Cato Farms Stream Restoration
Project No. 72
2008 Monitoring Report (Final): Year 4 of 5

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EXECUTIVE SUMMARY

Executive Summary

The Cato Farms Stream Restoration Project is located in Mecklenburg County, North Carolina. The stream restoration project consisted of restoring 2,444 linear feet of an unnamed tributary (UT) to Clark Creek, restoring the associated riparian zone, providing one cattle crossing, and fencing the riparian corridor to exclude cattle grazing. The following goals for the Cato Farms Stream Restoration Project were established through the North Carolina Ecosystem Enhancement Program (NCEEP).

1. Restore the stream to a stable form.
2. Restore the riparian zone adjacent to the stream.
3. Provide fencing to prevent cattle from entering the riparian area.

The Cato Farms Stream Restoration Project was restored by relocating approximately 1,833 linear feet (Reach 1) of the existing channel to establish an E-type channel (Priority 1). In addition, approximately 611 linear feet (Reach 2) of stream was restored in-place to create a B-type channel (Priority 3) to transition the channel to the confluence elevation with Clark Creek. The total stream linear footage of 2,444 represents the centerline footage, not the thalweg footage as provided in the as-built plans and is correct to exclude the 20 ft cattle crossing (bridge easement). Cato Farm's riparian areas were planted to improve habitat and stabilize streambanks. The entire site was fenced in to exclude cattle access to the UT and a cattle crossing was established at the lower end of the project. This report serves as year 4 of the 5 year monitoring plan for the Cato Farms Stream Restoration Site.

The 2008 vegetation plot monitoring results indicate that the Cato Farms Site appears to be meeting vegetation success criteria. Planted and naturally recruited vegetation is doing well at the site, although some minor vegetation problems were noted. Several small barren areas and a high live stake mortality was observed along the streambanks. The high live stake mortality observed could be from being planted in compacted soil, planted too high on the banks, or planted too late in the growing season. The survival rate for the 2008 woody vegetation monitored is 75%. The monitoring data indicates an average of 15 stems per plot. Using the monitoring plot's size of 10m x 10m (0.025 ac), the site density is approximately 520 planted stems per acre. The success goal for planted woody vegetation requires 320 stems per acre for year 4.

Results from the 2008 stream monitoring effort indicate that Cato Farms is maintaining vertical and lateral stability. The pattern, profile, and dimension of the restored channel appear to be stable. However, channel thalweg conditions appear to be shifting due to in-stream vegetation growth. Throughout the entire reach, vegetation is growing in the middle of the channel, creating mid-channel bars and abnormal flow conditions. Typically, areas of instability noted from the 2008 monitoring year, which are re-occurring conditions do not appear to have advanced from the conditions observed in the 2007 monitoring year.

Overall, the Cato Farms Stream Restoration Project appears to be stable and has met stream and vegetation goals for monitoring year 4.

SECTION 1
PROJECT BACKGROUND

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PROJECT BACKGROUND

The background information provided in this report is referenced from the previous reports prepared by CH2MHill (2002) and North Carolina State University (2005).

1.1 Location and Setting

The Cato Farms Stream Restoration Project is located at the Cato Farms Property in Mecklenburg County, North Carolina immediately south of Huntersville-Concord Road just east of the Town of Huntersville (Figure 1.1). The stream restoration project consisted of restoring 2,444 linear feet of an UT to Clark Creek, restoring the associated riparian zone, providing one cattle crossing, and fencing the riparian corridor to exclude cattle access.

To access the site from Charlotte, take Interstate 77 North to Exit 23 (Gilead Road) and turn right off the exit heading east. Gilead Road will turn into Huntersville-Concord Road. Take Huntersville-Concord Road from this point for approximately 2 miles. Huntersville-Concord Road will cross the UT at a low point in the road. The tributary is located approximately 1,000 feet downstream from where Huntersville-Concord Road crosses the UT to Clark Creek.

1.2 Mitigation Structure and Objectives

The UT to Clark Creek is located within the Southern Outer Piedmont Physiographic Region. The UT site drains approximately 0.41 square miles to Clark Creek, within the Yadkin-Pee Dee River Basin (HUC 3040105). The UT runs through the agricultural property of William Cato and family. Prior to restoration, the site was predominantly utilized for cattle grazing. Historically, the land was cleared to provide pasture land, with access to the stream for cattle watering. The UT appears to previously have been channelized/straightened, and ditches were created to drain adjacent wetlands. These activities are thought to have inhibited stream channel stability; therefore, producing an incised, eroded stream. Furthermore, the channel incision may have caused adjacent hydric soils to become less saturated. The following goals were established for the Cato Farms Stream Restoration Project.

1. Restore the stream to a stable form.
2. Restore the riparian zone adjacent to the stream.
3. Provide a crossing for cattle at one location along the project reach.
4. Provide fencing to exclude cattle access to the UT and the riparian areas.

The Cato Farms Stream Restoration Project was restored by relocating approximately 1,833 linear feet (Reach 1) of the existing channel to establish an E-type channel (Priority 1) and restoring in-place approximately 611 linear feet (Reach 2) to create a B-type channel (Priority 3) to transition the channel to the confluence elevation with Clark Creek. The total stream linear footage of 2,444 represents the centerline footage, not the thalweg footage as provided in the as-

built plans and is correct to exclude the 20 ft cattle crossing (bridge easement). Cato Farm's riparian areas were planted to improve habitat and stabilize streambanks.

A sinuous, stable pattern, with riffle-pool bed features was constructed. Cross vanes and constructed riffles were installed to provide bank stabilization and maintain grade control. Riparian vegetation were preserved by fencing in the entire site to exclude cattle access to the UT and establishing a cattle crossing at the lower end of the project (Table 1.1). Riparian areas along Reach 1 were planted with native grasses and woody stem vegetation. Streambanks were stabilized with geotextile matting, native grasses, and live stakes. Reach 2 was soil bioengineered (live staked) with shrubs.

Table 1.1
Project Mitigation Structure and Objectives
Cato Farms Stream Restoration/Project No. 72

Segment/Reach	Mitigation Type	Approach	Linear Footage or Acres	Stationing (ft)*	Comments
Reach 1	Restoration	P1	1,833 linear feet	0+00-18+33	Channel restoration, relocation with use of grade control and bank protection structures.
Reach 2	Transition	P3	611 linear feet	18+33-24+44	Channel restoration, in-place with use of grade control and bank protection structures.

Component Summations

Restoration Level	Stream (lf)	Wetland (ac)		Upland (ac)	Buffer (ac)	BMP
		Riparian	Non-Riparian			
Restoration (R)	2,444	N/A	N/A	N/A	N/A	N/A
Enhancement (E)	N/A	N/A	N/A	N/A	N/A	N/A
Enhancement I (E)	N/A	N/A	N/A	N/A	N/A	N/A
Enhancement II (E)	N/A	N/A	N/A	N/A	N/A	N/A
Creation (C)	N/A	N/A	N/A	N/A	N/A	N/A
Preservation (P)	N/A	N/A	N/A	N/A	N/A	N/A
HQ Preservation (P)	N/A	N/A	N/A	N/A	N/A	N/A
Totals	**2,444**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

*Stationing linear footage represents the centerline footage, not the thalweg footage and is correct to exclude the 20 ft cattle crossing (bridge easement).

1.3 Project History and Background

The stream restoration was designed by CH2MHill. Monitoring has been conducted annually from 2005 to present. This report serves as the 4th year of the 5 year monitoring plan for the Cato Farms Stream Restoration Site. Tables 1.2 and 1.3 provide detailed project activity, history and contact information for this project. Table 1.4 provides more in-depth watershed/site background for the UT to Clark Creek.

Table 1.2
Project Activity and Reporting History
Cato Farms Stream Restoration/Project No. 72

Activity or Report	Data Collection Completed	Actual Completion or Delivery
Restoration Plan	N/A	July 2002
Final Design-90%	N/A	November 2002
Construction	N/A	N/A
Temporary S&E mix applied to entire project area*	N/A	N/A
Permanent seed mix applied to reach	N/A	N/A
Mitigation Plan/ As-Built (Year 0 Monitoring)	N/A	Summer 2004
Year 1 Monitoring	June 2005	January 2005
Year 2 Monitoring	September 2006	November 2006
Year 3 Monitoring	August 2007	November 2007
Year 4 Monitoring	June 2008	November 2008
Year 5 Monitoring	TBD	TBD
*Seed and mulch are added as each section of construction is completed.		

Table 1.3
Project Contacts
Cato Farms Stream Restoration/Project No. 72

Designer	CH2MHill 4824 Parkway Plaza Boulevard, Suite 200 Charlotte, NC 28217
Contractor's Name	Unknown
Planting Contractor	Unknown
Seeding Contractor	Unknown
Monitoring Performers	Jordan, Jones, & Goulding 9101 Southern Pine Blvd., Suite 160 Charlotte, NC 28273
Stream Monitoring, POC	Kirsten Young, 704-527-4106 ext.246
Vegetation Monitoring, POC	

Table 1.4
Project Background
Cato Farms Stream Restoration/Project No. 72

Project County	Mecklenburg, North Carolina
Drainage Area	0.41 sq. mi
Drainage impervious cover estimate	< 5%
Stream Order	1st
Physiographic Region	Piedmont
Ecoregion	Southern Outer Piedmont
Rosgen Classification of As-built	E (~2,000 ft) B (~500 ft)
Cowardin Classification	N/A
Dominant soil types	Monacan, Cecil, Enon, Iredell, Helena, and Wilkes
Reference site ID	Coffey Creek UT to Little Sugar Creek
USGS HUC for Project and Reference	3040105
NCDWQ Sub-basin for Project and Reference	03-07-11
NCDWQ classification for Project and Reference	C
Any portion of any project segment 303d list?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reason for 303d listing or stressor?	N/A
% of project easement fenced?	100%

1.4 Monitoring Plan View

The monitoring plan view map (Figure 1.2) illustrates the location of the longitudinal profile stations, cross-section stations, vegetation plots, and photo points. A total of six cross-sections were previously established within Reach 1 and 2. Approximately 2,147 linear feet of longitudinal profile was monitored. Eight previously established vegetation plots were monitored in 2008. Photographs were taken upstream and downstream at each cross-section and at existing photo points.

SECTION 2

PROJECT CONDITION AND MONITORING RESULTS

SECTION 2

PROJECT CONDITION AND MONITORING RESULTS

The following monitoring results are from the 2008 (year 4 of 5) survey completed in June 2008.

2.1 Vegetation Assessment

Eight previously established vegetation monitoring plots were monitored within the riparian buffer of the Cato Farm Stream Restoration Project. Vegetation assessments were conducted following the NCEEP 2004 Stem Counting Protocol which consists of counting woody stems within the established vegetation plots. Planted zones related to the stream restoration consist of the streambank and the buffer area adjacent to the stream. The riparian zone begins at the top of bank and proceeds perpendicular to the stream. The planted streambank initiates at base flow elevation and extends to the top of bank. The overall success of these two particular planted zones is good. Live stakes (*Salix nigra* and *Cornus amomum*) and herbaceous species (*Carex* sp., *Juncus* sp., and *Panicum* sp.) along the streambank are healthy and abundant, with the exception of a few small areas. The riparian buffer is dominated by a thick herbaceous layer with numerous shrubs and saplings throughout. Natural recruitment vegetation continues to be dominant. This is likely due to the native seed bank.

Overall, planted and naturally recruited vegetation is doing well at the site. Some minor vegetation problems were noted. There are several small barren areas and high live stake mortality observed along the streambanks. The high live stake mortality observed could be from being planted in compacted soil, planted too high on the banks, or planted too late in the growing season. The majority of the live stakes throughout the project area are thriving.

2.1.1 Soil Data

The Cato Farms Stream Restoration Project is situated between a narrow ridge and valley within the Southern Outer Piedmont Belt of the North Carolina Piedmont Physiographic Province. Researchable data indicates that the soils within the project area are those found in alluvial landforms in this physiographic region; however, grading and filling activities during construction likely have disturbed the parent soil material.

Review of the *Soil Survey of Mecklenburg County, North Carolina* indicates that four soil series are found within or adjacent to the project limits. These soil series consist of Enon, Helena, Monacan, and Wilkes. Enon soils are very deep, well-drained soils on ridges and side slopes of the Piedmont uplands. The soils are formed in clayey residuum weathered from mafic or intermediate igneous and metamorphic rocks such as diorite, gabbro, gneiss, and schist of the Piedmont uplands. Slopes range from 0 to 45 percent for the Enon series. Helena soils are very deep, well-drained soils on broad ridges and toe slopes of the Piedmont uplands. The soils are formed in residuum weathered from a mixture of felsic, intermediate, or mafic igneous, or metamorphic rocks such as granite, or granite gneiss that may be cut by dykes of gabbro and diorite, or mixed with hornblende schist or hornblende gneiss. Slopes range from 0 to 15 percent for the Helena series; however, these soils are generally found on slopes that range from 0 to 10

percent. Monacan soils are very deep, well-drained to somewhat poorly-drained soils found along stream corridors. These soils are formed in recent alluvium sediments of the Piedmont and Coastal Plain. Slopes are generally less than 2 percent. Wilkes soils are shallow, well-drained soils adjacent to drainageways. They are formed in residuum weathered from intermediate and mafic crystalline rocks on the Piedmont uplands. Slopes range from 0 to 25 percent for the Wilkes series. Please refer to Table 2.1 for the preliminary soil data of the soil series within the project area.

Table 2.1
Preliminary Soil Data
Cato Farms Stream Restoration/Project No. 72

Series	Max Depth (in)	% Clay on Surface	K Factor	T Factor	OM %
Enon	60	5 - 20	0.34	4	0.0 – 3.0
Helena	64	5 - 20	0.37	3	0.0 – 2.0
Monacan	65	7 - 27	0.28	4	0.0 – 3.0
Wilkes	45	5 - 20	0.28	2	0.0 – 2.0

2.1.2 Vegetative Current Conditions

During the initial assessment survey conducted in January 2008, it was noted that some minor areas of streambank have suffered localized loss of vegetative cover. The compaction of soil and nutrient poor conditions may be a contributing to the mortality of live stakes and herbaceous cover in these limited areas. It was observed that many of the problem areas noted during the previous vegetation assessments (2005-2007) have improved throughout the growing seasons. It should be noted that much of the sites herbaceous cover in the riparian area is dog-fennel (*Eupatorium capillifolium*). Although it is not listed as an invasive species for North Carolina, control of this species may need to be addressed in order to allow for preferred riparian species to establish. Please refer to Appendix 1.1 for the vegetative current conditions table.

2.1.3 Vegetative Current Condition Plan View

Please refer to Appendix 3 for location of vegetative current condition areas on-site and Appendix 1.2 for representative vegetation current condition photos.

2.1.4 Stem Counts

JJG conducted the vegetative assessment and vegetative plot analysis in June 2008. The eight previously established vegetative plots represent the riparian buffer zone and streambank vegetation.

Trees planted within the plots monitored include white oak (*Quercus alba*), swamp chestnut oak (*Quercus michauxii*), river birch (*Betula nigra*), American sycamore (*Platanus occidentalis*), green ash (*Fraxinus pennsylvanica*), black willow (*Salix nigra*), silky dogwood (*Cornus amomum*), box-elder (*Acer negundo*), and black gum (*Nyssa sylvatica*). In addition, natural

recruitment vegetation was also monitored within these plots. Species encountered were tulip poplar (*Liriodendron tulipifera*), sweet gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), tag alder (*Alnus serrulata*), Eastern red cedar (*Juniperus virgiana*), oak species (*Quercus* spp.), and species that were originally planted. Refer to Table 2.2 for a summary of stem counts for planted species.

The survival rate for the woody vegetation monitored for 2008 is 75%. The monitoring data indicates an average of 15 stems per plot. Using the monitoring plots size of 10m x 10m (0.025 ac), the site density is approximately 520 planted stems per acre. The success goal for planted woody vegetation is 320 stems per acre. Furthermore, many natural recruitment stems were observed within all eight plots. If these volunteers were also included in the stem average and site density calculation, then the number would increase dramatically. The site has satisfied this goal for monitoring year 4.

In conclusion, the vegetation within the Cato Farms Stream Restoration Project meets the success criteria for year 4. Although some loss of streambank vegetation has occurred, the overall growth of the riparian buffer is good.

2.1.5 Vegetation Plot Photos

Please refer to Appendix 1.3 for photographs of the monitoring plots.

Table 2.2
Stem Counts for Planted Species Arranged by Plot
Cato Farms Stream Restoration/Project No. 72

Stem Counts for Planted Species Arranged by Plot – MY-2008												
	Vegetation Plots Monitored (MY-2008)								MY 4-2008	MY 3-2007	MY 2-2006	MY 1-2005
Species	**Plot 1**	**Plot 2**	**Plot 3**	**Plot 4**	**Plot 5**	**Plot 6**	**Plot 7**	**Plot 8**	**Totals**	**Totals**	**Totals**	**Totals**
Shrubs												
Aronia arbutifolia	0	0	0	0	2	0	0	0	**2**	**2**	**3**	**13**
Cephalanthus occidentalis	0	2	1	0	1	0	0	0	**4**	**6**	**4**	**8**
Cornus amomum	3	0	2	4	10	0	3	10	**32**	**32**	**32**	**44**
Cornus sericea	0	0	0	3	0	0	0	0	**3**	**3**	**3**	**5**
Salix nigra	4	1	1	0	1	4	3	2	**16**	**16**	**16**	**16**
Sambucus canadensis	0	2	1	0	0	0	0	0	**3**	**3**	**2**	**5**
Trees												
Acer negundo	1	2	2	0	2	1	4	4	**16**	**18**	**18**	**18**
Carpinus caroliniana	0	0	0	0	0	0	0	0	**0**	**0**	**0**	**1**
Carya aquatica	0	0	0	0	0	0	0	0	**0**	**0**	**0**	**3**
Fraxinus pennsylvanica	0	1	0	0	0	2	2	0	**5**	**5**	**5**	**5**
Juglans nigra	0	0	0	0	0	0	0	1	**1**	**0**	**0**	**1**
Nyssa sylvatica	2	0	0	0	0	0	0	0	**2**	**1**	**1**	**1**
Populus deltoides	0	0	0	0	1	1	0	2	**4**	**2**	**2**	**2**
Quercus alba	0	1	0	0	0	1	1	2	**5**	**5**	**5**	**6**
Quercus michauxii	1	2	0	3	0	3	2	2	**13**	**14**	**14**	**14**
Total Planted Live Stems (2008)	**11**	**11**	**7**	**10**	**17**	**12**	**15**	**23**	**106**	**N/A**	**N/A**	**N/A**
Average # of Stems (2008)	**13**											
Percent Survival (2008)	**85%**	**79%**	**70%**	**67%**	**94%**	**66%**	**54%**	**88%**	**Avg =75%**			
Stem Density (2008)	**520**											
Volunteer Stems												
Species	**Plot 1**	**Plot 2**	**Plot 3**	**Plot 4**	**Plot 5**	**Plot 6**	**Plot 7**	**Plot 8**	**Total MY 4- 2008**			
Acer rubrum	1	2	2	1		1	>10	>10	**>27**			
Acer negundo								2	**2**			
Alnus serrulata	2	0	0	0	0	0	0	0	**2**			
Liquidambar styraciflua			>20	4	1	3	>19	>20	**>67**			
Juglans nigra								2	**2**			
Juniperous virginiana	3	2		2					**7**			
Platanus occidentalis	2						5	4	**11**			
Pinus taeda	4	2	1						**7**			
Salix nigra	2								**2**			
Total Volunteer Stems (2008)	**14**	**6**	**3**	**7**	**1**	**4**	**5**	**8**	**>125**			

2.2 Stream Assessment

Stream dimension, pattern, profile and substrate were evaluated within 2,500 linear feet of the stream restoration site. The stream assessment included walking the entire stream reach and monitoring 2,147 linear feet of longitudinal profile and six pre-established cross-sections. Please refer to Table 2.3 and Appendix 2 for the stability assessment, stream photographs, and raw data, Table 2.4 for the baseline morphology and hydraulic as-built summary, Table 2.5 for monitoring years 2003-2008 morphology and hydraulic summary, and Appendix 3 for the current condition plan view map.

2.2.1 Stream Current Condition Plan View

Please refer to Appendix 3 for location of stream current condition areas on-site.

2.2.2 Stream Current Condition Table

Please refer to Appendix 2.1 for the stream current condition table.

2.2.3 Numbered Issues Photo Section

Please refer to Appendix 2.2 for representative stream current condition photos.

2.2.4 Fixed Photo Station Photos

Please refer to Appendix 2.3 for stream photo station photos and Appendix 2.4 for stream cross-section photos.

2.2.5 Stability Assessment

Overall, the pattern, profile and dimension of the restored channel appear to be stable. However, channel thalweg conditions appear to be shifting due to in-stream vegetation growth. Throughout the entire reach, vegetation is growing in the middle of the channel, creating mid-channel bars and abnormal flow conditions. Typically, areas of instability noted for the 2008 monitoring year, which are re-occurring conditions do not appear to have advanced from the conditions observed in the 2007 monitoring year. The following general observations were noted.

- In several outer bends, there are areas of moderate to severe bank erosion under the matting due to the lack of vegetative cover (Approximate stationing 9+15 and 17+00).
- Overall, the structures appear to be in good condition; however, the outer arm of some structures are lacking vegetative cover; therefore, moderate to severe scouring has occurred over the years (Stationing 21+00, 21+50, 22+50, 22+90, 23+90, 23+25, and 24+30).
- Several cross vanes (Stationing 22+40, 22+80, and 24+68) have vegetation growing on the inverts.

- Throughout the entire stream restoration project, in-stream vegetation is growing in the middle of the channel, creating abnormal flow conditions. These conditions could lead to aggradation in future monitoring years.

Reach 1

Within Reach 1, cross-sections 3, 4, 5, and 6 are located. Cross-sections 3, 4 and 5, which are all pools, have had sediment deposition, which is showing a decrease in the bankfull mean depth and area. However, no significant changes in channel dimension were observed that indicate lateral or vertical instability is occurring.

The average water surface slope and the average bankfull slope were very similar for the surveyed reach, 0.0063 ft/ft and 0.0062 ft/ft respectively. The surveyed water surface slope was slightly lower than the proposed 0.0100 ft/ft, but similar to the previous monitoring years surveyed slopes. The profile appears stable and is not showing vertical incision; however, fine silt deposition has impacted the streambed morphology. Upstream sources from construction development and abnormal rainfall conditions are most likely attributing to the increase in sediment deposition. Several compound pools have developed throughout the reach, which is most likely due to the increase of in-stream vegetation growth and sediment deposition.

Reach 2

Overall, the structures within the transition zone appear to be in good condition; however, the outer arm of some structures are lacking vegetative cover; therefore, moderate to severe scouring has occurred over the monitoring years (Stationing 21+00, 21+50, 22+50, 22+90, 23+90, 23+25, and 24+30). A few cross vanes (stationing 23+80, and 24+28) have vegetation growing on the invert.

Cross-sections 1 and 2 are located within Reach 2. Both cross-section 1 and 2 are riffles and appear to be stable with minimal erosion occurring. The average water surface slope and the average bankfull slope were very similar for the surveyed reach, 0.0093 ft/ft and 0.0083 ft/ft respectively. The surveyed water surface slope was slightly lower than the proposed 0.010 ft/ft and steeper than the previous surveyed slopes in 2006 (0.0080 ft/ft and 0.0070 ft/ft, respectively). The profile appears stable and is not showing significant shifting in the bed features; however, results indicate there is a slight change. This change could be due to the change in flow conditions from the increase of in-stream vegetation growth.

In summary, Reach 1 and 2 stream dimension, pattern, and profile appear stable. In-stream vegetation growth is advancing, resulting in abnormal flow conditions throughout the channel.

Table 2.3
Categorical Stream Feature Visual Stability Assessment
Cato Farms Stream Restoration/Project No. 72

Reach 1

Feature	As-Built	MY1 (2005)	MY2 (2006)	MY3 (2007)	MY4 (2008)	MY5 (2009)
A. Riffles	-	-	99%	14%	0%	
B. Pools	-	-	100%	100%	83%	
C. Thalweg	-	-	92%	91%	100%	
D. Meanders	-	-	94%	99%	98%	
E. Bed General	-	-	100%	99%	92%	
F. Vanes/J Hooks, etc	-	-	N/A	N/A	N/A	
G. Wads and Boulders	-	-	N/A	N/A	N/A	
H. Bank Performance	-	-	96%	96%	95%	

Reach 2

Feature	As-Built	MY1 (2005)	MY2 (2006)	MY3 (2007)	MY4 (2008)	MY5 (2009)
A. Riffles	-	-	38%	17%	17%	
B. Pools	-	-	100%	100%	100%	
C. Thalweg	-	-	100%	100%	100%	
D. Meanders	-	-	98%	100%	100%	
E. Bed General	-	-	100%	100%	100%	
F. Vanes/J Hooks, etc	-	-	100%	73%	86%	
G. Wads and Boulders	-	-	N/A	N/A	N/A	
H. Bank Performance	-	-	99%	91%	97%	

(Cells noted with a (-), data was not provided)

2.2.6 Quantitative Measures Tables

Tables 2.4 and 2.5 display morphological summary data from all monitoring years. Raw survey data can be found in Appendix 2.

Table 2.4
Baseline Morphology and Hydraulic As-Built Summary
Cato Farms Stream Restoration/Project No. 72

	USGS Gauge Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream		Design		As-Built	
DIMENSION	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**UR**	**MR**	**LR**	**Coffey Creek**	**Park South Drive**	**Restoration Reach (Reach 1)**	**Transition Reach (Reach 2)**	**Restoration Reach (Reach 1)**	**Transition Reach (Reach 2)**
Bankfull Width (ft)	USGS Gauge Data is unavailable for this tributary			-			7.7	5.2	7.6	31.6	5.9	7.00	13.50	6.58-8.91	14.51
Floodprone Width (ft)							16	7	11	46	29	34.20	19.67	-	-
Bankfull Cross-sectional Area (ft^2)							5.7	8.6	9.7	55.4	6.7	8.60	9.70	4.20-7.08	3.09
Bankfull Mean Depth (ft)							0.7	1.65	1.3	1.8	1.1	1.33	0.75	-	-
Bankfull Max Depth (ft)							1.9	2	1.9	2.5	1.5	1.76	1.06	-	-
Width/Depth Ratio							10.4	3.2		18	5.2	5.25	17.99	7.32-18.95	66.2
Entrenchment Ratio							2.1	1.3	6	1.5	4.9	4.89	1.46	2.90-4.85	1.67
Wetted Perimeter (ft)							-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)							-	-	-	-	-	-	-	-	-
Bank Height Ratio							1.92	2.19	3.21	1.33	1.83	1.00	1.65-6.41	-	-
PATTERN															
Channel Beltwidth (ft)	-			-			8	5.5	8	226	36	42.6	96.64	-	
Radius of Curvature (ft)							0	0	0	115.7-467.2	11.1-23.5	13.09-27.72	49.47-199.78	13.0-28.0	
Meander Wave Length (ft)							-	0	0	747-849	44-61	51.89-71.94	319.13-363.04	-	
Meander Width Ratio							1.04	1.05	1.05	7.16	6.07	6.07	7.16	6	
PROFILE															
Riffle Length (ft)	-			-			-	-	-	-	-	-	-	-	-
Riffle Slope (ft/ft)							-	-	-	-	-	-	-	-0.0036	0.1330
Pool Length (ft)							-	-	-	-	-	-	-	-	-
Pool to Pool Spacing (ft)							17.5-32.5	35.2-35.9	3.55-33.3	100-120	14-27	16.51-31.84	42.76-51.31	-	-
SUBSTRATE															
D50 (mm)	-			-			-	0.5	1.2	2.3	0.8	0.82	1.2	<2	1
D84 (mm)							0	4	9	142	8	8.3	8.64	>2-1	5
ADDITIONAL REACH PARAMETERS	**USGS Gauge Data**			**Regional Curve Interval**			**Pre-Existing Condition**			**Project Reference Stream**		**Design**		**As-Built**	
Valley Length (ft)	-			-			-	-	-	-	-	-	-	-	
Channel Length (ft)							-	-	-	-	-	-	-	-	
Sinuosity							1.01	1.04	1.1	1.22	1.39	1.39	1.22	1.39	-
Water Surface Slope (ft/ft)							0.0098	0.0092	0.0154	0.01	0.0123	0.01	0.01	0.006	0.015
Bankfull Slope (ft/ft)							-	-	-	-	-	-	-	-	-
Rosgen Classification							E6	G5c	G5c	B4c	E5	E	B	E	B

Cells noted with a (-), data was not provided

Table 2.5
Morphology and Hydraulic Monitoring Summary
Cato Farms Stream Restoration/Project No. 72
Reach 1

PARAMETER	Cross-Section 3-Pool					Cross-Section 4-Pool					Cross-Section 5-Pool					Cross-Section 6-Riffle		
DIMENSION	MY1 (2005)	MY2 (2006)	MY3 (2007)	MY4 (2008)	MY5 (2009)	MY1 (2005)	MY2 (2006)	MY3 (2007)	MY4 (2008)	MY5 (2009)	MY1 (2005)	MY2 (2006)	MY3 (2007)	MY4 (2008)	MY5 (2009)	MY3 (2007)**	MY4 (2008)	MY5 (2009)
Bankfull Width (ft)	6.70	7.7	7.38	7.34		16.20	14.40	15.58	14		7.00	11.50	11.91	12.02		9.04	8.79	
Floodprone Width (ft)	-	N/A	N/A	N/A		-	N/A	N/A	N/A		-	N/A	N/A	N/A		>100	25.09	
Bankfull Cross-sectional Area	6.40	7.65	6.76	5.79		8.40	9.07	8.07	8.47		6.00	9.10	9.15	9.05		8.20	6.90	
Bankfull Mean Depth	-	0.99	0.92	0.79		-	0.63	0.52	0.6		-	0.79	0.77	0.75		0.91	0.79	
Bankfull Max Depth	1.90	2.04	1.88	1.78		1.60	1.63	1.62	1.54		2.10	2.36	2.30	2.22		2.21	1.31	
Width/Depth Ratio	-	7.78	8.02	9.29		-	22.86	29.96	23.33		-	14.56	15.47	16.03		9.93	11.13	
Entrenchment Ratio	-	N/A	N/A	N/A		-	N/A	N/A	N/A		-	N/A	N/A	N/A		>2.2	2.85	
Wetted Perimeter (ft)	-	9.13	8.44	8.68		-	15.26	16.95	14.96		-	13.2	14.06	13.94		10.71	9.51	
Hydraulic Radius (ft)	-	0.84	0.8	0.67		-	0.59	0.48	0.57		-	0.69	0.65	0.65		0.77	0.73	
Bank Height Ratio	-	1.00	1.00	1.00		-	1.00	1.00	1.00		-	1.00	1.00	1.00		1.00	1.00	
SUBSTRATE (Reachwide)																		
D50 (mm)	Silt	0.35	0.06	0.05		0.10	0.44	0.06	0.04		0.38	0.36	0.11	0.04		0.13	0.03	
D84 (mm)	0.19	1.04	0.38	0.18		0.23	0.87	0.43	0.06		0.86	0.84	0.58	0.06		0.75	0.06	
PROFILE	Reach 1																	
	MY1 (2005)*			MY2 (2006)			MY3 (2007)			MY4 (2008)			MY 5 (2009)					
Riffle Length (ft)	8	80	13	2	42	9	4	14	9	N/A								
Riffle Slope (ft/ft)	0.0023	0.0080	0.0189	0.0000	0.0621	0.0066	0.0054	0.0622	0.0244									
Pool Length (ft)	8.00	118.00	20.00	2.40	74.20	15.30	1	83	29	11	66	25						
Pool to Pool Spacing (ft)	15.50	215.00	33.50	8.00	99.70	33.85	21	202	60	13	188	51						
ADDITIONAL REACH PARAMETERS	**MY1 (2005)***	**MY2 (2006)**	**MY3 (2007)**	**MY4 (2008)**	**MY5 (2009)**													
		Reach 1	Reach 1	Reach 1	Reach 1													
Valley Length (ft)	3614.06	1240.00	1240.00	1240.00														
Channel Length (ft)	2512	2000	2000	2000														
Sinuosity	1.44	1.61	1.61	1.61														
Water Surface Slope (ft/ft)	0.0071	0.0063	0.0062	0.0063														
Bankfull Slope (ft/ft)	0.0069	0.0060	0.0068	0.0062														
Rosgen Classification	E5/B5	E	E	E														

*2005 Survey did not break up stream into separate types of restoration reaches for profile or additional reach parameter calculations and Reach 2 survey lengths were different between monitoring years 2005 and 2006
Cells noted with a (-), data was not provided
Cells noted with a (N/A), data was not applicable

Table 2.5
Morphology and Hydraulic Monitoring Summary
Cato Farms Stream Restoration/Project No. 72
Reach 2

PARAMETER	Cross-Section 1-Riffle					Cross-Section 2-Riffle				
DIMENSION	MY1 (2005)	MY2 (2006)	MY3 (2007)	MY4 (2008)	MY5 (2009)	MY1 (2005)	MY2 (2006)	MY3 (2007)	MY4 (2008)	MY5 (2009)
Bankfull Width (ft)	6.20	5.96	9.02	9.5		10.70	12.00	11.06	9.39	
Floodprone Width (ft)	28.10	>100	29.75	28.73		24.80	>100	>100	24.7	
Bankfull Cross-sectional Area	5.40	4.09	6.09	5.91		4.40	3.14	2.74	3.31	
Bankfull Mean Depth	0.90	0.69	0.67	0.62		0.40	0.26	0.25	0.35	
Bankfull Max Depth	1.70	1.26	1.64	1.66		0.70	0.76	0.81	0.8	
Width/Depth Ratio	7.20	8.64	13.46	15.32		26.20	46.15	44.24	26.83	
Entrenchment Ratio	4.50	>2.2	3.30	3.02		2.30	>2.2	>2.2	2.63	
Wetted Perimeter (ft)	-	6.53	9.92	10.82		-	15.71	11.69	9.93	
Hydraulic Radius (ft)	-	0.63	0.61	0.55		-	0.21	0.23	0.33	
Bank Height Ratio	-	1.00	1.00	1.00		-	1.00	1.00	1.00	
SUBSTRATE (Reachwide)										
D50 (mm)	0.27	0.71	0.05	0.31		0.06	0.66	0.05	0.05	
D84 (mm)	0.50	1.51	0.8	0.92		0.31	2.02	1.00	0.5	

PROFILE	Reach 2														
	MY1 (2005)*			MY2 (2006)			MY3 (2007)			MY4 (2008)			MY 5 (2009)		
Riffle Length (ft)	-	-	-	7.80	18.20	11.90	N/A	N/A	N/A	5	13	6			
Riffle Slope (ft/ft)	-	-	-	0.0051	0.0218	0.0121	N/A	N/A	N/A	0.0099	0.0584	0.0300			
Pool Length (ft)	-	-	-	18.40	37.60	21.40	15	35	3	20	25	22			
Pool to Pool Spacing (ft)	-	-	-	5.3	51.9	21.8	36	105	4	18	41	30			

ADDITIONAL REACH PARAMETERS	MY1 (2005)*	MY2 (2006)	MY3 (2007)	MY4 (2008)	MY5 (2009)
		Reach 2	Reach 2	Reach 2	Reach 2
Valley Length (ft)	3614.06	420	420	420	
Channel Length (ft)	2512	512	512	512	
Sinuosity	1.44	1.22	1.22	1.22	
Water Surface Slope (ft/ft)	0.0071	0.0080	0.0090	0.0063	
Bankfull Slope (ft/ft)	0.0069	0.0070	0.0080	0.0062	
Rosgen Classification	E5/B5	B	B	B	

*2005 Survey did not break up stream into separate types of restoration reaches for profile and additional reach parameter calculations and Reach 2 survey lengths were different between monitoring years 2005 and 2006

Cells noted with a (-), data was not provided

Cells noted with a (N/A), data was not applicable

2.2.7. Hydrologic Criteria

The Cato Farms Stream Restoration Project has a crest gauge located on site that was installed following the 2007 survey. Therefore visual assessments are noted for bankfull verification from the 2006 and 2007 surveys. Indicators such as wrack lines and vegetation layover were observed at the bankfull and greater elevations within the restoration site during the 2006 and 2007 stream surveys. One bankfull or greater event was recorded during the 2008 monitoring year. A local USGS gauge, Clark Creek, is located within the area, but the drainage area is larger than 10 square miles and was not used per NCEEP recommendation. Table 2.6 summarized the visual assessment results below.

Table 2.6
Verification of Bankfull Events
Cato Farms Stream Restoration Project/Project No. 72

Date of Collection	Date of Occurrence	Method	Photo # (if available)
Summer/Fall 2006	Unknown	Visual Assessment	N/A
Spring/Summer 2007	Unknown	Visual Assessment	N/A
Spring 2008	Unknown	Crest Gauge	N/A

SECTION 3
METHODOLOGY

SECTION 3
METHODOLOGY

3.1 Methodology

Methods employed for the Cato Farms Stream Restoration Project were a combination of those established by standard regulatory guidance and procedures documents as well as previous monitoring reports completed by North Carolina State University and CH2MHill. Geomorphic and stream assessments were performed following guidelines outlined in the Stream Channel Reference Sites: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in the Stream Restoration a Natural Channel Design Handbook (Doll et al, 2003). Vegetation assessments were conducted following the NCEEP 2004 Stem Counting Protocol which consists of counting woody stems within the established vegetation plots. JJG used the *Manual of the Vascular Flora of the Carolinas* by Albert R. Radford, Harry E. Ahles, and C. Ritchie Bell as the taxonomic standard for vegetation nomenclature for this report.

SECTION 4
REFERENCES

SECTION 4
REFERENCES

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Harrelson, Cheryl C; Rawlins, C.L.; Potyondy, John P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique.* Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

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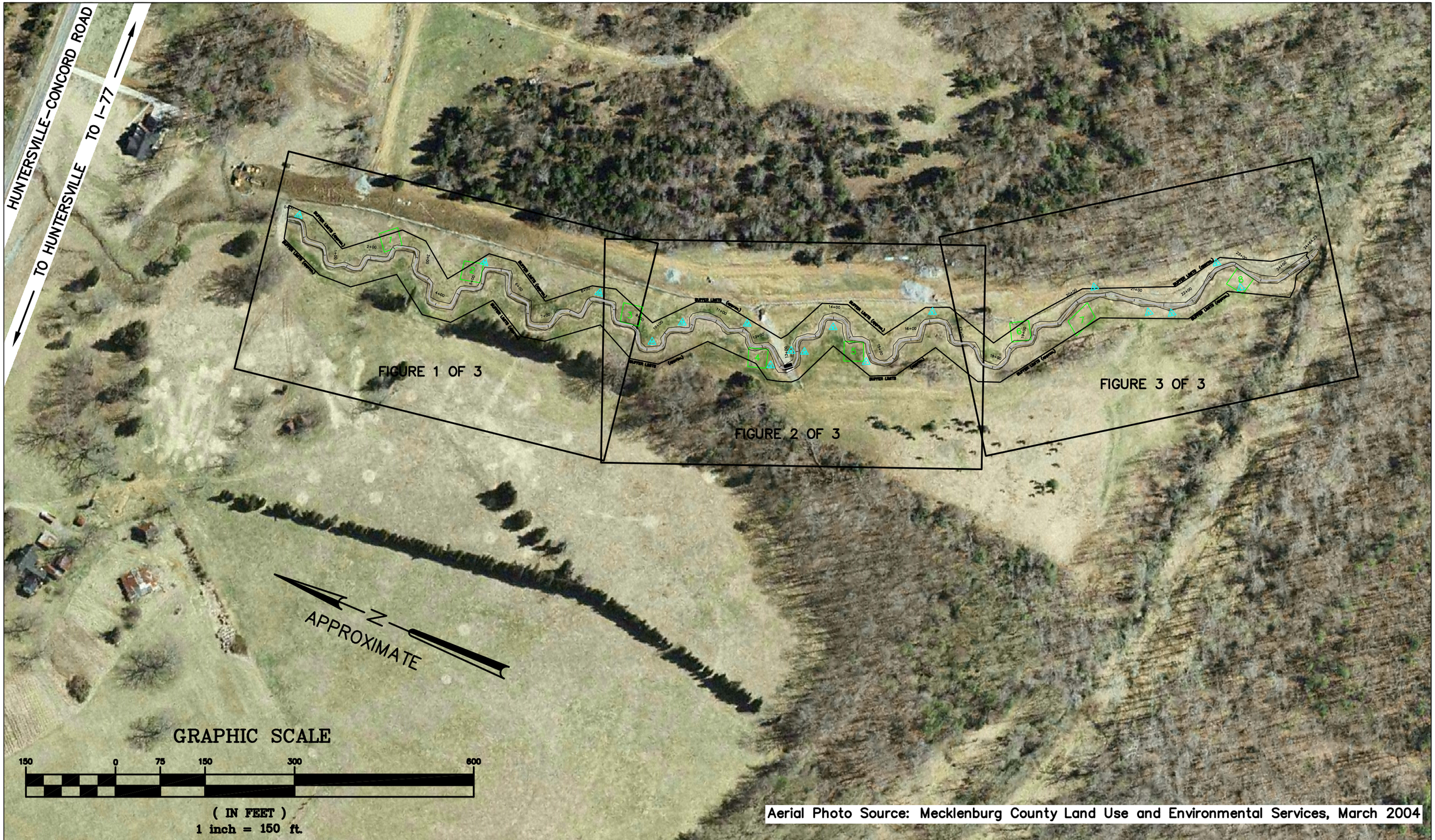
SECTION 5
FIGURES



Ecosystem Enhancement PROGRAM

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 72
MECKLENBURG COUNTY
NORTH CAROLINA
MONITORING
YEAR 4 OF 5

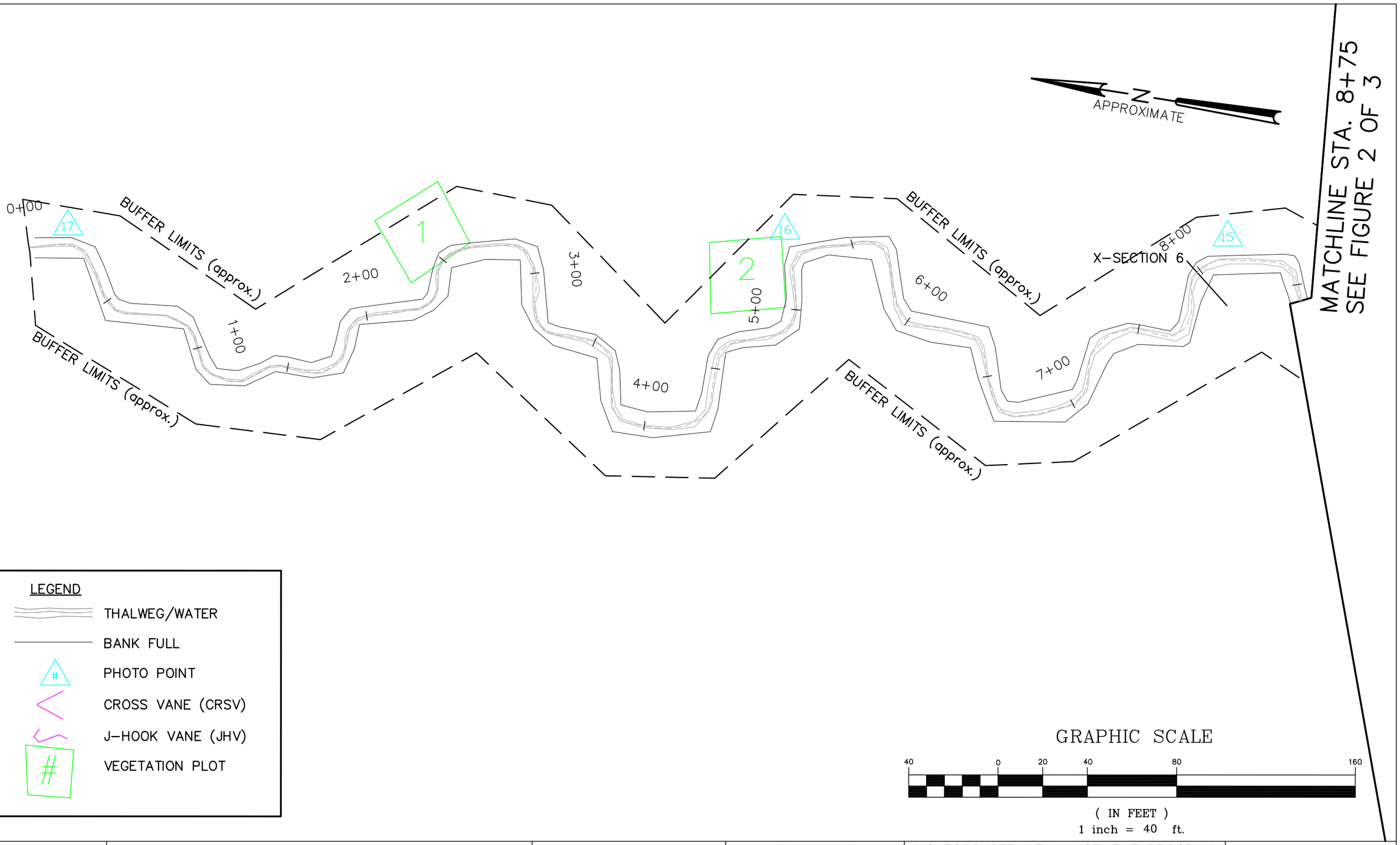
JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
CATO FARMS STREAM RESTORATION

FIGURE 1.2
MONITORING PLAN VIEW MAP

DATE : FEBRUARY 2009
SCALE : 1"=150'
JOB NO.: 03060004

FIGURE KEY



NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 72
MECKLENBURG COUNTY
NORTH CAROLINA
MONITORING
YEAR 4 OF 5

NC ECOSYSTEM ENHANCEMENT PROGRAM
CATO FARMS STREAM RESTORATION

FIGURE 1.2
MONITORING PLAN VIEW

DATE : FEBRUARY 2009
SCALE : 1"=40'
JOB NO.: 03060004

FIGURE 1 OF 3

MATCHLINE STA. 8+75
SEE FIGURE 1 OF 3

MATCHLINE STA. 17+75
SEE FIGURE 3 OF 3

N
APPROXIMATE

BUFFER LIMITS (approx.)

BUFFER LIMITS (approx.)

BUFFER LIMITS (approx.)

BUFFER LIMITS

9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00

X–SECTION 5
X–SECTION 4
X–SECTION 3

BRIDGE

3
4
5
6
7
8
9
10
11
12
13
14

LEGEND

- THALWEG/WATER
- BANK FULL
- PHOTO POINT
- CROSS VANE (CRSV)
- J–HOOK VANE (JHV)
- VEGETATION PLOT

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 72
MECKLENBURG COUNTY
NORTH CAROLINA
MONITORING
YEAR 4 OF 5

NC ECOSYSTEM ENHANCEMENT PROGRAM
CATO FARMS STREAM RESTORATION

FIGURE 1.2
MONITORING PLAN VIEW MAP

DATE : FEBRUARY 2009
SCALE : 1"=40'
JOB NO.: 03060004

FIGURE 2 OF 3

MATCHLINE STA. 17+75
SEE FIGURE 2 OF 3

N
APPROXIMATE

CRSV-8
CRSV-7
CRSV-6
CRSV-3
JHV-1
CRSV-5
CRSV-4
CRSV-2
CRSV-1

X-SECTION 2
X-SECTON 1

18+00
19+00
20+00
21+00
22+00
23+00
24+00
24+64.23

BUFFER LIMITS (approx.)
BUFFER LIMITS (approx.)
BUFFER LIMITS (approx.)

6
7
8

1
2
3
4
5

LEGEND

- THALWEG/WATER
- BANK FULL
- # PHOTO POINT
- CROSS VANE (CRSV)
- J-HOOK VANE (JHV)
- # VEGETATION PLOT

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

Ecosystem Enhancement PROGRAM

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 72
MECKLENBURG COUNTY
NORTH CAROLINA
MONITORING
YEAR 4 OF 5

JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
CATO FARMS STREAM RESTORATION

FIGURE 1.2
MONITORING PLAN VIEW MAP

DATE : FEBRUARY 2009
SCALE : 1"=40'
JOB NO.: 03060004

FIGURE 3 OF 3

SECTION 6
APPENDICES

Appendix 1 - Vegetation Raw Data

Appendix 2 - Geomorphic and Stream Stability Data

Appendix 3 – Current Condition Plan View (Integrated)

APPENDIX 1
VEGETATION RAW DATA

1. **Vegetation Survey Data Tables***

2. **Representative Vegetation Current Condition Photos**

3. **Vegetation Monitoring Plot Photos**

*Raw data tables have been provided electronically.

Main Channel (2,500 lf)

Feature Issue	Station Numbers	Suspected Cause	Photo ID #
Vegetative Cover - Poor	10+35 - 10+50	Poor vegetative cover - LB	1
	15+75 - 15+85	Bare slope/exposed - RB	
	16+25 - 16+50	Baren benches & points/dead stakes - RB	
	18+25 - 18+75	Bare bank, dead live stakes - BB	
In-Stream Vegetation	3+90 - 4+50	Soft rush and grasses in main channel	2
	5+10 - 6+00	Soft rush and grasses in main channel-Sporadic	
	6+70 - 9+00	Soft rush and grasses in main channel-Sporadic	
	10+00 - 10+04	Soft rush and grasses in main channel	
	10+95 - 11+05	Soft rush and grasses in main channel-Sporadic	
	11+75 - 12+00	Soft rush and grasses in main channel	
	12+25 - 13+25	Soft rush and grasses in main channel	
	14+00 - 14+25	Soft rush and grasses in main channel-Sporadic	
	14+75 - 14+87	Soft rush and grasses in main channel	
	15+24 - 15+26	Soft rush and grasses in main channel	
	15+73 - 16+24	Soft rush and grasses in main channel	
	17+25 - 17+35	Soft rush and grasses in main channel	
	18+75	Soft rush and grasses in main channel	
	19+75 - 19+78	Soft rush and grasses in main channel	
	22+40	soft rush on invert	
	22+80	soft rush on invert	
	24+68	soft rush on invert	

LB - Left Bank Looking Downstream, RB - Right Bank Looking Downstream, BB - Both Banks, TOB - Top of Bank
Please refer to Appendix 1.2 for Current Condition Photos

1. In-Stream Vegetation (3/2008)

2. Poor Vegetation Cover (3/2008)

Prepared For: Ecosystem Enhancement Program	Cato Farms Stream Restoration Year 4 of 5	Date: February 2009 Project No.: 72
	Appendix 1.2 Representative Vegetation Current Condition Photos	JJG

Monitoring Plot 1 (6/2008)

Monitoring Plot 2 (6/2008)

Monitoring Plot 3 (6/2008)

Monitoring Plot 4 (6/2008)

Prepared For: Ecosystem Enhancement Program	Cato Farms Stream Restoration Year 4 of 5	Date: February 2009 Project No.: 72
	Appendix 1.3 Vegetation Monitoring Plot Photos	JJG

Monitoring Plot 5 (6/2008)

Monitoring Plot 6 (6/2008)

Monitoring Plot 7 (6/2008)

Monitoring Plot 8 (6/2008)

Prepared For: Ecosystem Enhancement Program	Cato Farms Stream Restoration Year 4 of 5	Date: February 2009 Project No.: 72
	Appendix 1.3 Vegetation Monitoring Plot Photos	JJG

APPENDIX 2
GEOMORPHIC AND STREAM STABILITY DATA

1. **Stream Current Condition Table**
2. **Representative Stream Current Condition Photos**
3. **Stream Photo Station Photos**
4. **Stream Cross-Section Photos**
5. **Qualitative Visual Stability Assessment**
6. **Cross-Section Plots and Raw Data Tables***
7. **Longitudinal Plots and Raw Data Tables***
8. **Pebble Count Plots and Raw Data Tables***

*Raw data tables have been provided electronically.

Main Channel (2,500 lf)

Feature Issue	Station Numbers	Suspected Cause	Photo ID #
Bank Erosion - Moderate	2+20 -2+30	Scour under matting, loose matting - LB	1
	2+45 - 2+55	Bare bank - LB	
	4+10 - 4+30	Bank erosion under matting - BB	
	4+95 - 5+10	Bank erosion - RB	
	5+75 - 5+80	Bank erosion under matting - LB	
	6+05 - 6+15	Bank erosion under matting - RB	
	17+25 - 17+35	Bank erosion under matting - LB	
	18+50 - 18+75	No vegetation cover - RB	
	22+00 - 22+10	Bank erosion under matting - RB	
	23+50 - 23+70	Moderate bank erosion - RB	
Bank Erosion - Severe	9+15 - 9+25	Severe bank erosion under matting - LB	2
	16+85 - 17+59	Severe bank erosion under matting - LB	
	17+50 - 17+70	Bank erosion eroded bank severe - RB	
Structure - Stressed	21+50	Lack of Veg around cross-vane arm - LB	6
	22+90	Scour under cross vane arm - LB	
	24+30	Scour behind cross vane arm - RB	

LB - Left Bank Looking Downstream, RB - Right Bank Looking Downstream, BB - Both Banks, TOB - Top of Bank
Please refer to Appendix 2.2 for Current Condition Photos

1. Bank Erosion: Moderate (3/2008)

2. Bank Erosion: Severe (3/2008)

Photo Point 1: View Upstream (5/2008)

Photo Point 1: View Downstream (5/2008)

Photo Point 2: View Upstream (5/2008)

Photo Point 2: View Downstream (5/2008)

Photo Point 3: View Upstream (5/2008)

Photo Point 3: View Downstream (5/2008)

Photo Point 4: View Upstream (5/2008)

Photo Point 4: View Downstream (5/2008)

Photo Point 5: View Upstream (5/2008)

Photo Point 5: View Downstream (5/2008)

Photo Point 6: View Upstream (5/2008)

Photo Point 6: View Downstream (5/2008)

Photo Point 7: View Upstream (5/2008)

Photo Point 7: View Downstream (5/2008)

Photo Point 8: View Upstream (5/2008)

Photo Point 8: View Downstream (5/2008)

Photo Point 9: View Upstream (5/2008)

Photo Point 9: View Downstream (5/2008)

Photo Point 10: View Upstream (5/2008)

Photo Point 10: View Downstream (5/2008)

Photo Point 11: View Upstream (5/2008)

Photo Point 11: View Downstream (5/2008)

Photo Point 12: View Upstream (5/2008)

Photo Point 12: View Downstream (5/2008)

Photo Point 13: View Upstream (5/2008)

Photo Point 13: View Downstream (5/2008)

Photo Point 14: View Upstream (5/2008)

Photo Point 14: View Downstream (5/2008)

Photo Point 15: View Upstream (5/2008)

Photo Point 15: View Downstream (5/2008)

Photo Point 16: View Upstream (5/2008)

Photo Point 16: View Downstream (5/2008)

Photo Point 17: View Upstream (5/2008)

Photo Point 17: View Downstream (5/2008)

Cross-Section 1: View Upstream (5/2008)

Cross-Section 1: View Downstream (5/2008)

Cross-Section 2: View Upstream (5/2008)

Cross-Section 2: View Downstream (5/2008)

Prepared For: Ecosystem Enhancement Program	Cato Farms Stream Restoration Year 4 of 5	Date: February 2009 Project No.: 72
	Appendix 2.4 Stream Cross-Section Photos	JJG

Cross-Section 3: View Upstream (5/2008)

Cross-Section 3: View Downstream (5/2008)

Cross-Section 4: View Upstream (5/2008)

Cross-Section 4: View Downstream (5/2008)

Prepared For: Ecosystem Enhancement Program	Cato Farms Stream Restoration Year 4 of 5	Date: February 2009 Project No.: 72
	Appendix 2.4 Stream Cross-Section Photos	JJG

Cross-Section 5: View Upstream (5/2008)

Cross-Section 5: View Downstream (5/2008)

Cross-Section 6: View Upstream (5/2008)

Cross-Section 6: View Downstream (5/2008)

Reach 1 (1629 linear feet)

Feature Category		(# Stable) Number Performing as Intended	Total Number assessed per as-built survey	Total Number/ feet in unstable state	% Perform in Stable Condition	Feature Perform Mean or Total
A. Riffles	1. Present?	0	8	N/A	0%	**50%**
	2. Armor Stable?	8			100%	
	3. Facet grade appears stable?	8			100%	
	4. Minimal evidence of embedding/fining?	0			0%	
	5. Length appropriate?	-			-	
B. Pools	1. Present?	39	39	N/A	100%	**85%**
	2. Sufficiently deep?	27			69%	
	3. Length Appropriate?	-			-	
C. Thalweg*	1. Upstream of meander bend centering?	47	47	N/A	95%	**98%**
	2. Downstream of meander centering?	47			100%	
D. Meanders	1. Outer bend in state of limited/controlled erosion?	44	47	N/A	94%	**98%**
	2. Of those eroding, # w/concomitant point bar formation?	47			100%	
	3. Apparent Rc within spec?	47			100%	
	4. Sufficient floodplain access and relief?	47			100%	
E. Bed General	1. General channel bed aggradation areas (bar formation)?	N/A		14/625	84%	**92%**
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?			0/0	100%	
F. Bank Performance**	1. Actively eroding, wasting, or slumping bank	N/A		11/204	95%	**95%**
G. Vanes/J-Hooks, etc	1. Free of back or arm scour?	N/A				
	2. Height appropriate?					
	3. Angle and geometry appear appropriate?					
	4. Free of piping or other structural failures?					
H. Wads/ Boulders	1. Free of scour?	N/A				
	2. Footing stable?					

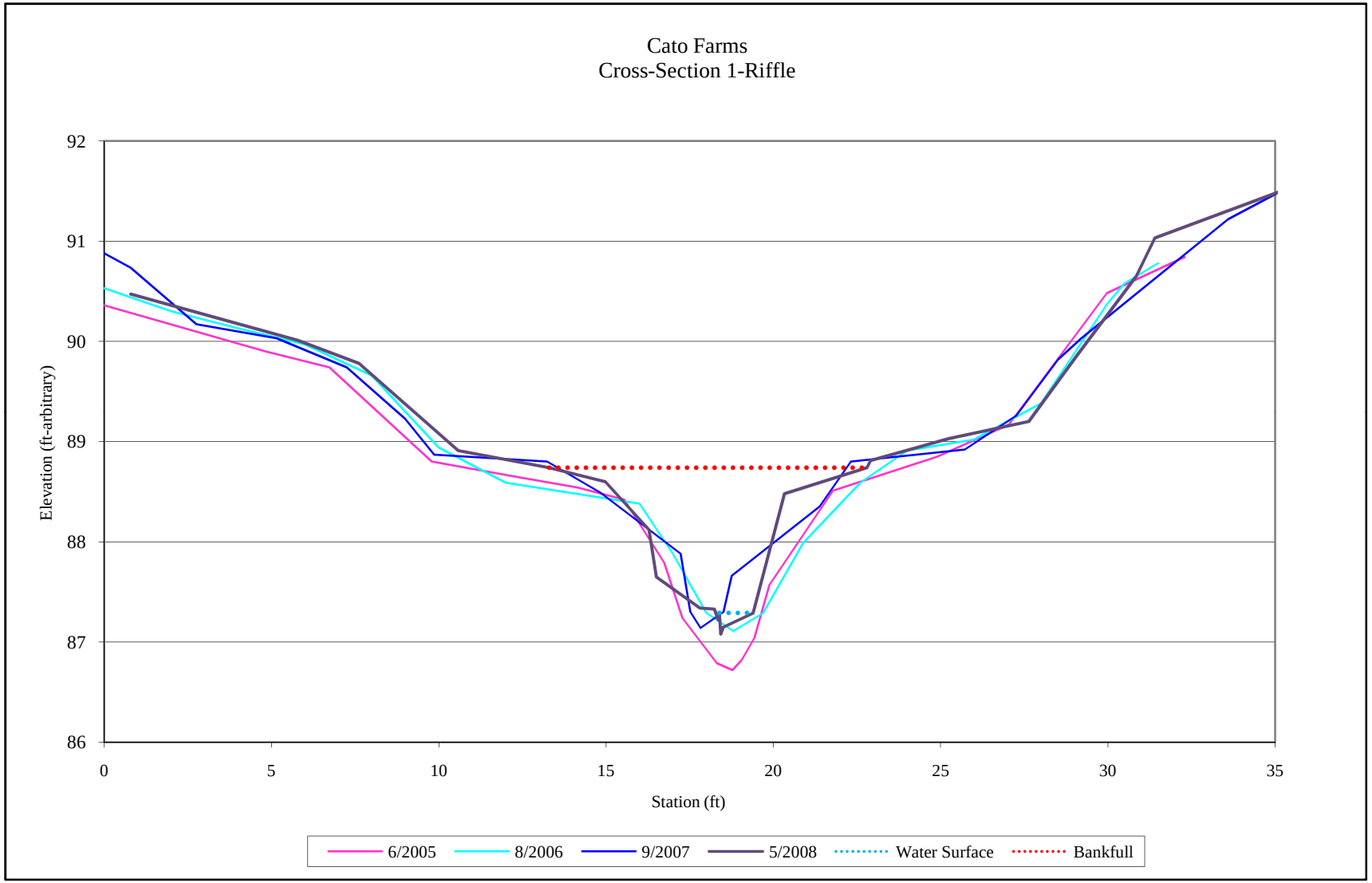
*Channel had abnormal flow conditions, TW was difficult to distinguish in field due to in-stream vegetation growth

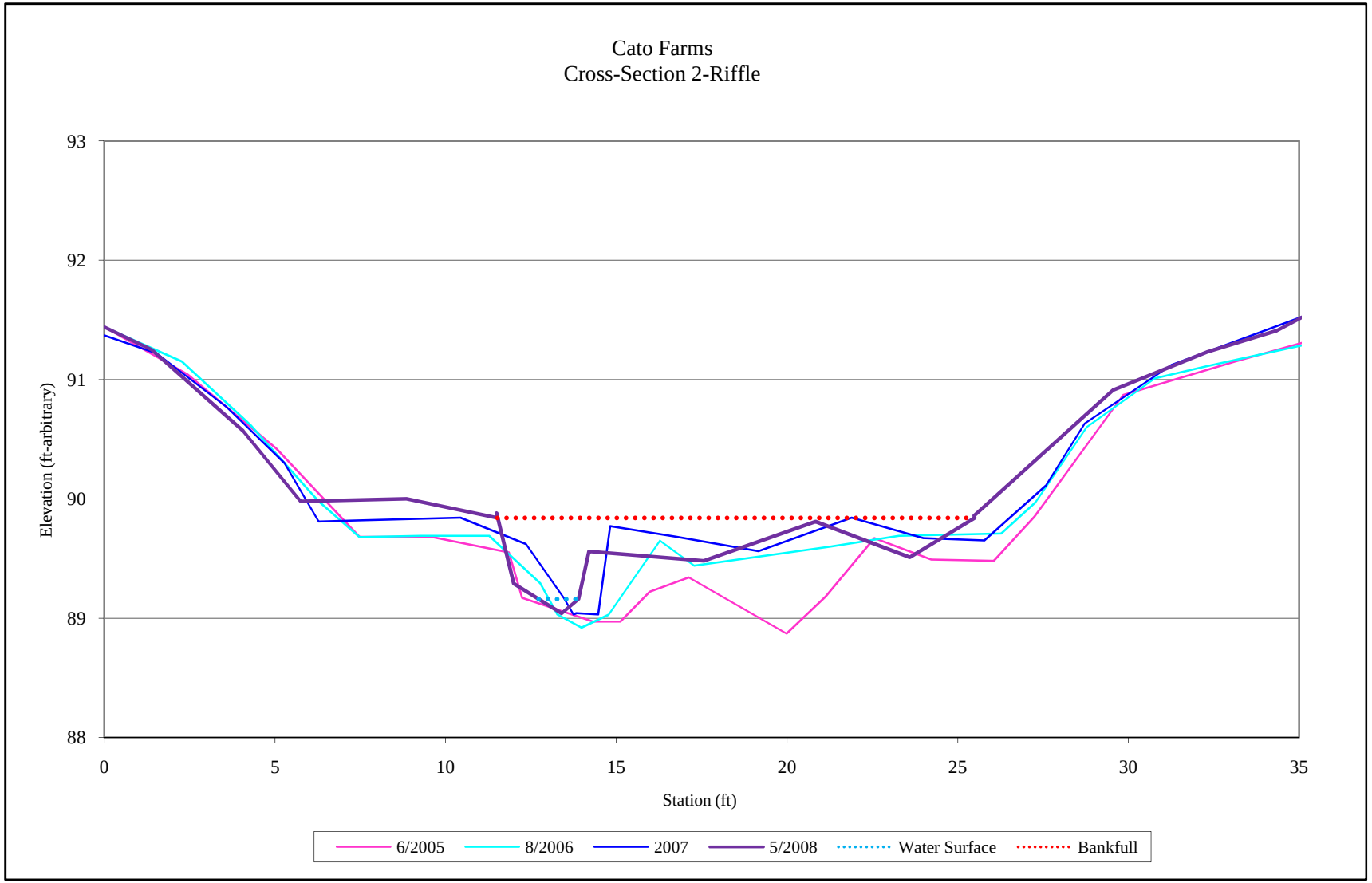
**Although bank erosion has occurred along the reach, only 35 feet are actively eroding.

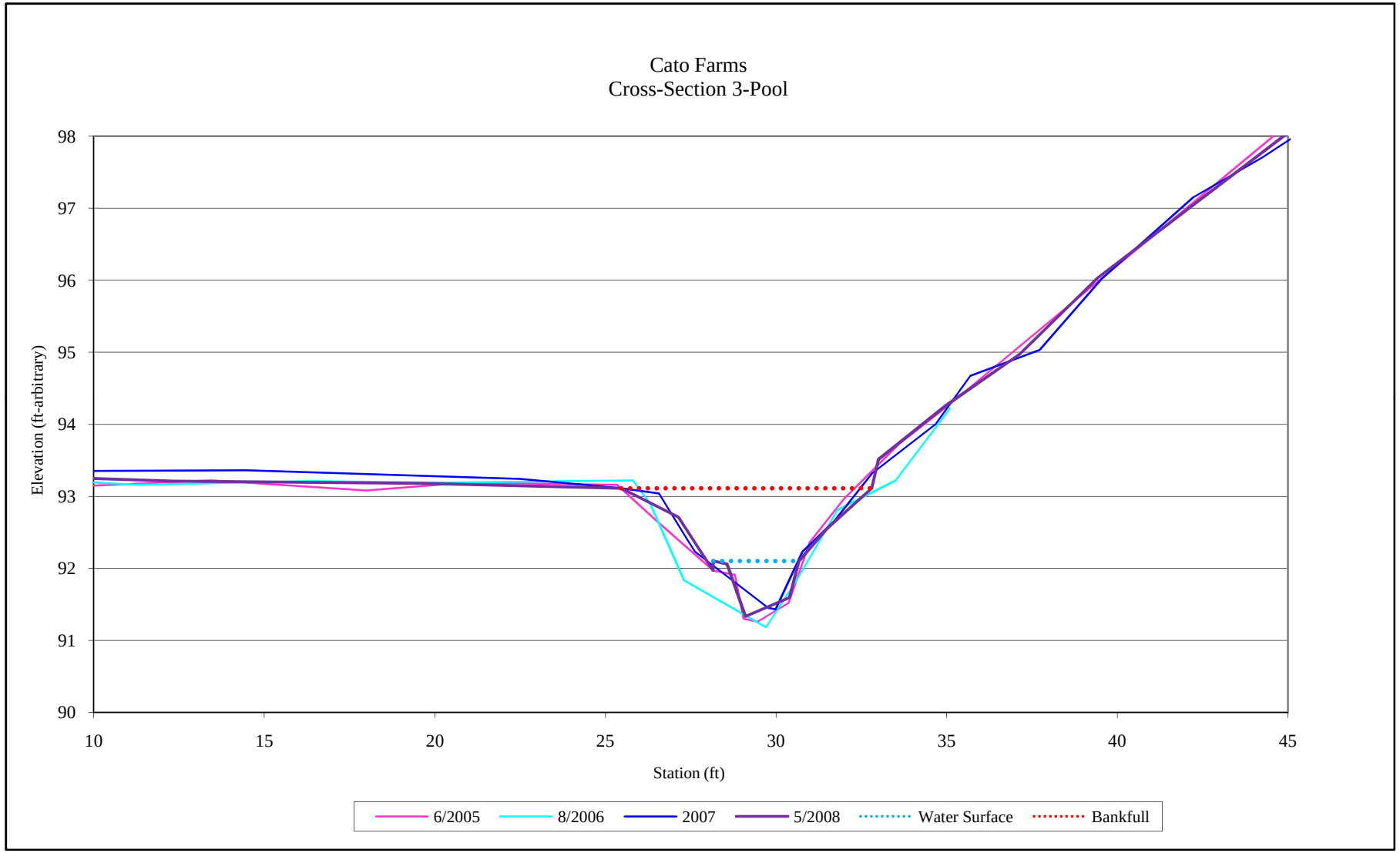
Reach 2 (814 linear feet)

Feature Category		(# Stable) Number Performing as Intended	Total Number assessed per as-built survey	Total Number/ feet in unstable state	% Perform in Stable Condition	Feature Perform Mean or Total
A. Riffles	1. Present?	N/A				
	2. Armor Stable?					
	3. Facet grade appears stable?					
	4. Minimal evidence of embedding/fining?					
	5. Length appropriate?					
B. Pools	1. Present?	8	8	N/A	100%	**100%**
	2. Sufficiently deep?	8			100%	
	3. Length Appropriate?	-			-	
C. Thalweg	1. Upstream of meander bend centering?	4	4	N/A	100	**100%**
	2. Downstream of meander centering?	4			100	
D. Meanders	1. Outer bend in state of limited/controlled erosion?	4	4	N/A	100%	**100%**
	2. Of those eroding, # w/concomitant point bar formation?	N/A			100%	
	3. Apparent Rc within spec?	4			100%	
	4. Sufficient floodplain access and relief?	4			100%	
E. Bed General	1. General channel bed aggradation areas (bar formation)?	N/A		0/0	100%	**100%**
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?			0/0	100%	
F. Bank Performance*	1. Actively eroding, wasting, or slumping bank	N/A		2/30*	97%	**97%**
G. Vanes/J-Hooks, etc	1. Free of back or arm scour?	8	11	N/A	73%	**86%**
	2. Height appropriate?	-			-	
	3. Angle and geometry appear appropriate?	-			-	
	4. Free of piping or other structural failures?	11			100%	
H. Wads/ Boulders	1. Free of scour?	N/A				
	2. Footing stable?					

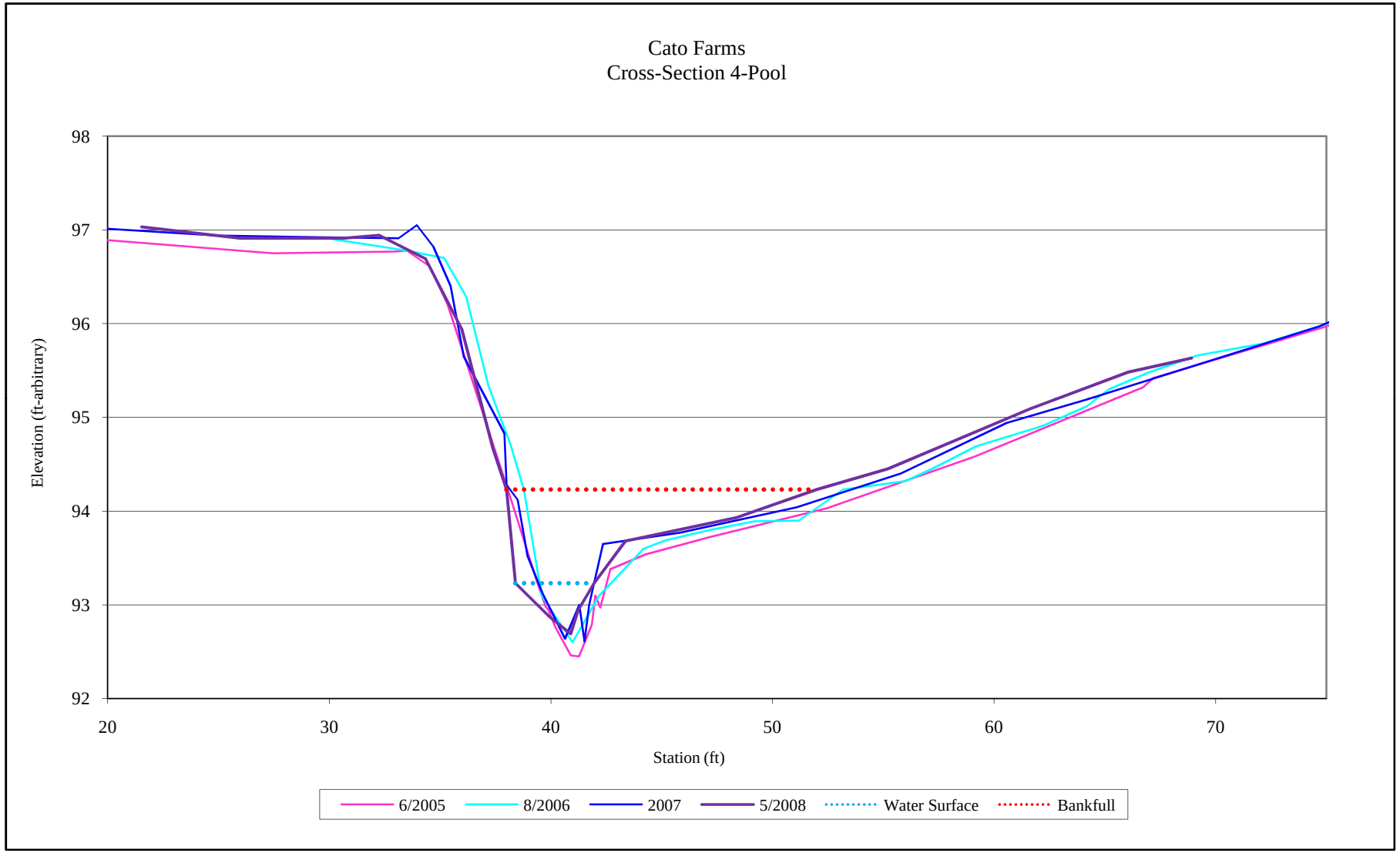
*Although bank erosion was recorded along the reach, the banks have not advanced from the previous monitoring year


Cato Farms
Cross-Section 1-Riffle
92
91
90
89
88
87
86
Elevation (ft-arbitrary)
0
5
10
15
20
25
30
35
Station (ft)
6/2005
8/2006
9/2007
5/2008
Water Surface
Bankfull

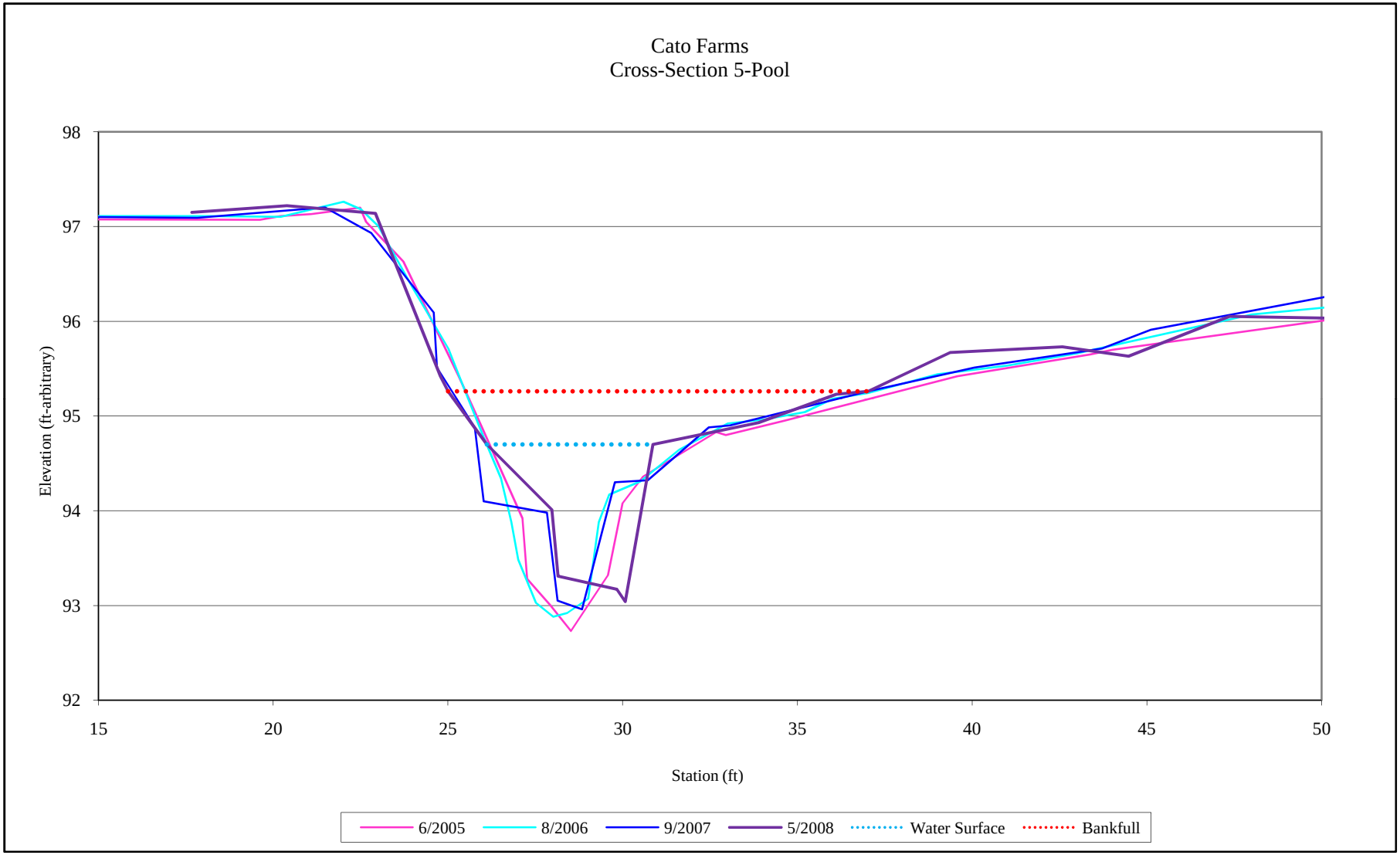

Cato Farms
Cross-Section 2-Riffle
Elevation (ft-arbitrary)
93
92
91
90
89
88
0
5
10
15
20
25
30
35
Station (ft)
6/2005
8/2006
2007
5/2008
Water Surface
Bankfull

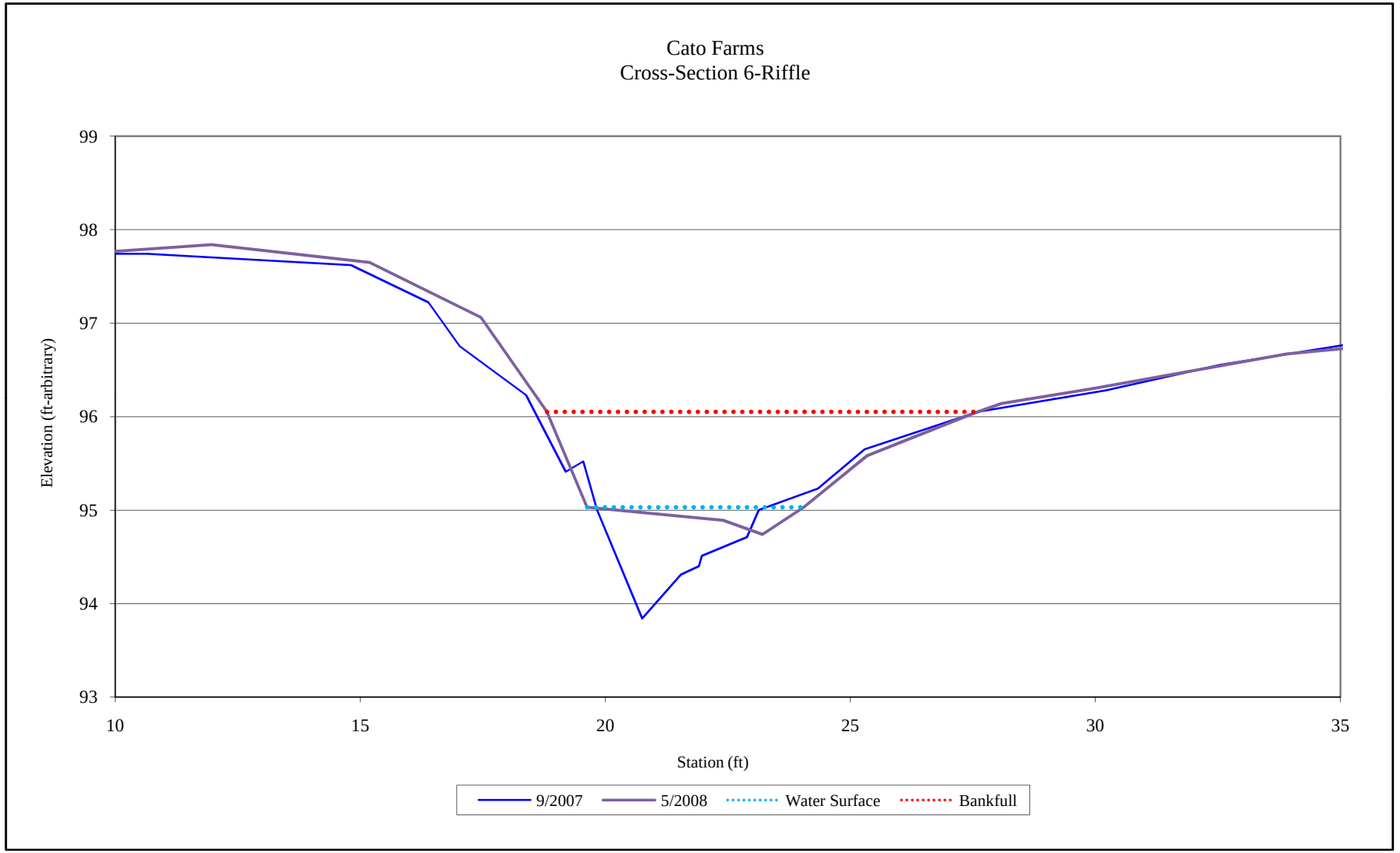


Appendix 2.6 Cross-Section Plots and Raw Data Tables
Cato Farms Stream Restoration
Year 4 of 5



Appendix 2.6 Cross-Section Plots and Raw Data Tables
Cato Farms Stream Restoration
Year 4 of 5


Cato Farms
Cross-Section 5-Pool
Elevation (ft-arbitrary)
98
97
96
95
94
93
92
15
20
25
30
35
40
45
50
Station (ft)
6/2005
8/2006
9/2007
5/2008
Water Surface
Bankfull

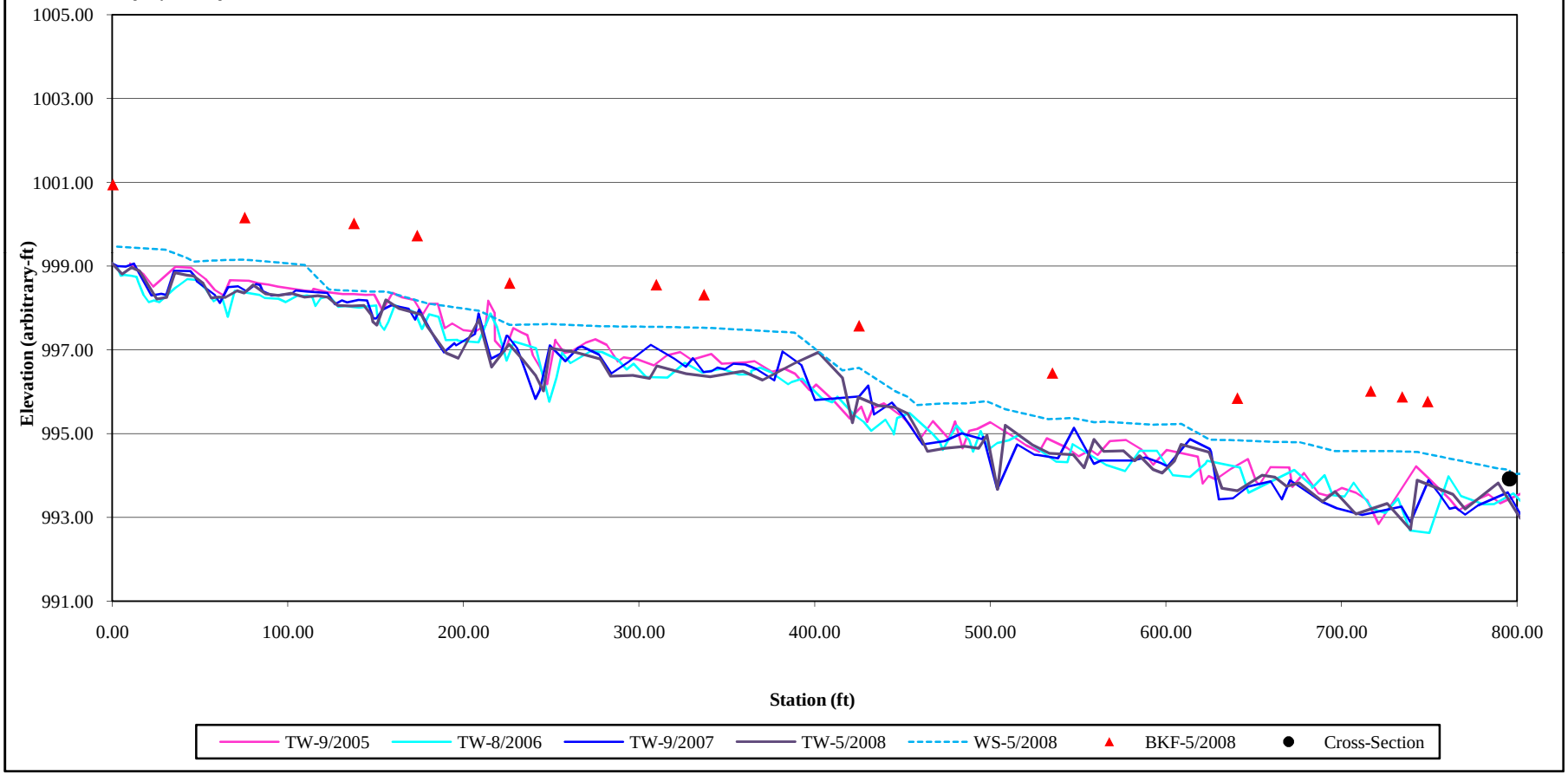


Appendix 2.6 Cross-Section Plots and Raw Data Tables
Cato Farms Stream Restoration
Year 4 of 5

Cato Farms
Longitudinal Profile
2008 Monitoring Year

Bankfull/Top of Bank = -0.0063*STA + 1000.7
Water Surface = -0.0064*STA + 999.39

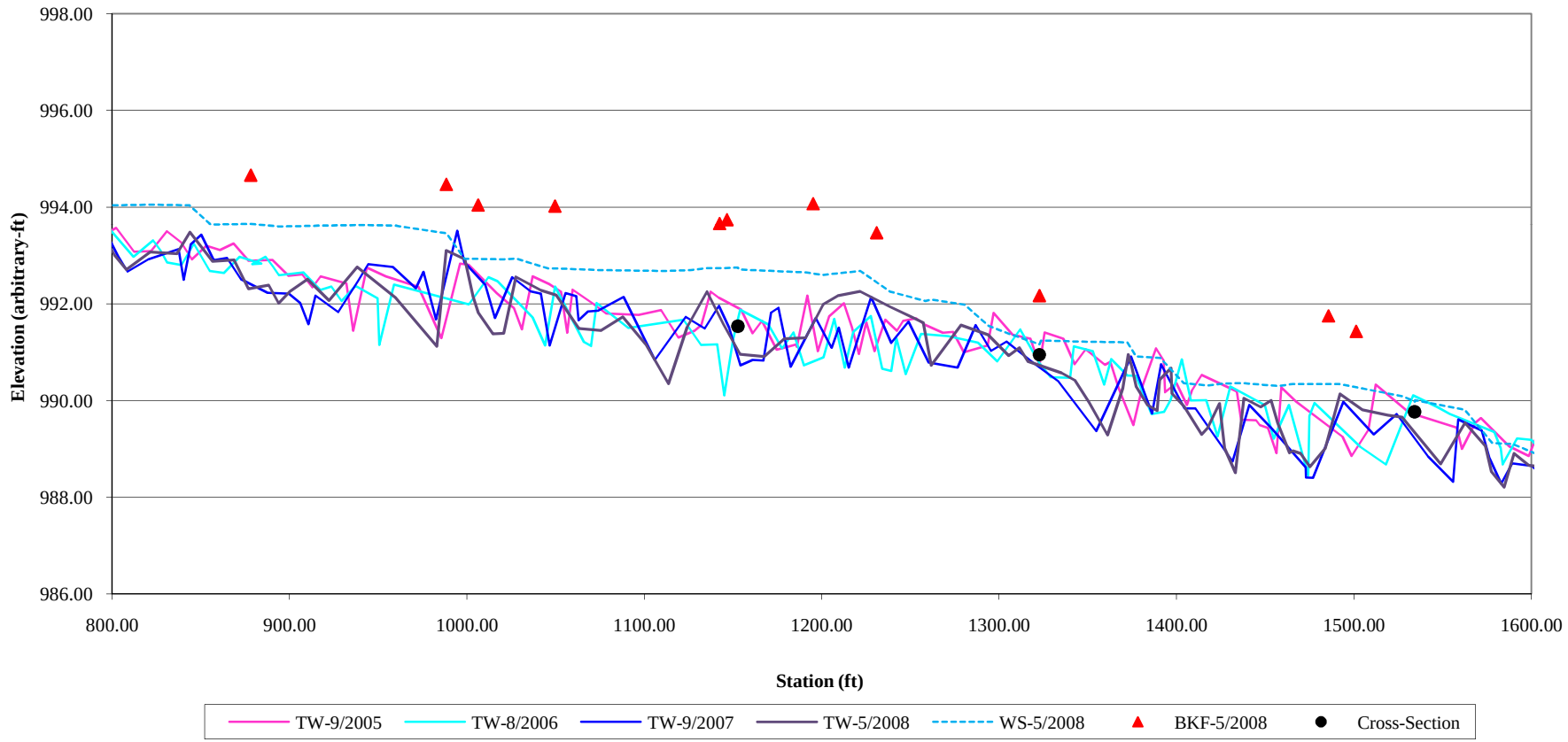
Slope equations represent entire reach.



Cato Farms
Longitudinal Profile
2008 Monitoring Year

Bankfull/Top of Bank = -0.0063*STA + 1000.7
Water Surface = -0.0064*STA + 999.39

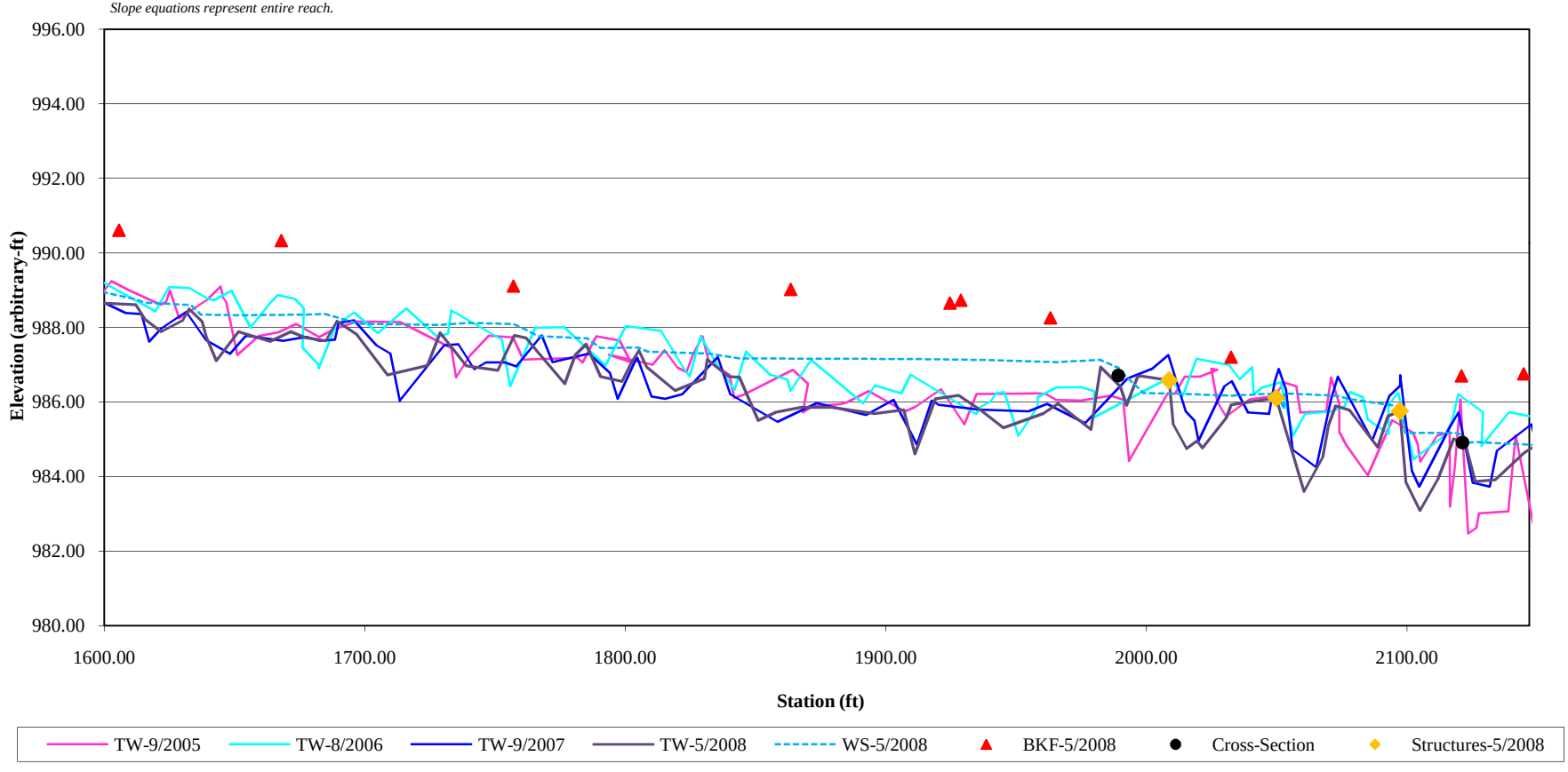
Slope equations represent entire reach.

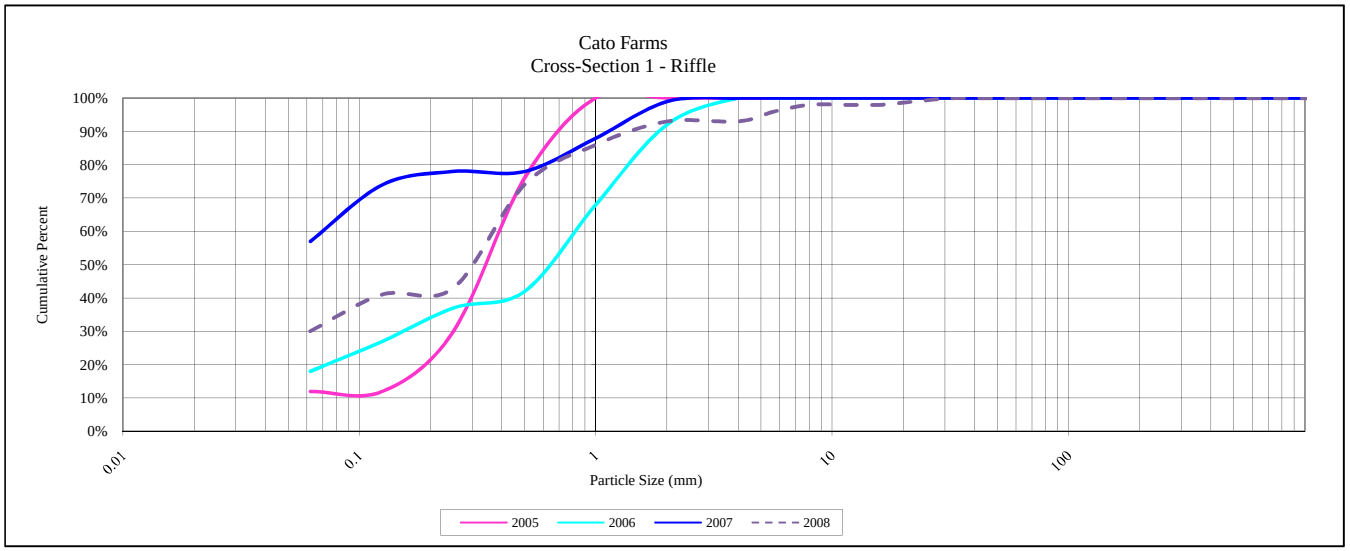


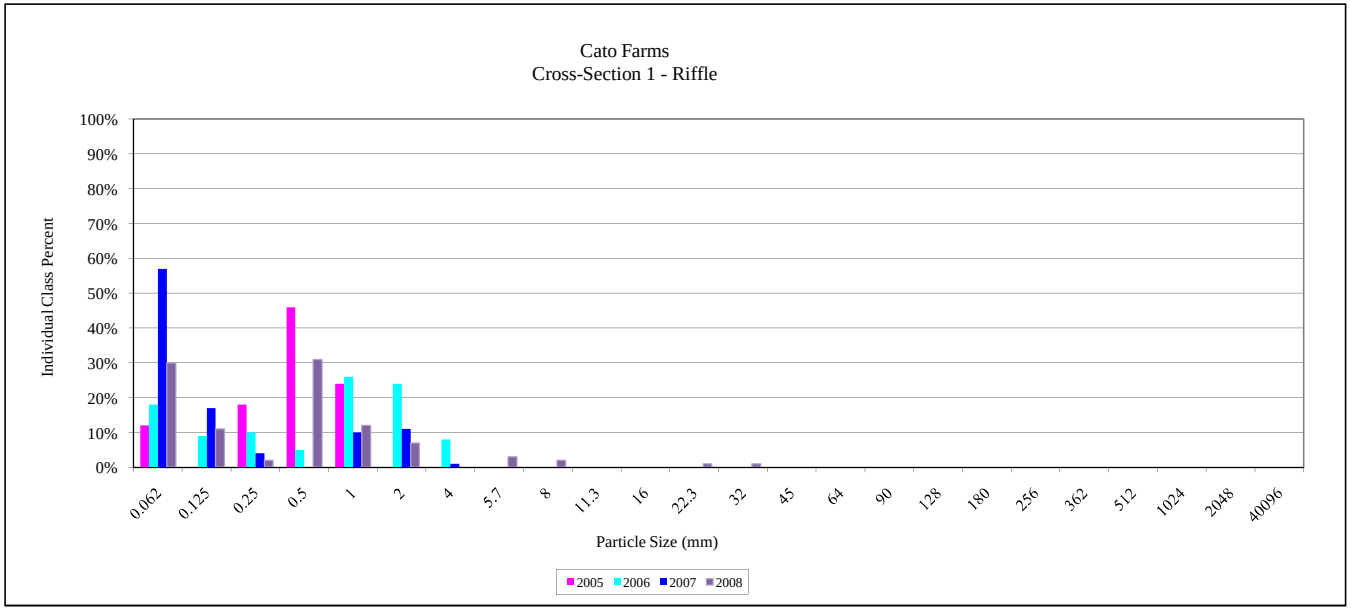
Cato Farms
Longitudinal Profile
2008 Monitoring Year

Bankfull/Top of Bank = -0.0063*STA + 1000.7
Water Surface = -0.0064*STA + 999.39

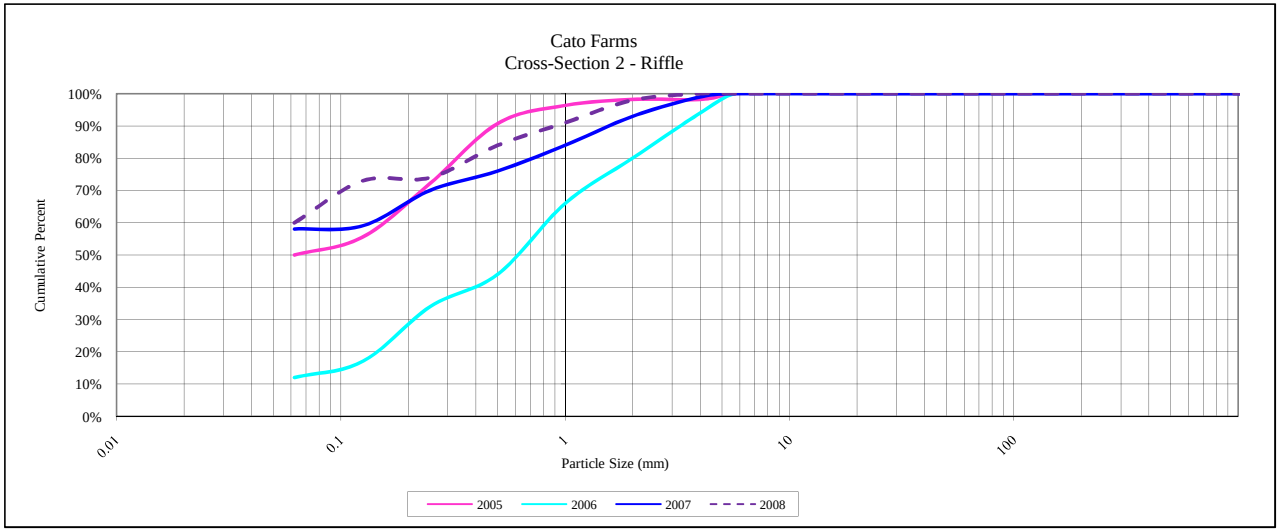
Slope equations represent entire reach.

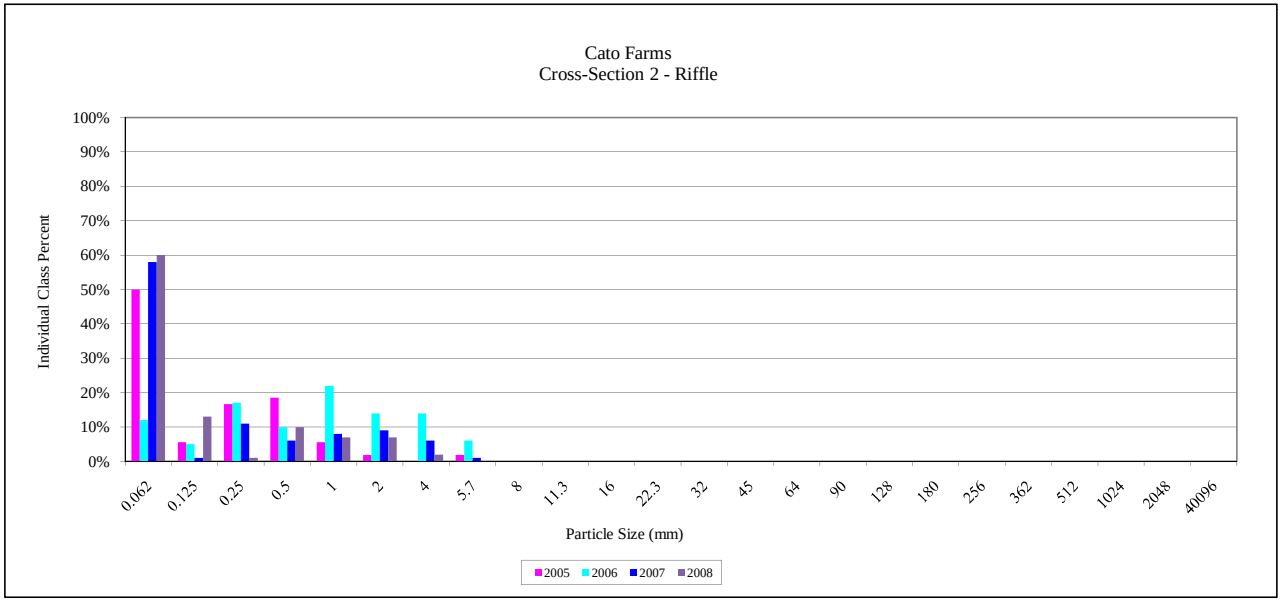


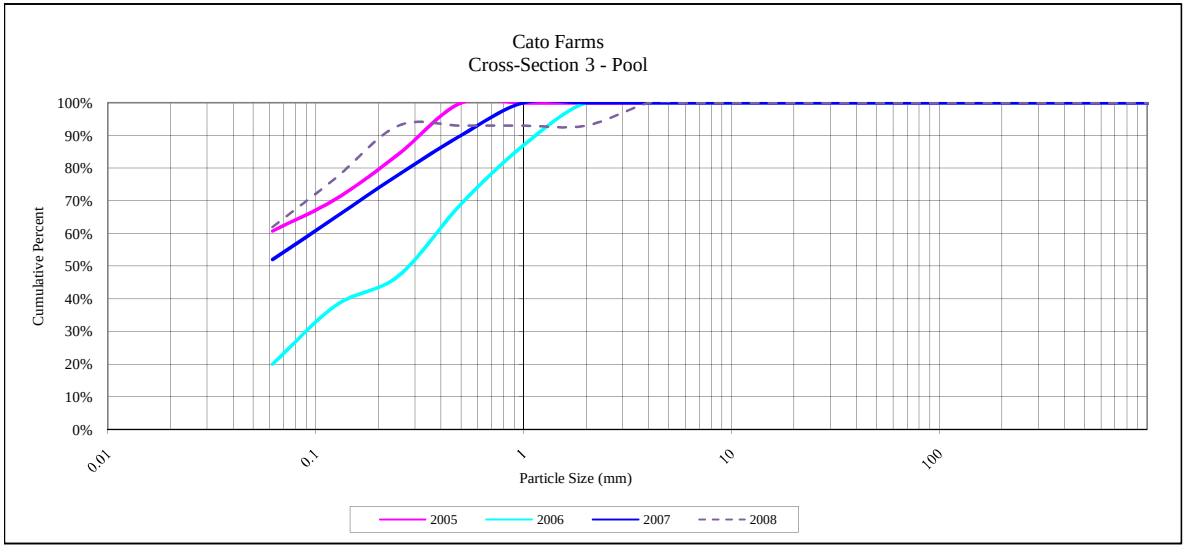


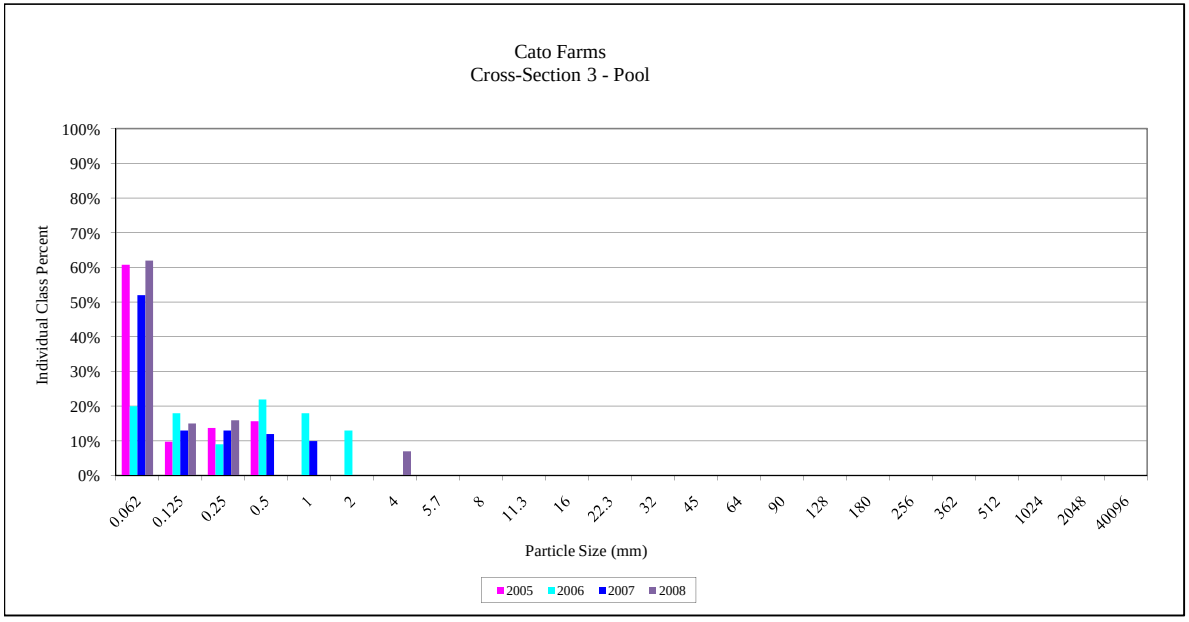


Appendix 2.8 Pebble Count Plots and Raw Data Tables
Cato Farms Stream Restoration
Year 4 of 5

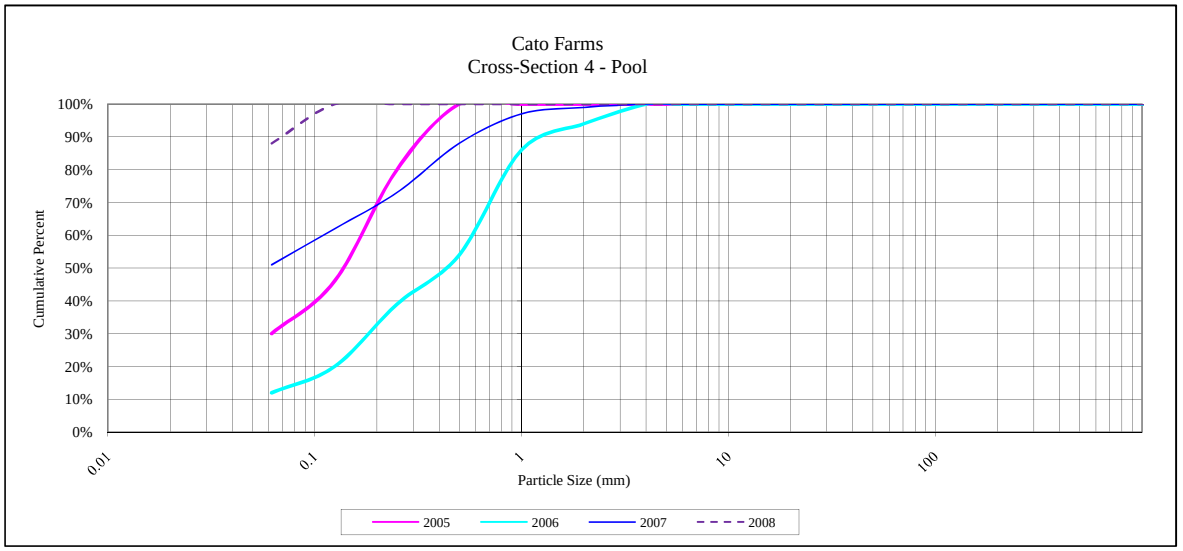

Cato Farms
Cross-Section 2 - Riffle
Cumulative Percent
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.1
1
10
100
Particle Size (mm)
2005
2006
2007
2008

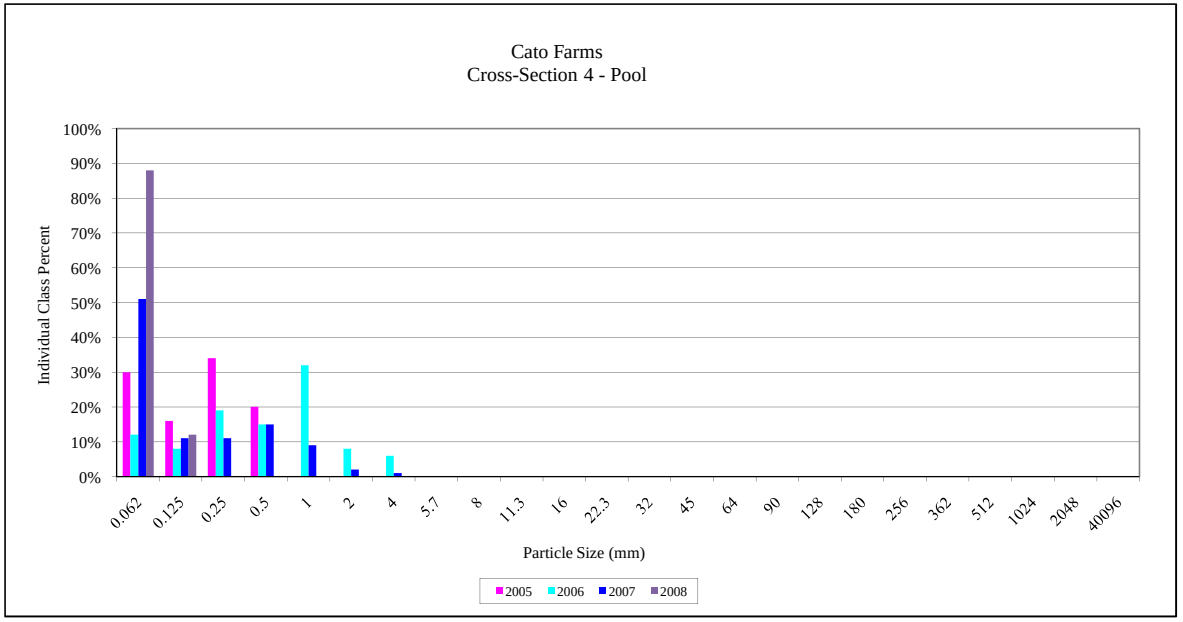

Cato Farms
Cross-Section 2 - Riffle
Individual Class Percent
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.062
0.125
0.25
0.5
1
2
4
5.7
8
11.3
16
22.3
32
45
64
90
128
180
256
362
512
1024
2048
4096
Particle Size (mm)
2005
2006
2007
2008



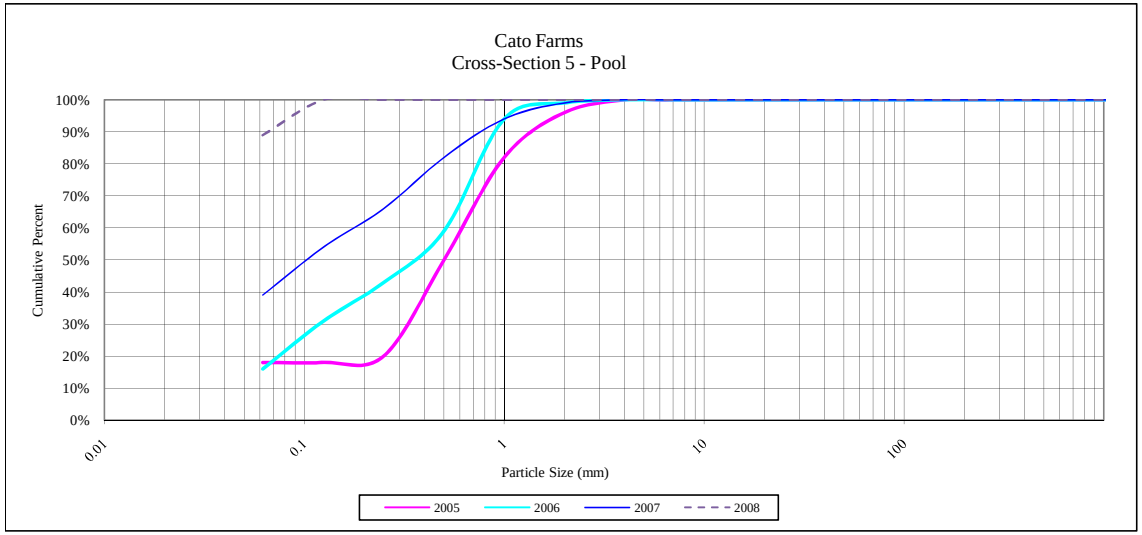


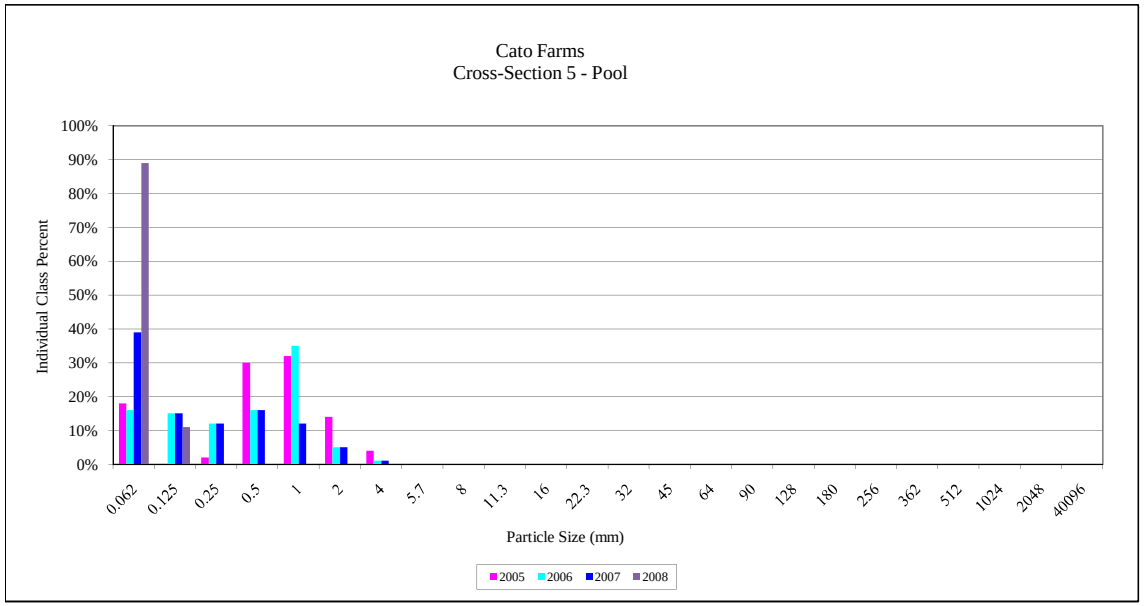
Appendix 2.8 Pebble Count Plots and Raw Data Tables
Cato Farms Stream Restoration
Year 4 of 5





Appendix 2.8 Pebble Count Plots and Raw Data Tables
Cato Farms Stream Restoration
Year 4 of 5

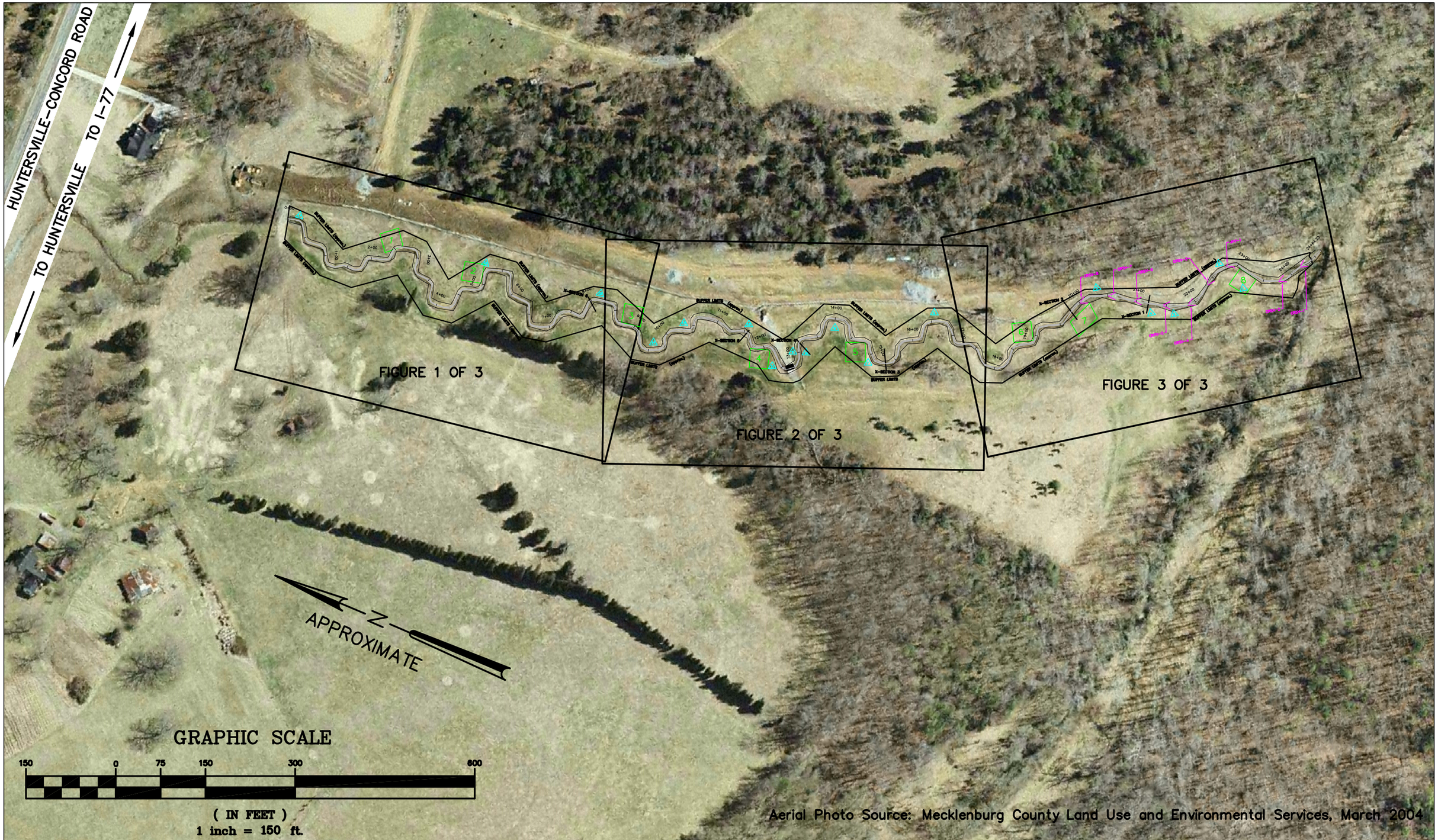




Appendix 2.8 Pebble Count Plots and Raw Data Tables
Cato Farms Stream Restoration
Year 4 of 5

APPENDIX 3
CURRENT CONDITION PLAN VIEW (INTEGRATED)

1. Current Condition Plan View Map (Integrated)



NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

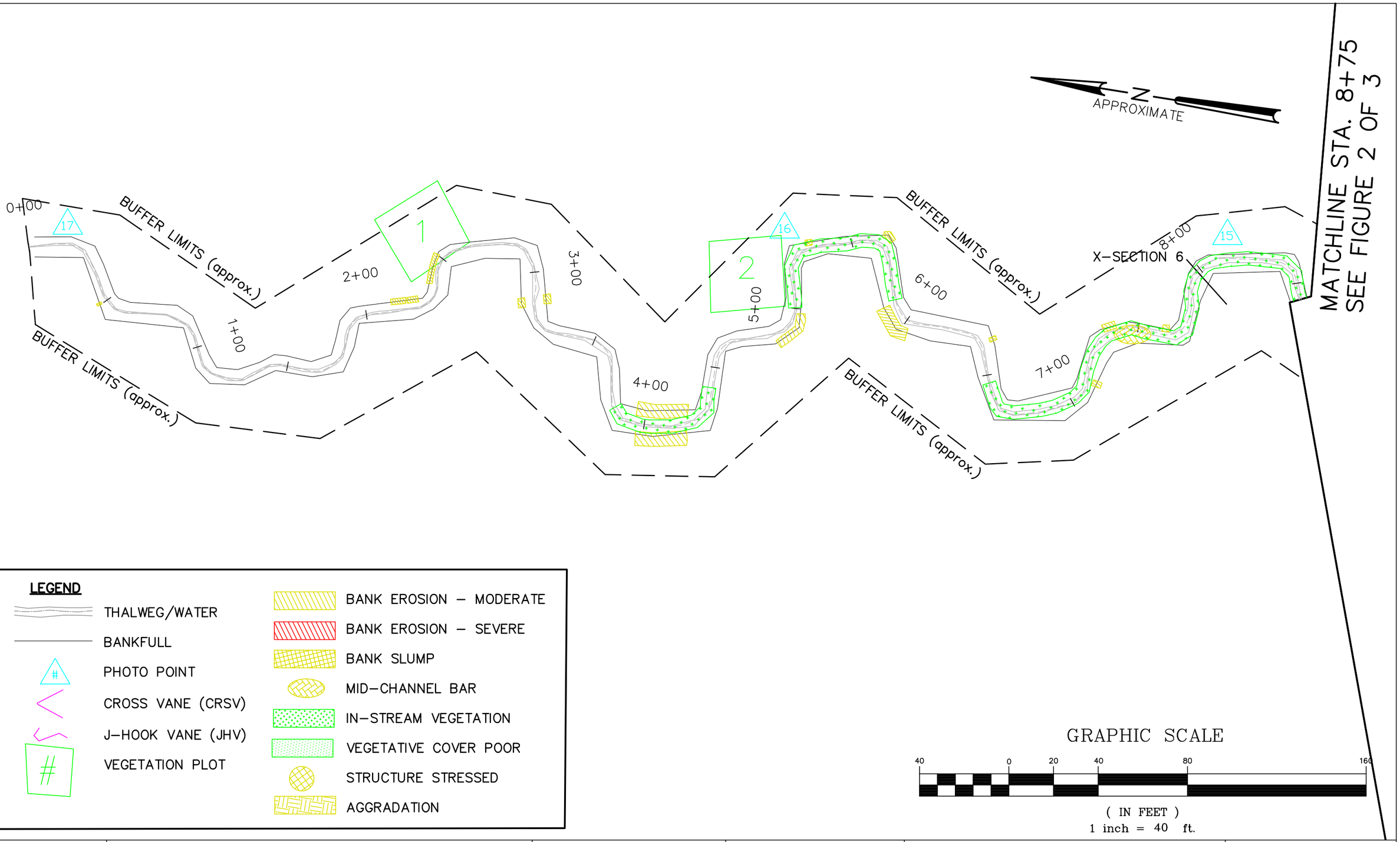
PROJECT NO. 72
MECKLENBURG COUNTY
NORTH CAROLINA
MONITORING
YEAR 4 OF 5

NC ECOSYSTEM ENHANCEMENT PROGRAM
CATO FARMS STREAM RESTORATION

APPENDIX 3
CURRENT CONDITION PLAN VIEW

DATE : FEBRUARY 2009
SCALE : 1"=150'
JOB NO.: 03060004

FIGURE KEY



LEGEND

- THALWEG/WATER
- BANKFULL
- PHOTO POINT
- CROSS VANE (CRSV)
- J-HOOK VANE (JHV)
- VEGETATION PLOT
- BANK EROSION – MODERATE
- BANK EROSION – SEVERE
- BANK SLUMP
- MID-CHANNEL BAR
- IN-STREAM VEGETATION
- VEGETATIVE COVER POOR
- STRUCTURE STRESSED
- AGGRADATION

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

Ecosystem Enhancement PROGRAM

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 72
MECKLENBURG COUNTY
NORTH CAROLINA
MONITORING
YEAR 4 OF 5

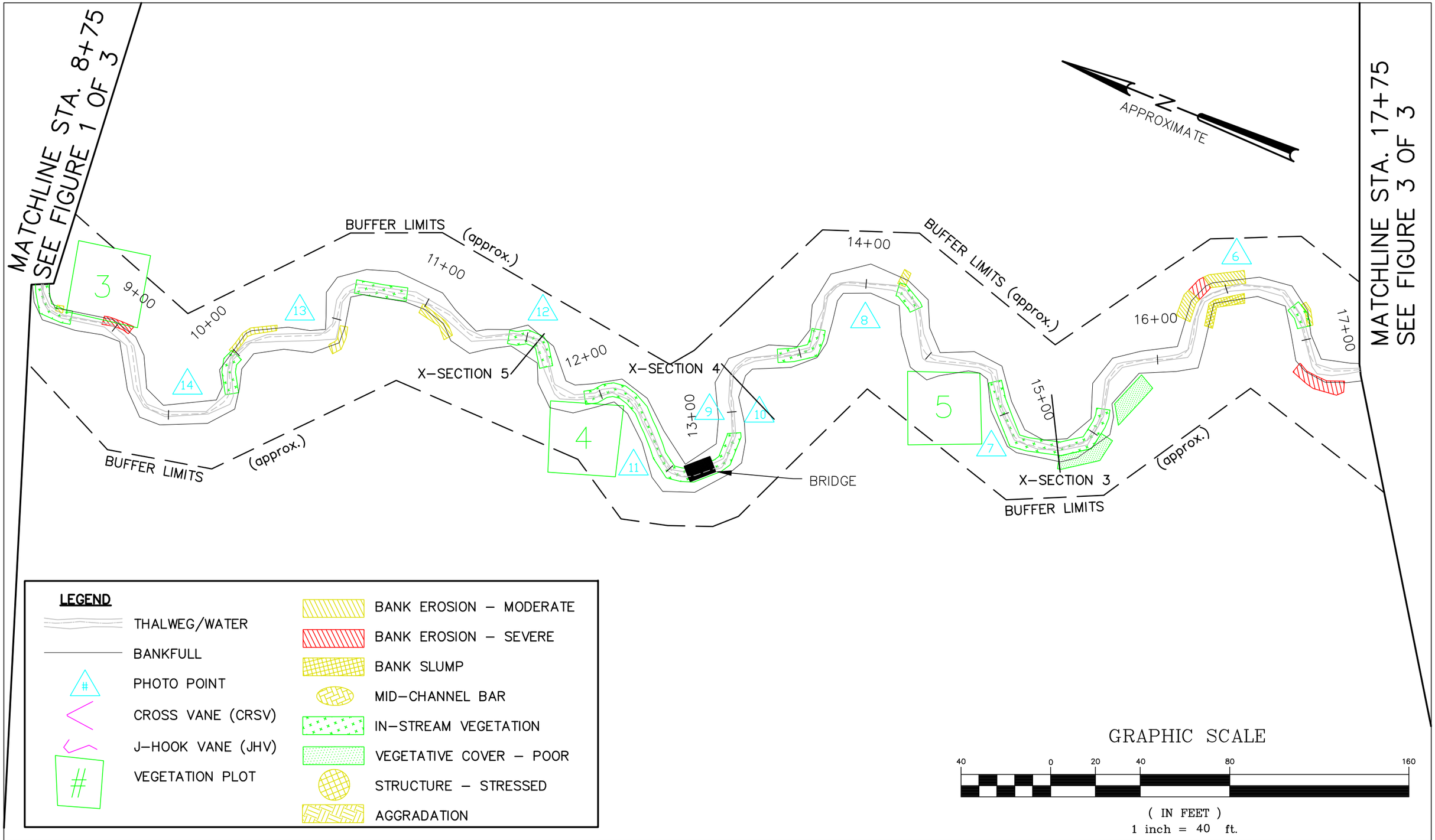
JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
CATO FARMS STREAM RESTORATION

APPENDIX 3
CURRENT CONDITION PLAN VIEW

DATE : FEBRUARY 2009
SCALE : 1"=40'
JOB NO.: 03060004

FIGURE 1 OF 3



LEGEND

- THALWEG/WATER
- BANKFULL
- PHOTO POINT
- CROSS VANE (CRSV)
- J-HOOK VANE (JHV)
- VEGETATION PLOT
- BANK EROSION – MODERATE
- BANK EROSION – SEVERE
- BANK SLUMP
- MID-CHANNEL BAR
- IN-STREAM VEGETATION
- VEGETATIVE COVER – POOR
- STRUCTURE – STRESSED
- AGGRADATION

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

Ecosystem Enhancement PROGRAM

NOTES:
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PROJECT NO. 72
MECKLENBURG COUNTY
NORTH CAROLINA
MONITORING
YEAR 4 OF 5

JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
CATO FARMS STREAM RESTORATION

APPENDIX 3
CURRENT CONDITION PLAN VIEW

DATE : FEBRUARY 2009
SCALE : 1"=40'
JOB NO.: 03060004

FIGURE 2 OF 3

MATCHLINE STA. 17+75
SEE FIGURE 2 OF 3

APPROXIMATE N

CRSV-8
CRSV-7
CRSV-6
CRSV-3
JHV-1
CRSV-5
CRSV-4
CRSV-2
CRSV-1

X-SECTION 2
X-SECTON 1

BUFFER LIMITS (approx.)

18+00
19+00
20+00
21+00
22+00
23+00
24+00
24+64.23

LEGEND

- THALWEG/WATER
- BANKFULL
- PHOTO POINT
- CROSS VANE (CRSV)
- J-HOOK VANE (JHV)
- VEGETATION PLOT
- BANK EROSION – MODERATE
- BANK EROSION – SEVERE
- BANK SLUMP
- MID-CHANNEL BAR
- IN-STREAM VEGETATION
- VEGETATIVE COVER – POOR
- STRUCTURE – STRESSED
- AGGRADATION

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

Ecosystem Enhancement PROGRAM

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 72
MECKLENBURG COUNTY
NORTH CAROLINA
MONITORING
YEAR 4 OF 5

JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
CATO FARMS STREAM RESTORATION

APPENDIX 3
CURRENT CONDITION PLAN VIEW

DATE : FEBRUARY 2009
SCALE : 1"=40'
JOB NO.: 03060004

FIGURE 3 OF 3