MONITORING YEAR 1 AND 2 REPORT

BOWLIN-PEAK CREEK MITIGATION SITE

Ashe County, North Carolina

FINAL

EEP Project Number: 92606
Contract Number: D06082; Task Order: 06NW01-1

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Ecosystem Enhancement PROGRAM

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1 Executive Summary

This report summarizes the 2008 monitoring year 1 (MY1) and 2009 MY2 condition of the Peak Creek mitigation project on 2,719 linear feet (lf) of Peak Creek, located in the New River drainage, Ashe County, North Carolina. Existing condition and as-built data comparisons are presented where possible.

The enhancement project's goal was to improve aquatic habitat, riparian area vegetation, and stream channel stability in order to meet stream mitigation requirements. The objectives were to increase fish habitat diversity by installing root wads, rock cross vanes, and rock vanes, stabilize, reslope, and revegetate eroding stream banks to make the banks more resistant to erosion and flooding, eradicate invasive exotic plant species, and implement a farm management plan to reduce stream impacts from livestock, plant native trees, shrubs, on all disturbed banks and on the floodplain to provide long-term bank stability, stream shading, and cover and food for wildlife, and protect the stream and riparian corridor through the purchase of a permanent conservation easement. Project construction was completed in October 2007.

During the stream visual assessments, three potential areas of concern were identified in MY1 - 30 ft of eroding stream bank and two small center bars. Only two of the previously identified areas of concern were identified in MY2, the eroding stream bank and one small center bar that was present prior to enhancement activities. Over the two monitoring years the stream bank has eroded and the stream channel has migrated several feet to the left, when looking downstream. Live stakes were planted along the eroding stream bank during the MY2 survey to help stabilize it. This eroding stream bank constitutes <1% of the total stream bank on the project.

Two bankfull or greater events were recorded by the on-site crest gage. Each event took place in a different monitoring year, September 2008 and May 2009.

The enhancement work did not change the stream channel's overall pattern. Installation of log and rock structures with their associated pools did result in changes in the longitudinal profile. As expected, the stream channel has adjusted slightly since the as-built survey, but it appears to have stabilized between MY1 and MY2. The channel slope has remained unchanged over the two years of monitoring at 0.0093 ft/ft. Mean riffle length increased from 30.8 ft during the as-built survey to 34.0 ft in MY1 and 33.0 ft in MY2. The mean pool lengths have decreased slightly over time; 35.1 ft from the as-built survey to 32.2 ft in MY1 and 27.8 ft in MY2. Mean pool-to-pool spacing has followed the same trend, with an as-built survey value of 35.1 ft decreasing to 32.2 ft in MY1 and 27.8 ft in MY2.

Seven permanent stream channel cross-sections, four riffles and three pools, were monitored along the project. Some channel adjustments have occurred after construction, mostly within the first year. Mean riffle bankfull width increased slightly from 30.1 ft in the as-built survey to 31.2 ft in MY1 and 32.2 ft in MY2. Mean riffle cross-section area also increased slightly from 47.9 ft^2 in the as-built survey to 52.7 ft^2 in MY1 and 52.4 ft^2 in MY2. The stream channel and stream banks were relatively stable for all cross-sections.

Over the course of monitoring, the D50 particle size of the reach-wide pebble count increased from 31.7 mm in the as-built survey to 45.0 mm and 64.0 mm during MY1 and MY2 surveys. The reach-wide pebble counts D16 particle size decreased from 6.2 mm in the as-built survey to 0.5 mm in MY2. It appears the riffles are effectively transporting sediment; however, sand and small gravel appears to be accumulating in some of the pools. Cross-section riffle and pool pebble count data support this explanation. The riffle cross-section pebble counts mean D50 particle size has increase slightly, while three of the four pool cross-section pebble counts have decreased. The likely source of the additional sediment is from eroding stream banks and upland soil erosion due to logging operations upstream of the project.

Following construction, a total of 769 containerized and bare root native trees and shrubs were planted in 1.0 acre of the riparian area (769 stems/acre) and 2,000 live stakes were planted along the stream bank. The remaining 1.0 acre of riparian habitat contained existing mature vegetation. Three 100-m^2 plots were established to monitor planted and pre-existing vegetation. Monitoring plots cover 4% of the 2.0 acre riparian habitat. The total mean stem counts for the three vegetation plots increased from 126 (1700 stems/acre) in the as-built survey to 153 (2064 stems/acre) in MY1 to 270 (3642 stems/acre) in MY2. Natural recruitment of native woody vegetation was observed in all vegetation monitoring plots and account for the increased number of stems.

Multiflora rose *Rosa multiflora* has been an ongoing problem at this site because of the existing seeds in the soil and it's prevalence in the adjacent pasture. It was sprayed with a Glyphosate based herbicide solution the past two springs. These treatments have drastically reduced the number of multiflora rose plants at the project site. To ensure overall success, treatments will continue in the spring of years 3 and 5 after construction.

An existing stream ford was improved, the easement was fenced to exclude livestock, and an alternative watering system for livestock was installed according to the farm management plan (Mickey and Scott 2002). All best management practices were checked in MY1 and MY2 and were function properly.

The MY1-MY2 visual assessment, geomorphic, and vegetative surveys indicate some minor stream channel adjustments have occurred since construction; however, adjustments are well within the expected range. With only small isolated areas of channel bed material aggradation and channel bank instability observed, the Peak Creek mitigation site is meeting all morphometric and riparian vegetation success criteria for the second monitoring year.

2 Project Goals, Background, and Attributes

This monitoring report describes the project's background and summarizes stream channel and vegetation monitoring for MY1 and MY2 completed during 2008 and 2009 on 2,719 linear feet (lf) of Peak Creek and compares it with the as-built conditions to the extent possible.

2.1 Location and Setting

Peak Creek is a tributary to the South Fork New River in the New River drainage in Ashe County, North Carolina. Peak Creek (Appendix A Figure A.1.) is located in the Blue Ridge Province of the Appalachian Mountains. The watershed upstream of the project site has an area of approximately 4.4 square miles. The project is 4.1 miles southwest of Laurel Springs, 12.2 miles southeast of Jefferson, and 30.8 miles northwest of Wilkesboro.

Land uses within the watershed consist mostly of rural farms containing pastures and forested wood lots. The less steep valley floors are used to raise crops and graze livestock. While a significant portion of the watershed remains in second growth forest, some Christmas tree farms have been developed.

2.2 Project Goals and Objectives

The project's original goal was to improve aquatic habitat and riparian area vegetation and to reestablish channel stability in order for the NCDOT to meet its off-site stream mitigation requirements for the US 421 (TIP number R-0529) road improvement project in Watauga County. This will be discussed further in the Section 2.4. Project History, Contracts, and Attribute Data.

The objectives of the Bowlin-Peak Creek enhancement project were as follows (Mickey and Scott 2002):

1. Increase fish habitat diversity by installing root wads, rock cross vanes, and rock vanes.
2. Stabilize, slope and vegetate eroding stream banks to make the banks more resistant to erosion and flooding.
3. Eradicate invasive exotic species such as multiflora rose.
4. Construct a stable stream crossing at the existing ford location.
5. Exclude livestock from the riparian zone by installing exclusionary fencing and providing an alternate drinking water source.
6. Plant native trees, shrubs, and ground cover on all disturbed banks and along the channel to provide long-term bank stability, stream shading, and cover and food for wildlife.
7. Provide long-term protection of the stream and riparian corridor by the purchase of a permanent conservation easement.

2.3 Project Structure, Restoration Type, and Approach

2.3.1 Project Structure

The project area consists of two separate reaches, reach 1 (station 1+34 to 18+50) is protected by a conservation easement on both sides of the creek, whereas reach 2 (stations 0+00 to 1+34 and 18+50 to 27+90) has a conservation easement on only one side of the creek. (Appendix A Figure A.2. and Table A.1.). In reach 2 the conservation easement line is located along the center line of the stream and only protects the left stream bank. There were no differences in geomorphology, hydrology, or soils of the two reaches; therefore, the same type of approach (enhancement I) was used throughout the project. The two reaches are distinguished only for purposes of determining mitigation credits; reach 2 was not included as an expected asset. For the remainder of this document, the two reaches will be considered as one.

2.3.2 Restoration Type and Approach

Historic dredging of the stream channel, gravel mining, and poor riparian zone management on the Bowlin-Peak Creek site resulted in stream bank instability at numerous locations, adverse water quality impacts through increased sedimentation, and degraded aquatic habitat (Mickey and Scott 2002). The narrow riparian zone, <15 feet on each bank, was fairly intact along sections of the stream and consisted primarily of tag alder *Alnus serrulata*, multiflora rose, silky dogwood *Cornus amomum*, red maple *Acer rubrum*, and black cherry *Prunus serotina*. Most of the vegetated streambanks were stable, except in areas where multiflora rose predominated.

The desire to protect existing vegetation and the narrow width of the conservation easement limited the stream improvement options to enhancement II (Appendix A Table A.1.). The average width of the conservation easement from easement boundary to easement boundary is approximately 66 ft, ranging from 50 ft to 85 ft. The enhancement plan included reshaping eroding stream banks while leaving as much of the existing native vegetation intact; installation of in-stream structures to improve bank stability and aquatic habitat; physical removal and herbicide treatment of multiflora rose; re-vegetating the banks with native plant species; and construction of fencing for livestock exclusion and installation of an alternative watering source. Peak Creek's degraded C4 stream type (Rosgen 1996) was enhanced to more stable C4, E4, and F4 stream types.

2.4 Project History, Contracts, and Attribute Data

The project's background and history are summarized in Appendix A Tables A.2.-A.4.:

- Appendix A Table A.2. – reporting and milestone history for the project.
- Appendix A Table A.3. − contact information for the project's consultants, contractors, and suppliers.
- Appendix A Table A.4. – general geographical, morphological, and water quality characteristics of the project.

It should be noted that this site was identified and established under older mitigation permitting guidance and that the narrower conservation easement width and portions of the stream being protected on only one side of the stream bank were acceptable at the time.

The NCDOT had contracted with the NCWRC to provide off-site stream mitigation for impacts from the relocation of US 421 (TIP number R-0529) from the South Fork New River in Boone to the Blue Ridge Parkway in Deep Gap. For that project, a total of 14,814 linear feet of stream mitigation were required by the United States Army Corps of Engineers (USACE) Section 404 permit and 7,407 linear feet of mitigation were required by the North Carolina Division of Water Quality (NCDWQ) Section 401 water quality certification. Subsequent mitigation sites were originally permitted under the US 421 project and not via individual permits. The USACE Section 404 permit (Action ID No. 19970761) was issued on 4 May 1998 and the NCDWQ Section 401 permit (Project number 970616) was issued on 20 April 1998.

The Peak Creek site on the Bowlin property was presented to the US 421 mitigation review team as a potential mitigation site in 2000; in 2002 the landowners agreed to the proposed conservation easement boundary. The pre-construction notification and the Peak Creek site mitigation plan were submitted to the USACE and NCDWQ in May 2003. The plan was approved by NCDWQ (Certification number 030599) on 29 May 2003 (NCWRC 2009). No comments were received from the USACE; therefore it was assumed that the project was approved under the general permit conditions. Acquisition of the conservation easement was delayed due to problems obtaining valid appraisals. The NCDWQ permit was reissued on 15 August 2006 (Appendix E). In attempting to renew the USACE permit, it was determined that the original permit had expired, negating the NCDWQ August 2006 permit and requiring new permits to be obtained. A conservation easement on the property was purchased in the fall of 2006. In 2006, responsibility for this site was transferred from NCDOT to the EEP. Under a new memorandum of agreement and interagency contract, EEP tasked the NCWRC to complete this project. New Section 404 (Action ID No. 200702632; 11 Aug 2007) and Section 401 (Project number 030599; 20 Aug 2007) permits were obtained.

2.5 Monitoring Plan Views

The monitoring plan view is located in Appendix A Figure A.3.

3 Methods

3.1 Stream Morphology

Four representative riffle and three representative pool cross-sections were measured, the longitudinal profile surveyed, cross-section and reach-wide pebble count data were collected, and stream stability was visually assessed on 8-10 September 2008 for monitoring year 1 and on 11-20 May 2009 for monitoring year 2. The measured and surveyed data were taken using standard stream survey techniques (Harrelson et al. 1994, EEP 2006). A Nikon DTM 821 total station was used to survey the stream's pattern, profile, and cross-sectional dimensions. Mountain and piedmont regional hydraulic geometry curve data were used to evaluate bankfull elevation conditions in the field (Harman et al. 1999). Cross-section data were used to classify the stream based on existing morphological features of the stream channel and valley type (Rosgen 1994, 1996). Site conditions were analyzed using RIVERMorph stream assessment and restoration software, Version 4.3 (RSARS 2008) and AutoCAD Version 2004.0.0. Detailed methods and deviations in standard methods are detailed in individual sections below.

3.2 Hydrology

A crest gage was installed during construction to monitor on-site occurrence of bankfull events (NCWRC 2009). The crest gage bankfull water elevation is approximately 2.8 ft above the channel bed. The crest gage was checked every time the site was visited and bankfull or near bankfull events were recorded. Wrack lines and deposition areas were photographed to augment gage readings. Additionally, the United States Geological Survey's (USGS) South Fork New River flow gage data (gage number 03161000 located near Jefferson, North Carolina) was reviewed to corroborate the occurrence of bankfull events at the Peak Creek site. Bankfull discharge at the South Fork New River flow gage was estimated by using the established gage height vs. discharge relationship calculated from historic gage data and relating the bankfull elevation in the field to the gage height. Bankfull discharge was estimated at 3,220 cubic feet per second at the South Fork New River gage station (Mickey and Scott 2002).

3.3 Vegetation

Vegetation surveys were completed on 02 September 2008 for monitoring year 1 and on 01 June 2009 for monitoring year 2 and followed the EEP and the Carolina Vegetation Survey level 2 protocol (Lee et al. 2006). Monitoring followed standard regulatory guidance, procedures, and success criteria (USACE 2003).

The stream morphology, hydrology and vegetation data will be compared with previous survey data and will be used to illustrate the degree of departure of the stream channel and substrate characteristics, if any, from the desired condition (NCWRC 2009).

4 Project Conditions and Monitoring Results

4.1 Morphological Stream Assessment

4.1.1 Bank Stability Assessment

Bank erosion hazard index and near bank sheer stress are used to estimate sediment export from stream bank erosion (Rosgen 2006). They were not assessed for pre-construction conditions and, therefore, not required to determine the success of the project.

4.1.2 Stream Problem Areas

The stream problem areas plan view, stream problem areas summary table, and photographs are located in Appendix A Figure A.3, Appendix B Table B.1.1, and Appendix B Section 1, respectively.

No problem areas were identified during the MY1 and MY2 monitoring periods. However, three stream potential areas of concern were identified in MY1, 30 ft of eroding stream bank (Appendix B Section 1.1: photo PA1) and 2 small center bars (Appendix B Section 1.1: photo PA2 and PA3). Only two of the previously identified potential areas of concern were identified in MY2 (Appendix B Section 1.2: photo PA1 and PA3). When looking downstream, the left stream bank from station 7+15 to station 7+45 appeared to erode and migrate several feet to the left during the MY1 survey and migrated another foot by the MY2 survey. Live stakes were planted along the eroding stream bank during the MY2 survey to help stabilize it. The stream bank will be re-evaluated in MY3 to determine if any remedial action is necessary. If the stream bank does not stabilize by MY3, the banks should be reshaped by hand and a brush mattress should be installed using on site material.

The small center bar at station 12+44 was present only for the MY1 survey. Its formation is probably a result of sediment moving through the project site as the stream channel adjusted to a more steady state after construction. The center bar at station 19+89 was present prior to construction. The center bar was low in elevation with a stable riffle and stable stream banks adjacent to it. The stream channel is overly wide in this section due to historic gravel mining. It has not changed over time and should not cause further instability. No remedial action is needed and should just be watched over time.

4.1.3 Fixed Point Photographs

Fixed station photographs document pre- and post-construction conditions and are located in Appendix B Section 2.

4.1.4 Stability Assessment

A visual stability assessment of the project reach was performed during the MY1 and MY2 surveys (Appendix B Table B.3.2). The as-built categorical features were determined from the as-built report and plan view drawing and assumed to be stable immediately following construction (NCWRC 2009). As such, channel features, including meanders, stream bed, stream banks, and in-stream structures were examined for stability and enumerated during MY1-MY2 surveys (Appendix B Table B.3.1 and Table B.3.2). Based on the morphological data and the visual stability assessment, all of stream feature categories were found to be over 92% stable for the two monitoring years.

4.1.5 Quantitative Measures Summary

Morphological data is summarized in the following:

- Appendix B Table B.4.1. summarizes the pre-construction, reference reach, design, as-built, and monitoring quantitative morphological data collected from the cross-section surveys, longitudinal profile surveys, and pebble counts for Peak Creek.
- Appendix B Table B.4.2. summarizes the as-built and monitoring quantitative morphological data collected for each cross-section.
- Annual cross-section plots are located in Appendix B section B.5.
- Annual longitudinal profile plots are located in Appendix B section B.6.

- Annual pebble count cumulative frequency distribution plots are located in Appendix B section B.7.

4.1.5.1 Profile

The enhancement work changed the profile of the stream channel through the addition of log and rock structures with their associated pools and the relocation of approximately 100 lf of stream channel. Therefore, monitoring year data were compared with as-built conditions.

The entire project's stream channel was surveyed in MY1 and MY2. Feature lengths, slopes, depths, and spacing were calculated following each monitoring survey (Appendix B Table B.4.1). Channel slope has remained unchanged over the course of monitoring at 0.0093 ft/ft. Riffle lengths have ranged from 1.8 ft to 128.0 ft in the two monitoring years with means of 34.0 in MY1 and 33.0 in MY2. They varied little from the as-built survey, with a range of 6.4 ft to 123.6 ft and a mean of 30.8 ft. Mean riffle slope decreased from 0.021during the as-built survey to 0.017 in MY1 and remained at 0.017 in MY2. The riffles slopes are not outside of the expected norms and may be readjusting to something closer to its pre-construction condition.

Pool-to-pool spacing has not changed significantly since the as-built survey. The MY1 and MY2 values have ranged from 25.9 ft to 192.0 ft and 40.2 ft to 192.2 ft, with means of 94.6 ft and 97.5 ft. The as-built survey values ranged from 34.8 ft to 194.3 ft, with a mean of 91.6 ft. The mean pool lengths have decreased slightly over time; 35.1 ft from the as-built survey to 32.2 ft in MY1 and 27.8 ft in MY2. The variation in pool-to-pool spacing and pool lengths could be due to one small pool behind a log vane at station 3+73 filling over time and where each feature was identified in the field. The annual longitudinal profile overlays (Appendix B.6) suggest the stream channel adjusted between the as-built survey and MY1. However, the stream channel in MY1 and MY2 surveys are very similar and appeared to have stabilized. Thalweg alignment and edge of water survey points that define the location of the active channel indicate some isolated lateral movement of the thalweg since construction (Appendix A Figure A.3), but overall, the channel bed has maintained the desired slope with no evidence of down-cutting observed.

4.1.5.2 Dimension

The current/developing bankfull feature for cross-sections 4 and 6 were used to calculate dimension morphological data for Appendix B, Table B.4.1, instead of the fixed bankfull pin elevation. The developing bankfull feature appeared to represent a more accurate bankfull elevation. However, this resulted in greater variation because these measurements were not taken from a fixed location. As expected, some channel adjustments have occurred after construction, mostly within the first year and after the first few bankfull rain events. The stream channel and stream banks were relatively stable for all cross-sections.

Channel dimensions from riffle cross-sections (n=4) surveyed during MY1 and MY2 were compared with the range of values and mean for the as-built condition for each parameter (Appendix B Table B.4.1 and Table B.4.2). As-built values for riffle bankfull width ranged from 20.6 ft to 36.8 ft, with a mean of 30.1 ft. Bankfull widths for MY1 and MY2 ranged from 20.6 ft to 39.6 ft and 20.8 ft to 38.5 ft, with means of 31.2 ft and 32.2 ft. As-built values for riffle cross-section area ranged from 35.3 ft^2 to 60.4 ft^2, with a mean of 47.9 ft^2. Riffle cross-section area for MY1 and MY2 ranged from 39.5 ft^2 to 69.2 ft^2 and 40.6 ft^2 to 65.2 ft^2, with means of 52.7 ft^2 and 52.4 ft^2. As-built values for riffle mean depth ranged from 1.0 ft to 2.0 ft, with a mean of 1.6 ft. Bankfull widths for MY1 and MY2 ranged from 1.2 ft to 2.0 ft and 1.2 ft to 2.1 ft, with means of 1.7 ft and 1.7 ft. Although there was some variability in the cross-section dimension measurements between monitoring years, these changes are not outside expected norms and do not suggest an unstable stream channel.

Specific details of the individual cross-sections are listed below:

- Cross-section 1 transects a riffle. Between the as-built survey and MY1 the left bank migrated approximately 0.9 ft to the left and the stream channel thalweg elevation lowered by approximately 0.2 ft. The stream channel remained stable between the MY1 and MY2 surveys.
- Cross-section 2 transects a pool and the downstream portion of a log cross-vane. The annual cross-section overlay (Appendix B.5) suggests the right bank migrated approximately 0.8 ft to the right from the as-built condition to MY1 and then migrated back to its original position in MY2. The bank did not actually move. The discrepancy is just a function of not surveying the exact same points every year.
- Cross-section 3 transects a pool downstream of a rock cross-vane. The MY1 cross-section was survey slightly upstream of the as-built and MY2 surveys. The large hump in the middle of the MY1 stream channel is a boulder from the rock cross-vane.
- Cross-section 4 transects a riffle. The stream channel along this cross-section has remained stable. The existing bankfull bench on the right bank continued to developed and increased in elevation by 0.2 ft between the as-built survey and MY1. It has remained relatively stable since that time.
- Cross-section 5 transects a pool and the downstream portion of a rock J-hook on the left stream bank. The thalweg moved approximately 1.2 ft to the right between the as-built survey and MY1 and has remained stable since that time.
- Cross-section 6 transects a riffle. The stream channel has remained stable the since the as-built survey with only minor channel adjustments.
- Cross-section 7 transects a riffle. No enhancement activities were performed at this cross-section. Approximately 1.6 ft of the right bank sloughed off between the as-built survey and MY1. However, the stream channel and stream banks have remained stable since the MY1 monitoring.

4.1.5.3 Pattern

Enhancement work was mainly oriented towards reshaping banks to establish a bankfull bench and did not change the stream pattern. Because only minor modifications were made to the stream pattern, additional data (Appendix B Table B.4.1.) will be collected in monitoring year 5 only if profile and dimensional data and visual assessments indicate that significant geomorphological changes have occurred.

4.1.5.4 Substrate Data

Reach-wide substrate particle analysis revealed that the D50 and D84 increased from the as-built condition through the MY2 (Appendix B Section 7); from 31.7 mm to 64.0 mm and 88.3 mm to 174.2 mm, respectively. The D50 changed slightly from coarse gravel to very coarse gravel and the D84 particle categories changed from small cobble to large cobble. The D16 size class was the only size class to consistently decrease from the as-built condition to MY2, from 6.2 mm to 0.5 mm, indicating an increase in sand. It appears the riffles are effectively transporting sediment; however, sand and small gravel appear to be accumulating in some of the pools.

Substrate particle counts also were conducted at each of the seven established cross-sections. Particle data from the four riffle cross-sections were pooled to generate statistical values for each monitoring year. The mean D50 particle size increased slightly from 39.5 mm in the as-built survey to 42.6 mm in MY1 and 48.7 mm in MY2 (Appendix B Table B.4.1). All riffle pebble counts for the D50 particle size have been in the very course gravel category over the course of monitoring (Appendix B Table B.4.2). The D50 particle size for each of the three pool cross-sections also are summarized in Appendix B Table B.4.2. Smaller sized sediment particles appear to be accumulating in two of the three pools; the D50 particle sizes have decreased from cobble and course gravel to medium gravel. The finer sediment appears to be coming from upstream sediment sources since the stream banks within the project are stable. Logging operations have been going on within the watershed in the past several years.

4.2 Hydrologic Criteria

Bankfull measurements were recorded twice from the on-site crest gage since construction ended in November 2007 (Appendix B Table B.8.1.). Each record was taken in separate monitoring years, September 2008 and May 2009. Additionally, three bankfull or greater discharge events were identified at the USGS South Fork New River flow gage station near Jefferson, North Carolina (Appendix B Table B.8.1. and Figure B.9.1.).

4.3 Vegetation Assessment

Vegetation was surveyed in three 100-m^2 representative plots (Appendix A Figure A.3). Monitoring plots cover 4% of the 2.0 acres of riparian habitat. Vegetation data, including plot attributes and vegetation metadata, stem counts, plant vigor, and plant damage for MY1 and MY2 are presented in Appendix C Tables C.1.3.-C.1.8. The total mean stem counts for the three vegetation plots increased from 126 (1700 stems/acre) in the as-built survey to 153 (2064 stems/acre) in MY1 to 270 (3642 stems/acre) in MY2. A majority of the planted stems in each monitoring year were considered to be in excellent to good condition, 78% in MY1 and 66% in MY2. This increase in stems is attributed to native volunteer plants establishing throughout the riparian area. A decrease in planted stem vigor was expected due to the number of bare root trees planted, the fact that a vegetation plot is located near a public fishing access area, and the established deer population in the area.

Stem counts for plot 1 revealed 13 planted live stems (526 stems/acre) with a total of 100 planted and natural/volunteer live stems (4,047 stems/acre) in MY1 and 11 planted live stems (445 stems/acre) with a total of 151 planted and natural/volunteer live stems (6,111 stems/acre) in MY2. Stem counts for plot 2 revealed 16 planted live stems (647 stems/acre) with a total of 19 planted and natural/volunteer live stems (769 stems/acre) in MY1 and 16 planted live stems (647 stems/acre) with a total of 23 planted and natural/volunteer live stems (931 stems/acre) in MY2. Stem counts for plot 3 revealed 12 planted live stems (486 stems/acre) with a total of 39 planted and natural/volunteer live stems (1,578 stems/acre) in MY1 and 10 planted live stems (405 stems/acre) with a total of 96 planted and natural/volunteer live stems (3,885 stems/acre) in MY2. The increase in woody stems is attributed largely to volunteers from tag alder and nine bark *Physocarpus opulifolius* in plot 1 and Hawthorn *Crataegus sp.* in plot 3. Tag alder is becoming established on all disturbed stream banks throughout the project area.

The project as a whole and each vegetation plot exceeded the USACE requirement for 320 stems per acre through the third year of monitoring.

4.3.1 Vegetative Problem Areas

There are no specific vegetation problem areas. However, multiflora rose is still found throughout the project site. It was sprayed with a glyphosate based herbicide on 04 April 2008, 07 May 2008, 29 April 2009, and 07 May 2009 to help reduce the density of the infestation. The physical removal of plants during construction and the subsequent herbicide treatments have greatly reduced the number of plants. Multiflora rose will be an on going problem at this site because of the existing seed bed and the presence of additional plants in the adjacent pasture.

4.4 Farm Management Plan

The livestock management program developed for this project (Mickey and Scott 2002) included the improvement of the existing stream-crossing, installation of four watering tanks, drilling of a well and pump installation, and fencing to exclude livestock from the riparian zone. All best management practices were functioning properly at the time of the year one and year two monitoring surveys.

4.5 Summary

The MY1 and MY2 monitoring surveys reveal that the project site is performing as designed with minimal changes in any of the major morphological components. Dimension, pattern, and profile parameters measured on Peak Creek suggest the stream channel has remained stable since construction. Although substrate particle size has fluctuated slightly since construction, the bed material generally has remained in the gravel and cobble categories. There has been an increase in fine particle sized substrate in the pools due to upstream sources of sediment. One isolated area of minor bank sloughing has been observed. The stream bank will be re-evaluated in MY3 to determine if any remedial action is necessary. With little exception, constructed log and rock structures remain stable and are performing as desired. The project continues to perform as desired with only minor changes observed in channel form or function, while having met the

USACE requirement of having at least two bankfull events measured in separate monitoring years.

Planted vegetation performance has exceeding the USACE requirement for 320 stems per acre through the third year of monitoring in all three vegetation monitoring plots (USACE 2003). With the addition of natural stem contributions, the vegetation plots had an average stem density of 3,642 stems per acre in MY2. Invasive exotic vegetation still persists throughout the project site. Two years of herbicide treatment has reduced the quantity and size of the plants. Continued spring herbicide treatments for the next three years will further reduce population size and viable seed in the seed bank.

Overall, the Peak Creek mitigation site in Ashe County, North Carolina is performing satisfactorily two monitoring years after construction.

5 Acknowledgements

M. Fowlkes, J. Wasseen, II, and J. Ferguson of the NCWRC collected and analyzed the field data; M. Fowlkes prepared this report. T. Ewing improved the report with his thorough review and thoughtful suggestions.

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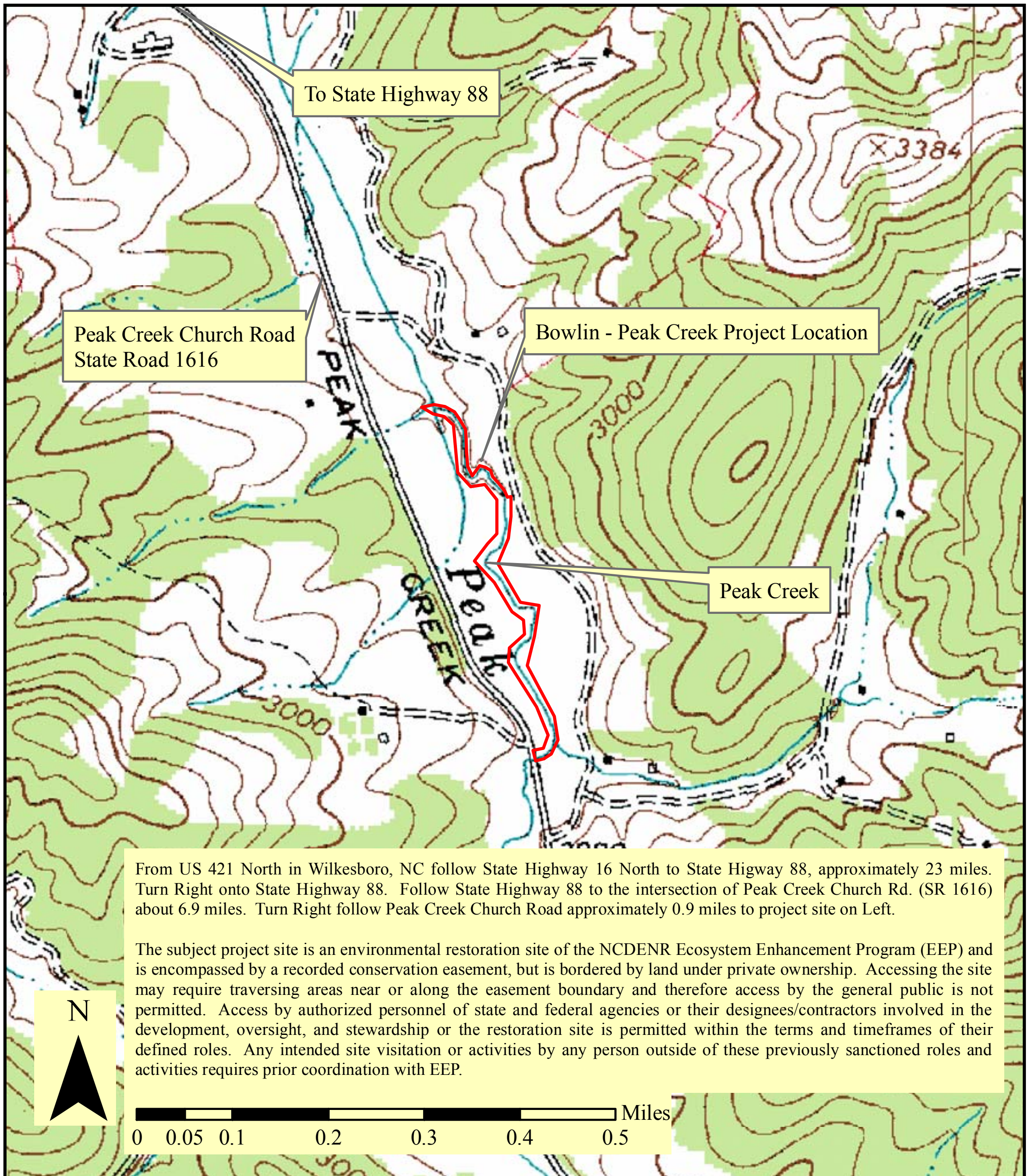
RSARS (RIVERMorph Stream Assessment and Restoration Software). 2008. Version 4.3 Professional edition. Copyright 2002-2007, RIVERMorph LLC, Louisville, Kentucky. Available: www.rivermorph.com. (July 2009).

USACE (U.S. Army Corps of Engineers), Wilmington District, U. S. Environmental Protection Agency, North Carolina Wildlife Resources Commission, and the North Carolina Division of Water Quality. 2003. Stream Mitigation guidelines. Wilmington, North Carolina.

Appendix A General Tables and Figures

Figure A.1 Vicinity Map.

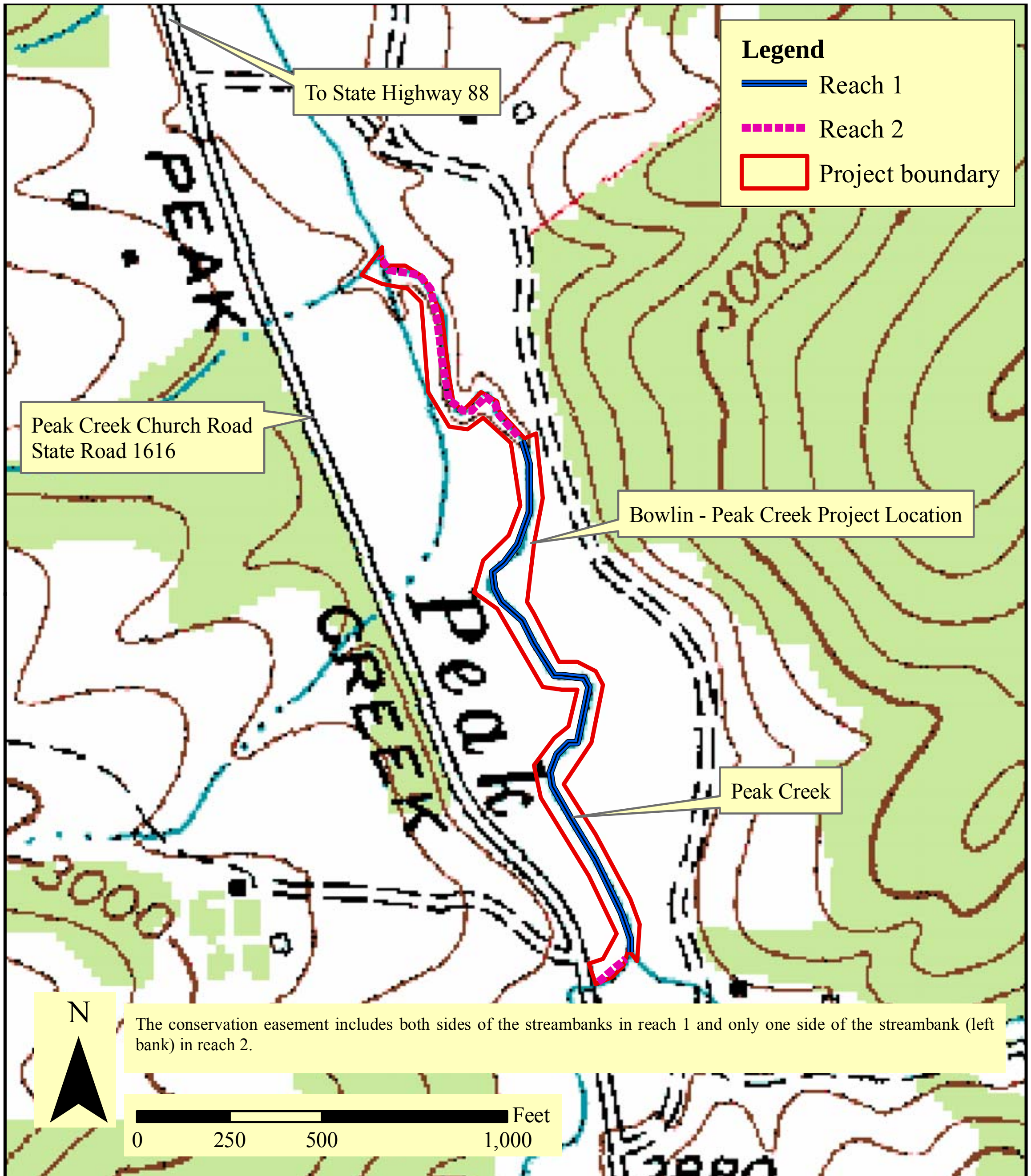


Ecosystem Enhancement Program

Project Vicinity Map.
Bowlin - Peak Creek Mitigation Site
EEP Project Number: 92606, As-built (2007)
Ashe County, North Carolina
May 2008

Source:
United States Department of the Interior, Geological Survey
Laurel Springs Quadrangle, 7.5 Minute Series (Topographic).

Figure A.2 Project Component and Asset Map.



Project Component Map.
Bowlin - Peak Creek Mitigation Site
EEP Project Number: 92606, As-built (2007)
Ashe County, North Carolina
May 2008

Source:
United States Department of the Interior, Geological Survey
Laurel Springs Quadrangle, 7.5 Minute Series (Topographic).

Figure A.3 Monitoring Plan View.

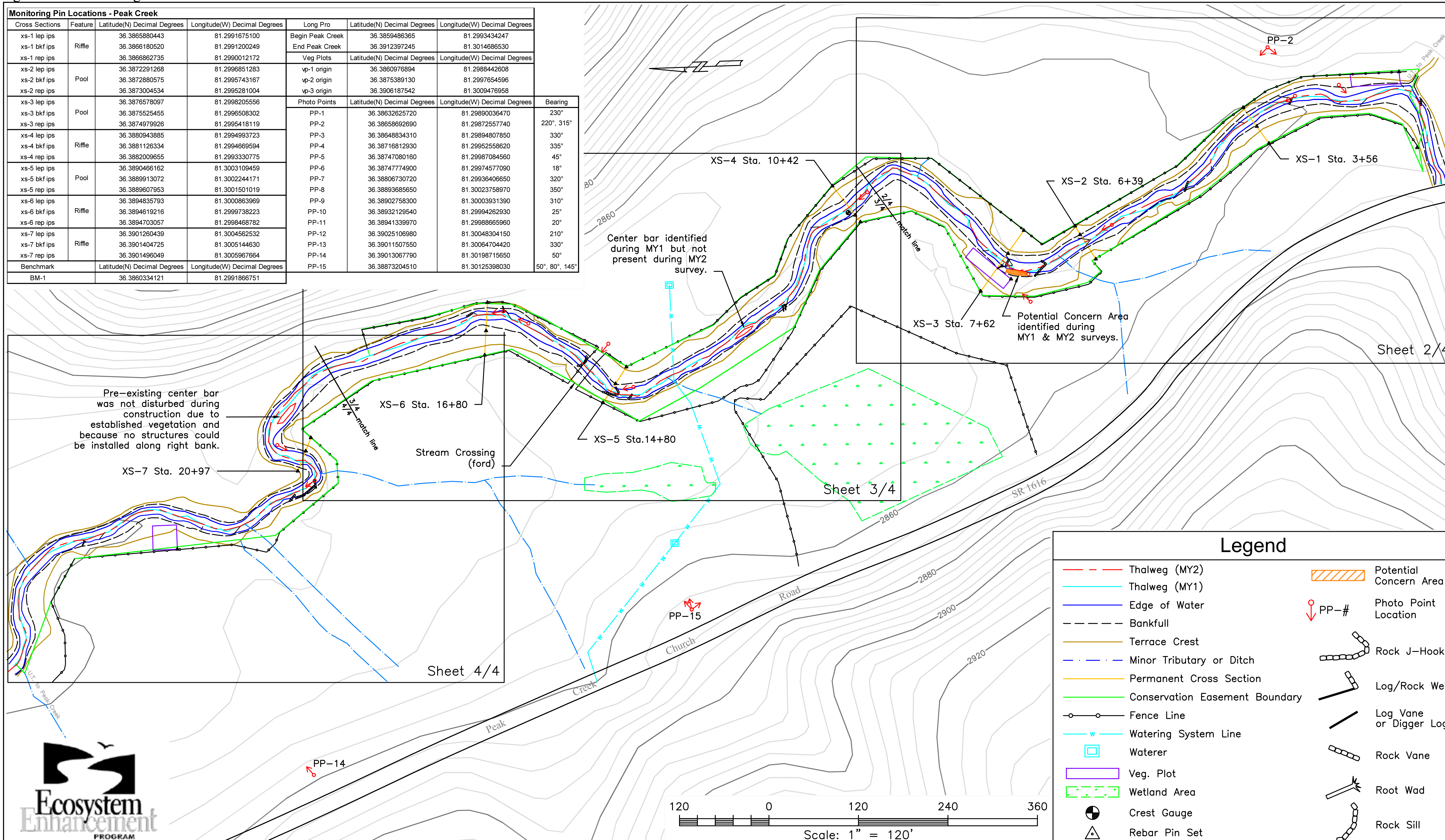
Monitoring Pin Locations - Peak Creek

Cross Sections	Feature	Latitude(N) Decimal Degrees	Longitude(W) Decimal Degrees
xs-1 lep ips	Riffle	36.3865880443	81.2991675100
xs-1 bkf ips		36.3866180520	81.2991200249
xs-1 rep ips		36.3866862735	81.2990012172
xs-2 lep ips	Pool	36.3872291268	81.2996851283
xs-2 bkf ips		36.3872880575	81.2995743167
xs-2 rep ips		36.3873004534	81.2995281004
xs-3 lep ips	Pool	36.3876578097	81.2998205556
xs-3 bkf ips		36.3875525455	81.2996508302
xs-3 rep ips		36.3874979926	81.2995418119
xs-4 lep ips	Riffle	36.3880943885	81.2994993723
xs-4 bkf ips		36.3881126334	81.2994669594
xs-4 rep ips		36.3882009655	81.2993330775
xs-5 lep ips	Pool	36.3890466162	81.3003109459
xs-5 bkf ips		36.3889913072	81.3002244171
xs-5 rep ips		36.3889607953	81.3001501019
xs-6 lep ips	Riffle	36.3894835793	81.3000863969
xs-6 bkf ips		36.3894619216	81.2999738223
xs-6 rep ips		36.3894703057	81.2998468782
xs-7 lep ips	Riffle	36.3901260439	81.3004562532
xs-7 bkf ips		36.3901404725	81.3005144630
xs-7 rep ips		36.3901496049	81.3005967664
Benchmark		**Latitude(N) Decimal Degrees**	**Longitude(W) Decimal Degrees**
BM-1		36.3860334121	81.2991866751

Long Pro	Latitude(N) Decimal Degrees	Longitude(W) Decimal Degrees
Begin Peak Creek	36.3859486365	81.2993434247
End Peak Creek	36.3912397245	81.3014686530

Veg Plots	Latitude(N) Decimal Degrees	Longitude(W) Decimal Degrees
vp-1 origin	36.3860976894	81.2988442608
vp-2 origin	36.3875389130	81.2997654596
vp-3 origin	36.3906187542	81.3009476958

Photo Points	Latitude(N) Decimal Degrees	Longitude(W) Decimal Degrees	Bearing
PP-1	36.38632625720	81.29890036470	230°
PP-2	36.38658692690	81.29872557740	220°, 315°
PP-3	36.38648834310	81.29894807850	330°
PP-4	36.38716812930	81.29952558620	335°
PP-5	36.38747080160	81.29987084560	45°
PP-6	36.38747774900	81.29974577090	18°
PP-7	36.38806730720	81.29936406650	320°
PP-8	36.38893685650	81.30023758970	350°
PP-9	36.38902758300	81.30003931390	310°
PP-10	36.38932129540	81.29994262930	25°
PP-11	36.38941339970	81.29988665960	20°
PP-12	36.39025106980	81.30048304150	210°
PP-13	36.39011507550	81.30064704420	330°
PP-14	36.39013067790	81.30198715650	50°
PP-15	36.38873204510	81.30125398030	50°, 80°, 145°



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Bowlin - Peak Creek Stream Enhancement Project
Ashe County EEP Project Number 92606
MY1 & MY2 Overall Plan View

SURVEYED BY: JW,MF DATE: 05/09
DRAWN BY: JF DATE: 06/09
REVISION: DATE: 03/11
CAD FILE ID: Bowlin MY2 Plan.dwg

SHEET 1 OF 4

Figure A.3 Monitoring Plan View.

Monitoring Pin Locations - Peak Creek

Cross Sections	Feature	Latitude(N) Decimal Degrees	Longitude(W) Decimal Degrees
xs-1 lep ips	Riffle	36.3865880443	81.2991675100
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xs-2 bkf ips		36.3872880575	81.2995743167
xs-2 rep ips		36.3873004534	81.2995281004
xs-3 lep ips	Pool	36.3876578097	81.2998205556
xs-3 bkf ips		36.3875525455	81.2996508302
xs-3 rep ips		36.3874979926	81.2995418119
xs-4 lep ips	Riffle	36.3880943885	81.2994993723
xs-4 bkf ips		36.3881126334	81.2994669594
xs-4 rep ips		36.3882009655	81.2993330775
xs-5 lep ips	Pool	36.3890466162	81.3003109459
xs-5 bkf ips		36.3889913072	81.3002244171
xs-5 rep ips		36.3889607953	81.3001501019
xs-6 lep ips	Riffle	36.3894835793	81.3000863969
xs-6 bkf ips		36.3894619216	81.2999738223
xs-6 rep ips		36.3894703057	81.2998468782
xs-7 lep ips	Riffle	36.3901260439	81.3004562532
xs-7 bkf ips		36.3901404725	81.3005144630
xs-7 rep ips		36.3901496049	81.3005967664

Benchmark	Latitude(N) Decimal Degrees	Longitude(W) Decimal Degrees
BM-1	36.3860334121	81.2991866751

Long Pro	Latitude(N) Decimal Degrees	Longitude(W) Decimal Degrees
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Veg Plots	Latitude(N) Decimal Degrees	Longitude(W) Decimal Degrees
vp-1 origin	36.3860976894	81.2988442608
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vp-3 origin	36.3906187542	81.3009476958

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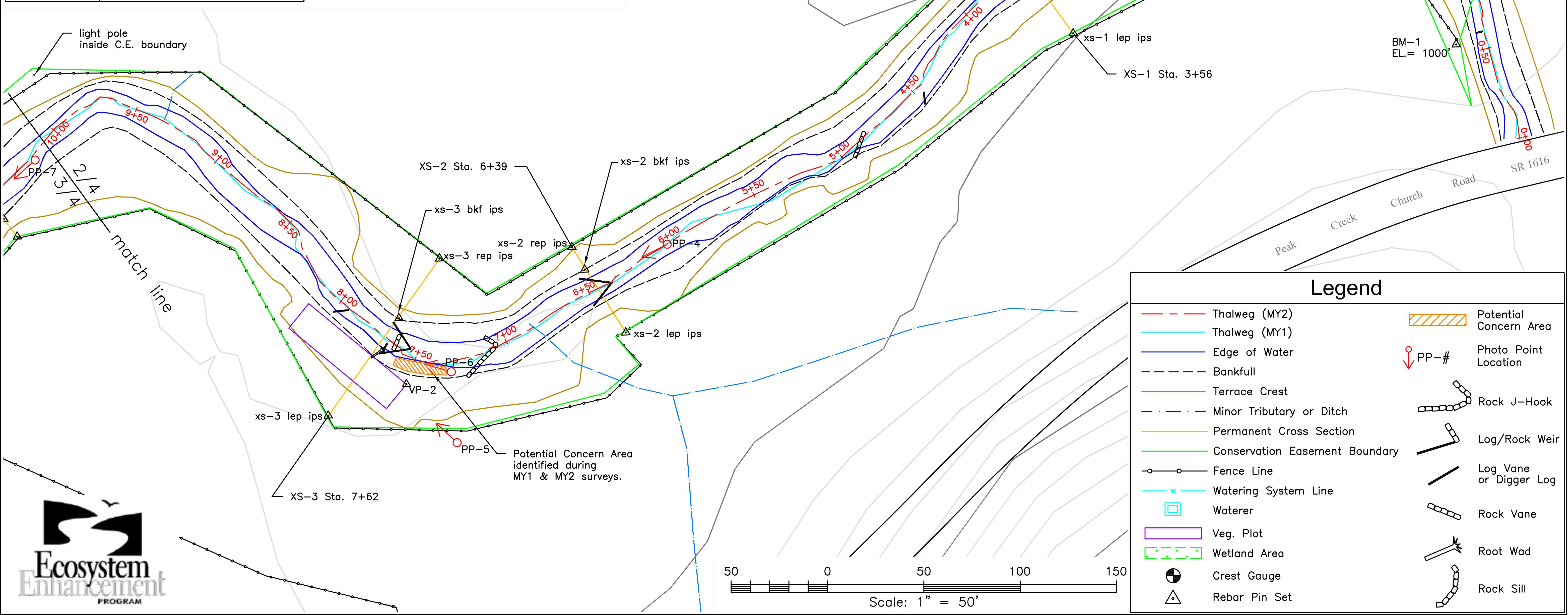
PP-15	36.38873204510	81.30125398030	50°, 80°, 145°



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Bowlin - Peak Creek Stream Enhancement Project
Ashe County EEP Project Number 92606
MY1 & MY2 Plan View Sta. 0+00 - Sta. 10+00

SURVEYED BY: JW, MF	DATE: 05/09
DRAWN BY: JF	DATE: 06/09
REVISION:	DATE: 03/11
CAD FILE ID: Bowlin MY2 Plan.dwg	

SHEET 2 OF 4

Figure A.3 Monitoring Plan View.

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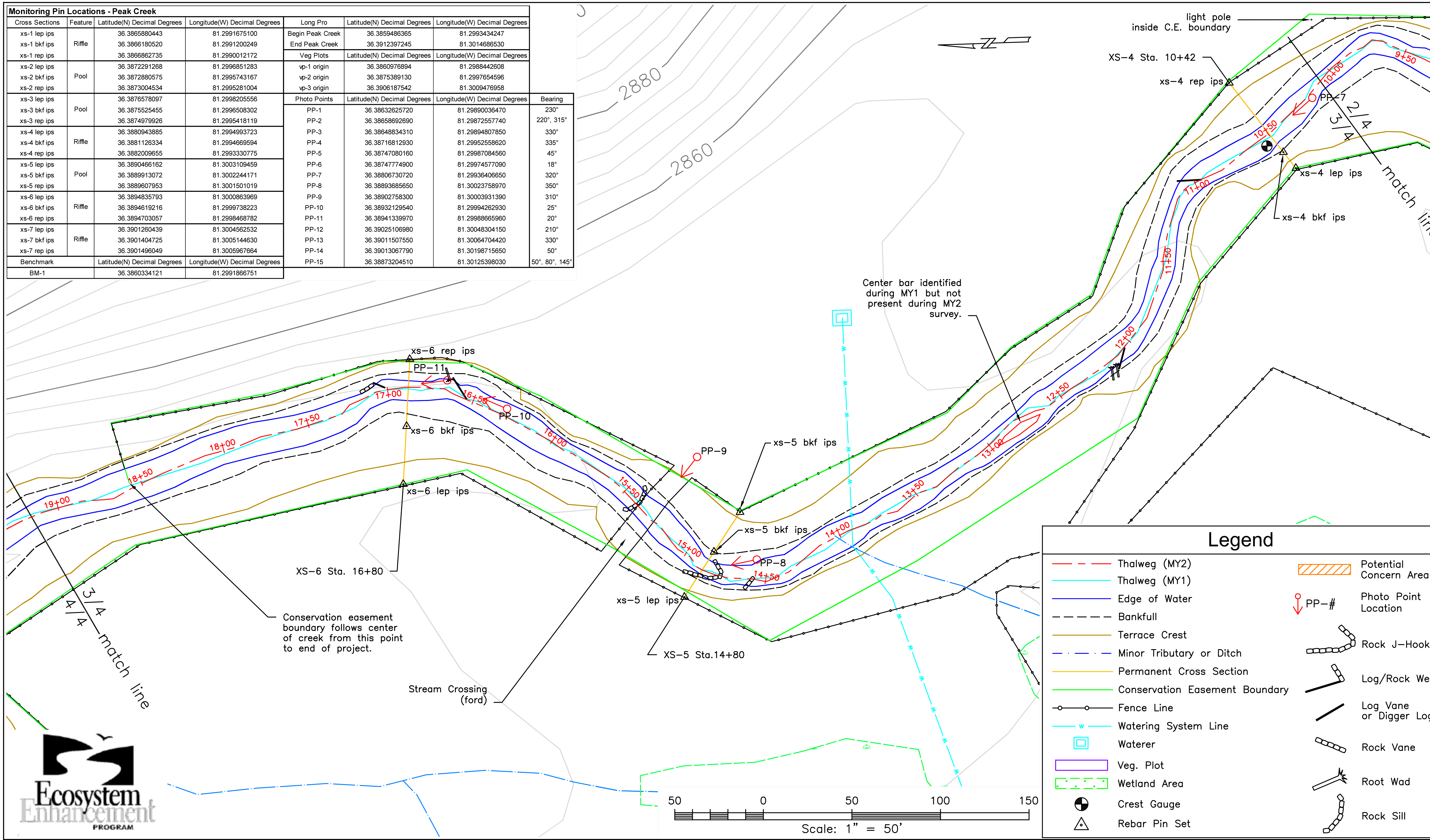

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CAD FILE ID: Bowlin MY2 Plan.dwg	

SHEET 3 OF 4

Figure A.3 Monitoring Plan View.

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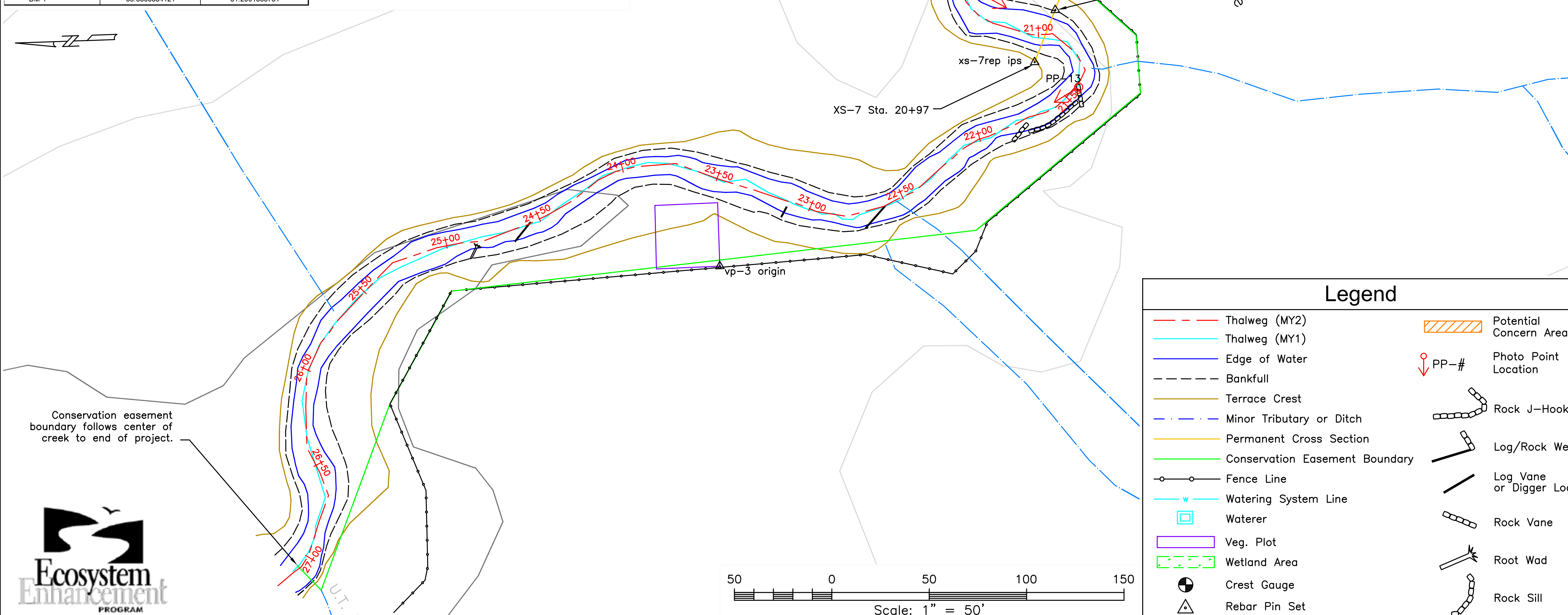

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MY1 & MY2 Plan View Sta.19+10 - Sta.27+20

SURVEYED BY: JW, MF	DATE: 05/09
DRAWN BY: JF	DATE: 06/09
REVISION:	DATE: 03/11
CAD FILE ID: Bowlin MY2 Plan.dwg	

SHEET 4 OF 4

Table A.1 Project Components.

Project Segment or Reach ID	Existing feet/Acres	Restoration Level[a]	Approach[b]	Restored Feet/Acres	Stationing	Buffer Acres	Comment
Peak Creek Reach 1	1,707 lf	EI	P3	1,773 lf	1+34-19+07	1.5	Installed rock vanes, rock j-hooks, root wads, digger logs, and log vanes, sloped banks and created bankfull benches on both sides of the stream.
Peak Creek Reach 2[c]	1,003 lf	EI	P3	1,003 lf	0+0-1+34 18+50-27+19	0.5	Installed rock vanes, rock j-hooks, root wads, digger logs, and log vanes, sloped banks and created bankfull benches on one side of the stream channel.

Component Summations

Restoration Level	Stream (lf)	Riparian Wetland (Acre)		Non-Riparian	Upland (Acre)	Buffer (Acre)	BMP
		Riverine	Non-Riverine				
Restoration							
Enhancement							
Enhancement I[c]	1773					1.5	
Enhancement II							
Creation							
Preservation							
HQ Preservation							
Totals	**1773**	**0**		**0**	**0**	**1.5**	**BMP Count**

(shaded) = Non-Applicable

R = Restoration EII = Enhancement II P3 = Priority 3 lf = Linear Feet

EI = Enhancment I S = Stabilization SS = Stream Bank Stabilization

[a]Source: USACE 2003.

[b]Source: Rosgen 2006.

[c]Reach 2 was excluded from the Component Summation Totals because the conservation easement protects only one side of the stream channel.

Table A.2 Project Activity and Reporting History.

Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	Apr 2002	Dec 2002
Final Design	Apr 2002	Dec 2002
NCDWQ 401 Water Quality Certification	NA	May 2003, Aug 2007
USACE 404 Permit	NA	Apr 1998, Aug 2007
Acquired conservation easement	NA	Sep 2006
Erosion and Sediment Control Design Plan Approved	NA	May 2007
Trout Buffer waiver	NA	Jun 2007
Construction	NA	Nov 2007
Temporary seed mix applied to entire project area	NA	Nov 2007
Permanent seed mix applied to entire project area	NA	Nov 2007
Bare root and live stakes plantings for the entire project area	NA	Feb 2008
Mitigation/As-built (Year 0 Monitoring - baseline)	Dec 2007, Feb 2008	May 2009
Year 1 Monitoring	Sep 2008	Nov 2010
Year 2 Monitoring	May 2009, Jun 2009	Nov 2010
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		

Table A.3 Project Contact Table.

Designer North Carolina Wildlife Resources Commission Watershed Enhancement Group Field Office	Mr. Joseph H. Mickey, Mr. Mark Fowlkes 1701 Mail Service Center Raleigh, NC 27699-1701 (336) 527-1547
Construction Contractor North Carolina Wildlife Resources Commission Watershed Enhancement Group Field Office	Mr. Mark Fowlkes P.O. Box 387 Elkin, NC 28621 (336) 527-1547
Sub-Construction Contractor Yadkin Valley Construction, Inc. Grading and Fencin	Mr. Terry Benton 2961 Old 60 Hwy Ronda, NC 28670 (336) 984-2219
Planting Contractor North Carolina Wildlife Resources Commission Watershed Enhancement Group Field Office	Mr. Mark Fowlkes P.O. Box 387 Elkin, NC 28621 (336) 527-1547
Seeding Contractor North Carolina Wildlife Resources Commission Watershed Enhancement Group Field Office	Mr. Mark Fowlkes P.O. Box 387 Elkin, NC 28621 (336) 527-1547
Seed Mix Sources	New England Wetland Plants, Inc. (413) 548-8000
Nursery Stock Suppliers	North Carolina Forest Service (888) NC-Trees
	River Bend Farms (336) 366-2982
	Foggy Mountain Nursery (336) 977-2958
Monitoring Performers North Carolina Wildlife Resources Commission Watershed Enhancement Group Field Office	Mr. Mark Fowlkes P.O. Box 387 Elkin, NC 28621 (336) 527-1547

Table A.4 Project Attribute Table.

Project County	Ashe
Physiographic Region Reference: http://www.geology.enr.state.nc.us/proj_earth/proj_earth.htm	Blue Ridge Province
Ecoregion (Reference: USACE 2003)	New River Plateau
Project River Basin	New River
USGS HUC for Project (14 digit)	05050001020050
NCDWQ Sub-basin for Project	05-07-01
Within extent of EEP Watershed Plan?	Yes
NCWRC Class (Warm, Cool, Cold)	Cold
Percent of project easement fenced or demarcated	100
Beaver activity observed during design phase?	Yes
Restoration Component Attribute Table	
	Peak Creek
Drainage Area (square miles)	4.44
Stream Order (Reference: USGS 1:24,000 Topographic maps)	Third
Restored length (ft)	2719
Perennial or Intermittent	Perennial
Watershed type (Rural, Urban, Developing, etc.)	Rural
Watershed LULC Distribution (e.g.) (percent)	
Residential	<1%
Ag-Row Crop	<1%
Ag-Livestock	24%
Forested	74%
Watershed impervious cover (percent)	<10%
NCDWQ AU/Index number	10-1-35 (2)a
NCDWQ Classification	B Tr+
303d listed?	No; Peak Creek 303d listed 3.3 miles downstream of project
Upstream 303d listed segment?	No
Reasons for 303d listing or stressor	Toxic impacts and habitat degradation
NCDWQ 404 Water Quality Certification Number	3626
USACE 401 Action ID Number	200702632
Total acreage of easement	3
Total vegetated acreage within easement	2
Total planted acreage as part of the restoration	1
Rosgen stream classification of pre-existing	C4
Rosgen stream classification of as-built	C4
Valley Type	VIII
Valley Slope	1.3%
Valley side slope range (e.g. 2-3%)	25-45%
Valley toe slope range (e.g. 2-3%)	15-25%
Cowardin classification (Reference: Coward 1979)	Riverine, upper perennial, unconsolidated bottom
Trout Waters Designation	Tr
Species of concern, endangered, etc.? (Y/N)	Bog turtle
Dominant soil series and characteristics	
Series	Toxaway
Depth	0 to 72 inches
Clay percent	17%
K	0.17
T	5

N/A = Not applicable "-" = Items that are unavailable U = Unknown

Appendix B   Morphological Summary Data

B.1   Representative Stream Problem Area Photographs

No problem areas were identified during MY1 and MY2 periods that would require immediate action. However, several potential areas of concern were identified and are listed below.

Table B.1.1 Stream Problem Areas.

Feature/Issue	Station Number/Range	Suspected Cause	Photograph Number
MY1 Potential Areas of Concern			
Eroding left bank	7+15	Unstable bank	PA1_08Sep2008
Center bar	12+44	Excess sediment in channel	PA2_08Sep2008
Center/transverse bar	19+89	Historic gravel mining	PA3_08Sep2008
MY2 Potential Areas of Concern			
Eroding left bank	7+15	Unstable bank	PA1_20May2009
Center/transverse bar	19+89	Historic gravel mining	PA2_20May2009

B.1.1   MY1 Problem Area Photographs

PA1, eroding left bank: 08 Sep 2008.

PA2, center bar: 08 Sep 2008.


PA3, center/transverse bar: 08 Sep 2008.

B.1.2 MY2 Problem Area Photographs


PA1, eroding left bank: 20 May 2009.


PA3, center/transverse bar: 20 May 2009.

B.2 Stream Photograph Points


PS-1, bearing 230°: 17 Apr 02.


PS-1, bearing 230°: 26 Mar 08.


PS-1, bearing 230°: 08 Sep 08.


PS-1, bearing 230°: 20 May 09.


PS-2, bearing 220°: 29 Jan 08.


PS-2, bearing 220°: 08 Sep 08.


PS-2, bearing 220°: 20 May 09.


PS-2, bearing 315°: 29 Jan 08.


PS-2, bearing 315°: 08 Sep 08.


PS-2, bearing 315°: 20 May 09.


PS-3, bearing 330°: 17 Apr 02.


PS-3, bearing 330°: 19 Sep 07.


PS-3, bearing 330°: 25 Sep 07.


PS-3, bearing 330°: 08 Sep 08.


PS-3, bearing 330°: 20 May 09.


PS-4, bearing 335°: 17 Apr 02.


PS-4, bearing 335°: 01 Jan 08.


PS-4, bearing 335°: 08 Sep 08.


PS-4, bearing 335°: 20 May 09.


PS-5, bearing 35°: 24 Sep 02.


PS-5, bearing 45°: 26 Mar 08. Note: stream channel moved to the right.


PS-5, bearing 35°: 08 Sep 08.


PS-5, bearing 35°: 20 May 09.


PS-6, bearing 18°: 08 Jan 08.


PS-6, bearing 18°: 08 Sep 08.


PS-6, bearing 18°: 20 May 09.

Pre-construction view of cross-section 4 at station 10+43 looking upstream; 17 Apr 02.

PS-7, bearing 320°: Post-construction view of cross-section 4 at station 10+43 looking down stream; 08 Jan 08.

PS-7, bearing 320°: 08 Sep 08.

PS-7, bearing 320°: 20 May 09.

PS-8, bearing 350°: 17 Apr 02.

PS-8, bearing 350°: 26 Mar 08.

PS-8, bearing 350°: 08 Sep 08.

PS-8, bearing 350°: 20 May 09.


PS-9, bearing 310°: 17 Apr 02.


PS-9, bearing 310°: 26 Mar 08.


PS-9, bearing 310°: 08 Sep 08.


PS-9, bearing 310°: 20 May 09.


PS-10, bearing 25°: 17 Apr 02.


PS-10, bearing 25°: 26 Mar 08.


PS-10, bearing 25°: 08 Sep 08.


PS-10, bearing 25°: 20 May 09.


PS-11, bearing 20°: Pre-construction view of cross-section 6 at station 20+90; 19 Mar 07.


PS-11, bearing 20°: Post-construction view of cross-section 6 at station 20+90; 08 Jan 08.


PS-11, bearing 20°: 08 Sep 08.


PS-11, bearing 20°: 20 May 09.


PS-12, bearing 210°: 17 Apr 02.


PS-12, bearing 210°: 08 Jan 08.


PS-12, bearing 210°: 08 Sep 08.


PS-12, bearing 210°: 20 May 09.


PS-13, bearing 330°: 19 Mar 07.


PS-13, bearing 330°: 26 Mar 08.


PS-13, bearing 330°: 08 Sep 08.


PS-13, bearing 330°: 20 May 09.


PS-14, bearing 50°: 29 Jan 08.


PS-14, bearing 50°: 11 Sep 08.


PS-14, bearing 50°: 20 May 09.

PS-15, bearing 50°: 29 Jan 08.

PS-15, bearing 50°: 11 Sep 08.

PS-15, bearing 50°: 20 May 09.


PS-15, bearing 80°: 29 Jan 08.


PS-15, bearing 80°: 11 Sep 08.


PS-15, bearing 80°: 20 May 09.


PS-15, bearing 145°: 29 Jan 08.


PS-15, bearing 145°: 11 Sep 08.


PS-15, bearing 145°: 20 May 09.

B.3 Qualitative Visual Stability Assessment

Table B.3.1 Categorical Stream Feature Visual Stability Assessment Summary.

Features	**Initial**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
A. Riffles	100%	99%	100%			
B. Pools	100%	94%	94%			
C. Thalweg	100%	93%	93%			
D. Meanders	100%	98%	98%			
E. Bed General	100%	99%	100%			
F. Bank Condition	100%	99%	99%			
G. Vanes / J Hooks etc.	100%	97%	97%			
F. Wads and Boulders	100%	100%	100%			

Table B.3.2 Visual Morphological Stability Assessment.

MY1 Visual Morphological Stability Assessment						
Feature Category	Metric (per As-built and references baselines)	(# Stable) Number Performing as Intended	Total Number per As-built	Total Number feet in unstable state[1]	Percent Perform In Stable Condition[2]	Feature Performance Mean or Total[3]
A. Riffles	1. Present?	30	30	NA	100%	
	2. Armor stable (e.g. no displacement)?	28	30	NA	93%	
	3. Facet grade appears stable?	30	30	NA	100%	
	4. Minimal evidence of embedding/fining?	30	30	NA	100%	
	5. Length appropriate?	30	30	NA	100%	99%
B. Pools	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)[4]	27	28	NA	96%	
	2. Sufficiently deep (Max Pool D:Mean BKF>1.6?	26	28	NA	93%	
	3. Length appropriate?	26	28	NA	93%	94%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?[5]	14	15	NA	93%	
	2. Downstream of meander (glide/inflection) centering?[5]	14	15	NA	93%	93%
D. Meanders	1. Outer bend in state of limited/controlled erosion?	12	13	NA	92%	
	2. Of those eroding, # w/ concomitant point bar formation?	0	0	NA	100%	
	3. Apparent Rc within spec?	13	13	NA	100%	
	4. Sufficient floodplain access and relief?	13	13	NA	100%	98%
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	2/23	99%	
	2. Channel bed degradation - areas of increasing downcutting or head cutting?	NA	NA	NA	100%	99%
F. Bank[6]	1. Actively eroding, wasting, or slumping bank	NA	NA	30	99%	99%
G. Vanes	1. Free of back or arm scour?	22	24	NA	92%	
	2. Height appropriate?	23	24	NA	96%	
	3. Angle and geometry appear appropriate?	24	24	NA	100%	
	4. Free of piping or other structural failures?	24	24	NA	100%	97%
H. Wads/ Boulders	1. Free of scour?	4	4	NA	100%	
	2. Footing stable?	4	4	NA	100%	100%

1. Metrics that are spatial estimates that are continuous variables should be entered as:
The number of locals over the reach for which the failing condition is observed / followed by the total linear distance (feet) or area for which the failing or unstable condition is observed.
2. In the case of categorical metrics for which a feature count is involved, this is simply calculated as the number of functional features that are in a stated of stability as a percentage of the total. In the case of those metrics based on footage or aerial extent it is that amount in a state of failure or instability expressed as a porportion of the total amount of that feature. The resulting proportion is then subtracted from 1 and then multiplied by 100 to give a percentage that represents the proportion of that feature category in a state of apparent stability
3. The mean of the metrics for a givien feature category.
4. Was the feature actually present as compared to the As-built or has the featrue been completely obsucred (aggraded) of removed (degraded)
5. Is the thalweg centering up on the channel between meander bends?
6. Amount of active bank failure/erosion. This should be the tally of all stressed and failing banks from the problem area plan view, which can then be calculated as indicated in footnote 1 above.

MY2 Visual Morphological Stability Assessment						
Feature Category	Metric (per As-built and references baselines)	(# Stable) Number Performing as Intended	Total Number per As-built	Total Number feet in unstable state[1]	Percent Perform In Stable Condition[2]	Feature Performance Mean or Total[3]
A. Riffles	1. Present?	30	30	NA	100%	
	2. Armor stable (e.g. no displacement)?	30	30	NA	100%	
	3. Facet grade appears stable?	30	30	NA	100%	
	4. Minimal evidence of embedding/fining?	30	30	NA	100%	
	5. Length appropriate?	30	30	NA	100%	100%
B. Pools	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)[4]	27	28	NA	96%	
	2. Sufficiently deep (Max Pool D:Mean BKF>1.6?	26	28	NA	93%	
	3. Length appropriate?	26	28	NA	93%	94%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?[5]	14	15	NA	93%	
	2. Downstream of meander (glide/inflection) centering?[5]	14	15	NA	93%	93%
D. Meanders	1. Outer bend in state of limited/controlled erosion?	12	13	NA	92%	
	2. Of those eroding, # w/concomitant point bar formation?	0	0	NA	100%	
	3. Apparent Rc within spec?	13	13	NA	100%	
	4. Sufficient floodplain access and relief?	13	13	NA	100%	98%
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	10	100%	
	2. Channel bed degradation - areas of increasing downcutting or head cutting?	NA	NA	0	100%	100%
F. Bank[6]	1. Actively eroding, wasting, or slumping bank	0	0	30	99%	99%
G. Vanes	1. Free of back or arm scour?	22	24	NA	92%	
	2. Height appropriate?	23	24	NA	96%	
	3. Angle and geometry appear appropriate?	24	24	NA	100%	
	4. Free of piping or other structural failures?	24	24	NA	100%	97%
H. Wads/ Boulders	1. Free of scour?	4	4	NA	100%	
	2. Footing stable?	4	4	NA	100%	100%

1. Metrics that are spatial estimates that are continuous variables should be entered as:
The number of locals over the reach for which the failing condition is observed / followed by the total linear distance (feet) or area for which the failing or unstable condition is observed.
2. In the case of categorical metrics for which a feature count is involved, this is simply calculated as the number of functional features that are in a stated of stability as a percentage of the total. In the case of those metrics based on footage or aerial extent it is that amount in a state of failure or instability expressed as a porportion of the total amount of that feature. The resulting proportion is then subtracted from 1 and then multiplied by 100 to give a percentage that represents the proportion of that feature category in a state of apparent stability
3. The mean of the metrics for a givien feature category.
4. Was the feature actually present as compared to the As-built or has the featrue been completely obsucred (aggraded) of removed (degraded)
5. Is the thalweg centering up on the channel between meander bends?
6. Amount of active bank failure/erosion. This should be the tally of all stressed and failing banks from the problem area plan view, which can then be calculated as indicated in footnote 1 above.

B.4 Morphological Summary Tables

Table B.4.1 Baseline Stream Data Summary.

Parameter	Regional Curve Interval			Pre-Existing Condition			Reference Reach(es) Data			Design			As-built / Baseline						MY1						MY2					
Dimension and Substrate – Riffle	LL	UL	Eq.	Min	Max	Mean	Min	Max	Typical	Min	Max	Typical	Min	Max	Median	Mean	SD	n	Min	Max	Median	Mean	SD	n	Min	Max	Median	Mean	SD	n
Bankfull Width (ft)		34.0		22.4	44.9	33.2			28.1	28.4	35.8	34.0	20.6	36.8	31.6	30.1	7.4	4	20.6	39.6	32.2	31.2	7.9	4	20.8	38.5	34.8	32.2	7.8	4
Floodprone Width (ft)				66.0	100.0	100.0			125.0	100.0	300.0	100.0	48.3	166.8	94.9	101.2	53.0	4	57.1	185.9	95.5	108.5	58.5	4	57.9	176.6	95.2	106.2	54.2	4
Bankfull Cross-Sectional Area (ft^2)	56.0	60.0	$=20.87x^{0.68}$	52.3	61.3	56.9			62.0	56.0	60.0	58.0	35.3	60.4	47.9	47.9	11.8	4	39.5	69.2	51.0	52.7	14.6	4	40.6	65.2	51.9	52.4	11.7	4
Bankfull Mean Depth (ft)		1.8		1.3	2.6	1.7			2.2	1.6	2.1	1.8	1.0	2.0	1.8	1.6	0.5	4	1.2	2.0	1.9	1.7	0.4	4	1.2	2.1	1.7	1.7	0.4	4
Bankfull Max Depth (ft)				3.4	3.8	3.5			3.1	3.0	3.4	3.5	2.5	3.5	2.8	2.9	0.4	4	2.5	3.7	3.0	3.0	0.5	4	2.7	3.5	3.0	3.0	0.4	4
Width/Depth Ratio				8.8	34.9	19.4			12.7	13.8	21.7	>12.0	10.4	34.6	18.5	20.5	10.7	4	10.2	28.3	19.3	19.3	7.9	4	9.7	28.7	21.9	20.6	7.9	4
Entrenchment Ratio				1.5	4.5	3.0			4.4			>2.2	1.4	5.9	3.3	3.5	1.9	4	1.7	6.0	3.2	3.5	1.8	4	1.7	5.0	3.2	3.3	1.4	4
Bank Height Ratio				1.0	1.3	1.1			1.2	1.0	1.04	1.03	1.0	2.1	1.6	1.6	0.5	4	1.0	2.0	1.5	1.5	0.6	4	1.0	2.0	1.4	1.4	0.5	4
Bankfull Wetted Perimeter (ft)				26.2	46.8	34.1			30.5				24.2	39.6	33.9	32.9	7.1	4	22.7	47.5	33.7	34.4	10.2	4	23.2	41.3	36.5	34.4	7.8	4
Hydraulic Radius (ft)				1.2	2.2	1.7			2.0				0.9	1.8	1.6	1.5	0.4	4	1.1	1.9	1.6	1.6	0.3	4	1.1	1.9	1.6	1.6	0.3	4
D50 (mm)						36.9			15.9			Gravel	34.8	42.4	40.5	39.5	3.7	4	34.4	60.0	37.9	42.6	11.9	4	37.4	57.7	49.9	48.7	8.4	4
Profile																														
Riffle Length (ft)				30.0	247.0	100.0	24.0	132.0	78.0				6.4	123.6	28.5	30.8	22.9	30	4.3	128.0	25.8	34.0	27.3	29	1.8	126.8	28.9	33.0	25.6	29
Riffle Slope (ft/ft)				0.007	0.027	0.015	0.002	0.018	0.015				0.002	0.054	0.019	0.021	0.014	30	0.001	0.065	0.015	0.017	0.013	29	0.003	0.055	0.015	0.017	0.012	29
Pool Length (ft)				14.0	89.0	50.0	10.0	66.0	66.0				4.5	81.2	30.8	35.1	19.4	29	8.8	85.0	26.2	32.2	19.4	28	4.8	76.5	24.6	27.8	18.4	28
Pool Max depth (ft)						5.0			3.3				2.8	6.4	4.1	4.2	0.6	31	3.1	6.8	4.2	4.2	0.7	29	3.2	7.1	4.4	4.4	0.7	29
Pool to Pool Spacing (ft)				36.0	264.0	100.0	44.0	225.0	80.0				34.8	194.3	80.6	91.6	40.5	28	25.9	192.0	84.1	94.6	39.4	28	40.2	192.2	97.5	100.0	37.0	28
Pattern																														
Channel Beltwidth (ft)				64.0	68.0	66.0			240.0				35.8	63.0	53.3	51.2	11.6	6												
Radius of Curvature (ft)				10	15.4	12.7	10	15.4	12.7				16.3	43.3	30.2	30.8	10.3	9												
Rc:Bankfullwidth (ft/ft)				0.3	0.5	0.4			0.5				0.5	1.4	0.9	0.9	0.4	6												
Meander Wavelength (ft)				68.0	100.0	84.0	335.0	440.0	380.0				57.0	132.8	117.1	106.1	28.3	6												
Meander Width Ratio				1.9	2.0	2.0			8.5				1.9	4.4	3.9	3.5	0.9	6												

Table B.5.1 Continued

Parameter	Regional Curve			Pre-Existing Condition	Reference Reach(es) Data	Design	As-built / Baseline	MY1	MY2
Substrate, bed and transport parameters									
[a]Ri % / Ru % / P % / G % / S %				65.0 / / 35.0 / /	58.0 / / 42.0 / /		34.6 / 10.2 / 38.1 / 17.1 /	36.7 / 15.1 / 33.6 / 14.6 /	36.0 / 18.4 / 29.2 / 16.4 /
[a]SC % / Sa % / G % / C % / B % / Be %				10.0 / 18.0 / 50.0 / 31.0 / 0.0 / 0.0	11.0 / 20.0 / 35.0 / 33.0 / 1.0 / 0.0				
[a]D16 / D35 / D50 / D84 / Di^p / Di^{sp}				0.8 / 7.9 / 22.4 / 78.0 / 101.0 / 300.0 / 110.0	0.2 / 3.4 / 15.9 / 107.0 / 164.0 / /				
Reach Sheer Stress (competency) lb/.ft[b]				0.9		0.9	1.1		
Max part size (mm) mobilized at bankfull				350.0		140.7	159.9		
Stream Power (transport capacity) W/m[b]						93.2	99.8		
Additional Reach Parameters									
Drainage Area (mi^2)				4.4	4.5	4.5	4.4	4.4	4.4
Impervious cover estimate (%)				<10	<10	<10	<10	<10	<10
Rosgen Classification				C4	C4	C4	C4, B4c, F4	B4c, C4, E4	B4c, C4, E4
Bankfull Velocity (fps)				6.2		6.2	6.12		
Bankfull Discharge (cfs)		254.9	$=84.6x^{0.74}$	350		350	338.4		
Valley Length (ft)				2,065	520	2,065	2,065	2,065	2,065
Channel Thalweg Length (ft)				2,710	864	2,710	2,719	2,715	2,723
Sinuosity (ft)				1.3	1.6	1.3	1.3	1.3	1.3
Water Surface Slope (Channel) (ft/ft)				0.0097	0.0077	0.0097	0.0093	0.0093	0.0093
Bankfull Slope (ft/ft)				0.0091	0.0077	0.0097	0.0091	0.0091	0.0091

[a]Riffle, Run, Pool, Glide, Step; Subpavement Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock, Di^p = max pavement, Di^{sp} = max subpave. Shaded cells indicate that these will typically not be filled in

[b] Methodology described in report and RiverMorph (2008).

Table B.4.2 Morphology and Hydraulic Summary (Dimensional Parameters - Cross Section).

Dimension and Substrate	Cross Section 1 at Station 3+56 (Riffle) MY0	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
Bankfull Width (ft)	34.9	33.4	34.2				
Floodprone Width (ft)	48.3	57.1	57.9				
Bankfull Cross-sectional Area (ft^2)	35.3	39.5	40.6				
Bankfull Mean Depth (ft)	1.0	1.2	1.2				
Bankfull Max Depth (ft)	2.5	2.7	2.7				
Bankfull Width/Depth Ratio	34.6	28.3	28.7				
Bankfull Entrenchment Ratio	1.4	1.7	1.7				
Bankfull Bank Height Ratio	2.1	2.0	2.0				
Based on current/developing bankfull feature							
Bankfull Width (ft)							
Floodprone Width (ft)							
Bankfull Cross-sectional Area (ft^2)							
Bankfull Mean Depth (ft)							
Bankfull Max Depth (ft)							
Bankfull Width/Depth Ratio							
Bankfull Entrenchment Ratio							
Bankfull Bank Height Ratio							
Cross-sectional Area between end pins (ft^2)	141.4	146.9	148.9				
D50	38.5	39.9	57.7				

Dimension and Substrate	Cross Section 2 at Station 6+39 (Pool) MY0	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
Bankfull Width (ft)	18.7	18.4	18.8				
Floodprone Width (ft)	159.7	159.7	159.7				
Bankfull Cross-sectional Area (ft^2)	32.4	33.5	33.7				
Bankfull Mean Depth (ft)	1.7	1.8	1.8				
Bankfull Max Depth (ft)	3.3	3.2	3.6				
Bankfull Width/Depth Ratio	10.8	10.1	10.5				
Bankfull Entrenchment Ratio	8.6	8.7	8.5				
Bankfull Bank Height Ratio	1.9	1.9	1.8				
Based on current/developing bankfull feature							
Bankfull Width (ft)							
Floodprone Width (ft)							
Bankfull Cross-sectional Area (ft^2)							
Bankfull Mean Depth (ft)							
Bankfull Max Depth (ft)							
Bankfull Width/Depth Ratio							
Bankfull Entrenchment Ratio							
Bankfull Bank Height Ratio							
Cross-sectional Area between end pins (ft^2)	113.3	115.8	116.0				
D50	49.3	35.0	74.1				

Dimension and Substrate	Cross Section 3 at Station 7+62 (Pool) MY0	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
Bankfull Width (ft)	19.9	21.2	19.3				
Floodprone Width (ft)	218.4	218.4	218.4				
Bankfull Cross-sectional Area (ft^2)	48.5	50.7	52.8				
Bankfull Mean Depth (ft)	2.4	2.4	2.7				
Bankfull Max Depth (ft)	3.9	4.1	4.1				
Bankfull Width/Depth Ratio	8.1	8.8	7.1				
Bankfull Entrenchment Ratio	11.0	10.3	11.3				
Bankfull Bank Height Ratio	1.2	1.1	1.1				
Based on current/developing bankfull feature							
Bankfull Width (ft)							
Floodprone Width (ft)							
Bankfull Cross-sectional Area (ft^2)							
Bankfull Mean Depth (ft)							
Bankfull Max Depth (ft)							
Bankfull Width/Depth Ratio							
Bankfull Entrenchment Ratio							
Bankfull Bank Height Ratio							
Cross-sectional Area between end pins (ft^2)	152.8	164.2	162.7				
D50	20.7	19.3	9.9				

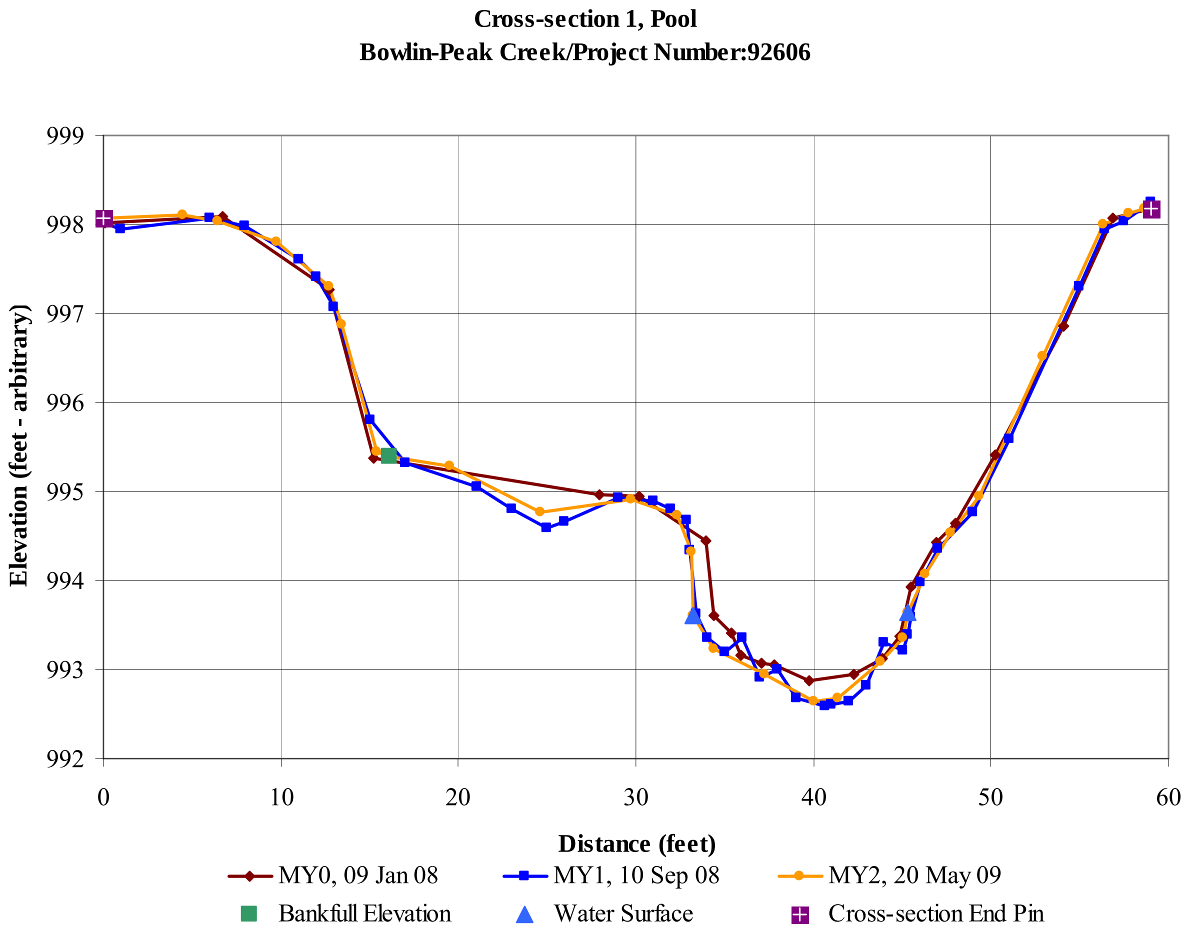
Dimension and Substrate	Cross Section 4 at Station 10+43 (Riffle) MY0	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
Bankfull Width (ft)	25.8	25.4	25.8				
Floodprone Width (ft)	121.7	113.2	124.4				
Bankfull Cross-sectional Area (ft^2)	48.5	46.8	48.0				
Bankfull Mean Depth (ft)	1.9	1.8	1.9				
Bankfull Max Depth (ft)	2.8	2.7	2.7				
Bankfull Width/Depth Ratio	13.7	13.8	13.9				
Bankfull Entrenchment Ratio	4.7	4.5	4.8				
Bankfull Bank Height Ratio	1.1	1.2	1.1				
Based on current/developing bankfull feature							
Bankfull Width (ft)	28.2	31.1	35.3				
Floodprone Width (ft)	166.8	185.9	176.6				
Bankfull Cross-sectional Area (ft^2)	55.0	60.6	59.3				
Bankfull Mean Depth (ft)	2.0	2.0	1.7				
Bankfull Max Depth (ft)	3.0	3.2	30.8				
Bankfull Width/Depth Ratio	14.5	15.9	21.0				
Bankfull Entrenchment Ratio	5.9	6.0	5.0				
Bankfull Bank Height Ratio	1.4	1.0	1.0				
Cross-sectional Area between end pins (ft^2)	79.9	78.3	78.2				
D50	34.8	36.0	37.4				

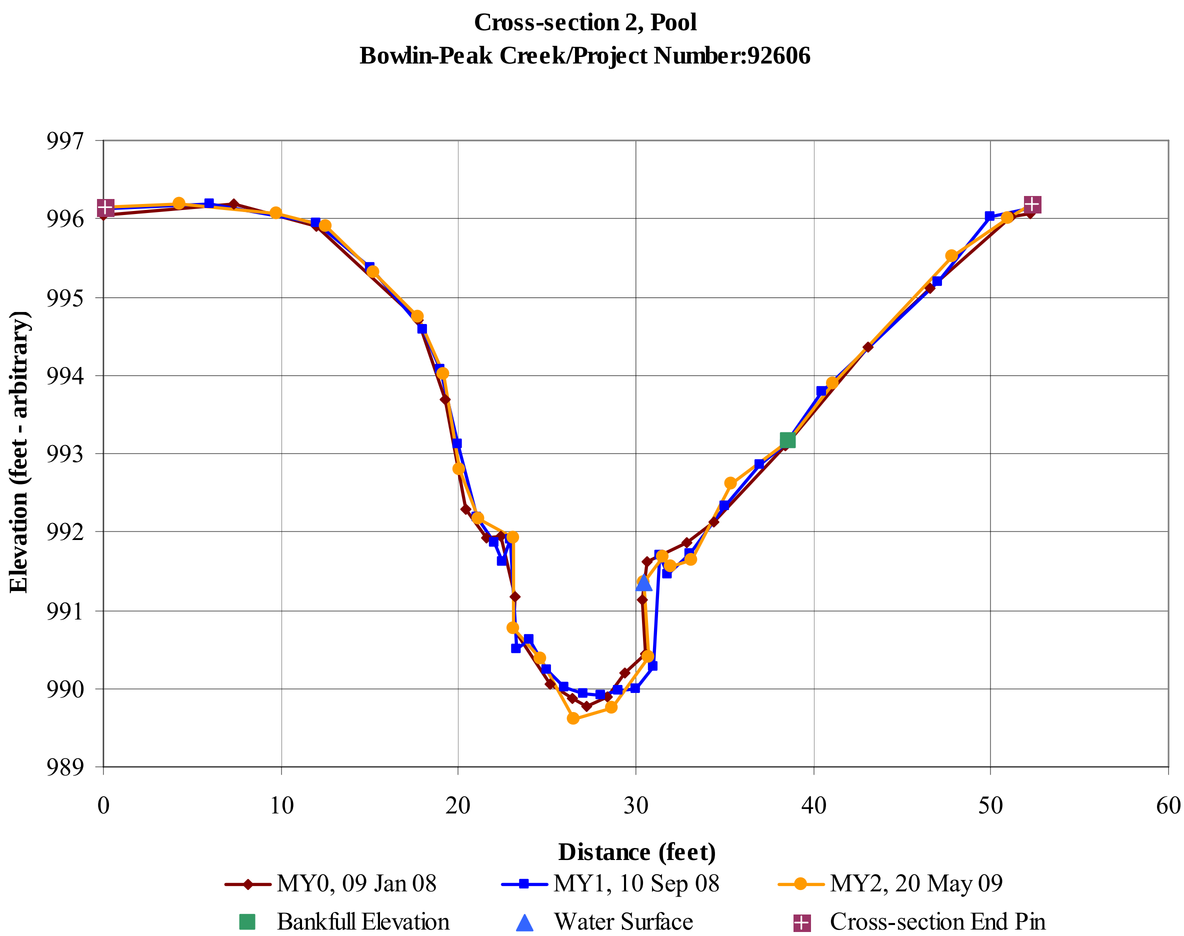
Dimension and Substrate	Cross Section 5 at Station 14+80 (Pool) MY0	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
Bankfull Width (ft)	20.4	20.5	21.1				
Floodprone Width (ft)	171.9	171.9	171.9				
Bankfull Cross-sectional Area (ft^2)	48.3	48.1	49.3				
Bankfull Mean Depth (ft)	2.4	2.3	2.3				
Bankfull Max Depth (ft)	4.8	4.7	4.6				
Bankfull Width/Depth Ratio	8.6	8.8	9.1				
Bankfull Entrenchment Ratio	8.4	8.4	8.1				
Bankfull Bank Height Ratio	1.1	1.0	1.1				
Based on current/developing bankfull feature							
Bankfull Width (ft)							
Floodprone Width (ft)							
Bankfull Cross-sectional Area (ft^2)							
Bankfull Mean Depth (ft)							
Bankfull Max Depth (ft)							
Bankfull Width/Depth Ratio							
Bankfull Entrenchment Ratio							
Bankfull Bank Height Ratio							
Cross-sectional Area between end pins (ft^2)	124.0	122.5	127.6				
D50	67.1	54.5	12.5				

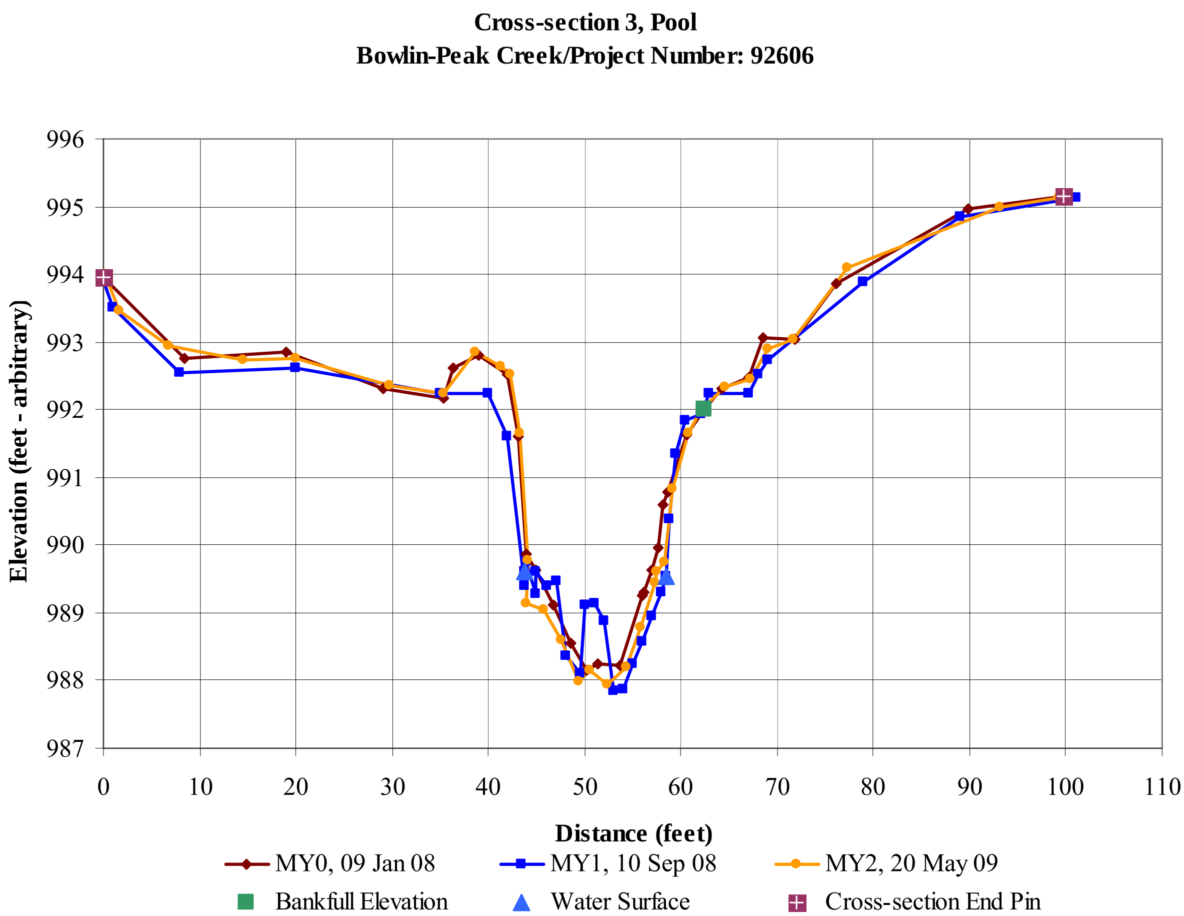
Dimension and Substrate	Cross Section 6 at Station 16+80 (Riffle) MY0	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
Bankfull Width (ft)	25.4	25.9	27.0				
Floodprone Width (ft)	86.7	88.0	89.3				
Bankfull Cross-sectional Area (ft^2)	33.2	34.8	36.1				
Bankfull Mean Depth (ft)	1.3	1.4	1.3				
Bankfull Max Depth (ft)	2.7	2.7	2.7				
Bankfull Width/Depth Ratio	19.6	19.2	20.2				
Bankfull Entrenchment Ratio	3.4	3.4	3.3				
Bankfull Bank Height Ratio	1.3	1.4	1.3				
Based on current/developing bankfull feature							
Bankfull Width (ft)	36.8	39.6	38.5				
Floodprone Width (ft)	119.7	121.0	120.3				
Bankfull Cross-sectional Area (ft^2)	60.4	69.2	65.2				
Bankfull Mean Depth (ft)	1.6	1.8	1.7				
Bankfull Max Depth (ft)	3.5	3.7	3.5				
Bankfull Width/Depth Ratio	22.5	22.7	22.8				
Bankfull Entrenchment Ratio	3.3	3.1	3.1				
Bankfull Bank Height Ratio	1.0	1.0	1.0				
Cross-sectional Area between end pins (ft^2)	176.4	177.5	178.7				
D50	42.4	60.0	50.9				

Dimension and Substrate	Cross Section 7 at Station 20+97 (Riffle) MY0	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
Bankfull Width (ft)	20.6	20.6	20.8				
Floodprone Width (ft)	70.0	70.0	70.0				
Bankfull Cross-sectional Area (ft^2)	40.8	41.4	44.6				
Bankfull Mean Depth (ft)	2.0	2.0	2.1				
Bankfull Max Depth (ft)	2.7	2.5	2.8				
Bankfull Width/Depth Ratio	10.4	10.2	9.7				
Bankfull Entrenchment Ratio	3.4	3.4	3.4				
Bankfull Bank Height Ratio	1.9	2.0	1.8				
Based on current/developing bankfull feature							
Bankfull Width (ft)							
Floodprone Width (ft)							
Bankfull Cross-sectional Area (ft^2)							
Bankfull Mean Depth (ft)							
Bankfull Max Depth (ft)							
Bankfull Width/Depth Ratio							
Bankfull Entrenchment Ratio							
Bankfull Bank Height Ratio							
Cross-sectional Area between end pins (ft^2)	101.4	102.6	102.0				
D50	42.4	34.4	48.8				

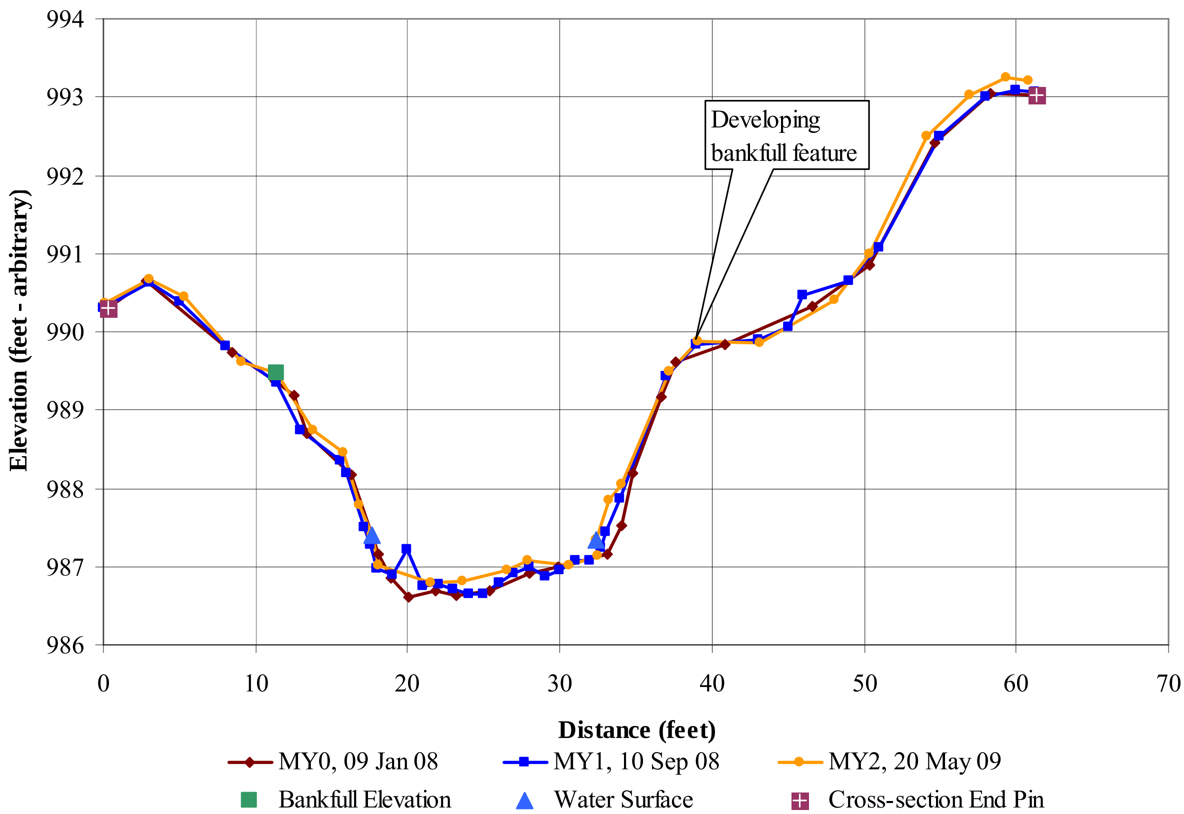
B.5 Annual Overlays of Cross-Section Plots



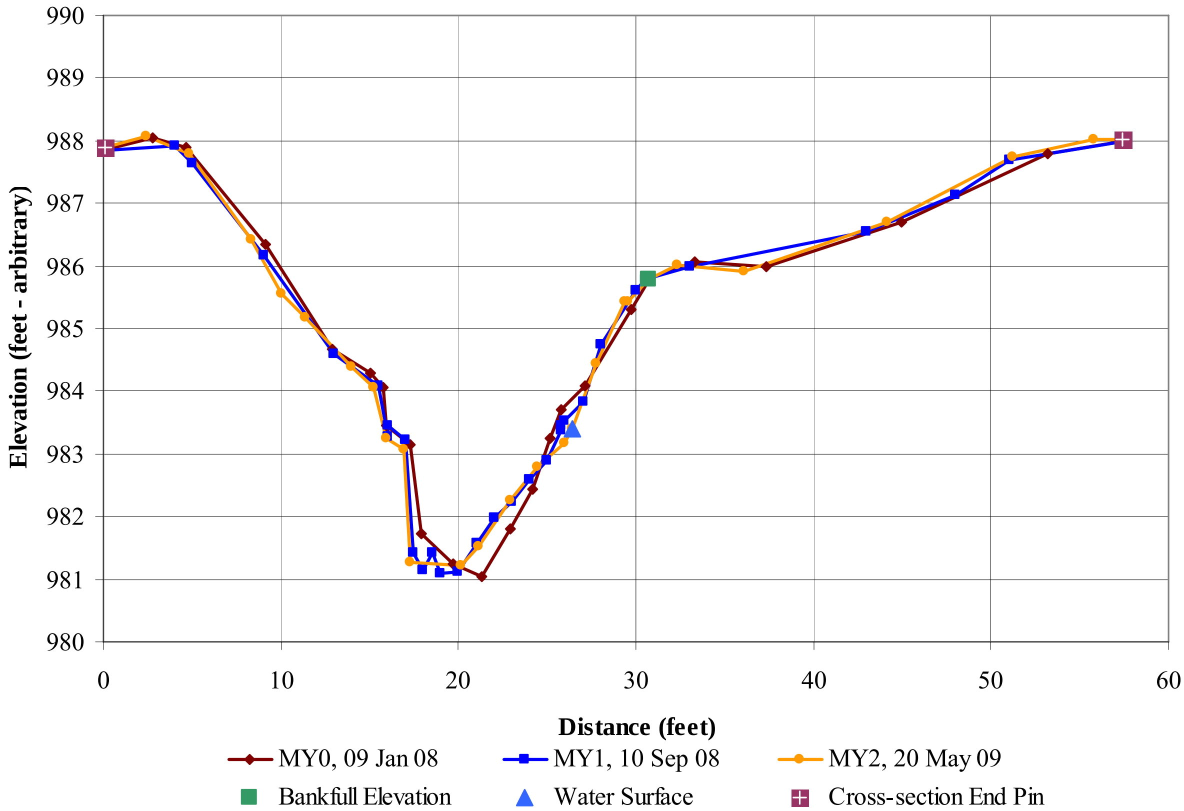

Cross-section 2, Pool
Bowlin-Peak Creek/Project Number:92606
997
996
995
994
993
992
991
990
989
Elevation (feet - arbitrary)
0
10
20
30
40
50
60
Distance (feet)
MY0, 09 Jan 08
MY1, 10 Sep 08
MY2, 20 May 09
Bankfull Elevation
Water Surface
Cross-section End Pin


Cross-section 3, Pool
Bowlin-Peak Creek/Project Number: 92606
996
995
994
993
992
991
990
989
988
987
Elevation (feet - arbitrary)
0
10
20
30
40
50
60
70
80
90
100
110
Distance (feet)
MY0, 09 Jan 08
MY1, 10 Sep 08
MY2, 20 May 09
Bankfull Elevation
Water Surface
Cross-section End Pin

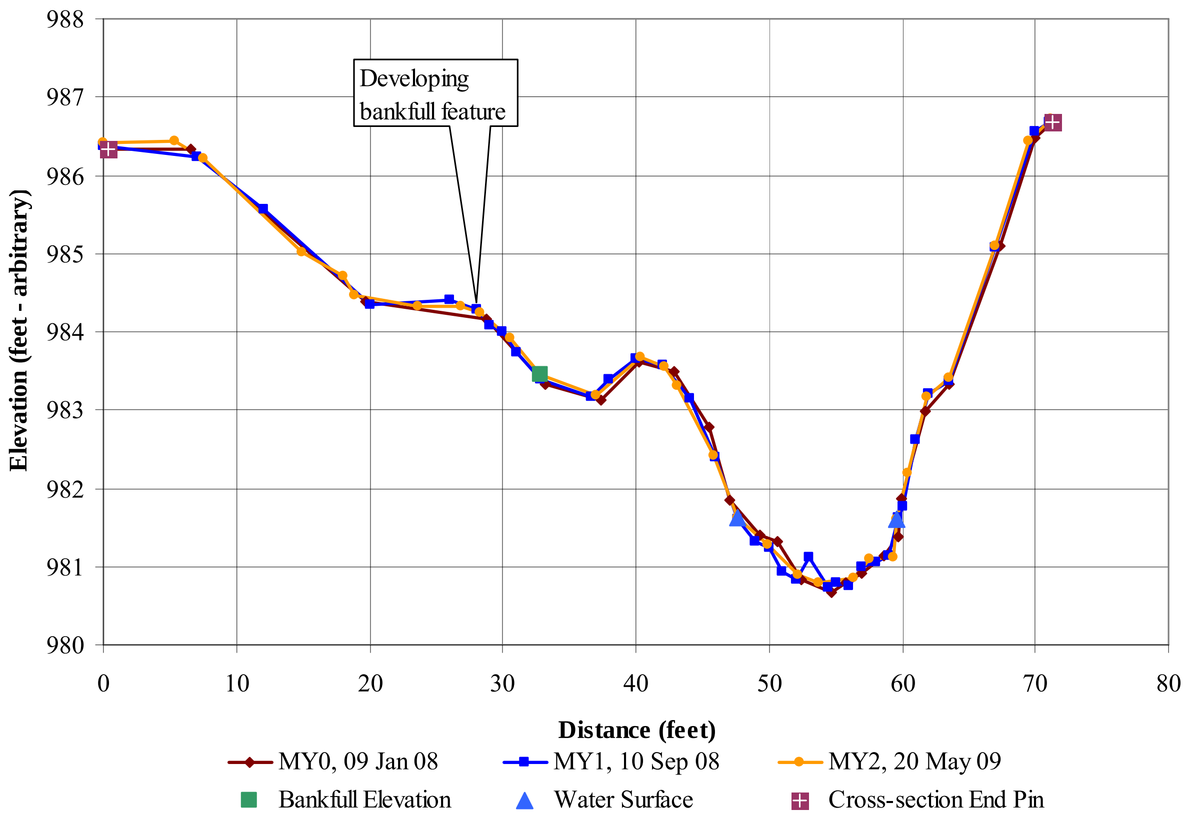
Cross-section 4, Riffle
Bowlin-Peak Creek/Project Number: 92606



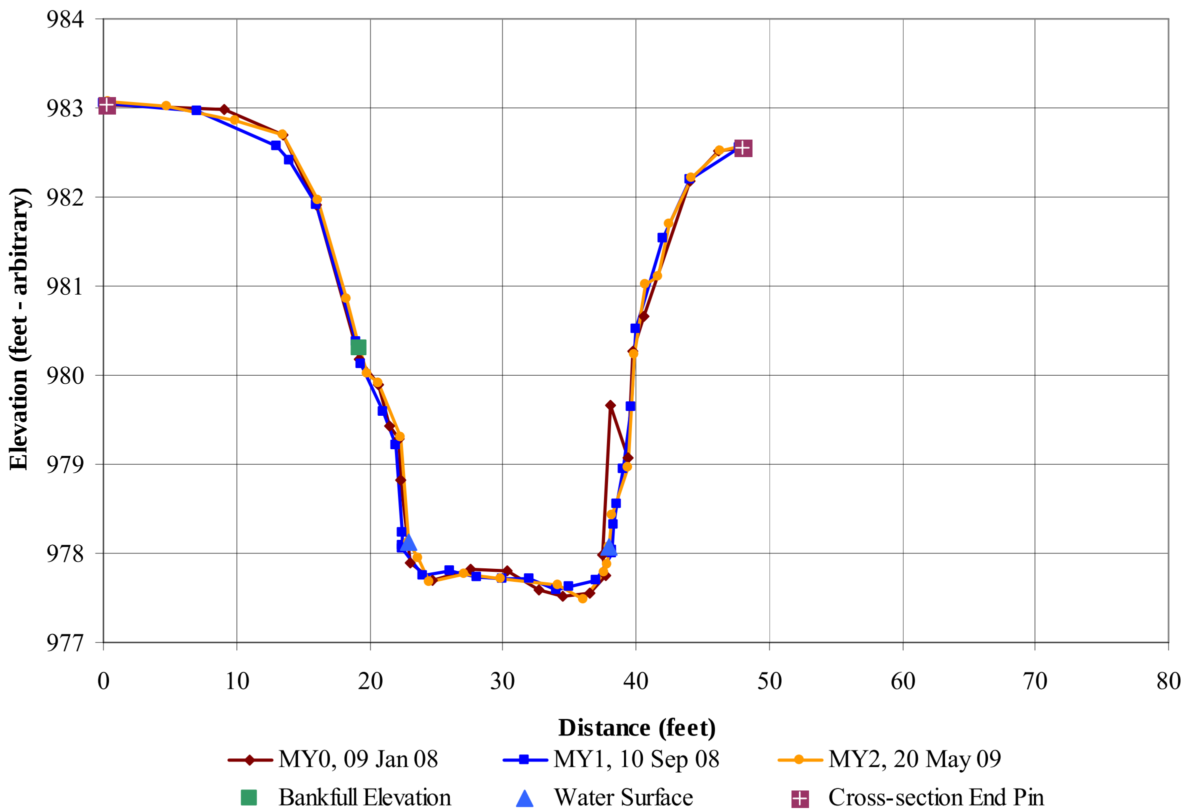
Cross-section 5, Pool
Bowlin-Peak Creek/Project Number:92606



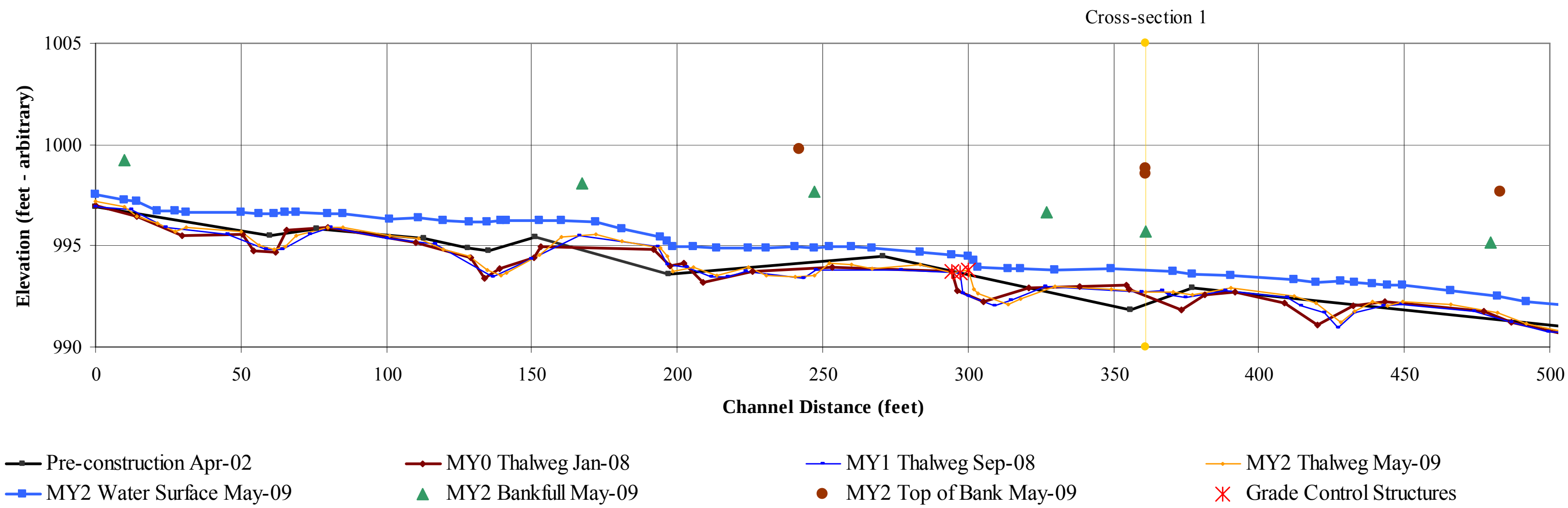
Cross-section 6, Riffle
Bowlin-Peak Creek/Project Number:92606

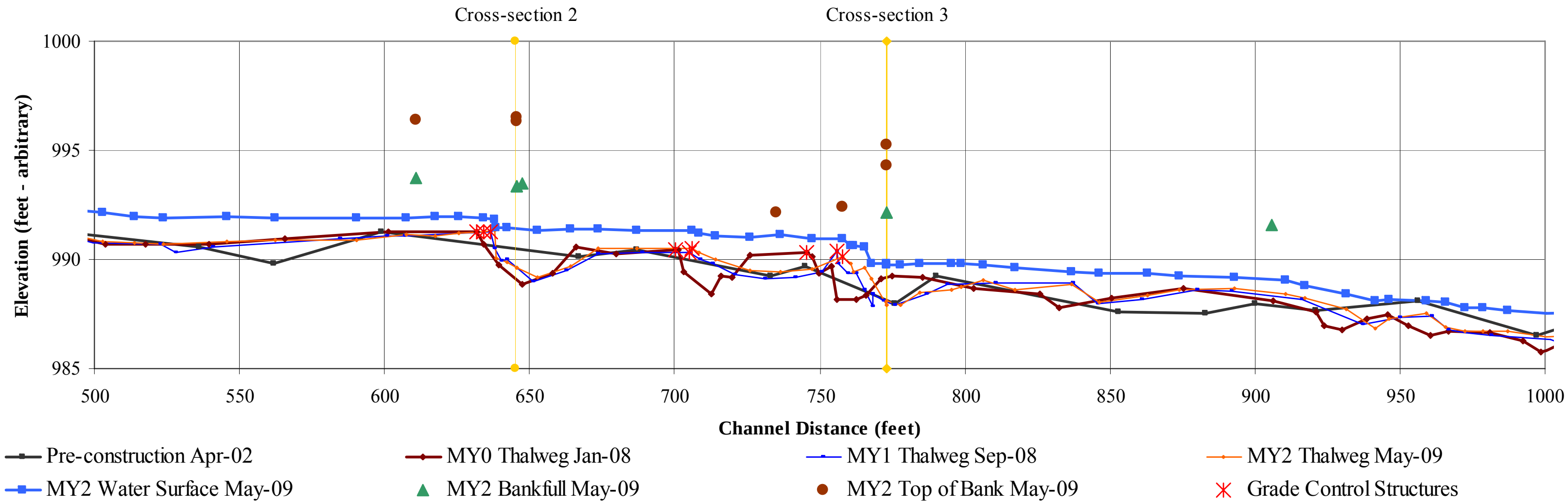


Cross-section 7, Riffle
Bowlin-Peak Creek/Project Number: 92606

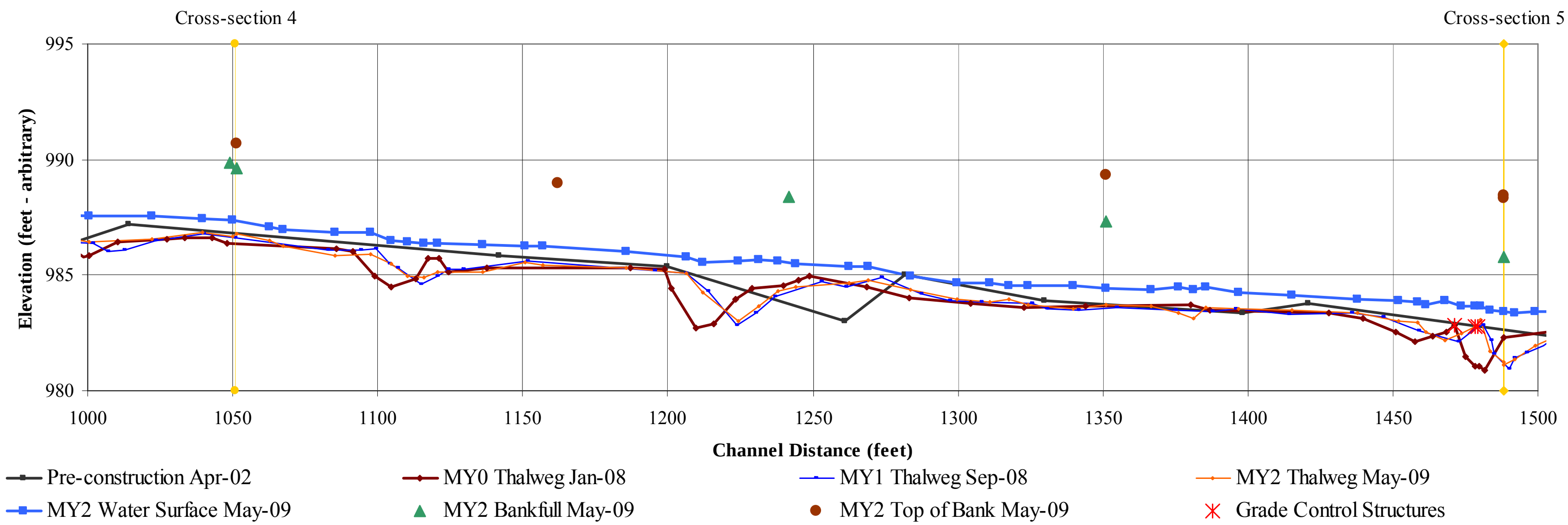


B.6 Annual Overlays of Longitudinal Profile Plots

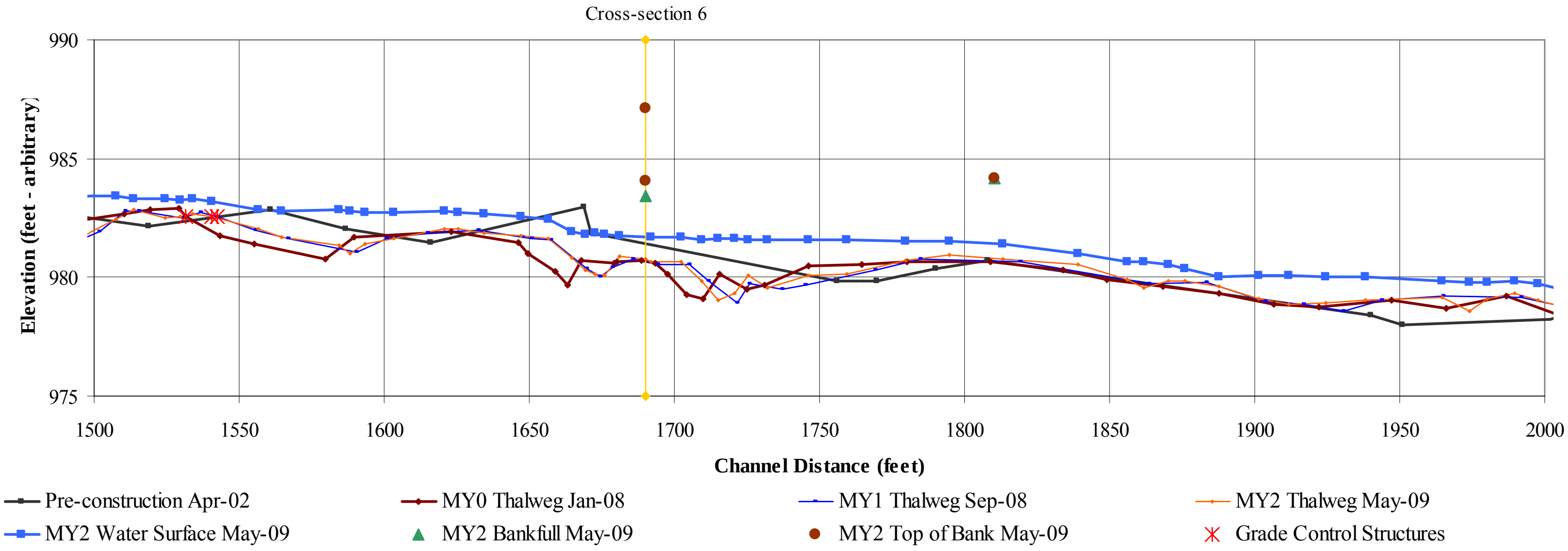


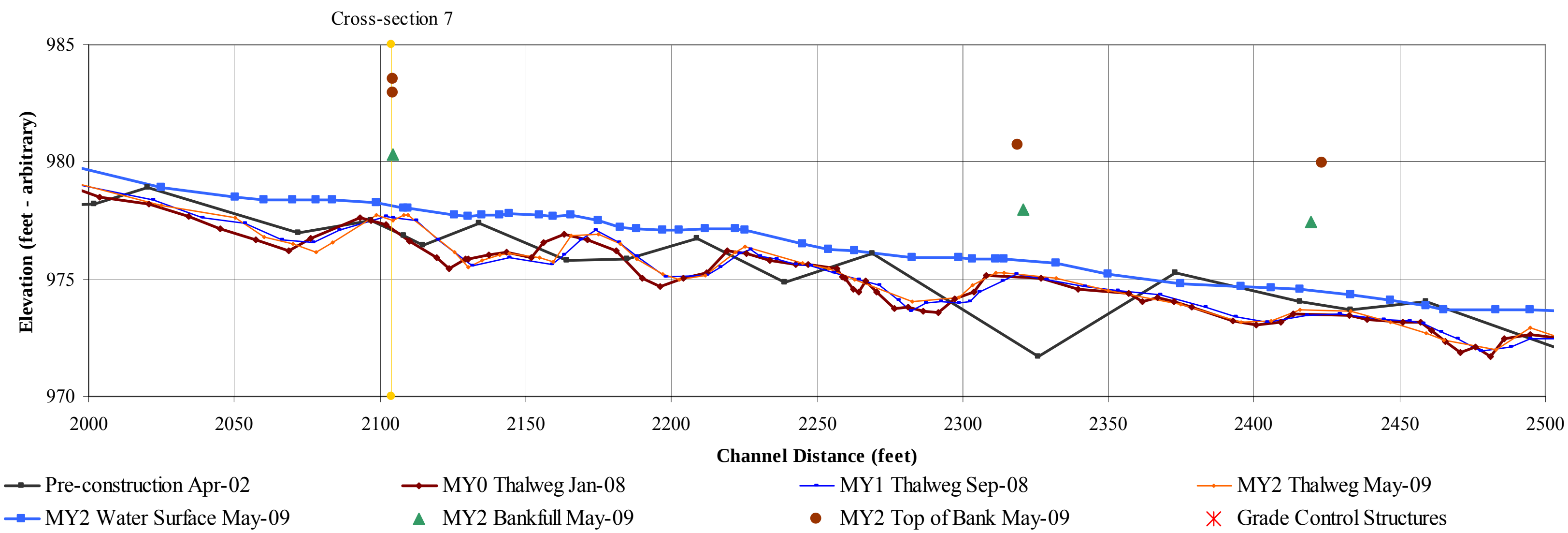


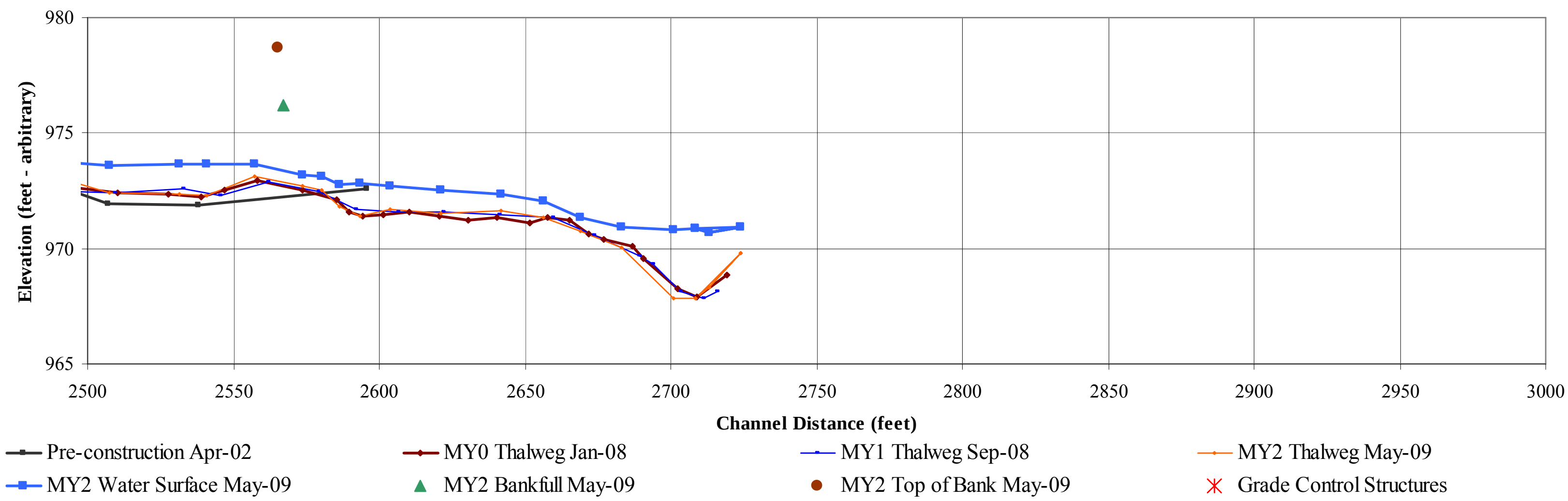
Cross-section 2
Cross-section 3
Elevation (feet - arbitrary)
1000
995
990
985
500
550
600
650
700
750
800
850
900
950
1000
Channel Distance (feet)
Pre-construction Apr-02
MY0 Thalweg Jan-08
MY1 Thalweg Sep-08
MY2 Thalweg May-09
MY2 Water Surface May-09
MY2 Bankfull May-09
MY2 Top of Bank May-09
Grade Control Structures



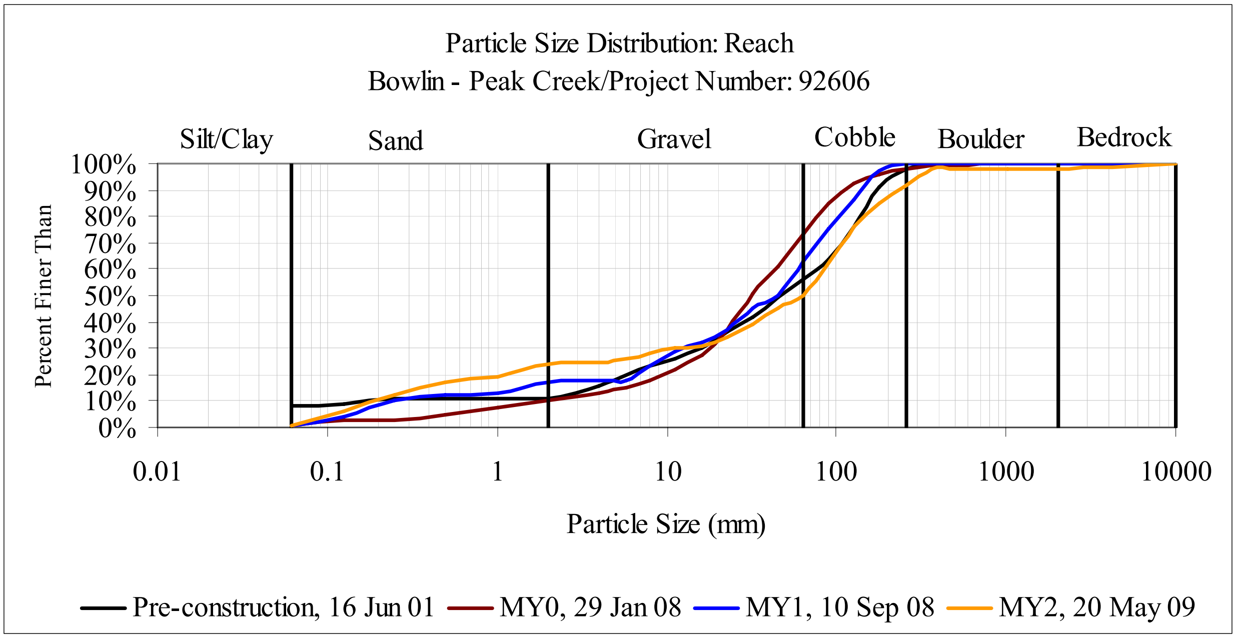
Cross-section 4
Cross-section 5
Elevation (feet - arbitrary)
995
990
985
980
1000
1050
1100
1150
1200
1250
1300
1350
1400
1450
1500
Channel Distance (feet)
Pre-construction Apr-02
MY0 Thalweg Jan-08
MY1 Thalweg Sep-08
MY2 Thalweg May-09
MY2 Water Surface May-09
MY2 Bankfull May-09
MY2 Top of Bank May-09
Grade Control Structures


Cross-section 6
990
985
980
975
Elevation (feet - arbitrary)
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000
Channel Distance (feet)
Pre-construction Apr-02
MY0 Thalweg Jan-08
MY1 Thalweg Sep-08
MY2 Thalweg May-09
MY2 Water Surface May-09
MY2 Bankfull May-09
MY2 Top of Bank May-09
Grade Control Structures

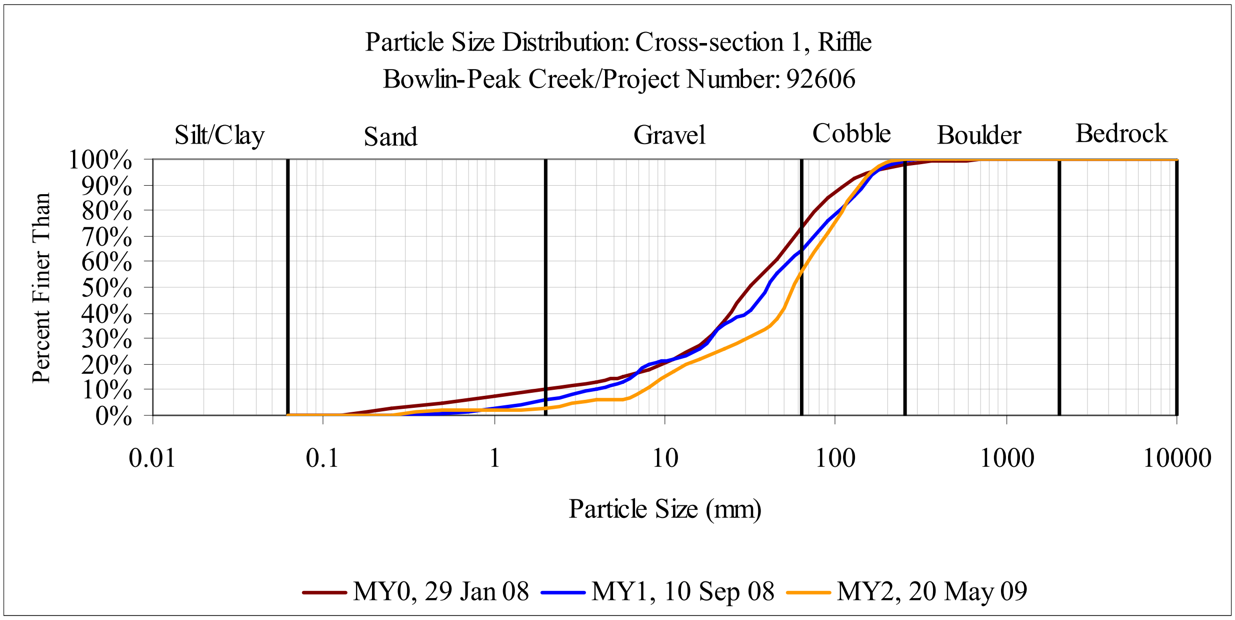

Cross-section 7
985
980
975
970
Elevation (feet - arbitrary)
2000
2050
2100
2150
2200
2250
2300
2350
2400
2450
2500
Channel Distance (feet)
Pre-construction Apr-02
MY0 Thalweg Jan-08
MY1 Thalweg Sep-08
MY2 Thalweg May-09
MY2 Water Surface May-09
MY2 Bankfull May-09
MY2 Top of Bank May-09
Grade Control Structures


980
975
970
965
Elevation (feet - arbitrary)
2500
2550
2600
2650
2700
2750
2800
2850
2900
2950
3000
Channel Distance (feet)
Pre-construction Apr-02
MY0 Thalweg Jan-08
MY1 Thalweg Sep-08
MY2 Thalweg May-09
MY2 Water Surface May-09
MY2 Bankfull May-09
MY2 Top of Bank May-09
Grade Control Structures

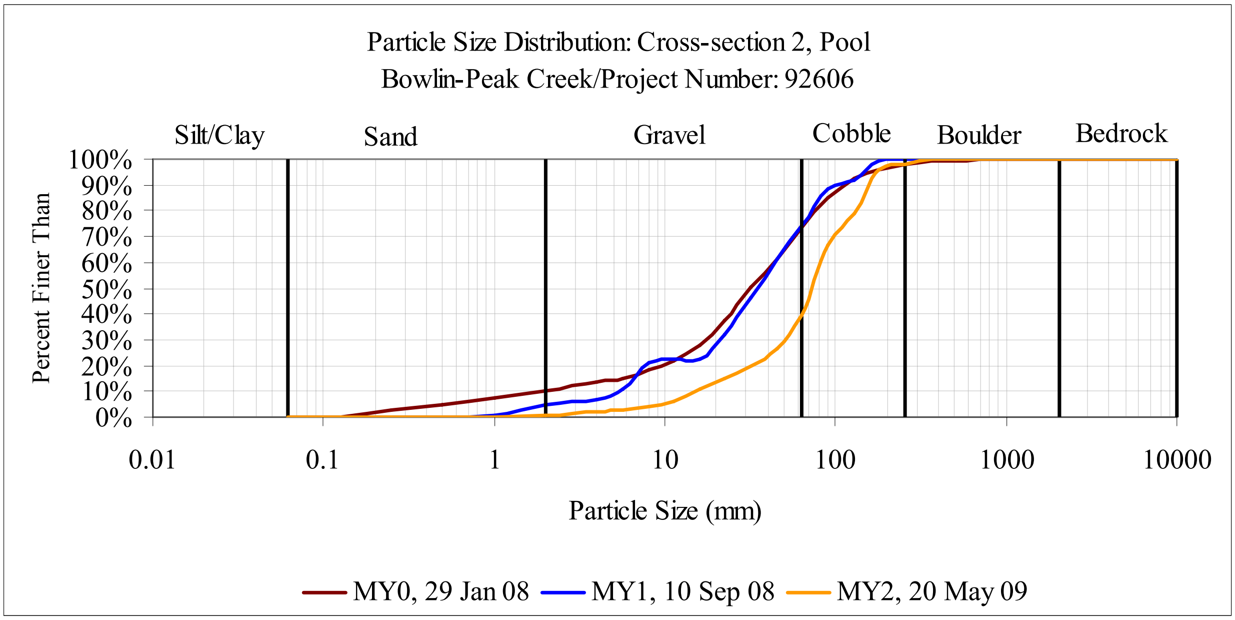
B.7 Pebble Count Cumulative Frequency Distribution Plots



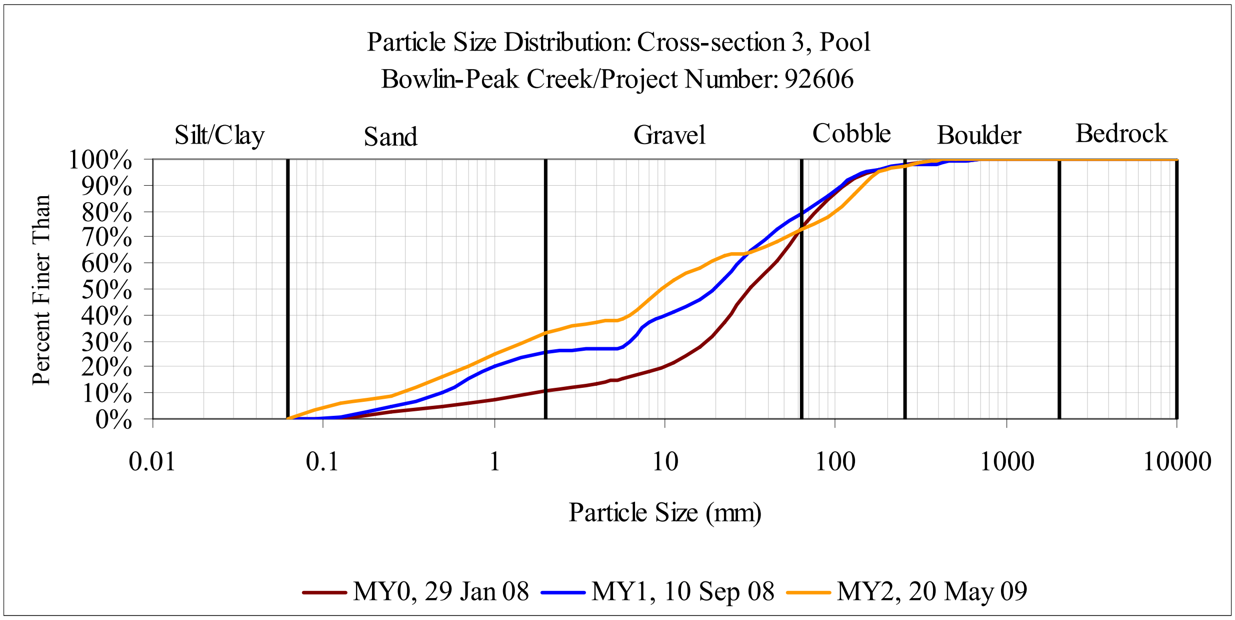
Size Class Index	Particle size (mm) in year sampled			
	Pre-construction	**MY0**	**MY1**	**MY2**
D16	4.0	6.3	1.8	0.5
D35	21.5	21.1	20.0	24.5
D50	47.7	31.7	45.0	64.0
D84	155.7	88.3	121.1	174.2
D95	223.4	163.8	170.6	309.0
D100	362.0	1,024.0	256.0	Bedrock



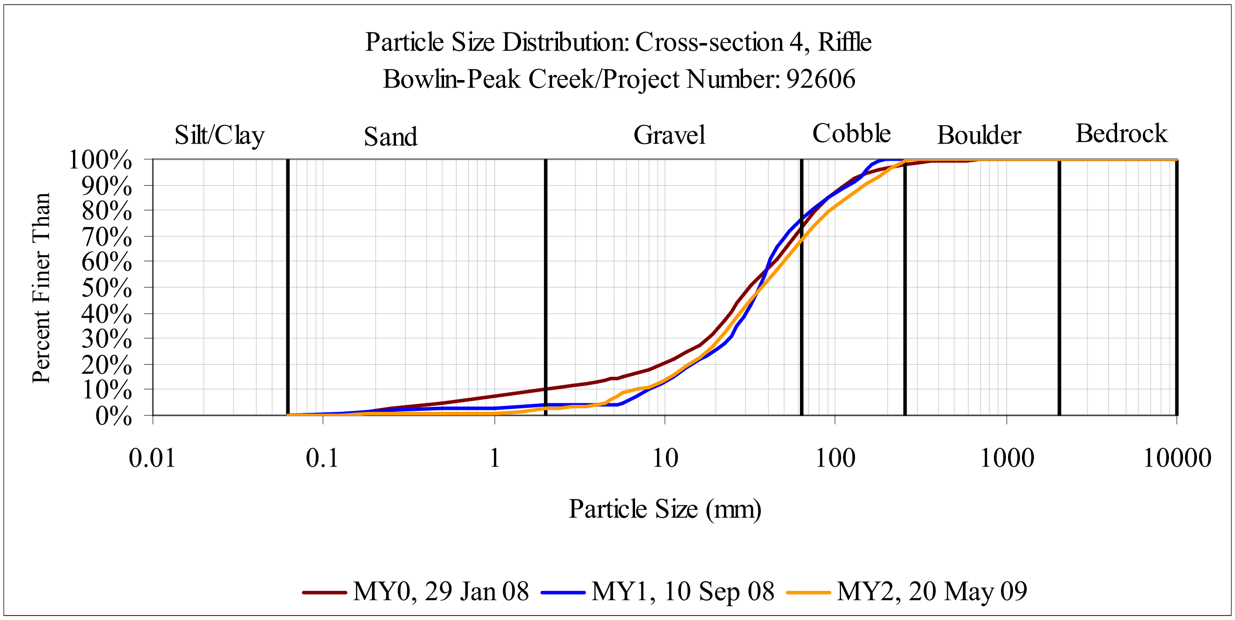
Size Class	Particle size (mm) in year sampled		
Index	MY0	MY1	MY2
D16	6.3	6.6	10.8
D35	21.1	22.4	39.4
D50	31.7	39.9	57.7
D84	88.3	121.0	120.9
D95	163.8	175.1	169.6
D100	1,024.0	362.0	256.0



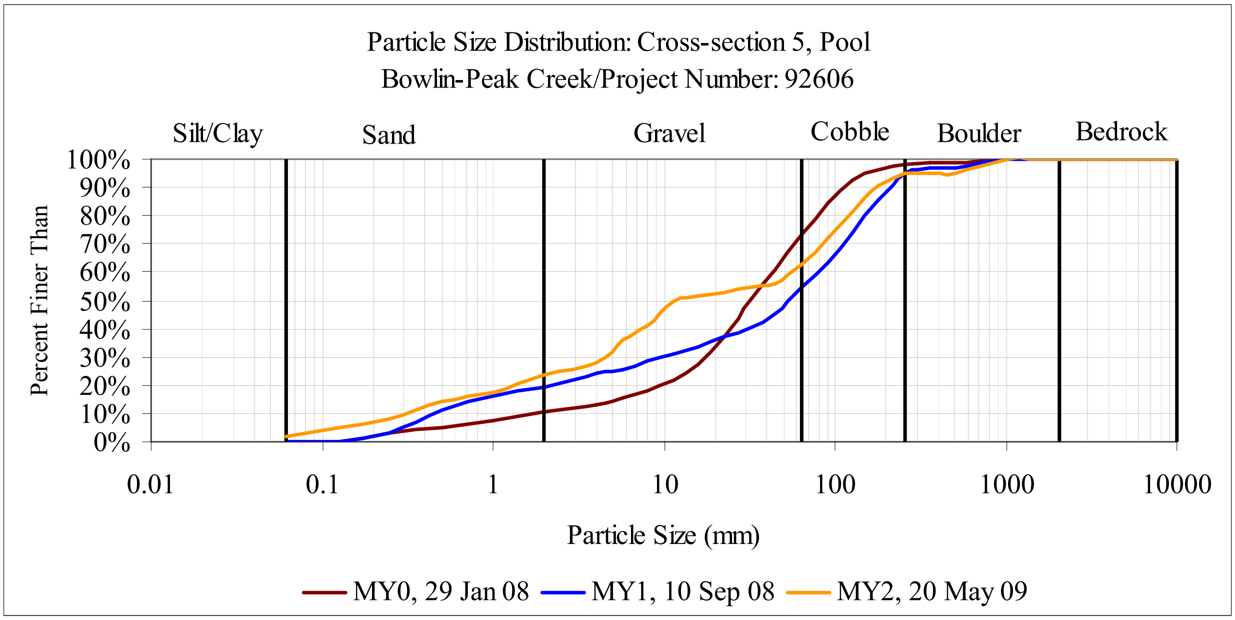
Size Class	**Particle size (mm) in year sampled**		
Index	**MY0**	**MY1**	**MY2**
D16	18.9	6.9	24.8
D35	34.4	24.7	57.2
D50	49.3	35.0	74.1
D84	88.5	82.3	142.8
D95	104.3	149.9	176.8
D100	256.0	256.0	361.0



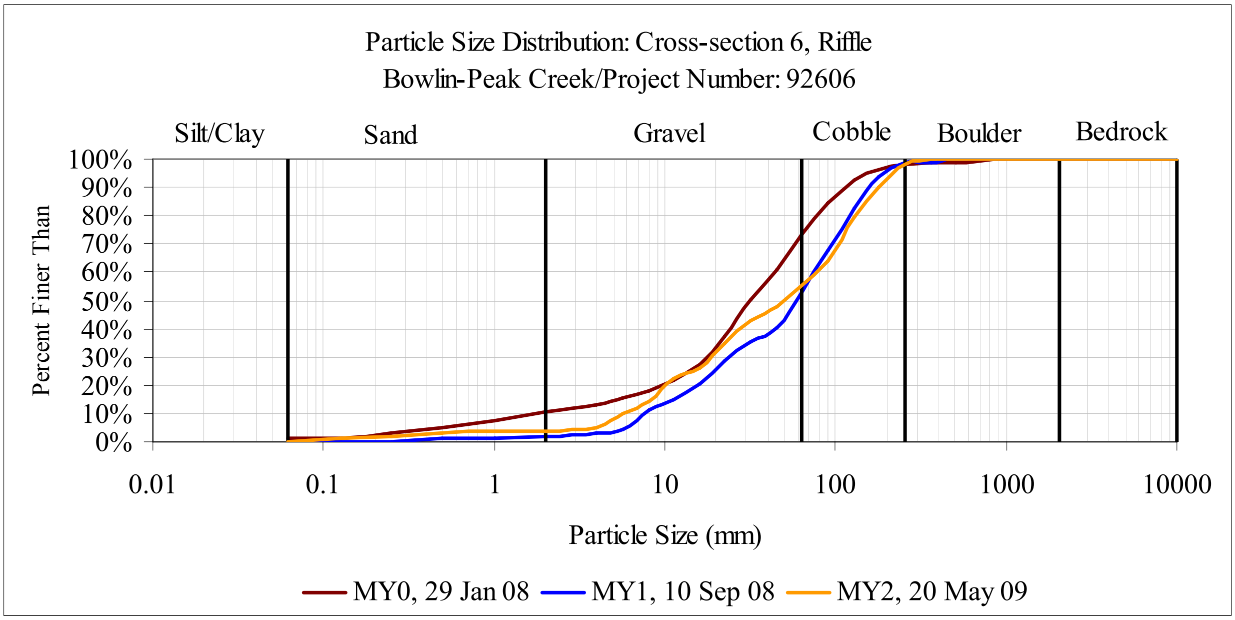
Size Class Index	Particle size (mm) in year sampled		
	MY0	**MY1**	**MY2**
D16	6.3	0.8	0.5
D35	14.4	7.5	3.0
D50	20.7	19.3	9.9
D84	48.5	82.6	117.5
D95	79.3	162.7	179.1
D100	180.0	1,024.0	512.0



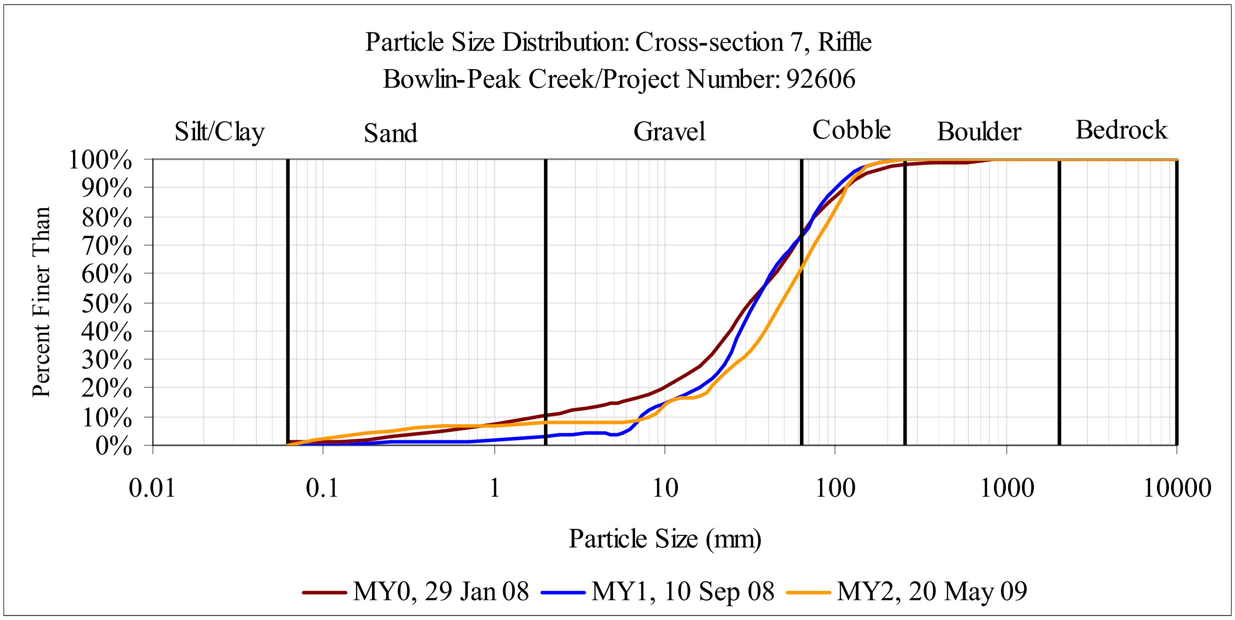
Size Class Index	**Particle size (mm) in year sampled**		
	MY0	**MY1**	**MY2**
D16	9.4	12.0	11.5
D35	22.2	27.0	25.6
D50	34.8	36.0	37.4
D84	79.3	86.8	112.3
D95	127.6	154.0	204.0
D100	362.0	256.0	362.0



Size Class Index	Particle size (mm) in year sampled		
	MY0	MY1	MY2
D16	21.8	1.0	0.8
D35	38.6	18.7	5.5
D50	67.1	54.5	12.5
D84	141.8	172.0	142.3
D95	268.5	258.6	526.9
D100	2,047.9	1,024.0	1,024.0



Size Class	**Particle size (mm) in year sampled**		
Index	**MY0**	**MY1**	**MY2**
D16	5.1	12.1	8.6
D35	23.8	31.5	22.7
D50	42.4	60.0	50.9
D84	114.4	133.5	149.4
D95	180.0	196.0	226.1
D100	265.0	512.0	362.0



Size Class	Particle size (mm) in year sampled		
Index	MY0	MY1	MY2
D16	15.2	11.3	11.3
D35	27.7	26.1	33.9
D50	42.4	34.4	48.8
D84	81.9	84.4	104.3
D95	122.0	123.8	138.4
D100	256.0	256.0	256.0

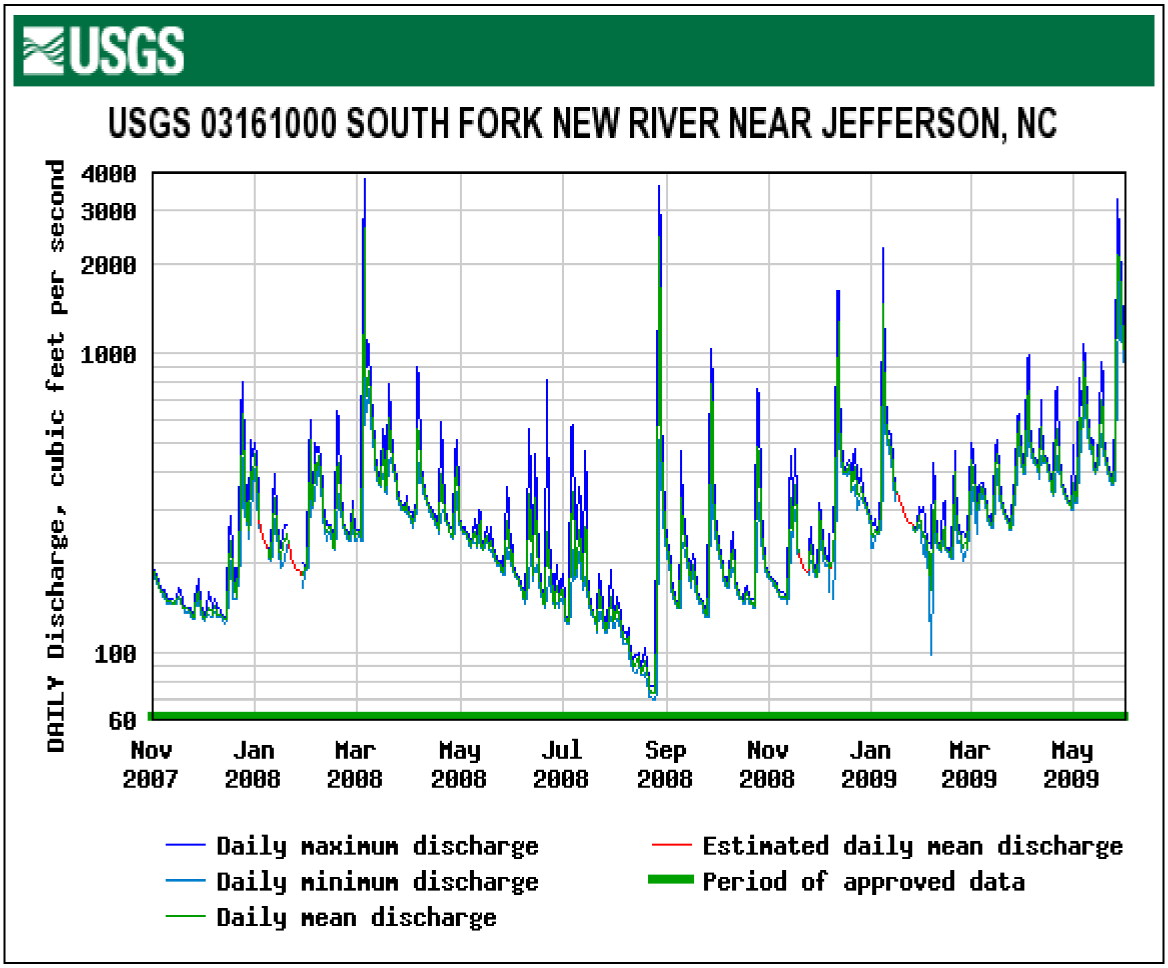
B.8 Bankfull Verification Data and Photographs

Table B.8.1 Verification of Bankfull Events.

Date of Data Collection	Date of Occurrence	Method	Photograph Number
	05-Mar-2008	3,780 CFS at S. Fork New River USGS gage	
	27-Aug-2008	3,590 CFS at S. Fork New River USGS gage	
08-Sep-2008	Unknown	2.95 ft on Crest gage	
11-May-2009	Unknown	2.86 ft on Crest gage	
	27-May-2009	3,240 CFS at S. Fork New River USGS gage	

B.9 Hydrologic Data

Figure B.9.1 USGS Hydrograph.



Note: Bankfull at the Peak Creek site was determined to correspond to 3,220 cubic feet per second at the South Fork New River gage station.

Appendix C Vegetation Data

C.1 Vegetation Data Summary Tables

Table C.1.1 Vegetation Plot Attribute Data.

MY1 Vegetation Plot Attribute Data						
Plot Identification	**Community Type**	**Planting Zone Identification**	**Reach Identification**	**Associated Gauge(s)**	**Method[a]**	**CVS Level**
92606-Elkin-VP1	Riparian	N/A	Peak Creek	No	N/A	2
92606-Elkin-VP2	Riparian	N/A	Peak Creek	No	N/A	2
92606-Elkin-VP3	Riparian	N/A	Peak Creek	No	N/A	2

N/A = Not applicable.

[a]Denote method if other than CVS method.

MY2 Vegetation Plot Attribute Data						
Plot Identification	**Community Type**	**Planting Zone Identification**	**Reach Identification**	**Associated Gauge(s)**	**Method[a]**	**CVS Level**
92606-Elkin-VP1	Riparian	N/A	Peak Creek	No	N/A	2
92606-Elkin-VP2	Riparian	N/A	Peak Creek	No	N/A	2
92606-Elkin-VP3	Riparian	N/A	Peak Creek	No	N/A	2

N/A = Not applicable.

[a]Denote method if other than CVS method.

Table C.1.2 Vegetation Metadata.

MY1 Vegetation Metadata	
Report Prepared By	Jim Wasseen II
Date Prepared	9/3/2008 11:19
Database Name	NCWRCElkin-08-B.mdb
Database Location	C:\Documents and Settings\Staci Hining\My Documents\Stream Mitigation\EEP\Veg Monitoring Stuff
Computer Name	WASSEEN
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT------------	
Metadata	This worksheet, which is a summary of the project and the project data.
Project Planted	Each project is listed with its PLANTED stems, for each year. This excludes live stakes and lists stems per acre.
Project Total Stems	Each project is listed with its TOTAL stems, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems. Listed in stems per acre.
Plots	List of plots surveyed.
Vigor	Frequency distribution of vigor classes.
Vigor by Spp.	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp.	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and Spp.	Count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY-------------------------------------	
Project Code	92606
Project Name	Bowlin-Peak Creek
Description	Enhanced approximately 2,800 ft of Peak Creek on the Bowlin property. The enhncement included: bank sloping, placement of rock and log vanes, and rootwads. The site was replanted with native vegetation upon completion of the project.
River Basin	New
Length(ft)	
Stream-to-Edge Width (ft)	
Area (sq m)	8093.71
Required Plots (calculated)	3
Sampled Plots	3

MY2 Vegetation Metadata	
Report Prepared By	Jim Wasseen II
Date Prepared	6/5/2009 15:14
Database Name	NCWRCElkin_2009-A.mdb
Database Location	C:\Documents and Settings\Jim Wasseen\My Documents\Stream Mitigation\EEP\Veg Monitoring Stuff
Computer Name	HP80482773187
File Size	56676352
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT------------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Project Planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Project Total Stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp.	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp.	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and Spp.	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY-------------------------------------	
Project Code	92606
project Name	Bowlin-Peak Creek
Description	Enhanced approximately 2,800 ft of Peak Creek on the Bowlin property. The enhncement included: bank sloping, placement of rock and log vanes, and rootwads. The site was replanted with native vegetation upon completion of the project.
River Basin	New
Length (ft)	
Stream-to-edge width (ft)	
Area (sq m)	8093.71
Required Plots (calculated)	3
Sampled Plots	3

Table C.1.3 Vegetation Vigor by Species.

MY1 Vegetation Vigor by Species							
Species	**Vigor Class[a]**						
	4	**3**	**2**	**1**	**0**	**Missing**	**Unknown**
Acer saccharum		1	1				
Betula nigra	1	1			1		
Cornus amomum	2	1			1		
Juglans nigra		1	1				
Quercus alba	3						
Rhododendron calendulaceum	1	1	1				
Rhododendron catawbiense	2						
Rhododendron maximum	1						
Robinia pseudoacacia	3	1		1			
Salix sericea	2						
Sambucus canadensis	2						
Tsuga caroliniana	1						
Carpinus caroliniana	1						
Vaccinium	2	1	1				
Quercus rubra					1		
Lindera benzoin	2	3			1		
Physocarpus opulifolius	2				1		
Acer rubrum	1						
Total:18	**26**	**10**	**4**	**1**	**5**		

[a]4 = Excellent, 3 = Good, 2 = Weak, 1 = Unlikely to survive, 0 = Dead, Missing = Plant missing, Unknown = Unknown vigor

MY2 Vegetation Vigor by Species						
Species	**Vigor Class[a]**					
	4	**3**	**2**	**1**	**0**	**Missing**
Acer saccharum	1	1				
Betula nigra		1			1	
Cornus amomum	3					
Juglans nigra		1	1			
Quercus alba	1	2				
Rhododendron calendulaceum		1	2			
Rhododendron catawbiense		1		1		
Rhododendron maximum			1			
Robinia pseudoacacia		1	2	1	1	
Salix sericea	2					
Sambucus canadensis	1				1	
Tsuga caroliniana	1					
Carpinus caroliniana	1					
Vaccinium	4					
Lindera benzoin		2	2		1	
Physocarpus opulifolius	2					
Acer rubrum		1				
Total:17	**16**	**11**	**8**	**2**	**4**	

[a]4 = Excellent, 3 = Good, 2 = Weak, 1 = Unlikely to survive,
0 = Dead, Missing = Plant missing

Table C.1.4 Vegetation Damage by Species.

MY1 Vegetation Damage by Species					
Species	**All Damage Categories**	**No damage**	**Deer**	**Insects**	**Unknown**
Acer rubrum	1	1			
Acer saccharum	2	2			
Betula nigra	3	2	1		
Carpinus caroliniana	1	1			
Cornus amomum	4	3	1		
Juglans nigra	2		1		1
Lindera benzoin	6	5	1		
Physocarpus opulifolius	3	3			
Quercus alba	3	3			
Quercus rubra	1	1			
Rhododendron calendulaceum	3	2	1		
Rhododendron catawbiense	2	2			
Rhododendron maximum	1	1			
Robinia pseudoacacia	5	4			1
Salix sericea	2	2			
Sambucus canadensis	2	2			
Tsuga caroliniana	1	1			
Vaccinium	4	1	2	1	
Total: 18	**46**	**36**	**7**	**1**	**2**

MY2 Vegetation Damage by Species				
Species	**All Damage Categories**	**No Damage**	**Human Trampled**	**Unknown**
Acer rubrum	1	1		
Acer saccharum	2	2		
Betula nigra	2	1		1
Carpinus caroliniana	1	1		
Cornus amomum	3	3		
Juglans nigra	2	2		
Lindera benzoin	5	5		
Physocarpus opulifolius	2	2		
Quercus alba	3	3		
Rhododendron calendulaceum	3	2	1	
Rhododendron catawbiense	2	2		
Rhododendron maximum	1	1		
Robinia pseudoacacia	5	5		
Salix sericea	2	2		
Sambucus canadensis	2	2		
Tsuga caroliniana	1	1		
Vaccinium	4	4		
TOTAL: 17	**41**	**39**	**1**	**1**

Table C.1.5 Vegetation Damage by Plot.

MY1 Vegetation Damage by Plot					
Plot	**All Damage Categories**	**No damage**	**Deer**	**Insects**	**Unknown**
92606-Elkin-VP1-year:1	15	14			1
92606-Elkin-VP2-year:1	18	14	2	1	1
92606-Elkin-VP3-year:1	13	8	5		
Total: 3	**46**	**36**	**7**	**1**	**2**

MY2 Vegetation Damage by Plot				
Plot	**All Damage Categories**	**No Damage**	**Human Trampled**	**Unknown**
92606-Elkin-VP1-year:2	13	13		
92606-Elkin-VP2-year:2	16	14	1	1
92606-Elkin-VP3-year:2	12	12		
Total: 3	**41**	**39**	**1**	**1**

Table C.1.6 Planted Stems Counted by Plot and Species.

MY1 Planted Stems Counted by Plot and Species.						
Species	**Total Planted Stems**	**Number of Plots**	**Avgerage Number of Stems**	**Plot 92606-Elkin-VP1-Year:1**	**Plot 92606-Elkin-VP2-Year:1**	**Plot 92606-Elkin-VP3-Year:1**
Acer rubrum	1	1	1	1		
Acer saccharum	2	1	2		2	
Betula nigra	2	2	1		1	1
Carpinus caroliniana	1	1	1		1	
Cornus amomum	3	2	1.5	2	1	
Juglans nigra	2	2	1	1		1
Lindera benzoin	5	3	1.67	2	2	1
Physocarpus opulifolius	2	1	2	2		
Quercus alba	3	2	1.5	1	2	
Rhododendron calendulaceum	3	2	1.5		2	1
Rhododendron catawbiense	2	2	1		1	1
Rhododendron maximum	1	1	1		1	
Robinia pseudoacacia	5	2	2.5		1	4
Salix sericea	2	1	2	2		
Sambucus canadensis	2	1	2	2		
Tsuga caroliniana	1	1	1		1	
Vaccinium	4	2	2		1	3
Total: 17	**41**	**17**		**13**	**16**	**12**

MY2 Planted Stems Counted by Plot and Species.						
Species	**Total Planted Stems**	**Number of Plots**	**Average Number of Stems**	**Plot 92606-Elkin-VP1-Year:2**	**Plot 92606-Elkin-VP2-Year:2**	**Plot 92606-Elkin-VP3-Year:2**
Acer rubrum	1	1	1	1		
Acer saccharum	2	1	2		2	
Betula nigra	1	1	1		1	
Carpinus caroliniana	1	1	1		1	
Cornus amomum	3	2	1.5	2	1	
Juglans nigra	2	2	1	1		1
Lindera benzoin	4	3	1.33	1	2	1
Physocarpus opulifolius	2	1	2	2		
Quercus alba	3	2	1.5	1	2	
Rhododendron calendulaceum	3	2	1.5		2	1
Rhododendron catawbiense	2	2	1		1	1
Rhododendron maximum	1	1	1		1	
Robinia pseudoacacia	4	2	2		1	3
Salix sericea	2	1	2	2		
Sambucus canadensis	1	1	1	1		
Tsuga caroliniana	1	1	1		1	
Vaccinium	4	2	2		1	3
TOTAL: 17	**37**	**17**		**11**	**16**	**10**

Table C.1.7 All Stems Counted by Plot and Species.

MY1 All Stems Counted by Plot and Species.						
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**92606-Elkin-VP1-Year:1**	**92606-Elkin-VP2-Year:1**	**92606-Elkin-VP3-Year:1**
Acer saccharum	2	1	2		2	
Alnus serrulata	53	2	27	50		3
Betula nigra	3	2	2		2	1
Cornus amomum	4	2	2	3	1	
Fraxinus pennsylvanica	1	1	1			1
Juglans nigra	2	2	1	1		1
Quercus alba	3	2	2	1	2	
Rhododendron calendulaceum	3	2	2		2	1
Rhododendron catawbiense	2	2	1		1	1
Rhododendron maximum	1	1	1		1	
Robinia pseudoacacia	5	2	3		1	4
Salix nigra	1	1	1	1		
Salix sericea	2	1	2	2		
Sambucus canadensis	2	1	2	2		
Tsuga caroliniana	1	1	1		1	
Carpinus caroliniana	1	1	1		1	
Vaccinium	4	2	2		1	3
Quercus rubra	2	2	1	1		1
Lindera benzoin	21	3	7	5	3	13
Crataegus	4	1	4			4
Physocarpus opulifolius	32	3	11	30	1	1
Prunus serotina	5	2	3	3		2
Acer rubrum	4	2	2	1		3
Total: 23	**158**	**23**		**100**	**19**	**39**

MY2 All Stems Counted by Plot and Species.						
Species	**Total Stems**	**Number of Plots Species Were Found**	**Average Number of Stems**	**Plot 92606-Elkin-VP1-Year:2**	**Plot 92606-Elkin-VP2-Year:2**	**Plot 92606-Elkin-VP3-Year:2**
Acer saccharum	2	1	2		2	
Alnus serrulata	80	3	26.67	72	4	4
Betula nigra	2	2	1		1	1
Cornus amomum	3	2	1.5	2	1	
Fraxinus pennsylvanica	1	1	1			1
Juglans nigra	2	2	1	1		1
Quercus alba	3	2	1.5	1	2	
Rhododendron calendulaceum	3	2	1.5		2	1
Rhododendron catawbiense	2	2	1		1	1
Rhododendron maximum	1	1	1		1	
Robinia pseudoacacia	5	2	2.5		1	4
Salix nigra	1	1	1	1		
Salix sericea	3	2	1.5	2	1	
Sambucus canadensis	2	1	2	2		
Tsuga caroliniana	1	1	1		1	
Carpinus caroliniana	1	1	1		1	
Vaccinium	4	2	2		1	3
Quercus rubra	1	1	1	1		
Lindera benzoin	17	3	5.67	2	2	13
Crataegus	59	1	59			59
Physocarpus opulifolius	62	3	20.67	60	1	1
Prunus serotina	14	3	4.67	5	1	8
Spiraea	3	1	3	3		
Acer rubrum	2	2	1	1		1
TOTAL:24	**274**	**24**		**153**	**23**	**98**

Table C.1.8 Planted and Total Stem Counts

Scientific Name	Common Name	Species Type	Current Plot Data (MY2 2009)									Annual Means								
			92606-Elkin-VP1			92606-Elkin-VP2			92606-Elkin-VP3			MY2 (2009)			MY1 (2008)			MY0 (2008)		
			Pw/LS[a]	P-all[b]	Total[c]	Pw/LS	P-all	Total	Pw/LS	P-all	Total	Pw/LS	P-all	Total	Pw/LS	P-all	Total	Pw/LS	P-all	Total
Acer saccharum	Sugar maple	Shrub Tree					2	2					2	2		2	2		2	2
Alnus serrulata	Hazel alder	Shrub Tree			72			4			4			80			53			47
Betula nigra	River birch	Tree					1	1					1	1		2	2		3	3
Cornus amomum	Silky dogwood	Shrub	2	2	2	1	1	1				3	3	3	3	3	3	4	4	4
Fraxinus pennsylvanica	Green ash	Tree									1			1			1			
Juglans nigra	Black walnut	Tree		1	1					1	1		2	2		2	2		2	2
Quercus alba	White oak	Tree		1	1		2	2					3	3		3	3		3	3
Rhododendron calendulaceum	Flame azalea	Shrub					2	2		1	1		3	3		3	3		3	3
Rhododendron catawbiense	Catawba rosebay	Shrub Tree					1	1		1	1		2	2		2	2		2	2
Rhododendron maximum	Great laurel	Shrub Tree					1	1					1	1		1	1		1	1
Robinia pseudoacacia	Black locust	Tree					1	1		3	3		4	4		5	5		5	5
Salix nigra	Black willow	Tree			1									1			1			1
Salix sericea	Silky willow	Shrub Tree	2	2	2			1				2	2	3	2	2	2	2	2	2
Sambucus canadensis	Common Elderberry	Shrub Tree	1	1	1							1	1	1	2	2	2	1	1	1
Sassafras albidum	Sassafras	Shrub Tree																		10
Tsuga caroliniana	Carolina hemlock	Tree					1	1					1	1		1	1		1	1
Carpinus caroliniana	American hornbeam	Shrub Tree					1	1					1	1		1	1		1	1
Vaccinium	Blueberry	Shrub Vine Tree					1	1		3	3		4	4		4	4		4	4
Quercus rubra	Northern red oak	Tree			1									1			1		1	1
Lindera benzoin	Northern spicebush	Shrub Tree		1	1		2	2		1	13		4	16		5	20		6	6
Crataegus	Hawthorn	Shrub Tree									59			59			4			14
Physocarpus opulifolius	Common ninebark	Shrub	2	2	60			1			1	2	2	62	2	2	31	3	3	10
Prunus serotina	Black cherry	Shrub Tree			5			1			8			14			5			
Spiraea	Spirea	Shrub			3									3						
Acer rubrum	Red maple	Tree		1	1						1		1	2		1	4		1	3
		Stem count	7	11	151	1	16	23	0	10	96	8	37	270	9	41	153	10	45	126
		Size (ares)	1			1			1			3			3			3		
		Size (ACRES)	0.02			0.02			0.02			0.07			0.07			0.07		
		Species count	4	8	13	1	12	16	0	6	12	4	17	24	4	17	23	4	18	22
		Stems per ACRE	283	445	6111	40	647	931	0	405	3885	108	499	3642	121	553	2064	135	607	1700

[a]Live stake planted stems only

[b]All planted stems

[c]Total number of stems including planted stems and volunteer stems

Numbers are highlighted when volunteer stem are present

C.2 Vegetation Problem Area Photographs

There are no vegetation problem areas for MY1 or MY2.

C.3 Vegetation Monitoring Plot Photographs

Vegetation plot 92606-01-VP1a, monitoring year 0, 20 Mar 08.

Vegetation plot 92606-01-VP1b, monitoring year 0, 20 Mar 08.

Vegetation plot 92606-01-VP1a, monitoring year 1, 02 Sep 08.

Vegetation plot 92606-01-VP1b, monitoring year 1, 02 Sep 08.

Vegetation plot 92606-01-VP1a, monitoring year 2, 02 Jun 09.

Vegetation plot 92606-01-VP1b, monitoring year 2, 02 Jun 09.


Vegetation plot 92606-01-VP2a,
monitoring year 0, 20 Mar 08.


Vegetation plot 92606-01-VP2b,
monitoring year 0, 20 Mar 08.


Vegetation plot 92606-01-VP2a,
monitoring year 1, 02 Sep 08.


Vegetation plot 92606-01-VP2b,
monitoring year 1, 02 Sep 08.


Vegetation plot 92606-01-VP2a,
monitoring year 2, 02 Jun 09.


Vegetation plot 92606-01-VP2b,
monitoring year 2, 02 Jun 09.


Vegetation plot 92606-01-VP3a, monitoring year 0, 20 Mar 08.


Vegetation plot 92606-01-VP3b, monitoring year 0, 20 Mar 08.


Vegetation plot 92606-01-VP3a, monitoring year 1, 02 Sep 08.


Vegetation plot 92606-01-VP3b, monitoring year 1, 02 Sep 08.


Vegetation plot 92606-01-VP3a, monitoring year 2, 02 Jun 09.


Vegetation plot 92606-01-VP3b, monitoring year 2, 02 Jun 09.