MONITORING YEAR 3 AND YEAR 4 REPORT

PLEMMONS/KIRKPATRICK MITIGATION SITE
SPRING CREEK

Madison County, North Carolina

FINAL

EEP Project Number: 92607
Contract Number: D06082; Task Order: 06FB05-1

Period Covered: January 2009 – December 2010

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Prepared by the North Carolina Wildlife Resources Commission
in Partnership with the
North Carolina Ecosystem Enhancement Program
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Ecosystem Enhancement PROGRAM

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1 Executive Summary

This report summarizes the monitoring year 3 (MY3) and monitoring year 4 (MY4) conditions of the Spring Creek stream mitigation project, in Madison County, North Carolina. A 50 foot wide permanent conservation easement was acquired on both sides of the stream channel; total project area consists of 2.10 acres, including the stream channel. The riparian buffer as measured from the bankfull elevation to the conservation easement boundary encompasses 1.43 acres. A total of 680 ft of stream channel is contained within the easement. The right bank riparian area was protected by fencing installed along the entire easement boundary. The left bank riparian area was demarcated by a low berm extending the entire length of the easement boundary. Project objectives to establish a conservation easement, remove all foreign materials from the easement area, and re-vegetate the area with native herbaceous and woody plants were accomplished. Project objectives to reduce bank erosion by reshaping both channel banks to a stable slope and restoring one large meander bend to a stable radius of curvature were achieved.

Following construction in August 2006, the project site was revegetated with native plants. Herbaceous plants were established using a perennial seed mixture; whereas, woody vegetation was established by installing livestakes and containerized shrubs and trees. Three vegetation survey plots were established and surveyed utilizing the CVS protocol to identify and enumerate planted stems. The average density of planted woody stems for all plots combined was found to be 648 stems per acre in the as-built (MY0) survey, 364 stems per acre in the MY1 survey, 297 stems per acre in the MY2 survey, 270 stems per acre in the MY3 survey, and 256 stems per acre in the MY4 survey. Planted woody stem density in MY4 is slightly below the year-4 success criteria of 288 stems per acre. However, during the MY4 survey natural recruitment of woody stems were observed in all three vegetation monitoring plots. The addition of the recruited stems resulted in a total stem density of 540 stems per acre.

Channel geomorphology data were collected at pre-established locations during the MY3 and MY4 surveys. Riffle bankfull widths ranged from 45 to 56 ft in MY3 and 43 to 57 ft in MY4. These values closely approximated the 46 to 55 ft range found in the as-built survey. Riffle cross-sectional areas ranged from 152 to 183 ft^2 during the MY0 survey; riffle cross-sectional areas fell approximated this same rage during the MY3 (151 to 172 ft^2) and MY4 (151 to 171 ft^2) surveys. Riffle mean and maximum depths at bankfull ranged from 2.8 to 3.8 ft and 4.5 to 5.4 ft during the MY0 survey, 2.7 to 3.5 ft and 4.6 to 5.3 ft for the MY3 survey, and 2.7 to 3.5 and 4.9 to 5.3 ft for the MY4 survey. The bank height ratio continues to be 1.0. The water surface slope of 0.010 ft/ft has remained unchanged since MY0. Over the course of monitoring, the D50 particle size of the reach-wide pebble count has ranged from 19.3 mm to 77.0 mm. The D50 for the riffle pebble count at cross-section 8 has been in to the small cobble category each monitoring year except MY3 and MY4, when it was in the coarse and very coarse gravel categories.

The MY3 and MY4 geomorphic, vegetative, and visual assessment surveys of the mitigation site were found to be within the design criteria for this C4 stream channel. With little to no apparent aggradation or degradation of the channel bed or channel bank instability observed, the Spring Creek mitigation site is meeting all morphometric success criteria four years removed from project construction. While planted woody material is doing well, planted stem density for all plots combined is slightly below the established year-4 success criteria.

2 Project Background

2.1 Project Objectives

Project objectives for the Spring Creek mitigation site, as stated in the restoration design plan document (NCWRC 2005), were as follows:

- Establish a conservation easement on both stream banks for the entire length of the restoration project;
- Remove the existing invasive exotic vegetation;
- Remove an abandoned barn, automobile bodies, school bus, and other foreign materials from the stream banks and riparian area;
- Remove the berm from the top of the left bank;
- Remove the channel constrictions at stations 3+50 and 4+75;
- Reduce stream bank erosion on the right bank of the meander bend by establishing a stable radius of curvature and installing in-stream structures and bank protection;
- Install two additional in-stream structures to enhance aquatic habitat features;
- Shape banks to a stable slope, create a bankfull bench, and inner berm features;
- Re-establish native vegetation within the riparian zone; and
- Design and construct a livestock corral and feed/waste structure, watering system, and install fencing (Plemmons property, right bank) to exclude livestock from the conservation easement and stream.

2.2 Project Structure, Restoration Type, and Approach

Channel morphology was modified by implementing restoration component activities (USACE 2003; Table 1). Restoration involved removing nonnative invasive vegetation and lowering the existing stream banks to create a bench that will allow bankfull or greater flows to access the floodplain. Also, two rock vanes (left bank) and a J-hook log vane (right bank) were installed. Using a Priority III approach (NSCRI 2003), restoration activities to repair bank sloughing and lateral channel migration involved constructing a meander bend to the desired channel dimension, pattern, and profile. J-hook structures were installed at the point-of-curvature and point-of-tangency of the constructed meander. Root-wad structures were placed along the near bank of the restored meander bend to provide added bank protection and aquatic habitat diversity. Overall, the project included 680 ft of stream channel restoration (Table 1).

Table 1.─Project Restoration Components.

Spring Creek (EEP project number 92607)							
Project Segment or Reach ID	**Existing Feet/Acres**	**Restoration Level[a]**	**Approach[b]**	**Restored Feet/Acres**	**Stationing**	**Riparian Buffer Acres**	**Comment**
Reach I	680	R	P3	680	0+00 to 6+80	1.4	
R = Restoration		EII = Enhancement II		C = Creation		P1 = Priority I	
EI = Enhancement I		S = Stabilization		P = Preservation		P2 = Priority II	
[a]Source: USACE 2003		[b]Source: Rosgen 2006				P3 = Priority III	

2.3 Location and Setting

The Spring Creek stream mitigation project is a 2.1 acre site in the west-central portion of Madison County, N.C. (Figure 1). The site is located just off of NC 209, beginning at the downstream side of the Baltimore Branch Road bridge (SR 1151), approximately 3.5 miles north of Trust and 11.5 miles south of Hot Springs, N.C. The Spring Creek project site is located in the U.S. Geological Survey 14 digit hydrologic unit 06010105120010, has a 29.3 mi^2 drainage area, is a fourth order stream at the project location, and is on a tributary to the French Broad River. The project site is in a rural setting of pasture, farmland, and low density dwellings.

2.4 Project History and Background

Prior to the project, the stream had been destabilized through channelizing, berming (left bank), and livestock hoof-shear (right bank). Landowners had tried to stabilize sloughing vertical banks using buses and automobile bodies, but this approach was unsightly and in most areas created additional problems. The North Carolina Wildlife Resources Commission (NCWRC) performed the initial site assessment, designed the restoration plans, and provided construction oversight (NCWRC 2005). The North Carolina Department of Transportation acquired the site from two landowners (Von and Linda G. Plemmons and Hazel Kirkpatrick) under a previous agreement with the NCWRC. Responsibility for the project was transferred to the N.C. Ecosystem Enhancement Program (NCEEP) in 2005. Construction of the Spring Creek project took place 1-25 Aug 2006. Stream and riparian impacts were addressed using natural channel design techniques, eliminating livestock access to the creek, and removing all foreign materials (automobile bodies, storage shed, etc.) from within the project footprint. The as-built survey was completed in September 2006. Vegetation planting was completed in December 2006; the baseline vegetation survey was completed in January 2007. Additional project details regarding project history, timeline, background, contact information, and general physical and water quality characteristics can be found in Tables 2-4.

Table 2.─Project Activity and Reporting History.

Spring Creek (EEP project number 92607)		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Conservation easement acquired (by N.C. Department of Transportation)		October 2005
Restoration Plan	July 2005	December 2005
Final Design - 90%	NA	December 2005
Construction		August 2006
Temporary S&E seed mix applied to entire project area		August 2006
Permanent seed mix applied to entire project area		August 2006
As-built physical survey	September 2006	September 2008
Containerized plantings installed over entire project area		December 2006
As-built vegetation survey	March 2007	July 2007
Mitigation Plan/As-built (Year 0 Monitoring - baseline)	September 2006	February 2009
Year 1 Monitoring	December 2007	June 2009
Year 2 Monitoring	October 2008	June 2009
Year 3 Monitoring	December 2009	February 2011
Year 4 Monitoring	December 2010	February 2011
Year 5+ Monitoring		

Bolded items represent those events or deliverables that are variable. Non-bolded items represent events that are standard components over the course of a typical project

Table 3.─Project Contact Table.

Table 3. Project Contacts Table Spring Creek (EEP project number 92607)	
Designer(s): Jeff Ferguson Scott Loftis	**Firm Information/Address:** North Carolina Wildlife Resources Commission 1751Varsity Drive NCSU Centennial Campus Raleigh, NC 27695
Construction Contractor: Todd Hodges	**Firm Information/Address:** Constructioneering, LLC P.O. Box 537 Patterson, NC 28661
Planting Contractor: Chad Bradley	**Company Information/Address:** Construction and Landscape Services, Inc. 77 Paradise Ridge Marshall, NC 28753
Seeding Contractor: Todd Hodges and NCWRC **Seed Mix Sources** Ernst Conservation Seeds, LLP **Nursery Stock Suppliers** Carolina Native Nursery	**Company Information/Address:** Same as above **Company and Contact Phone:** 1-800-873-3321 **Company and Contact Phone:** 828-682-1471
Monitoring Performers:	**Firm Information/Address:**
Stream Monitoring POC	Scott Loftis, NCWRC, same as above
Vegetation Monitoring POC	Scott Loftis, NCWRC, same as above
Wetland Monitoring POC	

Table 4.─Project Background Table.

Spring Creek (EEP project number 92607)					
Project County	Madison				
Physiographic Region	Blue Ridge Mountains				
Ecoregion (Reference: USACE 2003)	Southern Crystalline Ridges and Mountains				
Project River Basin	French Broad River				
USGS HUC for Project (14 digit)	06010105120010				
NCDWQ Sub-basin for Project	Lower French Broad 04-03-04				
Within extent of EEP Watershed Plan?	No				
NCWRC Class (Warm, Cool, Cold)	Cold				
Percent of project easement fenced or demarcated	100% (left bank = berm, right bank = fence)				
Beaver activity observed during design phase?	No				
	Reach 1	Reach 2	Reach 3	Reach 4	Tract 5
Drainage Area (mi^2)	29.3				
Stream Order	4				
Restored length (ft)	680				
Perennial or Intermittent	Perennial				
Watershed type (Rural, Urban, Developing, etc.)	Rural				
Watershed LULC Distribution (e.g.) (percent)					
Residential	10				
Ag-Row Crop	5				
Ag-Livestock	10				
Forested	75				
Etc.					
Watershed impervious cover (percent)	<5				
NCDWQ AU/Index number	61218 – (1)				
NCDWQ Classification	C, Tr				
303d listed?	No				
Upstream 303d listed segment?	No				
Reasons for 303d listing or stressor	NA				
NCDWQ 404 Water Quality Certification Number	06-0288 Mad. Co				
USACE 401 Action ID Number	200630639				
Total acreage of conservation easement (including stream channel)	2.1				
Total (undisturbed) vegetated acreage within easement	<0.1				
Total riparian buffer acreage as part of the restoration	1.4				
Rosgen stream classification of pre-existing	C4				
Rosgen stream classification of as-built	C4				
Valley Type	VIII, alluvial				
Valley Slope	0.0115				
Valley side slope range (e.g. 2-3%)	<10 %				
Valley toe slope range (e.g. 2-3%)	<5 %				
Cowardin classification (Reference: Cowardin 1979)					
Trout waters designation (NCWRC)	Yes				
Species of concern, endangered, etc.? (Y/N)	No				
Dominant soil series and characteristics					
Series	Reddies				
Depth (in)	30-40				
Clay (%)	25				
K					
T					

2.5 Monitoring Plan View

The as-built survey data revealed the baseline condition of the project reach's geomorphology, stability, and vegetation following construction (Figure 2). The eight original cross-sections (3 riffles, 1 run, 2 pools, and 2 glides) were not all resurveyed per the NCEEP written comments following the MY2 report review. Only the riffle (XS2, XS3, and XS8) and pool (XS4 and XS6) cross sections were repeated in MY3 and MY4 to compare channel morphology over time. The longitudinal profile of the entire project reach has been resurveyed each year. The MY3 and MY4 combined plan view drawing shows the current condition of the channel and adjacent topography within the project reach (Figure 3).

3 Methods

Post-construction conditions for the Spring Creek mitigation site were determined during December 2007 (MY1), October 2008 (MY2), December 2009 (MY3), and December 2010 (MY4). Representative cross-sectional dimensions and longitudinal profile data were collected using standard stream channel survey techniques (Harrelson et al. 1994; NCSRI 2003). The geomorphology of the stream was classified using the Rosgen (1996) stream classification system. Project site, reference reach, and as-built conditions were analyzed and the project design developed using RIVERMorph stream assessment and restoration software, Version 4.3 (RSARS 2010) and AutoCAD (2004) Version 2004.0.0. U.S. Geological Survey 1:24,000 topographical maps were used to determine stream drainage area. Mountain and piedmont regional hydraulic geometry curve data were used as a field guide and in the design plan (Harman et al. 1999, 2000; Doll et al. 2002). Bed material composition and mobility was assessed by doing one reach-wide and one riffle cross-section pebble count during MY1 and one reach-wide and three riffles during MY2-MY4 (NCSRI 2003). Vegetation surveys and data reduction were completed following established protocols (Lee et al. 2006). References to the left and right channel banks in this document are oriented when viewing the channel in the downstream direction.

4 Project Conditions and Monitoring Results

4.1 Vegetation Assessment

The Spring Creek mitigation site was revegetated during December 2006 with a variety of plant types including annual and perennial native seed mixes, livestakes, and containerized woody species. For additional information regarding the revegetation of the project site following construction and location of vegetation monitoring plots refer to the as-built report (NCWRC 2008). A number of mature trees representing a variety of species were not disturbed during construction. Most of these trees were located along the rim of the floodplain at the bankfull elevation (Figure 2). They were retained because they were contributing to bank stability, providing shade to the stream, and would be a seed source that would contribute to natural revegetation of the project area.

The woody plants installed in December 2006 appeared to be performing well following installation and were beginning to bud by late March 2007. Subsequently, a severe freeze occurred in April 2007, damaging many of the tender stems. Baseline vegetation monitoring had taken place just prior to the late freeze; therefore, the MY1 vegetation assessment provides insight into to the extent of damage the late freeze had on the planted stems.

The three established 10 m x 10 m vegetation assessment plots have been resurveyed in each of the four consecutive monitoring years. Stem counts, plant vigor, and plant damage was assessed for each plot (Appendix A, Tables A.1.1.-A.1.6.).

Vegetation Plot 1.-Six planted stems (243 stems per acre) were documented in vegetation plot 1 during the MY0 survey. The same six woody stems were found in MY1, suggesting that the planted stems were not affected by the April 2007 freeze. Four planted stems were recorded during the MY2-MY4 surveys (162 stems per acre; Appendix Table A.1.5.). One red maple *Acer rubrum* and one witch hazel *Hamamelis virginiana* were determined to be dead. However, six previously undocumented non-planted woody stems were present in MY2 and increased to nine in MY4, indicating natural regeneration was occurring. Recruited stems included two dogwood *Cornus florida*, a sumac *Rhus typhina,* and six black cherry *Prunus serotina*. The woody stem density increased from 162 to 526 stems per acre when the nine non-planted stems were included (Appendix Table A.1.6.).

Vegetation Plot 2.-Nine planted stems were found in vegetation plot 2 (364 stems per acre) in MY0. Of the 9 planted stems counted in MY0, only 8 were recounted in MY1. A possum haw *Ilex decidua* was apparently overlooked during the MY1 survey, as it was again present and counted in the MY2 survey. However, during MY2 two planted serviceberry *Amelanchier laevis* were determined to be dead or missing, resulting in a planted stem density of 283 stems per acre. Five planted stems were counted in MY3 and MY4; one spicebush *Lindera benzoi*n and one sourwood *Oxydendrum arboreum* were dead (202 stems per acre; Appendix Table A.1.5.). Nine non-planted woody stems representing two species were present in MY4 survey, increasing the total woody stem density from 202 to 567 stems per acre (Appendix Table A.1.6.).

Vegetation Plot 3.-In vegetation plot 3, 33 planted stems were recorded (1,336 stems per acre) in MY0. Approximately 40% (13) of the woody stems counted in vegetation plot 3 were planted as live stakes. Live stakes in vegetation plot 3 consisted of silky dogwood *Cornus amomum*, ninebark *Physocarpus opulifolius*, and silky willow *Salix sericea*. Twenty fewer stems were counted in MY1, and 22 fewer stems were counted in MY2 when compared to the MY0 data. Twelve of the 22 dead or missing stems were installed as livestakes. The MY2 density of the 11 remaining stems in vegetation plot 3 was 445 stems per acre. In MY3 eleven planted stems were again counted; ten stems were present in MY4 representing a density of 405 stems per acre (Appendix Table A.1.5.). Three non-planted woody stems were found in MY4 increasing the total woody stem density from 405 to 526 stems per acre (Appendix Table A.1.6.).

The average woody stem density in MY4 was 256 stems per acre for planted stems and 540 stems per acre when naturally recruited stems were included (Appendix Tables A.1.5. and A.1.6.). Two of the three monitored plots have not met the year-4 success criteria for planted woody stem density; vegetation plot 3 exceeded the success criteria for MY1-MY4. Twelve of the 29 total dead or missing stems were planted as livestakes. Natural regeneration (21 stems) has helped to offset the loss of the 29 planted stems. The late freeze in 2007 likely resulted in some mortality of the planted stems, but two growing seasons of severe drought following plant installation also is a likely a large contributor to planted stem mortality.

4.1.1 Vegetation Problem Areas Table Summary

Small isolated areas of multiflora rose *Rosa multiflora* and Chinese privet *Ligustrum sinense* were observed during the MY3 and MY4 site assessments (Appendix Table A.3.1.). The observed non-native vegetation most likely regenerated from root stock remaining in the soil following ground clearing. The lower most portion of the right bank (Sta. 5+75) has the highest density of Chinese privet and multiflora rose of which some mature stems were not removed during construction.

4.1.2 Vegetative Problem Areas Plan View

A vegetation problem areas plan view was not generated for MY3 or MY4 because ground cover vegetation and planted stems have performed satisfactorily since installation; there were no areas of the conservation easement that were devoid of vegetation. However, the location of non-native vegetation was noted on the plan view for MY3-MY4 (Figure 3).

4.1.3 Vegetative Problem Areas Photographs

Vegetative problem area photographs were not taken in MY0 and MY1 because of the isolated occurrence of very few invasive plant stems. However, pictures were taken during the MY2-MY4 surveys to provide visual record of the occurrence, size, and dispersal of non-native vegetation (Appendix A.4). No significant problems with the planted vegetation were observed in MY3 or MY4.

4.1.4 Vegetative Monitoring Plot Photographs

Vegetative monitoring plot photographs were taken during each of the vegetation monitoring surveys to record the performance of the vegetation plots over time (Appendix A.5). Location, orientation, and dimension information for each of the vegetation monitoring plots is located in Appendix Table A.5.1.

4.2 Stream Assessment

4.2.1 Procedural Items

4.2.1.1 Morphometric Criteria

Channel cross-sectional dimensions, pattern, and longitudinal profile were surveyed in December 2009 and again in December 2010 to document morphological characteristics of the active channel for MY3 and MY4. In addition, the locations of all constructed stream features (i.e., rock vanes, log vane, and J-hook vanes) were assessed for stability and structural integrity. Because this report documents survey findings from both MY3 and MY4, both monitoring years are reflected on the plan view drawing (Figure 3). Moreover, no deviation has occurred between established survey stations nor has any channel instability been observed between MY0 and MY4.

4.2.1.2 Hydrologic Criteria

One bankfull event was documented between the end of construction and completion of the as-built survey (Table 5). A wrack line above the bankfull elevation was observed and photographed for verification on 5 Sep 2006 (Appendix B.9). To monitor additional bankfull events, a simple crest gauge was installed on the left bank (sta. 2+30) downstream of cross-section 2 and adjacent to a large sycamore tree. The crest gage was dislodged in July 2008 during a flow event that approached three-quarters of the bankfull elevation. The crest gage was relocated adjacent to the root wad structures in the large meander bend (Sta. 4+00). With the widespread drought conditions experienced during the 2007 and 2008 monitoring years, no bankfull events were documented. A second bankfull event was observed on 9 Dec 2009 and verified by the rivers crest elevation on the gage. Photograph documentation of the 9 Dec 2009 bankfull event is provided in Appendix B.9.

Table 5.—Verification of Bankfull Events.

Spring Creek (EEP project number 92607)			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo Number (if available)**
5 Sep 2006	1 Sep 2006	Wrack line observation	Appendix B.9
9 Dec 2009	9 Dec 2009	Crest gage and wrack line	Appendix B.9

4.2.1.3 Bank Stability Assessment

Bank erosion hazard index (BEHI) and near bank stress (NBS) assessments are only conducted in monitoring year 5. Table 6 below is a place holder and not populated with data.

Table 6.—BEHI and Sediment Export Estimates.

Spring Creek (EEP project number 92607)															
Time Point	**Segment/Reach**	**Linear Footage or Acreage**	**Extreme**		**Very High**		**High**		**Moderate**		**Low**		**Very Low**		**Sediment Export**
			FT	**%**	**FT**	**%**	**FT**	**%**	**FT**	**%**	**FT**	**%**	**FT**	**%**	**Ton/year**

4.2.2 Stream Problem Areas Table Summary

No stream problem areas were observed during the MY1-MY4 surveys (Appendix Table B.1.). Appendix Table B.1.1, Stream Problem Areas, is used as a place holder for future monitoring reports.

4.2.3 Stream Problem Areas Plan View

No problem areas with regards to channel morphology or stability were observed during the MY1-MY4 surveys (Appendix B.2). As such, a problem area plan view was not generated.

4.2.4 Numbered Issue Photographs

No stream channel problem areas were observed during the MY1-MY4 surveys; therefore, issue or problem area photos are not included in this monitoring report (Appendix B.3).

4.2.5 Fixed Station Photographs

Fixed station photographs document pre- and post-construction channel conditions and provide a time series view of the mitigation site floodplain and channel through MY4 (Appendix B.4).

4.2.6 Stability Assessment

A visual assessment of the project reach was performed to inspect the morphological stability of the channel and to serve as a basis for comparison with future channel stability monitoring (Appendix B.5). Channel features, including meanders, stream bed, stream banks, and in-stream structures were examined and enumerated (Appendix Table B.5.1.). Based on the morphological data, all stream features were found to be stable (Table 7).

Table 7.─Categorical Stream Feature Visual Stability Assessment.

Spring Creek (EEP project number 92607)						
	Entire Reach (sta. 0+00 to 6+80)					
Features	**As-built 2006**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
A. Riffles	100%	100%	100%	100%	100%	
B. Pools	100%	100%	100%	100%	100%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	100%	100%	100%	100%	
E. Bed General	100%	100%	100%	100%	100%	
F. Bank Condition	100%	100%	100%	100%	100%	
G. Vanes/J Hooks etc.	100%	100%	100%	100%	100%	
F. Wads and Boulders	100%	100%	100%	100%	100%	

4.2.7 Quantitative Measures Summary

Monitoring year 3 and MY4 morphological data obtained from established survey stations were compared with pre-existing, reference, design, as-built, and past monitoring years data (Tables 8 and 9). Morphology and hydraulic data presented in Table 8 are from riffle cross-sections 2, 3, and 8. Morphological data presented in Table 9 reflect past and current dimensions for each of the eight individual cross-sections initially monitored along the project reach. These data are included in this report because they were collected before NCEEP requested that the NCWRC reduce the number of cross-sections monitored as a cost savings measure. As such, cross-sections 1 (run), 5 (glide), and 7 (glide) were excluded from the MY3 and MY4 surveys. All future monitoring will only include the three riffle cross-sections and two pool cross-sections (numbers 4 and 6). Cross-sectional dimension, longitudinal profile, and pebble count survey data plots were used to evaluate the degree of departure of the channel from the as-built condition (Appendices B.6-B.8).

Dimension.-Channel dimensions data from five of the eight original cross-sections were collected along the project reach and plotted for visual comparison (Appendix B.6). Channel dimensions from riffle cross-sections (n = 3) resurveyed during MY3 and MY4 were compared with the range of values for the design and as-built conditions for each parameter (Table 8). Design values for riffle bankfull width ranged from 49 to 53 ft; values from the as-built survey ranged from 46 to 55 ft. Bankfull widths for MY3 and MY4 ranged from45 to 56 ft and 43 to 57 ft (Table 8). Riffle cross-section 2 has had the most variation in bankfull width (≥5 ft; MY2) and has been slightly wider than the design bankfull width each of the four monitoring years (Table 9). Although this deviation has been noted in the cross-sectional survey data, cross-section 2 appears to be stable. The increase in bankfull width is likely a result of a small elevation change in the floodplain near the bankfull elevation on the right bank that developed following construction. Bankfull width at cross-section 3 (43 to 46 ft) has been slightly narrower than the design width, but shows no sign of instability through MY4.

Design values for riffle cross-sectional area ranged from 173 to 200 ft^2. Bankfull cross-sectional area ranged from 152 to 184 ft^2 for the as-built channel. Each of the three riffle cross-sections surveyed during MY3 (151 to 172 ft^2) and MY4 (151 to 171 ft^2) were similar to the as-built values and approximated the range of design values for cross-sectional area (Table 8).

Mean depth at bankfull for as-built riffle cross-sections ranged from 2.8 to 3.8 ft (Table 8). Mean depth at bankfull for MY3 and MY4 riffle cross-sections ranged from 2.7 to 3.5 ft. Cross-section 2 mean depth (2.6 to 2.8 ft) has been slightly lower than the design mean depth (3.3 to 3.8 ft) in each monitoring year; whereas, cross-sections 3 and 8 have been within the design range for mean depth during MY0-MY4 (Table 9).

Riffle bankfull maximum depth design values ranged from 4.6 to 5.4 ft (Table 8). Bankfull maximum depths for the three surveyed riffle cross-sections ranged from 4.5 to 5.8 ft during MY0 through MY4. Cross-section 2 had a maximum bankfull depth of 4.5 ft in MY0, slightly below the range of design values. Cross-section 2 fell within the design range for riffle maximums depths from MY1 to MY4 (Table 9). The maximum bankfull depths at cross-section 3 (4.9 to 5.1 ft) have been within the design values each of the monitoring years. The maximum depth at bankfull for cross-section 8 was 5.4 ft during MY0 and MY1. The maximum depth at this cross-section increased in MY2 to 5.8 ft, likely from a misread high rod during the survey. Cross-section 8 (5.3 ft) fell within the design range again for riffle maximum depth during MY3 and MY4

Bank height ratio (BHR), a measure of channel bank vertical stability improved from a moderately unstable and unstable condition (BHR = 1.2-1.5) before construction to a stable condition (BHR = 1.0) post-construction (Tables 8 and 9). Bank height ratios for MY0-MY4 remained unchanged, indicating continued channel bank stability and maintenance of the desired elevation at which flows are accessing the floodplain.

The channel's entrenchment condition was improved by removing a three to four foot high berm from the top of the left bank. The resulting entrenchment ratio, a measure of vertical containment, increased from it pre-construction value of 3.2. Mean entrenchment ratios taken from measurements at riffle cross-sections were found to be 14.9 and 15.1 for MY1 through MY4 (Table 8). Table 9 provides entrenchment ratios for each individual cross-sections.

Pattern.-Minimal to no observed change in pattern geometry has occurred at the project site over the four years post-construction. Channel sinuosity (1.13) is low due to only a single meander bend located within the project reach. The channel belt width, radius of curvature, and meander wavelength has remained close to the values obtained from the MY0 baseline survey (Table 8). Pattern geometry data for MY1 was not generated nor included in Table 8.

Profile.-The entire length (680 ft) of the longitudinal profile was surveyed during MY0-MY4 (Figure 3; Appendix B.7). Feature lengths, slopes, depths, and spacing were calculated following each monitoring survey (Table 8). From post-construction through MY4, riffle lengths have ranged from 14 to 77 ft, which approximate the design values (25 to 75 ft) for riffle length. Riffle slopes have ranged from 0.002 ft/ft to 0.024 ft/ft over the course of all monitoring surveys. With the exception of three riffle slope calculation (MY0 = 0.002; MY1 = 0.005; MY2 = 0.024), all riffle slopes have been maintained within the design range of values (0.008 to 0.023 ft/ft). Pool lengths have closely approximated design values across in each of the monitoring years, ranging from 16 to 67 ft. Pool-to-pool spacing decreased following construction and has ranged from 61 to 194 ft over all monitoring years. Construction of five in-stream structures (J-hooks and rock vanes) increased the number pool features within the project reach and is the reason pool-to-pool spacing is lower than pre-existing, reference, or design values. The thalweg alignment and edge of water survey points that define the location of the active channel indicate only minimal changes (thalweg movement) over the 4 years post-construction.

Substrate Data.-Reach-wide substrate particle analysis revealed that the D50 and D84 for the existing channel were 43.4 mm and 128.0 mm (Table 8). These values fall within the very coarse gravel and small cobble particle size categories. Slight changes were noted in the reach-wide analysis for the as-built channel where the D50 was 31.2 mm, coarse gravel, and the D84 was 115.7 mm, small cobble. The D50 particles sizes ranged from 19.3 to 77.0 mm and the D84 particles sizes ranged from 82.9 to 175.9 mm during MY1-MY4. Overall, the D50 substrate particle size has been within the coarse to very coarse gravel categories each monitoring year except MY2 (65.6 mm) and MY4 (77.0 mm) when the D50 fell within the small coble category. Plots of the MY0-MY4 cumulative percent of particles finer than a specific particle size for the reach-wide pebble counts are summarized in Appendix B.8.

Riffle substrate particle analyses at cross-section 8 revealed that the D50 was 90.0 mm in MY0, 78.4 mm in MY1, 65.7 mm in MY2, 27.3 mm in MY3, and 52.6 mm in MY4 (Table 9). The D50 at cross-section 8 decreased in particle size each of the first three monitoring years but remained in the small cobble range (65.7-90.0 mm). The D50 at riffle cross-section 8 during MY3 and MY4 was within the coarse to very coarse gravel categories. Beginning in MY2, riffle pebble data have been collected from two additional riffles (cross-sections 2 and 3) to obtain statistical values for this parameter (Table 8). The D50 particle sizes for cross-sections 2 and 3 have raged from 16.0 to 40.9 mm, coarse to very coarse gravel particle size categories. Riffle substrate data along with field observations suggests the project site stream channel is made up of a gravel and cobble matrix. Plots of the cumulative percent of particles finer than a specific particle size for the three riffle pebble counts are summarized in Appendix B.8.

4.2.8 Summary of Results

Monitoring surveys in each of the four years post-construction reveal that the Spring Creek mitigation site is performing as designed with minimal to no change in any of the major morphological components. Dimension, pattern, and profile parameters suggest the stream channel has remained stable since construction and after experiencing two documented bankfull events. Although substrate particle size has fluctuated slightly since construction, the bed material has remained in the gravel and cobble categories with no observed aggradation, degradation, or accumulation of fine particle sizes. Constructed stream structures remain stable and performing as desired. Planted vegetation performance has been marginal with just one of three vegetation monitoring plots meeting the success criteria. The average density for all three plots combined is just under the year-4 minimum success criteria. With the addition of natural stem contributions, the three vegetation plots exceed the minimum success criteria. Overall, the project reach continues to perform as desired with little to no change observed in form or function.

Table 8.─Baseline and Monitoring Morphology and Hydraulic Summary.

Spring Creek (EEP project number 92607) Entire Project Reach - 680 feet																		
Parameter	**USGS Gage Data**			**Regional Curve Interval**			**Pre-Existing Condition[b]**			**Project Reference Stream[b]**			**Design[b]**			**As-built**		
							n = 2			n = 2			n = 3			n = 3		
Dimension (Riffles only)	Min	Max	Med	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Med
BF Width (ft)						58.0	51.1	52.6	51.8	29.5	37.2	33.3	49.2	52.9	51.6	46.3	54.5	54.3
Floodprone Width (ft)							158.8	168.6	163.7	150.0	329.0	239.5	236.5	518.6	377.5	717.3	827.0	748.0
BF Cross-Sectional Area (ft2)						200.0	170.4	173.2	171.8	64.9	75.5	70.2	173.2	200.0	182.1	152.2	183.8	175.0
BF Mean Depth (ft)						3.7	3.3	3.3	3.3	2.0	2.2	2.1	3.3	3.8	3.5	2.8	3.8	3.4
BF Max Depth (ft)							5.4	5.4	5.4	3.0	3.3	3.2	4.6	5.4	5.0	4.5	5.4	5.0
Width/Depth Ratio						15.7	15.3	15.9	15.6	13.4	18.3	15.9	14.0	14.0	14.0	12.3	19.4	16.3
Entrenchment Ratio							3.0	3.3	3.2	4.0	11.2	7.6	9.4	10.2	9.8	13.8	15.5	15.2
Bank Height Ratio							1.2	1.5	1.4	1.2	1.3	1.2	1.0	1.0	1.0	1.0	1.0	1.0
Wetted Perimeter (ft)							54.0	55.4	54.7	31.6	38.2	34.9				48.9	59.1	55.9
Hydraulic Radius (ft)							3.1	3.2	3.1	2.0	2.1	2.0	3.1	3.2	3.2	2.7	3.6	3.1
Pattern																		
Channel Beltwidth (ft)							210	250	230	59	75	65	93	118	104	134	134	134
Radius of Curvature (ft)							29	402	156	40	69	51	63	109	85	193	193	193
Meander Wavelength (ft)							860	1518	1188	350	350	350	552	660	589	564	564	564
Meander Width Ratio							4.0	4.8	4.4	1.8	2.3	1.9	3.7	5.7	4.7	2.4	2.4	2.4
Profile																		
Riffle Length (ft)							17.1	42.7	27.8	28.9	120.0	63.6	25.0	75.0	50.0	18.3	69.1	25.4
Riffle Slope (ft/ft)							0.007	0.024	0.016	0.011	0.032	0.022	0.008	0.023	0.016	0.002	0.019	0.010
Pool Length (ft)							50.1	100.2	75.1	16.3	42.7	32.9	25.7	67.2	46.8	20.9	45.1	27.9
Pool Spacing (ft)							302.6	349.5	326.5	285.8	343.9	307.9	450.5	542.0	485.3	82.3	189.1	143.0
Substrate (reach-wide)	Values determined from pooled reach-wide pebble counts based on the proportions of the number of riffles and pools																	
D50 (mm)							43.4			54.5						31.2		
D84 (mm)							128.0			180						115.7		
Additional Reach Parameters																		
Valley Length (ft)							600			900			600			600		
Channel Length (ft)							680			953			680			680		
Sinuosity							1.13			1.06			1.13			1.13		
Water Surface Slope (ft/ft)							0.010			0.014			0.010			0.010		
BF Slope (ft/ft)							0.010			0.014			0.010			0.010		
Rosgen Classification							C4			C4			C4			C4		
Habitat Index[a]																		
Macrobenthos[a]																		

[a]Inclusion will be project specific and determined by as-built monitoring plan success criteria.
[b]Median values were not generated for existing, reference, or design parameters based on low sample sizes and Rivermorph outputs only provide mean values.

Table 8. Continued

Spring Creek (EEP project number 92607) Entire Project Reach - 680 feet																		
Parameter	**MY1**						**MY2**						**MY3**					
Dimension and Substrate – Riffles Only (Cross-section 2,3,8)	Min	Max	Med	Mean	SD	n	Min	Max	Med	Mean	SD	n	Min	Max	Med	Mean	SD	n
Bankfull Width (ft)	45.9	56.1	52.3	51.4	5.2	3	44.7	59.2	51.3	51.7	7.3	3	45.0	55.6	52.9	51.2	5.5	3
Floodprone Width (ft)	717.3	827.0	748.0	764.1	56.6	3	717.3	827.0	748.0	764.1	56.6	3	717.3	827.0	748.0	764.1	56.6	3
Bankfull Cross-Sectional Area (ft^2)	155.4	174.1	164.3	164.6	9.4	3	155.7	169.5	161.0	162.1	7.0	3	151.4	171.7	158.6	160.6	10.3	3
Bankfull Mean Depth (ft)	2.8	3.6	3.3	3.2	0.4	3	2.6	3.6	3.3	3.2	0.5	3	2.7	3.5	3.2	3.2	0.4	3
Bankfull Max Depth (ft)	4.6	5.4	5.1	5.1	0.4	3	4.7	5.8	4.9	5.2	0.6	3	4.6	5.3	5.2	5.0	0.4	3
Width/Depth Ratio	12.8	20.3	15.7	16.3	3.8	3	12.4	22.5	15.6	16.8	5.2	3	12.8	20.4	16.3	16.5	3.8	3
Entrenchment Ratio	13.3	15.8	15.6	14.9	1.4	3	12.6	16.1	16.1	14.9	2.0	3	13.5	15.9	15.6	15.0	1.4	3
Bank Height Ratio	1.0	1.0	1.0	1.0	0.0	3	1.0	1.0	1.0	1.0	0.0	3	1.0	1.0	1.0	1.0	0.0	3
Bankfull Wetted Perimeter (ft)	48.3	58.0	55.1	53.8	5.0	3	47.3	61.1	53.9	54.1	6.9	3	47.9	57.1	55.1	53.4	4.9	3
Hydraulic Radius (ft)	2.7	3.4	3.2	3.1	0.4	3	2.6	3.4	3.2	3.0	0.4	3	2.7	3.3	3.1	3.0	0.3	3
D50 (mm)			78.4			1	18.4	65.7	25.0	36.3	25.7	3	23.8	38.5	27.3	29.9	7.7	3
Profile																		
Riffle Length (ft)	14.6	76.6	39.6	40.2	22.9	5	14.0	70.9	30.1	37.2	21.8	5	25.4	72.2	28.9	38.6	19.5	5
Riffle Slope (ft/ft)	0.005	0.019	0.016	0.014	0.005	5	0.009	0.024	0.017	0.016	0.006	5	0.009	0.020	0.015	0.014	0.004	5
Pool Length (ft)	19.3	63.0	38.1	40.4	15.8	5	16.1	67.0	33.4	37.7	18.6	5	24.2	67.8	50.2	48.0	18.2	5
Pool Max depth (ft)	5.0	6.5	5.6	5.7	0.7	5	5.0	6.4	5.7	5.7	0.6	5	5.5	7.1	5.9	6.1	0.7	5
Pool to Pool Spacing (ft)	74.5	193.2	143.8	138.8	49.1	5	82.3	185.9	143.4	138.8	42.8	5	89.3	191.5	136.9	138.6	41.8	5
Pattern																		
Channel Beltwidth (ft)									143.8			1			168.4			
Radius of Curvature (ft)									192.0			1			179.2			
Rc:Bankfull width (ft/ft)									3.7			1			3.5			
Meander Wavelength (ft)									583.8			1			543.6			
Meander Width Ratio									2.8			1			3.3			
Substrate (reach-wide)	Values determined from pooled reach-wide pebble counts based on the proportions of the number of riffles and pools																	
D50 (mm)			65.6						56.2						19.3			
D84 (mm)			175.9						115.0						82.9			

Table 8. Continued

Spring Creek (EEP project number 92607) Entire Project Reach - 680 feet																		
Parameter	**MY4**						**MY5**						**MY**					
Dimension and Substrate – Riffles Only (Cross-section 2,3,8)	Min	Max	Med	Mean	SD	n	Min	Max	Med	Mean	SD	n	Min	Max	Med	Mean	SD	n
Bankfull Width (ft)	43.4	56.7	52.8	51.0	6.9	3												
Floodprone Width (ft)	717.3	827.0	748.0	764.1	56.6	3												
Bankfull Cross-Sectional Area (ft^2)	151.4	170.5	155.7	159.2	10.0	3												
Bankfull Mean Depth (ft)	2.7	3.5	3.2	3.2	0.4	3												
Bankfull Max Depth (ft)	4.7	5.3	4.9	5.0	0.3	3												
Width/Depth Ratio	12.4	20.7	16.4	16.5	4.1	3												
Entrenchment Ratio	13.2	16.5	15.7	15.1	1.7	3												
Bank Height Ratio	1.0	1.0	1.0	1.0	0.0	3												
Bankfull Wetted Perimeter (ft)	46.2	58.2	55.1	53.2	6.2	3												
Hydraulic Radius (ft)	2.7	3.3	3.1	3.0	0.3	3												
D50 (mm)	16.0	52.6	40.9	36.5	18.7	3												
Profile																		
Riffle Length (ft)	23.2	50.5	24.0	29.6	11.7	5												
Riffle Slope (ft/ft)	0.010	0.019	0.013	0.014	0.004	5												
Pool Length (ft)	15.7	56.7	28.4	31.3	16.7	5												
Pool Max depth (ft)	5.3	6.8	5.9	6.0	0.7	5												
Pool to Pool Spacing (ft)	61.2	194.0	154.2	140.9	56.6	4												
Pattern																		
Channel Beltwidth (ft)			165.0															
Radius of Curvature (ft)			182.6															
Rc:Bankfull width (ft/ft)			3.6															
Meander Wavelength (ft)			539.5															
Meander Width Ratio			3.2															
Substrate (reach-wide)	Values determined from pooled reach-wide pebble counts based on the proportions of the number of riffles and pools																	
D50 (mm)			77.0															
D84 (mm)			119.0															

Table 9.─Morphology and Hydraulic Monitoring Summary (Dimensional Parameters – Cross-sections).

Spring Creek (EEP project number 92607) Entire Project Reach - 680 feet																		
	Cross-Section 1 (Run)						Cross-Section 2 (Riffle)						Cross-Section 3 (Riffle)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation																		
Bankfull Width (ft)	54.8	52.1	51.7				54.3	56.1	59.2	55.6	56.7		46.3	45.9	44.7	45.0	43.4	
Floodprone Width (ft)	752.4	752.4	752.4				748.0	748.0	748.0	748.0	748.0		717.3	717.3	717.3	717.3	717.3	
Bankfull Cross-sectional Area (ft^2)	166.0	172.8	171.9				152.2	155.4	155.7	151.4	155.7		175.0	164.3	161.0	158.6	151.4	
Bankfull Mean Depth (ft)	3.0	3.3	3.3				2.8	2.8	2.6	2.7	2.7		3.8	3.6	3.6	3.5	3.5	
Bankfull Max Depth (ft)	5.7	5.4	5.8				4.5	4.6	4.7	4.6	4.7		5.0	5.1	4.9	5.2	4.9	
Bankfull Width/Depth Ratio	18.1	15.7	15.6				19.4	20.3	22.5	20.4	20.7		12.3	12.8	12.4	12.8	12.4	
Bankfull Entrenchment Ratio	13.7	14.5	14.6				13.8	13.3	12.6	13.5	13.2		15.5	15.6	16.1	15.9	16.5	
Bankfull Bank Height Ratio	1.0	1.0	1.0				1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	
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)																		
D50(mm)									18.4	38.5	16.0				25.0	23.8	40.9	
	Cross-Section 4 (Pool)						Cross-Section 5 (Glide)						Cross-Section 6 (Pool)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation																		
Bankfull Width (ft)	56.1	57.3	57.8	57.9	57.4		53.1	50.8	50.8				58.1	57.5	55.0	58.8	57.5	
Floodprone Width (ft)	728.8	728.8	728.8	728.8	728.8		712.5	712.5	712.5				714.6	714.6	714.6	714.6	714.6	
Bankfull Cross-sectional Area (ft^2)	207.2	195.6	200.6	189.2	183.8		166.1	153.7	149.0				196.2	189.4	182.3	177.5	171.3	
Bankfull Mean Depth (ft)	3.7	3.4	3.5	3.3	3.2		3.1	3.0	2.9				3.4	3.3	3.3	3.0	3.0	
Bankfull Max Depth (ft)	6.6	6.6	6.6	6.5	6.3		5.8	5.0	4.9				6.4	6.0	5.9	6.2	5.9	
Bankfull Width/Depth Ratio	15.2	16.8	16.6	17.7	17.9		16.7	16.8	17.3				17.3	17.4	16.6	19.5	19.3	
Bankfull Entrenchment Ratio	13.0	12.7	12.6	12.6	12.7		13.4	14.0	14.0				12.3	12.4	13.0	12.1	12.4	
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0				1.0	1.0	1.0	1.0	1.0	
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)																		
D50(mm)																		

Table 9. Continued.

Spring Creek (EEP project number 92607) Entire Project Reach - 680 feet																		
	Cross-Section 7 (Glide)						Cross-Section 8 (Riffle)						Cross-Section					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation																		
Bankfull Width (ft)	51.8	49.5	51.4				54.5	52.3	51.3	52.9	52.8							
Floodprone Width (ft)	678.3	678.3	678.3				827.0	827.0	827.0	827.0	827.0							
Bankfull Cross-sectional Area (ft^2)	165.0	157.0	161.5				182.7	174.1	169.5	171.7	170.5							
Bankfull Mean Depth (ft)	3.2	3.2	3.1				3.4	3.3	3.3	3.2	3.2							
Bankfull Max Depth (ft)	5.0	4.7	4.8				5.4	5.4	5.8	5.3	5.3							
Bankfull Width/Depth Ratio	16.2	15.6	16.4				16.3	15.7	15.6	16.3	16.4							
Bankfull Entrenchment Ratio	13.1	13.7	13.2				15.2	15.8	16.1	15.6	15.7							
Bankfull Bank Height Ratio	1.0	1.0	1.0				1.0	1.0	1.0	1.0	1.0							
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)																		
D50(mm)							90.0	78.4	65.7	27.3	52.6							

5 Acknowledgements

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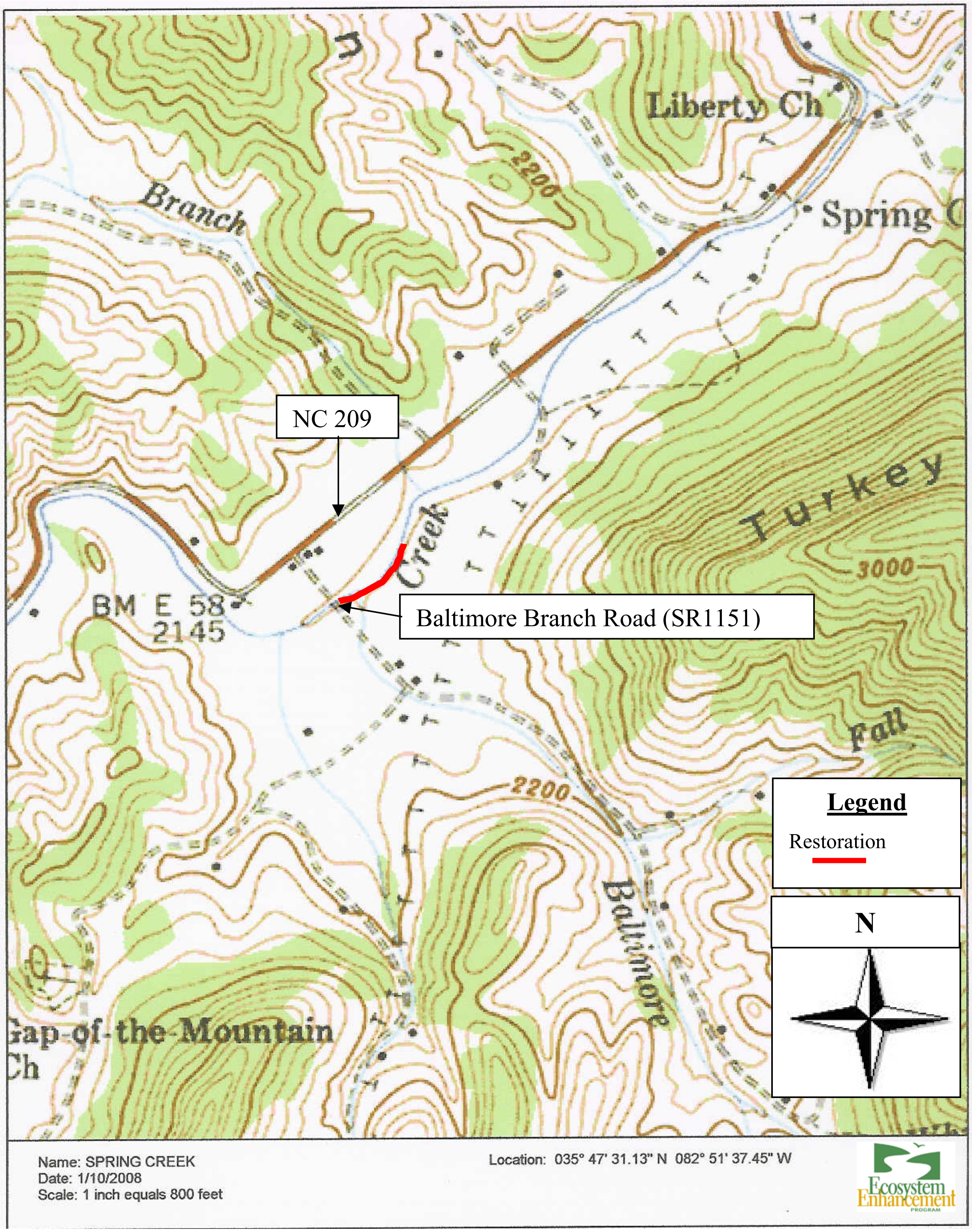


Figure 1.—Spring Creek mitigation site, French Broad River basin, Madison County, N.C. EEP project number 92607.

NOTE:

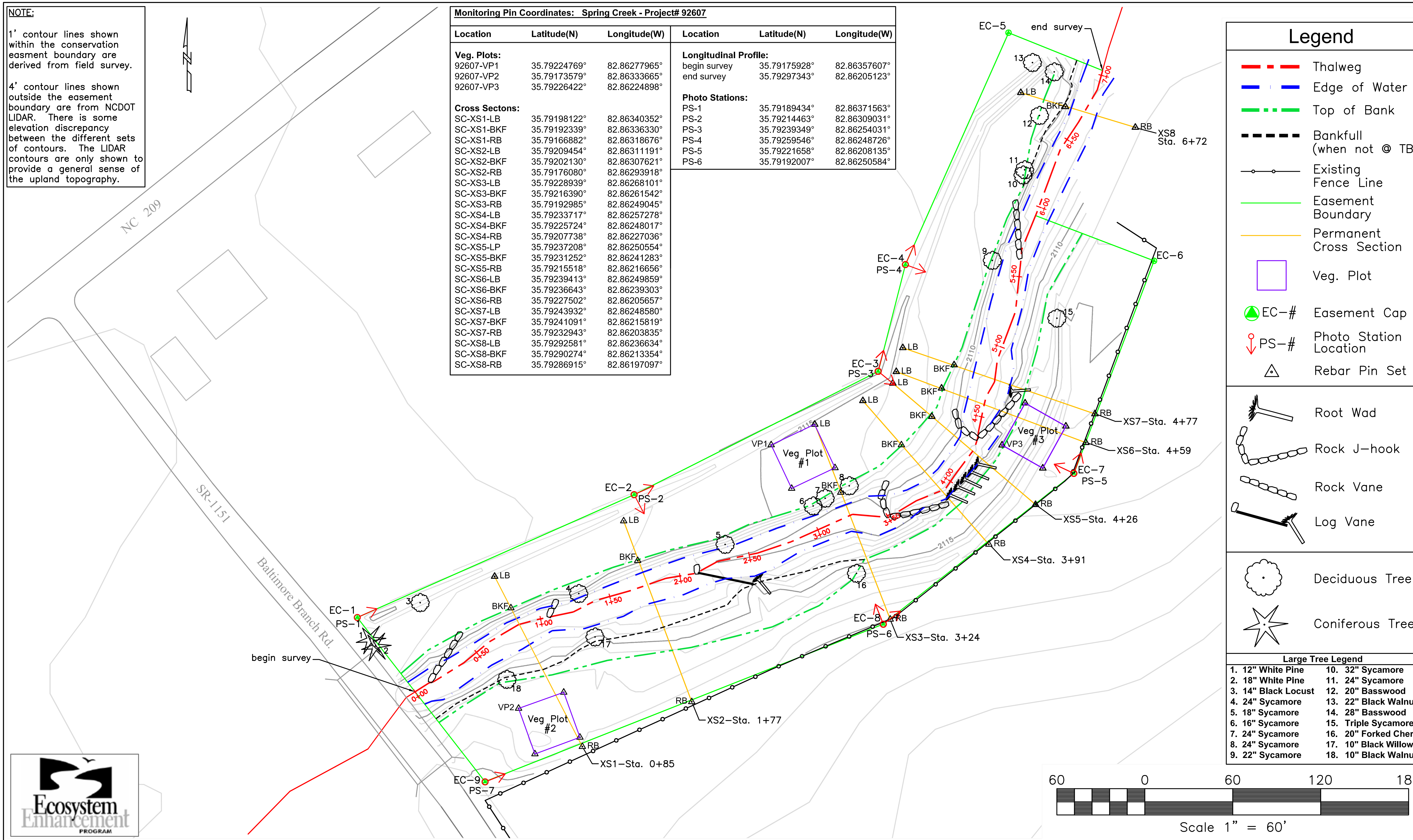
1' contour lines shown within the conservation easment boundary are derived from field survey.

4' contour lines shown outside the easement boundary are from NCDOT LIDAR. There is some elevation discrepancy between the different sets of contours. The LIDAR contours are only shown to provide a general sense of the upland topography.

Monitoring Pin Coordinates: Spring Creek - Project# 92607

Location	Latitude(N)	Longitude(W)
Veg. Plots:		
92607-VP1	35.79224769°	82.86277965°
92607-VP2	35.79173579°	82.86333665°
92607-VP3	35.79226422°	82.86224898°
Cross Sectons:		
SC-XS1-LB	35.79198122°	82.86340352°
SC-XS1-BKF	35.79192339°	82.86336330°
SC-XS1-RB	35.79166882°	82.86318676°
SC-XS2-LB	35.79209454°	82.86311191°
SC-XS2-BKF	35.79202130°	82.86307621°
SC-XS2-RB	35.79176080°	82.86293918°
SC-XS3-LB	35.79228939°	82.86268101°
SC-XS3-BKF	35.79216390°	82.86261542°
SC-XS3-RB	35.79192985°	82.86249045°
SC-XS4-LB	35.79233717°	82.86257278°
SC-XS4-BKF	35.79225724°	82.86248017°
SC-XS4-RB	35.79207738°	82.86227036°
SC-XS5-LP	35.79237208°	82.86250554°
SC-XS5-BKF	35.79231252°	82.86241283°
SC-XS5-RB	35.79215518°	82.86216656°
SC-XS6-LB	35.79239413°	82.86249859°
SC-XS6-BKF	35.79236643°	82.86239303°
SC-XS6-RB	35.79227502°	82.86205657°
SC-XS7-LB	35.79243932°	82.86248580°
SC-XS7-BKF	35.79241091°	82.86215819°
SC-XS7-RB	35.79232943°	82.86203835°
SC-XS8-LB	35.79292581°	82.86236634°
SC-XS8-BKF	35.79290274°	82.86213354°
SC-XS8-RB	35.79286915°	82.86197097°

Location	Latitude(N)	Longitude(W)
Longitudinal Profile:		
begin survey	35.79175928°	82.86357607°
end survey	35.79297343°	82.86205123°
Photo Stations:		
PS-1	35.79189434°	82.86371563°
PS-2	35.79214463°	82.86309031°
PS-3	35.79239349°	82.86254031°
PS-4	35.79259546°	82.86248726°
PS-5	35.79221658°	82.86208135°
PS-6	35.79192007°	82.86250584°



NORTH CAROLINA WILDLIFE RESOURCES COMMISSION WATERSHED ENHANCEMENT GROUP 20830 GREAT SMOKY MOUNTAIN EXPRESSWAY WAYNESVILLE, NORTH CAROLINA 28786 828.452.6191 Ext.26 OFFICE 828.452.7772 FAX	Spring Creek Project #92607 Madison County Plemmons-Kirkpatrick Site As-Built Survey	DRAWN BY: JCF — DATE: 01-08 APPROVED: — DATE: SURVEY BY: CSL, JCF — DATE: 09-06 CAD FILE ID: pkasblt.dwg	SHEET 1 OF 1

FIGURE 2. - Plemmons/Kirkpatrick Mitigation Site, Spring Creek, French Broad River Drainage, Madison County, NC. EEP Project #92607, As-Built Plan View.

NOTE:

1' contour lines shown within the conservation easment boundary are derived from field survey.

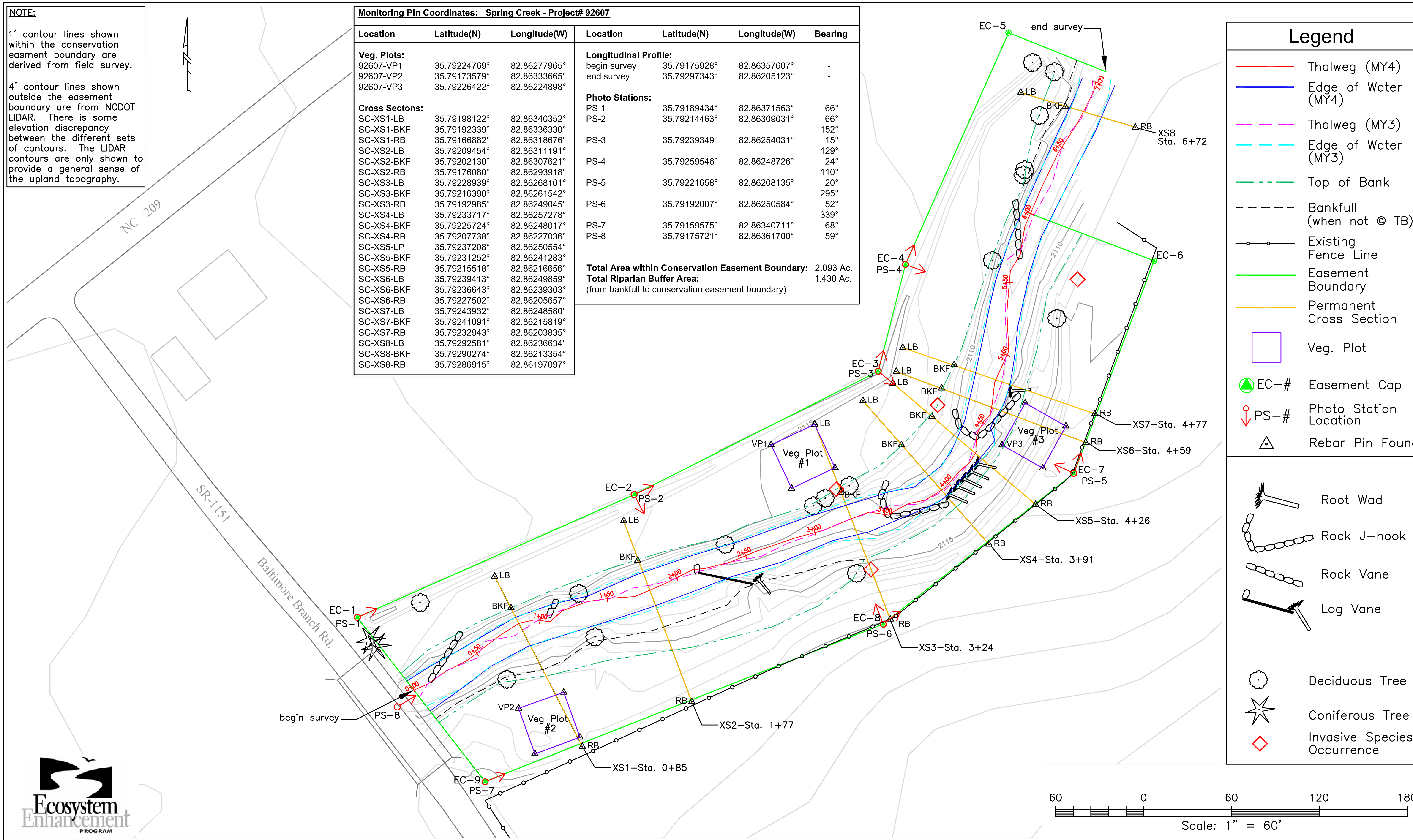
4' contour lines shown outside the easement boundary are from NCDOT LIDAR. There is some elevation discrepancy between the different sets of contours. The LIDAR contours are only shown to provide a general sense of the upland topography.

Monitoring Pin Coordinates: Spring Creek - Project# 92607

Location	Latitude(N)	Longitude(W)
Veg. Plots:		
92607-VP1	35.79224769°	82.86277965°
92607-VP2	35.79173579°	82.86333665°
92607-VP3	35.79226422°	82.86224898°
Cross Sectons:		
SC-XS1-LB	35.79198122°	82.86340352°
SC-XS1-BKF	35.79192339°	82.86336330°
SC-XS1-RB	35.79166882°	82.86318676°
SC-XS2-LB	35.79209454°	82.86311191°
SC-XS2-BKF	35.79202130°	82.86307621°
SC-XS2-RB	35.79176080°	82.86293918°
SC-XS3-LB	35.79228939°	82.86268101°
SC-XS3-BKF	35.79216390°	82.86261542°
SC-XS3-RB	35.79192985°	82.86249045°
SC-XS4-LB	35.79233717°	82.86257278°
SC-XS4-BKF	35.79225724°	82.86248017°
SC-XS4-RB	35.79207738°	82.86227036°
SC-XS5-LP	35.79237208°	82.86250554°
SC-XS5-BKF	35.79231252°	82.86241283°
SC-XS5-RB	35.79215518°	82.86216656°
SC-XS6-LB	35.79239413°	82.86249859°
SC-XS6-BKF	35.79236643°	82.86239303°
SC-XS6-RB	35.79227502°	82.86205657°
SC-XS7-LB	35.79243932°	82.86248580°
SC-XS7-BKF	35.79241091°	82.86215819°
SC-XS7-RB	35.79232943°	82.86203835°
SC-XS8-LB	35.79292581°	82.86236634°
SC-XS8-BKF	35.79290274°	82.86213354°
SC-XS8-RB	35.79286915°	82.86197097°

Location	Latitude(N)	Longitude(W)	Bearing
Longitudinal Profile:			
begin survey	35.79175928°	82.86357607°	-
end survey	35.79297343°	82.86205123°	-
Photo Stations:			
PS-1	35.79189434°	82.86371563°	66°
PS-2	35.79214463°	82.86309031°	66°
			152°
PS-3	35.79239349°	82.86254031°	15°
			129°
PS-4	35.79259546°	82.86248726°	24°
			110°
PS-5	35.79221658°	82.86208135°	20°
			295°
PS-6	35.79192007°	82.86250584°	52°
			339°
PS-7	35.79159575°	82.86340711°	68°
PS-8	35.79175721°	82.86361700°	59°

Total Area within Conservation Easement Boundary: 2.093 Ac.
Total Riparian Buffer Area: 1.430 Ac.
(from bankfull to conservation easement boundary)



NORTH CAROLINA WILDLIFE RESOURCES COMMISSION
WATERSHED ENHANCEMENT GROUP

20830 GREAT SMOKY MOUNTAIN EXPRESSWAY
WAYNESVILLE, NORTH CAROLINA 28786
828.452.6191 Ext.26 OFFICE
828.452.7772 FAX

Spring Creek Project #92607
Madison County — Plemmons-Kirkpatrick Site
MY3 & MY4 Survey - Plan View

DRAWN BY: JCF	DATE: 16-MAY-11
APPROVED:	DATE:
SURVEY BY: CSL, JCF	DATE: 10-09 & 11-10
CAD FILE ID: PK -MY3-4.dwg	

SHEET 1 OF 1

FIGURE 3. - Plemmons/Kirkpatrick Mitigation Site, Spring Creek, French Broad River Drainage, Madison County, NC. EEP Project #92607, MY3 & MY4 Plan View.

Appendix A.─Vegetation Data

A.1 Vegetation Data Tables

Table A.1.1.─Vegetation Metadata.

MY4 Vegetation Metadata Spring Creek (EEP project number 92607)	
Report Prepared By	C. Scott Loftis, A. Brent Burgess
Date Prepared	4 Jan 2011 16:35
Database Name	NCWRCBalsam-07-A.mdb
Database Location	C:\Documents and Settings\Micky Clemmons\My Documents\ My Data\Restoration Projects\CVS-EEP veg data
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT	
Metadata	This worksheet, which is a summary of the project and the project data.
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.
Stem Count by Plot and Spp.	Count of living stems of each species for each plot; dead and missing stems are excluded.
PROJECT SUMMARY	
Project Code/Number	92607
Project Name	Spring Creek
Description	Von and Linda G. Plemmons/Hazel Kirkpatrick properties, Madison County, N.C.
Length (ft)	680
Stream-to-Edge Width (ft)	50
Area (m^2/acres)	8,498.4/2.1 acres
Required Plots (calculated)	3
Sampled Plots	3

Table A.1.2.─Vegetation Vigor by Species.

MY0 Vegetation Vigor by Species Spring Creek (EEP project number 92607)						
Species	**4**	**3**	**2**	**1**	**0**	**Missing**
Acer rubrum	1					
Aesculus flava	1					
Alnus serrulata	1	1				
Amelanchier laevis	5					
Aronia arbutifolia	1					
Cephalanthus occidentalis	4					
Cornus amomum (Live stake)	6					
Halesia carolina	1					
Nyssa aquatica	1					
Oxydendrum arboreum	2					
Quercus coccinea	2					
Rhododendron catawbiense	1					
Salix sericea (Live stake)	3					
Sambucus canadensis	2					
Sorbus americana	2					
Viburnum dentatum	2					
Ilex decidua	2					
Hamamelis virginiana	3					
Lindera benzoin	3					
Physocarpus opulifolius (Live stake)	4					
TOT: 20	**47**	**1**				

MY1 Vegetation Vigor by Species Spring Creek (EEP project number 92607)						
Species	**4**	**3**	**2**	**1**	**0**	**Missing**
Acer rubrum		1				
Aesculus flava		1				
Alnus serrulata	1				1	
Amelanchier laevis	4				1	
Aronia arbutifolia		1				
Cephalanthus occidentalis		2			2	
Cornus amomum (Live stake)					6	
Halesia carolina		1				
Nyssa aquatica		1				
Oxydendrum arboreum				1	1	
Quercus coccinea		2				
Rhododendron catawbiense					1	
Salix sericea (Live stake)	1				2	
Sambucus canadensis	1				1	
Sorbus americana	1	1				
Viburnum dentatum	1				1	
Ilex decidua	1				1	
Hamamelis virginiana	2	1				
Lindera benzoin		2			1	
Physocarpus opulifolius (Live stake)	2				2	
TOT: 20	**14**	**13**		**1**	**20**	

Table A.1.2. Continued.

MY2 Vegetation Vigor by Species Spring Creek (EEP project number 92607)							
Species	**4**	**3**	**2**	**1**	**0**	**Missing**	**Unknown**
Acer rubrum					1		
Aesculus flava		1					
Alnus serrulata		1			1		
Amelanchier laevis		1		1	1	2	
Aronia arbutifolia		1					
Cephalanthus occidentalis		2			2		
Cornus amomum					6		
Halesia carolina	1						
Nyssa aquatica		1					
Oxydendrum arboreum		1			1		
Quercus coccinea		2					
Rhododendron catawbiense					1		
Salix sericea					3		
Sambucus canadensis		1			1		
Sorbus americana		2					
Viburnum dentatum		1			1		
Ilex decidua	1				1		
Hamamelis virginiana		1	1		1		
Lindera benzoin		2			1		
Physocarpus opulifolius		1			3		
TOT: 20	**2**	**18**	**1**	**1**	**24**	**2**	

MY3 Vegetation Vigor by Species Spring Creek (EEP project number 92607)							
Species	**4**	**3**	**2**	**1**	**0**	**Missing**	**Unknown**
Acer rubrum						1	
Aesculus flava		1				1	
Alnus serrulata		1			1		
Amelanchier laevis		2			1	2	
Aronia arbutifolia			1				
Cephalanthus occidentalis			1	1	2		
Cornus amomum					6		
Halesia carolina		1					
Hamamelis virginiana		1	1			1	
Ilex decidua		1			1		
Lindera benzoin			1		1	1	
Nyssa aquatica		1					
Oxydendrum arboreum					1	1	
Physocarpus opulifolius			1		3		
Quercus coccinea		2					
Rhododendron catawbiense					1		
Salix sericea					3		
Sambucus canadensis			1		1		
Sorbus americana		2					
Viburnum dentatum		1			1		
TOT: 20		**13**	**6**	**1**	**22**	**7**	

Table A.1.2. Continued.

MY4 Vegetation Vigor by Species Spring Creek (EEP project number 92607)							
Species	**4**	**3**	**2**	**1**	**0**	**Missing**	**Unknown**
Acer rubrum					1		
Aesculus flava		1			1		
Alnus serrulata		1			1		
Amelanchier laevis			2		3		
Aronia arbutifolia			1				
Cephalanthus occidentalis			1		3		
Cornus amomum					6		
Halesia carolina		1					
Hamamelis virginiana			2		1		
Ilex decidua			1		1		
Lindera benzoin			1		2		
Nyssa aquatica			1				
Oxydendrum arboreum					2		
Physocarpus opulifolius			1		3		
Quercus coccinea	2						
Rhododendron catawbiense					1		
Salix sericea					3		
Sambucus canadensis					2		
Sorbus americana			1		1		
Viburnum dentatum		1			1		
TOT: 20	**2**	**4**	**11**		**32**		

Table A.1.3.─Vegetation Damage by Species.

MY0 Vegetation Damage by Species Spring Creek (EEP project number 92607)		
Species	**All Damage Categories**	**No Damage**
Acer rubrum	1	1
Aesculus flava	1	1
Alnus serrulata	2	2
Amelanchier laevis	5	5
Aronia arbutifolia	1	1
Cephalanthus occidentalis	4	4
Cornus amomum	6	6
Halesia carolina	1	1
Hamamelis virginiana	3	3
Ilex decidua	2	2
Lindera benzoin	3	3
Nyssa aquatica	1	1
Oxydendrum arboreum	2	2
Physocarpus opulifolius	4	4
Quercus coccinea	2	2
Rhododendron catawbiense	1	1
Salix sericea	3	3
Sambucus canadensis	2	2
Sorbus americana	2	2
Viburnum dentatum	2	2
TOT: 20	**48**	**48**

MY1 Vegetation Damage by Species Spring Creek (EEP project number 92607)						
Species	**All Damage Categories**	**No Damage**	**Enter other damage**	**Human Trampled**	**Storm**	**Unknown**
Acer rubrum	1	1				
Aesculus flava	1	1				
Alnus serrulata	2	1				1
Amelanchier laevis	5	4				1
Aronia arbutifolia	1	1				
Cephalanthus occidentalis	4	2				2
Cornus amomum	6					6
Halesia carolina	1	1				
Hamamelis virginiana	3	3				
Ilex decidua	2	1				1
Lindera benzoin	3	1		1		1
Nyssa aquatica	1	1				
Oxydendrum arboreum	2	1				1
Physocarpus opulifolius	4	2				2
Quercus coccinea	2	2				
Rhododendron catawbiense	1		1			
Salix sericea	3	1				2
Sambucus canadensis	2	1				1
Sorbus americana	2	2				
Viburnum dentatum	2	1			1	
TOT: 20	**48**	**27**	**1**	**1**	**1**	**18**

Table A.1.3. Continued.

MY2 Vegetation Damage by Species Spring Creek (EEP project number 92607)						
Species	**All Damage Categories**	**No Damage**	**Enter other damage**	**Human Trampled**	**Storm**	**Unknown**
Acer rubrum	1					1
Aesculus flava	1					1
Alnus serrulata	2	1				1
Amelanchier laevis	5	2	1			2
Aronia arbutifolia	1	1				
Cephalanthus occidentalis	4	2				2
Cornus amomum	6					6
Halesia carolina	1	1				
Hamamelis virginiana	3	1	1			1
Ilex decidua	2	1				1
Lindera benzoin	3	2		1		
Nyssa aquatica	1	1				
Oxydendrum arboreum	2	1				1
Physocarpus opulifolius	4	3				1
Quercus coccinea	2	2				
Rhododendron catawbiense	1					1
Salix sericea	3					3
Sambucus canadensis	2	1				1
Sorbus americana	2	2				
Viburnum dentatum	2	1				1
TOT: 20	**48**	**22**	**2**	**1**		**23**

MY3 Vegetation Damage by Species			
Spring Creek (EEP project number 92607)			
Species	**All Damage Categories**	**No Damage**	**Unknown**
Acer rubrum	1		1
Aesculus flava	2	1	1
Alnus serrulata	2	1	1
Amelanchier laevis	5	2	3
Aronia arbutifolia	1	1	
Cephalanthus occidentalis	4	2	2
Cornus amomum	6		6
Halesia carolina	1	1	
Hamamelis virginiana	3	1	2
Ilex decidua	2	1	1
Lindera benzoin	3	2	1
Nyssa aquatica	1	1	
Oxydendrum arboreum	2	1	1
Physocarpus opulifolius	4	3	1
Quercus coccinea	2	2	
Rhododendron catawbiense	1		1
Salix sericea	3		3
Sambucus canadensis	2	1	1
Sorbus americana	2	2	
Viburnum dentatum	2	1	1
TOT: 20	**49**	**23**	**26**

Table A.1.3. Continued.

MY4 Vegetation Damage by Species				
Spring Creek (EEP project number 92607)				
Species	**All Damage Categories**	**No Damage**	**Unknown**	**Vine**
Acer rubrum	1		1	
Aesculus flava	2	1	1	
Alnus serrulata	2	1	1	
Amelanchier laevis	5	1	3	1
Aronia arbutifolia	1	1		
Cephalanthus occidentalis	4	2	2	
Cornus amomum	6		6	
Halesia carolina	1	1		
Hamamelis virginiana	3	1	2	
Ilex decidua	2	1	1	
Lindera benzoin	3	2	1	
Nyssa aquatica	1	1		
Oxydendrum arboreum	2	1	1	
Physocarpus opulifolius	4	3	1	
Quercus coccinea	2	2		
Rhododendron catawbiense	1		1	
Salix sericea	3		3	
Sambucus canadensis	2	1	1	
Sorbus americana	2	2		
Viburnum dentatum	2	1	1	
TOT: 20	**49**	**22**	**27**	**1**

Table A.1.4.─Vegetation Damage by Plot.

MY0 Vegetation Damage by Plot Spring Creek (EEP project number 92607)		
Plot	**All Damage Categories**	**No Damage**
92607-SL/BB-VP1	6	6
92607-SL/BB-VP2	9	9
92607-SL/BB-VP3	33	33
TOT: 3	**48**	**48**

MY1 Vegetation Damage by Plot Spring Creek (EEP project number 92607)						
Plot	**All Damage Categories**	**No Damage**	**Other Damage**	**Human Trampled**	**Storm**	**Unknown**
92607-SL/BB-VP1	6	6				
92607-SL/BB-VP2	9	8				1
92607-SL/BB-VP3	33	13	1			19
TOT: 3	**48**	**27**	**1**			**20**

MY2 Vegetation Damage by Plot Spring Creek (EEP project number 92607)						
Plot	**All Damage Categories**	**No Damage**	**Other Damage**	**Human Trampled**	**Storm**	**Unknown**
92607-SL/BB-VP1	6	4				2
92607-SL/BB-VP2	9	7				2
92607-SL/BB-VP3	33	11				22
TOT: 3	**48**	**22**				**26**

MY3 Vegetation Damage by Plot Spring Creek (EEP project number 92607)				
Plot	**All Damage Categories**	**No Damage**	**Unknown**	**Vine**
92607-Balsam-VP1-year:3	7	4	3	
92607-Balsam-VP2-year:3	9	5	4	
92607-Balsam-VP3-year:3	33	11	22	
TOT: 3	**49**	**20**	**29**	

MY4 Vegetation Damage by Plot Spring Creek (EEP project number 92607)				
Plot	**All Damage Categories**	**No Damage**	**Unknown**	**Vine**
92607-SL/ABB-VP1-year:4	7	4	3	
92607-SL/ABB-VP2-year:4	9	3	5	1
92607-SL/ABB-VP3-year:4	33	10	23	
TOT: 3	**49**	**17**	**31**	**1**

Table A.1.5.─Planted Stem Count by Plot and Species.

MY0 Planted Stem Count by Plot and Species Spring Creek (EEP project number 92607)						
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**Plot 92607 VP1**	**Plot 92607 VP2**	**Plot 92607 VP3**
Acer rubrum	1	1	1	1		
Aesculus flava	1	1	1	1		
Alnus serrulata	2	1	2			2
Amelanchier laevis	5	2	2.5		4	1
Aronia arbutifolia	1	1	1			1
Cephalanthus occidentalis	4	1	4			4
Cornus amomum	6	1	6			6
Halesia carolina	1	1	1		1	
Hamamelis virginiana	3	3	1	1	1	1
Ilex decidua	2	2	1		1	1
Lindera benzoin	3	2	1.5		1	2
Nyssa aquatica	1	1	1			1
Oxydendrum arboreum	2	2	1		1	1
Physocarpus opulifolius	4	1	4			4
Quercus coccinea	2	1	2	2		
Rhododendron catawbiense	1	1	1			1
Salix sericea	3	1	3			3
Sambucus canadensis	2	1	2			2
Sorbus americana	2	1	2			2
Viburnum dentatum	2	2	1	1		1
TOT: 20	**48**			**6**	**9**	**33**
Density (stems/acre)	**648**			**243**	**364**	**1,336**

MY1 Planted Stem Count by Plot and Species Spring Creek (EEP project number 92607)						
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**Plot 92607 VP1**	**Plot 92607 VP2**	**Plot 92607 VP3**
Acer rubrum	1	1	1	1		
Aesculus flava	1	1	1	1		
Alnus serrulata	1	1	1			1
Amelanchier laevis	4	1	4		4	
Aronia arbutifolia	1	1	1			1
Cephalanthus occidentalis	2	1	2			2
Cornus amomum						
Halesia carolina	1	1	1		1	
Hamamelis virginiana	3	3	1	1	1	1
Ilex decidua						
Lindera benzoin	2	2	1		1	1
Nyssa aquatica	1	1	1			1
Oxydendrum arboreum	1	1	1		1	
Physocarpus opulifolius	2	1	2			2
Quercus coccinea	2	1	2	2		
Rhododendron catawbiense						
Salix sericea	1	1	1			1
Sambucus canadensis	1	1	1			1
Sorbus americana	2	1	2			2
Viburnum dentatum	1	1	1	1		
TOT: 20	**27**			**6**	**8**	**13**
Density (stems/acre)	**364**			**243**	**323**	**526**

Table A.1.5. Continued.

MY2 Planted Stem Count by Plot and Species Spring Creek (EEP project number 92607)						
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**Plot 92607 VP1**	**Plot 92607 VP2**	**Plot 92607 VP3**
Acer rubrum						
Aesculus flava	1	1	1	1		
Alnus serrulata	1	1	1			1
Amelanchier laevis	2	1	2		2	
Aronia arbutifolia	1	1	1			1
Cephalanthus occidentalis	2	1	2			2
Cornus amomum						
Halesia carolina	1	1	1		1	
Hamamelis virginiana	2	2	1		1	1
Ilex decidua	1	1	1		1	
Lindera benzoin	2	2	1		1	1
Nyssa aquatica	1	1	1			1
Oxydendrum arboreum	1	1	1		1	
Physocarpus opulifolius	1	1	1			1
Quercus coccinea	2	1	2	2		
Rhododendron catawbiense						
Salix sericea						
Sambucus canadensis	1	1	1			1
Sorbus americana	2	1	2			2
Viburnum dentatum	1	1	1	1		
TOT: 20	**22**			**4**	**7**	**11**
Density (stems/acre)	**297**			**162**	**283**	**445**

MY3 Planted Stem Count by Plot and Species Spring Creek (EEP project number 92607)						
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**Plot 92607 VP1**	**Plot 92607 VP2**	**Plot 92607 VP3**
Aesculus flava	1	1	1	1		
Alnus serrulata	1	1	1			1
Amelanchier laevis	2	1	2		2	
Aronia arbutifolia	1	1	1			1
Cephalanthus occidentalis	2	1	2			2
Halesia carolina	1	1	1		1	
Hamamelis virginiana	2	2	1		1	1
Ilex decidua	1	1	1		1	
Lindera benzoin	1	1	1			1
Nyssa aquatica	1	1	1			1
Physocarpus opulifolius	1	1	1			1
Quercus coccinea	2	1	2	2		
Sambucus canadensis	1	1	1			1
Sorbus americana	2	1	2			2
Viburnum dentatum	1	1	1	1		
TOT: 15	**20**			**4**	**5**	**11**
Density (stems/acre)	**270**			**162**	**283**	**445**

Table A.1.5. Continued.

MY4 Planted Stem Count by Plot and Species Spring Creek (EEP project number 92607)						
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**Plot 92607 VP1**	**Plot 92607 VP2**	**Plot 92607 VP3**
Aesculus flava	1	1	1	1		
Alnus serrulata	1	1	1			1
Amelanchier laevis	2	1	2		2	
Aronia arbutifolia	1	1	1			1
Cephalanthus occidentalis	2	1	1			2
Halesia carolina	1	1	1		1	
Hamamelis virginiana	2	2	1		1	1
Ilex decidua	1	1	1		1	
Lindera benzoin	1	1	1			1
Nyssa aquatica	1	1	1			1
Physocarpus opulifolius	1	1	1			1
Quercus coccinea	2	1	2	2		
Sorbus americana	2	1	1			2
Viburnum dentatum	1	1	1	1		
TOT: 14	**19**			**4**	**5**	**10**
Density (stems/acre)	**256**			**162**	**283**	**405**

Table A.1.6.─All Stems Counted by Plot and Species.

MY2 All Stems Counted by Plot and Species Spring Creek (EEP project number 92607)						
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**Plot 92607 VP1**	**Plot 92607 VP2**	**Plot 92607 VP3**
Acer rubrum						
Aesculus flava	1	1	1	1		
Alnus serrulata	1	1	1			1
Amelanchier laevis	2	2	1		2	
Aronia arbutifolia	1	1	1			1
Cephalanthus occidentalis	2	1	2			2
Cornus amomum						
Cornus florida **(non-planted)**	1	1	1	**1**		
Halesia carolina	1	1	1		1	
Hamamelis virginiana	2	1	1		1	1
Ilex decidua	1	1	1		1	
Juglans nigra **(non-planted)**	2	2	1	**1**	**1**	
Lindera benzoin	2	2	1		1	1
Nyssa aquatica	1	1	1			1
Oxydendrum arboreum	1	1	1		1	
Physocarpus opulifolius	1	1	1			1
Prunus serotina **(non-planted)**	4	1	4	**4**		
Quercus coccinea	2	1	2	2		
Rhododendron catawbiense						
Salix sericea						
Sambucus canadensis	1	1	1			1
Sorbus americana	2	1	2			2
Viburnum dentatum	1	1	1	1		
TOT: 23	**29**			**10**	**8**	**11**
Density (stems/acre) (including non-planted stems)	**391**			**405 (6)**	**324 (1)**	**445 (0)**

Table A.1.6. Continued.

MY3 All Stems Counted by Plot and Species Spring Creek (EEP project number 92607)						
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**Plot 92607 VP1**	**Plot 92607 VP2**	**Plot 92607 VP3**
Aesculus flava	1	1	1	1		
Alnus serrulata	1	1	2			1
Amelanchier laevis	2	1	1.5		2	
Aronia arbutifolia	1	1	1			1
Cephalanthus occidentalis	2	1	2			2
Cornus amomum	1	1	1	**1**		
Cornus florida **(non-planted)**	1	1	1	**1**		
Halesia carolina	1	1	1		1	
Hamamelis virginiana	2	2	1		1	1
Ilex decidua	1	1	1		1	
Lindera benzoin	1	1	1			1
Nyssa aquatica	1	1	1			1
Oxydendrum arboreum						
Physocarpus opulifolius	1	1	1			1
Prunus serotina **(non-planted)**	7	1	7	**7**		
Quercus coccinea	2	1	2	2		
Rhododendron catawbiense						
Rhus typhina **(non-planted)**	2	2	1	**1**	**1**	
Salix sericea						
Sambucus canadensis **(non-planted)**	8	2	4.5		**7**	1
Sorbus americana	2	1	2			2
Viburnum dentatum	1	2	1	1		
TOT: 22	**38**			**14**	**13**	**11**
Density (stems/acre) (including non-planted stems)	**513**			**567 (10)**	**526 (8)**	**445 (0)**

Table A.1.6. Continued.

MY4 All Stems Counted by Plot and Species Spring Creek (EEP project number 92607)						
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**Plot 92607 VP1**	**Plot 92607 VP2**	**Plot 92607 VP3**
Acer rubrum						
Aesculus flava	1	1	2	1		
Alnus serrulata	1	1	1			1
Amelanchier laevis	2	1	2		2	
Aronia arbutifolia	1	1	1			1
Cephalanthus occidentalis	2	1	2			2
Cornus amomum	1	1	1			**1**
Cornus florida **(non-planted)**	2	1	2	**2**		
Halesia carolina	1	1	1		1	
Hamamelis virginiana	2	2	1		1	1
Ilex decidua	1	2	1		1	
Lindera benzoin	1	1	1			1
Nyssa aquatica	1	1	1			1
Oxydendrum arboreum						
Physocarpus opulifolius	1	1	1			1
Prunus serotina **(non-planted)**	8	2	3.5	**6**		**2**
Quercus coccinea	2	1	2	2		
Rhododendron catawbiense						
Rhus typhina **(non-planted)**	2	2	1	**1**	**1**	
Salix sericea						
Sambucus canadensis **(non-planted)**	8	1	8		**8**	
Sorbus americana	2	1	2			2
Viburnum dentatum	1	2	1	1		
TOT: 22	**40**			**13**	**14**	**13**
Density (stems/acre) (including non-planted stems)	**540**			**526 (9)**	**567 (9)**	**526 (3)**

A.2 Vegetation Problem Areas Plan View

The non-native vegetation observed at the site remains at a relatively low density overall with the most concentrated portion of invasive vegetation located on the right bank at the lower end of the project site. The locations Vegetation problem areas or invasive species occurrences were noted on the MY3-MY4 plan view (Figure 3).

A.3 Vegetation Problem Areas Table

Table A.3.1.─Vegetation Problem Areas.

MY0 Vegetation Problem Areas Spring Creek (EEP project number 92607)			
Feature/Issue	**Station Number/Range**	**Probable Cause**	**Photo Number**
Chinese privet present – sprouting	3+00, left bank	Root stock	
Multi-flora rose present - sprouting	5+75, right bank	Parent Stock	

MY1 Vegetation Problem Areas Spring Creek (EEP project number 92607)			
Feature/Issue	**Station Number/Range**	**Probable Cause**	**Photo Number**
Chinese privet present – sprouting	3+00, left bank	Root stock	
Multi-flora rose, Privet present - sprouting	5+75, right bank	Parent Stock	

MY2 Vegetation Problem Areas Spring Creek (EEP project number 92607)			
Feature/Issue	**Station Number/Range**	**Probable Cause**	**Photo Number**
Chinese privet - sparse	3+00, left bank	Root stock	NA
Multi-flora rose - clump	4+75, left bank	Root stock	1
Multi-flora rose, Chinese privet, honeysuckle - clumps	5+75, right bank	Parent Stock	2

MY3 Vegetation Problem Areas Spring Creek (EEP project number 92607)			
Feature/Issue	**Station Number/Range**	**Probable Cause**	**Photo Number**
Chinese privet - sparse	3+00, left bank	Root stock	NA
Multi-flora rose - clump	4+75, left bank	Root stock	1
Multi-flora rose, Chinese privet, honeysuckle - clumps	5+75, right bank	Parent Stock	2
Chinese privet – single stem	3+25, right bank	Seed	3

MY4 Vegetation Problem Areas Spring Creek (EEP project number 92607)			
Feature/Issue	**Station Number/Range**	**Probable Cause**	**Photo Number**
Chinese privet - sparse	3+00, left bank	Root stock	NA
Multi-flora rose - clump	4+75, left bank	Root stock	1
Multi-flora rose, Chinese privet, honeysuckle - clumps	5+75, right bank	Parent Stock	2
Chinese privet – single stem	3+25, right bank	Seed	3

A.4 Vegetation Problem Areas Photographs

Vegetation problem area photo 1, 13 Feb 2009.

Vegetation problem area photo 2, 13 Feb 2009.

Vegetation problem area photo 3, 9 Dec 2009.

A.5 Vegetation Monitoring Plot Photographs

Table A.5.1.―Vegetation Monitoring Plot Photographs

Vegetation Monitoring Plots Photographs Spring Creek (EEP project number 92607)			
Stream	**Location**	**Bearing (Degrees from North)**	**Plot Dimensions (m)**
Spring Creek	Plot 1 left bank sta. 3+00	Plot origin (x,y) 180^o	10 X 10
Spring Creek	Plot 2 right bank sta. 0+50	Plot origin (x,y) 190^o	10 X 10
Spring Creek	Plot 3 right bank sta. 4+50	Plot origin (x,y) 200^o	10 X 10

Vegetation plot 1, facing downstream (0,0), 19 Jun 2007.

Vegetation plot 1, facing upstream (10,10), 19 Jun 2007.

Vegetation plot 1, facing downstream, (0,0) 16 Jan 2008.

Vegetation plot 1, facing upstream, (10,0) 16 Jan 2008.

A.5. Continued.

Vegetation plot 1, facing downstream, (0,0) 19 Aug 2008.

Vegetation plot 1, facing upstream, (0,10) 19 Aug 2008.

Vegetation plot 1, facing downstream, (0,0) 18 Nov 2009.

Vegetation plot 1, facing upstream, (10,10) 18 Nov 2009.

Vegetation plot 1, facing downstream, (0,0) 10 Oct 2010.

Vegetation plot 1, facing upstream, (0,10) 10 Oct 2010.

A.5. Continued.

Vegetation plot 2, facing downstream (0,0) 19 Jun 2007.

No photo available for vegetation plot 2, facing upstream, (10,0), January 2007.

Vegetation plot 2, facing downstream, (0,0) 16 Jan 2008.

Vegetation plot 2, facing upstream, (10,0) 16 Jan 2008.

Vegetation plot 2, facing downstream, (0,0) 19 Aug 2008.

Vegetation plot 2, facing upstream, (10,0) 19 Aug 2008.

A.5. Continued.

Vegetation plot 2, facing downstream (0,0) 18 Nov 2009.

Vegetation plot 2, facing upstream, (10,10) 18 Nov 2009.

Vegetation plot 2, facing downstream (0,0) 10 Oct 2010.

Vegetation plot 2, facing upstream, (10,10) 10 Oct 2010.

A.5. Continued.


Vegetation plot 3, facing downstream (0,0) 19 Jun 2007.


Vegetation plot 3, facing upstream (10,10) 19 Jun 2007.


Vegetation plot 3, facing downstream, (0,0) 16 Jan 2008.


Vegetation plot 3, facing upstream, (10,0) 16 Jan 2008.


Vegetation plot 3, facing downstream, (0,0) 19 Aug 2008.


Vegetation plot 3, facing upstream, (10,0) 19 Aug 2008.

A.5. Continued.

Vegetation plot 3, facing downstream, (0,0) 18 Nov 2009.

Vegetation plot 3, facing upstream (10,10) 18 Nov 2009.

Vegetation plot 3, facing downstream, (0,0) 10 Oct 2010.

Vegetation plot 3, facing upstream (10,10) 10 Oct 2010.

Appendix B.─Stream Data

B.1 Stream Problem Areas Table

No problem areas were observed during the MY3 and MY4 surveys. Appendix Table B.1.1, Stream Problem Areas, is used as a place holder for future monitoring reports.

Table B.1.1.─Stream Problem Areas

Stream Problem Areas Spring Creek (EEP project number 92607)			
Feature/Issue	**Station numbers**	**Suspected Cause**	**Photo number**
Aggradation/Bar Formation			
Bank Scour			
Engineered structures - back or arm scour, Etc.			

B.2 Stream Problem Areas Plan View

No stream problem areas were observed during the MY3 or MY4 surveys; therefore no problem area plan view was prepared.

B.3 Representative Stream Problem Area Photographs

No problem areas were observed during MY3 or MY4 surveys; therefore, issue or problem photos are not provided.

B.4 Stream Photographic Stations

Photo station 1, left bank facing downstream, 5 Sep 2006.

Photo station 1, left bank facing downstream, 5 Dec 2007.

Photo station 1, left bank facing downstream, 3 Oct 2008.

Photo station 1, left bank facing downstream, 9 Dec 2009.

Photo station 1, left bank facing downstream, 13 Oct 2010.

B.4. Continued.

Photo station 2, left bank facing downstream, 5 Sep 2006.

Photo station 2, left bank facing downstream, 5 Dec 2007.

Photo station 2, left bank facing downstream, 3 Oct 2008.

Photo station 2, left bank facing downstream, 9 Dec 2009.

Photo station 2, left bank facing downstream, 13 Oct 2010.

B.4. Continued.

Photo Station 2, left to right bank, 5 Sep 2006.

Photo Station 2, left to right bank, 5 Dec 2007.

Photo Station 2, left to right bank, 3 Oct 2008.

Photo Station 2, left to right bank, 9 Dec 2009.

Photo Station 2, left to right bank, 13 Oct 2010.

B.4. Continued.

Photo station 3, left bank facing downstream, 5 Sep 2006.

Photo station 3, left bank facing downstream, 5 Dec 2007.

Photo station 3, left bank facing downstream, 3 Oct 2008.

Photo station 3, left bank facing downstream, 9 Dec 2009.

Photo station 3, left bank facing downstream, 13 Oct 2010.

B.4. Continued.

Photo station 3, left to right bank, 5 Sep 2006.

Photo station 3, left to right bank, 5 Dec 2007.

Photo station 3, left to right bank, 3 Oct 2008.

Photo station 3, left to right bank, 9 Dec 2009.

Photo station 3, left to right bank, 13 Oct 2010.

B.4. Continued.

Photo station 4, left bank facing downstream, 5 Sep 2006.

Photo station 4, left bank facing downstream, 5 Dec 2007.

Photo station 4, left bank facing downstream, 3 Oct 2008.

Photo station 4, left bank facing downstream, 9 Dec 2009.

Photo station 4, left bank facing downstream, 13 Oct 2010.

B.4. Continued.

Photo station 4, left to right bank, 5 Sep 2006.

Photo station 4, left to right bank, 5 Dec 2007.

Photo station 4, left to right bank, 3 Oct 2008.

Photo station 4, left to right bank, 9 Dec 2009.

Photo station 4, left to right bank, 13 Oct 2010.

B.4. Continued.

Photo station 5, right bank facing downstream, 5 Sep 2006.

No photo available for station 4, left to right bank, 5 Dec 2007.

Photo station 5, right bank facing downstream, 3 Oct 2008.

Photo station 5, right bank facing downstream, 9 Dec 2009.

B.4. Continued.

Photo station 5, right to left bank, 5 Sep 2006.

Photo station 5, right to left bank, 5 Dec 2007.

Photo station 5, right to left bank, 3 Oct 2008.

Photo station 5, right to left bank, 9 Dec 2009.

Photo station 5, right to left bank, 13 Oct 2010.

B.4. Continued.

Photo station 6, right bank facing downstream, 5 Sep 2006.

No photo available for station 6, left to right bank, 5 Dec 2007.

Photo station 6, right bank facing downstream, 3 Oct 2008.

Photo station 6, right bank facing downstream, 9 Dec 2009.

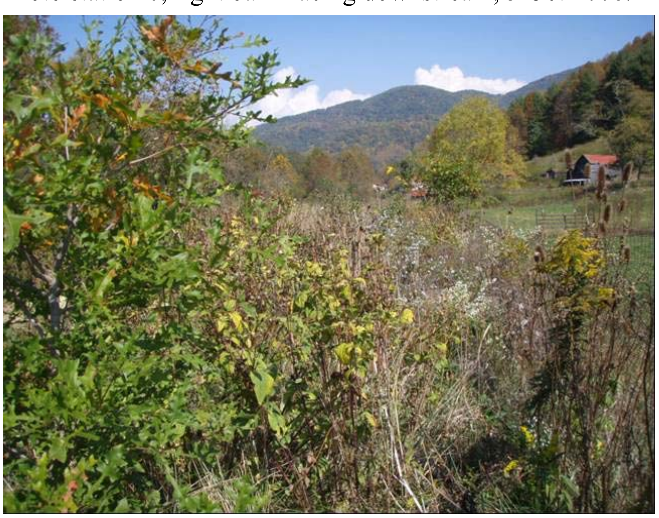


Photo station 6, right bank facing downstream, 13 Oct 2010.

B.4. Continued.

Photo station 6, right to left bank, 5 Sep 2006.

Photo station 6, right to left bank, 5 Dec 2007.

Photo station 6, right to left bank, 3 Oct 2008.

Photo station 6, right to left bank, 9Dec 2009.

Photo station 6, right to left bank, 13 Oct 2010.

B.4. Continued.

Photo station 7, right bank facing downstream, 6 Jan 2004.

Photo station 7, right bank facing downstream, 5 Jan 2007.

Photo station 7, right bank facing downstream, 5 Dec 2007.

Photo station 7, right bank facing downstream, 3 Oct 2008.

Photo station 7, right bank facing downstream, 9 Dec 2009.

Photo station 7, right bank facing downstream, 13 Oct 2010.

B.4. Continued.


Photo station 8, SR 1151 bridge downstream, 5 Sep 2006.


Photo station 8, SR 1151 bridge downstream, 5 Dec 2007.


Photo station 8, SR 1151 bridge downstream, 3 Oct 2008.

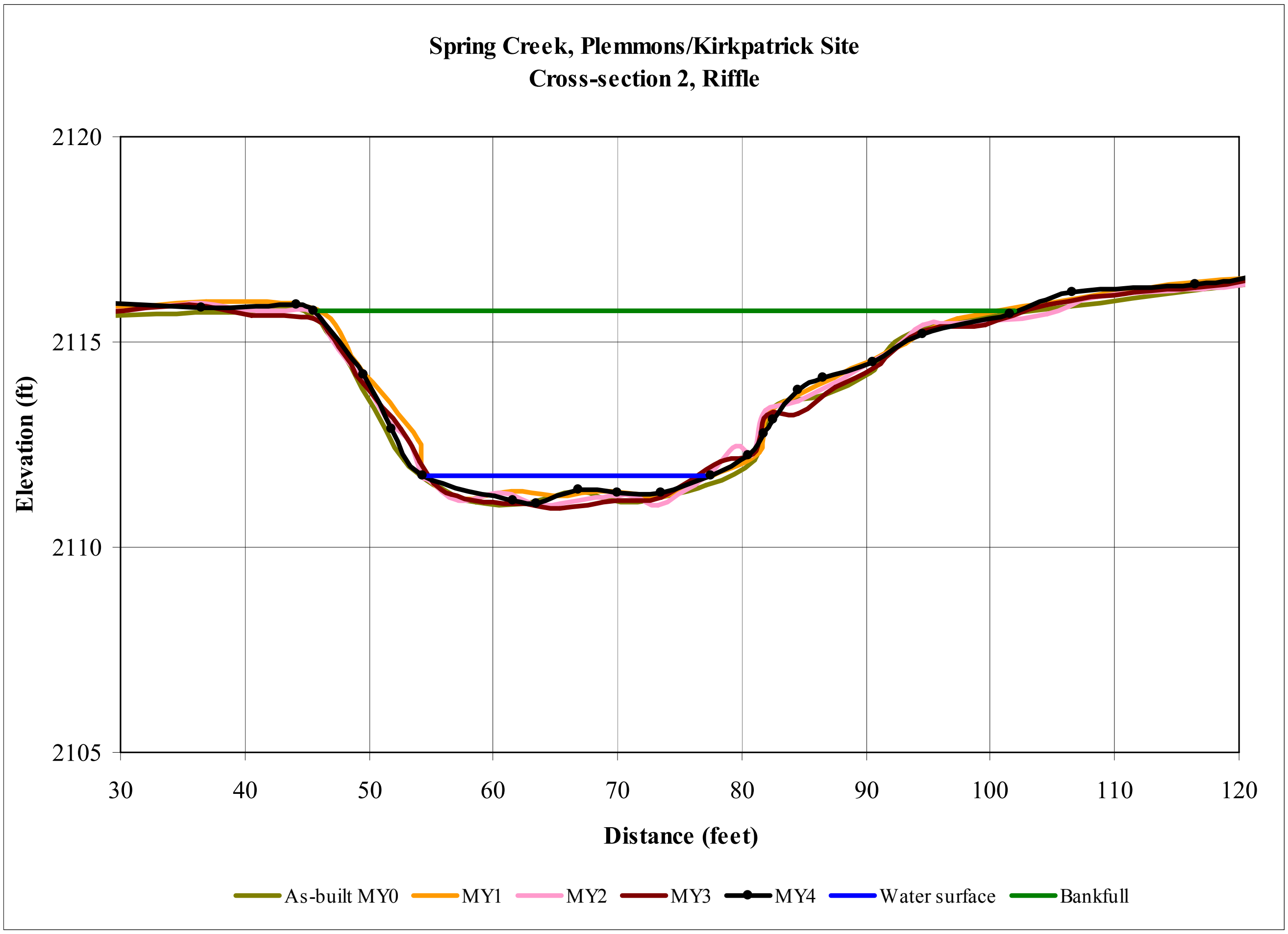

Photo station 8, SR 1151 bridge downstream, 9 Dec 2009.


Photo station 8, SR 1151 bridge downstream, 13 Oct 2010.

B.5 Visual Morphological Stability Assessment Table

MY4 Visual Morphological Stability Assessment **Spring Creek (EEP project number 92607)** **Sta. 0+00 to 6+80 (680 feet)**						
Feature Category	Metric (per As-built and reference baselines)	(Number Stable) Number Performing as Intended	Total Number per As-built	Total Number /feet in unstable state	% Perform in Stable Condition	Feature Perform Mean or Total
A. Riffles	1. Present?	5	5	NA	100	5
	2. Armor stable (e.g. no displacement)?	5	5	NA	100	5
	3. Facet grade appears stable?	5	5	NA	100	5
	4. Minimal evidence of embedding/fining?	5	5	NA	100	5
	5. Length appropriate?	5	5	NA	100	5
B. Pools	1. Present? (e.g. not subject to severe aggrad. Or migrat.)?	5	5	NA	100	5
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6)?	5	5	NA	100	5
	3. Length appropriate?	5	5	NA	100	5
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	1	1	NA	100	1
	2. Downstream of meander (glide/inflection) centering?	1	1	NA	100	1
D. Meanders	1. Outer bend in state of limited/controlled erosion?	1	1	NA	100	1
	2. Of those eroding, number w/concomitant point bar formation?	1	1	NA	100	1
	3. Apparent Rc within specifications?	1	1	NA	100	1
	4. Sufficient floodplain access and relief?	1	1	NA	100	1
E. Bed	1. General channel bed aggradation areas (bar formation)?	NA	NA	0/0	100	NA
General	2. Channel bed degradation – areas of increasing down cutting or head cutting?	NA	NA	0/0	100	NA
F. Bank	1. Actively eroding, wasting, or slumping bank?	NA	NA	0/0	100	NA
G. Vanes	1. Free of back or arm scour?	5	5	NA	100	5
	2. Height appropriate?	5	5	NA	100	5
	3. Angle and geometry appear appropriate?	5	5	NA	100	5
	4. Free of piping or other structural failures?	5	5	NA	100	5
H. Wads/	1. Free of scour?	6	6	NA	100	6
Boulders	2. Footing stable?	6	6	NA	100	6

B.6 Annual Overlays of Cross-Section Plots. Solid red line in photograph represents location where surveyed transect crossed the stream channel.



Cross-section 2, facing downstream, 5 Dec 07, MY1.

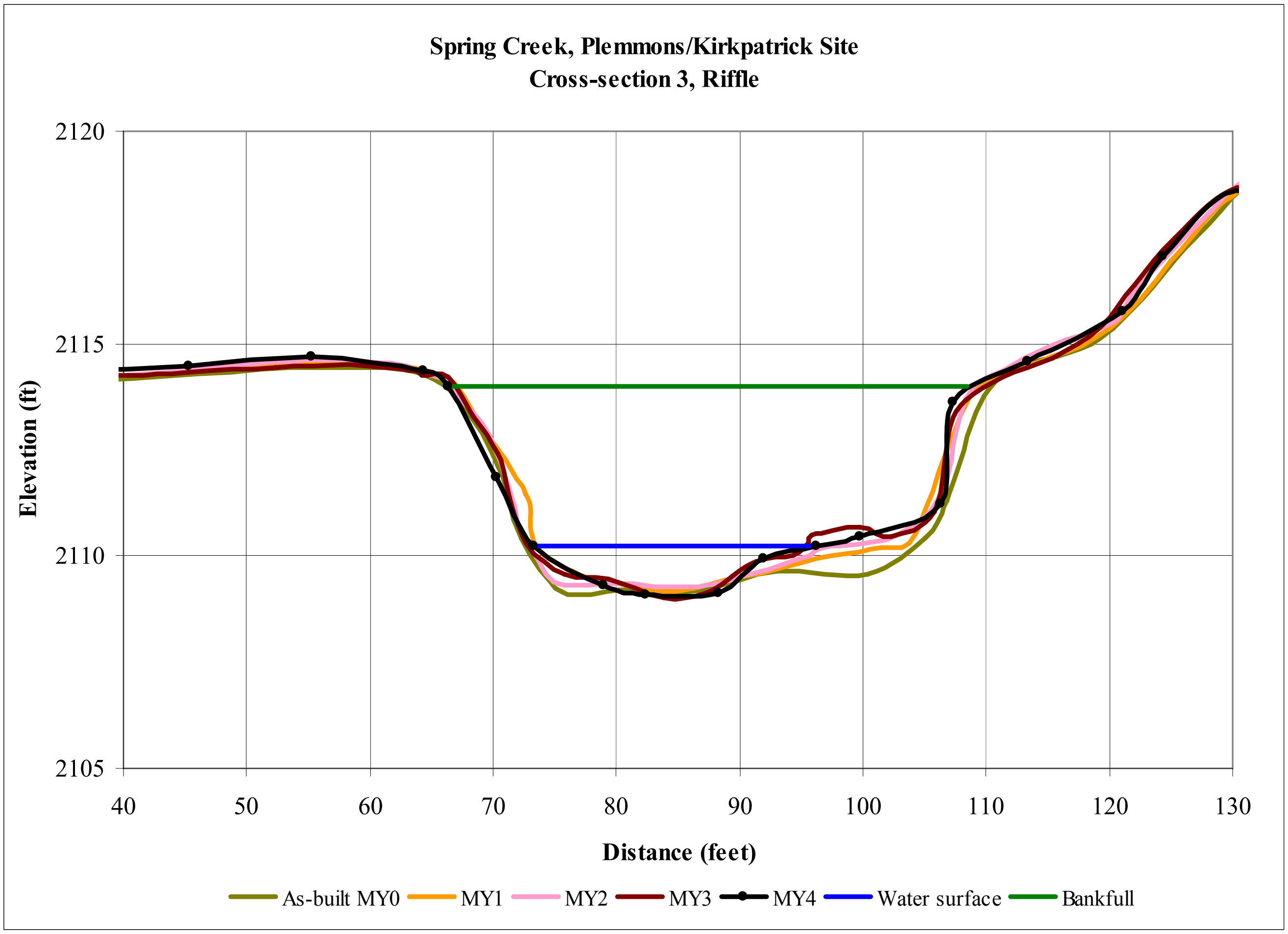
Cross-section 2, facing downstream, 3 Oct 08, MY2

B.6. Continued.

Cross-section 2, facing downstream, 9 Dec 2009, MY3

No photograph for Cross-section 2 in MY4.

B.6. Continued.



Cross-section 3, facing downstream, 5 Dec 07.

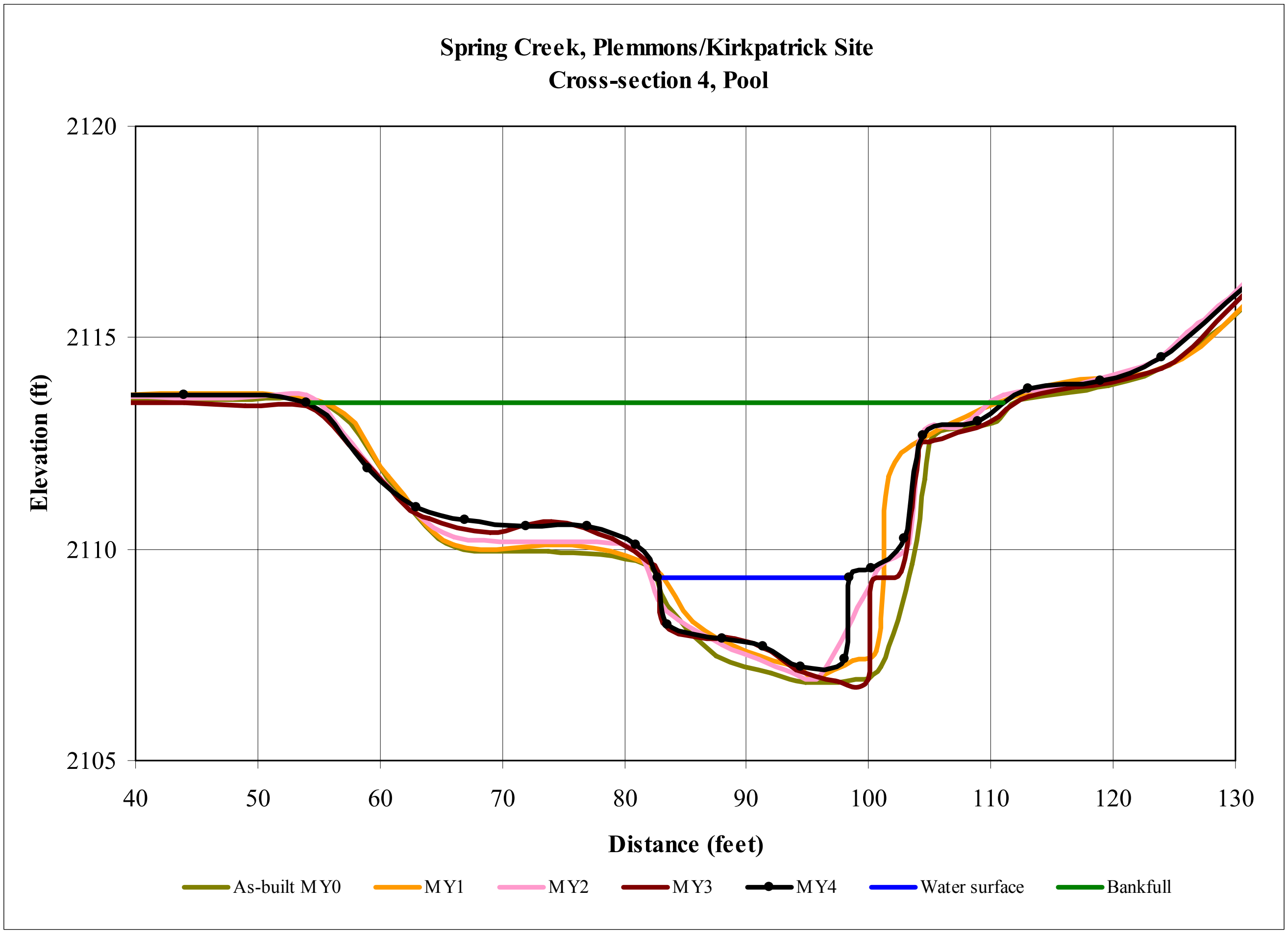
Cross-section 3, facing downstream, 3 Oct 08.

B.6. Continued.

Cross-section 3, facing downstream, 9 Dec 2009, MY3

Cross-section 3, facing downstream, 13 Oct 2010, MY4.

B.6. Continued.




Cross-section 4, facing downstream, 5 Dec 07.

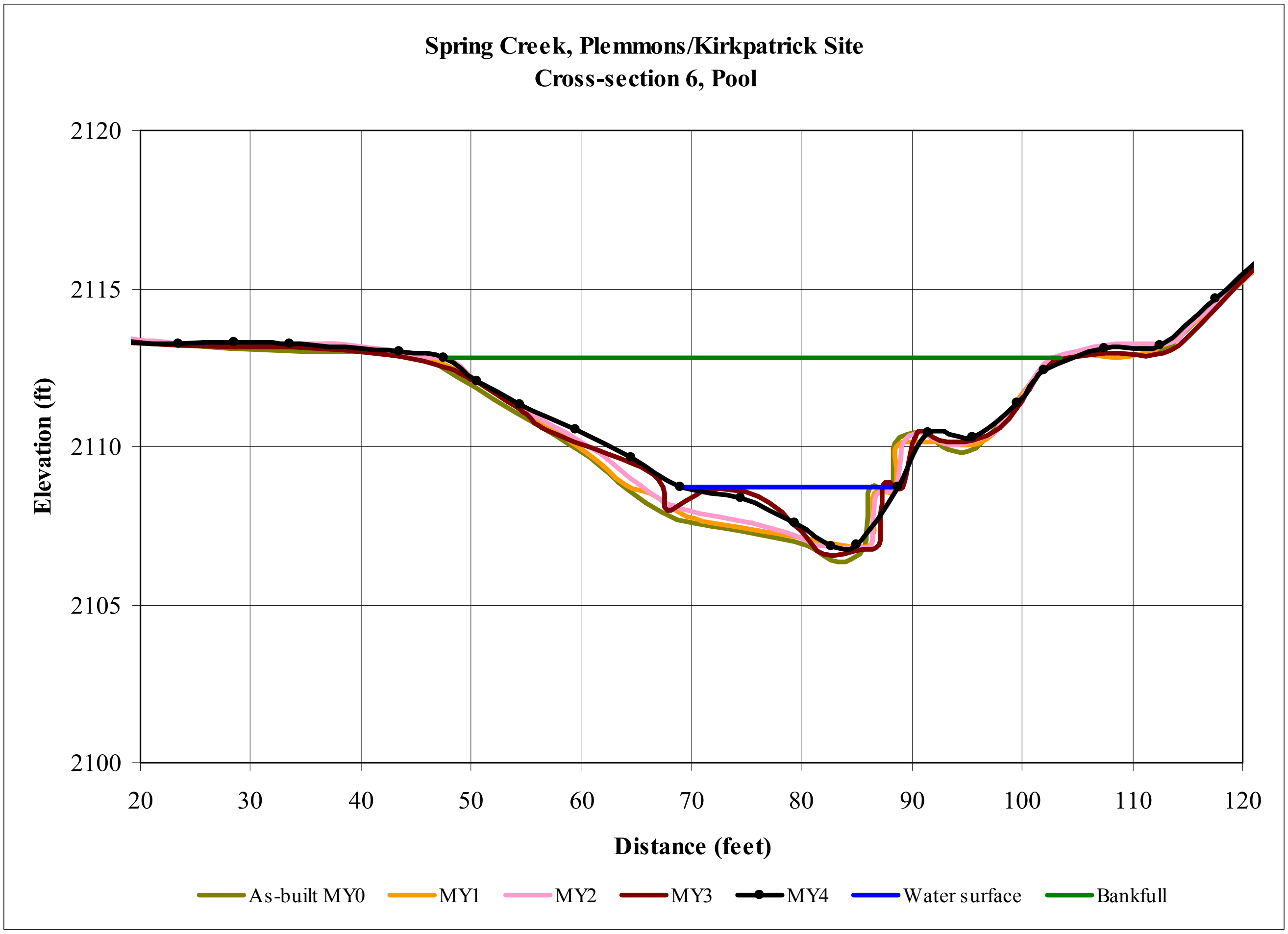

Cross-section 4, facing downstream, 3 Oct 08.

B.6. Continued.

Cross-section 4, facing downstream, 9 Dec 2009, MY3

Cross-section 4, facing downstream, 13 Oct 2010, MY4.

B.6. Continued.



Cross-section 6, facing downstream, 5 Dec 07.

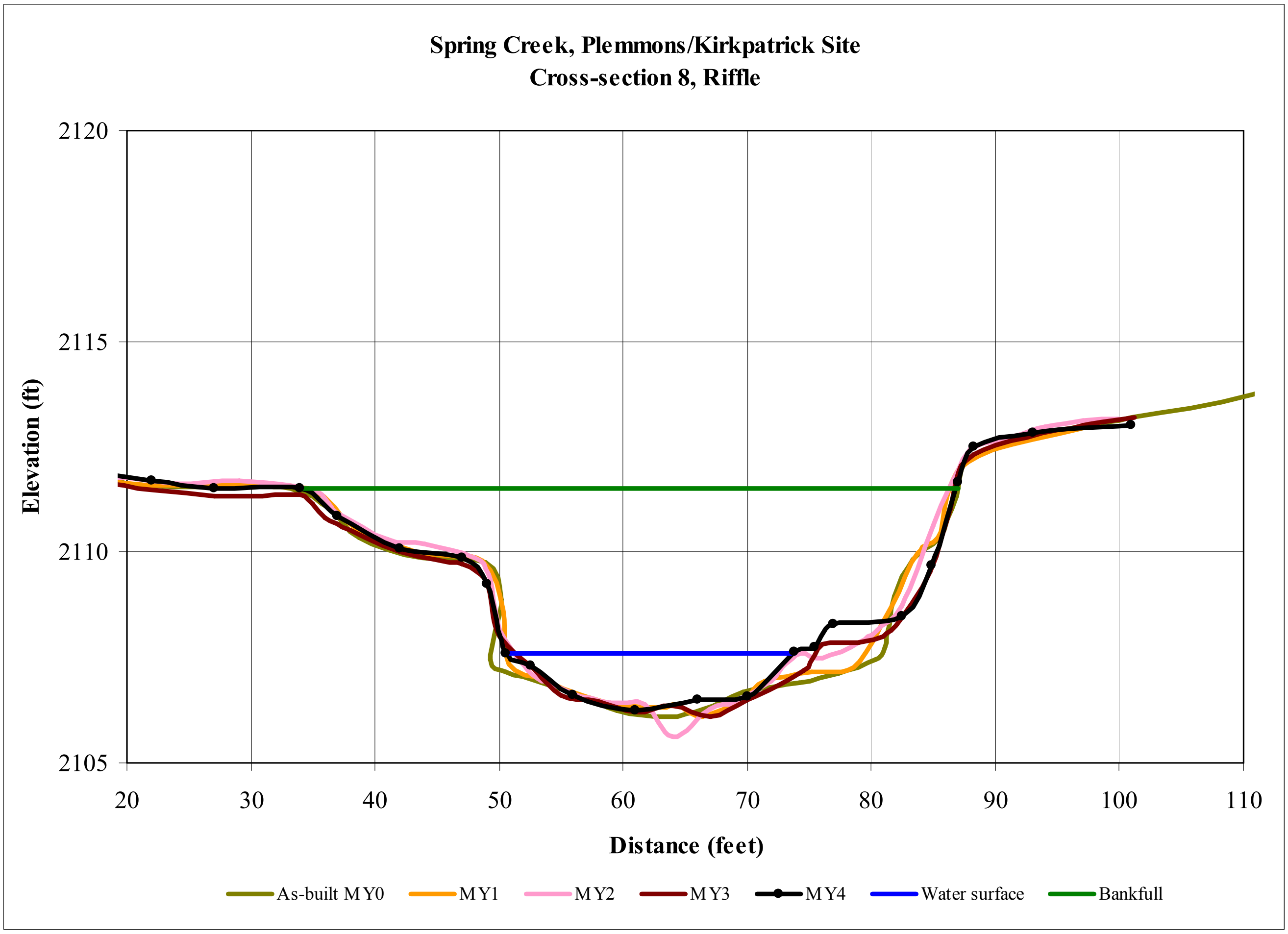
Cross-section 6, facing downstream, 3 Oct 08

B.6. Continued.

Cross-section 6, facing downstream, 9 Dec 2009, MY3

Cross-section 6, facing downstream, 13 Oct 2010, MY4.

B.6. Continued.



Cross-section 8, facing downstream, 5 Dec 07.

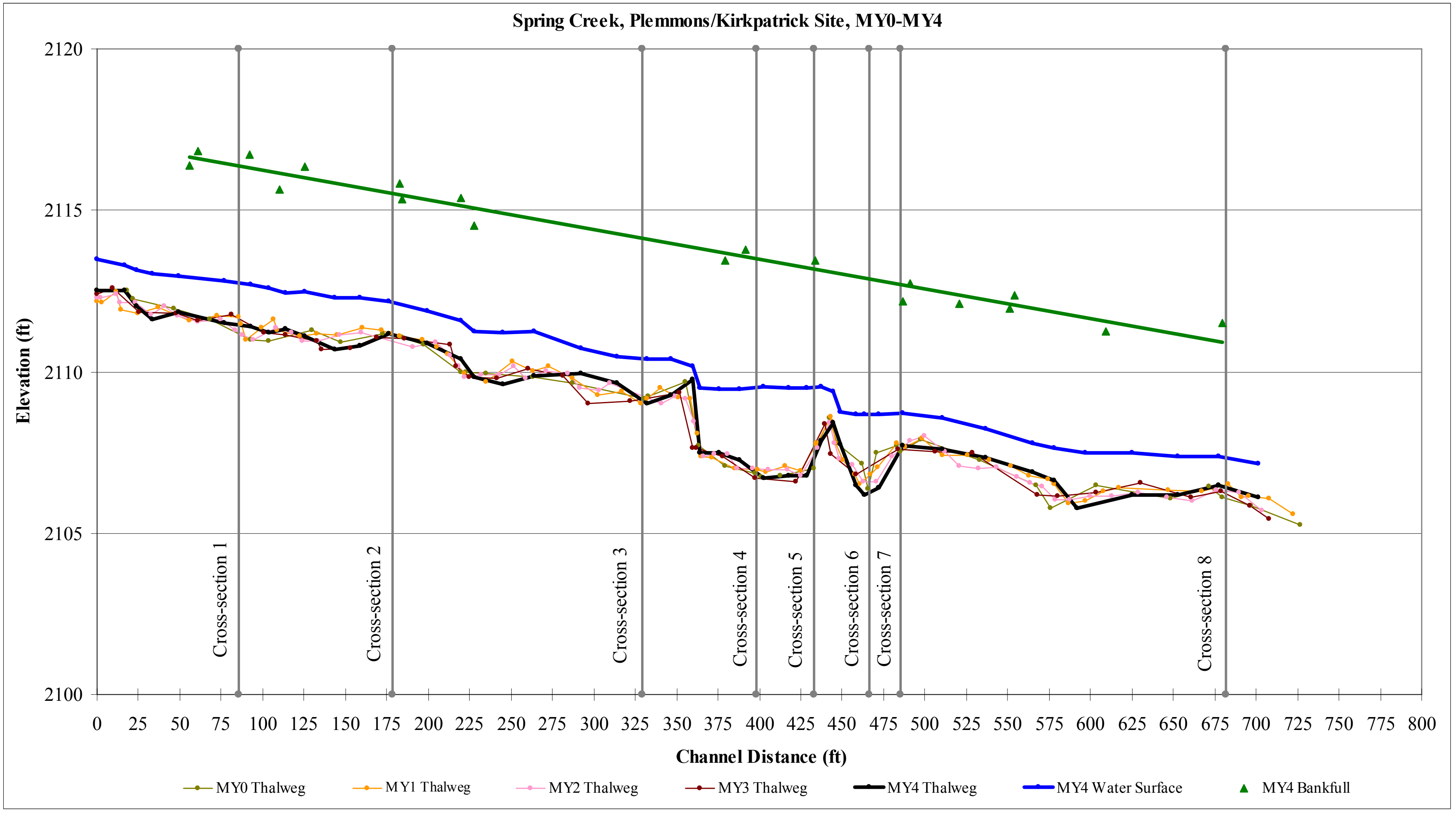
Cross-section-8, facing downstream, 3 Oct 08.

B.6. Continued.

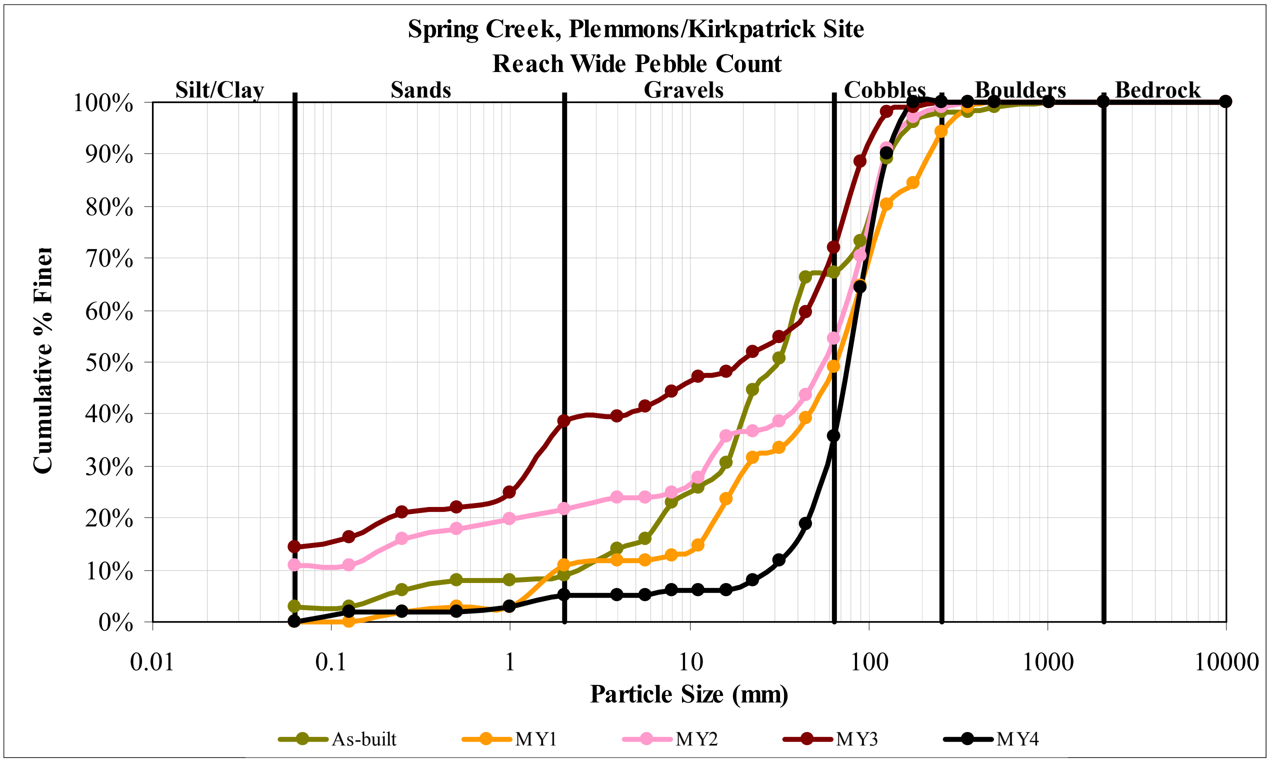
Cross-section 8, facing downstream, 9 Dec 2009, MY3

Cross-section 8, facing downstream, 13 Oct 2010, MY4.

B.7 Annual Overlays of Longitudinal Profile Plots.

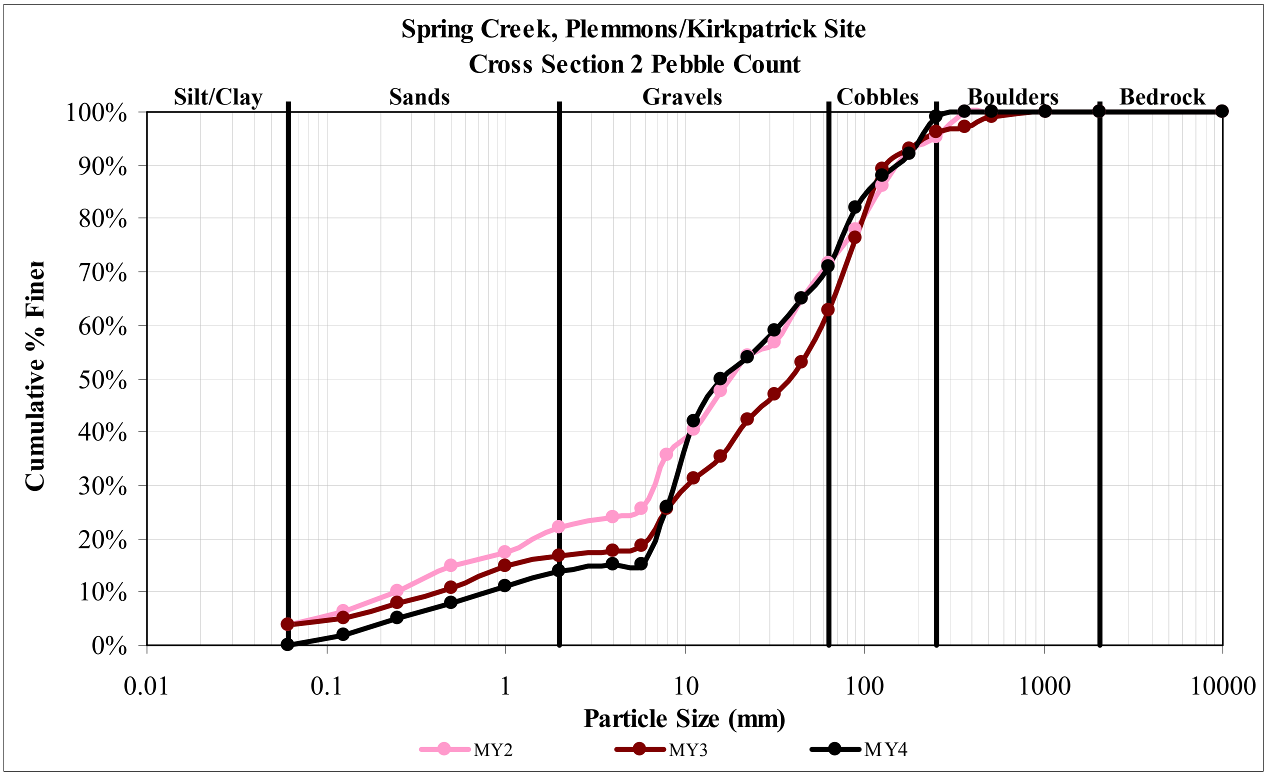


B.8 Pebble Count Cumulative Frequency Plots.



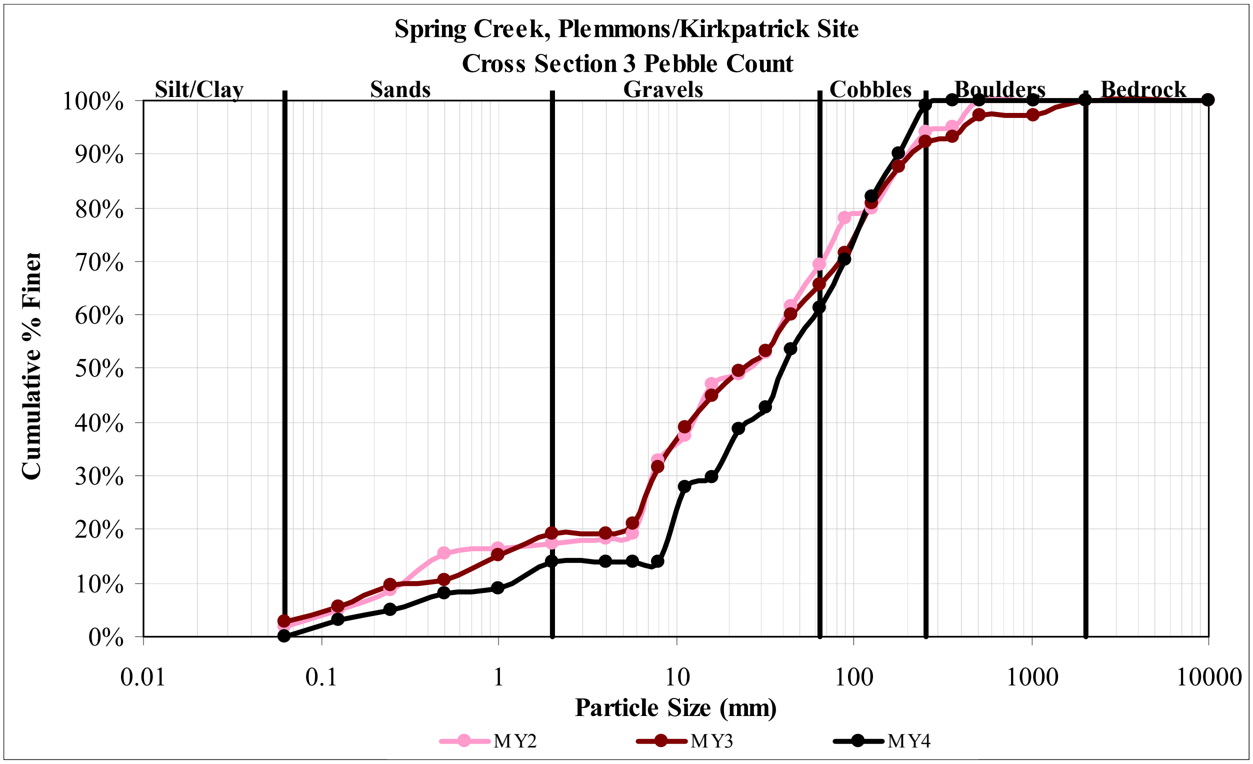
Plemmons/Kirkpatrick Reach-Wide Pebble Data						
	Particle Size by Category					
Category	MY0	MY1	MY2	MY3	MY4	MY5
D16 (mm)	5.8	12.0	0.3	0.1	39.7	
D35 (mm)	18.1	35.7	15.6	1.7	63.3	
D50 (mm)	31.2	65.6	56.2	19.3	77.0	
D84 (mm)	115.7	175.9	115.0	82.9	119.0	
D95 (mm)	172.2	275.0	162.2	115.8	153.7	
	Percent Bed Material by Category					
Category	MY0	MY1	MY2	MY3	MY4	MY5
Silt/Clay	3.0%	0.0%	11.0%	14.0%	0.0%	
Sand	6.0%	11.0%	11.0%	24.0%	5.0%	
Gravel	58.0%	38.0%	32.0%	34.0%	31.0%	
Cobble	31.0%	45.0%	44.0%	28.0%	64.0%	
Boulder	2.0%	6.0%	1.0%	0.0%	0.0%	
Bedrock	0.0%	0.0%	0.0%	0.0%	0.0%	

B.8. Continued.



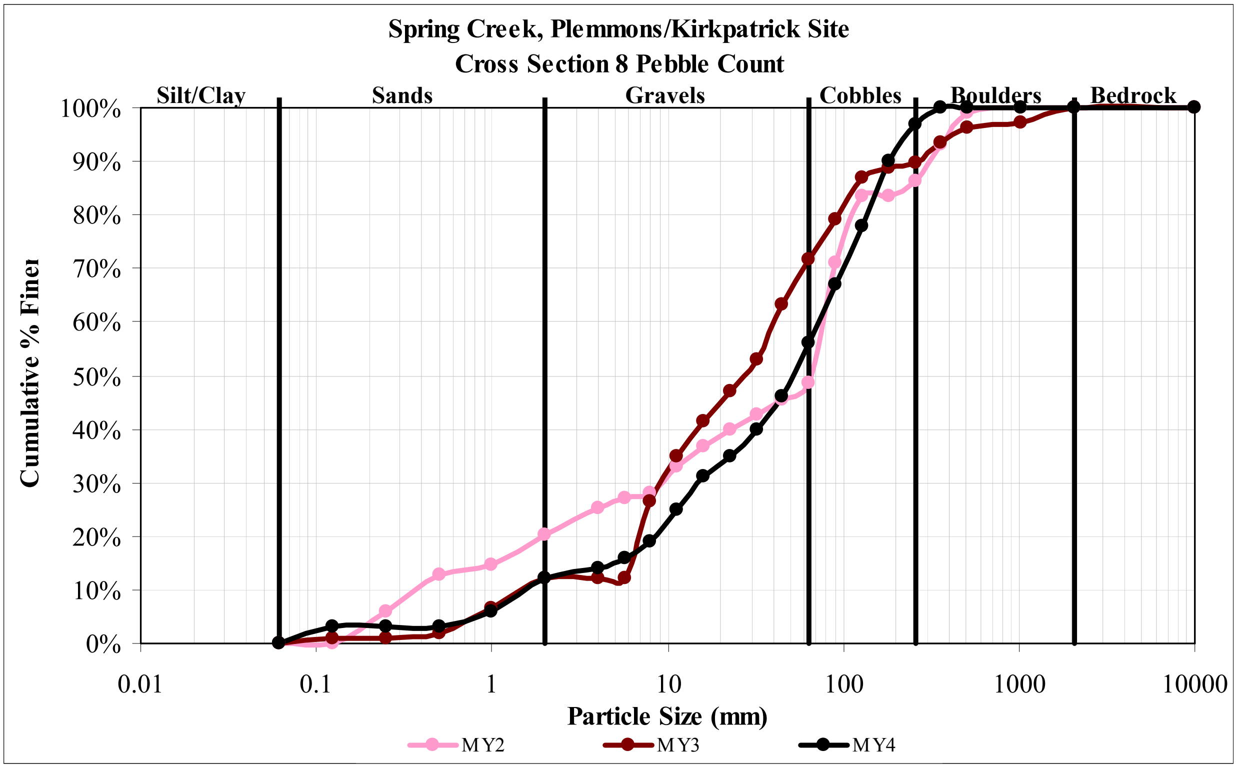
Plemmons/Kirkpatrick Cross Section 2 Pebble Data						
	Particle Size by Category					
Category	MY0	MY1	MY2	MY3	MY4	MY5
D16 (mm)	No Data	No Data	0.7	1.7	5.9	
D35 (mm)			7.8	15.7	9.9	
D50 (mm)			18.4	38.5	16.0	
D84 (mm)			117.7	112.4	102.7	
D95 (mm)			244.7	228.1	212.6	
	Percent Bed Material by Category					
Category	MY0	MY1	MY2	MY3	MY4	MY5
Silt/Clay	No Data	No Data	4.0%	4.0%	0.0%	
Sand			18.0%	13.0%	14.0%	
Gravel			50.0%	46.0%	57.0%	
Cobble			24.0%	33.0%	28.0%	
Boulder			5.0%	4.0%	1.0%	
Bedrock			0.0%	0.0%	0.0%	

B.8. Continued.



Plemmons/Kirkpatrick Cross Section 3 Pebble Data						
	Particle Size by Category					
Category	MY0	MY1	MY2	MY3	MY4	MY5
D16 (mm)	No Data	No Data	0.8	1.2	8.5	
D35 (mm)			9.6	9.6	19.9	
D50 (mm)			25.0	23.8	40.9	
D84 (mm)			156.3	151.8	140.0	
D95 (mm)			341.0	427.8	221.8	
	Percent Bed Material by Category					
Category	MY0	MY1	MY2	MY3	MY4	MY5
Silt/Clay	No Data	No Data	2.0%	3.0%	0.0%	
Sand			15.0%	16.0%	14.0%	
Gravel			52.0%	47.0%	48.0%	
Cobble			25.0%	27.0%	38.0%	
Boulder			6.0%	8.0%	1.0%	
Bedrock			0.0%	0.0%	0.0%	

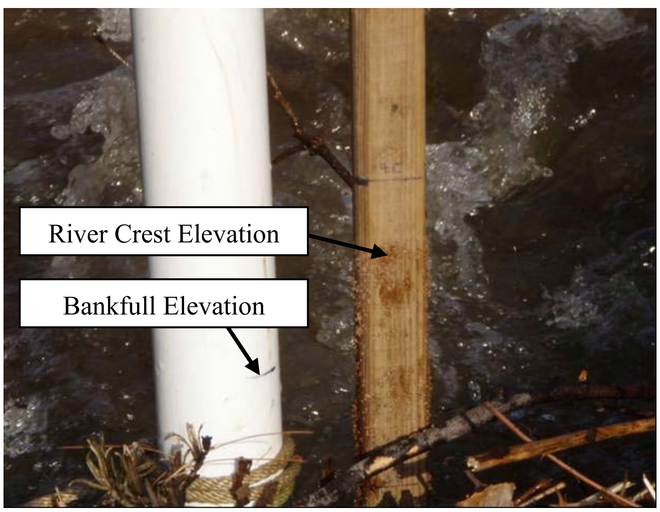
B.8. Continued.



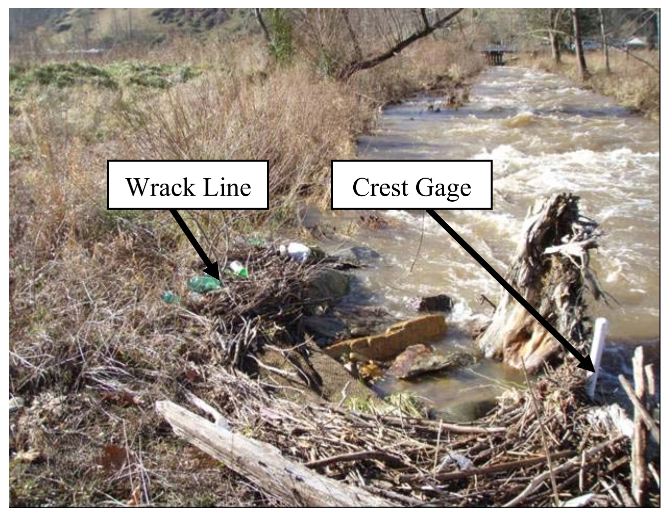
Plemmons/Kirkpatrick Cross Section 3 Pebble Data						
	Particle Size by Category					
Category	MY0	MY1	MY2	MY3	MY4	MY5
D16 (mm)	27.1	14.6	1.3	6.3	5.7	
D35 (mm)	62.4	55.4	13.7	11.4	22.6	
D50 (mm)	90.0	78.4	65.7	27.3	52.6	
D84 (mm)	154.6	127.3	193.1	113.9	154.0	
D95 (mm)	253.4	201.6	408.3	446.8	234.3	
	Percent Bed Material by Category					
Category	MY0	MY1	MY2	MY3	MY4	MY5
Silt/Clay	0.0%	0.0%	0.0%	0.0%	0.0%	
Sand	10.0%	1.0%	20.0%	12.0%	12.0%	
Gravel	26.0%	39.0%	28.0%	59.0%	44.0%	
Cobble	59.0%	57.0%	38.0%	18.0%	41.0%	
Boulder	5.0%	3.0%	14.0%	10.0%	3.0%	
Bedrock	0.0%	0.0%	0.0%	0.0%	0.0%	

B.9 Bankfull Event Verification Photographs

Wrack line following bankfull event on 1 Sep 2006.



Bankfull verification on crest gage, 9 Dec 2009.



Wrack line following bankfull event, 9 Dec 2009.