EEP Project Closeout Summary

Project ID and Status		Project Setting and Background		Project Timeline	
Project Name:	Forest Hills	**Basin:**	Cape Fear	**Restoration Plan:**	February 2003
EEP ID:	139	**Physiographic Region:**	Piedmont	**Construction Complete:**	Jan 2005
County:	Durham	**Ecoregion:**	Triassic Basin	**Monitoring Year 1:**	Sept 2005
Project Type:	Stream Restoration	**14-Digit HUC:**	03030002060120	**Monitoring Year 2:**	Sept 2006
Current Status:	5 years of monitoring complete	**NCDWQ Sub-basin:**	03-06-05	**Monitoring Year 3:**	July 2007
		Thermal Regime:	Warm	**Monitoring Year 4:**	July 2008
		Trout Water:	No	**Monitoring Year 5:**	July 2009
		Designer:	KCI Associates of North Carolina		
		Monitoring:	KCI Robert J. Goldstein & Associates		

Table 1. Project Restoration Components and Mitigation Assets

Stream		Asset Data						
Drainage/Hydrology Component	**Stationing**	**Asset Map #**	**Approach**	**Level**	**Ratio**	**Ratio Multiplier**	**Feet**	**SMU**
After culvert under East Forest Hills Blvd at University Drive and Vickers Avenue intersection to culvert under East Forest Hills Boulevard	10+00 to 30+90	1	P2	R	1.00	1.00	2,038	2,023
After culvert under East Forest Hills Boulevard to the southern edge of the conservation easement east of Forestwood Dr. and Wilshire Dr. intersection	31+48 to 40+31	2	P2	R	1.00	1.00	899	899

Asset Summary

Level	Feet	SMU
R	2,922	2,922

Figure 1. Project Asset Map.

Figure 2. Example Pre-existing Condition Photos

Upstream Project limits. (East Forest Hills Drive culvert/pipe, looking upstream.)

Typical degraded section in downstream project area. (Sta. 34+00, looking downstream.)

Incised stream section in upstream project area. (Near Sta. 13+00, looking downstream.)

Typical degraded stream section in upstream project area. (Near Sta. 15+40, looking downstream.)

Figure 3. Monitoring Year 1 and Monitoring Year 5 Comparison Photos

PP #1 – Looking Upstream

MY 1 (2005)

Closeout (04/19/10)

PP #4 – Looking Downstream

MY 1 (2005)

Closeout (04/19/10)

PP #5 –UT Entering Stream

MY 1 (2005)

Closeout (04/19/10)

PP #8 – Looking Upstream

MY 1 (2005)

Closeout (04/19/10)

PP #10 – Looking Downstream

MY 1 (2005)

Closeout (04/19/10)

PP #13 – Looking Upstream

MY 1 (2005)

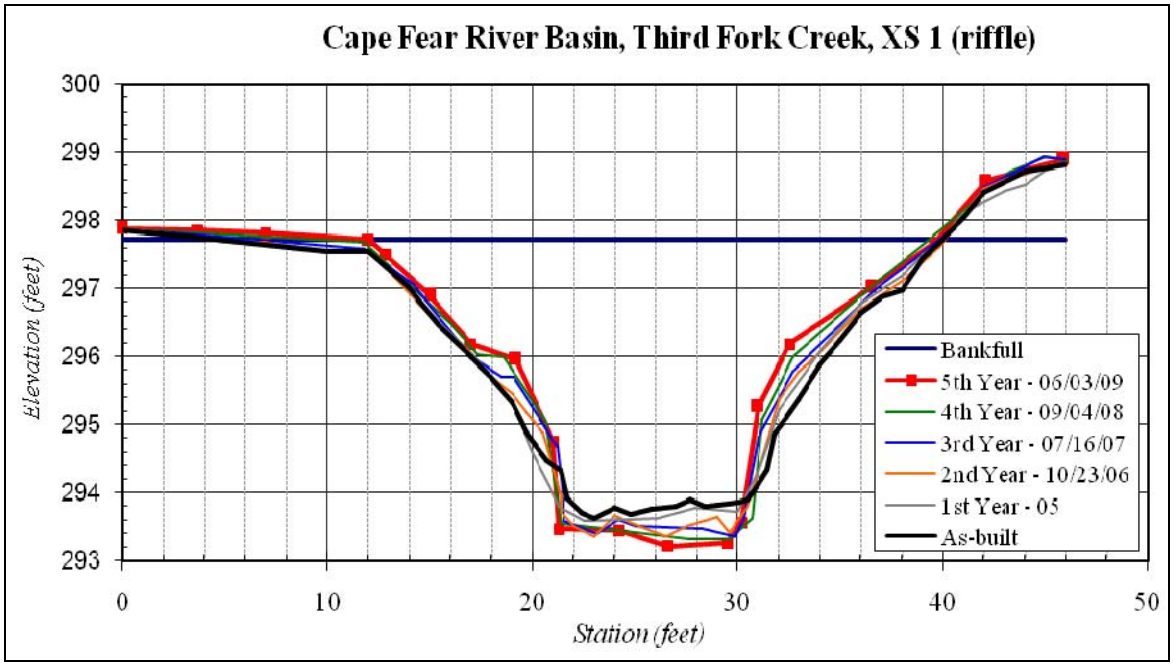
Closeout (04/19/10)

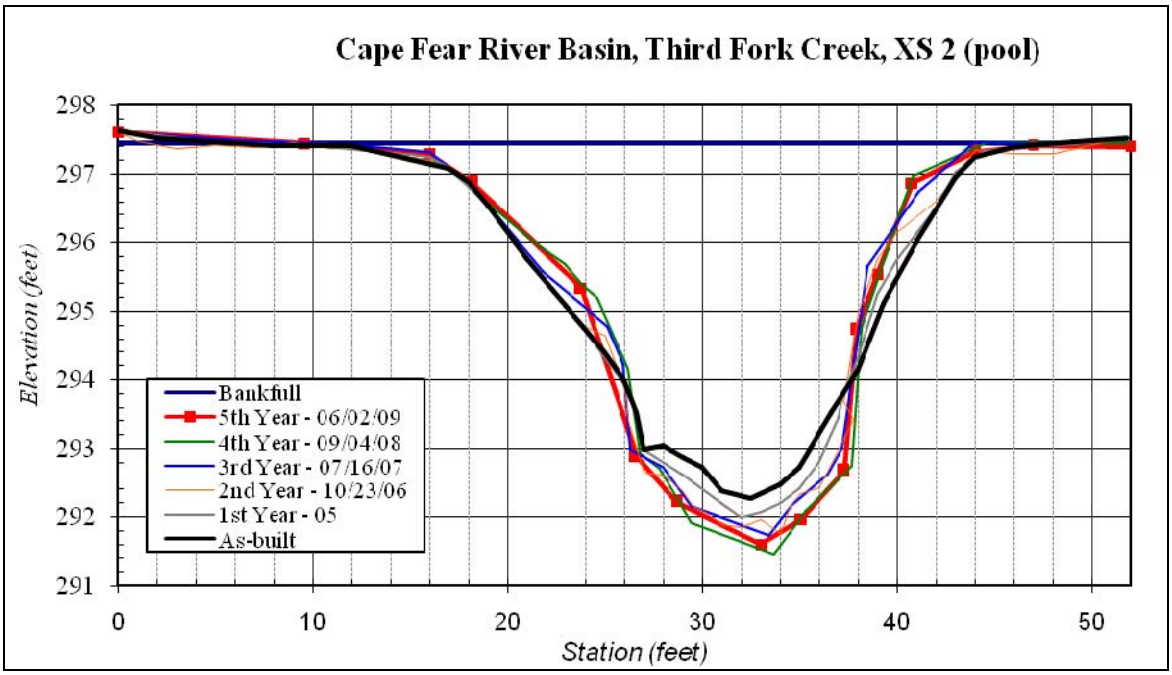
Channel Stability

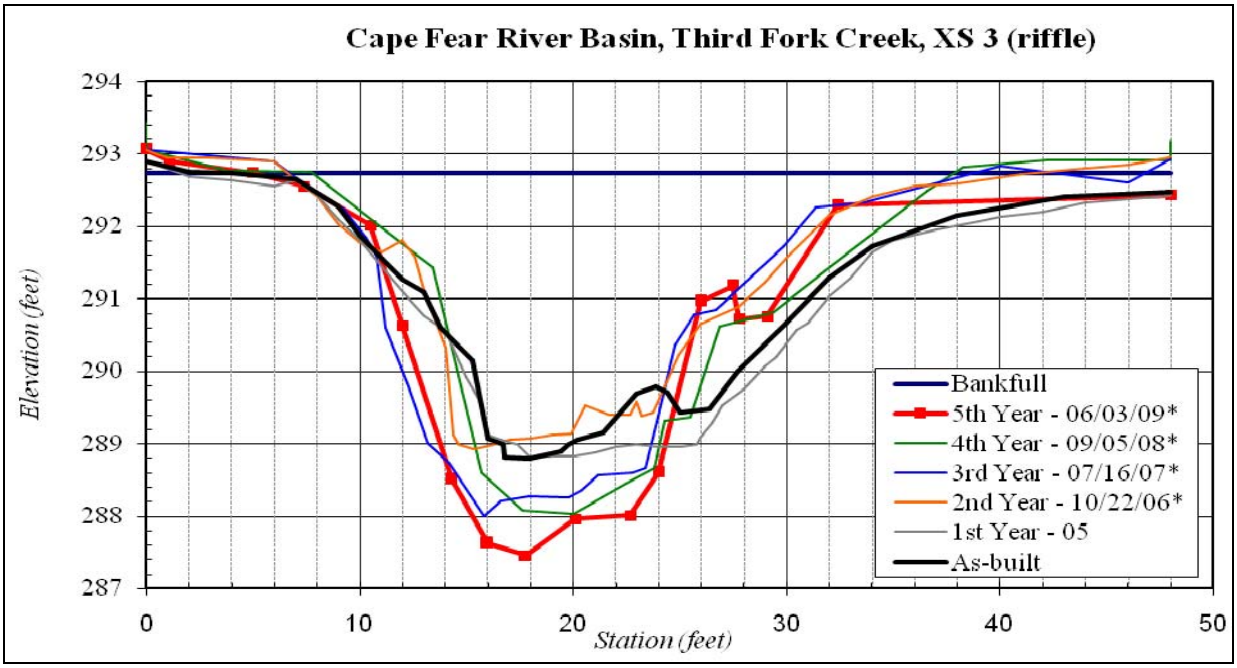
Dimension

Repeat survey data indicates project X-sections have been characterized by some incision and also channel narrowing. Despite the incision, grade control structures still rated at or above 95 % stable in the monitoring year-5 visual assessment indicating overall project stability. Narrowing was due in part to the success of stream bank vegetation (primarily *Salix nigra* and *Cornus amomum*). As the site has matured the system has stabilized and these problems declined. Four X-sections were installed on the site during the as-built survey and surveyed for all five monitoring years. The endpoints for X-sections three and four could not be relocated in 2006 and new endpoints were established based on available data. Figure 5 shows the change in channel appearance that occurred between Monitoring Years 1 and 5.

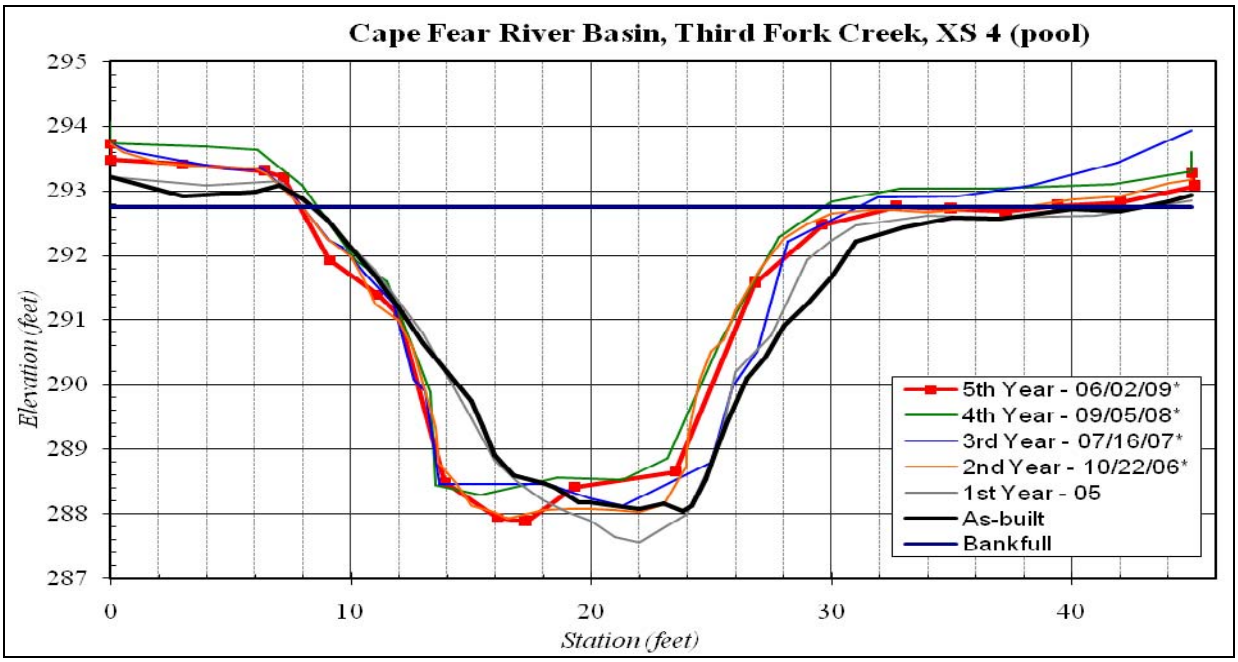
Figure 4. Annual X-Section Plots







*X-section ends could not be relocated in 2006. Ends re-established based on available GIS data and best professional judgment.



* X-section ends could not be relocated in 2006. Ends re-established based on available GIS data and best professional judgment.

Figure 5. X-Section 1 Photo MY 1 and MY 5

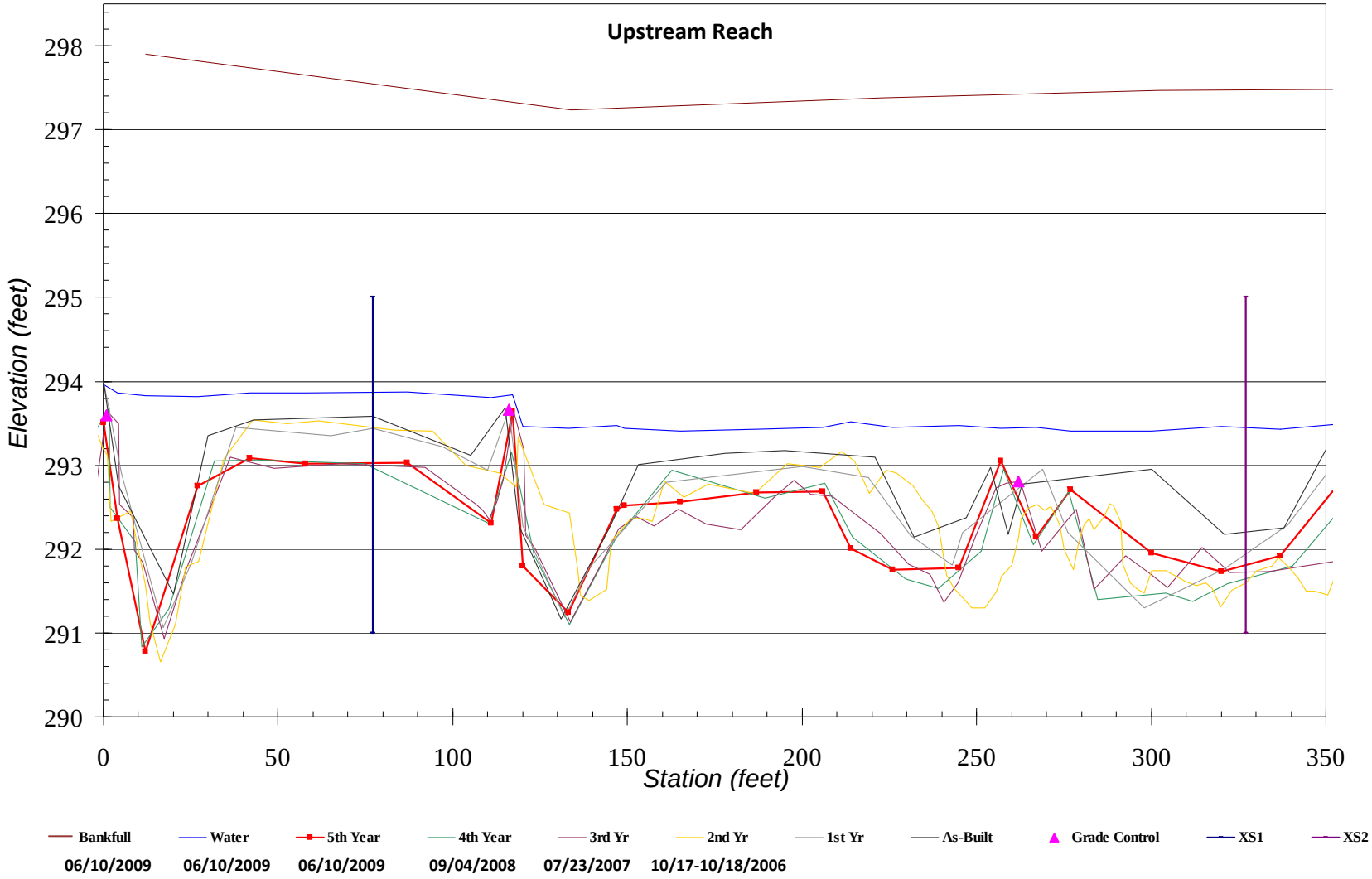
MY 1 (2005)

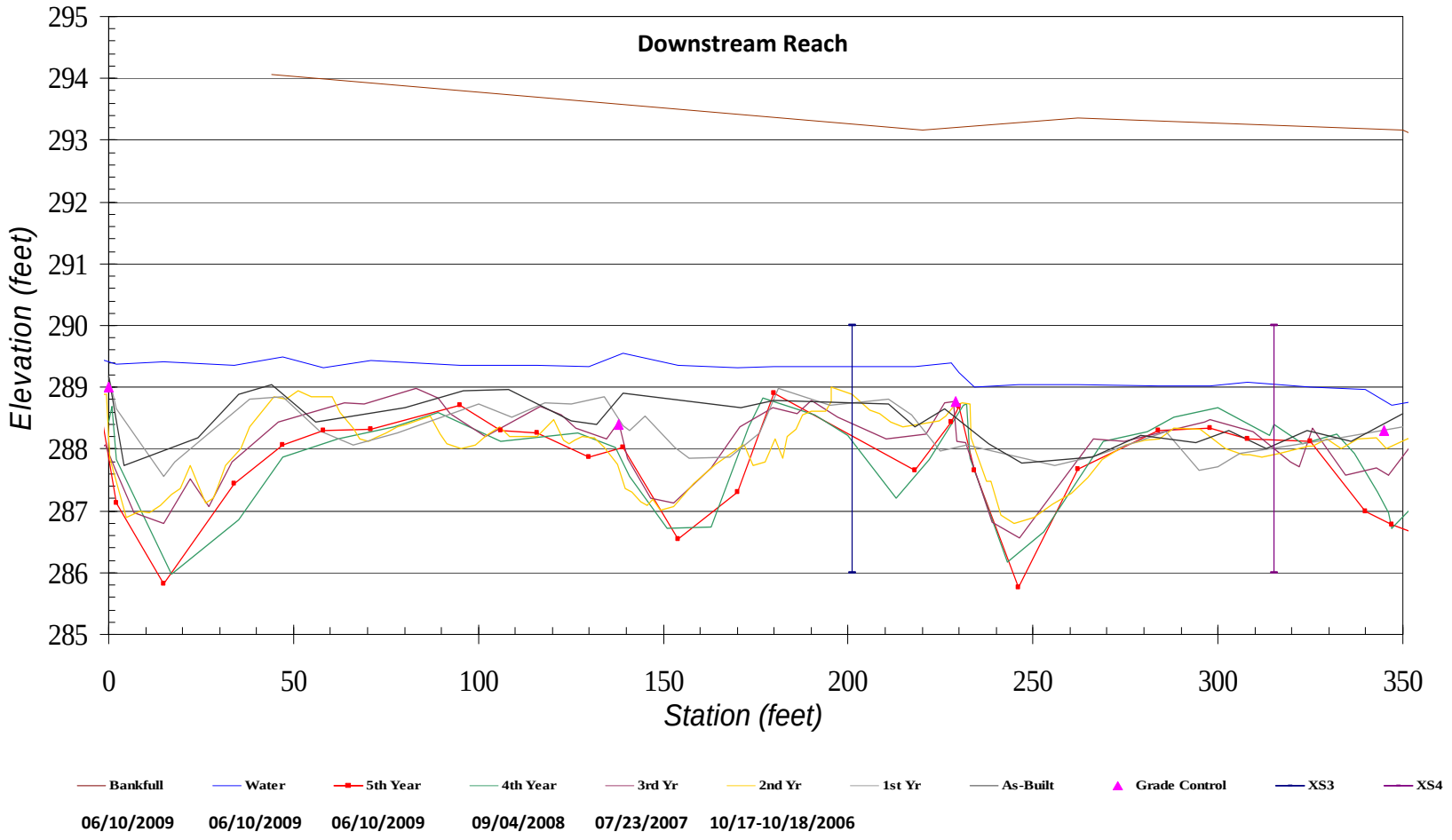
MY 5 (2009)

Profile

Repeat longitudinal profile data indicates the site initially experienced some bed degradation, but stabilized in Monitoring Years 4 and 5. Approximately 350 feet of both the upstream and downstream reaches of the project were surveyed for all five monitoring years. Slope and spacing varied from year to year, but the overall riffle-pool morphology was maintained.

Figure 7. Longitudinal Profile Plot for Upstream and Downstream Reaches




Downstream Reach
Elevation (feet)
295
294
293
292
291
290
289
288
287
286
285
0
50
100
150
200
250
300
350
Station (feet)
Bankfull
Water
5th Year
4th Year
3rd Yr
2nd Yr
1st Yr
As-Built
Grade Control
XS3
XS4
06/10/2009
06/10/2009
06/10/2009
09/04/2008
07/23/2007
10/17-10/18/2006

Substrate

The restoration plan (KCI Associates of NC, 2003) reported the existing median (d50) channel grain size was medium sand (0.31mm and 0.41 mm in the upper and lower reaches, respectively) and that the project design would not attempt to alter the caliber of bed material. Repeat pebble count data shows median riffle particles have ranged from very fine sand to coarse sand and recent visual assessments indicate sand bar formation, particularly in the upstream portion of the project. This is likely related to eroding stream banks upstream of the restoration site.

Table 2. Riffle X-Section Substrate Means

X-Section	MY1	MY2	MY3	MY4	MY5	Average
XS 1	0.06 Very fine sand	0.04 Very fine sand	0.36 Medium sand	0.04 Very fine sand	0.04 Very fine sand	0.11 Very fine sand
XS 3	0.49 Medium sand	6.27 Fine gravel	0.76 Coarse sand	0.76 Medium sand	0.06 Very fine sand	1.67 Very coarse sand

Status of Engineered Structures and Stream Bank Stability

Grade control structures at the site consisted of rock cross vanes and j-hooks, and overall the structures were stable and functioning as intended. Due to upstream, off-site sources, the first three pools associated with cross-vanes at the northern end of the project are filled with fine sediment. However this condition is not considered a structural failure and the fine sediment may be expected to be mobilized out of pools depending on future reach sediment balances. A few j-hook structures have experienced backcutting but project structure stability rated at or above 95 % in the monitoring year 5 visual assessment (Figure 6).

Some stream bank scour and slumping has occurred along the project, however, as the channel shape stabilized and riparian vegetation became more established this problem declined. During the last evaluation, less than 5 % of the total bank length was identified as erosional. This amount of bank erosion is considered a success, particularly in comparison with pre-project conditions (Figure 2).

Figure 6. Grade-control structure at confluence of leftbank tributary (04/15/10)

Bankfull Hydrology Data

Onsite observations and evaluation of a crest gauge installed on 13 June 2007, indicated that the site experienced at least one bankfull event during each monitoring year, exceeding the success criteria of two bankfull events in separate years over the five-year monitoring period. Table 3 outlines bankfull verification for the site.

Table 3. Verification of Bankfull Events

Date of Data Collection	Date of Occurrence	Method
16 July 2007	13 June 2007 (crest gauge installation date) – 16 July 2007 CRONOS data suggest 14 June or 11 July 2007*	Crest gauge evaluation; On-site high water indicators
12 October 2007	16 July 2007 – 12 October 2007 CRONOS data suggest 28 July, 15 August, or 23 August 2007*	Crest gauge evaluation; On-site high water indicators
6 May 2008	12 October 2007 – 5 May 2008 CRONOS data suggest 4 March 2008 or 27-28 April 2008*	Crest gauge evaluation; On-site high water indicators
28 October 2008	6 May – 28 October 2008 CRONOS data suggest 5 July, 28 August, 6 September, and 26 September 2008*	Crest gauge evaluation; On-site high water indicators
6 March 2009	29 October 2008 – 6 March 2009 CRONOS data suggests 2 March 2009*	Crest gauge evaluation; On-site high water indicators
17 July 2009	7 March 2009 – 17 July 2009 CRONOS data suggest 5 June and 10 June 2009*	Crest gauge evaluation; On-site high water indicators

*Based on data from State Climate Office of North Carolina NC CRONOS database (http://www.nc-climate.ncsu.edu/cronos/) for ECONET station DURH and CoCoRaHS station NC-DH-6.

Vegetative Performance

Planted buffer vegetation is successful along the project. All 8 vegetation monitoring plots exceeded 260 planted stems per acre in monitoring year 5 and had an average planted density of 829 stems per acre. In Monitoring Year 2, the CVS-EEP protocol was adopted and revised vegetation monitoring plots were established. Given that the data collected in MY1 was not comparable to data collected in later years, it is not included in Table 4.

As outlined in the 2003 Restoration Plan, park utilization requirements dictated that the 30-foot riparian buffer adjacent to the channel could be fully forested, but the next 20 foot wide strip was planted with native grasses. Additional portions of the buffer adjacent to existing utilities needed to be left free of woody vegetation. The conservation easement depicted in Figure 1 has an average riparian buffer width of at least 50 feet.

A number of exotic invasive species have been identified on the site. Of particular concern were Japanese knotweed (*Polygonum cuspidatum*) and Japanese hops (*Humulus japonicas)*. The site was initially treated for invasive species in 2008 and follow-up treatments are scheduled for 2010 and 2011.

Table 4. Planted Live Stem Counts per Acre by Monitoring Year and Plot

Monitoring Year	Vegetation Plot								
	1	2	3	4	5	6	7	8	Average
1	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	1,335	1,173	1,295	486	405	1,578	688	405	900
3	1,295	1,173	1,254	445	405	1,537	688	405	880
4	1,416	1,173	1,335	445	405	1,295	688	405	875
5	1,335	1,173	1,173	445	405	1,173	688	405	829

Project Goals, Outcomes, and Conclusions

This report summarizes the key information provided in the project's restoration plan, mitigation plan, and monitoring reports. Further details can be found in those materials, which may be accessed on the NCEEP website (http://www.nceep.net/eep_projects.html). According to the 2003 Restoration Plan, the project's goals and objectives were to (a) restore a stable channel morphology capable of moving the watershed's flows and sediment; (b) reduce sediment-related water quality impacts resulting from lateral bank erosion and bed degradation; (c) improve aquatic habitat diversity by establishing a riffle-pool bed variability and using in-stream structures; (d) restore a vegetative riparian buffer using native plant species; and (e) improve natural aesthetics in an urban park setting.

Geomorphic data collected on site over the 5-year monitoring period indicated that the restoration project has resulted in a stable channel and robust riparian buffer. Although longitudinal profile and X-section plots indicate some initial downcutting, this has stabilized. Similarly, lateral movement of the channel declined as stream bank vegetation has become more established. Overall, the site maintained a riffle-pool morphology and most in-stream structures were stable and helped create a variety of aquatic habitats. Sediment loading from upstream sources is apparent, but the project reaches have generally been effective at transporting input material. Planted vegetation density at the site was excellent and a native riparian buffer was well-established.

EEP considers the project to be functioning well and seeks regulatory closure on the assets detailed in Table 1.