LITTLE TROUBLESOME CREEK MITIGATION SITE

Rockingham County, NC
NCDENR Contract 003267
NCEEP Project Number 94640

Monitoring Year 1 Annual Report
FINAL

Data Collection Period: September-November 2012
Submission Date: January 11, 2013

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LITTLE TROUBLESOME CREEK MITIGATION SITE
Monitoring Year 1 Annual Report

APPENDICES

1.0 Executive Summary

The Little Troublesome Creek Mitigation Site is a full-delivery stream and wetland restoration project for the North Carolina Ecosystem Enhancement Program (NCEEP) in Rockingham County, NC. The stream area, hereafter referred to as the Stream Site, is located on the southeastern side of Reidsville along Irvin and Little Troublesome Creeks. The wetland area, hereafter referred to as the Wetland Site, is located approximately four miles southeast of the Stream Site and is also adjacent to Little Troublesome Creek. The Stream Site is located south of Turner Road, east of the intersection of Turner Road and Way Street in the City of Reidsville, North Carolina. The Wetland Site is located approximately 3,000 feet southwest of the intersection of NC Highway 150 and Mizpah Church Road, south of the City of Reidsville. Little Troublesome Creek is located within the Haw River watershed (North Carolina Division of Water Quality (NCDWQ) Subbasin 03-06-01) of the Cape Fear River Basin (Hydrologic Unit 03030002010030).

The Stream Site is located in a mature bottomland hardwood forest within a 34.5-acre tract owned by Wildlands Little Troublesome Creek Holdings, LLC. A conservation easement has been recorded on 33 acres of the tract (Deed Book 1411, Page Number 2458). The wetland portion of the Little Troublesome Creek project is located within a tract of land owned by Jerry Apple. A conservation easement has been recorded on the 19-acre project area within the Apple tract (Deed Book 1412, Page Number 1685).

Little Troublesome Creek (NCDWQ Index No. 16-7), which is the main creek on the project site, has been classified as Class C; NSW waters. Class C waters are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture, and other uses. The Nutrient Sensitive Waters (NSW) classification is a supplemental classification for waters that are subject to excessive growth of microscopic or macroscopic vegetation and therefore need nutrient management. Directions and a map of the Site are provided in Figure 1.

1.1 Project Goals and Objectives

Prior to construction activities, the most significant watershed stressors identified during the technical assessment were stream bank erosion and instability. Other stressors included declining aquatic habitat, loss of forest, degraded riparian buffers, loss of wetlands, lack of urban stormwater detention, and water quality problems related to increased sediment and nutrient loadings. As a result of the aforementioned stressors, the Stream Site and Wetland Site had poor water quality due to sediment pollution and poor habitat due to lack of riparian and wetland vegetation. In particular, the Stream Site lacked stable streambank vegetation despite being surrounded by mature vegetation. The Stream Site also lacked in-stream bed diversity and exhibited unstable geomorphic conditions. Tables 1-4 in Appendix 1 present the pre-restoration conditions in detail for the Stream and Wetland Sites.

The primary objectives of the project were to stabilize highly eroding stream banks, reconnect streams to their historic floodplain, improve wetland hydrology and function, reduce nutrient levels, sediment input, and water temperature, increase dissolved oxygen concentrations, create appropriate in-stream and terrestrial habitat, and decrease channel velocities. These objectives were achieved by restoring 4,988 linear feet (LF) of perennial stream channel, and restoring, enhancing, and creating 18.0 acres of riparian wetland. The Stream Site and Wetland Site riparian areas were also planted to stabilize streambanks, improve habitat, and protect water quality.

The following primary project goals (measured) were established in the project Mitigation Plan (2011) to address the effects from watershed and project site stressors:

- Stabilize stream dimensions;
- Stabilize stream pattern and profile;
- Establish proper substrate distribution throughout stream;
- Establish wetland hydrology for restored wetlands; and
- Restore native vegetation throughout wetlands and buffer zones.

The following secondary project goals (unmeasured) were established in the project Mitigation Plan (2011) to address the effects from watershed and project site stressors:

- Decrease nutrient and urban runoff pollutant levels;
- Decrease sediment input;
- Decrease water temperature and increase dissolved oxygen levels;
- Create appropriate in-stream habitat;
- Create appropriate terrestrial habitat; and
- Decrease channel velocities.

The following project objectives were established to meet these primary and secondary goals:

- Riffle cross-sections of the restoration and enhancement reaches were constructed to remain stable and will show little change in bankfull area, maximum depth ratio, and width-to-depth ratio over time.
- The project was constructed so that the bedform features of the restoration reaches will remain stable overtime. This includes riffles that will remain steeper and shallower than the pools and pools that are deep with flat water surface slopes. The relative percentage of riffles and pools will not change significantly over time. Banks will be constructed so that bank height ratios will remain very near to 1.0 for nearly all of the restoration reaches.
- Stream substrate will remain coarse in the riffles and finer in the pools.
- A free groundwater surface will be present within 12 inches of the ground surface in the restored wetland areas for 7 percent of the growing season measured on consecutive days under typical precipitation conditions.

- Native vegetation appropriate for the wetland and riparian buffer zones were planted throughout both the Wetland and Stream Sites. The planted trees will become well established and survival criteria will be met.
- Off-site nutrient input will be absorbed on-site by filtering flood flows through restored floodplain areas and wetlands, where flood flows can disperse through native vegetation and be captured in vernal pools. Increased surface water residency time will provide contact treatment time and groundwater recharge potential.
- Sediment input from eroding stream banks was reduced by installing bioengineering and in-stream structures while creating a stable channel form using geomorphic design principles. Sediment from off-site sources will be captured by deposition on restored floodplain areas where native vegetation will slow overland flow velocities.
- Restored riffle/step-pool sequences where distinct points of re-aeration can occur will allow for oxygen levels to be maintained in the perennial reaches. Creation of deep pool zones will lower temperature, helping to maintain dissolved oxygen concentrations. Establishment and maintenance of riparian buffers will create long-term shading of the channel flow to minimize thermal heating.
- A channel form that includes riffle/pool sequences and gravel and cobble zones of macroinvertebrate habitat for fish was created. Large woody debris, rock structures, root wads, and native stream bank vegetation were introduced to substantially increase habitat value.
- Adjacent buffer areas were restored by removing invasive vegetation and planting native vegetation. These areas will be allowed to receive more regular and inundating flows. Riparian wetland areas were restored and enhanced to provide wetland habitat.
- By allowing for more overbank flooding and by increasing channel roughness, local channel velocities can be reduced. This will allow for less bank shear stress, formation of refuge zones during large storm events and zonal sorting of depositional material.

1.2 Monitoring Year 1 Data Assessment

The final restoration plan was submitted and accepted by NCEEP in June 2011. Construction activities were completed by Fluvial Solutions in May 2012. The baseline monitoring and as-built survey were completed between April and May 2012. The first annual monitoring assessment (Year 1) was completed in October 2012.

The Stream Site will be monitored for a total of five years, with the final monitoring activities conducted in 2016. The Wetland Site will be monitored for a total of seven years, with the final monitoring activities conducted in 2018. The close-out for both the Stream Site and Wetland Site will be conducted in 2019. Monitoring consists of collecting morphological, vegetative, and hydrological data on an annual basis to assess the project success based on the restoration goals and objectives. The success of the Stream Site will be assessed using measurements of

the stream channel's dimension, pattern, profile, substrate composition, permanent photographs, vegetation, and surface water hydrology. The success of the Wetland Site will be assessed using measurements of groundwater hydrology and vegetation. Any areas with identified high priority problems, such as streambank instability, aggradation/degradation, insufficient groundwater hydroperiod, or lack of vegetation establishment will be evaluated on a case-by-case basis. The problem areas will be visually noted and remedial actions will be discussed with NCEEP staff to determine a plan of action. A proposal of work will be submitted if remediation of an area is required.

1.2.1 Vegetative Assessment

A total of 35 vegetation plots were established within the project easement areas (22 at the Wetland Site; 13 at the Stream Site) using standard 10 meter by 10 meter vegetation monitoring plots. The number of monitoring quadrants required is based on the NCEEP monitoring guidance documents (version 2.0, 10/12/10). Vegetation assessments were conducted following the Carolina Vegetation Survey (CVS) Level 2 Protocol for Recording Vegetation (Lee et al, 2008).

The Stream Site included three plots along Little Troublesome Creek, five plots along Irvin Creek Reach 1, and five plots along Irvin Creek Reach 2. Due to the narrow planted corridor along UT1, vegetation plots were not established. Instead, a visual assessment of the planted corridor is used to evaluate vegetation growth success. Vegetation plots were randomly established within the planted corridor of the stream and wetland restoration areas to capture the heterogeneity of the designed vegetative communities. The vegetation plot corners have been marked and are recoverable either through field identification or with the use of a GPS unit. Reference photographs at the origin looking diagonally across the plot to the opposite corner were taken with the as-built. The final vegetative success criteria will be the survival of 260 planted stems per acre in the riparian corridor of the Stream Site at the end of year five monitoring, and 200 planted stems per acre within the Wetland Site at the end of year seven monitoring. The interim measure of vegetative success for the entire site will be the survival of at least 320 planted stems per acre at the end of the third monitoring year. The extent of invasive species coverage will also be monitored and controlled as necessary throughout the five-year monitoring period for streams and seven-year monitoring period for wetlands.

The monitoring year one (MY-1) vegetative survey was completed in September 2012. The 2012 annual vegetation monitoring on the Wetland Site resulted in an average survivability of 639 stems per acre, which is greater than the interim requirement of 320 stems/acre and approximately 9% less than the baseline density recorded (701 stems/acre) in April 2012. There was an average of 16 stems per plot compared to 17 stems per plot during the baseline monitoring (MY-0) for the Wetland Site. The average survivability on the Stream Site was 807 stems/acre, which is approximately 15% less than the baseline density recorded (953 stems/acre). There were an average of 20 stems per plot compared to 24 stems per plot in MY-0 for the Stream Site.

All 35 plots are on track to meet the success criteria required for monitoring year three (MY-3). Please refer to Appendix 3 for vegetation summary tables and raw data tables and Appendix 2 for vegetation plot photographs and the vegetation condition assessment table.

Maintenance Plan

Overall, both the Wetland Site and the Stream Site are on track to meet the required vegetation success criteria for MY-3. No maintenance is proposed at this time.

1.2.2 Stream Assessment

Morphological surveys for the MY-1 were conducted in October 2012. All streams within the Site met the success criteria for MY-1. Please refer to Appendix 2 for the visual assessment table, current condition plan view (CCPV), and photographs and Appendix 4 for morphological data and plots.

Riffle cross-sections surveyed along the restoration reaches have met success criteria for MY-1. The cross-sections appear stable and show little to no change in the bankfull area, maximum depth ratio, or width-to-depth ratio. All surveyed riffle cross-sections fell within the parameters defined for channels of the appropriate Rosgen stream type. The surveyed longitudinal profile data for the stream restoration reaches illustrates that the bedform features are maintaining lateral and vertical stability. The riffles are remaining steeper and shallower than the pools, while the pools are remaining deeper than riffles and maintaining flat water surface slopes. The longitudinal profiles show that the bank height ratios remain very near to 1.0 for all of the restoration reaches. Deposition within pools was documented in the longitudinal profile along UT1. The deposition is not affecting channel stability but will be monitored. In-stream structures, such as root wads used to enhance channel habitat and stability on the outside bank of meander bends are providing stability and habitat as designed. Pattern data will only be completed in monitoring year five (MY-5) if there are indicators from the profile or cross-sections that significant geomorphic adjustments have occurred. No changes were observed that indicated a change in the radius of curvature or channel belt width; therefore, pattern data is not included in the MY-1 report.

Substrate materials in the restoration reaches indicate a progression toward and the maintenance of coarser materials in the riffle features and smaller particles in the pool features.

At the end of the five year monitoring period, two or more bankfull events must occur in separate years within the restoration reach. Bankfull events were recorded on Irvin Creek, Little Troublesome Creek, and UT1 by crest gage or onsite observations (wrack lines) during the MY-1 data collection. Please refer to Appendix 5 to review the hydrologic data.

1.2.3 Wetland Assessment

Groundwater monitoring gages were established throughout the wetland restoration, enhancement, and creation areas on the Wetland Site. The gages were installed at appropriate locations so that the data collected will provide an indication of groundwater levels throughout the wetland project area. A total of eight groundwater gages were installed. According to local WETS station in Eden, NC, the growing season in Rockingham County runs from March 25th to November 6th (226 days). Wildlands installed two soil temperature loggers, one within each wetland, to collect additional growing season data. These probes can be used to better define the growing season using the threshold soil temperature of 41 degrees or higher measured at a depth of 12 inches (USACE, 2010). The probes indicate a longer growing season than that defined for Rockingham County by the WETS station data. A barotroll logger and a rain gage were also installed onsite. All monitoring gages were downloaded on a quarterly basis and will be maintained on an as needed basis. Monitoring gage locations are depicted on the CCPV maps in Appendix 2.

The success criteria for wetland hydrology is to have a free groundwater surface within 12 inches of the ground surface for 7 percent of the growing season, which is measured on consecutive days under typical precipitation conditions. Since installation in late March 2012, an onsite rainfall gage has recorded 20.95 inches of precipitation through mid-November. This is lower than the historic precipitation average between April and November of 31.65 inches collected by nearby weather station Reidsville 2 NW, NC7202 (USDA, 2002). Five of eight gages met the annual wetland hydrology success criteria. The inconsistent range of wetland hydrology success across the site is likely due to drier than normal weather. Please refer to Appendix 5 for wetland hydrology data and plots.

1.3 Monitoring Year 1 Summary

Overall, all streams within the Site are stable and functioning as designed. All vegetation plots met the success criteria required for MY-1 as seen in the CCPV. There has been at least one (1) bankfull event recorded along each restored project reach since construction commenced, therefore, the MY-5 hydrology attainment requirement has been partially met for the Site at this time. Currently five of eight groundwater gages are meeting success criteria for wetland hydrology. This is likely due to below normal precipitation. It is anticipated that success criteria will be met during years of typical rainfall.

Summary information/data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the Mitigation Plan documents available on NCEEP's website. All raw data supporting the tables and figures in the appendices is available from NCEEP upon request.

2.0 Methodology

Geomorphic data was collected followed the standards outlined in The Stream Channel Reference Site: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in the Stream Restoration: A Natural Channel Design Handbook (Doll et al., 2003). Longitudinal and cross-sectional data were collected using a total station and were georeferenced. Reach wide pebble counts were conducted along each restored reach for channel classification. Cross-section substrate analyses conducted in each surveyed riffle followed the 100 count wetted perimeter methodology. Subpavement samples were collected at each surveyed riffle cross-section and processed in an outsourced lab. All CCPV mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using was Pathfinder and ArcView. Crest gages were installed in surveyed riffle cross-sections and monitored quarterly. Hydrology attainment installation and monitoring methods are in accordance with the United States Army Corps of Engineers guidelines (2003). Vegetation monitoring protocols followed the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2008).

3.0 References

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

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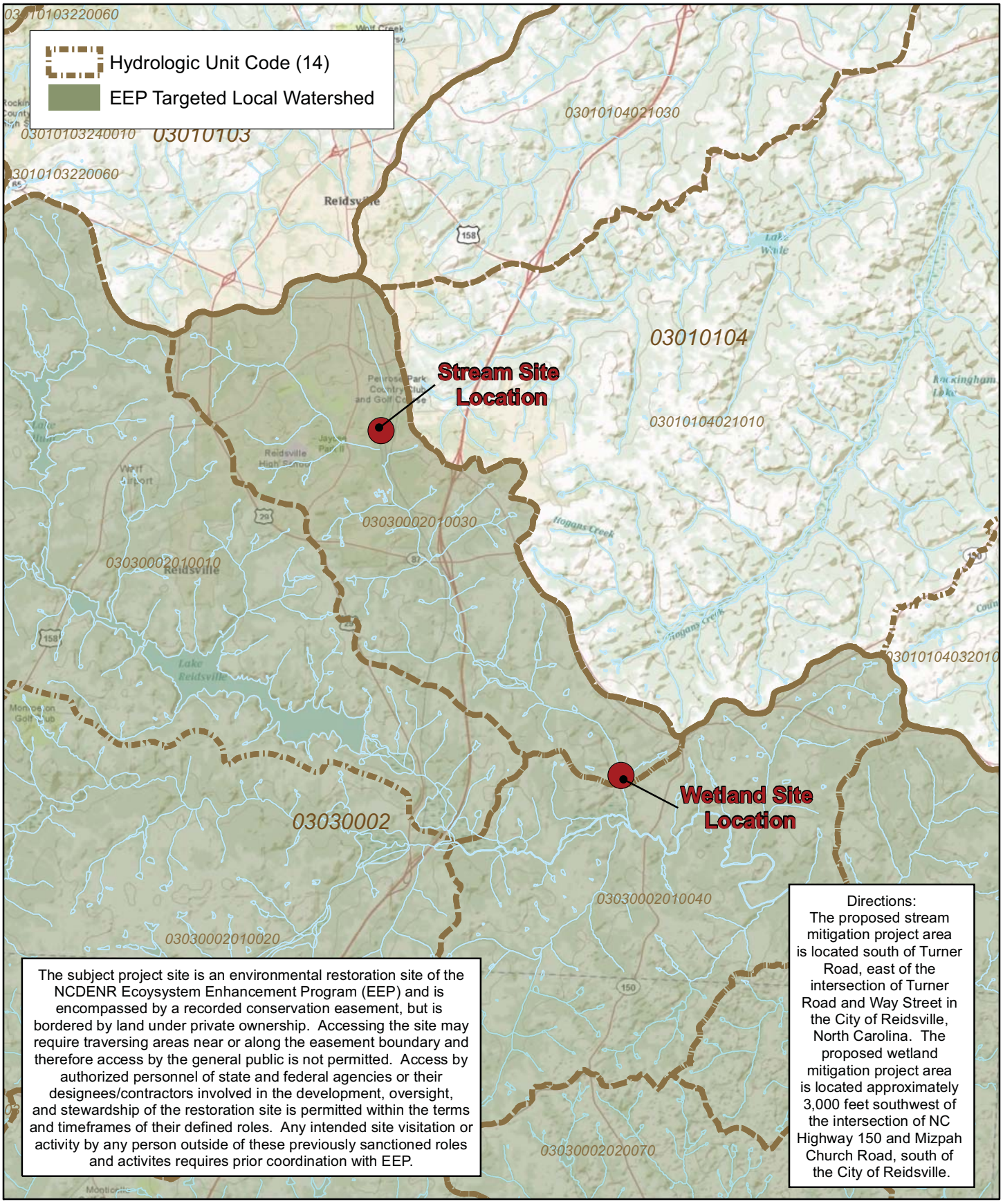
APPENDIX 1. General Tables and Figures



WILDLANDS ENGINEERING

Ecosystem Enhancement PROGRAM

0 0.75 1.5 Miles

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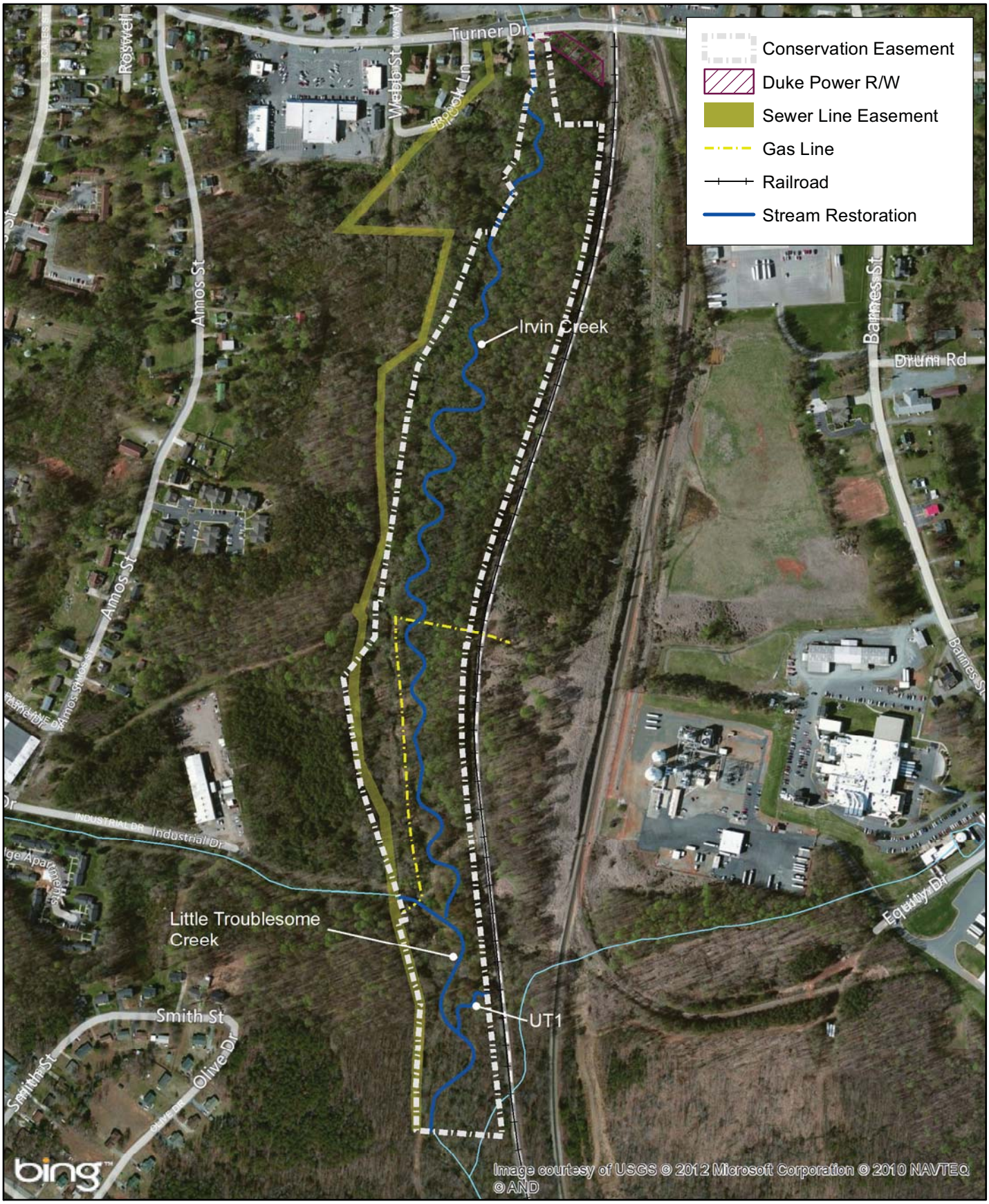
Figure 1 Project Vicinity Map
Little Troublesome Creek Mitigation Site
NCEEP Project Number 94640
Monitoring Year 1

Rockingham County, NC



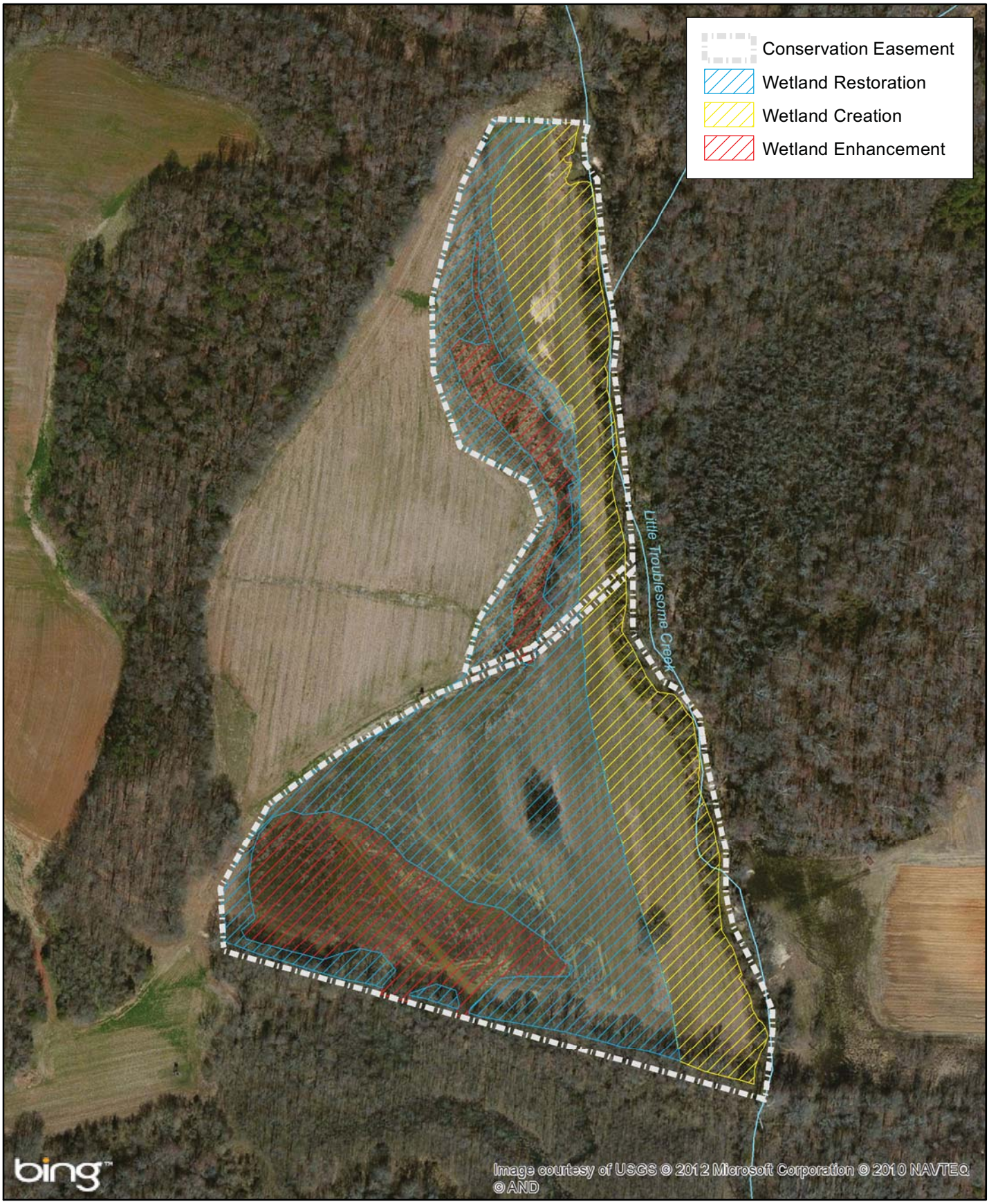
WILDLANDS ENGINEERING

Ecosystem Enhancement PROGRAM

0 250 500 Feet

Figure 2a Project Component/Asset Map
Little Troublesome Creek Mitigation Site
Stream Site
NCEEP Project Number 94640
Monitoring Year 1

Rockingham County, NC



WILDLANDS ENGINEERING

Ecosystem Enhancement PROGRAM

0 125 250 Feet

Figure 2b Project Component/Asset Map
Little Troublesome Creek Mitigation Site
Wetland Site
NCEEP Project Number 94640
Monitoring Year 1

Rockingham County, NC

Appendix 1. General Tables and Figures
Table 1. Project Components and Mitigation Credits
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Monitoring Year 1

Mitigation Credits									
	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer	Nitrogen Nutrient Offet	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	5,052	N/A	10.3	2.8	N/A	N/A	N/A	N/A	N/A

Project Components						
Reach ID	As-Built Stationing/ Location	Existing Footage (LF)	Approach	Restoration or Restoration Equivalent	Restoration Footage (LF) / Acreage (Ac)*	Mitigation Ratio
Irvin Creek - Reach 1	102+10 to 123+05	1,640	Priority 1	Restoration	1,793	1:1
Irvin Creek - Reach 2	123+05 to 142+37	1,505	Priority 1	Restoration	1,882	1:1
Little Troublesome Creek	200+00 to 211+71	1,080	Priority 1	Restoration	1,080	1:1
UT1	400+00 to 402+33	184	Priority 1/2	Restoration	233	1:1
RW1	N/A	N/A	Restoration	Restoration	8.7	1:1
RW1	N/A	N/A	Creation	Restoration Equivalent	4.9	3:1
RW1	N/A	3.7	Enhancement	Restoration Equivalent	3.7	1.3:1**

Component Summation						
Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	4,988	8.7	-	-	-	-
Enhancement		2.8	-	-	-	-
Enhancement I	-					
Enhancement II	-					
Creation		1.9	-	-		
Preservation	-	-	-	-		-
High Quality Preservation	-	-	-	-		-

BMP Elements									
Elements		Location		Purpose/Function		Notes			
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-

BR = Bioretention Cell; S F= Sand Filter; SW = Stormwater Wetland; WDP = Wet Detention Pond; DDP = Dry Detention Pond; FS = Filter Strip; S = Grassed Swale; LS = Level Spreader; NI = Natural Infiltration Area; FB = Forested Buffer

* Note that lengths do not match stationing because channel sections that do not generate credit have been removed from length calculations.

**The higher enhancement ratio was agreed to with Todd Tugwell, with the USACE, during a March 9, 2011 meeting for the several reasons. The higher ratio is warranted because of the low quality of the existing wetland enhancement zone. Currently the enhancement zone, like the restoration and creation zones, is being used for farming. The hydrology of the site has been altered by a drainage ditch and a berm along Little Troublesome Creek. There is no vegetation on the site except for some areas of grasses and cultivated crops. Enhancement activities performed on the site will include improving the hydrology of the enhancement zone (as well as the creation and restoration zones) and restoring the native vegetation. Therefore the functional uplift of the enhancement portion of the project will be nearly the same as that of the restoration zone and, thus, a high ratio for enhancement is appropriate.

Appendix 1. General Tables and Figures
Table 2. Project Activity and Reporting History
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Monitoring Year 1

Activity or Report	Date Collection Complete	Completion or Scheduled Delivery
Mitigation Plan	June 2011	June 2011
Final Design - Construction Plans	August 2011	August 2011
Construction	April 2012	May 2012
Temporary S&E mix applied to entire project area[1]	April 2012	May 2012
Permanent seed mix applied to reach/segments	April 2012	May 2012
Bare root plantings for reach/segments	April 2012	May 2012
Baseline Monitoring Document (Year 0 Monitoring - baseline)	April/May 2012	June 2012
Year 1 Monitoring	September / October 2012	December 2012
Year 2 Monitoring	2013	December 2013
Year 3 Monitoring	2014	December 2014
Year 4 Monitoring	2015	December 2015
Year 5 Monitoring	2016	December 2016
Year 6 Monitoring[2]	2017	December 2017
Year 7 Monitoring[2]	2018	December 2018

[1]Seed and mulch is added as each section of construction is completed.

Appendix 1. General Tables and Figures
Table 3. Project Contact Table
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Monitoring Year 1

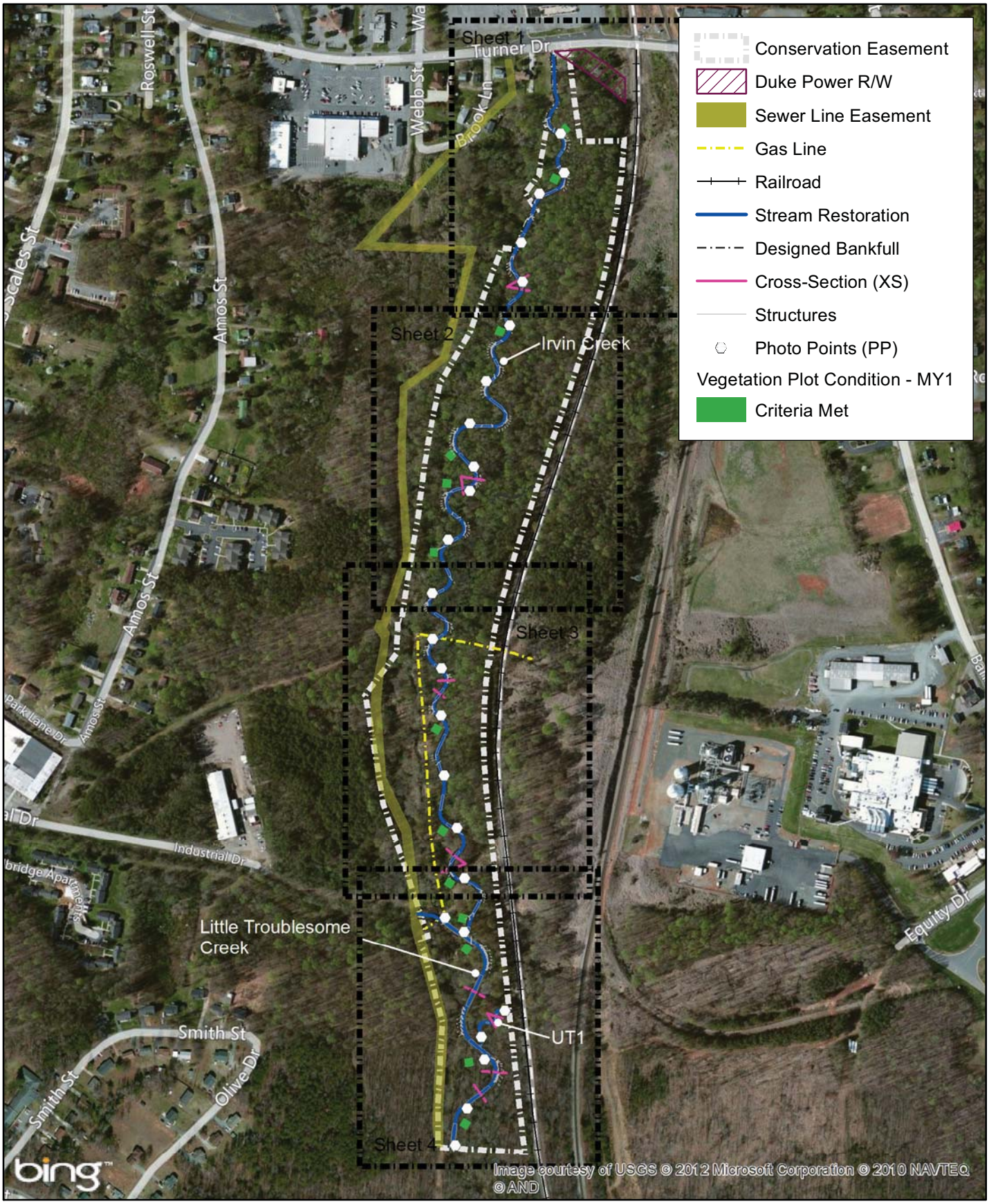
Designer	**Wildlands Engineering, Inc.**
Jeff Keaton, PE	5605 Chapel Hill Road, Suite 122 Raleigh, NC 27604 919.851.9986
Construction Contractor	**Fluvial Solutions**
Peter Jelenevsky	PO Box 28749 Raleigh, NC 28749
Planting Contractor - Stream Site	**Fluvial Solutions**
Peter Jelenevsky	PO Box 28749 Raleigh, NC 28749
Planting Contractor - Wetland Site	**Bruton Natural Systems, Inc.**
Charlie Bruton	PO Box 1197 Freemont, NC 27830 919.242.6555
Seeding Contractor - Stream and Wetland Site	**Fluvial Solutions**
Peter Jelenevsky	PO Box 28749 Raleigh, NC 28749
Seed Mix Sources	**Mellow Marsh Farm**
Nursery Stock Suppliers	**Arborgen** **Dykes and Son Nursery** **NC Forestry Service, Claridge Nursery**
Monitoring Performers	**Wildlands Engineering, Inc.**
Stream, Vegetation, and Wetland Monitoring, POC	Kirsten Y. Gimbert 704.332.7754, ext. 110

Appendix 1. General Tables and Figures
Table 4. Project Baseline Information and Attributes
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Monitoring Year 1

Project Information					
Project Name	Little Troublesome Creek Mitigation Site				
County	Rockingham				
Project Area (acres)	Stream Site: 33 acres, Wetland Site: 19 acres				
Project Coordinates (latitude and longitude)	36° 20' 96"N, 79° 39' 31"W				
Project Watershed Summary Information					
Physiographic Province	Inner Piedmont Belt of the Piedmont				
River Basin	Cape Fear				
USGS Hydrologic Unit 8-digit	03030002				
USGS Hydrologic Unit 14-digit	03030002010030				
DWQ Sub-basin	03-06-01				
Project Drainiage Area (acres)	3,254				
Project Drainage Area Percentage of Impervious Area	17%				
CGIA Land Use Classification	55% Forest Land,17% Cultivated Land, 28% Developed				
Reach Summary Information					
Parameters	**Irvin Creek Reach 1**	**Irvin Creek Reach 2**	**Little Troublesome Creek**	**UT1**	**RW1**
Length of reach (linear feet) - Post-Restoration	2,095	1,932	1,171	233	N/A
Drainage area (acres)	525	584	3,245	62	N/A
NCDWQ stream identification score	45	45	45.5	26.5	N/A
NCDWQ Water Quality Classification	C	C	C; NSW	C	C; NSW
Morphological Desription (stream type)	Perennial	Perennial	Perennial	Intermittent	N/A
Evolutionary trend (Simon's Model) - Pre- Restoration	Stage IV	Stage IV	Stage IV	Stage IV	N/A
Underlying mapped soils	CsA	CsA	CsA	CsA	CsA / HcA
Drainage class	Somewhat Poorly-Drained	Somewhat Poorly-Drained	Somewhat Poorly-Drained	Somewhat Poorly-Drained	Somewhat Poorly-Drained / Poorly Drained
Soil Hydric status	No	No	No	No	No / Yes
Slope	0-2%	0-2%	0-2%	0-2%	0-2%
FEMA classification	Zone AE				
Native vegetation community	Bottom-land forest				
Percent composition of exotic invasive vegetation - Post-Restoration	0%				
Regulatory Considerations					
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**		
Waters of the United States - Section 404	X	X	Little Troublesome Creek Mitigation Plan; USACE Nationwide Permit No.27 and DWQ 401 Water Quality Certification No. 3689		
Waters of the United States - Section 401	X	X			
Division of Land Quality (Dam Safety)	N/A	N/A	N/A		
Endangered Species Act	X	X	Little Troublesome Creek Mitigation Plan; studies found "no effect" (letter from USFWS)		
Historic Preservation Act	X	X	Little Troublesome Creek Mitigation Plan; No historic resources were found to be impacted (letter from SHPO)		
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A		
FEMA Floodplain Compliance	X	X	Approved CLOMR		
Essential Fisheries Habitat	N/A	N/A	N/A		

*LF provided included portions of the stream that will be monitoring and have been reconstructed, but for which mitigation credit will not be claimed. Please refer to Table 1 for the credit summary lengths.

APPENDIX 2. Visual Assessment Data



WILDLANDS ENGINEERING

Ecosystem Enhancement PROGRAM

0 250 500 Feet

Figure 3.0 Integrated Current Condition
Plan View (Key)
Little Troublesome Creek Mitigation Site
Stream Site
NCEEP Project Number 94640
Monitoring Year 1

Rockingham County, NC

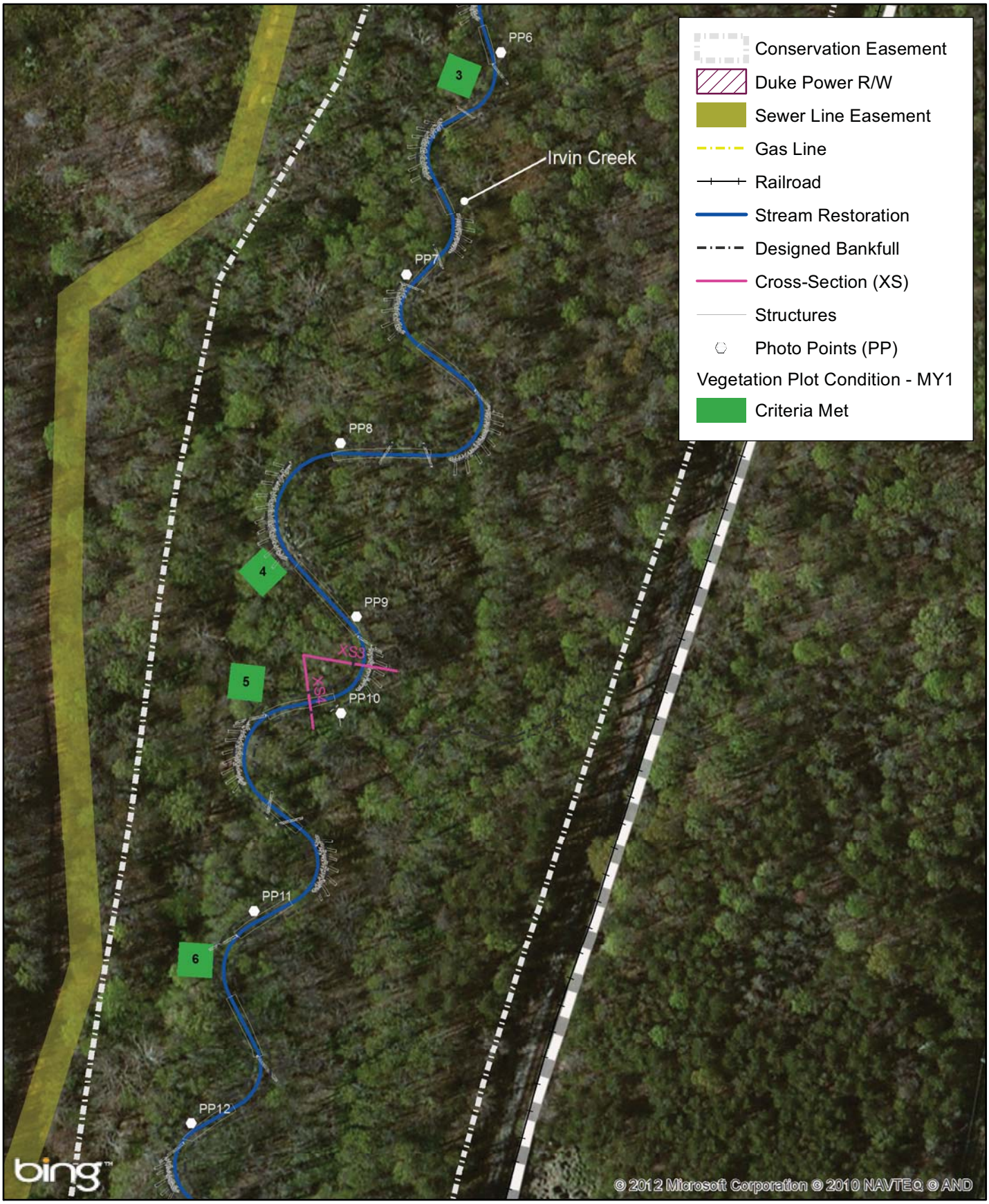
WILDLANDS ENGINEERING

Ecosystem Enhancement PROGRAM

0 62.5 125 Feet

Figure 3.1 Integrated Current Condition
Plan View (Sheet 1 of 4)
Little Troublesome Creek Mitigation Site
Stream Site
NCEEP Project Number 94640
Monitoring Year 1

Rockingham County, NC



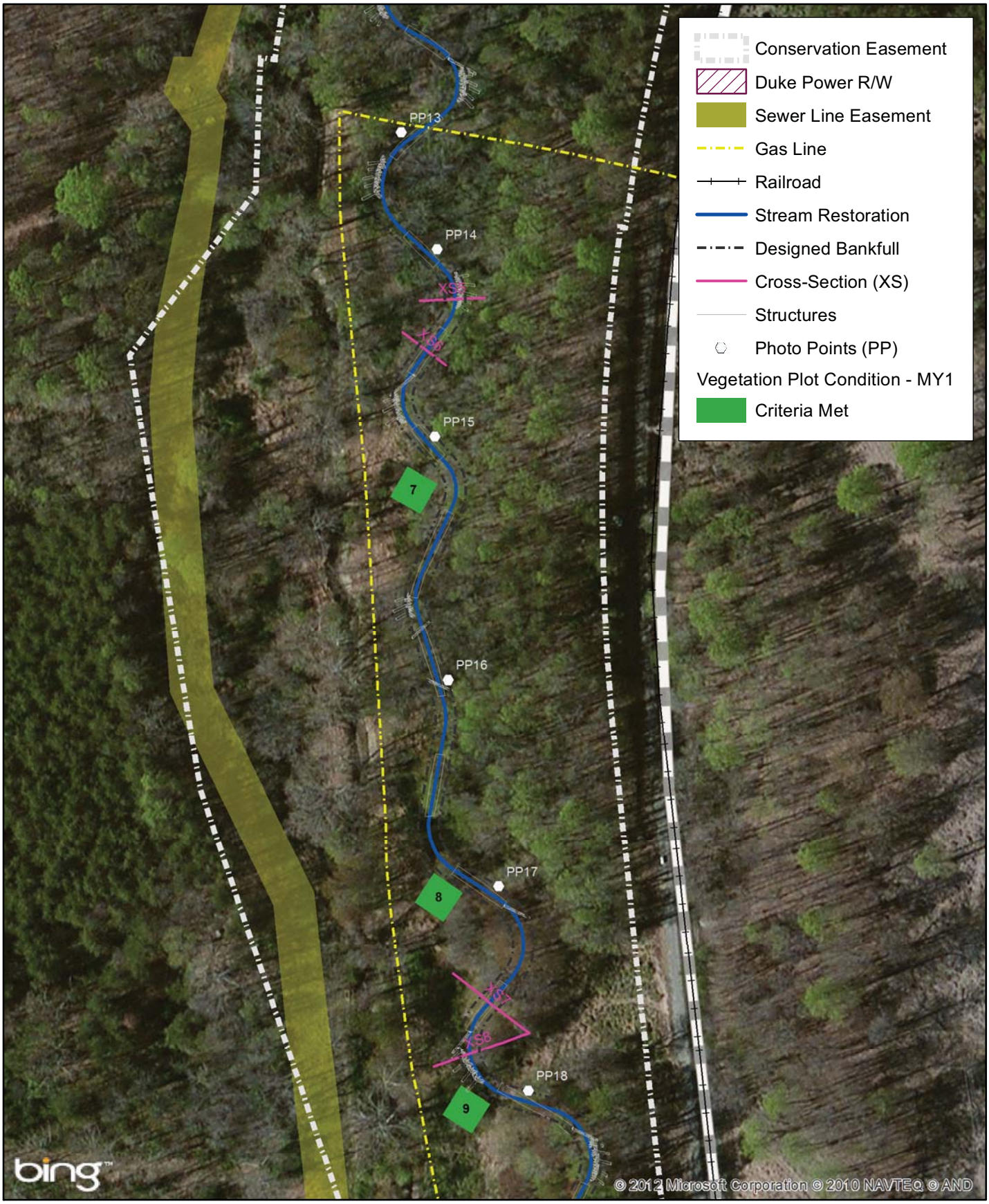
WILDLANDS ENGINEERING

Ecosystem Enhancement PROGRAM

0 62.5 125 Feet

Figure 3.2 Integrated Current Condition
Plan View (Sheet 2 of 4)
Little Troublesome Creek Mitigation Site
Stream Site
NCEEP Project Number 94640
Monitoring Year 1

Rockingham County, NC



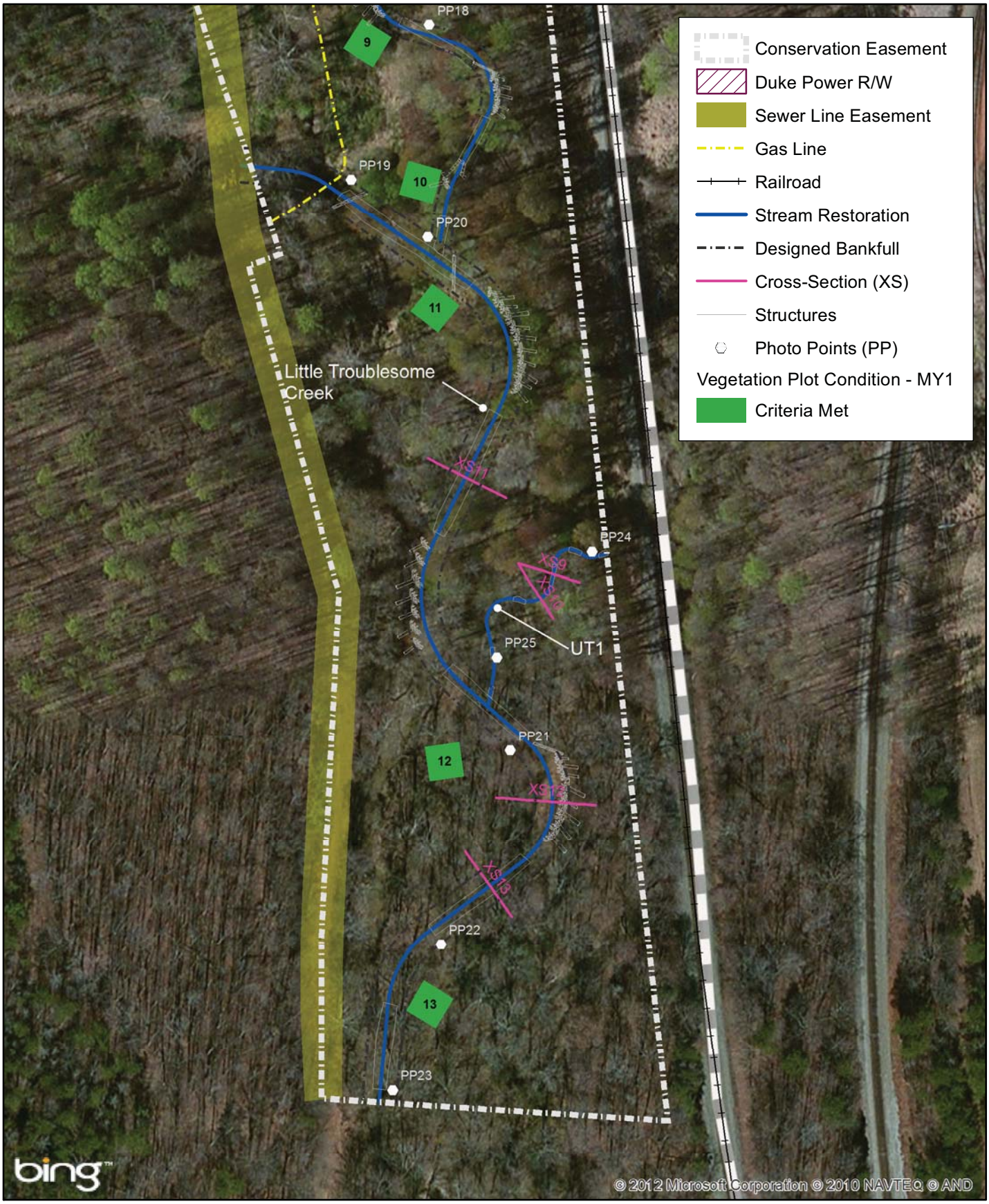
WILDLANDS ENGINEERING

Ecosystem Enhancement PROGRAM

0 62.5 125 Feet

Figure 3.3 Integrated Current Condition
Plan View (Sheet 3 of 4)
Little Troublesome Creek Mitigation Site
Stream Site
NCEEP Project Number 94640
Monitoring Year 1

Rockingham County, NC



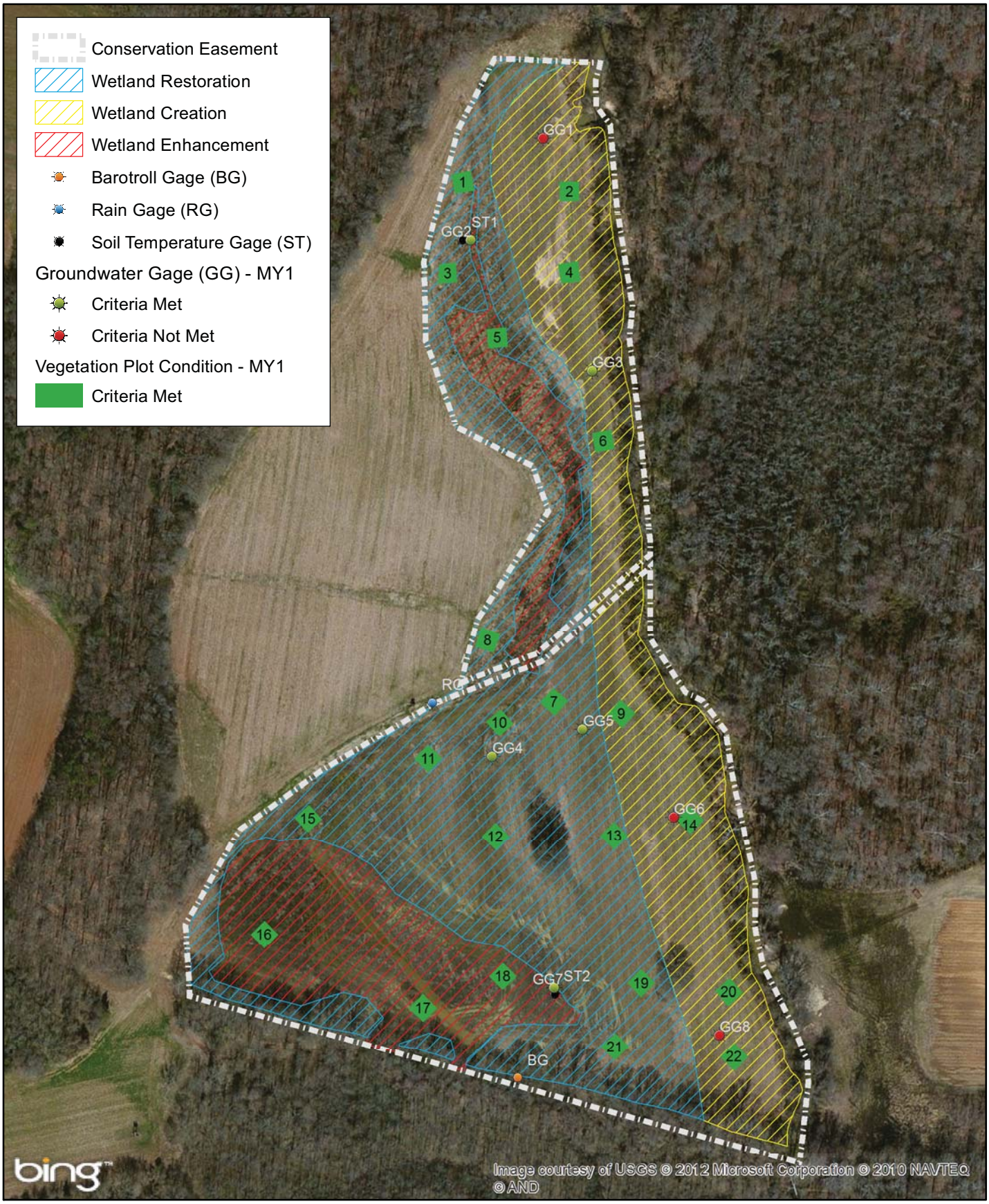
WILDLANDS ENGINEERING

Ecosystem Enhancement PROGRAM

0 62.5 125 Feet

Figure 3.4 Integrated Current Condition
Plan View (Sheet 4 of 4)
Little Troublesome Creek Mitigation Site
Stream Site
NCEEP Project Number 94640
Monitoring Year 1

Rockingham County, NC



WILDLANDS ENGINEERING

Ecosystem Enhancement PROGRAM

0 125 250 Feet

Figure 3.5 Integrated Current Condition
Plan View
Little Troublesome Creek Mitigation Site
Wetland Site
NCEEP Project Number 94640
Monitoring Year 1

Rockingham County, NC

Appendix 2. Visual Assessment Data
Table 5a. Visual Stream Morphology Stability Assessment Table
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 1 (1,793 LF)
Monitoring Year 1

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			0	0	100%			
		Degredation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	16	16			100%			
	3. Meander Pool Condition	Depth Sufficient	16	16			100%			
		Lenth Appropriate	16	16			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	16	16			100%			
		Thalweg centering at downstream of meander bend (Glide)	16	16			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dilodged boulders or logs.	36	36			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	24	24			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	24	24			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	31	31			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	12	12			100%			

Appendix 2. Visual Assessment Data
Table 5b. Visual Stream Morphology Stability Assessment Table
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 2 (1,882 LF)
Monitoring Year 1

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			0	0	100%			
		Degredation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	16	16			100%			
	3. Meander Pool Condition	Depth Sufficient	15	15			100%			
		Lenth Appropriate	15	15			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	15	15			100%			
		Thalweg centering at downstream of meander bend (Glide)	15	15			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dilodged boulders or logs.	35	35			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	19	19			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	9	9			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	19	19			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	19	19			100%			

Appendix 2. Visual Assessment Data
Table 5c. Visual Stream Morphology Stability Assessment Table
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
UT1 (233 LF)
Monitoring Year 1

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			0	0	100%			
		Degredation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	6	6			100%			
	3. Meander Pool Condition	Depth Sufficient	4	4			100%			
		Lenth Appropriate	4	4			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	4	4			100%			
		Thalweg centering at downstream of meander bend (Glide)	4	4			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dilodged boulders or logs.	6	6			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	6	6			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	0	0			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	0	0			100%			

Appendix 2. Visual Assessment Data
Table 5d. Visual Stream Morphology Stability Assessment Table
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Little Troublesome Creek (1,080 LF)
Monitoring Year 1

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			0	0	100%			
		Degredation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	5	5			100%			
	3. Meander Pool Condition	Depth Sufficient	4	4			100%			
		Lenth Appropriate	4	4			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	4	4			100%			
		Thalweg centering at downstream of meander bend (Glide)	4	4			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dilodged boulders or logs.	9	9			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	6	6			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	1	1			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	4	4			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	4	4			100%			

Appendix 2. Visual Assessment Data
Table 6. Vegetation Condition Assessment Table
Little Troublesome Creek Mitigation Site (EEP Project No. 94640)
Monitoring Year 1

Planted Acreage **33.7**

Vegetation Category	Definitions	Mapping Threshold (acres)	Number of Polygons	Combined Acreage	% of Planted Acreage*
Bare Areas	Very limited cover of both woody and herbaceous material	0.1	0	0	0.00%
Low Stem Density Areas^	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1	0	0.0	0%
		Total	**0**	**0.0**	**0%**
Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	0	0	0%
		Cumulative Total	**0**	**0.0**	**0%**

Easement Acreage **52**

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Planted Acreage
Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale).	1000	0	0	0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	0	0	0%

Stream Photographs

	
Photo Point 1 – looking upstream (10/26/2012)	Photo Point 1 – looking downstream (10/26/2012)
	
Photo Point 2 – looking upstream (10/26/2012)	Photo Point 2 – looking downstream (10/26/2012)
	
Photo Point 3 – looking upstream (10/26/2012)	Photo Point 3 – looking downstream (10/26/2012)

	
Photo Point 4 – looking upstream (10/26/2012)	Photo Point 4 – looking downstream (10/26/2012)
	
Photo Point 5 – looking upstream (10/26/2012)	Photo Point 5 – looking downstream (10/26/2012)
	
Photo Point 6 – looking upstream (10/26/2012)	Photo Point 6 – looking downstream (10/26/2012)

	
Photo Point 7 – looking upstream (10/26/2012)	Photo Point 7 – looking downstream (10/26/2012)
	
Photo Point 8 – looking upstream (10/26/2012)	Photo Point 8 – looking downstream (10/26/2012)
	
Photo Point 9 – looking upstream (10/26/2012)	Photo Point 9 – looking downstream (10/26/2012)

	
Photo Point 10 – looking upstream (10/26/2012)	Photo Point 10 – looking downstream (10/26/2012)
	
Photo Point 11 – looking upstream (10/26/2012)	Photo Point 11 – looking downstream (10/26/2012)
	
Photo Point 12 – looking upstream (10/26/2012)	Photo Point 12 – looking downstream (10/26/2012)

	
Photo Point 13 – looking upstream (10/26/2012)	Photo Point 13 – looking downstream (10/26/2012)
	
Photo Point 14 – looking upstream (10/26/2012)	Photo Point 14 – looking downstream (10/26/2012)
	
Photo Point 15 – looking upstream (10/26/2012)	Photo Point 15 – looking downstream (10/26/2012)

	
Photo Point 16 – looking upstream (10/26/2012)	Photo Point 16 – looking downstream (10/26/2012)
	
Photo Point 17 – looking upstream (10/26/2012)	Photo Point 17 – looking downstream (10/26/2012)
	
Photo Point 18 – looking upstream (10/26/2012)	Photo Point 18 – looking downstream (10/26/2012)

Photo Point 19 – looking upstream (10/26/2012)

Photo Point 19 – looking upstream (10/26/2012)

Photo Point 20 – looking upstream - Irvin (10/26/2012)

Photo Point 20 – looking upstream – LTC (10/26/2012)

Photo Point 20 – looking downstream - LTC (10/26/2012)

	
Photo Point 21 – looking upstream (10/26/2012)	Photo Point 21 – looking downstream (10/26/2012)
	
Photo Point 22 – looking upstream (10/26/2012)	Photo Point 22 – looking downstream (10/26/2012)
	
Photo Point 23 – looking upstream (10/26/2012)	Photo Point 23 – looking downstream (10/26/2012)

	
Photo Point 24 – looking upstream (10/26/2012)	Photo Point 24 – looking downstream (10/26/2012)
	
Photo Point 25 – looking upstream (10/26/2012)	Photo Point 25 – looking downstream (10/26/2012)

Stream Site Vegetation Photographs*

Numbers shown on posts in each vegetation plot photo do not correspond with vegetation plot identification numbers. Numbers listed under each photo is correct identification number.

Vegetation Plot 23 (09/19/2012)

Vegetation Plot 24 (09/19/2012)

Vegetation Plot 25 (09/19/2012)

Vegetation Plot 26 (09/19/2012)

Vegetation Plot 27 (09/19/2012)

Vegetation Plot 28 (09/19/2012)

	
Vegetation Plot 29 (09/19/2012)	Vegetation Plot 30 (09/19/2012)
	
Vegetation Plot 31 (09/19/2012)	Vegetation Plot 32 (09/19/2012)
	
Vegetation Plot 33 (09/19/2012)	Vegetation Plot 34 (09/19/2012)

Vegetation Plot 35 (09/19/2012)

Wetland Site Vegetation Photographs

Vegetation Plot 1 (9/20/2012)

Vegetation Plot 2 (9/20/2012)

Vegetation Plot 3 (9/20/2012)

Vegetation Plot 4 (9/20/2012)

Vegetation Plot 5 (9/20/2012)

Vegetation Plot 6 (9/20/2012)

Vegetation Plot 7 (9/20/2012)

Vegetation Plot 8 (9/20/2012)

Vegetation Plot 9 (9/20/2012)

Vegetation Plot 10 (9/20/2012)

Vegetation Plot 11 (9/20/2012)

Vegetation Plot 12 (9/20/2012)

Vegetation Plot 13 (9/20/2012)

Vegetation Plot 14 (9/20/2012)

Vegetation Plot 15 (9/20/2012)

Vegetation Plot 16 (9/20/2012)

Vegetation Plot 17 (9/20/2012)

Vegetation Plot 18 (9/20/2012)

	
Vegetation Plot 19 (9/20/2012)	Vegetation Plot 20 (9/20/2012)
	
Vegetation Plot 21 (9/20/2012)	Vegetation Plot 22 (9/20/2012)

APPENDIX 3. Vegetation Plot Data

Appendix 3. Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment

Little Troublesome Creek Mitigation Site (NCEEP Project No. 94

Monitoring Year 1

Plot	MY1 Success Criteria Met (Y/N)	Tract Mean
1	Y	
2	Y	
3	Y	
4	Y	
5	Y	
6	Y	
7	Y	
8	Y	
9	Y	
10	Y	
11	Y	
12	Y	
13	Y	
14	Y	
15	Y	
16	Y	
17	Y	
18	Y	100%
19	Y	
20	Y	
21	Y	
22	Y	
23	Y	
24	Y	
25	Y	
26	Y	
27	Y	
28	Y	
29	Y	
30	Y	
31	Y	
32	Y	
33	Y	
34	Y	
35	Y	

Appendix 3. Vegetation Plot Data
Table 8a. CVS Vegetation Tables - Metadata
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Wetland Site
Monitoring Year 1

Report Prepared By	Alea Tuttle
Date Prepared	*10/16/2012 0:00*
database name	*CVS Data Table Output- Wetland Site MY1*
database location	*\\WILDNCSVR\Projects\ActiveProjects\005-02124 Little Troublesome Creek FDP\Monitoring\Monitoring Year 1\Vegetation Assessment*
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	*Unknown*
PROJECT SUMMARY----------	
Project Code	94640
project Name	Little Troublesome Creek-Cotton Rd Site
Description	Wetland Mitigation Site
length (ft)	n/a
stream-to-edge width (ft)	n/a
area (sq m)	72843.42
Required Plots (calculated)	16
Sampled Plots	22

Appendix 3. Vegetation Plot Data
Table 8b. CVS Vegetation Tables - Metadata
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Stream Site
Monitoring Year 1

Report Prepared By	Alea Tuttle
Date Prepared	*10/16/2012 0:00*
database name	*CVS Data Table Output- Stream Site MY1*
database location	*\\WILDNCSVR\Projects\ActiveProjects\005-02124 Little Troublesome Creek FDP\Monitoring\Monitoring Year 1\Vegetation Assessment*
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	*Unknown*
PROJECT SUMMARY----------	
Project Code	94640
project Name	Little Troublesome Mitigation Site
Description	Stream Mitigation Site
length (ft)	n/a
stream-to-edge width (ft)	n/a
area (sq m)	50990.39
Required Plots (calculated)	13
Sampled Plots	13

Appendix 3. Vegetation Plot Data
Table 9a. Planted and Total Stem Counts (Species by Plot with Annual Means)
Little Troublesome Creek Mitigation Site (NCEEP Project No. 9464)
Wetland Site
Monitoring Year

			Current Data (MY1-9/2012)																						Annual Means			
			Plot 1		Plot 2		Plot 3		Plot 4		Plot 5		Plot 6		Plot 7		Plot 8		Plot 9		Plot 1		Plot 11		Current Mean		MY-4/212	
Species	Common Name	Type	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Alnus serrulata	hazel alder	Tree/Shrub	2	2	1	1	2	2	4	4	1	1	2	2	1	1	4	4					2	2	**2**	**2**	**3**	**3**
Betula nigra	river birch	Tree	1	1	1	1	4	4	3	3	1	1	3	3	3	3	2	2	6	6	3	3	5	5	**3**	**3**	**3**	**4**
Cornus amomum	silky dogwood	Shrub			1	1			4	4			6	6			2	2	1	1	2	2			**2**	**2**	**3**	**3**
Fraxinus americana	white ash	Tree																							**1**	**1**	**0**	**0**
Fraxinus pennsylvanica	green ash	Tree			3	3	6	6	2	2	11	11	2	2	8	8					2	2	5	5	**4**	**4**	**4**	**4**
Nyssa sylvatica	blackgum	Tree					2	2	3	3	5	5					3	3	5	5					**3**	**3**	**2**	**2**
Platanus occidentalis	american sycamore	Tree	7	7	2	2	5	5			3	3	1	1	3	3	5	5			4	4	6	6	**4**	**4**	**4**	**4**
Platycladus orientalis	oriental arborvitae	Shrub																							**1**	**1**	**0**	**0**
Quercus michauxii	swamp chestnut oak	Tree	4	4	3	3			1	1	1	1									5	5			**2**	**2**	**2**	**2**
Quercus phellos	willow oak	Tree	1	1			1	1	4	4	1	1	1	1	1	1			5	5	1	1			**2**	**2**	**2**	**2**
Unknown																									**0**	**0**	**2**	**2**
Plot Area (acres)			**0.0247**																									
Species Count			**5**	**5**	**6**	**6**	**6**	**6**	**7**	**7**	**7**	**7**	**6**	**6**	**5**	**5**	**5**	**5**	**4**	**4**	**6**	**6**	**4**	**4**	**10**	**10**	**6**	**6**
Stem Count			**15**	**15**	**11**	**11**	**20**	**20**	**21**	**21**	**23**	**23**	**15**	**15**	**16**	**16**	**16**	**16**	**17**	**17**	**17**	**17**	**18**	**18**	**16**	**16**	**17**	**17**
Stems per Acre			**607**	**607**	**445**	**445**	**810**	**810**	**850**	**850**	**931**	**931**	**607**	**607**	**648**	**648**	**648**	**648**	**688**	**688**	**688**	**688**	**729**	**729**	**639**	**639**	**701**	**701**

Type=Shrub or Tree
P = Planted
T = Total

Appendix 3. Vegetation Plot Data
Table 9b. Planted and Total Stem Counts (Species by Plot with Annual Means)
Little Troublesome Creek Mitigation Site (NCEEP Project No. 9464)
Wetland Site
Monitoring Year

			Current Data (MY1-9/2012)																						Annual Means			
			Plot 12		Plot 13		Plot 14		Plot 15		Plot 16		Plot 17		Plot 18		Plot 19		Plot 2		Plot 21		Plot 22		Current Mean		MY-4/212	
Species	Common Name	Type	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Alnus serrulata	hazel alder	Tree/Shrub	1	1	1	1	2	2			1	1									4	4	3	3	**2**	**2**	**3**	**3**
Betula nigra	river birch	Tree	4	4	2	2	3	3	3	3	3	3	1	1	1	1	3	3	3	3					**3**	**3**	**3**	**4**
Cornus amomum	silky dogwood	Shrub	3	3	1	1	2	2	1	1	2	2			1	1	3	3					1	1	**2**	**2**	**3**	**3**
Fraxinus americana	white ash	Tree													1	1									**1**	**1**	**0**	**0**
Fraxinus pennsylvanica	green ash	Tree	1	1	5	5	2	2	2	2	1	1	4	4	3	3	2	2	5	5	2	2	2	2	**4**	**4**	**4**	**4**
Nyssa sylvatica	blackgum	Tree	1	1	2	2											1	1			3	3	2	2	**3**	**3**	**2**	**2**
Platanus occidentalis	american sycamore	Tree					6	6	5	5	1	1	1	1	5	5	2	2	5	5	5	5	9	9	**4**	**4**	**4**	**4**
Platycladus orientalis	oriental arborvitae	Shrub	1	1																					**1**	**1**	**0**	**0**
Quercus michauxii	swamp chestnut oak	Tree	5	5	1	1			1	1			2	2							1	1			**2**	**2**	**2**	**2**
Quercus phellos	willow oak	Tree			4	4	3	3	1	1			1	1	2	2	5	5	2	2	1	1	1	1	**2**	**2**	**2**	**2**
Unknown																									**0**	**0**	**2**	**2**
Plot Area (acres)			**0.0247**																									
Species Count			**7**	**7**	**7**	**7**	**6**	**6**	**6**	**6**	**5**	**5**	**5**	**5**	**6**	**6**	**6**	**6**	**4**	**4**	**6**	**6**	**6**	**6**	**10**	**10**	**6**	**6**
Stem Count			**16**	**16**	**16**	**16**	**18**	**18**	**13**	**13**	**8**	**8**	**9**	**9**	**13**	**13**	**16**	**16**	**15**	**15**	**16**	**16**	**18**	**18**	**16**	**16**	**17**	**17**
Stems per Acre			**648**	**648**	**648**	**648**	**729**	**729**	**526**	**526**	**324**	**324**	**364**	**364**	**526**	**526**	**648**	**648**	**607**	**607**	**648**	**648**	**729**	**729**	**639**	**639**	**701**	**701**

Type=Shrub or Tree
P = Planted
T = Total

Appendix 3. Vegetation Plot Data
Table 9c. Planted and Total Stem Counts (Species by Plot with Annual Means)
Little Troublesome Creek Mitigation Site (NCEEP Project No. 9464)
Stream Site
Monitoring Year

			Current Data (MY1-9/2012)																								Annual Means			
			Plot 23		Plot 24		Plot 25		Plot 26		Plot 27		Plot 28		Plot 29		Plot 3		Plot 31		Plot 32		Plot 33		Plot 34		Plot 35		Current Mean		MY-4/212	
Species	**Common Name**	**Type**	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Betula nigra	river birch	Tree	2	2	1	1	2	2	2	2					1	1	2	2	9	9	7	7	7	7	1	1	2	2	**3**	**3**	**3**	**3**
Carpinus caroliniana	american hornbeam	Tree/Shrub	3	3	1	1	3	3	2	2	3	3	4	4	3	3	9	9					3	3	8	8	2	2	**4**	**4**	**4**	**4**
Cornus amomum	silky dogwood	Shrub			2	2																			2	2	2	2	**2**	**2**	**3**	**3**
Fraxinus pennsylvanica	green ash	Tree	4	4	3	3	13	13	6	6	7	7	6	6	6	6	2	2	7	7	3	3	1	1	3	3	2	2	**5**	**5**	**5**	**5**
Liriodendron tulipifera	tuliptree	Tree	8	8	2	2					1	1	2	2			6	6	5	5	1	1	1	1	5	5			**3**	**3**	**3**	**3**
Platanus occidentalis	american sycamore	Tree	5	5	3	3	2	2	5	5	13	13	11	11	1	1	2	2	2	2	1	1	1	1			3	3	**4**	**4**	**6**	**6**
Quercus phellos	willow oak	Tree			4	4																	4	4	7	7	5	5	**5**	**5**	**6**	**6**
Quercus rubra	northern red oak	Tree			3	3											2	2	2	2	1	1					5	5	**2**	**3**	**2**	**2**
Unknown																													**0**	**0**	**1**	**1**
Plot Area (acres)			**0.0247**																													
Species Count			**5**	**5**	**8**	**8**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**6**	**6**	**5**	**5**	**5**	**5**	**6**	**6**	**6**	**6**	**7**	**7**	**5**	**5**	**6**	**6**
Stem Count			**22**	**22**	**19**	**19**	**20**	**20**	**15**	**15**	**24**	**24**	**23**	**23**	**11**	**11**	**23**	**23**	**25**	**25**	**13**	**13**	**17**	**17**	**26**	**26**	**21**	**21**	**20**	**20**	**24**	**24**
Stems per Acre			**891**	**891**	**769**	**769**	**810**	**810**	**607**	**607**	**972**	**972**	**931**	**931**	**445**	**445**	**931**	**931**	**1012**	**1012**	**526**	**526**	**688**	**688**	**1053**	**1053**	**850**	**850**	**807**	**807**	**953**	**953**

Type=Shrub or Tree
P = Planted
T = Total

APPENDIX 4. Morphological Summary Data and Plots

Appendix 4. Morphological Summary Data and Plots
Table 10a. Baseline Stream Data Summary
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reaches 1 and 2
Monitoring Year 1

Parameter	Gage	Pre-Restoration Condition				Reference Reach Data								Design[1]				As-Built/Baseline			
		Irvin Creek Reach 1		Irvin Creek Reach 2		Collins Creek		UT to Belews Creed		UT to Rocky Creek		Spencer Creek		Irvin Creek Reach 1		Irvin Creek Reach 2		Irvin Creek Reach 1		Irvin Creek Reach 2	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																					
Bankfull Width (ft)	n/a	17.7		15.2	17.2	11.9	20.1	14.4		12.2		8.7		19.0		19.0		18.6	19.7	18.1	20.9
Floodprone Width (ft)		21.0		18.0	21.0	60.0		200.0		72.0		229.0		80+		200+		200+	200+	200+	200+
Bankfull Mean Depth		1.5		1.9	2.0	1.6	2.7	2.0		1.3		1.2		1.6		1.6		1.6	1.7	1.6	1.6
Bankfull Max Depth		1.8		2.4	2.6	3.3	4.2	2.7		1.8		1.9		2.2		2.2		2.4	2.6	2.4	2.4
Bankfull Cross-sectional Area (ft^2)		27.3		30.6	32.8	32.9		27.4		16.3		10.6		29.7		29.7		29.3	33.7	29.0	32.7
Width/Depth Ratio		11.5		8.0	8.6	4.4	12.1	7.6		9.1		7.3		12.0		12.0		11.5	11.8	11.3	13.3
Entrenchment Ratio		1.2		1.2	1.2	2.0	3.0	34.7		6.0		26.3		2.2+		2.2+		2.2+	2.2+	2.2+	2.2+
Bank Height Ratio		1.9	3.3	2.3	2.5	1.0	1.1	1.0		1.0		1.0		1.0		1.0		1.0	1.0	1.0	1.0
d50 (mm)		32.8		24.2														22.6		18.6	
Profile																					
Riffle Length (ft)	n/a					-		-		-		-		-	-	-	-	18	92	17	73
Riffle Slope (ft/ft)		0.001	0.0250	0.0019	0.017	0.0030	0.0080	-		0.0606	0.0892	0.0100	0.0670	0.0060	0.0080	0.0070	0.0147	0.0039	0.0215	0.0021	0.0280
Pool Length (ft)						-		-		-		-		-		-		32	141	46	85
Pool Max Depth (ft)		2.09	3.65	2.27	3.33	2.4		4.6		2.2		2.5		2.8	4.0	2.9	4.0	3.7	4.2	3.6	4.0
Pool Spacing (ft)^		39	60	27	76	32	80	75		26	81	13	47	76	133	77	135	57	236	91	142
Pool Volume (ft^3)																					
Pattern																					
Channel Beltwidth (ft)	n/a	39	81	46	94	-		31	32	-		24	52	57	152	58	154	52	151	49	86
Radius of Curvature (ft)		57	114	100	251	-		16	27	-		5	22	38	57	38	58	38	59	38	62
Rc:Bankfull Width (ft/ft)		3.2	6.4	6.6	14.6	-		2.2	4.1	-		1.5	2.8	2	3	2	3	2.0	3.1	2	3
Meander Wave Length (ft)		86	175	175	348	-		71	101	-		54	196	152	228	154	231	150	235	166	229
Meander Width Ratio		2.2	4.6	3	5.5	-		2.15	2.22	-		2.8	6	3	8	3	8	2.7	7.9	3	5
Substrate, Bed and Transport Parameters																					
Ri%/Ru%/P%/G%/S%	n/a																				
SC%/Sa%/G%/C%/B%/Be%																					
d16/d35/d50/d84/d95/d100		0.1/0.6/14.8/56.1/98.3/>2048		0.1/0.3/4.5/24.7/31.3/45.0		N/A		N/A		N/A		N/A						<0.062/<0.062/22.6/48.53/64.0/128		<0.062/<0.062/18.55/48.28/78.53/180.0	
Reach Shear Stress (Competency) lb/ft^2		0.88		0.42										0.38		0.43		0.38	0.41	0.40	
Max part size (mm) mobilized at bankfull																					
Stream Power (Capacity) W/m^2																					
Additional Reach Parameters																					
Drainage Area (SM)	n/a	0.67	0.82	0.82	0.91	1.68		3.40		1.1		0.5		0.82		0.91		0.82		0.91	
Watershed Impervious Cover Estimate (%)		17		17		-		-		-		-		17		17		17		17	
Rosgen Classification		G4c		G4c		E4		E5		E4b		E4/C4		C4		C4		C		C	
Bankfull Velocity (fps)		3.3		3.00	3.30									3.0		3.3		2.7	3.1	3.1	3.4
Bankfull Discharge (cfs)		90		100		115	150	125		85		N/A		90		100		90		100	
Q-NFF regression		110		126																	
Q-USGS extrapolation		-		-																	
Q-Mannings		122		99	102	-															
Valley Length (ft)		1490.9		1505.0		-		-		-		-		-		-					
Channel Thalweg Length (ft)		1640.0		1505.0		-		-		-		-		2057*		1919*		2095*		1932*	
Sinuosity (ft)		1.1		1.0		-		1.2		1.1		1.05		1.3		1.2		1.3		1.2	
Water Surface Slope (ft/ft)		-		-		0.003		0.007		0.0235		0.0132		-		-		N/A[1]		N/A[1]	
Bankfull Slope (ft/ft)		0.0107		0.0043		-		-		-		-		0.0045		0.0049		0.0045		0.0047	

(-): Data was not provided
N/A: Not Applicable

[1]Design parameters were expanded during the final design phase.
*LF provided included portions of the stream that will be monitored and have been reconstructed, but for which mitigation credit will not be claimed. Please refer to Table 1 in Appendix 1 for the credit summary lengths.
^Pool to pool spacing calculations were measured using the most downstream pool in the meander for the as-built compared to the design pool to pool spacing, which included pools and plunge pools in the min and max values.

Appendix 4. Morphological Summary Data and Plots
Table 10b. Baseline Stream Data Summary
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Little Troublesome Creek and UT1
Monitoring Year 1

Parameter	Gage	Pre-Restoration Condition[1]				Reference Reach Data		Design[1]				As-Built / Baseline			
		UT1		Little Troublesome Creek				UT1[2]		Little Troublesome		UT1[2]		Little Troublesome Creek	
		Min	Max			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle															
Bankfull Width (ft)	n/a	5.2		28.7		refer to table 5a		7.8		32.3		10.9		32.6	48.8
Floodprone Width (ft)		8.0		93.0				100+		285+		36.7		200+	
Bankfull Mean Depth		1.2		2.6				0.6		2.7		0.5		1.6	2.7
Bankfull Max Depth		1.9		3.3				0.9		3.8		1		4.1	4.2
Bankfull Cross-sectional Area (ft^2)		6.4		73.6				5.0		86.6		5.1		79.6	87.1
Width/Depth Ratio		4.3		11.2				12.0		12.0		23		12.2	30
Entrenchment Ratio		1.5		3.2				2.2+		2.2+		2.2+		2.2+	
Bank Height Ratio		1.2	2.5	1.6	2.8			1.0		1.0		1.0		1.0	
d50 (mm)		0.8		9.7								0.4		20.7	
Profile															
Riffle Length (ft)	n/a					refer to table 5a		-		-		11	26	79	142
Riffle Slope (ft/ft)[1]		0.0072	0.05	0.0007	0.0110			0.0185	0.0369	0.0066	0.0088	0.0231	0.0600	0.0063	0.0126
Pool Length (ft)								-		-		18	48	88	159
Pool Max Depth (ft)		2.24	3.31	3.19	5.25			1.2	1.6	4.8	6.7	1.2		5.9	
Pool Spacing (ft)^		29	42	46	127			24	43	129	226	35	59	206	267
Pool Volume (ft^3)															
Pattern															
Channel Beltwidth (ft)	n/a	-		119		refer to table 5a		27	62	113	258	27	62	113	258
Radius of Curvature (ft)		-		103	313			16	23	65	97	16	23	65	97
Rc:Bankfull Width (ft/ft)		-		3.6	10.9			2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Meander Wave Length (ft)		-		179	315			62	94	258	388	62	94	258	388
Meander Width Ratio		-		4.1				3.5	8.0	3.5	8.0	3.5	8.0	3.5	8.0
Substrate, Bed and Transport Parameters															
Ri%/Ru%/P%/G%/S%	n/a					refer to table 5a									
SC%/Sa%/G%/C%/B%/Be%															
d16/d35/d50/d84/d95/d100		.062/<0.062/<0.062/3.55/13.3/>20		0.2/0.5/1.0/22.0/30.2/>2048								<0.062/<0.062/0.4/44.2/64.0/128.0		<0.062/<0.062/20.73/61.79/110.07/180.0	
Reach Shear Stress (Competency) lb/ft^2		0.96		0.41				N/A[3]		N/A[3]		0.34		0.38	0.53
Max part size (mm) mobilized at bankfull															
Stream Power (Capacity) W/m^2															
Additional Reach Parameters															
Drainage Area (SM)	n/a	0.1		4.95	5.07	refer to table 5a		0.1		5.07		0.1		5.07	
Watershed Impervious Cover Estimate (%)		17		17				17		17		17		17	
Rosgen Classification		G5		C5				C5		C5		C5		C4	
Bankfull Velocity (fps)		4.4		5.0				2.7		4.3		2.7		4.2	4.6
Bankfull Discharge (cfs)		14		370				14		370		14		370	
Q-NFF regression		-		422											
Q-USGS extrapolation		-		-											
Q-Mannings		-		237											
Valley Length (ft)		184		982				-		-					
Channel Thalweg Length (ft)		184		1080				240		1158*		233		1171*	
Sinuosity (ft)		1.0		1.1				1.3		1.3		1.2		1.3	
Water Surface Slope (ft/ft)		-		-				-		-		N/A[1]		N/A[1]	
Bankfull Slope (ft/ft)		0.0183		0.0033				0.0123		0.0044		0.0126		0.0038	

(-): Data was not provided
N/A: Not Applicable

[1]Design parameters were expanded during the final design phase.

[2]Restoration approach was adjusted from a priority 1 to a priority 2 during the final design phase.

[3]The critical shear stress analysis was not perfomed on the sand bed channels.

*LF provided included portions of the stream that will be monitored and have been reconstructed, but for which mitigation credit will not be claimed. Please refer to Table 1 in Appendix 1 for the credit summary lengths.

^Pool to pool spacing calculations were measured using the most downstream pool in the meander for the as-built compared to the design pool to pool spacing, which included pools and plunge pools in the min and max values.

Appendix 4. Morphological Summary Data and Plots
Table 11. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reaches 1 and 2, Little Troublesome Creek, UT1
Monitoring Year 1

	Irvin Creek Reach 1																							
	Cross-Section 1 (Riffle)						Cross-Section 2 (Pool)						Cross-Section 3 (Pool)						Cross-Section 4 (Riffle)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
based on fixed bankfull elevation																								
Bankfull Width (ft)	18.6	17.7					19.9	18.0					31.1	31.1					19.7	20.2				
Floodprone Width (ft)	200+	200+					N/A	N/A					N/A	N/A					200+	200+				
Bankfull Mean Depth (ft)	1.6	1.5					1.9	2.2					1.9	1.9					1.7	1.7				
Bankfull Max Depth (ft)	2.4	2.5					3.7	4.0					4.2	4.2					2.6	2.7				
Bankfull Cross-Sectional Area (ft^2)	29.3	27.2					36.8	38.6					57.6	57.6					33.7	34.4				
Bankfull Width/Depth Ratio	11.8	11.6					10.7	8.4					16.8	16.8					11.5	11.9				
Bankfull Entrenchment Ratio	2.2+	2.2+					N/A	N/A					N/A	N/A					2.2+	2.2+				
Bankfull Bank Height Ratio	1.0	1.0					1.0	1.0					1.0	1.0					1.0	1.0				
	Irvin Creek Reach 2																							
	Cross-Section 5 (Pool)						Cross-Section 6 (Riffle)						Cross-Section 7 (Riffle)						Cross-Section 8 (Pool)					
based on fixed bankfull elevation	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
Bankfull Width (ft)	35.3	35.6					18.1	18.6					20.9	20.9					29.2	32.0				
Floodprone Width (ft)	N/A	N/A					200+	200+					200+	200+					N/A	N/A				
Bankfull Mean Depth (ft)	1.4	1.3					1.6	1.5					1.6	1.4					1.7	1.6				
Bankfull Max Depth (ft)	4.0	4.1					2.4	2.5					2.4	2.4					3.6	3.6				
Bankfull Cross-Sectional Area (ft^2)	47.9	46.0					29.0	27.8					32.7	28.7					50.1	50.0				
Bankfull Width/Depth Ratio	26.0	27.5					11.3	12.4					13.3	15.2					17.0	20.5				
Bankfull Entrenchment Ratio	N/A	N/A					2.2+	2.2+					2.2+	2.2+					N/A	N/A				
Bankfull Bank Height Ratio	1.0	1.0					1.0	1.0					1.0	1.0					1.0	1.0				
	UT1												Little Troublesome Creek											
	Cross-Section 9 (Riffle)						Cross-Section 10 (Pool)						Cross-Section 11 (Riffle)						Cross-Section 12 (Pool)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
based on fixed bankfull elevation																								
Bankfull Width (ft)	10.9	8.0					9.3	9.6					32.6	33.0					41.0	42.2				
Floodprone Width (ft)	36.7	35.7					N/A	N/A					200+	200+					N/A	N/A				
Bankfull Mean Depth (ft)	0.5	0.5					0.7	0.6					2.7	2.6					3.1	3.1				
Bankfull Max Depth (ft)	1.0	1.0					1.2	1.2					4.1	4.0					5.9	6.5				
Bankfull Cross-Sectional Area (ft^2)	5.1	4.1					6.4	5.6					87.1	84.6					125.3	128.8				
Bankfull Width/Depth Ratio	23.0	15.5					13.5	16.6					12.2	12.9					13.4	13.8				
Bankfull Entrenchment Ratio	2.2+	2.2+					N/A	N/A					2.2+	2.2+					N/A	N/A				
Bankfull Bank Height Ratio	1.0	1.0					1.0	1.0					1.0	1.0					1.0	1.0				
	Little Troublesome Creek																							
	Cross-Section 13 (Riffle)																							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**																		
based on fixed bankfull elevation																								
Bankfull Width (ft)	48.8	35.7																						
Floodprone Width (ft)	200+	200+																						
Bankfull Mean Depth (ft)	1.6	2.1																						
Bankfull Max Depth (ft)	4.2	3.9																						
Bankfull Cross-Sectional Area (ft^2)	79.6	74.8																						
Bankfull Width/Depth Ratio	30.0	17.1																						
Bankfull Entrenchment Ratio	2.2+	2.2+																						
Bankfull Bank Height Ratio	1.0	1.0																						

Appendix 4. Morphological Summary Data and Plots
Table 12a. Monitoring Data - Stream Reach Data Summary
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 1
Monitoring Year 1

Parameter	As-Built/Baseline		MY-1			MY-2			MY-3			MY-4			MY-5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	18.6	19.7	17.7	19.0	20.2												
Floodprone Width (ft)	200+	200+	200+	200+	200+												
Bankfull Mean Depth	1.6	1.7	1.5	1.6	1.7												
Bankfull Max Depth	2.4	2.6	2.5	2.6	2.7												
Bankfull Cross-sectional Area (ft^2)	29.3	33.7	27.2	30.8	34.4												
Width/Depth Ratio	11.5	11.8	11.6	11.7	11.9												
Entrenchment Ratio	2.2+	2.2+	2.2+	2.2+	2.2+												
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0												
D50 (mm)			35.0	-	44.2												
Profile																	
Riffle Length (ft)	18	92	11	41	79												
Riffle Slope (ft/ft)	0.0039	0.0215	0.0008	0.0075	0.0174												
Pool Length (ft)	32	141	33	63	153												
Pool Max Depth (ft)	3.7	4.2	3.5	4.2	6.3												
Pool Spacing (ft)	57	236	63	105	227												
Pool Volume (ft^3)																	
Pattern																	
Channel Beltwidth (ft)	52	151															
Radius of Curvature (ft)	38	59															
Rc:Bankfull Width (ft/ft)	2.0	3.1															
Meander Wave Length (ft)	150	235															
Meander Width Ratio	2.7	7.9															
Additional Reach Parameters																	
Rosgen Classification	C		C														
Channel Thalweg Length (ft)	2095		2095														
Sinuosity (ft)	1.3		1.3														
Water Surface Slope (ft/ft)	N/A		0.0044														
Bankfull Slope (ft/ft)	0.0045		0.0048														
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	<0.062/<0.062/22.6/48.53/64.0/128		0.2/0.7/9.7/38.4/57.9/362.0														
% of Reach with Eroding Banks			0%														

(-): Data was not provided
N/A: Not Applicable

Appendix 4. Morphological Summary Data and Plots
Table 12b. Monitoring Data - Stream Reach Data Summary
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 2
Monitoring Year 1

Parameter	As-Built / Baseline		MY-1			MY-2			MY-3			MY-4			MY-5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	18.1	20.9	18.6	19.8	20.9												
Floodprone Width (ft)	200+	200+	200+	200+	200+												
Bankfull Mean Depth	1.6	1.6	1.4	1.5	1.5												
Bankfull Max Depth	2.4	2.4	2.4	2.5	2.5												
Bankfull Cross-sectional Area (ft^2)	29.0	32.7	27.8	28.3	28.7												
Width/Depth Ratio	11.3	13.3	12.4	13.8	15.2												
Entrenchment Ratio	2.2+	2.2+	2.2+	2.2+	2.2+												
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0												
D50 (mm)			18.6	-	39.8												
Profile																	
Riffle Length (ft)	17	73	21	59	72												
Riffle Slope (ft/ft)	0.0021	0.0280	0.0026	0.0087	0.0149												
Pool Length (ft)	46	85	52	64	89												
Pool Max Depth (ft)	3.6	4.0	3.1	3.8	6.0												
Pool Spacing (ft)	91	142	89	123	139												
Pool Volume (ft^3)																	
Pattern																	
Channel Beltwidth (ft)	49	86															
Radius of Curvature (ft)	38	62															
Rc:Bankfull Width (ft/ft)	2	3															
Meander Wave Length (ft)	166	229															
Meander Width Ratio	3	5															
Additional Reach Parameters																	
Rosgen Classification	C		C														
Channel Thalweg Length (ft)	1932		1932														
Sinuosity (ft)	1.2		1.2														
Water Surface Slope (ft/ft)	N/A		0.0045														
Bankfull Slope (ft/ft)	0.0047		0.0049														
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	<0.062/<0.062/18.55/48.28/78.53/180.0		0.1/0.4/5.6/66.2/103.6/512.0														
% of Reach with Eroding Banks			0%														

(-): Data was not provided
N/A: Not Applicable

Appendix 4. Morphological Summary Data and Plots
Table 12c. Monitoring Data - Stream Reach Data Summary
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
UT1
Monitoring Year 1

Parameter	As-Built / Baseline		MY-1			MY-2			MY-3			MY-4			MY-5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	10.9		8.0														
Floodprone Width (ft)	36.7		35.7														
Bankfull Mean Depth	0.5		0.5														
Bankfull Max Depth	1.0		1.0														
Bankfull Cross-sectional Area (ft^2)	5.1		4.1														
Width/Depth Ratio	23.0		15.5														
Entrenchment Ratio	2.2+		2.2+														
Bank Height Ratio	1.0		1.0														
D50 (mm)			13.3														
Profile																	
Riffle Length (ft)	11	26	14	20	31												
Riffle Slope (ft/ft)	0.0231	0.0600	0.0089	0.0217	0.0448												
Pool Length (ft)	18	48	15	23	36												
Pool Max Depth (ft)	1.2		1.2	1.3	1.4												
Pool Spacing (ft)	35	59	43	52	62												
Pool Volume (ft^3)																	
Pattern																	
Channel Beltwidth (ft)	27	62															
Radius of Curvature (ft)	16	23															
Rc:Bankfull Width (ft/ft)	2.0	3.0															
Meander Wave Length (ft)	62	94															
Meander Width Ratio	3.5	8.0															
Additional Reach Parameters																	
Rosgen Classification	C5		C5														
Channel Thalweg Length (ft)	233		233														
Sinuosity (ft)	1.2		1.2														
Water Surface Slope (ft/ft)	N/A		0.0120														
Bankfull Slope (ft/ft)	0.0126		0.0121														
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	<0.062/<0.062/0.4/44.2/64.0/128.0		<0.062/0.1/0.5/50.6/90.0/128.0														
% of Reach with Eroding Banks			0%														

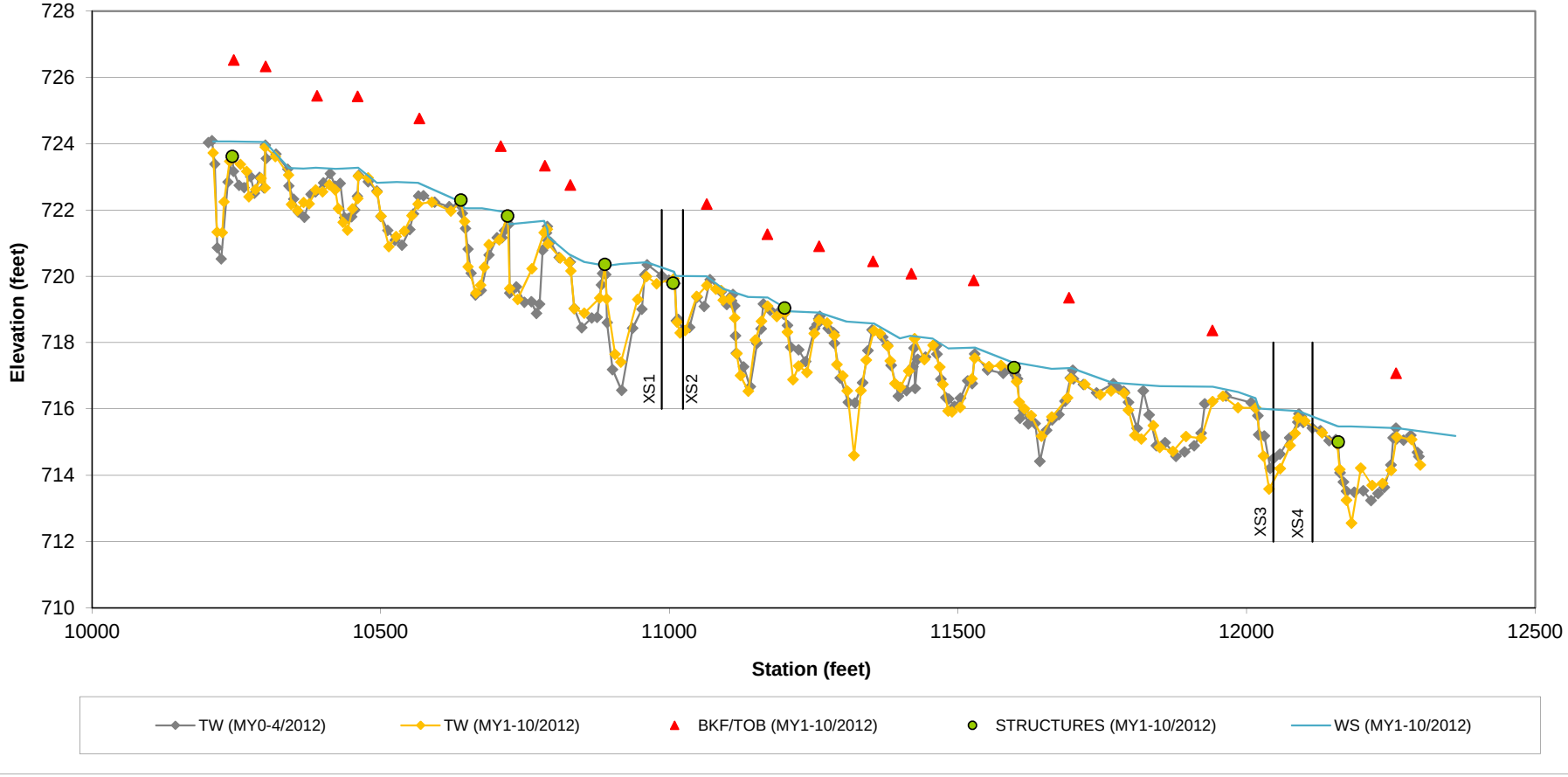
(-): Data was not provided
N/A: Not Applicable

Appendix 4. Morphological Summary Data and Plots
Table 12d. Monitoring Data - Stream Reach Data Summary
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Little Troublesome Creek
Monitoring Year 1

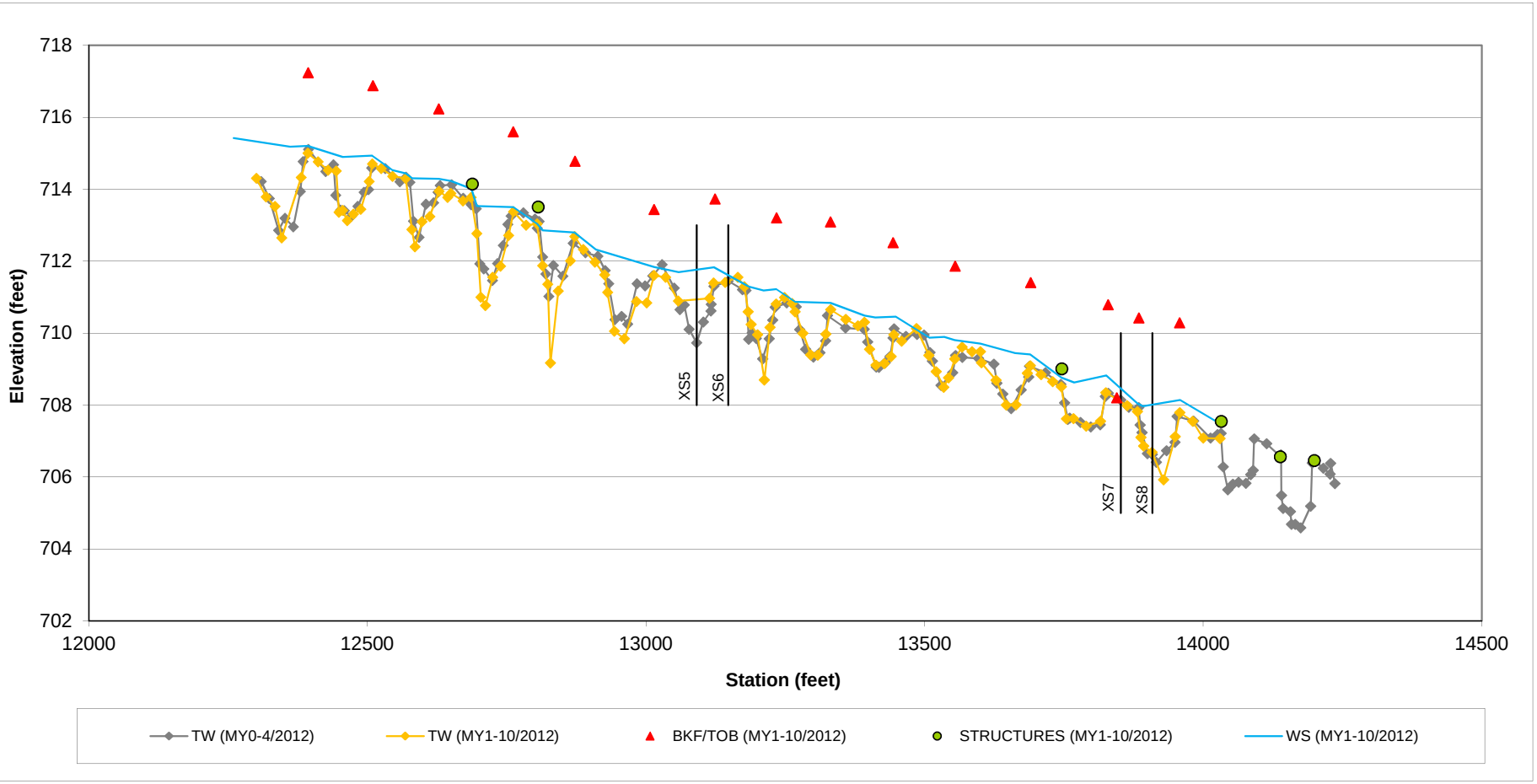
Parameter	As-Built / Baseline		MY-1			MY-2			MY-3			MY-4			MY-5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	32.6	48.8	33.0	34.4	35.7												
Floodprone Width (ft)	200+		200+	200+	200+												
Bankfull Mean Depth	1.6	2.7	2.1	2.4	2.6												
Bankfull Max Depth	4.1	4.2	3.9	4.0	4.0												
Bankfull Cross-sectional Area (ft^2)	79.6	87.1	74.8	79.7	84.6												
Width/Depth Ratio	12.2	30	12.9	15.0	17.1												
Entrenchment Ratio	2.2+		0.0	-	2.2+												
Bank Height Ratio	1.0		1.0	1.0	1.0												
d50 (mm)			32.7	-	39.7												
Profile																	
Riffle Length (ft)	79	142	74	107	147												
Riffle Slope (ft/ft)	0.0063	0.0126	0.0061	0.0071	0.0178												
Pool Length (ft)	88	159	88	121	168												
Pool Max Depth (ft)	5.9		6.0	6.3	7.7												
Pool Spacing (ft)	206	267	194	219	297												
Pool Volume (ft^3)																	
Pattern																	
Channel Beltwidth (ft)	113	258															
Radius of Curvature (ft)	65	97															
Rc:Bankfull Width (ft/ft)	2.0	3.0															
Meander Wave Length (ft)	258	388															
Meander Width Ratio	3.5	8.0															
Additional Reach Parameters																	
Rosgen Classification	C4		C4														
Channel Thalweg Length (ft)	1171		1171														
Sinuosity (ft)	1.3		1.3														
Water Surface Slope (ft/ft)	N/A		0.0039														
Bankfull Slope (ft/ft)	0.0038		0.0039														
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	<0.062/<0.062/20.73/61.79/110.07/180.0		<0.062/0.3/8.0/74.1/165.3/512.0														
% of Reach with Eroding Banks			0%														

(-): Data was not provided
N/A: Not Applicable

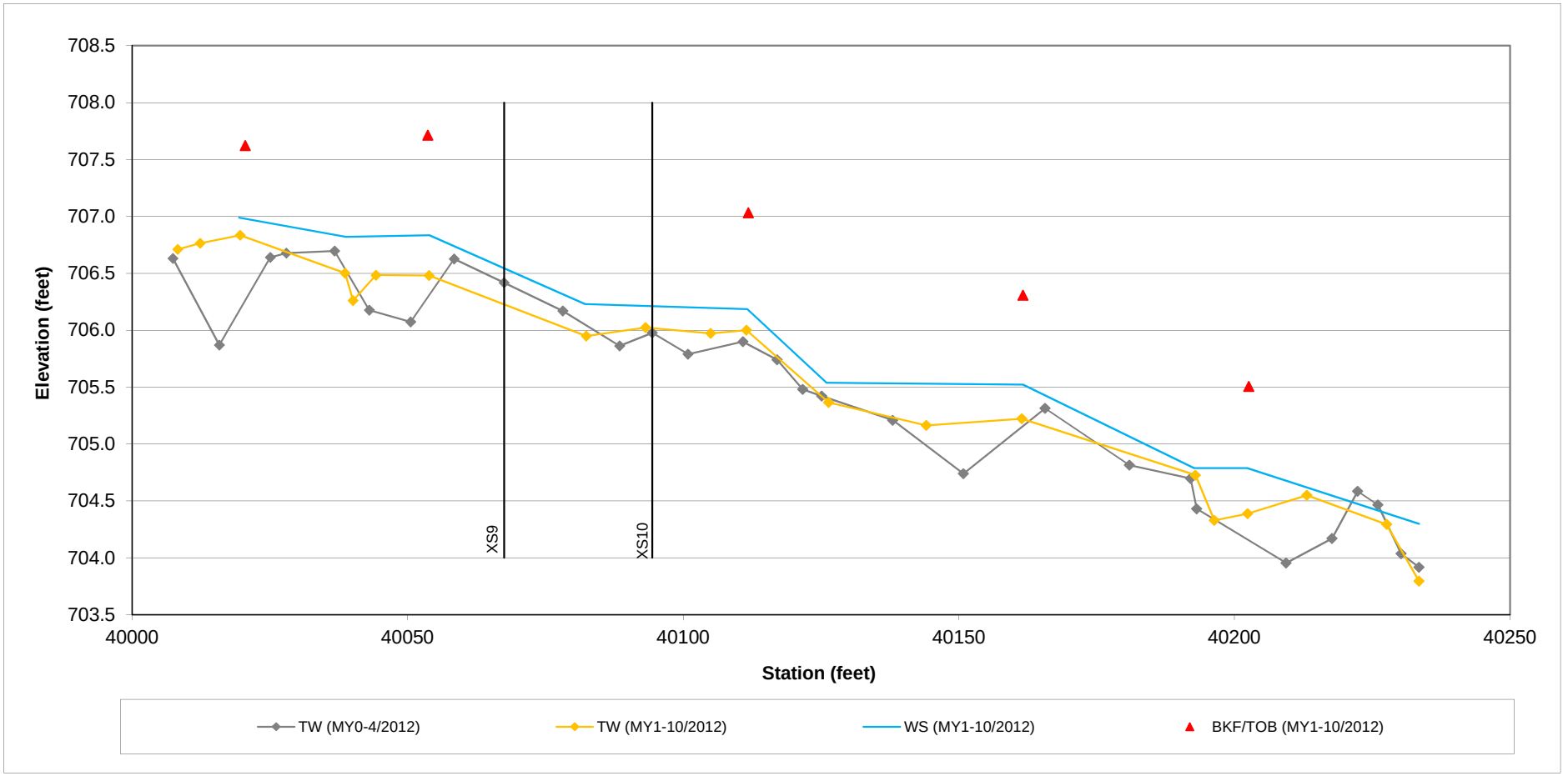
Appendix 4. Morphological Summary Data and Plots
Figure 4a. Longitudinal Profile Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 1
Monitoring Year 1



Appendix 4. Morphological Summary Data and Plots
Figure 4b. Longitudinal Profile Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 2
Monitoring Year 1



Appendix 4. Morphological Summary Data and Plots
Figure 4c. Longitudinal Profile Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
UT1
Monitoring Year 1



Appendix 4. Morphological Summary Data and Plots
Figure 4d. Longitudinal Profile Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Little Troublesome Creek
Monitoring Year 1

Appendix 4. Morphological Summary Data and Plots
Figure 5a. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 1, Cross-Section 1 (Riffle)
Monitoring Year 1

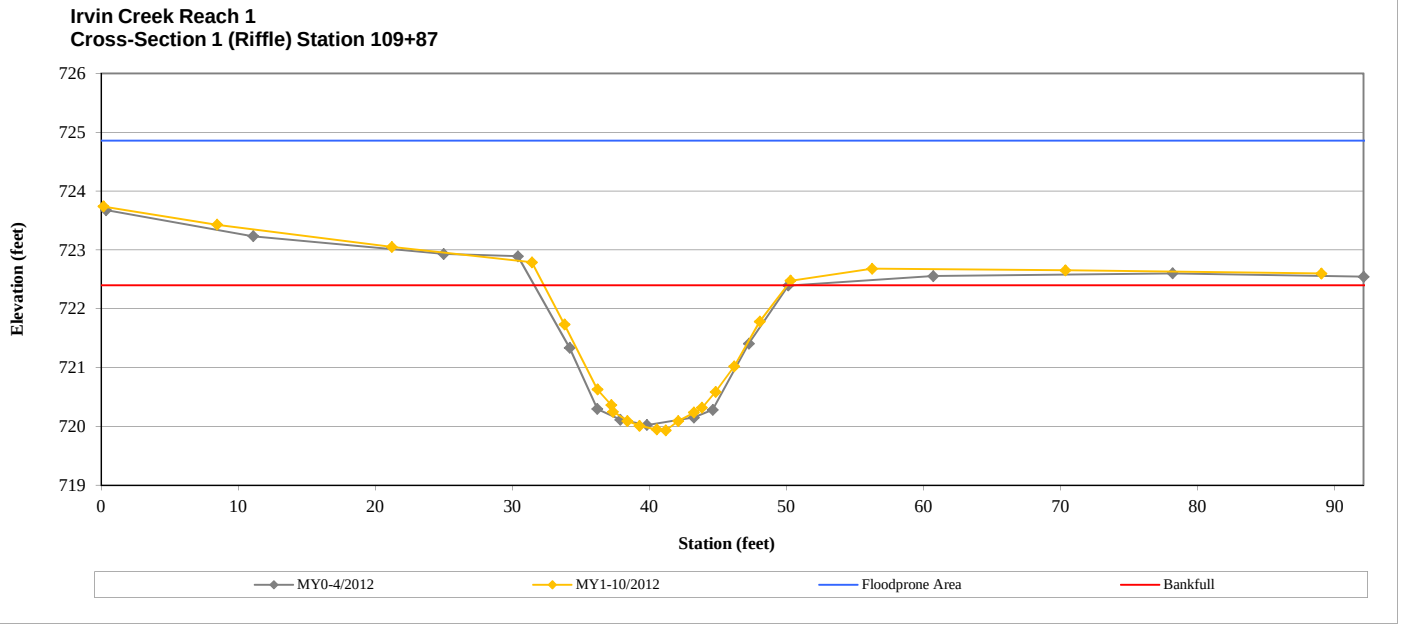
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	1
Drainage Area	0.8 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	722.4
Bankfull Cross-Sectional Area (ft2)	27.2
Bankfull Width (ft)	17.7
Flood Prone Area Elevation (ft)	724.86
Flood Prone Width (ft)	200+
Max Depth at Bankfull (ft)	2.5
Mean Depth at Bankfull (ft)	1.5
W/D Ratio	11.56
Entrenchment Ratio	2.2+
Bank Height Ratio	1.0
Stream Type	C

Cross-Section 1: View Upstream (10/18/2012)

Cross-Section 1: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.17	723.74		
8.46	723.43		
21.21	723.05		
31.43	722.79		
33.82	721.73		
36.22	720.63		
37.23	720.36		
37.35	720.25		
38.40	720.09		
39.29	720.01		
40.55	719.95		
41.20	719.94		
42.11	720.09		
43.26	720.24		
43.84	720.32		
44.83	720.59		
46.19	721.02		
48.06	721.78		
50.31	722.48		
56.26	722.68		
70.37	722.65		
89.05	722.60		



Appendix 4. Morphological Summary Data and Plots
Figure 5b. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 1, Cross-Section 2 (Pool)
Monitoring Year 1

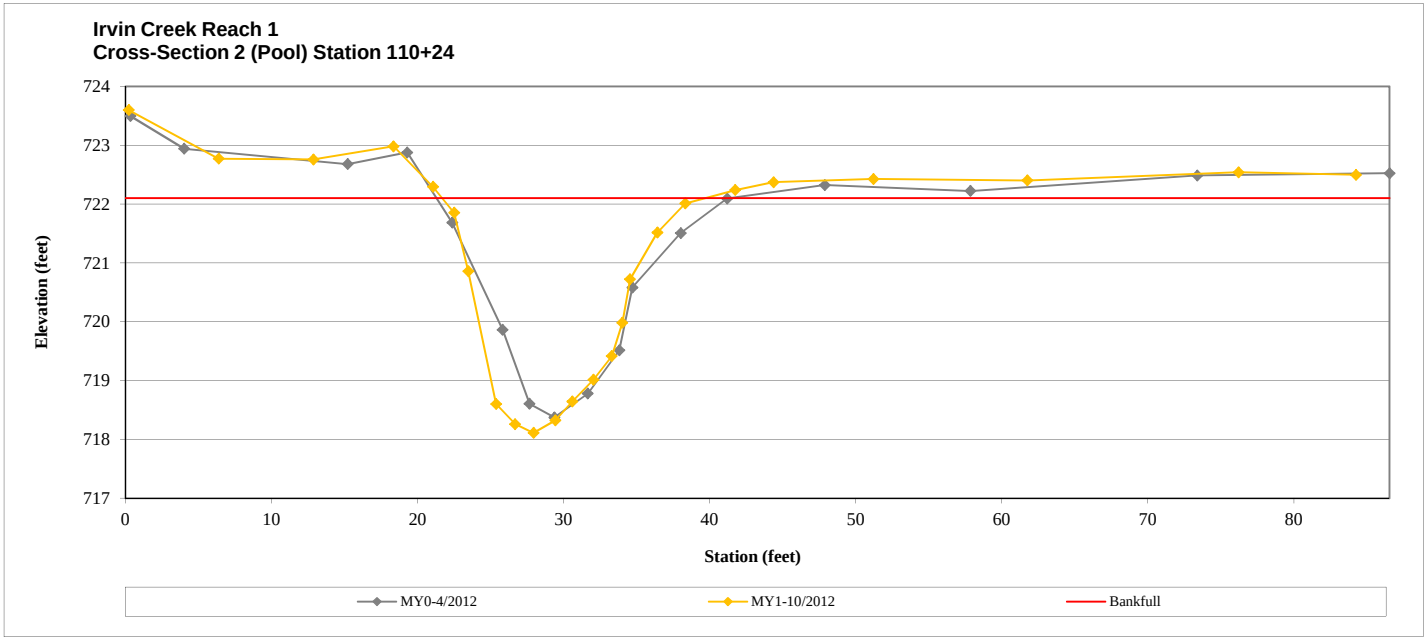
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	2
Drainage Area	0.8 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	722.1
Bankfull Cross-Sectional Area (ft2)	38.6
Bankfull Width (ft)	17.99
Flood Prone Area Elevation (ft)	N/A
Flood Prone Width (ft)	N/A
Max Depth at Bankfull (ft)	3.99
Mean Depth at Bankfull (ft)	2.15
W/D Ratio	8.38
Entrenchment Ratio	N/A
Bank Height Ratio	1.0
Stream Type	N/A

Cross-Section 2: View Upstream (10/18/2012)

Cross-Section 2: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.22	723.60		
6.38	722.77		
12.88	722.76		
18.36	722.98		
21.06	722.29		
22.51	721.85		
23.47	720.86		
25.38	718.60		
26.68	718.26		
27.94	718.11		
29.43	718.32		
30.61	718.65		
32.04	719.01		
33.30	719.42		
34.02	719.98		
34.55	720.72		
36.42	721.52		
38.33	722.01		
41.76	722.24		
44.38	722.37		
51.22	722.43		
61.76	722.40		
76.21	722.54		
84.27	722.50		



Appendix 4. Morphological Summary Data and Plots
Figure 5c. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 1, Cross-Section 3 (Pool)
Monitoring Year 1

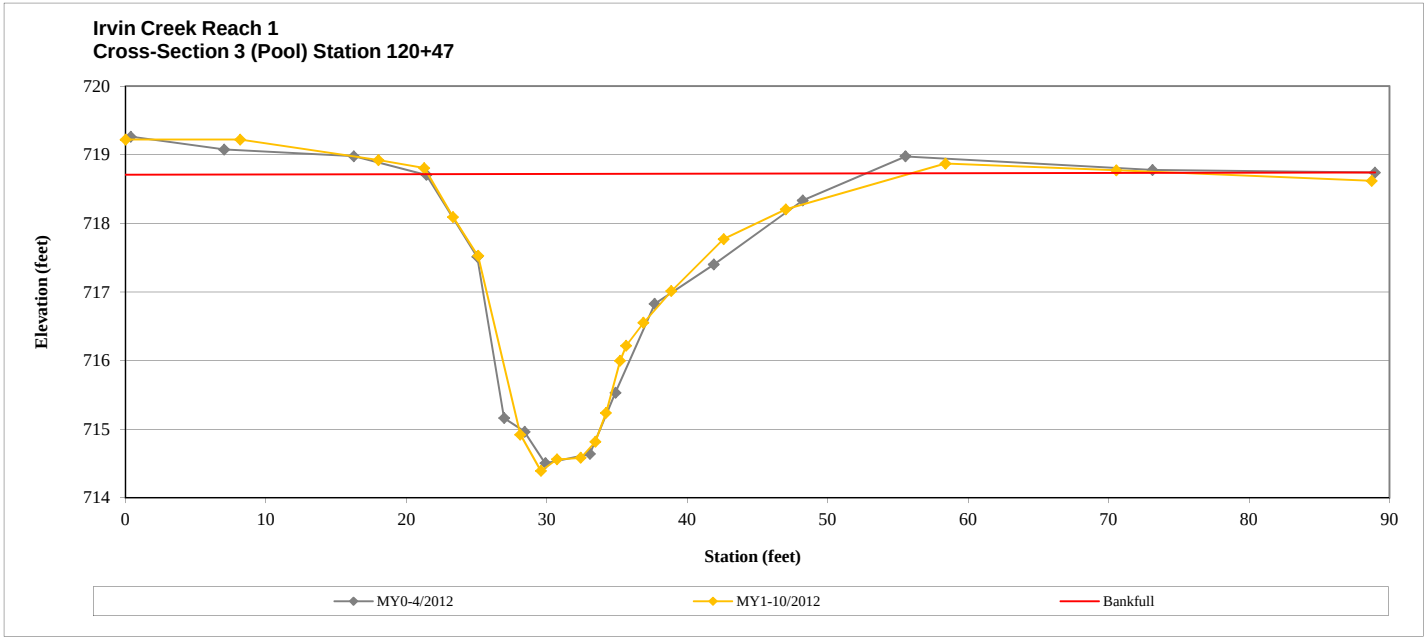
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	3
Drainage Area	0.8 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	718.7
Bankfull Cross-Sectional Area (ft2)	57.6
Bankfull Width (ft)	31.1
Flood Prone Area Elevation (ft)	N/A
Flood Prone Width (ft)	N/A
Max Depth at Bankfull (ft)	4.2
Mean Depth at Bankfull (ft)	1.9
W/D Ratio	16.8
Entrenchment Ratio	N/A
Bank Height Ratio	1.0
Stream Type	N/A

Cross-Section 3: View Upstream (10/18/2012)

Cross-Section 3: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.38	719.26		
7.03	719.08		
16.26	718.98		
21.44	718.71		
25.05	717.51		
26.96	715.16		
28.42	714.96		
29.90	714.51		
33.07	714.64		
34.89	715.53		
37.68	716.83		
41.90	717.40		
48.23	718.33		
55.54	718.98		
73.12	718.78		
88.97	718.74		



Appendix 4. Morphological Summary Data and Plots
Figure 5d. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 1, Cross-Section 4 (Riffle)
Monitoring Year 1

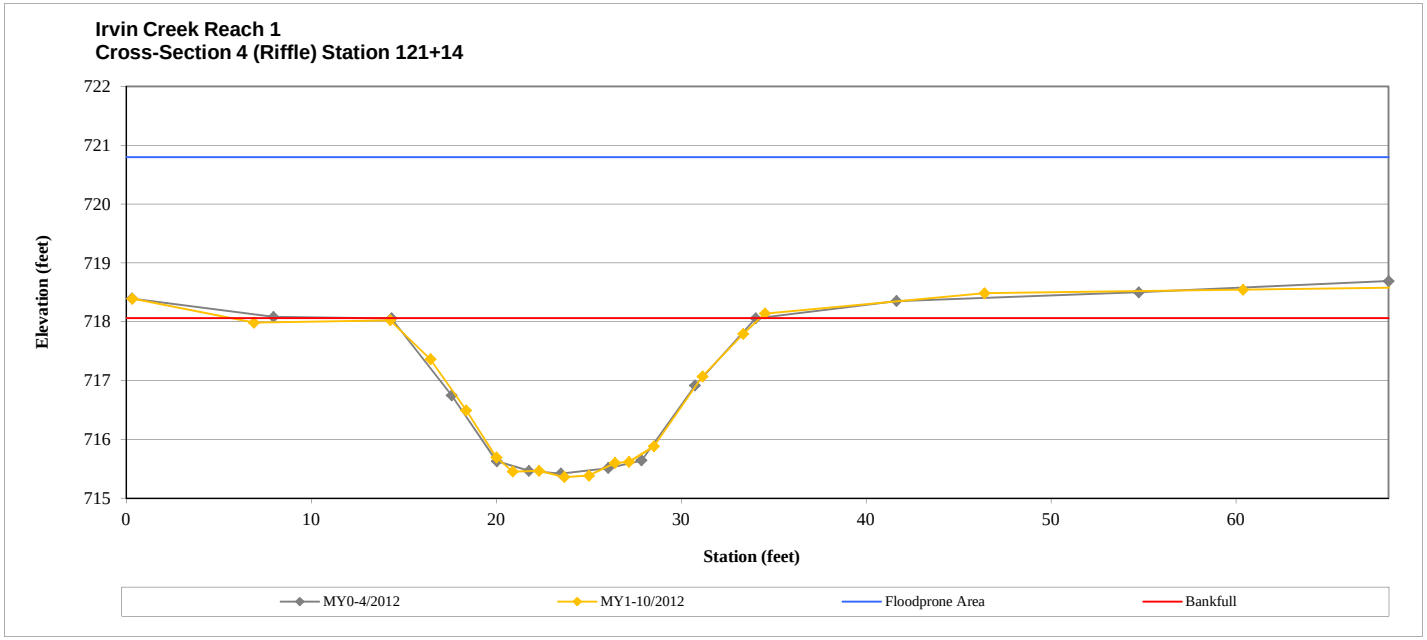
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	4
Drainage Area	0.8 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	718.1
Bankfull Cross-Sectional Area (ft2)	34.4
Bankfull Width (ft)	20.2
Flood Prone Area Elevation (ft)	720.8
Flood Prone Width (ft)	200+
Max Depth at Bankfull (ft)	2.7
Mean Depth at Bankfull (ft)	1.7
W/D Ratio	11.9
Entrenchment Ratio	2.2+
Bank Height Ratio	1.0
Stream Type	C

Cross-Section 4: View Upstream (10/18/2012)

Cross-Section 4: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.34	718.39		
6.92	717.99		
14.28	718.03		
16.46	717.36		
18.39	716.49		
20.02	715.69		
20.90	715.45		
22.33	715.47		
23.69	715.36		
25.02	715.38		
26.42	715.60		
27.19	715.62		
28.53	715.88		
31.16	717.07		
33.36	717.79		
34.54	718.14		
46.41	718.49		
60.38	718.55		
68.31	718.58		



Appendix 4. Morphological Summary Data and Plots
Figure 5e. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 2, Cross-Section 5 (Pool)
Monitoring Year 1

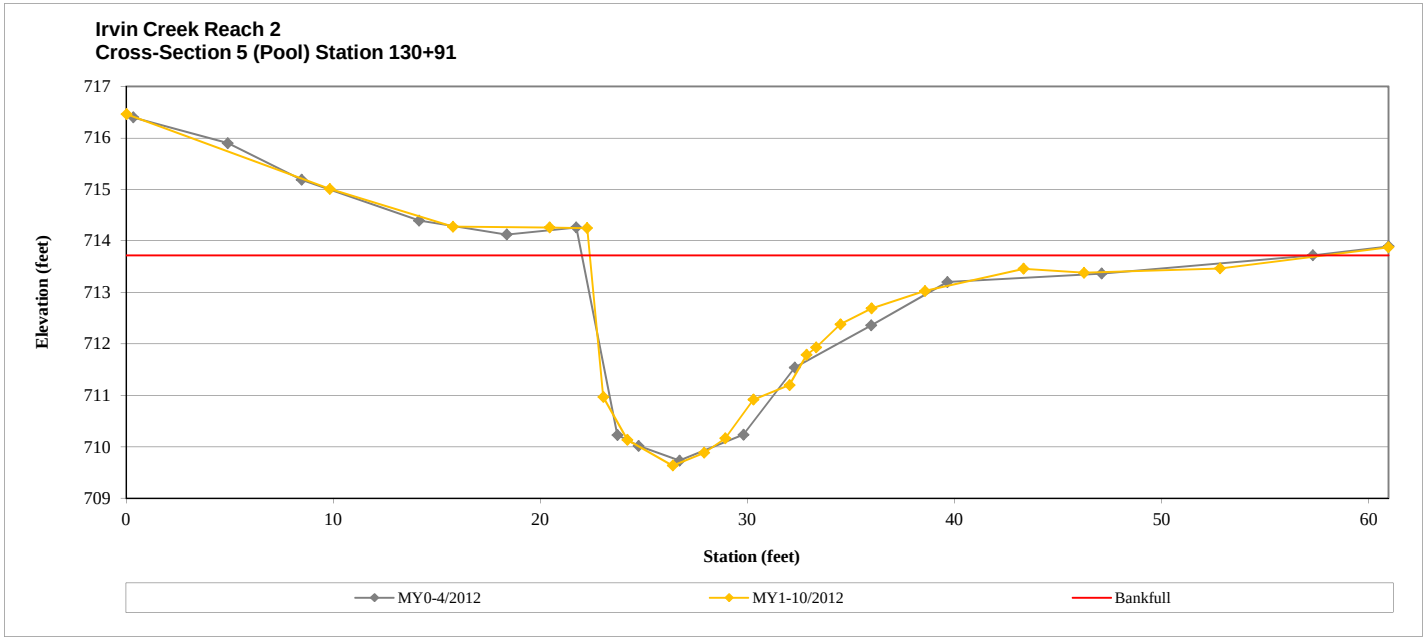
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	5
Drainage Area	0.9 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	713.7
Bankfull Cross-Sectional Area (ft2)	46.0
Bankfull Width (ft)	35.6
Flood Prone Area Elevation (ft)	N/A
Flood Prone Width (ft)	N/A
Max Depth at Bankfull (ft)	4.1
Mean Depth at Bankfull (ft)	1.3
W/D Ratio	27.5
Entrenchment Ratio	N/A
Bank Height Ratio	1.0
Stream Type	N/A

Cross-Section 5: View Upstream (10/18/2012)

Cross-Section 5: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.03	716.46		
9.83	715.01		
15.78	714.28		
20.45	714.26		
22.26	714.25		
23.04	710.97		
24.20	710.14		
26.40	709.64		
27.92	709.88		
28.93	710.17		
30.29	710.92		
32.04	711.20		
32.86	711.79		
33.33	711.93		
34.49	712.38		
35.99	712.69		
38.57	713.03		
43.34	713.46		
46.26	713.38		
52.82	713.46		
60.95	713.87		



Appendix 4. Morphological Summary Data and Plots
Figure 5f. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 2, Cross-Section 6 (Riffle)
Monitoring Year 1

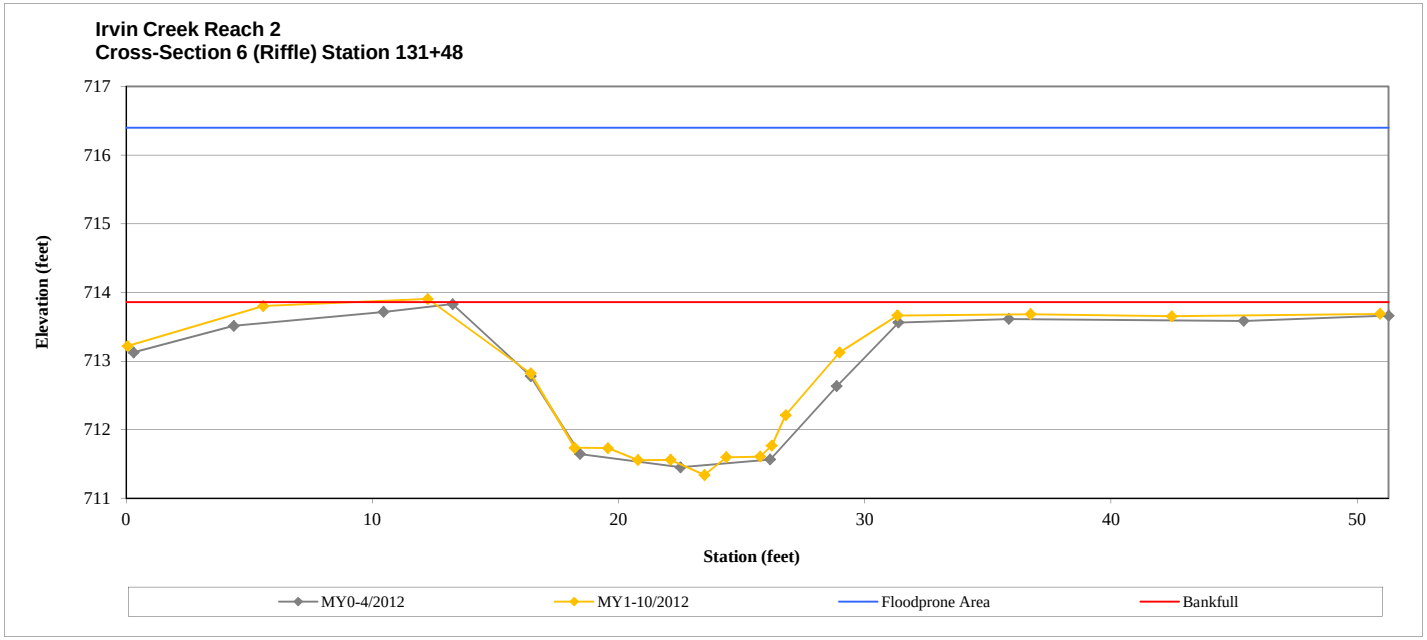
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	6
Drainage Area	0.9 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data*	
Bankfull Elevation (ft)	713.9
Bankfull Cross-Sectional Area (ft2)	27.8
Bankfull Width (ft)	18.6
Flood Prone Area Elevation (ft)	716.4
Flood Prone Width (ft)	200+
Max Depth at Bankfull (ft)	2.5
Mean Depth at Bankfull (ft)	1.5
W/D Ratio	12.4
Entrenchment Ratio	2.2+
Bank Height Ratio	1.0
Stream Type	C

Cross-Section 6: View Upstream (10/18/2012)

Cross-Section 6: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.06	713.22		
5.57	713.80		
12.25	713.90		
16.43	712.82		
18.22	711.74		
19.57	711.73		
20.79	711.56		
22.11	711.56		
23.49	711.34		
24.38	711.60		
25.75	711.61		
26.22	711.77		
26.79	712.21		
28.97	713.12		
31.33	713.66		
36.74	713.68		
42.47	713.65		
50.92	713.69		



Appendix 4. Morphological Summary Data and Plots
Figure 5g. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 2, Cross-Section 7 (Riffle)
Monitoring Year 1

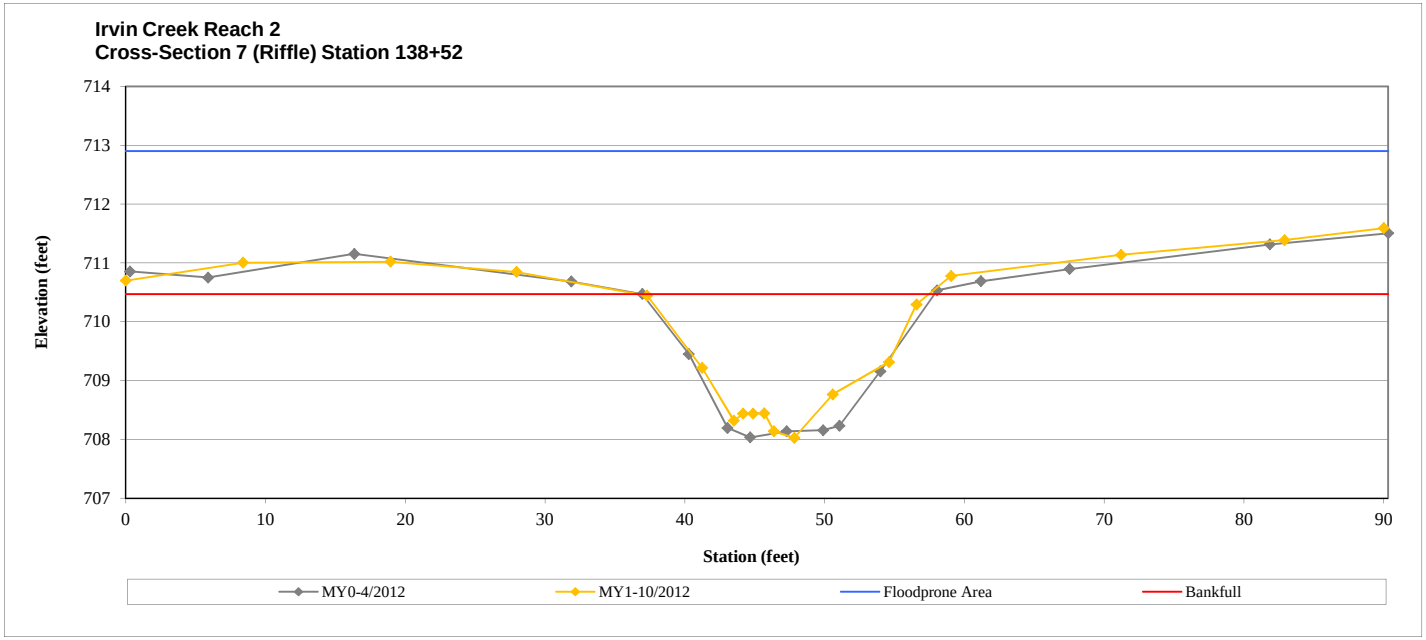
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	7
Drainage Area	0.9 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	710.5
Bankfull Cross-Sectional Area (ft2)	28.7
Bankfull Width (ft)	20.9
Flood Prone Area Elevation (ft)	712.9
Flood Prone Width (ft)	200+
Max Depth at Bankfull (ft)	2.4
Mean Depth at Bankfull (ft)	1.4
W/D Ratio	15.2
Entrenchment Ratio	2.2+
Bank Height Ratio	1.0
Stream Type	C

Cross-Section 7: View Upstream (10/18/2012)

Cross-Section 7: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.00	710.70		
8.40	711.00		
18.95	711.02		
27.96	710.85		
37.31	710.44		
41.23	709.22		
43.51	708.32		
44.17	708.44		
44.89	708.44		
45.69	708.45		
46.37	708.14		
47.83	708.03		
50.59	708.77		
54.62	709.32		
56.57	710.29		
59.04	710.78		
71.21	711.14		
82.91	711.39		
90.00	711.59		



Appendix 4. Morphological Summary Data and Plots
Figure 5h. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 2, Cross-Section 8 (Pool)
Monitoring Year 1

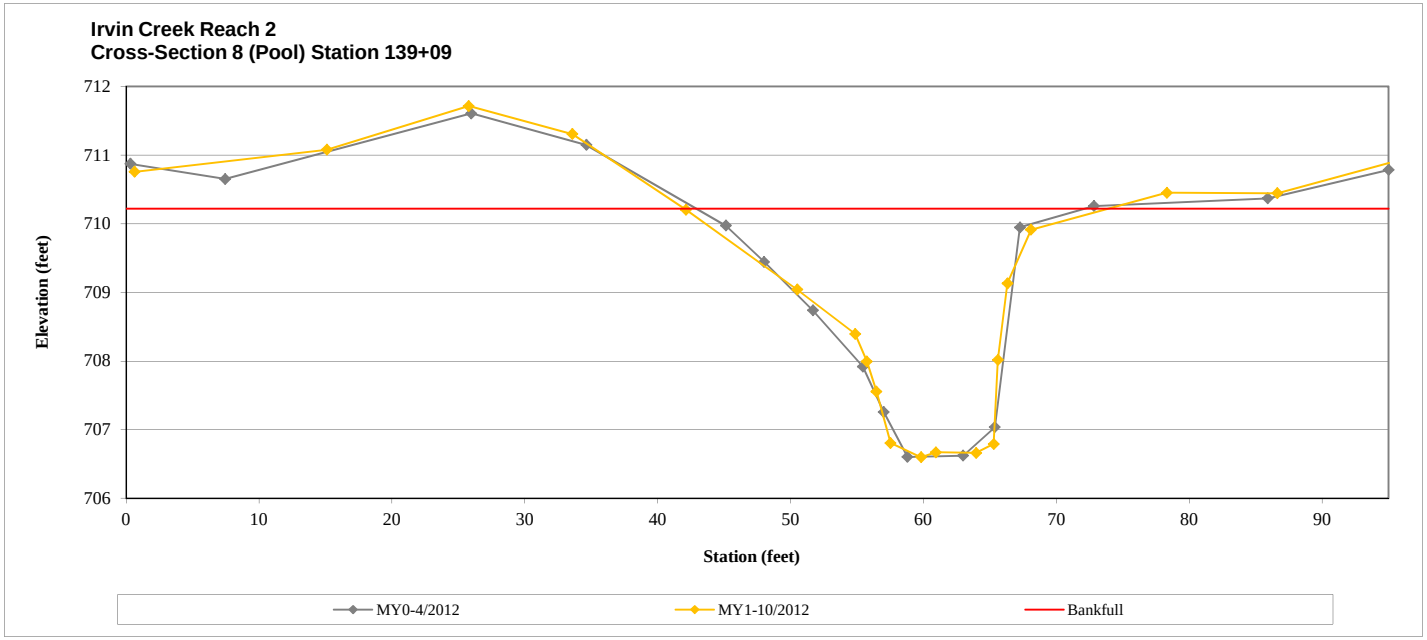
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	8
Drainage Area	0.9 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	710.2
Bankfull Cross-Sectional Area (ft2)	50.0
Bankfull Width (ft)	32.0
Flood Prone Area Elevation (ft)	N/A
Flood Prone Width (ft)	N/A
Max Depth at Bankfull (ft)	3.6
Mean Depth at Bankfull (ft)	1.6
W/D Ratio	20.5
Entrenchment Ratio	N/A
Bank Height Ratio	1.0
Stream Type	N/A

Cross-Section 8: View Upstream (10/18/2012)

Cross-Section 8: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.65	710.76		
15.10	711.08		
25.79	711.71		
33.58	711.31		
42.13	710.20		
50.50	709.04		
54.86	708.40		
55.74	708.00		
56.47	707.56		
57.52	706.81		
59.82	706.60		
60.94	706.67		
63.97	706.66		
65.29	706.79		
65.60	708.02		
66.33	709.13		
68.10	709.91		
78.32	710.45		
86.64	710.45		
95.04	710.89		



Appendix 4. Morphological Summary Data and Plots
Figure 5i. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
UT1, Cross-Section 9 (Riffle)
Monitoring Year 1

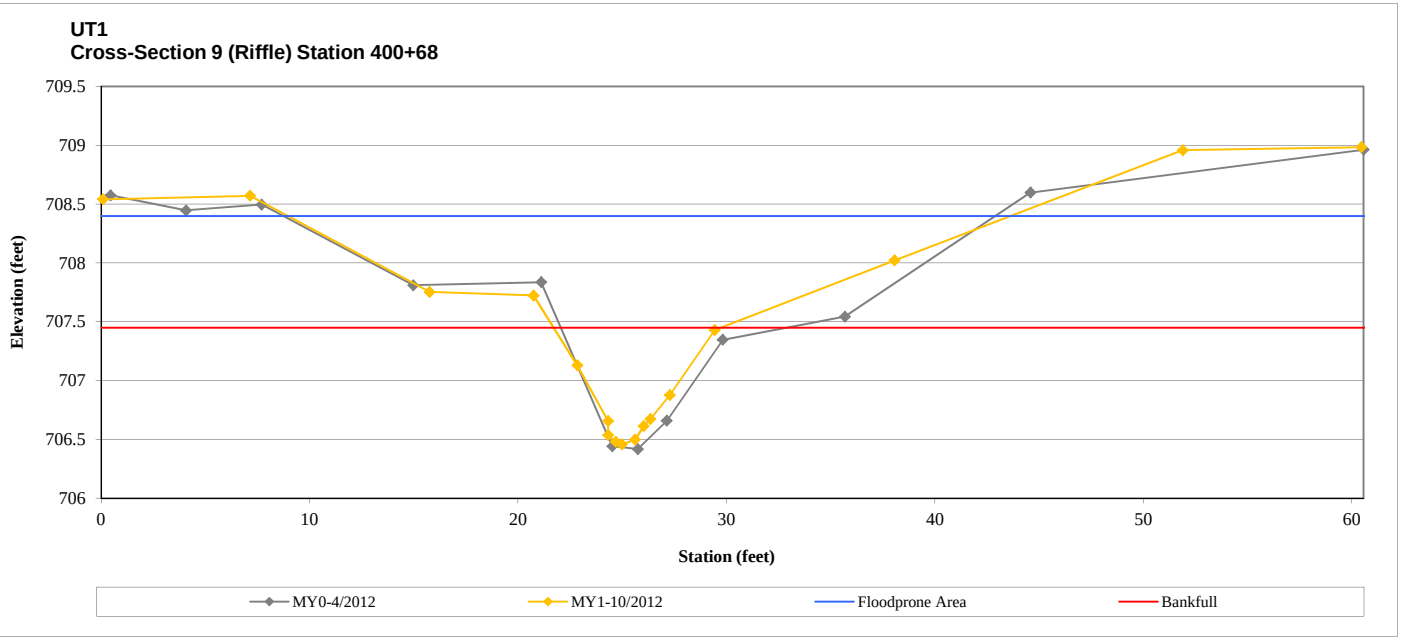
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	9
Drainage Area	0.1 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	707.5
Bankfull Cross-Sectional Area (ft2)	4.1
Bankfull Width (ft)	8.0
Flood Prone Area Elevation (ft)	708.4
Flood Prone Width (ft)	35.7
Max Depth at Bankfull (ft)	1.0
Mean Depth at Bankfull (ft)	0.5
W/D Ratio	15.5
Entrenchment Ratio	2.2+
Bank Height Ratio	1.0
Stream Type	C

Cross-Section 9: View Upstream (10/18/2012)

Cross-Section 9: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.09	708.54		
7.15	708.57		
15.76	707.75		
20.74	707.72		
22.85	707.13		
24.32	706.66		
24.33	706.54		
24.69	706.48		
24.98	706.46		
25.62	706.50		
26.03	706.61		
26.35	706.67		
27.28	706.88		
29.44	707.43		
38.06	708.02		
51.89	708.96		
60.46	708.98		



Appendix 4. Morphological Summary Data and Plots
Figure 5j. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
UT1, Cross-Section 10 (Pool)
Monitoring Year 1

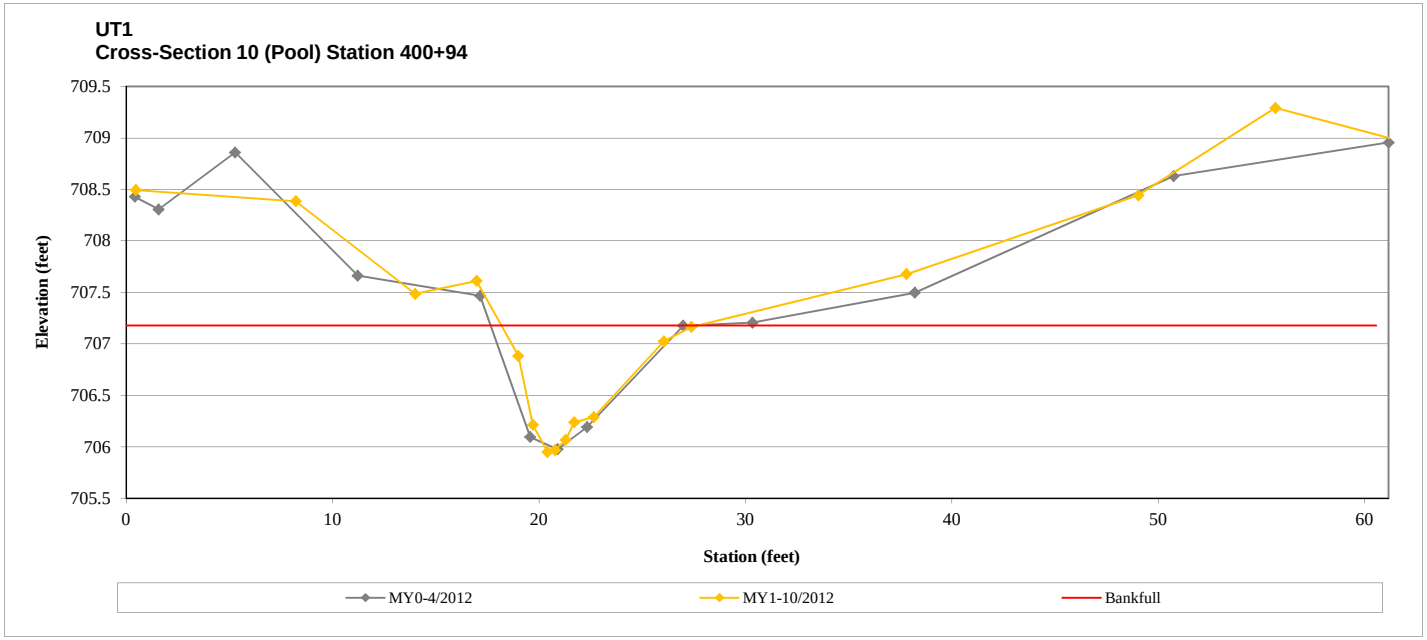
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	10
Drainage Area	0.1 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	707.2
Bankfull Cross-Sectional Area (ft2)	5.6
Bankfull Width (ft)	9.6
Flood Prone Area Elevation (ft)	N/A
Flood Prone Width (ft)	N/A
Max Depth at Bankfull (ft)	1.2
Mean Depth at Bankfull (ft)	0.6
W/D Ratio	16.6
Entrenchment Ratio	N/A
Bank Height Ratio	1.0
Stream Type	N/A

Cross-Section 10: View Upstream (10/18/2012)

Cross-Section 10: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.47	708.49		
8.22	708.39		
14.00	707.49		
16.98	707.61		
19.00	706.88		
19.71	706.21		
20.41	705.95		
20.78	705.97		
21.30	706.07		
21.71	706.24		
22.66	706.29		
26.06	707.03		
27.38	707.16		
37.81	707.68		
49.04	708.44		
55.68	709.29		
61.48	708.98		



Appendix 4. Morphological Summary Data and Plots
Figure 5k. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Little Troublesome Creek, Cross-Section 11 (Riffle)
Monitoring Year 1

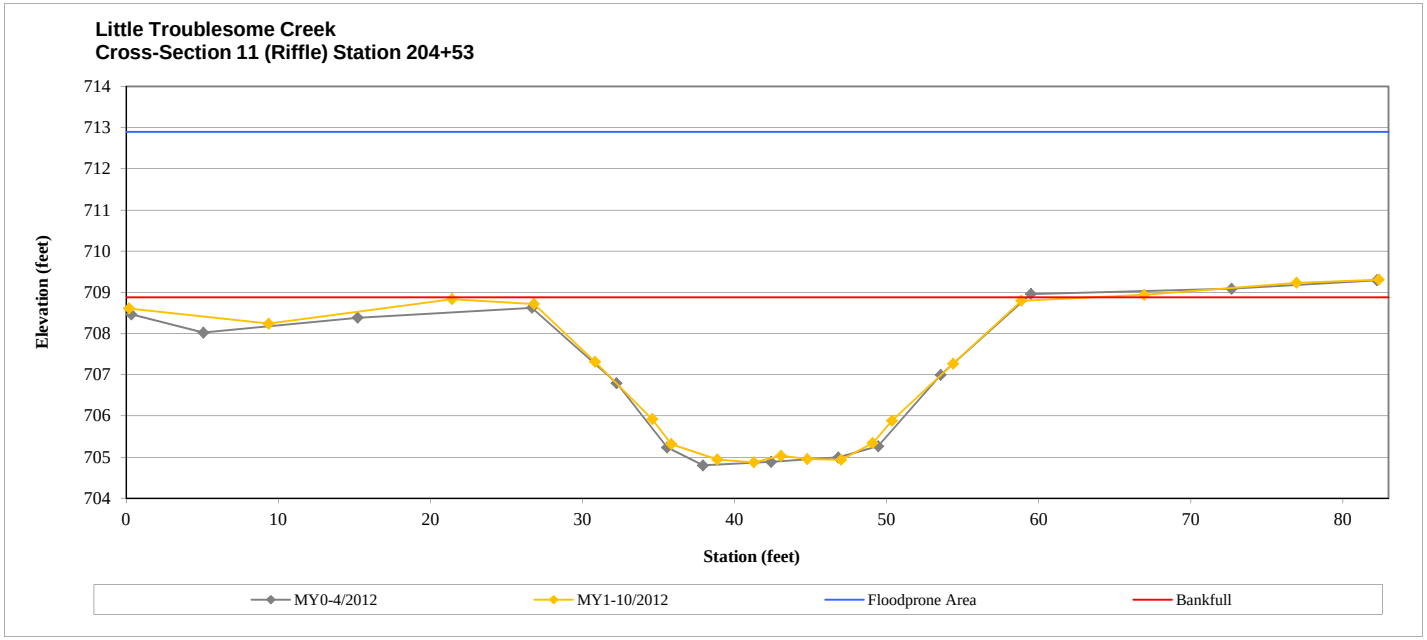
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	11
Drainage Area	5.1 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	708.9
Bankfull Cross-Sectional Area (ft2)	84.6
Bankfull Width (ft)	33.0
Flood Prone Area Elevation (ft)	712.9
Flood Prone Width (ft)	200+
Max Depth at Bankfull (ft)	4.0
Mean Depth at Bankfull (ft)	2.6
W/D Ratio	12.9
Entrenchment Ratio	2.2+
Bank Height Ratio	1.0
Stream Type	C

Cross-Section 11: View Upstream (10/18/2012)

Cross-Section 11: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.19	708.61		
9.38	708.24		
21.42	708.84		
26.82	708.72		
30.84	707.31		
34.59	705.92		
35.85	705.31		
38.88	704.94		
41.27	704.87		
43.05	705.03		
44.78	704.95		
47.01	704.93		
49.08	705.34		
50.36	705.89		
54.37	707.27		
58.86	708.80		
66.94	708.94		
76.95	709.23		
82.36	709.31		



Appendix 4. Morphological Summary Data and Plots
Figure 5l. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Little Troublesome Creek, Cross-Section 12 (Pool)
Monitoring Year 1

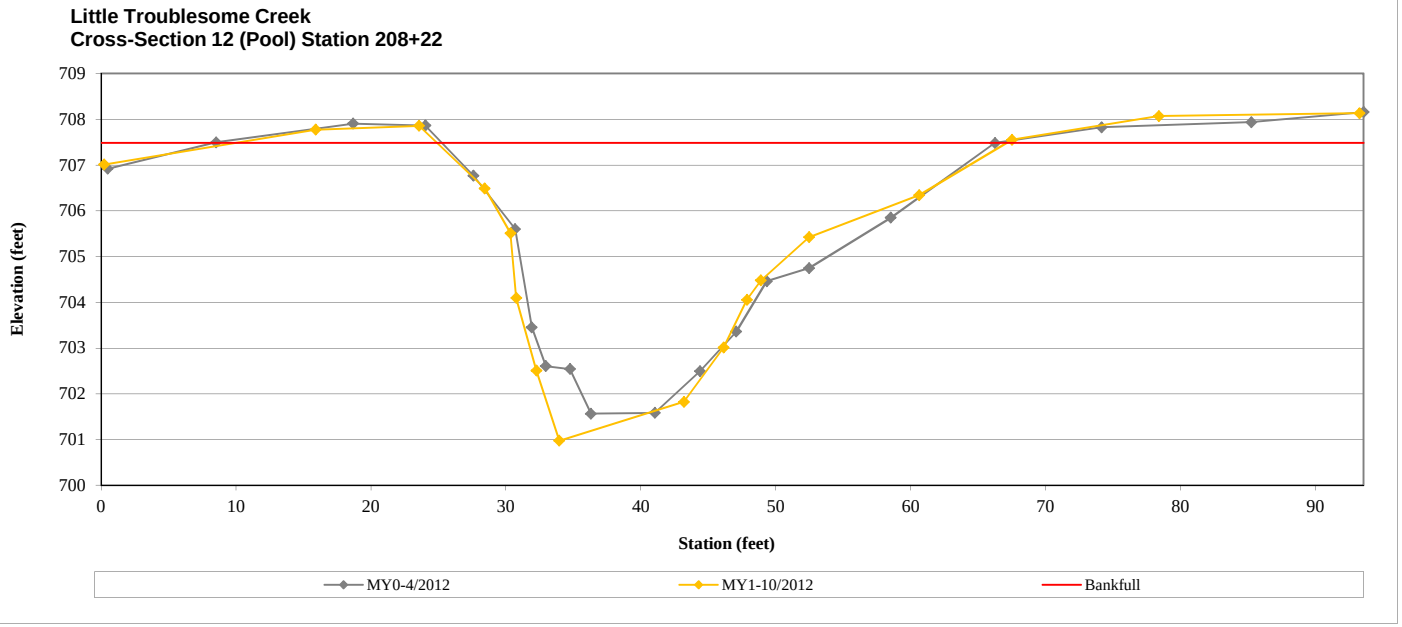
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	12
Drainage Area	5.1sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	707.5
Bankfull Cross-Sectional Area (ft2)	128.8
Bankfull Width (ft)	42.2
Flood Prone Area Elevation (ft)	N/A
Flood Prone Width (ft)	N/A
Max Depth at Bankfull (ft)	6.5
Mean Depth at Bankfull (ft)	3.1
W/D Ratio	13.8
Entrenchment Ratio	N/A
Bank Height Ratio	1.0
Stream Type	N/A

Cross-Section 12: View Upstream (10/18/2012)

Cross-Section 12: View Downstream (10/18/2012)

Station	Elevation	Station	Elevation
0.22	707.01		
15.90	707.77		
23.57	707.86		
28.43	706.49		
30.34	705.51		
30.76	704.09		
32.26	702.51		
33.95	700.97		
43.19	701.82		
46.13	703.01		
47.86	704.05		
48.90	704.48		
52.47	705.42		
60.64	706.34		
67.51	707.55		
78.40	708.07		
93.27	708.13		



Appendix 4. Morphological Summary Data and Plots
Figure 5m. Cross-Section Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Little Troublesome Creek, Cross-Section 13 (Riffle)
Monitoring Year 1

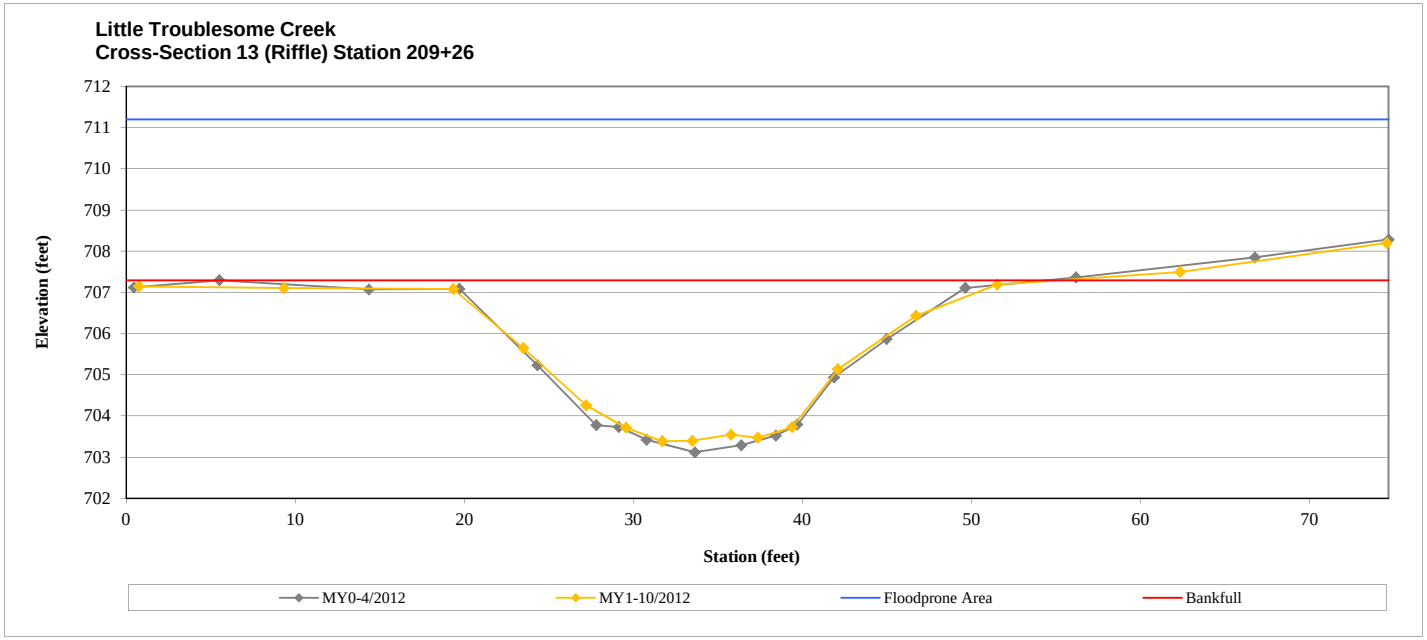
River Basin	Cape Fear
Watershed HUC	3030002
XS ID	13
Drainage Area	5.1 sq.mi
Date	10/18/2012
Field Crew	Wildlands Engineering

Summary Data	
Bankfull Elevation (ft)	707.3
Bankfull Cross-Sectional Area (ft2)	74.8
Bankfull Width (ft)	35.7
Flood Prone Area Elevation (ft)	711.2
Flood Prone Width (ft)	200+
Max Depth at Bankfull (ft)	3.9
Mean Depth at Bankfull (ft)	2.1
W/D Ratio	17.1
Entrenchment Ratio	2.1
Bank Height Ratio	1.0
Stream Type	C

Cross-Section 13: View Upstream (10/18/2012)

Cross-Section 13: View Downstream (10/18/2012)

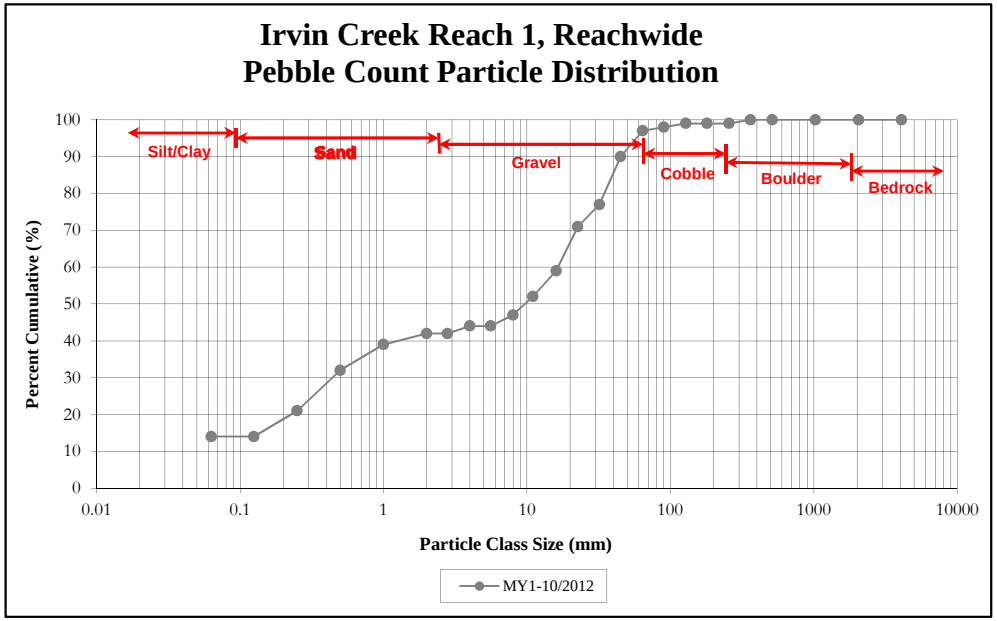
Station	Elevation	Station	Elevation
0.77	707.15		
9.35	707.10		
19.35	707.08		
23.49	705.65		
27.20	704.26		
29.58	703.71		
31.71	703.38		
33.49	703.40		
35.79	703.54		
37.38	703.47		
39.39	703.73		
42.11	705.13		
46.73	706.43		
51.54	707.19		
62.33	707.50		
74.56	708.20		

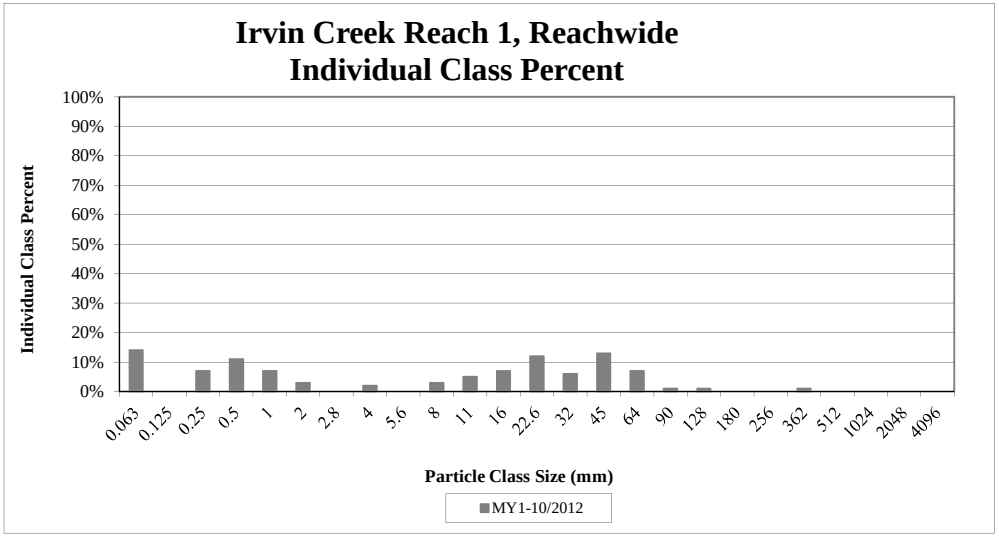


Appendix 4. Morphological Summary Data and Plots
Figure 6a. Reachwide and Cross-Section Pebble Count Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 1, Reachwide
Monitoring Year 1

Particle Class		Diameter (mm)		Particle Count			Irvin Creek Reach 1 Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	3	11	14	14	14
SAND	Very fine	0.062	0.125					14
	Fine	0.125	0.250		7	7	7	21
	Medium	0.250	0.500	1	10	11	11	32
	Coarse	0.5	1.0	1	6	7	7	39
	Very Coarse	1.0	2.0		3	3	3	42
GRAVEL	Very Fine	2.0	2.8					42
	Very Fine	2.8	4.0	1	1	2	2	44
	Fine	4.0	5.7					44
	Fine	5.7	8.0	1	2	3	3	47
	Medium	8.0	11.3	3	2	5	5	52
	Medium	11.3	16.0	2	5	7	7	59
	Coarse	16.0	22.6	10	2	12	12	71
	Coarse	22.6	32	6		6	6	77
	Very Coarse	32	45	12	1	13	13	90
	Very Coarse	45	64	7		7	7	97
COBBLE	Small	64	90	1		1	1	98
	Small	90	128	1		1	1	99
	Large	128	180					99
	Large	180	256					99
BOULDER	Small	256	362	1		1	1	100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.2
D_{35} =	0.7
D_{50} =	9.7
D_{84} =	38.4
D_{95} =	57.9
D_{100} =	362.0

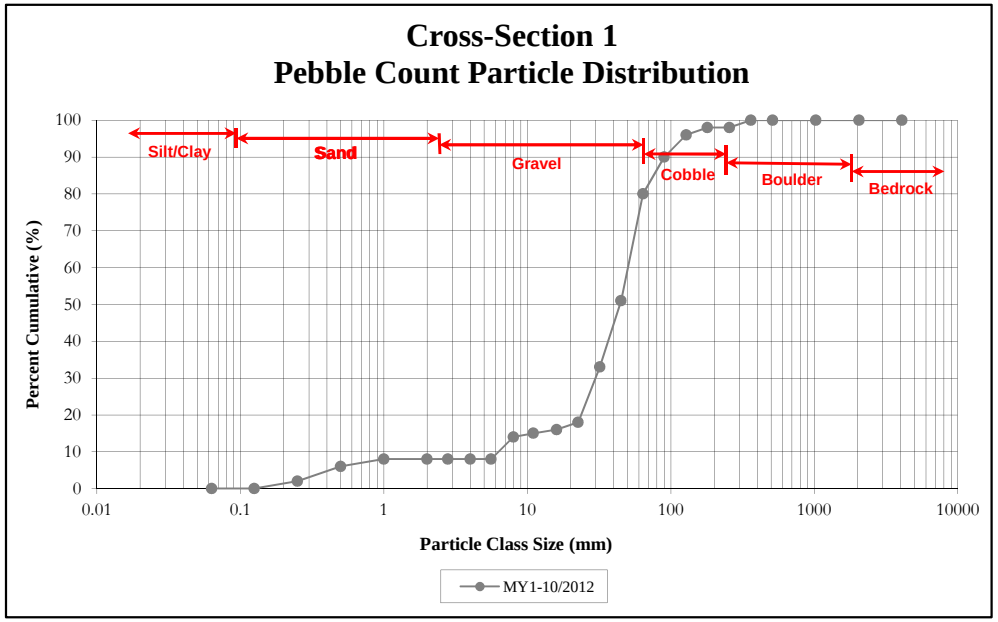


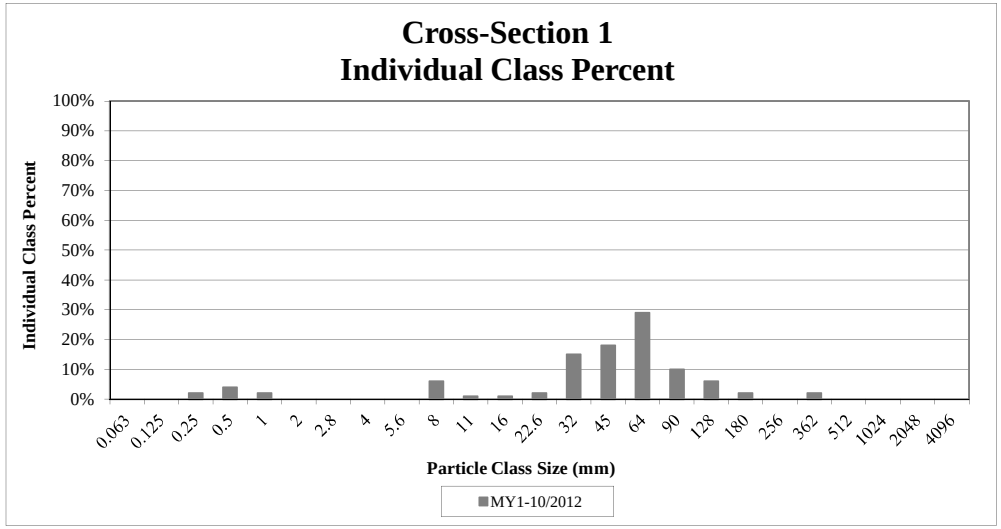


Appendix 4. Morphological Summary Data and Plots
Figure 6b. Reachwide and Cross-Section Substrate Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 1, Cross-Section 1 (Riffle)
Monitoring Year 1

Particle Class		Diameter (mm)		Particle Count	Cross-Section 1 Summary	
		min	max	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250	2	2	2
	Medium	0.250	0.500	4	4	6
	Coarse	0.5	1.0	2	2	8
	Very Coarse	1.0	2.0			8
GRAVEL	Very Fine	2.0	2.8			8
	Very Fine	2.8	4.0			8
	Fine	4.0	5.7			8
	Fine	5.7	8.0	6	6	14
	Medium	8.0	11.3	1	1	15
	Medium	11.3	16.0	1	1	16
	Coarse	16.0	22.6	2	2	18
	Coarse	22.6	32	15	15	33
	Very Coarse	32	45	18	18	51
	Very Coarse	45	64	29	29	80
COBBLE	Small	64	90	10	10	90
	Small	90	128	6	6	96
	Large	128	180	2	2	98
	Large	180	256			98
BOULDER	Small	256	362	2	2	100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 1 Channel materials (mm)	
D_{16} =	16.0
D_{35} =	33.2
D_{50} =	44.2
D_{84} =	73.4
D_{95} =	120.7
D_{100} =	362.0

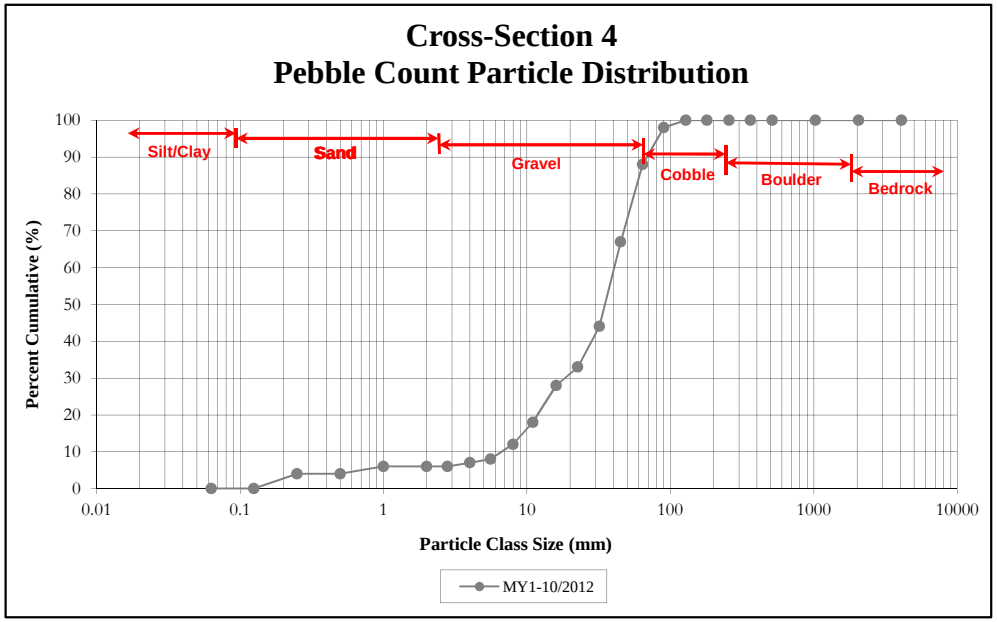


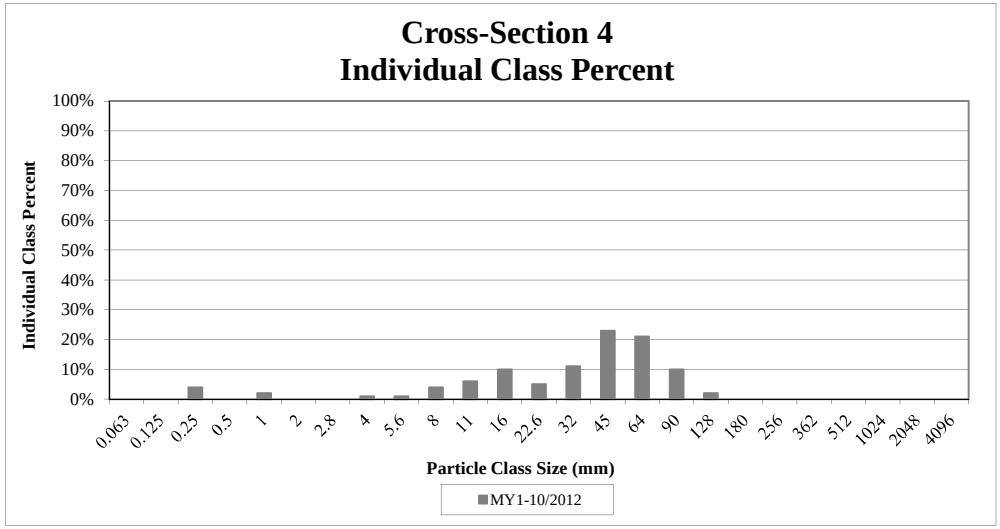


Appendix 4. Morphological Summary Data and Plots
Figure 6c. Reachwide and Cross-Section Substrate Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 1, Cross-Section 4 (Riffle)
Monitoring Year 1

Particle Class		Diameter (mm) min	Diameter (mm) max	Particle Count Total	Cross-Section 4 Summary Class Percentage	Cross-Section 4 Summary Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250	4	4	4
	Medium	0.250	0.500			4
	Coarse	0.5	1.0	2	2	6
	Very Coarse	1.0	2.0			6
GRAVEL	Very Fine	2.0	2.8			6
	Very Fine	2.8	4.0	1	1	7
	Fine	4.0	5.7	1	1	8
	Fine	5.7	8.0	4	4	12
	Medium	8.0	11.3	6	6	18
	Medium	11.3	16.0	10	10	28
	Coarse	16.0	22.6	5	5	33
	Coarse	22.6	32	11	11	44
	Very Coarse	32	45	23	23	67
	Very Coarse	45	64	21	21	88
COBBLE	Small	64	90	10	10	98
	Small	90	128	2	2	100
	Large	128	180			100
	Large	180	256			100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 4 Channel materials (mm)	
D_{16} =	9.9
D_{35} =	24.1
D_{50} =	35.0
D_{84} =	59.8
D_{95} =	81.3
D_{100} =	128.0

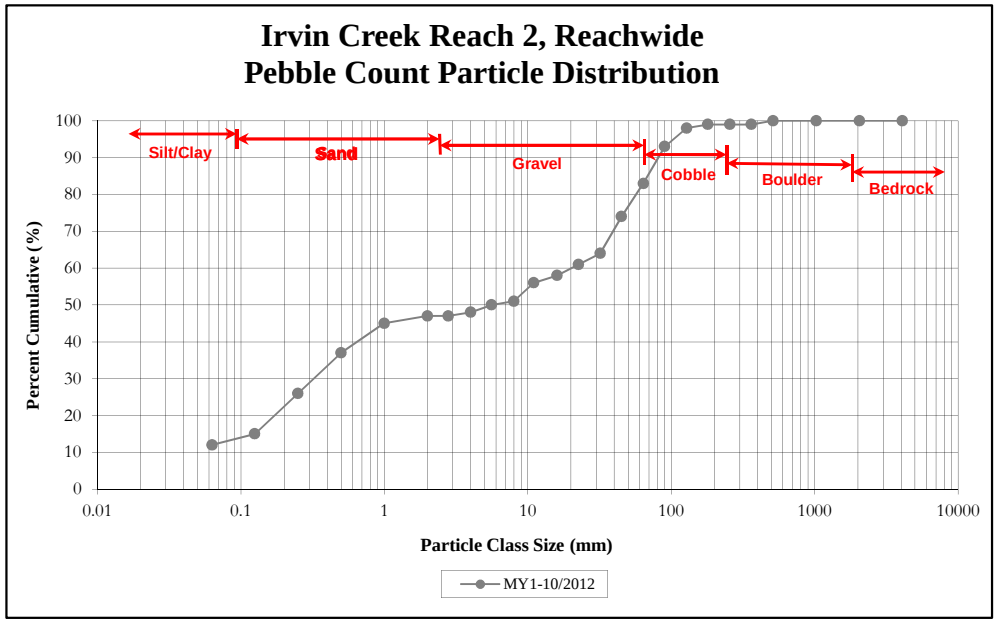


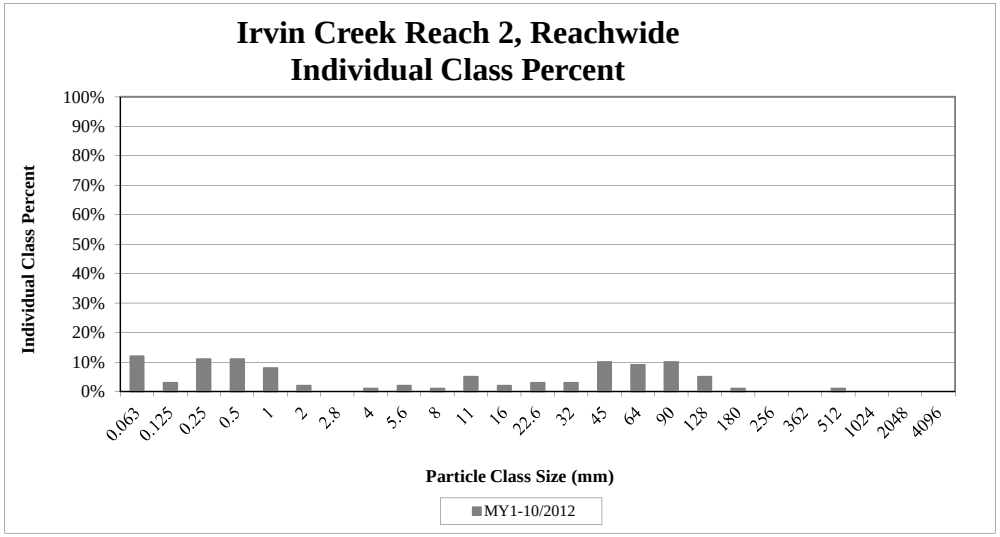


Appendix 4. Morphological Summary Data and Plots
Figure 6d. Reachwide and Cross-Section Pebble Count Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 2, Reachwide
Monitoring Year 1

Particle Class		Diameter (mm)		Particle Count			Irvin Creek Reach 2 Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		12	12	12	12
SAND	Very fine	0.062	0.125		3	3	3	15
	Fine	0.125	0.250		11	11	11	26
	Medium	0.250	0.500	1	10	11	11	37
	Coarse	0.5	1.0		8	8	8	45
	Very Coarse	1.0	2.0	1	1	2	2	47
GRAVEL	Very Fine	2.0	2.8					47
	Very Fine	2.8	4.0		1	1	1	48
	Fine	4.0	5.7	1	1	2	2	50
	Fine	5.7	8.0		1	1	1	51
	Medium	8.0	11.3	4	1	5	5	56
	Medium	11.3	16.0	2		2	2	58
	Coarse	16.0	22.6	3		3	3	61
	Coarse	22.6	32	3		3	3	64
	Very Coarse	32	45	10		10	10	74
	Very Coarse	45	64	9		9	9	83
COBBLE	Small	64	90	9	1	10	10	93
	Small	90	128	5		5	5	98
	Large	128	180	1		1	1	99
	Large	180	256					99
BOULDER	Small	256	362					99
	Small	362	512	1		1	1	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.1
D_{35} =	0.4
D_{50} =	5.6
D_{84} =	66.2
D_{95} =	103.6
D_{100} =	512.0

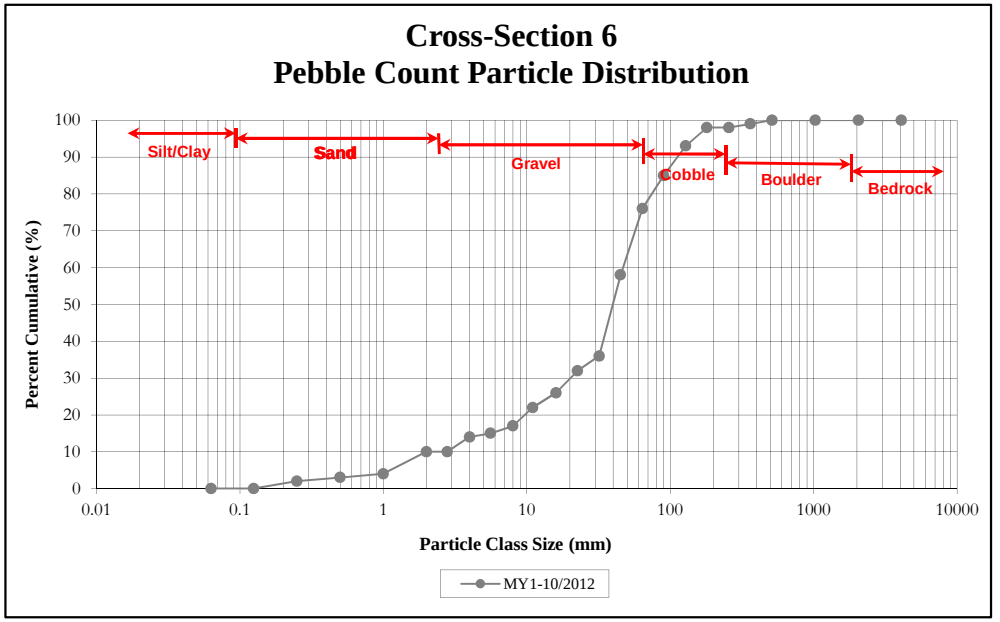


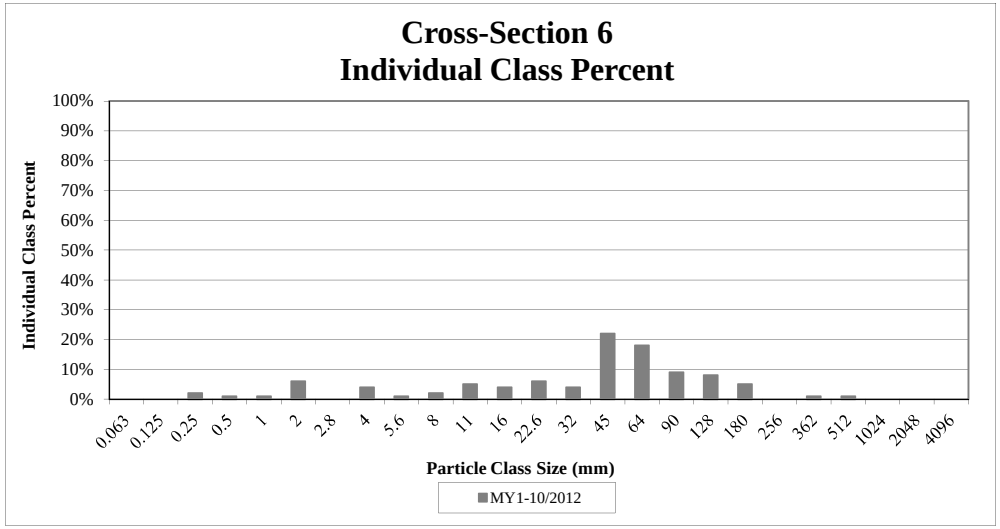


Appendix 4. Morphological Summary Data and Plots
Figure 6e. Reachwide and Cross-Section Substrate Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 2, Cross-Section 6 (Riffle)
Monitoring Year 0

Particle Class		Diameter (mm)		Particle Count	Cross-Section 6 Summary	
		min	max	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250	2	2	2
	Medium	0.250	0.500	1	1	3
	Coarse	0.5	1.0	1	1	4
	Very Coarse	1.0	2.0	6	6	10
GRAVEL	Very Fine	2.0	2.8			10
	Very Fine	2.8	4.0	4	4	14
	Fine	4.0	5.7	1	1	15
	Fine	5.7	8.0	2	2	17
	Medium	8.0	11.3	5	5	22
	Medium	11.3	16.0	4	4	26
	Coarse	16.0	22.6	6	6	32
	Coarse	22.6	32	4	4	36
	Very Coarse	32	45	22	22	58
	Very Coarse	45	64	18	18	76
COBBLE	Small	64	90	9	9	85
	Small	90	128	8	8	93
	Large	128	180	5	5	98
	Large	180	256			98
BOULDER	Small	256	362	1	1	99
	Small	362	512	1	1	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 6 Channel materials (mm)	
D_{16} =	6.7
D_{35} =	29.3
D_{50} =	39.8
D_{84} =	86.7
D_{95} =	146.7
D_{100} =	512.0

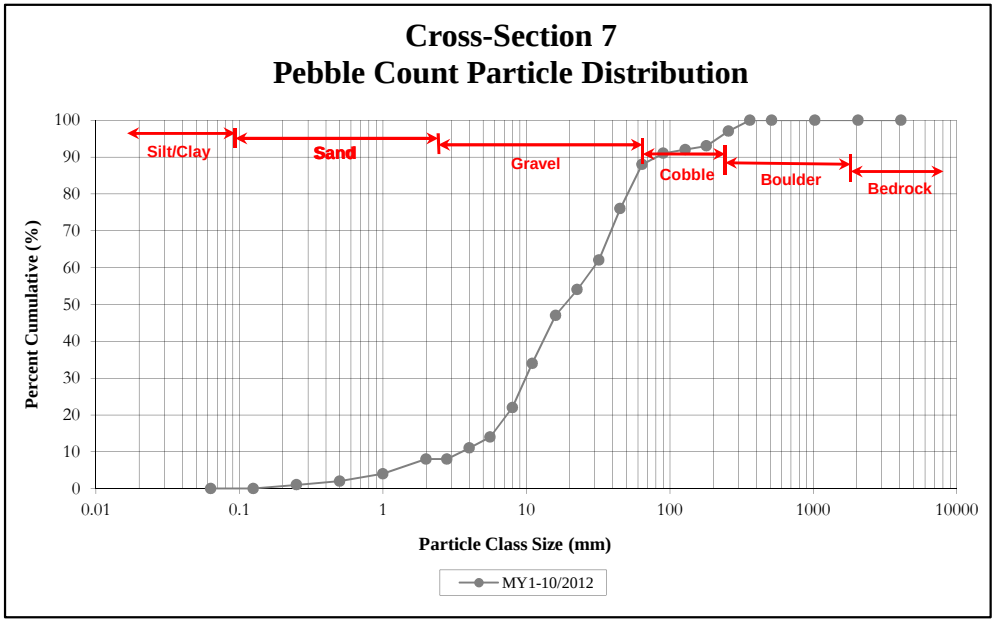


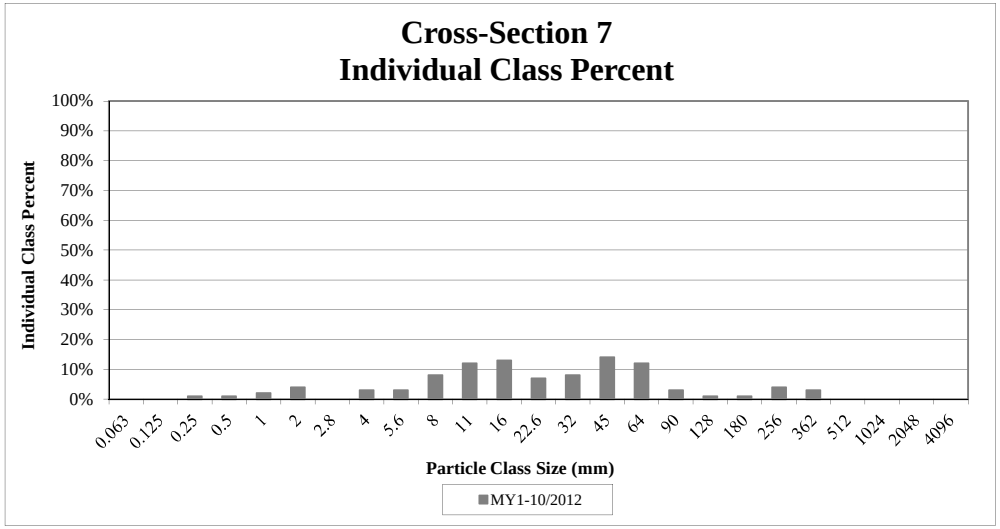


Appendix 4. Morphological Summary Data and Plots
Figure 6f. Reachwide and Cross-Section Substrate Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Irvin Creek Reach 2, Cross-Section 7 (Riffle)
Monitoring Year 1

Particle Class		Diameter (mm)		Particle Count	Cross-Section 7 Summary	
		min	max	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250	1	1	1
	Medium	0.250	0.500	1	1	2
	Coarse	0.5	1.0	2	2	4
	Very Coarse	1.0	2.0	4	4	8
GRAVEL	Very Fine	2.0	2.8			8
	Very Fine	2.8	4.0	3	3	11
	Fine	4.0	5.7	3	3	14
	Fine	5.7	8.0	8	8	22
	Medium	8.0	11.3	12	12	34
	Medium	11.3	16.0	13	13	47
	Coarse	16.0	22.6	7	7	54
	Coarse	22.6	32	8	8	62
	Very Coarse	32	45	14	14	76
	Very Coarse	45	64	12	12	88
COBBLE	Small	64	90	3	3	91
	Small	90	128	1	1	92
	Large	128	180	1	1	93
	Large	180	256	4	4	97
BOULDER	Small	256	362	3	3	100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 7 Channel materials (mm)	
D_{16} =	6.1
D_{35} =	11.3
D_{50} =	18.6
D_{84} =	56.9
D_{95} =	214.7
D_{100} =	362.0

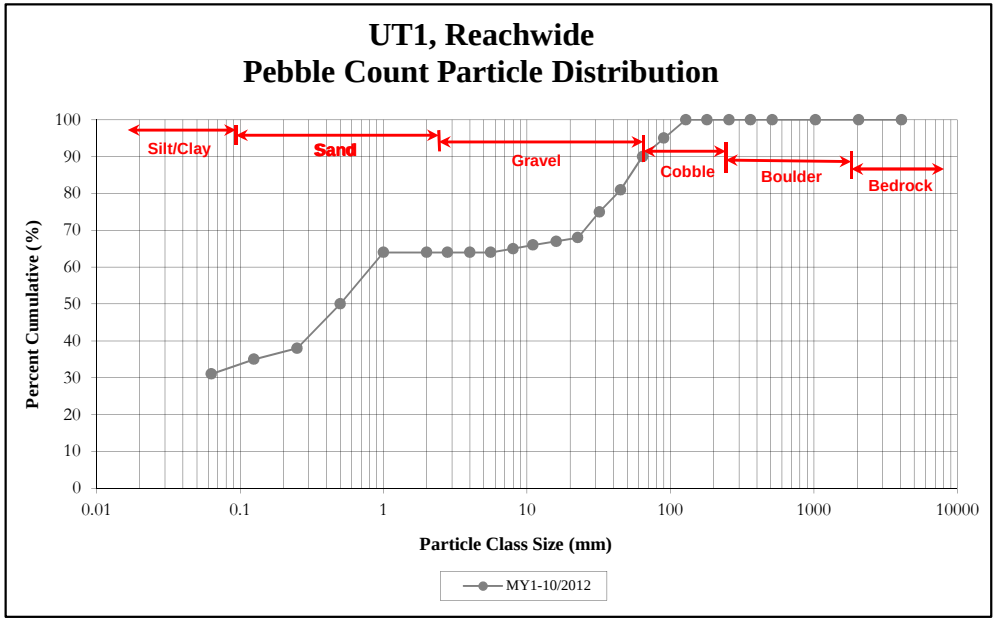


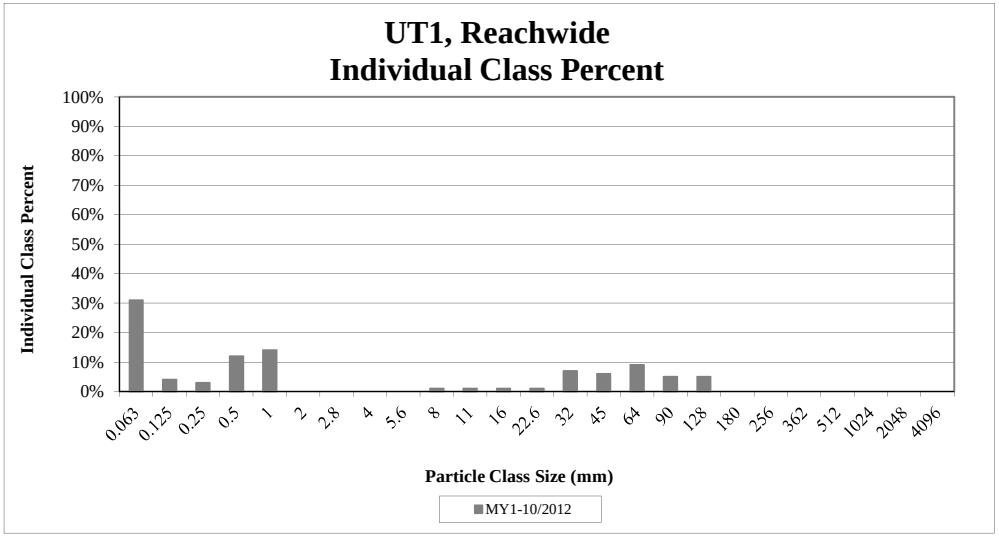


Appendix 4. Morphological Summary Data and Plots
Figure 6g. Reachwide and Cross-Section Pebble Count Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
UT1, Reachwide
Monitoring Year 1

Particle Class		Diameter (mm)		Particle Count			UT1 Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	5	26	31	31	31
SAND	Very fine	0.062	0.125		4	4	4	35
	Fine	0.125	0.250		3	3	3	38
	Medium	0.250	0.500	4	8	12	12	50
	Coarse	0.5	1.0	5	9	14	14	64
	Very Coarse	1.0	2.0					64
GRAVEL	Very Fine	2.0	2.8					64
	Very Fine	2.8	4.0					64
	Fine	4.0	5.7					64
	Fine	5.7	8.0	1		1	1	65
	Medium	8.0	11.3	1		1	1	66
	Medium	11.3	16.0	1		1	1	67
	Coarse	16.0	22.6	1		1	1	68
	Coarse	22.6	32	7		7	7	75
	Very Coarse	32	45	6		6	6	81
	Very Coarse	45	64	9		9	9	90
COBBLE	Small	64	90	5		5	5	95
	Small	90	128	5		5	5	100
	Large	128	180					100
	Large	180	256					100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	Silt/ Clay
D_{35} =	0.1
D_{50} =	0.5
D_{84} =	50.6
D_{95} =	90.0
D_{100} =	128.0

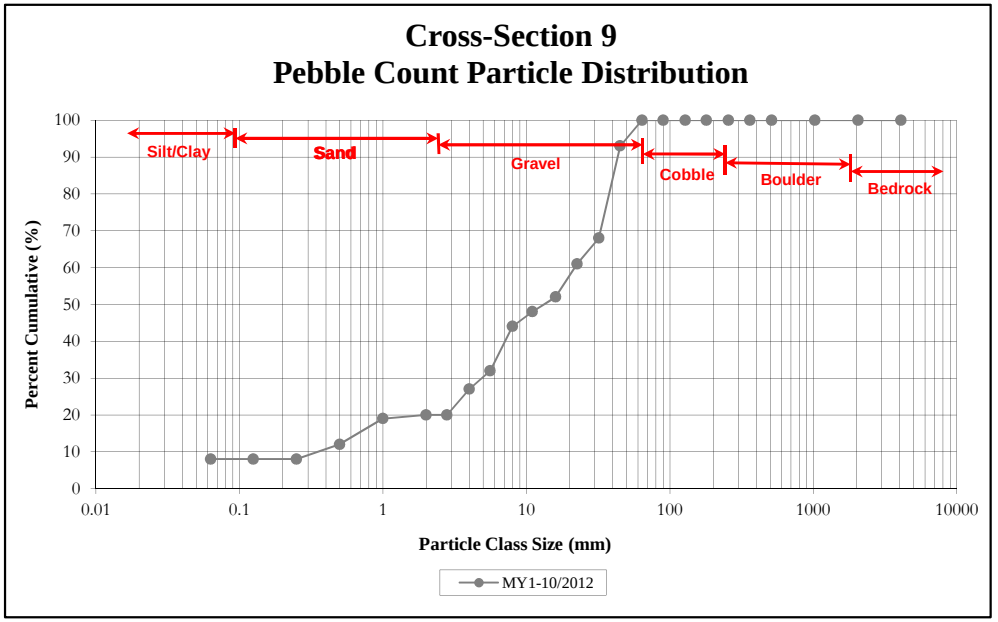


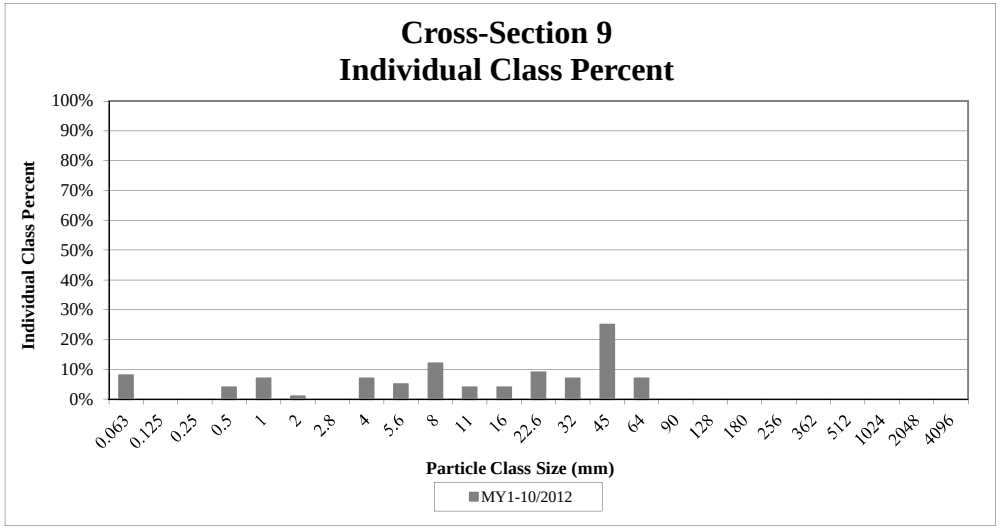


Appendix 4. Morphological Summary Data and Plots
Figure 6h. Reachwide and Cross-Section Substrate Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
UT1, Cross-Section 9 (Riffle)
Monitoring Year 1

Particle Class		Diameter (mm)		Particle Count	Cross-Section 9 Summary	
		min	max	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	8	8	8
SAND	Very fine	0.062	0.125			8
	Fine	0.125	0.250			8
	Medium	0.250	0.500	4	4	12
	Coarse	0.5	1.0	7	7	19
	Very Coarse	1.0	2.0	1	1	20
GRAVEL	Very Fine	2.0	2.8			20
	Very Fine	2.8	4.0	7	7	27
	Fine	4.0	5.7	5	5	32
	Fine	5.7	8.0	12	12	44
	Medium	8.0	11.3	4	4	48
	Medium	11.3	16.0	4	4	52
	Coarse	16.0	22.6	9	9	61
	Coarse	22.6	32	7	7	68
	Very Coarse	32	45	25	25	93
	Very Coarse	45	64	7	7	100
COBBLE	Small	64	90			100
	Small	90	128			100
	Large	128	180			100
	Large	180	256			100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 9 Channel materials (mm)	
D_{16} =	0.7
D_{35} =	6.1
D_{50} =	13.3
D_{84} =	39.8
D_{95} =	49.8
D_{100} =	64.0

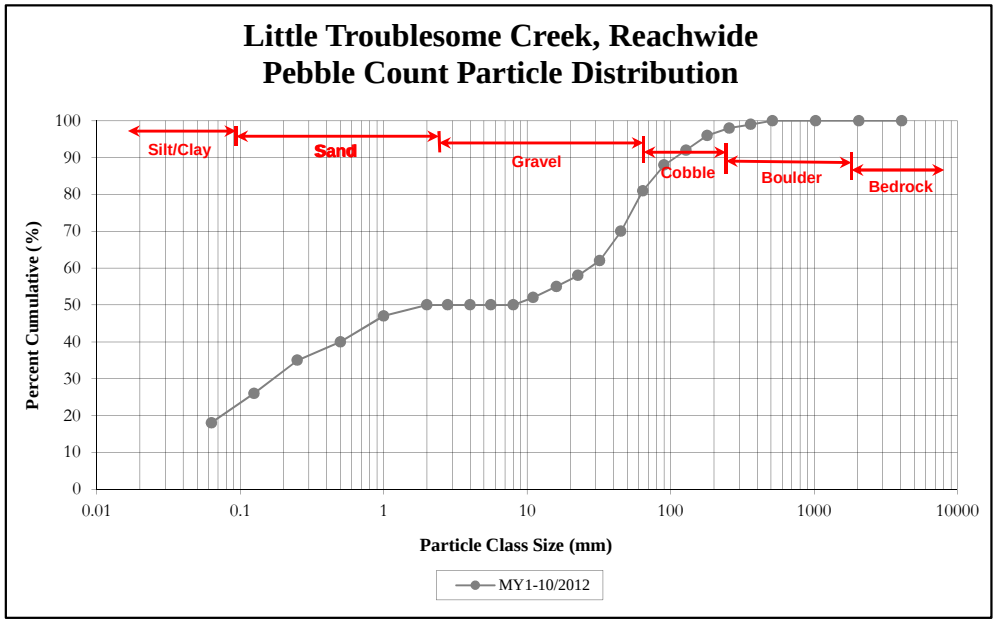


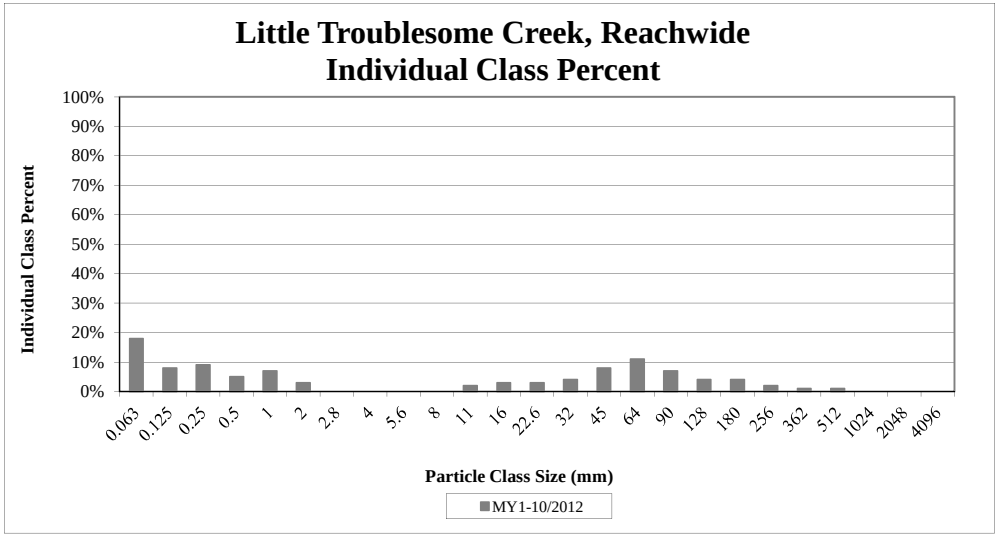


Appendix 4. Morphological Summary Data and Plots
Figure 6i. Reachwide and Cross-Section Pebble Count Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Little Troublesome Creek, Reachwide
Monitoring Year 1

Particle Class		Diameter (mm)		Particle Count			Little Troublesome Creek Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		18	18	18	18
SAND	Very fine	0.062	0.125		8	8	8	26
	Fine	0.125	0.250		9	9	9	35
	Medium	0.250	0.500		5	5	5	40
	Coarse	0.5	1.0	1	6	7	7	47
	Very Coarse	1.0	2.0		3	3	3	50
GRAVEL	Very Fine	2.0	2.8					50
	Very Fine	2.8	4.0					50
	Fine	4.0	5.7					50
	Fine	5.7	8.0					50
	Medium	8.0	11.3	2		2	2	52
	Medium	11.3	16.0	2	1	3	3	55
	Coarse	16.0	22.6	3		3	3	58
	Coarse	22.6	32	4		4	4	62
	Very Coarse	32	45	8		8	8	70
	Very Coarse	45	64	11		11	11	81
COBBLE	Small	64	90	7		7	7	88
	Small	90	128	4		4	4	92
	Large	128	180	4		4	4	96
	Large	180	256	2		2	2	98
BOULDER	Small	256	362	1		1	1	99
	Small	362	512	1		1	1	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	Silt/ Clay
D_{35} =	0.3
D_{50} =	8.0
D_{84} =	74.1
D_{95} =	165.3
D_{100} =	512.0

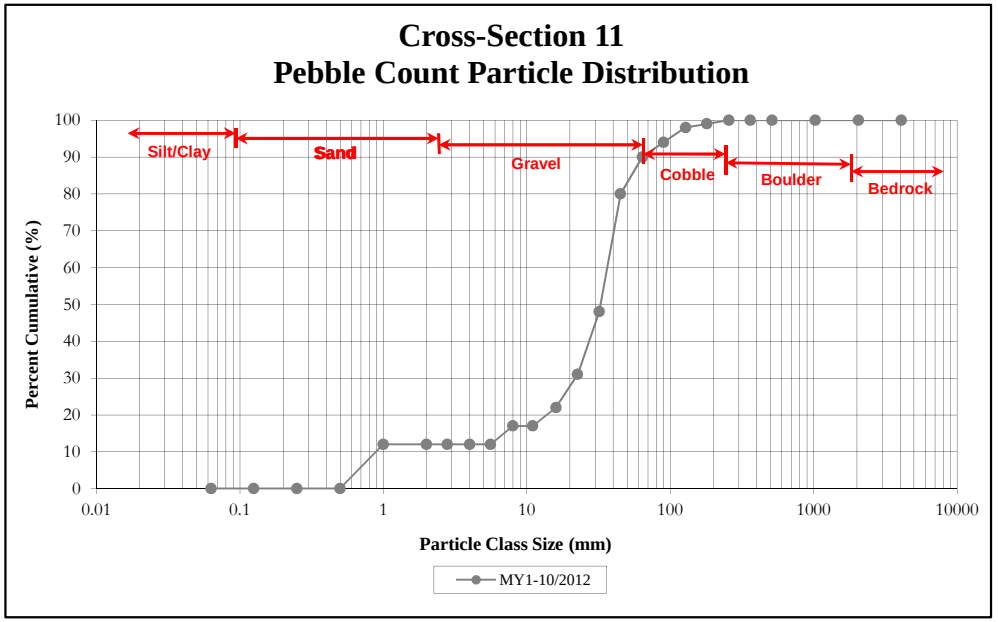


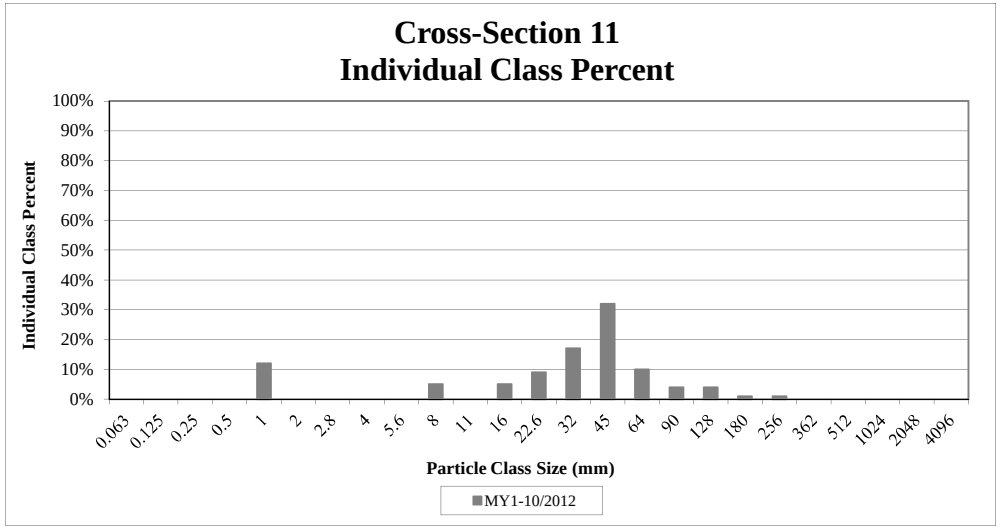


Appendix 4. Morphological Summary Data and Plots
Figure 6j. Reachwide and Cross-Section Substrate Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Little Troublesome Creek , Cross-Section 11 (Riffle)
Monitoring Year 1

Particle Class		Diameter (mm)		Particle Count	Cross-Section 11 Summary	
		min	max	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.250	0.500			0
	Coarse	0.5	1.0	12	12	12
	Very Coarse	1.0	2.0			12
GRAVEL	Very Fine	2.0	2.8			12
	Very Fine	2.8	4.0			12
	Fine	4.0	5.7			12
	Fine	5.7	8.0	5	5	17
	Medium	8.0	11.3			17
	Medium	11.3	16.0	5	5	22
	Coarse	16.0	22.6	9	9	31
	Coarse	22.6	32	17	17	48
	Very Coarse	32	45	32	32	80
	Very Coarse	45	64	10	10	90
COBBLE	Small	64	90	4	4	94
	Small	90	128	4	4	98
	Large	128	180	1	1	99
	Large	180	256	1	1	100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 11 Channel materials (mm)	
D_{16} =	7.4
D_{35} =	24.5
D_{50} =	32.7
D_{84} =	51.8
D_{95} =	98.3
D_{100} =	256.0





Appendix 4. Morphological Summary Data and Plots
Figure 6k. Reachwide and Cross-Section Substrate Plots
Little Troublesome Creek Mitigation Site (NCEEP Project No. 94640)
Little Troublesome Creek , Cross-Section 13 (Riffle)
Monitoring Year 1

Particle Class		Diameter (mm)		Particle Count	Cross-Section 13 Summary	
		min	max	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.250	0.500			0
	Coarse	0.5	1.0	4	4	4
	Very Coarse	1.0	2.0			4
GRAVEL	Very Fine	2.0	2.8			4
	Very Fine	2.8	4.0			4
	Fine	4.0	5.7	4	4	8
	Fine	5.7	8.0	1	1	9
	Medium	8.0	11.3	6	6	15
	Medium	11.3	16.0			15
	Coarse	16.0	22.6	4	4	19
	Coarse	22.6	32	12	12	31
	Very Coarse	32	45	30	30	61
	Very Coarse	45	64	13	13	74
COBBLE	Small	64	90	10	10	84
	Small	90	128	8	8	92
	Large	128	180	2	2	94
	Large	180	256	2	2	96
BOULDER	Small	256	362	2	2	98
	Small	362	512	2	2	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 13 Channel materials (mm)	
D_{16} =	17.4
D_{35} =	33.5
D_{50} =	39.7
D_{84} =	90.0
D_{95} =	214.7
D_{100} =	512.0