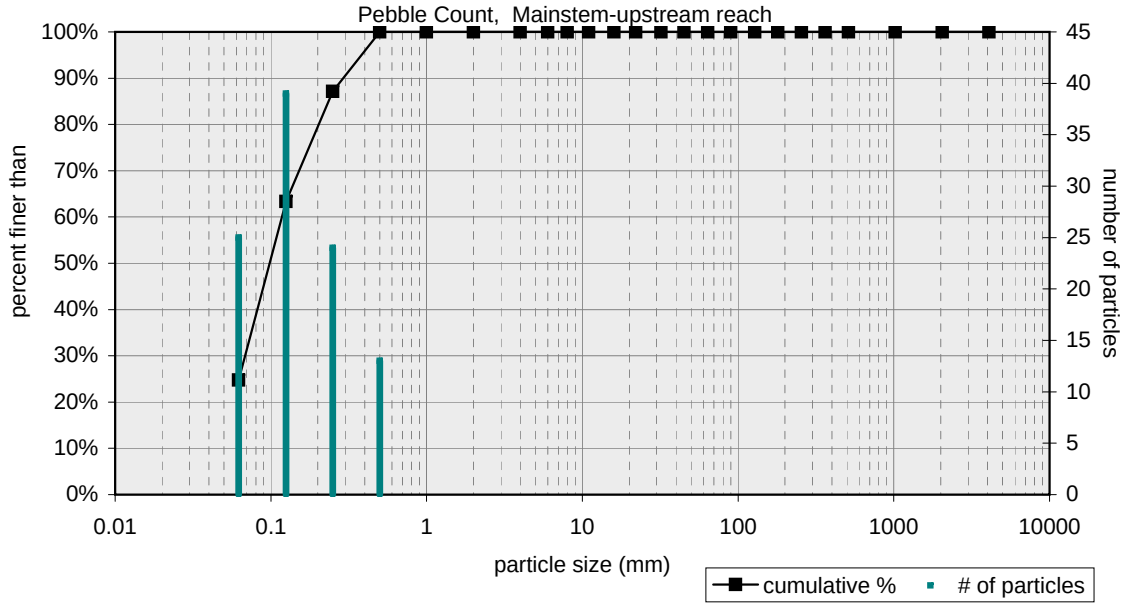


Pebble Count of Channel Reach

Pebble Count,
Mainstem-upstream reach
Rich Fork Creek
High Point, NC
Note: **11/11/2004**

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**25**	##
very fine sand	0.062	0.13	**39**	##
fine sand	0.13	0.25	**24**	##
medium sand	0.25	0.5	**13**	##
coarse sand	0.5	1		##
very coarse sand	1	2		##
very fine gravel	2	4		##
fine gravel	4	6		##
fine gravel	6	8		##
medium gravel	8	11		##
medium gravel	11	16		##
coarse gravel	16	22		##
coarse gravel	22	32		##
very coarse gravel	32	45		##
very coarse gravel	45	64		##
small cobble	64	90		##
medium cobble	90	128		##
large cobble	128	180		##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
		total particle count:	101	

bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	101



based on sediment particles only	size percent less than (mm) D16	D35	D50	D65	D84	D95	particle size distribution gradation	geo mean	std dev
	0.062	0.07	0.1	0	0	0	2.0	0.1	1.9

based on total count	percent by substrate type silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	25%	75%	0%	0%	0%	0%	0%	0%	0%

Rich Fork Creek Stream Monitoring

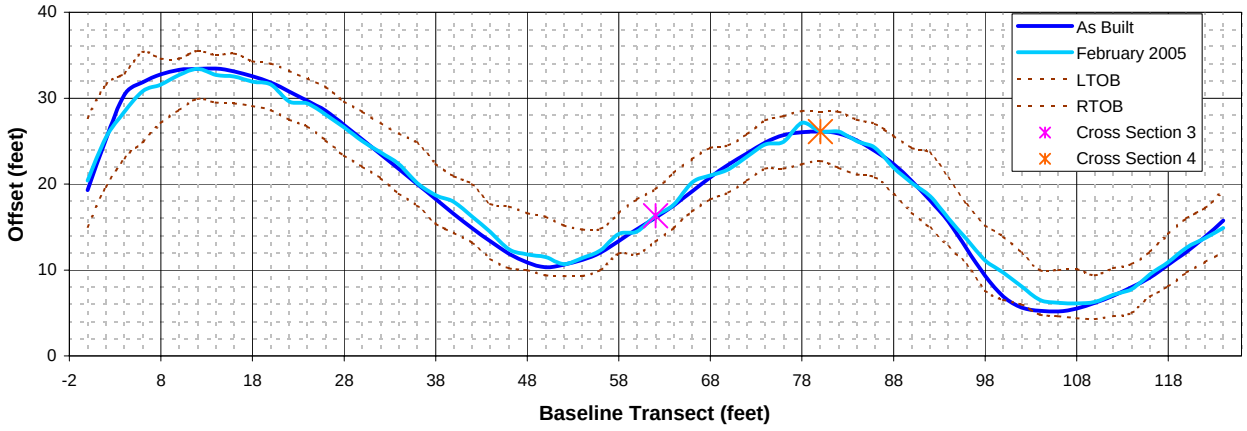
River Basin:	Yadkin
Watershed:	Rich Fork
Planform ID	Main Dwn
Date:	2/15/2005
Field Crew:	AS, MC

SUMMARY DATA	
Stream Segment Length:	149.00
Distance Between Survey Points:	124.00
Distance Between Stations:	2.00
Sinuosity:	1.20
Mean Radius of Curvature:	13.08
Belt Width:	27.30

View of mainstem downstream planform section looking downstream

Stream Type:	E5

Stream Segment Planform



Comments:

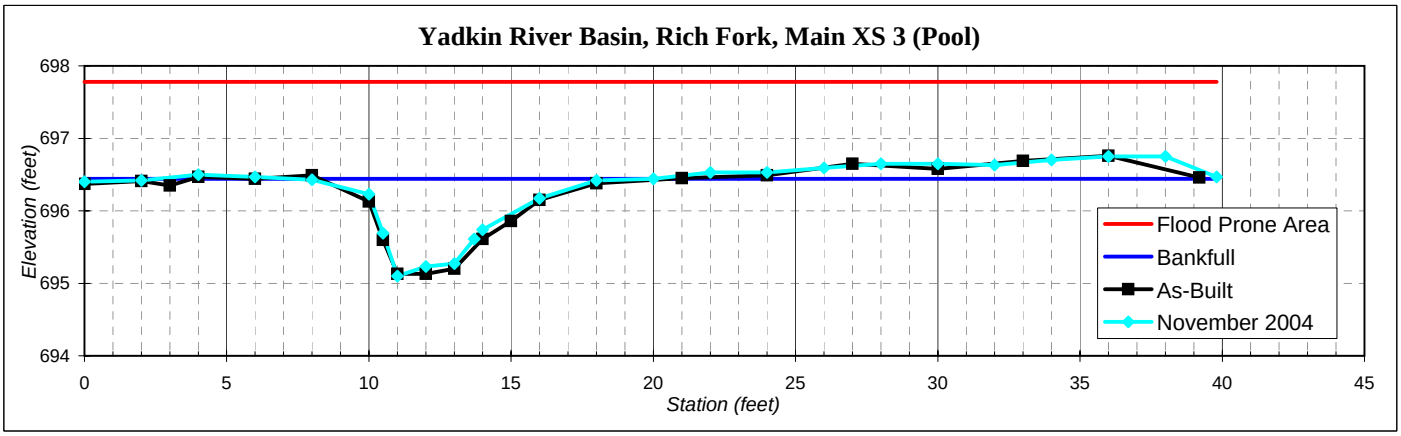
Rich Fork Creek Stream Monitoring

River Basin:	Yadkin
Watershed:	Rich Fork
XS ID	Main XS 3 (Pool)
Reach:	Main Downstream
Date:	11/12/2004
Field Crew:	BH

SUMMARY DATA	
Bankfull Elevation:	696.44
Bankfull Cross-Sectional Area:	5.72
Bankfull Width:	15.00
Flood Prone Area Elevation:	697.78
Flood Prone Width:	180.00
Max Depth at Bankfull:	1.34
Mean Depth at Bankfull:	0.38
W / D Ratio:	39.3
Entrenchment Ratio:	12.00
Bank Height Ratio:	0.99
Slope (ft/ft):	0.005
Discharge (cfs)	11

View of cross-section #3 looking upstream

Stream Type:	E5c



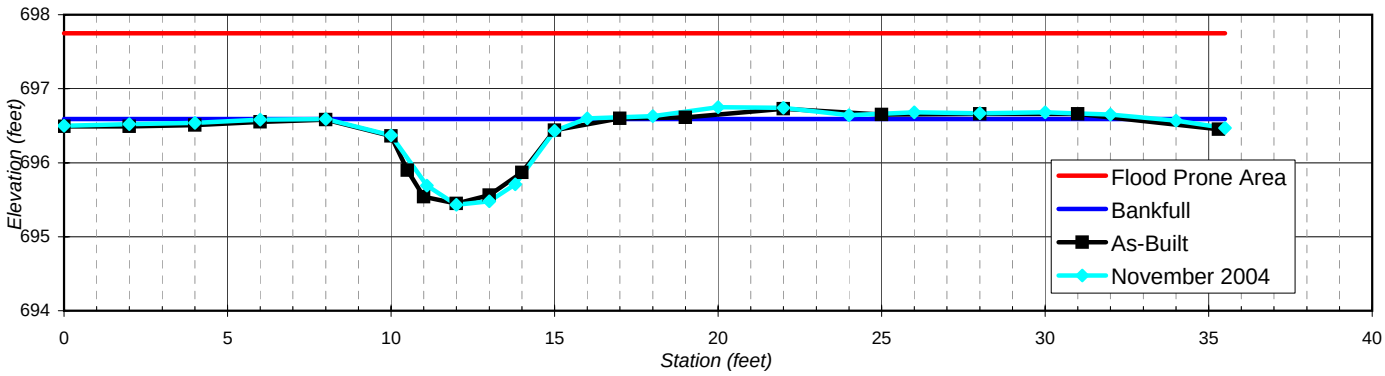
Rich Fork Creek Stream Monitoring

River Basin:	Yadkin
Watershed:	Rich Fork
XS ID	Main XS 4 (Riffle)
Reach:	Main Downstream
Date:	11/12/2004
Field Crew:	BH

SUMMARY DATA	
Bankfull Elevation:	696.59
Bankfull Cross-Sectional Area:	4.85
Bankfull Width:	17.94
Flood Prone Area Elevation:	697.75
Flood Prone Width:	130.00
Max Depth at Bankfull:	1.16
Mean Depth at Bankfull:	0.27
W / D Ratio:	66.3
Entrenchment Ratio:	7.25
Bank Height Ratio:	1.00
Slope (ft/ft):	0.005
Discharge (cfs)	7

View of cross-section #4 looking upstream

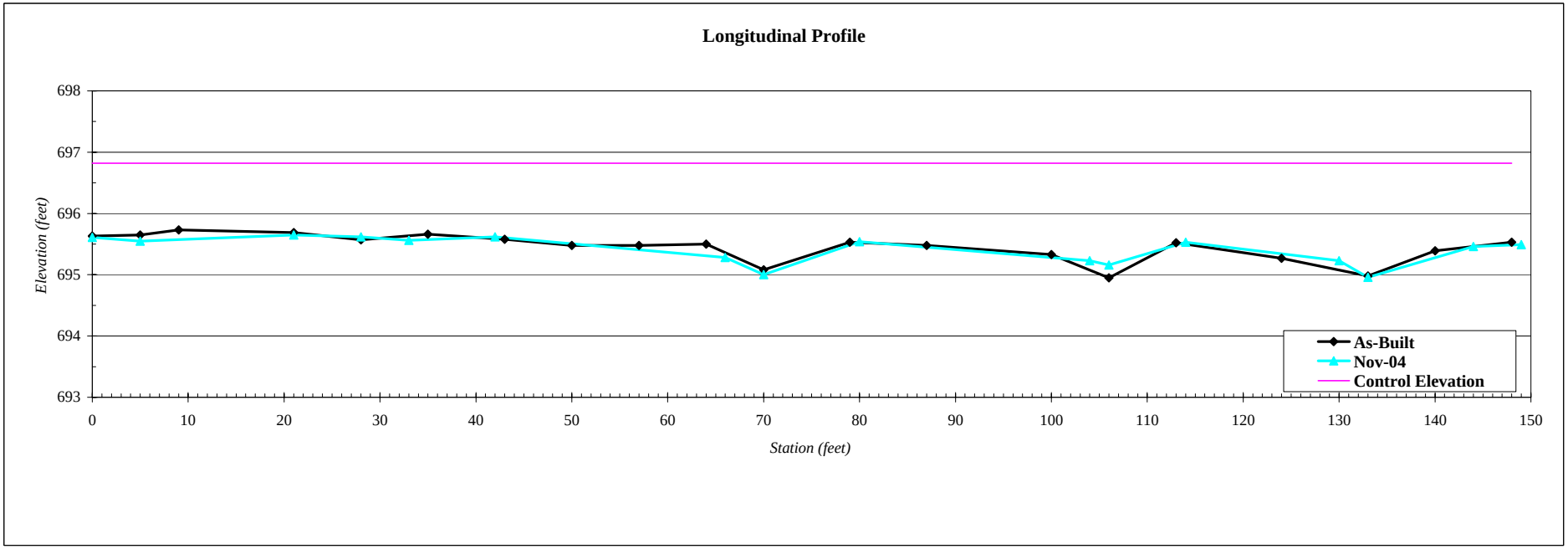
Stream Type:	E5c



Rich Fork Stream Stream Restoration Project
Longitudinal Profile

River Basin:	Yadkin
Watershed:	Rich Fork Creek
Reach:	Mainstem
Profile ID:	Downstream
Date:	November-04
Field Crew:	Hayes
Control Elevation:	696.82

Average Slope:	0.005
As-Built Avg. Depth:	0.87
November Avg. Depth:	0.82

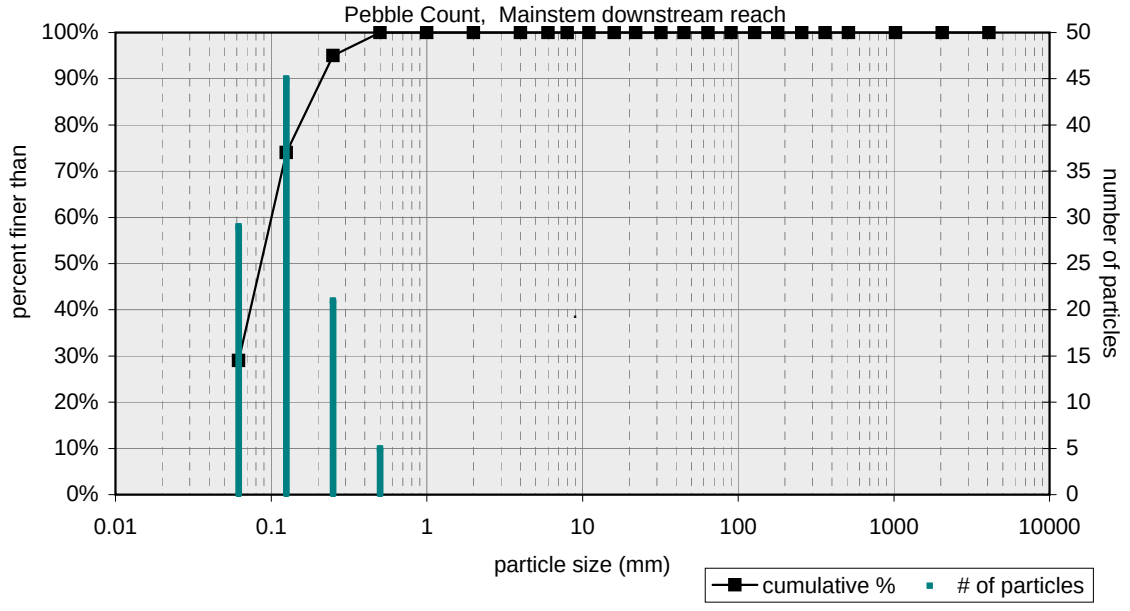


Pebble Count of Channel Reach

Pebble Count,
Mainstem downstream reach
Rich Fork Creek
High Point, NC
Note: **11/12/2004**

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**29**	##
very fine sand	0.062	0.13	**45**	##
fine sand	0.13	0.25	**21**	##
medium sand	0.25	0.5	**5**	##
coarse sand	0.5	1		##
very coarse sand	1	2		##
very fine gravel	2	4		##
fine gravel	4	6		##
fine gravel	6	8		##
medium gravel	8	11		##
medium gravel	11	16		##
coarse gravel	16	22		##
coarse gravel	22	32		##
very coarse gravel	32	45		##
very coarse gravel	45	64		##
small cobble	64	90		##
medium cobble	90	128		##
large cobble	128	180		##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
		total particle count:	100	

bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	100



based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	0.062	0.07	0.1	0	0	0	1.7	0.1	1.7

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	29%	71%	0%	0%	0%	0%	0%	0%	0%

Rich Fork Creek Stream Monitoring

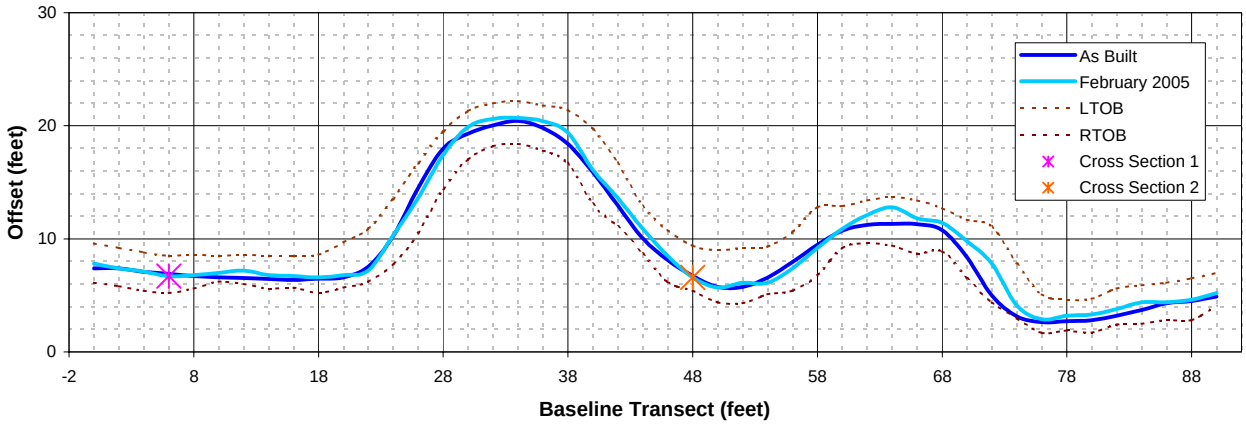
River Basin:	Yadkin
Watershed:	Rich Fork
Planform ID	Trib Up
Date:	2/15/2005
Field Crew:	AS, MC

SUMMARY DATA	
Stream Segment Length:	112.00
Distance Between Survey Points:	90.00
Distance Between Stations:	2.00
Sinuosity:	1.24
Mean Radius of Curvature:	7.39
Belt Width:	17.80

View of tributary upstream planform section looking downstream

Stream Type:	E5

Stream Segment Planform



Comments:

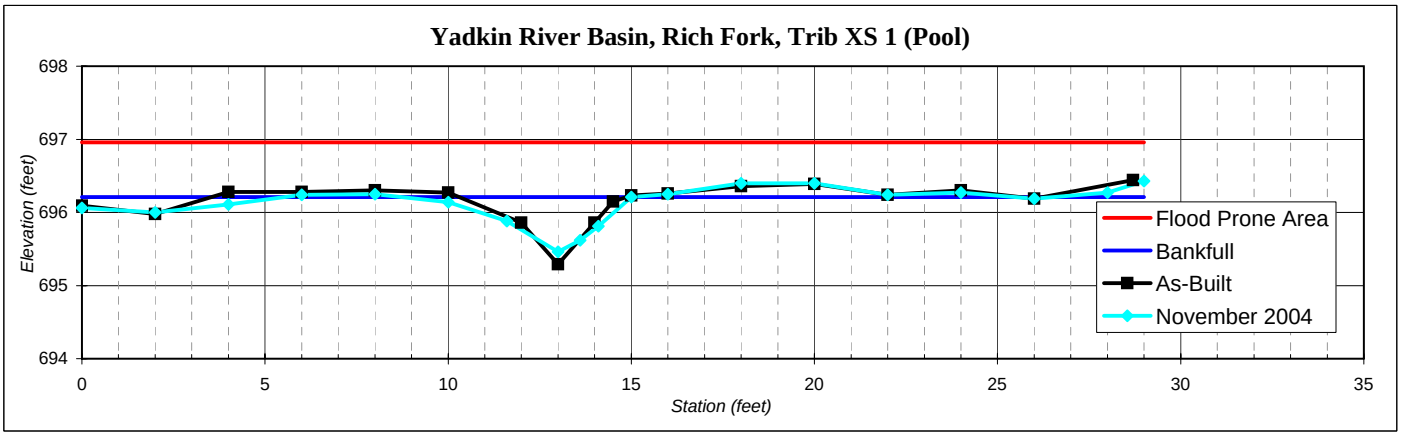
Rich Fork Creek Stream Monitoring

River Basin:	Yadkin
Watershed:	Rich Fork
XS ID	Trib XS 1 (Pool)
Reach:	Trib Upstream
Date:	11/17/2004
Field Crew:	BH

SUMMARY DATA	
Bankfull Elevation:	696.21
Bankfull Cross-Sectional Area:	2.71
Bankfull Width:	12.81
Flood Prone Area Elevation:	696.96
Flood Prone Width:	180.00
Max Depth at Bankfull:	0.75
Mean Depth at Bankfull:	0.21
W / D Ratio:	60.6
Entrenchment Ratio:	14.05
Bank Height Ratio:	1.00
Slope (ft/ft):	0.006
Discharge (cfs)	4

View of cross-section #3 looking upstream

Stream Type:	E5c



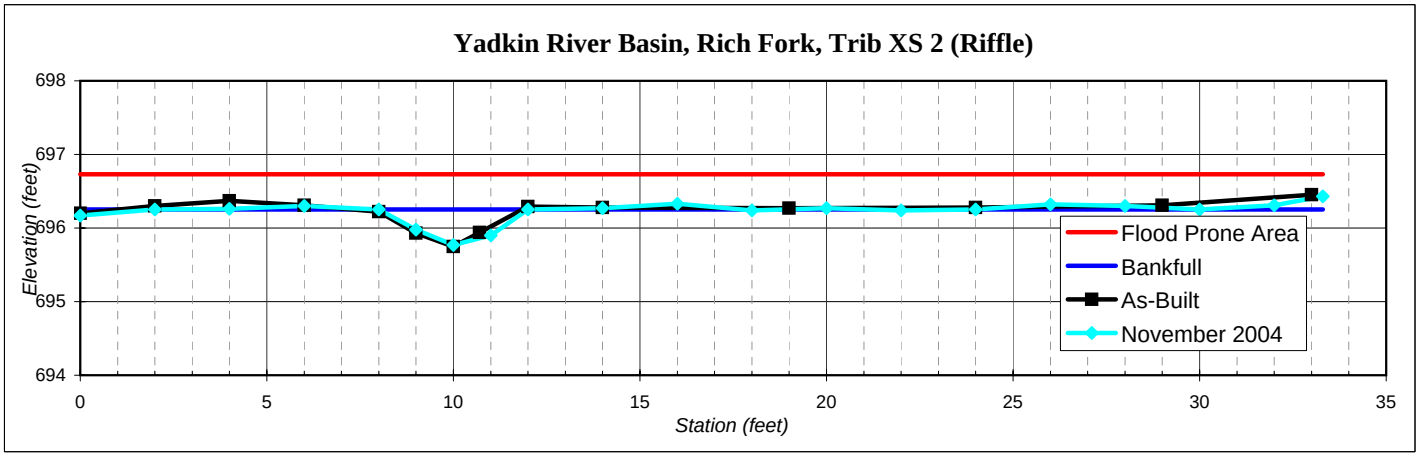
Rich Fork Creek Stream Monitoring

River Basin:	Yadkin
Watershed:	Rich Fork
XS ID	Trib XS 2 (Riffle)
Reach:	Trib Upstream
Date:	11/17/2004
Field Crew:	BH

SUMMARY DATA	
Bankfull Elevation:	696.25
Bankfull Cross-Sectional Area:	1.20
Bankfull Width:	9.56
Flood Prone Area Elevation:	696.73
Flood Prone Width:	240.00
Max Depth at Bankfull:	0.48
Mean Depth at Bankfull:	0.13
W / D Ratio:	76.2
Entrenchment Ratio:	25.12
Bank Height Ratio:	1.00
Slope (ft/ft):	0.006
Discharge (cfs)	1

View of cross-section #4 looking upstream

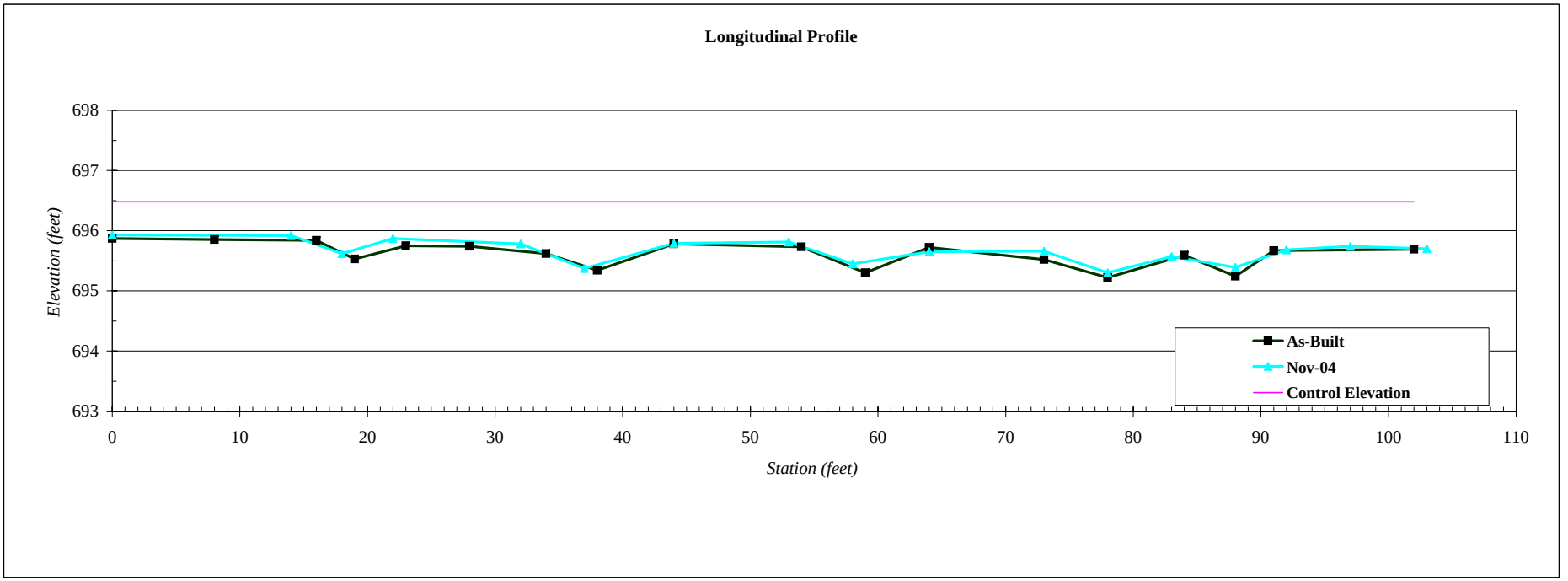
Stream Type:	E5c



Rich Fork Stream Restoration Project
Longitudinal Profile

River Basin:	Yadkin
Watershed:	Rich Fork Creek
Reach:	Tributary
Profile ID:	Upstream
Date:	November-04
Field Crew:	Hayes
Control Elevation:	696.48

Average Slope:	0.006
As-Built Avg. Depth:	0.87
November Avg. Depth:	0.82

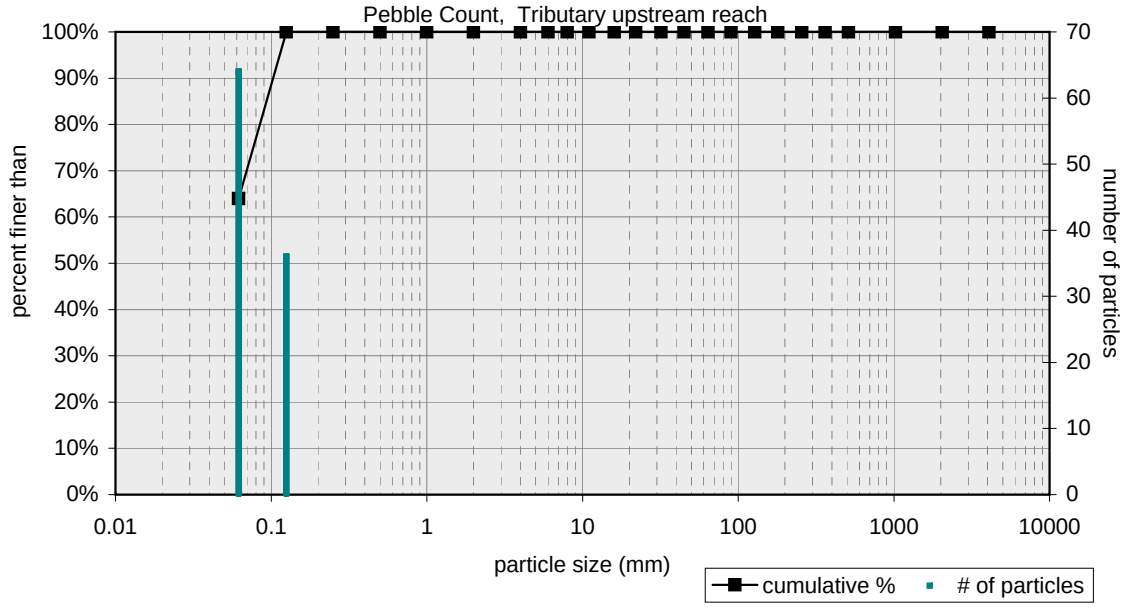


Pebble Count of Channel Reach

Pebble Count,
Tributary upstream reach
Rich Fork Creek
High Point, NC
Note: **11/17/2004**

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**64**	##
very fine sand	0.062	0.13	**36**	##
fine sand	0.13	0.25		##
medium sand	0.25	0.5		##
coarse sand	0.5	1		##
very coarse sand	1	2		##
very fine gravel	2	4		##
fine gravel	4	6		##
fine gravel	6	8		##
medium gravel	8	11		##
medium gravel	11	16		##
coarse gravel	16	22		##
coarse gravel	22	32		##
very coarse gravel	32	45		##
very coarse gravel	45	64		##
small cobble	64	90		##
medium cobble	90	128		##
large cobble	128	180		##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
		total particle count:	100	

bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	100



based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	0.062	0.06	0.1	0	0	0	1.2	0.1	1.2

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	64%	36%	0%	0%	0%	0%	0%	0%	0%

Rich Fork Creek Stream Monitoring

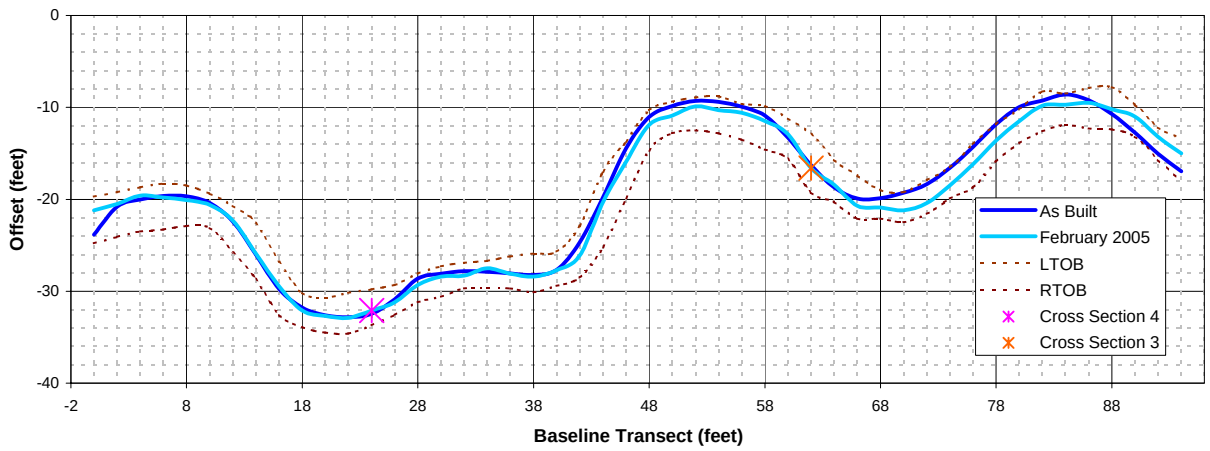
River Basin:	Yadkin
Watershed:	Rich Fork
Planform ID	Trib Dwn
Date:	2/15/2005
Field Crew:	AS, MC

SUMMARY DATA	
Stream Segment Length:	127.00
Distance Between Survey Points:	94.00
Distance Between Stations:	2.00
Sinuosity:	1.35
Mean Radius of Curvature:	7.27
Belt Width:	23.40

View of tributary downstream planform section looking downstream

Stream Type:	E5

Stream Segment Planform



Comments:

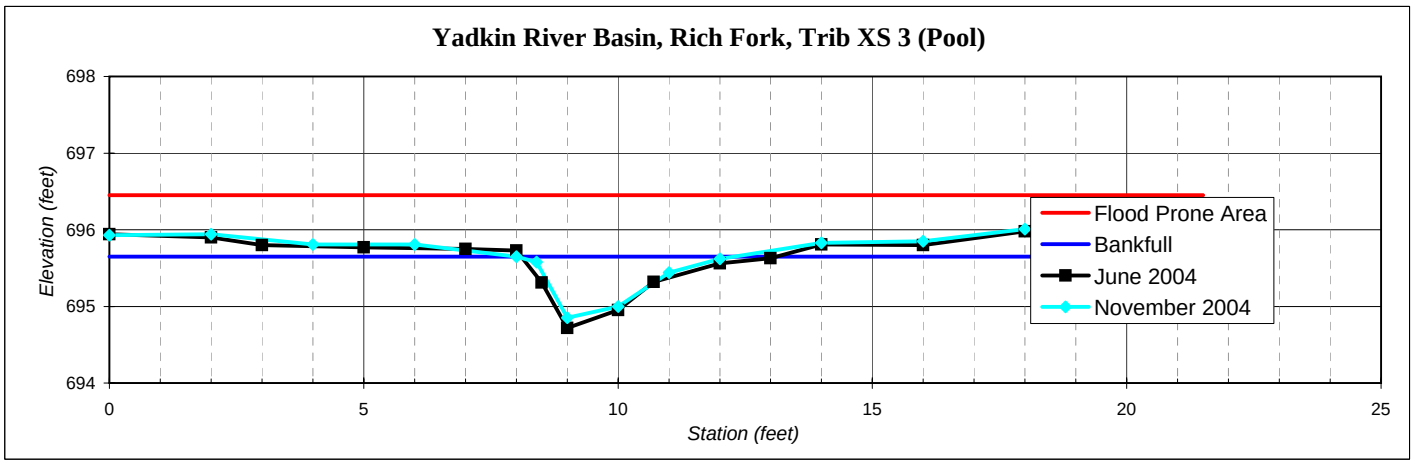
Rich Fork Creek Stream Monitoring

XS ID	Trib XS 3 (Pool)
Reach:	Trib Downstream
Date:	11/17/2004
Field Crew:	BH

SUMMARY DATA	
Bankfull Elevation:	695.65
Bankfull Cross-Sectional Area:	1.55
Bankfull Width:	4.29
Flood Prone Area Elevation:	696.45
Flood Prone Width:	240.00
Max Depth at Bankfull:	0.80
Mean Depth at Bankfull:	0.36
W / D Ratio:	11.8
Entrenchment Ratio:	56.00
Bank Height Ratio:	1.00
Slope (ft/ft):	0.006
Discharge (cfs)	3

View of cross-section #1 looking upstream

Stream Type:	E6c



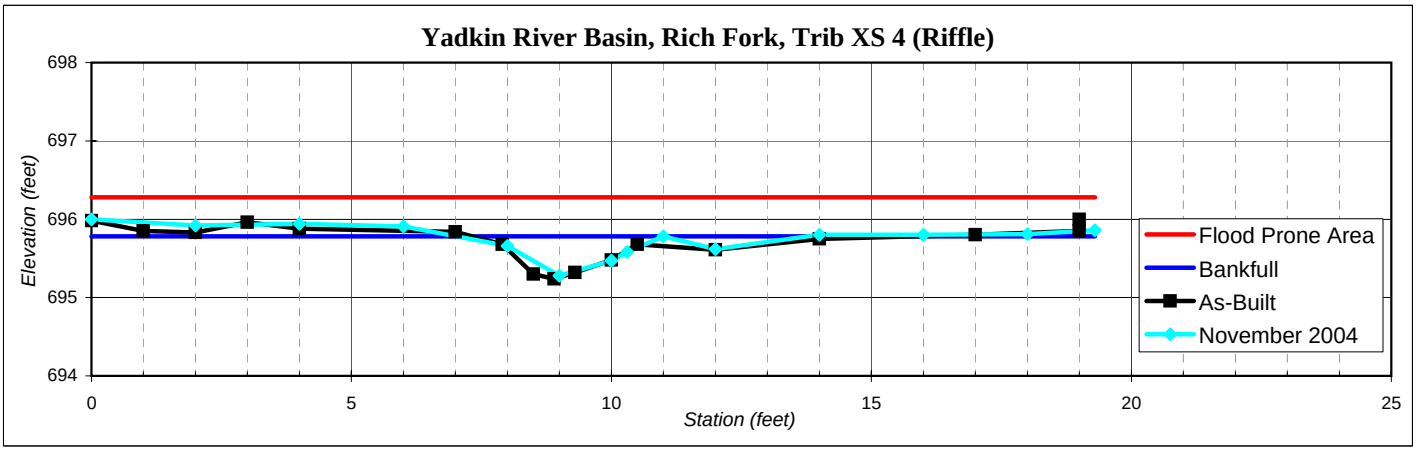
Rich Fork Creek Stream Monitoring

River Basin:	Yadkin
Watershed:	Rich Fork
XS ID	Trib XS 4 (Riffle)
Reach:	Trib Downstream
Date:	11/17/2004
Field Crew:	BH

SUMMARY DATA	
Bankfull Elevation:	695.78
Bankfull Cross-Sectional Area:	1.14
Bankfull Width:	6.74
Flood Prone Area Elevation:	696.28
Flood Prone Width:	240.00
Max Depth at Bankfull:	0.50
Mean Depth at Bankfull:	0.17
W / D Ratio:	39.8
Entrenchment Ratio:	35.62
Bank Height Ratio:	1.00
Slope (ft/ft):	0.006
Discharge (cfs)	1

View of cross-section #2 looking upstream

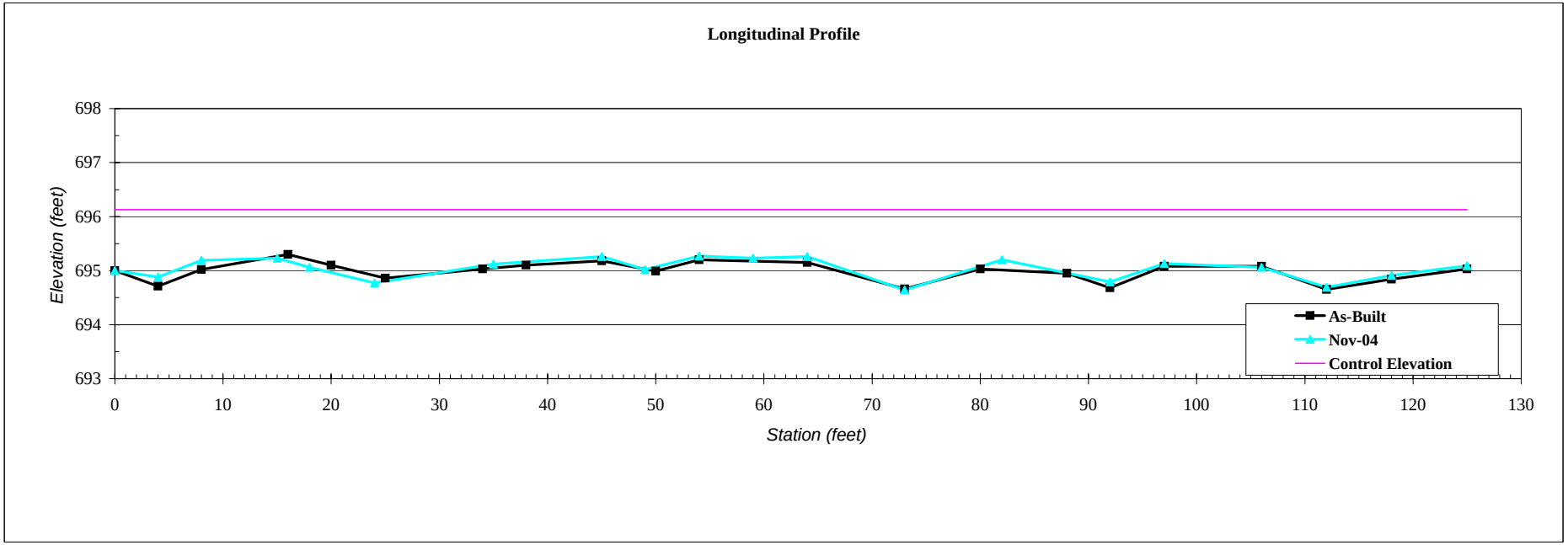
Stream Type:	E5c



Rich Fork Stream Restoration Project
Longitudinal Profile

River Basin:	Yadkin
Watershed:	Rich Fork Creek
Reach:	Tributary
Profile ID:	Downstream
Date:	November-04
Field Crew:	Hayes
Control Elevation:	696.13

Average Slope:	0.005
As-Built Avg. Depth:	1.15
November Avg. Depth:	1.09

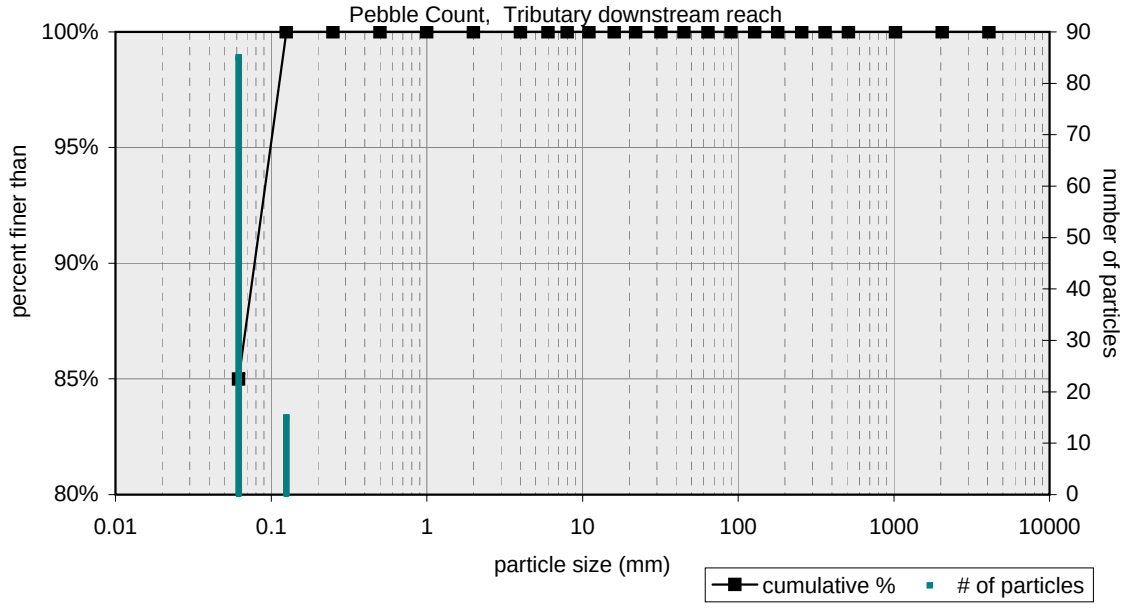


Pebble Count of Channel Reach

Pebble Count,
Tributary downstream reach
Rich Fork Creek
High Point, NC
Note: **11/17/2004**

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**85**	##
very fine sand	0.062	0.13	**15**	##
fine sand	0.13	0.25		##
medium sand	0.25	0.5		##
coarse sand	0.5	1		##
very coarse sand	1	2		##
very fine gravel	2	4		##
fine gravel	4	6		##
fine gravel	6	8		##
medium gravel	8	11		##
medium gravel	11	16		##
coarse gravel	16	22		##
coarse gravel	22	32		##
very coarse gravel	32	45		##
very coarse gravel	45	64		##
small cobble	64	90		##
medium cobble	90	128		##
large cobble	128	180		##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
		total particle count:	100	

bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	100



based on sediment particles only	size percent less than (mm) D16	D35	D50	D65	D84	D95	particle size distribution gradation	geo mean	std dev
	0.062	0.06	0.1	0	0	0	1.0	0.1	1.0

based on total count	percent by substrate type silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	85%	15%	0%	0%	0%	0%	0%	0%	0%

Appendix D
Benthic Macroinvertibrate Report

ECOLOGIC
Engineering/Construction

4321-A S. Elm-Eugene St. • Greensboro, NC 27406
(336) 335-1108 • Fax 335-3141
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February 10, 2005

Steven Stokes
KCI Associates of NC
Landmark Center I, Suite 220
4601 Six Forks Road
Raleigh, NC, 27609-5210

RE: Rich Fork Creek-Benthic Macroinvertibrate Sampling Results (Addendum to EcoLogic Report dated January 10, 2005)

Dear Steven:

The results from the benthic macroinvertibrate sampling we conducted at Rich Fork Creek are enclosed. We can provide you with a digital file of the results if you wish.

According to the data you shared with us, the benthic samples from pre-construction (February 12, 2002) were collected at three locations: upstream, mid-project and downstream. The data indicated a total of 26 species collected in all three samples. The upstream sample had 9 species, mid-project 6 species and downstream 16 species. The Tolerance Values ranged from 2.76 to 10.0, with the average being fairly high, indicating poor water quality. The Functional Feeding Groups seemed to be well represented and indicate at least a basic ecological function in the aquatic zone.

The samples collected by us post-construction (December 17, 2004) included the same reference sample upstream of the restoration and three (3) samples within the restoration reach. We sampled the main restoration channel, the restored tributary and the confluence of the restoration reaches just upstream of their confluence with Rich Fork Creek. We collected samples at the same locations as the physical monitoring transects.

The benthic lab results from the post-construction sampling identified a total of 41 species. The upstream sample had 10 species, the main channel 17, the restored tributary 18, and the confluence 13. Only two (2) species occur in all samples, three (3) species are found only in the restoration reaches, and all restored reaches have more taxa than the upstream reference reach. In addition, all restored reaches have more species diversity than the pre-construction samples. The most common single species pre-construction was also the most common species post-construction. The Tolerance Values range from 4.3 to 10.0 and, combined with the abundance values, give a Biotic Index of the restoration reaches between 6.77 and 7.63, which indicates water of generally poor quality. The Functional Feeding Group assessment shows a diversity of all feeding group types, indicating an ecological function comparable or slightly better than the

pre-construction channel. This is a promising situation for such a recently constructed restoration project.

It was evident during post-construction collection that the aquatic habitat within the restoration reaches was not very diverse. There is essentially no large woody debris, leaf-packs or large particles within any of the sampled areas. The low slope of the channel also allows very fine sediments to accumulate throughout the restored channels. The upstream reach is impacted by little or no riparian buffer, grazing farm animals with direct access to the creek, and headwaters dominated by a small pond.

The aquatic ecosystem is off to a good start and should improve as the riparian buffer and aquatic habitats mature. The aquatic system appears to have improved in benthic diversity since the pre-construction sampling. In addition, we observed large numbers of vertebrates (fish and amphibians) during the benthic sampling, which indicates a well functioning aquatic ecology.

If you have further questions regarding this assessment, please feel free to call. If we can be of further assistance to you on this or any other project, please let us know.

Sincerely,

EcoLogic Associates, P.C

for Kenneth A. Bridle, Ph.D.
Principal Biologist

Enclosure

BENTHIC MACROINVERTEBRATES COLLECTED FROM RICH FORK CREEK BASIN, DAVIDSON COUNTY, NORTH CAROLINA.

SPECIES	T.V.	F.F.G.	STA. 1 Main Channel	STA. 2 Trib.	Sta. 3 Confluence	Sta. 4 Upper Reach
MOLLUSCA						
Gastropoda						
Basommatophora						
Physidae						
Physella sp.	**8.8**	**CG**	2	5	3	2
ANNELIDA						
Oligochaeta	***10**	**CG**				
Tubificida						
Naididae	***8**	**CG**	2	1		
ARTHROPODA						
Crustacea						
Cladocera						
Daphnidae						
Ceriodaphnia sp.				1		
Copepoda				2		
Amphipoda						
Crangonyctidae						
Crangonyx sp.	**7.9**	**CG**				13
Decapoda						
Cambaridae	**7.5**					2
Cambarus sp.	**7.6**	**P**		1		
Insecta						
Ephemeroptera						
Baetidae		**CG**				
Centroptilum sp.	**6.6**	**CG**		2		
Ephemerellidae		**SC**				
Eurylophella sp.	**4.3**	**SC**	1	1		
Heptageniidae		**SC**				
Stenonema modestum	**5.5**	**SC**			7	
Leptophlebiidae		**CG**				
Leptophlebia sp.	**6.2**	**CG**	19	19	3	2
Odonata						
Aeshnidae		**P**				
Boyeria vinosa	**5.9**	**P**			1	
Coenagrionidae	***9**	**P**		1		
Argia sp.	**8.2**	**P**	1			1
Ischnura sp.	**9.5**		3			
Gomphidae		**P**				
Gomphus sp.	**5.8**	**P**			1	
Progomphus sp.					4	
Libellulidae		**P**				
Libellula sp.	**9.6**	**P**		3		
Plathemis sp.			5			
Plecoptera						
Perlodidae		**P**				
Clioperla clio	**4.7**	**P**			1	
Hemiptera						
Belostomatidae						

BENTHIC MACROINVERTEBRATES COLLECTED FROM RICH FORK CREEK BASIN, DAVIDSON COUNTY, NORTH CAROLINA.

SPECIES	T.V.	F.F.G.	STA. 1 Main Channel	STA. 2 Trib.	Sta. 3 Confluence	Sta. 4 Upper Reach
Belostoma sp.	**9.8**	**P**	1			
Corixidae	**9**	**PI**		1		
Trichoptera						
Phryganeidae		**SH**				
Ptilostomis sp.	**6.4**	**SH**	1	5	2	
Coleoptera						
Haliplidae						
Peltodytes sp.	**8.7**	**SH**		2		
Diptera						
Chironomidae						
Chaetocladius sp.	***6**	**CG**		2		
Chironomus sp.	**9.6**	**CG**	1		1	
Clinotanypus pinguis	**8.7**	**P**	1			1
Conchapelopia sp.	**8.4**	**P**	3		1	
Cricotopus bicinctus	**8.5**	**CG**	1			
Cricotopus sp.	***7**	**CG**				2
Cryptochironomus sp.	**6.4**	**P**			1	
Dicrotendipes neomodestus	**8.1**	**CG**	1			
Diplocladius cultriger	**7.4**	**CG**				3
Polypedilum fallax	**6.4**	**SH**			1	
Polypedilum illinoense	**9**	**SH**		5		
Procladius sp.	**9.1**	**P**	8			
Rheotanytarsus sp.	**5.9**	**FC**	1			
Tanypus sp.	**9.2**	**P**		2		
Tanytarsus sp.	**6.8**	**FC**		2	1	
Simuliidae		**FC**				
Simulium sp.	**6**	**FC**				5
Tipulidae		**SH**				
Tipula sp.	**7.3**	**SH**	1	1		2
TOTAL NO. OF ORGANISMS			**52**	**56**	**27**	**33**
TOTAL NO. OF TAXA			**17**	**18**	**13**	**10**
BIOTIC INDEX ASSIGNED VALUES			**7.63**	**7.45**	**6.77**	**7.47**

Appendix E
Permanent Photo Documentation Points

Photo Location 1: View looking toward large cedar and restored channel at confluence with Rich Fork Creek

Photo Location 2: View looking toward large cedar and vegetation monitoring plot #6 identified by yellow flag.

Photo Location 2: View looking toward vegetation-monitoring plot #1 identified by a yellow flag in left corner of the photo.

Photo Location 3: View looking east along the wetland preservation area.

Photo Location 4: View looking east with large cedar shown in the upper left corner of the photo.

Photo Location 5: View looking north toward tree line of wetland preservation area.

Photo Location 6: View looking west toward large cedar.

Photo Location 6: View looking from Rich Fork toward photo point #2 at the spoil pile.