



## ◊ North Carolina Wildlife Resources Commission ◊

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Gordon Myers, Executive Director

### MEMORANDUM

**TO:** Mac Haupt, Monitoring Supervisor  
N. C. Ecosystem Enhancement Program

**FROM:** Shannon Deaton, Habitat Conservation Program Manager  
N. C. Wildlife Resources Commission

**DATE:** 23 August 2012

**SUBJECT:** Second year monitoring for supplemental vegetation maintenance work at the Big Warrior Creek mitigation site in Wilkes County, North Carolina, NCEEP Project Number 00412, Task Order # 11-Yad01-2d.

This is to notify you that we have completed the draft monitoring report for stream repair and supplemental vegetation maintenance work at the Big Warrior Creek mitigation site in Wilkes County, North Carolina. It has been uploaded to the EEP FTP site in the North Carolina Wildlife Resources Commission folder for your review. The Commission was tasked by EEP to complete the repair work and monitor repairs for one year. Once finalized, this monitoring report will be the last deliverable and completes the Commission's responsibilities for this project as described in the scope of work under task order agreement 11-Yad01-2d.

Per your standard procedures, a draft version of this report is being submitted to Zack Mondry for review. Upon receipt of your comments, we will make the appropriate revisions and submit the final version. We welcome your comments with regards to both the report content and format. Our goal is to provide you with a quality report that meets your needs.

Please refer questions to Mark Fowlkes at [mark.fowlkes@ncwildlife.org](mailto:mark.fowlkes@ncwildlife.org) or 336-527-1547.

Cc: Zack Mondry  
M. McDonald  
M. Fowlkes  
T. Eliopoulos

# 1 Project Background and Attributes

## 1.1 Location and Setting

The Big Warrior Creek project site is located in the Yadkin River drainage, Wilkes County, North Carolina (Figure 1) in the Northern Inner Piedmont ecoregion. Big Warrior Creek is located on agricultural land approximately 8 miles southwest of Wilkesboro, in the Boomer community. The site encompasses 6,635 linear feet (lf) on Big Warrior Creek and 3,850 lf on two of its tributaries, Mountain Creek and an unnamed tributary. The watershed areas for Big Warrior Creek, Mountain Creek and the unnamed tributary at the project site is approximately 7.4 mi<sup>2</sup>, 1.77 mi<sup>2</sup> and 0.5 mi<sup>2</sup>, respectively.

## 1.2 Project History, Contracts and Maintenance Approach

The project's background and history are summarized in Table 1, Table 2, and Table 3:

- Table 1. – project restoration and maintenance components.
- Table 2. – reporting and milestone history for the project.
- Table 3. – contact information for the project's consultants, contractors, and suppliers.

In 2004, approximately 11,035 linear feet (lf) of Big Warrior Creek and two of its tributaries were restored in Wilkes County (Figure 1). The project has undergone 5 years of monitoring and is currently being considered for closeout. Subsequent monitoring of the project site found that several sections of stream bank and a structure on Mountain Creek became unstable and in need of repair (URS 2010). Additionally, woody vegetation densities throughout the project site did not meet the success criteria of 260 stems/acre (USACE 2003). Supplemental planting of these areas was recommended (URS 2010).

The North Carolina Ecosystem Enhancement Program (EEP) authorized the North Carolina Wildlife Resources Commission (Commission) to complete the repairs, plant supplemental woody vegetation and monitor repairs at the Big Warrior Creek site. This report discusses the monitoring data from the stream repairs and it includes photographic documentation of pre-construction and post-construction and survivorship of planted vegetation.

## 2 Monitoring

The stream repair sites were visually monitored quarterly for one year and at least three bankfull events. Monitoring consisted of photographic documentation. The supplemental vegetation was monitored for two growing seasons and sites visits were conducted on 1 Aug 2011 and 14 May 2012. Photographic documentation and stem counts of planted vegetation were obtained to determine survivorship at four plots.

### 3 Project Maintenance Condition

#### 3.1 Stream Channel Maintenance

Large storm events between March and December 2009 caused several bank erosion areas along Mountain Creek (Figure 1). The first rock vane failed at station 0+00 and caused the stream to divert around the structure entirely, resulting in 65 ft of bank erosion on the right stream bank. The loss of log bank armoring structures resulted in bank erosion on the left stream bank at station 7+90. The left stream bank moved 10-15 ft to the left over approximately 70 lf of stream. The fence along the conservation easement had to be moved back because of the bank erosion.

Stream channel maintenance work on the two eroding areas was completed between 20 June 2011 and 28 June 2011 (NCWRC 2011). Throughout the quarterly monitoring, the stream banks in the repaired area appeared stable and all structures were functioning properly (Figures 2–5). Planted woody vegetation also appeared healthy. However, one fence post at station 8+20 has begun to lean.

#### 3.2 Hydrology

Previous monitoring at the site extrapolated bankfull events based on US Geological Survey (USGS) stream gage discharge data for the Reddies River (USGS 02111500) at North Wilkesboro, NC (URS 2010). A bankfull event represents a discharge of approximately 2,250 cubic feet per second (cfs) at the gage. On-site evidence such as the height of wrack lines was also used to determine bankfull events.

During this monitoring year, three bankfull events were identified by on site evidence (Figure 6) and one was recorded at the USGS stream gage (Figure 7). In addition to the 14 May 2012 bankfull event with a discharge of 2,700 cfs, three half bankfull to near bankfull events also occurred; 1,580 cfs on 29 Nov 2011, 1,680 cfs on 7 Dec 2011, and 1,790 cfs on 22 Dec 2011. This exceeds the North Carolina Division of Water Quality's permit requirement of monitoring the site for at least two bankfull events.

#### 3.3 Supplemental Vegetation Maintenance and Monitoring

The 2009 Monitoring Year 5 report (URS 2010) indicated that planted woody vegetation was doing poorly along all three reaches. Only 5 of the 16 vegetation plots met the planted stem success criteria (USACE 2003). When volunteer stems were included, an additional three plots meet the success criteria.

In February 2011 a total of 345 containerized trees and shrubs were planted at designated areas (Figure 8) to augment low woody stem density at the site. These areas were planted at densities of either 100 stems/acre or 200 stems/acre, in order to exceed the success criteria of 260 stems/acre (USACE 2003).

The supplemental vegetation was monitored for two growing seasons and site visits were conducted on 1 Aug 2011 and 14 May 2012. This monitoring consisted of stem counts of planted vegetation to determine survivorship at four monitoring plots (Figure 9 and Table 4) and photographic documentation (Figure 10-13). More planted trees were found during the 2012 monitoring because the herbaceous vegetation had not grown very tall. At least 87% of all supplemental trees and shrubs planted survived two growing seasons in vegetation plot 1, 94% in vegetation plot 2, 100% in vegetation plot 3, and 83% in vegetation plot 4. Ninebark *Physocarpus opulifolius* was one of the more difficult species to find because it was planted near the water's edge where the herbaceous vegetation was denser and an area that partially flooded during monitoring. Additionally, survivorship of Northern Red Oak *Quercus rubra* in vegetation plot 4 decreased from 2011 monitoring; however, the overall survivorship of the vegetation plot did not change. Plants that were found appeared to be healthy and growing well. Overall, the supplemental planting appeared to be successful.

#### **4 Summary**

With the completion of the stream repair work and supplemental planting, stream bank erosion and low woody stem density at the Big Warrior Creek site has been abated. The added structures and stream bank reshaping provide the necessary bank protection and grade control to withstand bankfull events. The live stakes and potted and transplanted trees and shrubs in the repair areas appear healthy and help further reduce stream bank erosion. A majority of the supplemental planted trees and shrubs were found healthy and at 136 stems per acre will help meet the woody-stem criteria for this mitigation project. The site has remained stable after multiple bankfull and near bankfull storm events; which exceeds the North Carolina Division of Water Quality's permit requirement of monitoring the site for at least one year and two bankfull events. These repairs and improvements will help ensure the overall success of this restoration project and qualify it for closeout consideration by the regulatory agencies.

#### **5 References**

- EcoLogic Associates, P.C. 2006. Big Warrior Creek 2005 Monitoring Report, Monitoring Year One. Prepared for NC Ecosystem Enhancement Program. April 2006.
- NCDWQ (North Carolina Division of Water Quality). 2003. Yadkin-Pee Dee River basin water quality plan. Raleigh, North Carolina.
- NCWRC (North Carolina Wildlife Resources Commission). 2011. Maintenance summary report for the Big Warrior Creek mitigation site in Wilkes County, North Carolina, NCEEP Project Number 00412. Raleigh, North Carolina.
- URS (URS Corporation-North Carolina). 2010. Big Warrior Creek stream restoration, 2009 final monitoring report, monitoring year 5. Morrisville, North Carolina.
- USACE (United States Army Corps of Engineers, Wilmington District, United States Environmental Protection Agency, North Carolina Wildlife Resources Commission, and North Carolina Division of Water Quality). 2003. Stream mitigation guidelines.

Figure 1. Vicinity map.

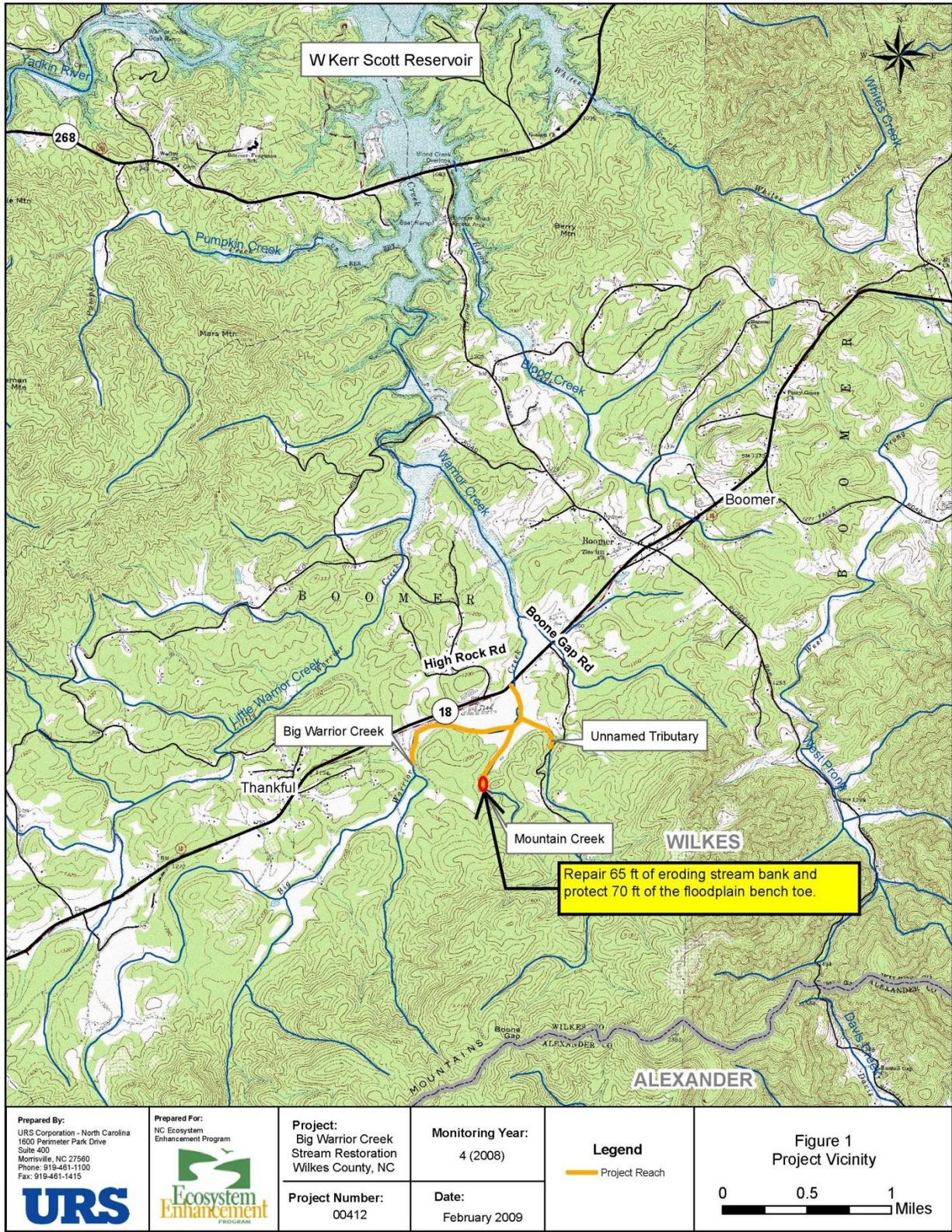


Figure 2. Photographic documentation looking downstream from Station 0+00 on Mountain Creek.



27 Oct 2010.



20 Jun 2011.



28 Jun 2011.



9 Sep 2011.



17 Jan 2012.



17 Apr 2012.

Figure 2. Continued.



14 Jun 2012.

Figure 3. Photographic documentation looking upstream from Station 0+65 on Mountain Creek.



28 Jun 2011.



9 Sep 2011.



17 Jan 2012.



17 Apr 2012.



14 Jun 2012.

Figure 4. Photographic Documentation from Station 7+90 on Mountain Creek.



27 Oct 2010.



22 Jun 2011.



28 Jun 2011.



17 Jul 2011.



9 Sep 2011.



17 Jan 2012.

Figure 4. Continued.



17 Apr 2012.



14 Jun 2012.

Figure 5. Photographic documentation at Station 8+20 on Mountain Creek.



28 Jun 2011.



9 Sep 2011.



17 Jan 2012.



17 Apr 2012.



14 Jun 2012.

Figure 6. Wrack line indicating bankfull storm events on Big warrior Creek. The top of the wrack line is identified by the red arrow.



17 Jul 2011.

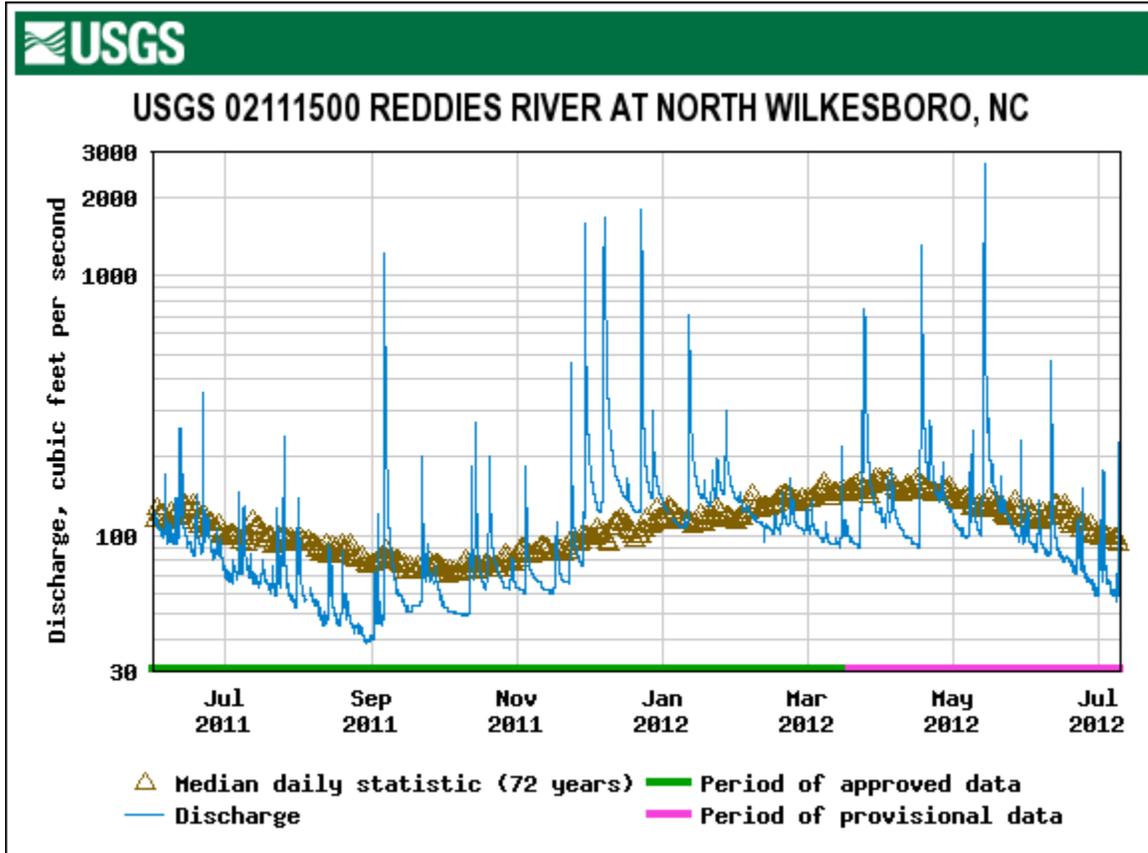


17 Apr 2012.



14 May 2012.

Figure 7. USGS Rain Gage (USGS 02111180) on Elk Creek in Elkville, NC.



Bankfull event is equivalent to a discharge of approximately 2,250 cubic feet per second.

Figure 8. Big Warrior Creek supplemental planting map.

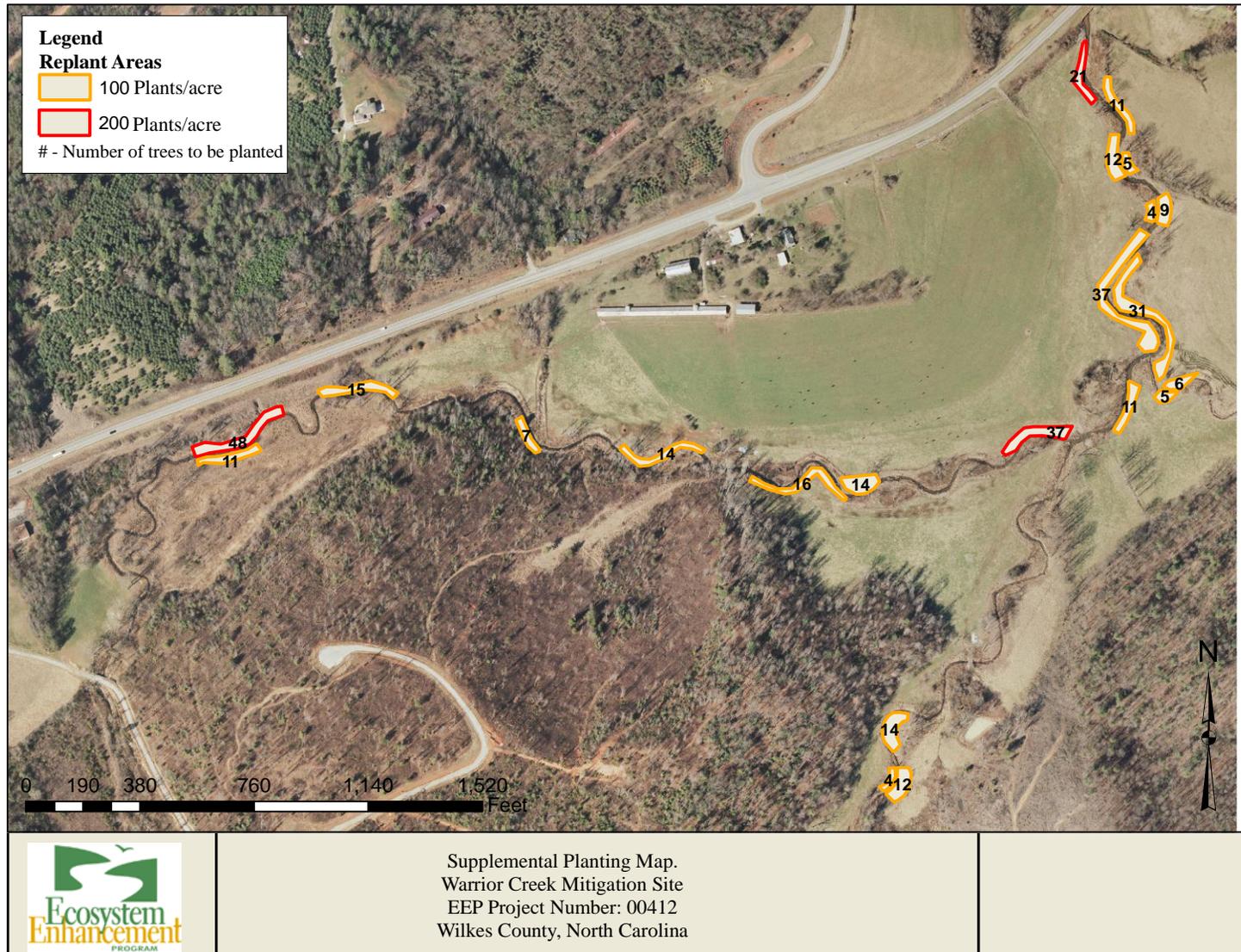


Figure 9. Big Warrior Creek vegetation monitoring map.

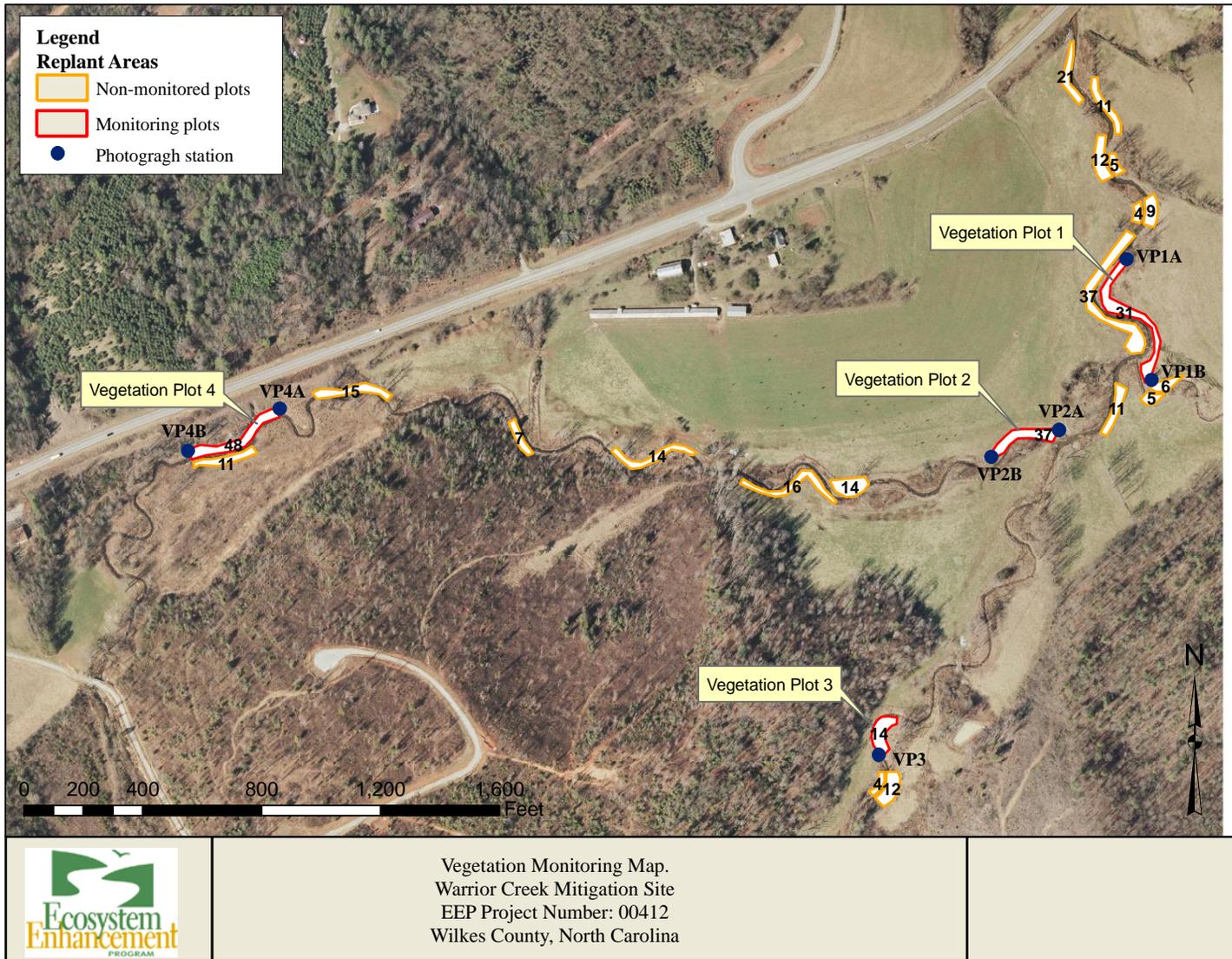


Figure 10. Photograph monitoring station of vegetation plot 1.



Photograph Station: VP1A; 17 Feb 2011.



Photograph Station: VP1B; 17 Feb 2011.



Photograph Station: VP1A; 1 Aug 2011.



Photograph Station: VP1B; 1 Aug 2011.



Photograph Station: VP1A; 14 May 2012.



Photograph Station: VP1B; 14 May 2012.

Figure 11. Photograph monitoring station of vegetation plot 2.



Photograph Station: VP2A; 17 Feb 2011.



Photograph Station: VP2B; 17 Feb 2011.



Photograph Station: VP2A; 1 Aug 2011.



Photograph Station: VP2B; 1 Aug 2011.



Photograph Station: VP2A; 14 May 2012.



Photograph Station: VP2B; 14 May 2012.

Figure 12. Photograph monitoring station of vegetation plot 3.



Photograph Station: VP3; 17 Feb 2011.



Photograph Station: VP3; 1 Aug 2011.



Photograph Station: VP3; 14 May 2012.

Figure 13. Photograph monitoring station of vegetation plot 4.



Photograph Station: VP4A; 17 Feb 2011.



Photograph Station: VP4B; 17 Feb 2011.



Photograph Station: VP4A; 1 Aug 2011.



Photograph Station: VP4A; 1 Aug 2011.



Photograph Station: VP4A; 14 May 2012.



Photograph Station: VP4A; 14 May 2012.

Table 1. Project Restoration and Maintenance Components.

Project Segment or Reach ID	Existing feet/Acres	Restoration Level <sup>a</sup>	Approach <sup>b</sup>	Restored Feet/Acres	Stationing <sup>c</sup>	Buffer Acres	Comment
<b>Existing Project</b>							
Big Warrior Creek	450 lf	EII	P3	450 lf	0+0 to 4+50		Linear footage from Ecologic's 2006 survey. No stream repair work is needed; supplemental planting at designated areas.
Big Warrior Creek	6,735 lf	R	P2	6,563 lf	4+50 to 70+00		Linear footage from Ecologic's 2006 survey. No stream repair work is needed; supplemental planting at designated areas.
Mountain Creek	2,415 lf	R	P2	2,373 lf	0+00 to 25+00		Linear footage from Ecologic's 2006 survey. Repair 100 lf of stream channel between stations 0+00 and 0+40 and stations 7+90 and 8+50. Supplemental planting at designated areas.
Unnamed Tributary	1,892 lf	R	P2	1,312 lf	0+00 to 15+00		Linear footage from Ecologic's 2006 survey. No stream repair work is needed; supplemental planting at designated areas.
<b>Component Summations</b>							
Restoration Level	Stream (lf)	Riparian Wetland (Acre)		Non-Riparian (Acres)	Upland (Acre)	Buffer (Acre)	BMP
		Riverine	Non-Riverine				
Restoration							
Enhancement							
Enhancement I							
Enhancement II							
Creation							
Preservation							
HQ Preservation							
<b>Totals</b>	<b>0</b>	<b>0.0</b>		<b>0.0</b>	<b>0.0</b>		<b>BMP Count</b>

= Non-Applicable

R = Restoration

EII = Enhancement II

P3 = Priority 3

lf = Linear Feet

EI = Enhancement I

S = Stabilization

SS = Stream Bank Stabilization

<sup>a</sup>Source: USACE 2003.

<sup>b</sup>Source: Rosgen 2006.

<sup>c</sup>Source: Ecologic 2006

Table 2. Project Activity and Reporting History.

<b>Activity or Report</b>	<b>Projected Data Collection</b>	<b>Data Collection Complete</b>	<b>Actual Completion or Delivery</b>
Restoration Plan		Unknown	Sep 2002
Construction		Unknown	Nov 2004
Permanent seed mix applied		Unknown	Unknown
Live stakes and woody plants installed		Unknown	Feb 2003
Mitigation/As-built (Year 0 Monitoring - baseline)		Dec 2004	Mar 2005
Year 1 Monitoring		Unknown	Apr 2006
Year 2 Monitoring		Sep 2006	Dec 2006
Year 3 Monitoring		Sep 2007	Nov 2007
Year 4 Monitoring		Oct 2008	Dec 2008
Year 5 Monitoring		Fall 2009	Apr 2011
<b>Supplemental planting of containerized material</b>		Feb 2011	Feb 2011
<b>Structural maintenance</b>		Jul 2011	Jul 2011
<b>Maintenance summary report</b>		Jul 2011	Aug 2011
2011 Supplemental vegetation monitoring		Aug 2011	Sep 2011
Quarterly 1 maintenance monitoring	Oct 2011	Sep 2011	Sep 2011
Quarterly 2 maintenance monitoring	Jan 2012	Jan 2012	Jan 2012
Quarterly 3 maintenance monitoring	Apr 2012	Apr 2012	Apr 2012
2012 Supplemental vegetation monitoring	Jun 2012	May 2012	May 2012
Quarterly 4 maintenance monitoring	Jul 2012	Jun 2012	Aug 2012

Table 3. Project Contacts.

<b>Design Firm:</b> Camp Dresser & Mckee (CDM)	Kelly Boone 5400 Glenwood Ave, Suite 300 Raleigh, NC 27612 919-787-5620
<b>Design Firm - Subcontractor:</b> Biohabitats	Ellen McClure 15 W. Aylesbury Road Timonium, MD 21093 410-337-3659
<b>Construction Contractor:</b> Shanrock Environmental	Mike Granson P.O. Box 14987 Greensboro, NC 27415 336-375-1989
<b>Planting and Seeding Contractor:</b> Seal Brothers Contracting	Brian Seal 131 W. Cleve Street Mt. Airy, NC 27030 336-710-3560
<b>Seed Mix Sources:</b>	Unknown
<b>Nursery Stock Suppliers:</b>	Unknown
<b>Monitoring Performers 2004:</b> Biohabitats	Ellen McClure 15 W. Aylesbury Road Timonium, MD 21093 410-337-3659
<b>Monitoring Performers 2005-2008:</b> URS Corporation - North Carolina	Kathleen McKeithan 1600 Perimeter Park Drive, Suite 400 Morrsville, NC 27560 919-461-1597
<b>2011 Repair and Replanting Contractor:</b> North Carolina Wildlife Resources Commission Watershed Enhancement Group Field Office	Mr. Mark Fowlkes P.O. Box 387 Elkin, NC 28621 336-527-1547
<b>2011 Sub-Construction Contractor:</b> Yadkin Valley Construction	Terry Benton 2961 Old 60 Highway Ronda, NC 28670 336-984-8989
<b>2011 Seed Mix Sources:</b>	Ernst Conservation Seed Inc. 800-873-3321
<b>2011 Nursery Stock Suppliers:</b>	North Carolina Wildlife Resources Commission 336-527-1547 River Bend Farms 336-366-2982
<b>Repair Monitoring Performers:</b> North Carolina Wildlife Resources Commission Watershed Enhancement Group Field Office	Mr. Mark Fowlkes P.O. Box 387 Elkin, NC 28621 336-527-1547

Table 4. Planting Summary for Vegetation per Planting Zone.

Vegetation Plot 1									
Scientific name	Common name	Stratum	Number Planted 2011	2011 Stem Count		2012 Stem Count		2011 Percent Change in Numbers <sup>a</sup>	2012 Percent Change in Numbers <sup>a</sup>
				Live	Dead	Live	Dead		
<i>Aronia arbutifolia</i>	Red chokeberry	Shrub	3	2		3		-33.3%	0.0%
<i>Cephalanthus occidentalis</i>	Button bush	Shrub	6	5		5		-16.7%	-16.7%
<i>Physocarpus opulifolius</i>	Ninebark	Shrub	3			1		-100.0%	-66.7%
<i>Salix nigra</i>	Black Willow	Shrub	5	4		4		-20.0%	-20.0%
<i>Quercus rubra</i>	Northern Red Oak	Canopy	5	4		5		-20.0%	0.0%
<i>Carpinus caroliniana</i>	Iron Wood	Subcanopy	9	8		9		-11.1%	0.0%
	<b>Total</b>		<b>31</b>	<b>23</b>	<b>0</b>	<b>27</b>	<b>0</b>	<b>-25.8%</b>	<b>-12.9%</b>
Vegetation Plot 2									
Scientific name	Common name	Stratum	Number Planted 2011	2011 Stem Count		2012 Stem Count		2011 Percent Change in Numbers <sup>a</sup>	2012 Percent Change in Numbers <sup>a</sup>
				Live	Dead	Live	Dead		
<i>Aronia arbutifolia</i>	Red chokeberry	Shrub	1		1		1	-100.0%	-100.0%
<i>Physocarpus opulifolius</i>	Ninebark	Shrub	5	4		4		-20.0%	-20.0%
<i>Fraxinus caroliniana</i>	Carolina Ashe	Canopy	3	3		3		0.0%	0.0%
<i>Quercus rubra</i>	Northern Red Oak	Canopy	20	20		20		0.0%	0.0%
<i>Carpinus caroliniana</i>	Iron Wood	Subcanopy	8	6		8		-25.0%	0.0%
	<b>Total</b>		<b>37</b>	<b>33</b>	<b>1</b>	<b>35</b>	<b>1</b>	<b>-10.8%</b>	<b>-5.4%</b>
Vegetation Plot 3									
Scientific name	Common name	Stratum	Number Planted 2011	2011 Stem Count		2012 Stem Count		2011 Percent Change in Numbers <sup>a</sup>	2012 Percent Change in Numbers <sup>a</sup>
				Live	Dead	Live	Dead		
<i>Aronia arbutifolia</i>	Red chokeberry	Shrub	10	10		10		0.0%	0.0%
<i>Cephalanthus occidentalis</i>	Button bush	Shrub	2	2		2		0.0%	0.0%
<i>Carpinus caroliniana</i>	Iron Wood	Subcanopy	2	2		2		0.0%	0.0%
	<b>Total</b>		<b>14</b>	<b>14</b>	<b>0</b>	<b>14</b>	<b>0</b>	<b>0.0%</b>	<b>0.0%</b>
Vegetation Plot 4									
Scientific name	Common name	Stratum	Number Planted 2011	2011 Stem Count		2012 Stem Count		2011 Percent Change in Numbers <sup>a</sup>	2012 Percent Change in Numbers <sup>a</sup>
				Live	Dead	Live	Dead		
<i>Aronia arbutifolia</i>	Red chokeberry	Shrub	9	7	1	9		-22.2%	0.0%
<i>Cephalanthus occidentalis</i>	Button bush	Shrub	12	11		11		-8.3%	-8.3%
<i>Physocarpus opulifolius</i>	Ninebark	Shrub	4	3		3		-25.0%	-25.0%
<i>Salix nigra</i>	Black Willow	Shrub	2	2		2		0.0%	0.0%
<i>Quercus rubra</i>	Northern Red Oak	Canopy	9	8		5	2	-11.1%	-44.4%
<i>Carpinus caroliniana</i>	Iron Wood	Subcanopy	12	9		10	1	-25.0%	-16.7%
	<b>Total</b>		<b>48</b>	<b>40</b>	<b>1</b>	<b>40</b>	<b>3</b>	<b>-16.7%</b>	<b>-16.7%</b>

<sup>a</sup>Calculated using number planted in 2011 and live stems counted