

**McKee Creek Stream Restoration
Monitoring Report – Year 2 of 5
Final**

**Contract # 004391
EEP Project # 92573
Cabarrus County, North Carolina**



**Collected October 2013
Completed 2013
Report December 19, 2013
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NCDENR-EEP
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Executive Summary/ Project Abstract

The site is located roughly 10 miles northeast of Charlotte, NC. Figure 1 includes a map and directions to the site. The restoration was designed by Withers & Ravenel and construction completed by River Works Inc. in June 2010. This report summarizes the monitoring efforts for Monitoring Year-2 (MY-2) 2013.

McKee Creek was divided into two reaches within the project site; McKee Creek – Reach 1 is upstream of Peach Orchard Road and McKee Creek – Reach 2 is downstream of the road crossing. The pre-project stream lengths of McKee Creek – Reach 1 and Reach 2 were 3,733 linear feet (lf) and 847 lf, respectively. The pre-project reach length of Clear Creek; was 1,513 lf. The total pre-project stream length within the project limits was 6,093 lf.

The stream design resulted in 1,641 lf of stream restoration on Clear Creek, and 1,096 lf of Level I stream enhancement and 3,240 lf of Level II stream enhancement on McKee Creek. The total of stream design is 5,977 lf.

The project goals and objectives stated in the McKee Creek Restoration Plan (NCEEP 2008) are as follows:

Project Goals:

- Restore through stream enhancement (Level I and Level II) McKee Creek;
- Restore Clear Creek (Priority I restoration);
- Restore the physical and biological processes of McKee and Clear Creeks;
- Restore riparian vegetation to the maximum extent feasible.

Project Objectives:

- Improve water quality by reducing bank erosion, restricting livestock access to the creeks, and re-establishing the riparian buffer;
- Stabilize McKee Creek through the use of in-stream structures and pattern re-alignment in selected areas;
- Restore the dimension, pattern, and profile of Clear Creek;
- Improve the floodplain functionality of Clear Creek by matching floodplain elevation with bank full stage;
- Improve the wildlife habitat functions of the site through riparian buffer establishment, improved stream bed form diversity, and improved floodplain functionality to reduce stream incision;
- Protect the site through a permanent conservation easement along the project reaches.

Prior to project completion the streams suffered from excess sedimentation, channel incision, bank degradation, and limited riparian vegetation. The *Lower Yadkin River Basin Local Watershed Plan* states both McKee Creek (from source to Reedy Creek) and Clear Creek (from source to McKee Creek) 303(d) listed streams; McKee Creek for fecal coliform and sediment and Clear Creek for fecal coliform. NCDENR indicates the potential sources of impairment for McKee Creek and Clear Creek include agriculture, land development, and urban runoff/ storm sewers. Additionally McKee Creek has non-municipal discharges from two minor NPDES permitted discharges from private wastewater treatment plants located upstream of the project site. It is stated in the LWP that DWQ studies of fecal coliform bacterial sources for McKee and Clear Creeks indicated that livestock grazing was one of the contributing factors.

Monitoring of the project began with a visual site assessment in the spring of 2012 to identify potential problems. Cross-sections, crest gages, vegetation plots, and photo points were also established at that time. Base line information is not available since no monitoring was performed from the completion of construction in June 2010 till the spring 2012.

Project Complications

In addition to the delayed initiation of monitoring, several other factors have been detrimental to the goals of this mitigation. Approximately a month prior to the initial visual site assessment, a tornado caused damage in the area off the confluence of Clear Creek and McKee Creek. See Figure 2. The tornado downed large diameter trees with many spanning McKee and Clear Creek. These downed trees have been cleared across Clear Creek but remain an obstacle to access on the south bank. Many of the fallen trees on McKee Creek remain from the edge of the project limits down to Clear Creek.

The downed trees on the south bank of Clear Creek have impeded the monitoring effort. These downed trees have either attracted beavers or been exacerbated by a beaver population, in the past. This assessment showed no current evidence of a beaver population, though observations will still be made to identify them.

Since completion of the stream restoration project a sewer line was constructed along McKee Creek. The sewer serves a development west of McKee Creek and north of Peach Orchard Road. The sewer parallels the McKee Creek west bank from Peach Orchard Road to roughly stream station 40+00 where it traverses the stream and follows the east bank to a wastewater treatment plant (WWTP) upstream of the project area. This gravity sewer bucks grade to reach the WWTP from Peach Orchard Road. The construction of the sewer stream crossing required armoring both sides of the stream bank with rip rap for roughly 30 feet. The sewer has an easement along the alignment for access and maintenance that will be cleared. The easement clearing impact to the riparian buffer is limited to the stream crossing. Additionally it appears that the majority of survey control set during the stream restoration construction was destroyed by the sewer line construction. New survey control had to be established along McKee Creek south of Peach Orchard Road in the fall of 2012.

It was noted in the Spring 2013 Assessment that Vegetation Plot 1 had been mowed over and most, if not all planted live stems had been cut to the ground. Evident was the regeneration of 6 planted stems in the plot which identifies a reduction in stems as compared to data collected in the Fall of 2012 (refer to the Vegetation Results section below for a more detailed description of the effects of this complication).

Vegetation Results

Success of the riparian buffer plantings will be based on plant survival, as per the buffer restoration guidelines, administered by the NC Division of Water Quality. Four (4) permanent monitoring plots were established along the restored buffer in spring of 2012. In order to be considered a successful restoration, the site must contain a minimum of 320 live stems per acre at year 3 and 260 live stems per acre at year 5. Year 2 shows an average of 515 live planted stems per acre with a minimum count of 242. These estimates are based on Level 2 of the CVS-EEP monitoring protocol and include only planted woody stems. The stem count is based on the average stem counts within the vegetation plots. Reference pictures of each monitoring plot were taken and attached to this report. The fact that all restored vegetation areas (on average) are performing above the requirement is good however most of the restoration area adjacent to Plot 1 and the sewer easement being mowed over will definitely limit this section in containing the minimum number of planted stems per acre after year 3. It should be noted that the combination of 6 (regenerated after mowing) planted live stems and the additional natural woody stems in Vegetation Plot 1 should yield minimum stem counts after year 3, but it is recommended that the mowed area in the vicinity of Vegetation Plot 1 (that does not have significant seedling regeneration or natural woody stems) be replanted with appropriate bare root seedlings as described on the original Reach 1 Vegetation Planting

Plan (Sheet 14) sealed on April 17, 2009 by Withers & Ravenel, Inc. This plan called for bare root vegetation to be planted at a target density of 680 stems per acre, spaced on an 8' by 8' grid.

Re-vegetation and elimination of invasives along McKee Creek Reach 2 was an important aspect of project success. The invasive species *Rosa multiflora* plagued the project site before and during construction. Construction logs indicate the *Rosa multiflora* was found to be three times greater than specified on the original plan and though denied, the contractor requested on-site burning multiple times. As a result, several rounds of spray treatment were applied followed by bush hogging the invasive species.

During the Fall 2013 assessment *Rosa multiflora* was prominent on both sides of the stream adjacent to Plot 1 and *Eleagnus umbellata*, *Lonicera japonica*, *Rosa multiflora* and *Rhus typhina* and were prominent in and around the vicinity of Plot 2. These plants are considered non-native invasive species and should be removed from the restoration areas to further limit the overtaking the native vegetation. While native and not necessarily considered invasive by most accounts, there is an also an abundance of *Rubus argutus* in and around Plot 2, making it difficult to access and document the plot. Invasives were last treated in November 2013 and treatment shall be repeated in the Spring of 2014 (early growing season), to allow more desirable species opportunity to become better established.

Stream Results

A visual qualitative assessment was performed to inspect channel facets, meanders, beds, banks, and installed structures. This visual assessment was confirmed and enhanced with a quantitative assessment of a physical stream survey for approximately 1600 feet. In general, Clear Creek appeared to be meeting expectation. A quick and dense development of vegetation proved to hold the stream together, along with the exclusion of bank damaging livestock. The vegetation is taking over the banks to a point that the cross-vane at 12+50 was not seen until the grass was pulled back and the boulders were found. An area of concern occurs at the double log sill around cross-section 24+00. The water surface on either side of the sill is the same but the sill itself is about 9-inches from being overtopped. This means that there is some sort of breach around the structure itself. Again a little further downstream at cross-section 24+50 the log vane is retaining a majority of the water but leaking seems to be occurring under the log, inferring an undercut. At the downstream end of the project site the first of the two cross-vanes at station 26+25 is beginning to fail. Sediment and vegetation on the right bank is falling into the structure and widening of the channel along the left bank is causing flows to top the structure on the left side. This widening to the left bank will most likely continue until the cross-vane is no longer keyed into the bank.

A full restoration was not performed on McKee Creek Reach 1 a majority of this reach was only re-vegetated. Stream survey of this reach was performed for roughly 105 feet. The re-alignment work that was done where the sharp bend used to be, is holding well. The J-hook that occupies this same area is filling in with fines, most likely due to development in the area. There do not seem to be any other outside factors.

McKee Creek Reach 2 appears to be stable despite the tornado damage. Cattle exclusion has allowed the banks to re-vegetate and stabilize. Effective floodplain connection remains from downstream of Peach Orchard Road for approximately 600 feet where the stream enters the tornado impacted area, approximately 465 feet of this was surveyed. The bank in the area of the most upstream cross-vane is falling into the stream along with a fallen tree. Both of which are very near the structure and may begin to fill it in as well. Fines that plagued this section in the previous year due to damming of the stream are not as severe and seem to be decreasing allowing this reach to return to its original designed condition.

Hydrology Results

During the fall assessment, crest gages were checked for bankfull occurrences. On Reach 2 of McKee Creek, flattened vegetation, validates the bankfull or greater events at crest gage 1. The reading of crest

gage 2 indicates events near bankfull, the presence of vegetation and small trees on the bank and at the very fringe of the floodplain leaned in the direction of flow are indicators of flow at or just above bankfull. Whether flow rates greatly exceeded the channel capacity or not is unknown but it demonstrates that this portion of the stream shows good floodplain connection and energy dissipation. Crest gage 3 had been toppled over most likely by a combination of inundated soil making it soft and a large storm event. Visual signs indicate that the water surface overtopped the gage completely.

The rainfall data provided in the appendix as Table 12 was for Cabarrus County per the NC Climate website through NCSU, during the period between Oct 2012 and Oct 2013 which totaled 48.69 inches. This is compared to the Harrisburg Town website, which quotes an average annual rainfall of 43.8 inches “consistent with the average rainfall for Cabarrus County.” This means that the site has experienced about a 5 inch rainfall surplus over the average year.

Wetlands

No formal wetland assessment of this site was performed. The site does have two small documented wetlands of 1,050 sf and 3,840 sf, which were discovered after the fall data collection. Both of these wetlands contain Chewacla type soils, according to the soils maps. In addition, there appears to be a small wetland just north of Peach Orchard Road approximately 150 ft west of the stream. The soil of this wetland appears to be moderately wet upon inspection and the surrounding ground and vegetation rather dry.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to 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 Baseline Monitoring Report (formerly Mitigation Plan) and in the Mitigation Plan (formerly the Restoration Plan) documents available on EEP’s website. All raw data supporting the tables and figures in the appendices is available from EEP upon request

Methodology

All survey was performed utilized either total station tradition survey methods or a survey grade GPS unit to capture points with high horizontal and vertical accuracy. The longitudinal stationing was formatted as close as possible to the original restoration plan stationing. The particle size distribution was collected using the standard Wolman pebble count procedure as taught by Dr. Gregory Jennings, North Carolina State University. The methodology used in this monitoring assessment followed the prescribed recommendation of the CVS-EEP Vegetation Monitoring Protocol Level-2.

References

Town of Harrisburg North Carolina, Visitors Page, Geography and Climate
<http://www.harrisburgnc.org/Visitors/GeographyClimate.aspx>

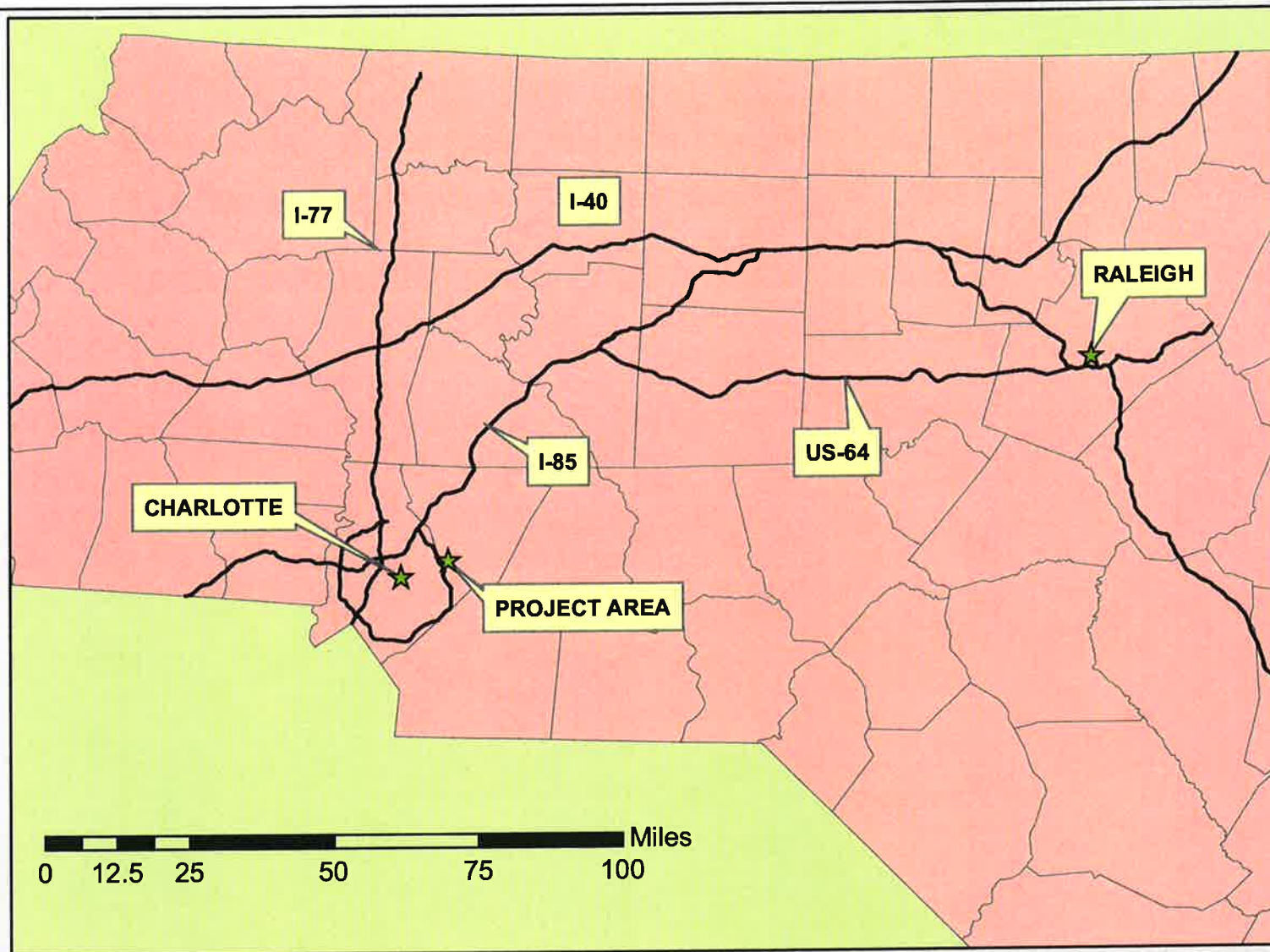
Lower Yadkin LWP– PFR, 2003 and WMP&R – Lower Yadkin LWP, 2004
http://www.nceep.net/services/lwps/Clarke_Creek/F_R_Rocky_Yadkin.pdf

Wolman Pebble Count,
<http://limnology.wisc.edu/courses/zoo548/Wolman%20Pebble%20Count.pdf>

Rainfall Data for Cabarrus County,
<http://www.nc-climate.ncsu.edu/cronos>

Appendix A
Project Vicinity Map and Background Tables

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Project Vicinity Map and Background Tables



The subject project site is an environmental restoration site of the NCDENR Ecosystem Enhancement Program (EEP) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, monitoring and stewardship of the restoration site is permitted within the terms and timeframes of their defined, pre-approved roles. Any intended site visitation or activity by any person outside of these previously sanctioned activities/roles requires prior coordination with EEP

Take US-64 West from the Raleigh area to I-85 (approximately 85 miles). Take I-85 south toward Charlotte (approximately 48 miles). Take exit 48 onto I-485 toward Rock Hill (approximately 8 miles) Take exit 39 onto Harrisburg Road north stay on Robinson Church for approximately 1 mile and then turn right onto NCSR 1169 Peach Orchard Road. Peach Orchard Road intersects the project site.

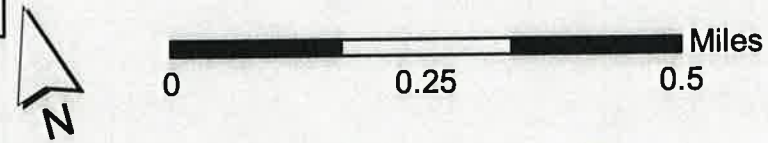
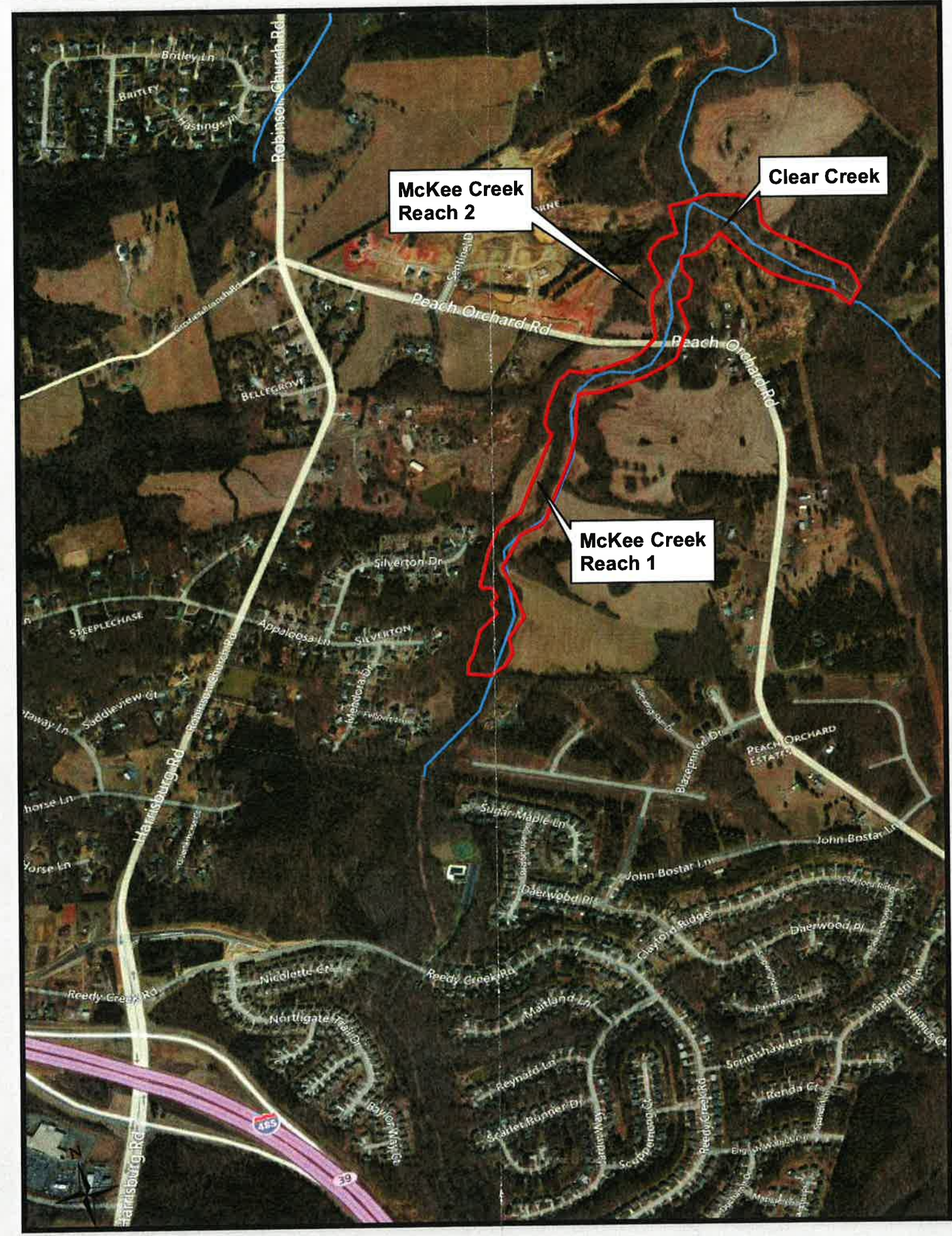


Figure 1: Vicinity Map
McKee Creek Stream Restoration
EEP # 92573
Cabarrus County, NC
December 3, 2012

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**Table 1. Project Components and Mitigation Credits
McKee Creek Project # 92573**

Project Component or Reach ID	Existing Feet/Acres	Restoration Level	Approach	Footage or Acreage	Stationing	Mitigation Ratio	Total Mitigation Assets	Comment
McKee Reach 1	3240	E2	P4	3240	10+00 - 25+00 29+00 - 46+40	2.5:1 MAX	1296	This is a mix of P2 and P4 as designated by the stationing.
McKee Reach 1	493	E1	P2	400	25+00 - 29+00	1.5:1 MAX	267	
McKee Reach 2	847	E1	P2	696	10+00 - 17+23.67	1.5:1 MAX	464	The reach is a mix of P2 and P3, but is mostly dominated by P2. Includes 200 lf of channel relocation
Clear Creek	1513	R	P1	1641	11+03.05 - 27+59.18	1 to 1	1641	Includes 1,351 lf of channel relocation

1 = BR = Bioretention Cell; SF = Sand Filter; SW = Stormwater Wetland; WDP = Wet Detention Pond; DDP = Dry Detention Pond;
 FS = Filter Strip; Grassed Swale = S; LS = Level Spreader; NI = Natural Infiltration Area, O = Other
 CF = Cattle Fencing; WS = Watering System; CH = Livestock Housing

**Table 1b. Component Summations
McKee Creek Project # 92573**

Restoration Level	Stream (lf)	Riparian Wetland (Ac)		Non-Ripar (Ac)	Upland (Ac)	Buffer (Ac)	BMP
		Riverine	Non-Riverine				
Restoration	1641						
Enhancement							
Enhancement I	1096						
Enhancement II	3240						
Creation							
Preservation							
HQ Preservation							
Totals (Feet/Acres)	5977	0	0	0	0	0	

Non-Applicable

**Table 2. Project Activity and Reporting History
McKee Creek Project # 92573**

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Restoration Plan		Aug-08
Final Design – Construction Plans		Apr-09
Construction		May-10
Containerized, bare root and B&B plantings for reach/segments 1&2		May-10
Mitigation Plan / As-built (Year 0 Monitoring – baseline)		
Spring Year 1 Monitoring	Apr-12	May-12
Fall Year 1 Monitoring	Oct-12	Nov-12
Spring Year 2 Monitoring	Apr-13	May-13
Beaver Removal		Summer -13
Invasives Treatment		Fall-13
Fall Year 2 Monitoring	Oct-13	Nov-13

Bolded items are examples of those items that are not standard, but may come up and should be included

Non-bolded items represent events that are standard components over the course of a typical project.

The above are obviously not the extent of potential relevant project activities, but are just provided as example as part of this exhibit.

**Table 3. Project Contacts Table
McKee Creek Project # 92573**

Designer	Withers & Ravenel, Inc. 115 MacKenan Drive Cary, NC 27511 Daniel Wiebke, E.I. (919) 469-3340
Primary project design POC	
Construction Contractor	River Works Inc. 6105 Chapel Hill Road Raleigh, NC 27607 Edward Haynes
Construction contractor POC	
Survey Contractor	Turner Land Surveying
Survey contractor POC	Elisabeth Turner
Planting Contractor	River Works Inc. 6105 Chapel Hill Road Raleigh, NC 27607 Edward Haynes
Planting contractor POC	
Seeding Contractor	Green Resources 5204 Highgreen Ct Colfax, NC 27235 Rodney Montgomery
Contractor point of contact	
Seed Mix Sources	
Nursery Stock Suppliers	Not Known
Monitoring Performers	Withers & Ravenel, Inc. 115 MacKenan Drive Cary, NC 27511
Stream Monitoring POC	Daniel Wiebke, E.I. (919) 535-5172
Vegetation Monitoring POC	Daniel Wiebke, E.I. (919) 535-5173
Wetland Monitoring POC	

Table 4. Project Attribute Table			
McKee Creek Project # 92573			
Project County	Cabarrus		
Physiographic Region	Piedmont		
Ecoregion	Southern Outer Piedmont		
Project River Basin	Yadkin-Pee Dee		
USGS HUC for Project (14 digit)			
NCDWQ Sub-basin for Project	Clear- 03-07-11/03-08-34		
Within extent of EEP Watershed Plan?	Name the plan document		
WRC Hab Class (Warm, Cool, Cold)	Cool		
% of project easement fenced or demarcated	McKee - 100% Clear-100%		
Beaver activity observed during design phase?	Yes		
Restoration Component Attribute Table			
	McKee Reach 1	McKee Reach 2	Clear Creek
Drainage area (acres)	4131	4214	635
Stream order	2	2	1
Restored length (feet)	3640	696	1641
Perennial or Intermittent	Perennial	Perennial	Perennial
Watershed type (Rural, Urban, Developing etc.)	Developing	Developing	Rural
Watershed LULC Distribution (e.g.) acres			
Single Family	2150	2147	106
Woods	1154	1166	469
Commercial	114	113	
Govt-Inst	73	73	
Warehouse	76	76	
Pasture	565	640	60
Watershed impervious cover (%)	16	16	4
NCDWQ AU/Index number			
NCDWQ classification	C	C	C/C
303d listed?	Yes	Yes	Yes
Upstream of a 303d listed segment?	Yes	Yes	Yes
Reasons for 303d listing or stressor	Fecal Coliform, Sediment	Fecal Coliform, Sediment	Fecal Coliform
Total acreage of easement	10.63	2.03	4.75
Total vegetated acreage within the easement	2.57	0.11	1.76
Total planted acreage as part of the restoration	2.57	0.11	1.76
Rosgen classification of pre-existing	E4	E4	E/C5
Rosgen classification of As-built	E4	E4	E/C5
Valley type	VIII	VIII	VIII
Valley slope	0.005	0.005	0.014
Valley side slope range (e.g. 2-3.%)	1-2%	1-2%	1-2%
Valley toe slope range (e.g. 2-3.%)	1-2%	1-2%	1-2%
Cowardin classification	PFO1A	PFO1A	PFO1A
Trout waters designation	No	No	No
Species of concern, endangered etc.? (Y/N)	Yes	Yes	Yes
Dominant soil series and characteristics			
Series	Chewacla	Chewacla	Chewacla
Depth	6 to 24 inches	6 to 24 inches	6 to 24 inches
Clay%	20.5	20.5	20.5
K	0.275	0.275	0.275
T	4.584	4.584	4.584

Use - for items that may not apply. Use "-" for items that are unavailable and "U" for items that are unknown

Appendix B
Visual Assessment Data

Table 5 **Visual Stream Morphology Stability Assessment**
 Reach ID McKee Creek Reach 1
 Assessed Length 3301

Major Channel Category	Channel Sub-Category	Metric	Number of 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	Adjusted % for Stabilizing Woody Vegetation
Bed	Vertical Stability	Aggradation- Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			1	10	95%			
		Degradation-Evidence of downcutting			0	0	100%			
	Riffle Condition	Texture/Substrate - Riffle maintains coarser substrate	0	0			100%			
	Meander Pool Condition	Depth Sufficient (Max Pool Depth: Mean Bankfull Depth>= 1.6)	0	0			100%			
		Length Appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle)	0	0			100%			
	Thalweg Position	Thalweg centering at upstream of meander bend (Run)	0	0			100%			
Thalweg centering at downstream of meander bend (glide)		0	0			100%				
Bank	Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and or scour and erosion			0	0	100%	0	0	100.00%
	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	100.00%
	Mass Wasting	Bank slumping, caving, or collapse			0	0	100%	0	0	100.00%
	Totals					0	0	100%	0	0
Engineered Structures	Overall Integrity	Structures physically intact with no dislodged boulders or logs	0	1			0%			
	Grade Control	Grade control structures exhibiting maintenance of grade across the sill	0	0			100%			
	Piping	Structures lacking any substation flow underneath sills or arms	0	0			100%			
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	0	0			100%			
	Habitat	Pool forming structures maintaining ~ Max Pool Depth: Mean Bankfull Depth >= 1.6 Rootwads/logs providing some cover at base-flow	1	1			100%			

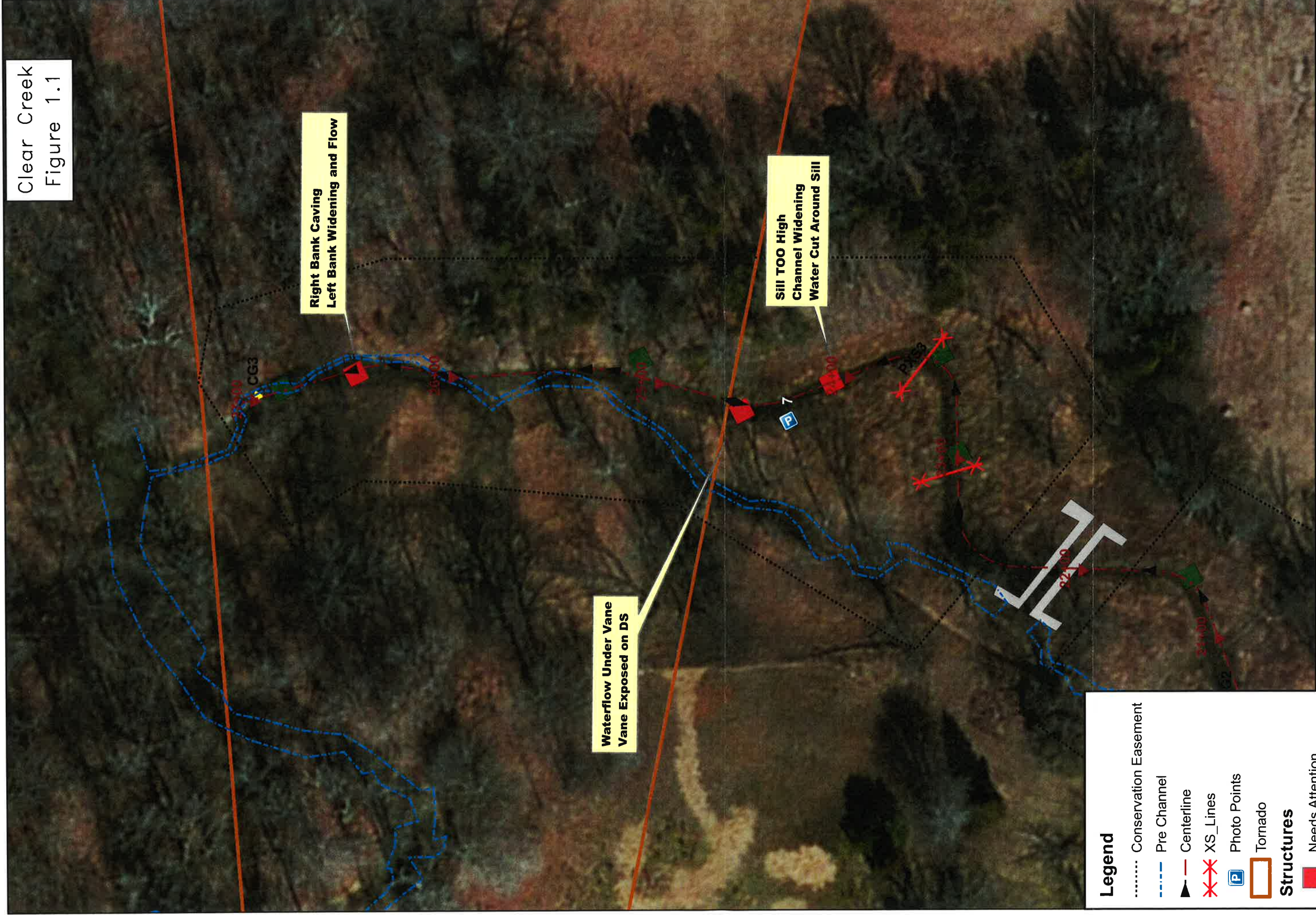
Table 5 **Visual Stream Morphology Stability Assessment**
 Reach ID McKee Creek Reach 2
 Assessed Length 723

Major Channel Category	Channel Sub-Category	Metric	Number of 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	Adjusted % for Stabilizing Woody Vegetation
Bed	Vertical Stability	Aggradation- Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		Degradation-Evidence of downcutting			0	0	100%			
	Riffle Condition	Texture/Substrate - Riffle maintains coarser substrate	0	0			100%			
	Meander Pool Condition	Depth Sufficient (Max Pool Depth: Mean Bankfull Depth >= 1.6)	4	4			100%			
		Length Appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle)	4	4			100%			
	Thalweg Position	Thalweg centering at upstream of meander bend (Run)	4	4			100%			
Thalweg centering at downstream of meander bend (glide)		4	4			100%				
Bank	Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and or scour and erosion			1	10	98%	0	0	100.00%
	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	100.00%
	Mass Wasting	Bank slumping, caving, or collapse			1	25	96%	0	0	100.00%
Totals					0	0	100%	0	0	100.00%
Engineered Structures	Overall Integrity	Structures physically intact with no dislodged boulders or logs	5	5			100%			
	Grade Control	Grade control structures exhibiting maintenance of grade across the sill	5	5			100%			
	Piping	Structures lacking any substation flow underneath sills or arms	5	5			100%			
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	5	5			100%			
	Habitat	Pool forming structures maintaining ~ Max Pool Depth: Mean Bankfull Depth >= 1.6 Rootwads/logs providing some cover at base-flow	5	5			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
 Reach ID Clear Creek
 Assessed Length 1566

Major Channel Category	Channel Sub-Category	Metric	Number of Stable Performing as Intended	Total Number in As-Built	Number of Unstable Sections	Amount of Unstable Footage	% Stable Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
Bed	Vertical Stability	Aggradation- Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		Degradation-Evidence of downcutting			0	0	100%			
	Riffle Condition	Texture/Substrate - Riffle maintains coarser substrate	2	2			100%			
	Meander Pool Condition	Depth Sufficient (Max Pool Depth: Mean Bankfull Depth >= 1.6)	16	16			100%			
		Length Appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle)	16	16			100%			
	Thalweg Position	Thalweg centering at upstream of meander bend (Run)	16	16			100%			
Thalweg centering at downstream of meadner bend (glide)		16	16			100%				
Bank	Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and or scour and erosion			0	0	100%	0	0	100.00%
	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			10	10	99%	0	0	99.00%
	Mass Wasting	Bank slumping, caving, or collapse			1	30	98%	0	0	100.00%
Totals					0	0	100%	0	0	100.00%
Engineered Structures	Overall Integrity	Structures physically intact with no dislodged boulders or logs	13	13			100%			
	Grade Control	Grade control structures exhibiting maintenance of grade across the sill	5	7			71%			
	Piping	Structures lacking any substation flow underneath sills or arms	18	20			90%			
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	19	20			95%			
	Habitat	Pool forming structures maintaining ~ Max Pool Depth: Mean Bankfull Depth >= 1.6 Rootwads/logs providing some cover at base-flow	5	5			100%			

Clear Creek
Figure 1.1



Legend

- Conservation Easement
- - - - Pre Channel
- ▲ Centerline
- ✕ XS_Lines
- 📷 Photo Points
- 📏 Tornado

Structures

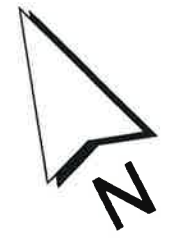
- 🔴 Needs Attention
- 🟢 Good Structure

VegetationPlot

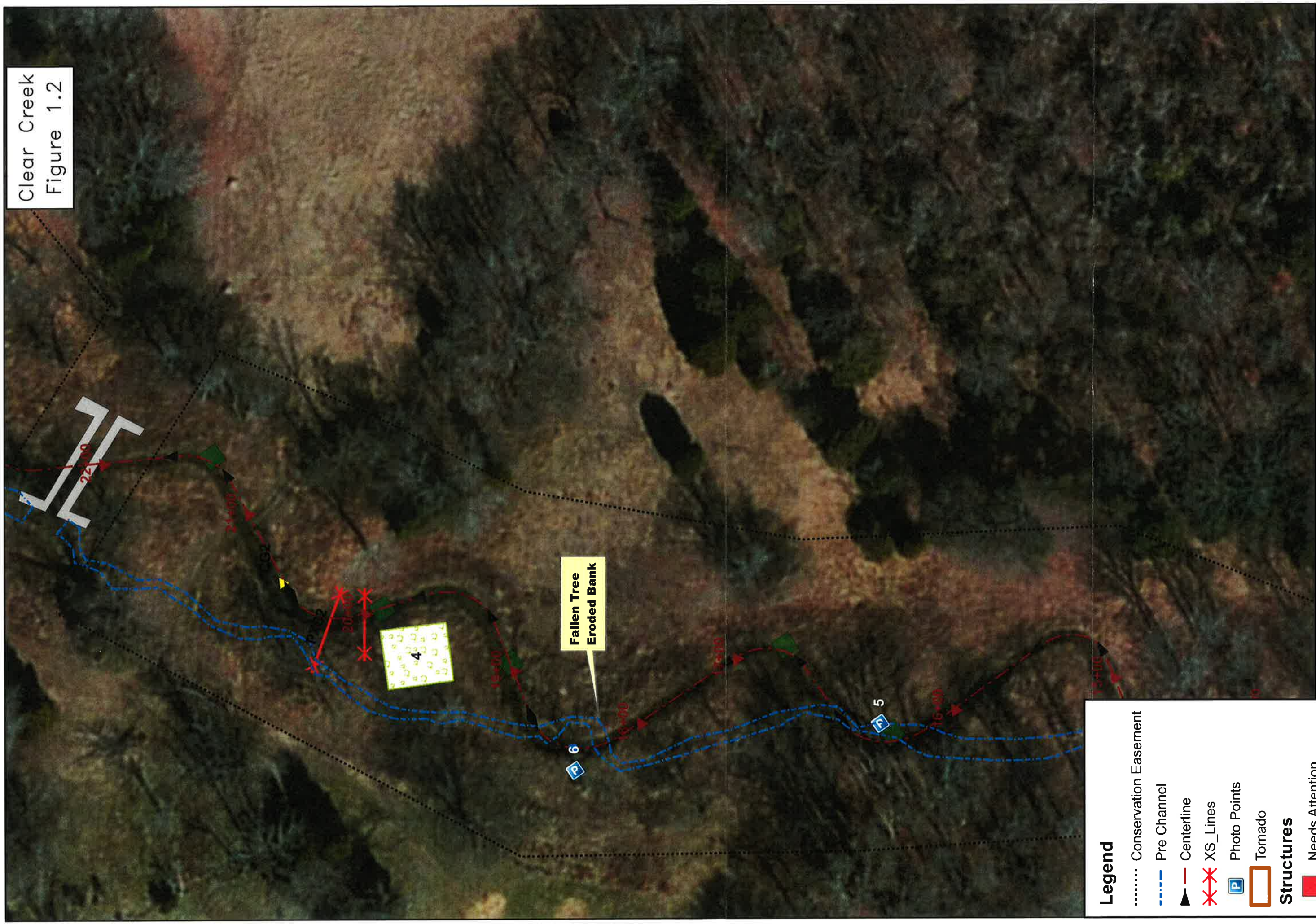
- 🔴 BAD
- 🟢 GOOD



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Clear Creek
Figure 1.2



Legend

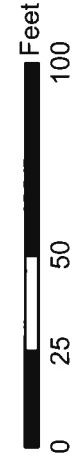
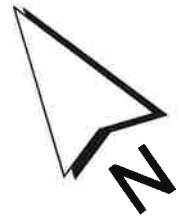
- Conservation Easement
- - - - - Pre Channel
- ▲ Centerline
- ✕ XS_Lines
- P Photo Points
- Tornado

Structures

- Needs Attention
- Good Structure

VegetationPlot

- BAD
- GOOD



Clear Creek
Figure 1.3



Legend

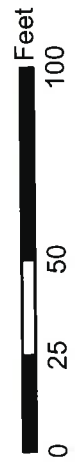
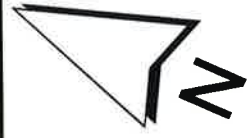
- Conservation Easement
- - - - Pre Channel
- ▲ Centerline
- ✕ XS_Lines
- P Photo Points
- ▭ Tornado

Structures

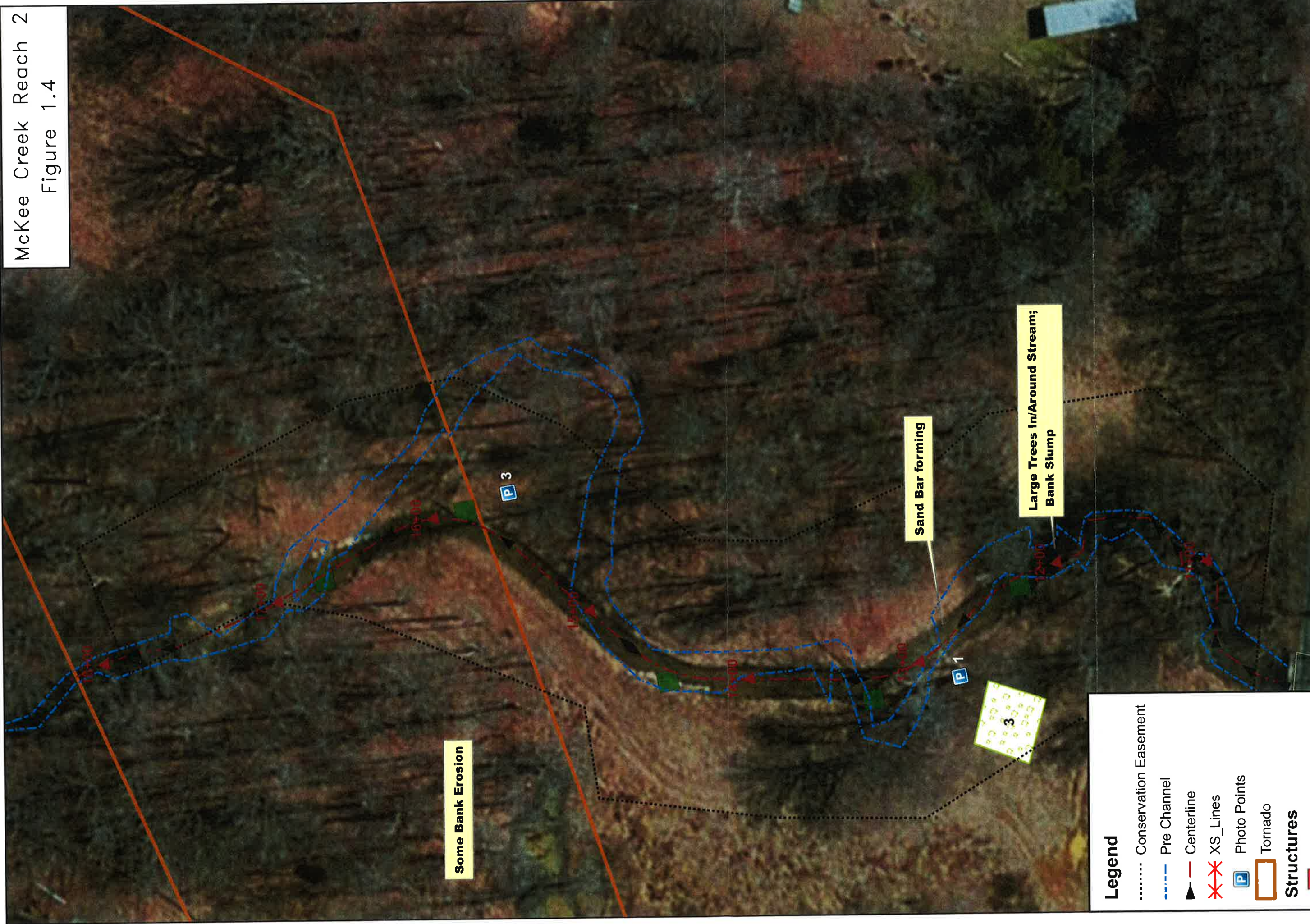
- Needs Attention
- Good Structure

VegetationPlot

- BAD
- GOOD



McKee Creek Reach 2
Figure 1.4



Legend

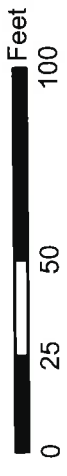
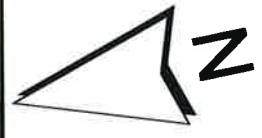
- Conservation Easement
- - - - - Pre Channel
- ▲ Centerline
- ✕ XS_Lines
- P Photo Points
- Tornado

Structures

- Needs Attention
- Good Structure

VegetationPlot

- BAD
- GOOD



McKee Creek Reach 1
Figure 1.6



Legend

- Conservation Easement
- - - - Pre Channel
- ▲ Centerline
- ✕ XS_Lines
- P Photo Points
- Tornado

Structures

- Needs Attention
- Good Structure

VegetationPlot

- BAD
- GOOD



McKee Creek Reach 1
Figure 1.7



Legend

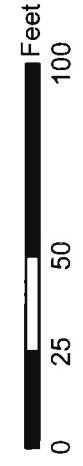
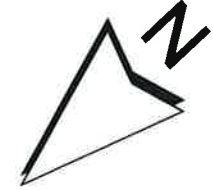
- Conservation Easement
- - - - Pre Channel
- ▲ Centerline
- ✕ XS_Lines
- P Photo Points
- Tornado

Structures

- Needs Attention
- Good Structure

VegetationPlot

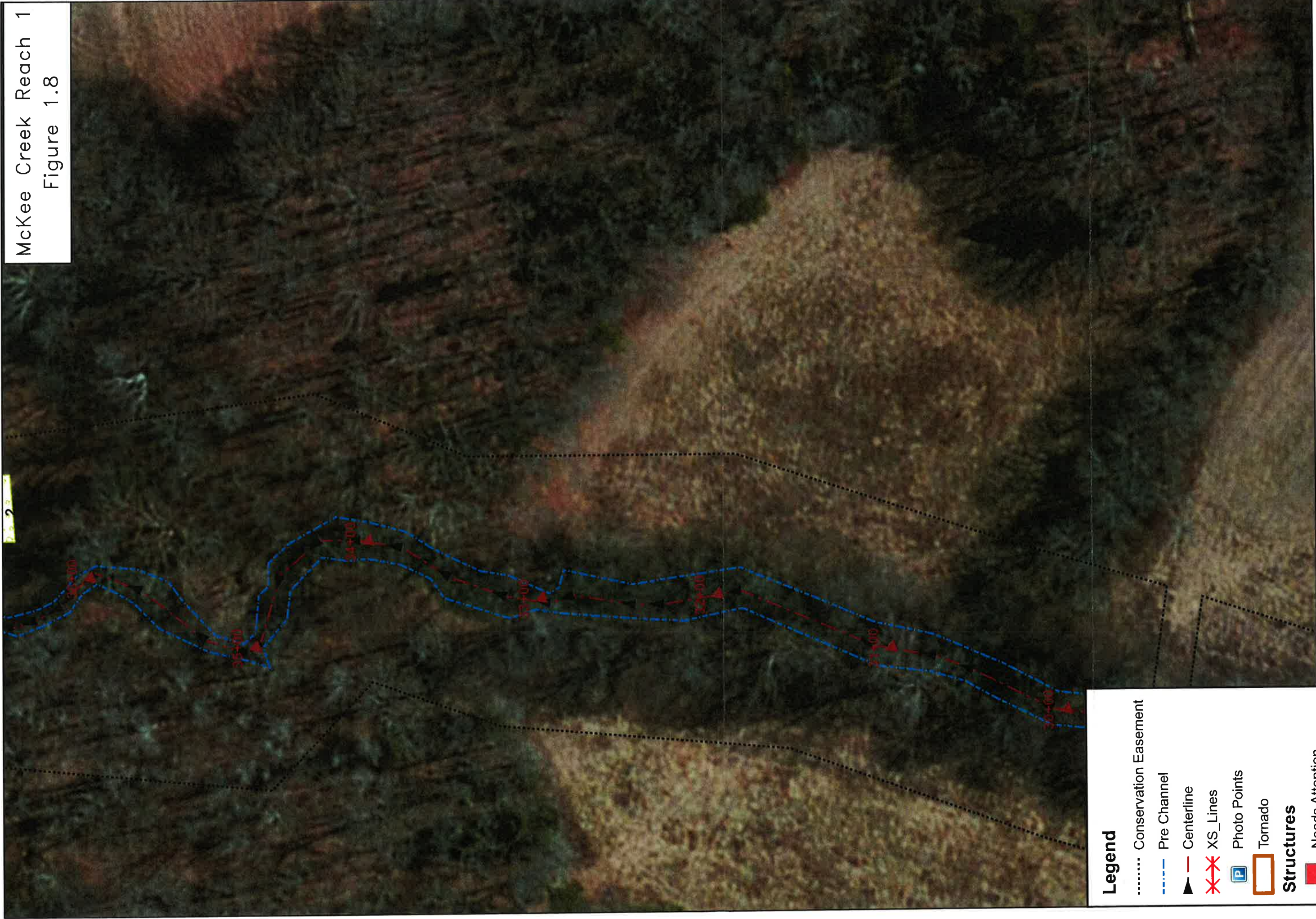
- BAD
- GOOD



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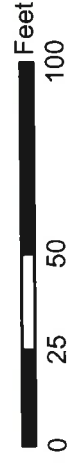
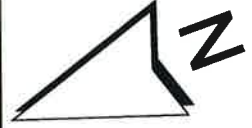


McKee Creek Reach 1
Figure 1.8



Legend

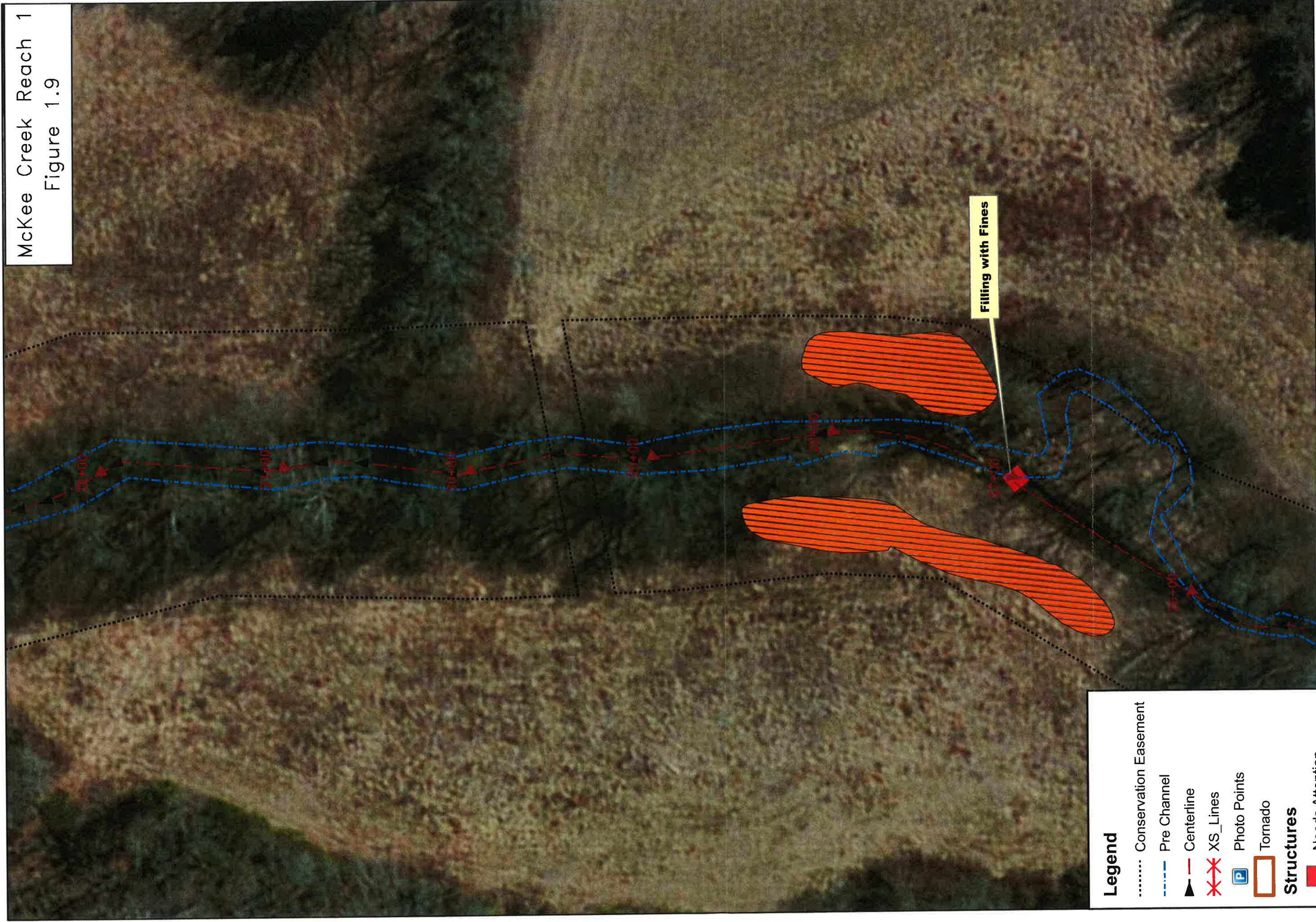
- Conservation Easement
- - - - - Pre Channel
- ▲ Centerline
- ✕ XS_Lines
- P Photo Points
- Tornado
- Structures**
- Needs Attention
- Good Structure
- VegetationPlot**
- ▭ BAD
- ▭ GOOD



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McKee Creek Reach 1
Figure 1.9



Legend

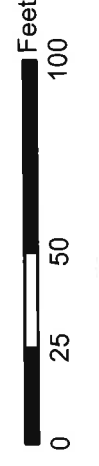
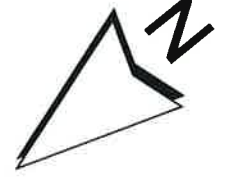
- Conservation Easement
- - - - Pre Channel
- ▲ Centerline
- ✕ XS_Lines
- P Photo Points
- Tornado

Structures

- Needs Attention
- Good Structure

VegetationPlot

- BAD
- GOOD



McKee Creek Reach 1
Figure 1.10



Legend

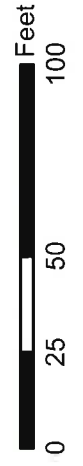
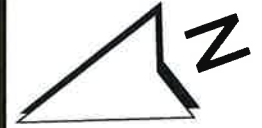
- Conservation Easement
- - - - - Pre Channel
- ▲ Centerline
- ✕ XS_Lines
- P Photo Points
- Tornado

Structures

- Needs Attention
- Good Structure

VegetationPlot

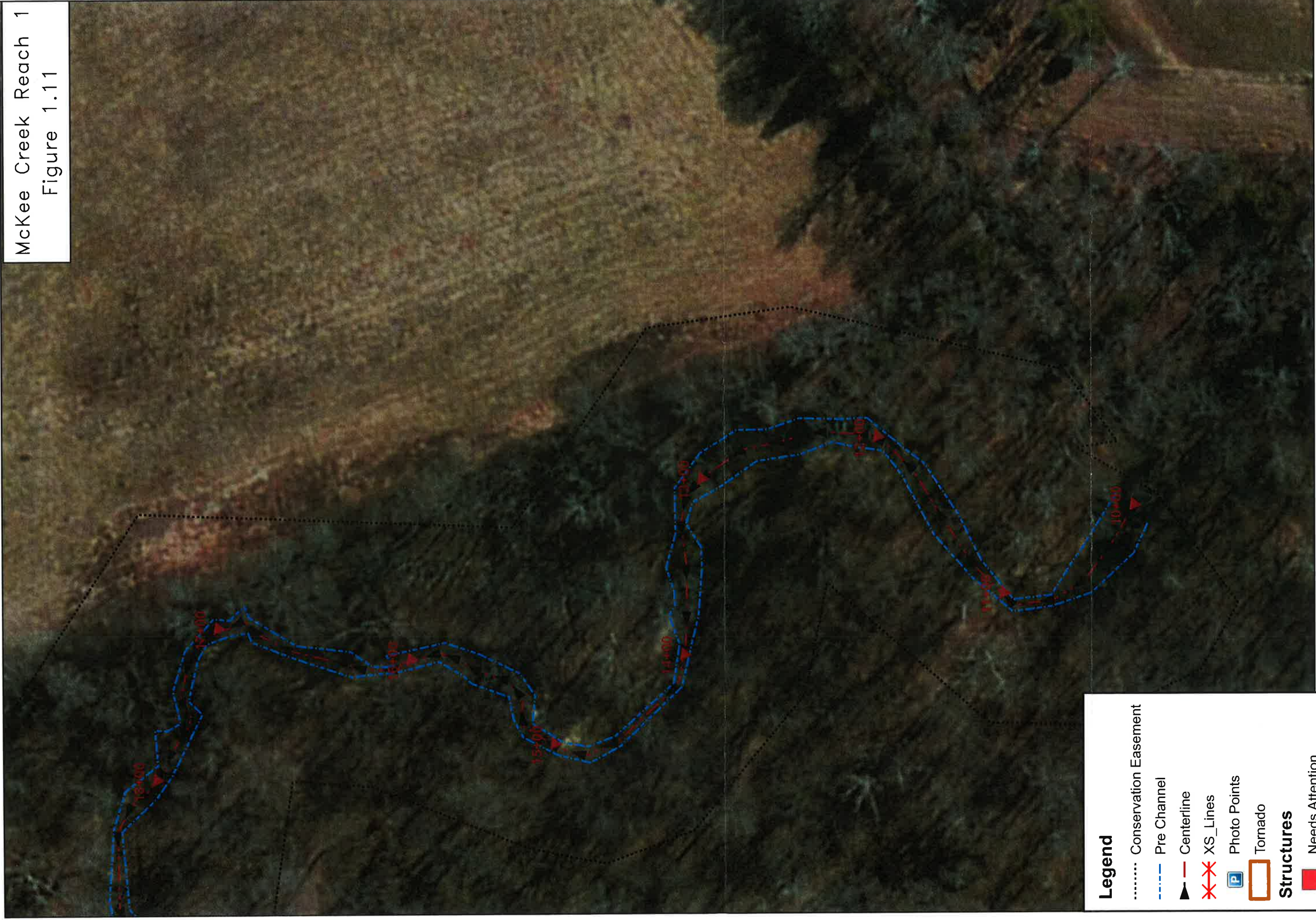
- BAD
- GOOD



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McKee Creek Reach 1
Figure 1.11



Legend

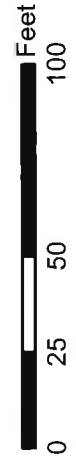
- Conservation Easement
- - - - - Pre Channel
- ▲ Centerline
- XX XS_Lines
- P Photo Points
- Tornado

Structures

- Needs Attention
- Good Structure

VegetationPlot

- BAD
- GOOD



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Figure 2
Overall Map
#D07063S



Photo 1
Veg Plot 1- Year 1 (2012)



Photo 2
Veg Plot 1- Year 2 (2013)



Photo 3
Veg Plot 2- Year 1 (2012)



Photo 4
Veg Plot 2- Year 2 (2013)



Photo 5
Veg Plot 3- Year 1 (2012)



Photo 6
Veg Plot 3- Year 2 (2013)



Photo 7
Veg Plot 4- Year 1 (2012)



Photo 8
Veg Plot 4- Year 2 (2013)



Photo 9
Riffle XS 1 - Year 1 (2012)



Photo 10
Riffle XS 1 - Year 2 (2013)



Photo 11
Pool XS 1 - Year 1 (2012)



Photo 12
Pool XS 1 - Year 2 (2013)



Photo 13
Riffle XS 2- Year 1 (2012)



Photo 14
Riffle XS 2- Year 2 (2013)



Photo 15
Pool XS 2 - Year 1 (2012)



Photo 16
Pool XS 2 - Year 2 (2013)



Photo 17
Riffle XS 3 - Year 1 (2012)



Photo 18
Riffle XS 3 - Year 2 (2013)



Photo 19
Pool XS 3 - Year 1 (2012)



Photo 20
Pool XS 3 - Year 2 (2013)



Photo 21
Photo Point 1- Year 1 (2012)



Photo 22
Photo Point 1- Year 2 (2013)



Photo 23
Photo Point 2- Year 1 (2012)



Photo 24
Photo Point 2- Year 2 (2013)



Photo 25
Photo Point 3- Year 1 (2012)



Photo 26
Photo Point 3- Year 2 (2013)



Photo 27
Photo Point 4- Year 1 (2012)



Photo 28
Photo Point 4- Year 2 (2013)



Photo 29
Photo Point 5- Year 1 (2012)



Photo 30
Photo Point 5- Year 2 (2013)



Photo 31
Photo Point 6- Year 1 (2012)



Photo 32
Photo Point 6- Year 2 (2013)



Photo 33
Photo Point 7- Year 1 (2012)



Photo 34
Photo Point 7- Year 2 (2013)



Appendix C
Vegetation Plot Data

Table 6 Vegetation Condition Assessment

McKee Creek Project # 92573

Planted Acreage		4.44		Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
Vegetation Category									
Bare Area				Very limited cover of both woody and herbaceous material	.1 acres	Pattern and Color	0	0	0
Low Stem Density Areas				Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria	.1 acres	Pattern and Color	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	.25 Acres	Pattern and Color	0	0	0

Easment Acreage		17.41		Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement
Vegetation Category									
Invasive Areas of Concern				Areas or points (if too small to render as polygons at map scale)	500 SF	Pattern and Color	1	0.011478421	0.07%
Easement Encroachment Areas				Areas or points (if too small to render as polygons at map scale)	None	Pattern and Color	0	0	0

Table 7. Veg Plot Criteria Attainment	
McKee Creek Project # 92573	
Vegetation Plot ID	Vegetation Survival Threshold Met?
1	No
2	Yes
3	Yes
4	Yes

Table 8. CVS Vegetation Plot Metadata	
McKee Creek Project # 92573	
Report Prepared By	Daniel Wiebke
Date Prepared	12/16/2013 11:15
database name	Withers&Ravenel-2013-A.mdb.mdb
database location	C:\Users\Daniel\Desktop
computer name	DANIEL-PC
file size	72744960
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY-----	
Project Code	92573
project Name	McKee Creek
Description	McKee Creek Upstream and Downstream of Peach Orchard and Clear Creek
River Basin	Yadkin-Pee Dee
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	8

Table 9. Planted Stem Counts (Species by Plot with Annual Means)
McKee Creek Project # 92573

Common Name	Type	Current Data												Annual Means					
		Plot 1			Plot 2			Plot 3			Plot 4			Current Mean		MY 1 (2012)			
		P	T		P	T		P	T		P	T		P	T	P	T		
<i>Acer negundo</i>		0	0	0	0	0	0	0	1	1	0	0	0	0	6	0	1.75	0	1.25
<i>Betula nigra</i>	Tree	1	1	0	0	0	2	4	4	0	0	0	0	0	0	0.75	1.25	0.75	1.25
<i>Carya aquatica</i>		0	3	2	2	2	0	1	1	0	0	0	0	0	0	0.5	1.5	0.5	0.5
<i>Diospyrus virginiana</i>		0	1	0	2	2	0	1	1	0	0	0	1	0	1	0	1.25	0	1
<i>Eleagnus umbellata</i>		0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0.5	0	0.75
<i>Fraxinus pennsylvanica</i>	Tree	0	0	3	3	3	1	1	1	0	0	0	1	0	0	1	1	1	1
<i>Juglans nigra</i>	Tree	3	3	0	0	0	0	0	0	0	2	4	4	1.25	1.75	1.75	1.75	1.75	1.75
<i>Liquidambar styraciflua</i>		0	1	0	34	34	1	1	1	1	0	2	2	0.25	0.75	0	9.5	0	9.5
<i>Liriodendron tulipifera</i>	Tree	0	0	0	0	0	0	0	0	0	2	2	2	0.5	0.5	0.75	0.5	0.75	0.75
<i>Plantanus</i>	Tree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25
<i>Platanus occidentalis</i>	Tree	2	2	5	5	5	3	3	3	3	9	12	12	4.75	5.5	4.5	5.5	4.5	4.25
<i>Quercus michauxii</i>	Tree	0	0	0	0	0	3	3	3	3	0	0	0	0.75	0.75	1	0.75	1	0.5
<i>Quercus nigra</i>		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Quercus sp.</i>	Shrub Tree	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0.5	0.5	0.5
<i>Rhus copallinum</i>		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25
<i>Salix nigra</i>	Tree	0	0	0	0	0	0	0	0	0	9	12	12	2.25	3	2.25	3	2.25	2.25
<i>Ulmus alata</i>		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.25
<i>Unknown</i>	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Plot Area (acres)		0.0247		0.0247	0.0247		0.0247		0.0247		0.0247		0.0247			0.0247		0.0247	0.0247
Species Count		3	6	3	7	3	5	8	8	4	4	7	7	3.75	7		7		
Stem Count		6	11	10	50	10	10	15	15	22	22	39	39	12	28.75	14	28.75	14	30
Stems Per Acre		243	445	405	2024	405	405	607	607	891	891	1579	1579	486	1164	567	1164	567	1215

Appendix D
Stream Survey Data

Table 10a. Baseline Stream Data Summary
 McKee Creek Project # 92573 - McKee-Reach 1

Parameter	Gauge#	Regional Curve			Pre-Existing Condition					Design					Monitoring Baseline				
		LL	UL	Eq.	Min	Med	Max	SD5	n	Min	Med	Max	SD5	n	Min	Med	Max	SD5	n
Dimension and Substrate - Rifle Only																			
Bankfull Width (ft)					27.5		31.8								31				
Floodprone Width (ft)					75		160								75		160		
Bankfull Mean Depth (ft)					2.1		2.8								2.6		4.4		
Bankfull Max Depth (ft)					3.5		4.4								3.4		4.4		
Bankfull Cross Sectional Area (ft ²)					68.2		77.6								80				
Width/Depth Ratio					10.2		14.9								12		5.2		
Entrenchment Ratio					2.6		5.5								2.4		5.2		
¹ Bank Height Ratio					1		2.1								1				
Profile																			
Rifle Length (ft)																			
Rifle Slope (ft/ft)					1.9		4.5								1.9		3.3		
Pool Length (ft)					3.1		6.4								5.2		7.7		
Pool Max depth (ft)					50		205								123.9		216.9		
Pool Spacing (ft)																			
Pattern																			
Channel Beltwidth (ft)					65		145								93		139		
Radius of Curvature (ft)					48		195								62		108		
Rc:Bankfull width (ft/ft)					27.5		31.8								31				
Meander Wavelength (ft)					101		305								235		350		
Meander Width Ratio					2.2		5								2		4.5		
Transport parameters																			
Reach Shear Stress (competency) lb/ft ²							0.49								0.52				
Max pert size (mm) mobilized at bankfull							45								45				
Stream Power (transport capacity) W/m ²																			
Additional Reach Parameters																			
Rosgen Classifier							E4								C4				
Bankfull Velocity (fps)							4.4-5.0								4.1				
Bankfull Discharge (cfs)							350												
Valley length (ft)																			
Channel Throat length (ft)																			
Sinuosity (ft)							1.28								1.16				
Water Surface Slope (Channel) (ft/ft)							0.0029								0.0032				
BF slope (ft/ft)							0.0029								0.0032				
² Bankfull Floodplain Area (acres)																			
⁴ % of Reach with Eroding Banks																			
Channel Stability or Habitat Metric																			
Biological or Other																			

Should cells indicate that data will typically not be filed in.

1 = The distributions for these parameters are available information from both the cross-section survey and the longitudinal profile. 2 = For projects with a potential USGS gauging station with the project reach (added bankfull verification - reach).

3 = Utilizing survey data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the top of the former marsh/bog.

4 = Percentage of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data. 5 = 0% (value/total only) (due to excess 3).

Table 10a. Baseline Stream Data Summary -R2
 McKee Creek Project # 92573 - McKee-Reach 2

Parameter	Gauge2		Regional Curve			Pre-Existing Condition						Design						Monitoring Baseline					
	LL	UL	Eq.	Min	Med	Max	SP5	n	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	SD5	n	
Dimension and Substrate - Riffle Only																							
Bankfull Width (ft)				25.5	26.8	28.8				31.9	160												
Floodprone Width (ft)				75	180				75														
Bankfull Mean Depth (ft)				2.1	2.8	4.4			3.4	2.6	4.4												
Bankfull Max Depth (ft)				3.5	4.4																		
Bankfull Cross Sectional Area (ft²)																							
Width/Depth Ratio				66.2	77.6				80														
Enrichment Ratio				10.2	14.9				12														
Mean Height Ratio				2.6	5.5				2.4														
				1	2.1				1														
Profile																							
Rifle Length (ft)				101	305																		
Rifle Slope (ft/ft)				0.0056	0.0131				0.0061		0.0106												
Pool Length (ft)																							
Pool Max depth (ft)				6.5	6.5				5.3		8												
Pool Spacing (ft)				45	180				127.7		223.6												
Pattern																							
Channel Belwidth (ft)				135	240				86		287												
Radius of Curvature (ft)				95	240				64		144												
Rc-Bankfull width (ft/ft)				25.5	26.8				31.9														
Meander Wavelength (ft)				208	377				243		477												
Meander Width Ratio				5	9.2				3		9												
Transport parameters																							
Reach Shear Stress (competency) lb/ft ²					0.33						0.38												
Max part size (mm) mobilized at bankfull					45						45												
Stream Power (transport capacity) W/m ²																							
Additional Reach Parameters																							
Region Classification					E-4						C-4												
Bankfull Velocity (fps)					4.0-4.5						4.1												
Bankfull Discharge (cfs)					350																		
Valley length (ft)																							
Channel Thalweg length (ft)																							
Sinuosity (ft)					1.5						1.17												
Water Surface Slope (Channel) (ft/ft)					0.0027						0.0027												
BF slope (ft/ft)					0.0018						0.0018												
Bankfull Floodplain Area (acres)																							
% of Reach with Eroding Banks																							
Channel Stability or Habitat Metrics																							
Biological or Other																							

Standard deviation that there will typically not be filled in.
 1 = The distribution for these parameters can include information from both the cross section survey and the longitudinal profile. 2 = For profiles with a predicted 15000 gage in line with its project reach (added to bankfull vertical datum - zero).
 3 = Utilizing survey data produced as contour of the bankfull floodplain area is zero, which should be the case first, the top of bank in the top of the terrain raster/lope.
 4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison in monitoring data. 5. Of value/total only if the is a reach. 3

Table 10a. Baseline Stream Data Summary -R2
McKee Creek Project # 92573 - Clear Creek

Parameter	Gauge#2		Regional Curve		Pre-Existing Condition						Design			Dixon Branch		
	LL	UL	Eq.	Min	Med	Max	SD5	n	Min	Med	Max	Min	Med	Max		
Dimension and Substrata - Riffle Only																
Bankfull Width (ft)				11.5		16.7				17.3		7.9		13.9		
Floodprone Width (ft)				50		150			90		190		35	100		
Bankfull Mean Depth (ft)				1.3		2				1.4		0.8		1.4		
<small>Bankfull Max Depth (ft)</small>				3.7		6.1			2.2		2.5		2	2.9		
Bankfull Cross Sectional Area (ft²)																
Width/Depth Ratio				21.8		24.8				25		11.3		13.2		
Entrenchment Ratio				5.8		12.8				12		5.4		10.8		
<small>Bank Height Ratio</small>				3.8		11.3			5.2		11		3.1	8.9		
				1.4		2.3				1		1.1		1.5		
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)				0.0056		0.0084			0.0061		0.0106		0.012	0.018		
Pool Length (ft)																
Pool Max depth (ft)				2.8		3.3			5.3		8		2.1	2.5		
Pool Spacing (ft)				57.5		116.9			127.7		223.6		10	45		
Pattern																
Channel Beltwidth (ft)				35		47			52		78		29	50		
Radius of Curvature (ft)				15		25			35		52		6	22		
Rc:Bankfull width (ft/ft)				11.5		16.7				17.3		7.9		13.9		
Meander Wavelength (ft)				45		75			132		196		48	85		
Meander Width Ratio				3.4		5.6			3		4.5		4.3	7.6		
Transport parameters																
Reach Shear Stress (competency) lb/ft ²																
Max part size (mm) mobilized at bankfull																
Stream Power (transport capacity) W/m ²																
Additional Reach Parameters																
Rosen Classification						E/C5				C4				E4		
Bankfull Velocity (fps)						3.3-3.9				3.6				3.6		
Bankfull Discharge (cfs)						89										
Valley length (ft)																
Channel Thaliweg length (ft)																
Sinuosity (ft)						1.12				1.21				1.3		
Water Surface Slope (Channel) (ft/ft)						0.0042				0.0071				0.0055		
<small>Bankfull Floodplain Area (acres)</small>						0.0042				0.0032				0.0055		
<small>4% of Reach with Eroding Bank</small>																
Channel Stability or Habitat Metric																
Biological or Other																

Shaded cells indicate that these will typically not be filled in.

1 - The distributions for these parameters can include information from both the cross-section surveys and the longitudinal profiles. 2 - For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3 - Utilizing survey data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/diaper.

4 - Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data. 5 - 0% value/indicated only if the seconds 3.

Table 10b. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
McKee Creek Project # 92573

Parameter	Pre-Existing Condition		Reference Reach(es) Data		Design		As-built/Baseline		
	10% / 10% / PK / GK / SK	18.5% / 50% / GK / CN / BK / BHR	0.7	27.8	49.4	83.2	109.5		
1919 / 031 / 052 / 081 / 091 / 101 / 111 / 121 / 131 / 141 / 151 / 161 / 171 / 181 / 191 / 201 / 211 / 221 / 231 / 241 / 251 / 261 / 271 / 281 / 291 / 301 / 311 / 321 / 331 / 341 / 351 / 361 / 371 / 381 / 391 / 401 / 411 / 421 / 431 / 441 / 451 / 461 / 471 / 481 / 491 / 501 / 511 / 521 / 531 / 541 / 551 / 561 / 571 / 581 / 591 / 601 / 611 / 621 / 631 / 641 / 651 / 661 / 671 / 681 / 691 / 701 / 711 / 721 / 731 / 741 / 751 / 761 / 771 / 781 / 791 / 801 / 811 / 821 / 831 / 841 / 851 / 861 / 871 / 881 / 891 / 901 / 911 / 921 / 931 / 941 / 951 / 961 / 971 / 981 / 991 / 1001									
2. Enrichment Class <1.5 / 1.51 / 1.99 / 2.04 / 2.07 / 2.09 / 2.15 <10									
3. Inaction Class <1.2 / 1.21 / 2.0 / 2.01 / 2.02 / 2.03 / 2.04 / 2.05 / 2.06 / 2.07 / 2.08 / 2.09 / 2.10 / 2.11 / 2.12 / 2.13 / 2.14 / 2.15 / 2.16 / 2.17 / 2.18 / 2.19 / 2.20 / 2.21 / 2.22 / 2.23 / 2.24 / 2.25 / 2.26 / 2.27 / 2.28 / 2.29 / 2.30 / 2.31 / 2.32 / 2.33 / 2.34 / 2.35 / 2.36 / 2.37 / 2.38 / 2.39 / 2.40 / 2.41 / 2.42 / 2.43 / 2.44 / 2.45 / 2.46 / 2.47 / 2.48 / 2.49 / 2.50 / 2.51 / 2.52 / 2.53 / 2.54 / 2.55 / 2.56 / 2.57 / 2.58 / 2.59 / 2.60 / 2.61 / 2.62 / 2.63 / 2.64 / 2.65 / 2.66 / 2.67 / 2.68 / 2.69 / 2.70 / 2.71 / 2.72 / 2.73 / 2.74 / 2.75 / 2.76 / 2.77 / 2.78 / 2.79 / 2.80 / 2.81 / 2.82 / 2.83 / 2.84 / 2.85 / 2.86 / 2.87 / 2.88 / 2.89 / 2.90 / 2.91 / 2.92 / 2.93 / 2.94 / 2.95 / 2.96 / 2.97 / 2.98 / 2.99 / 3.00									

Shaded cells indicate that these will typically not be filled in.

1 = Rills, Run, Pool, Gled, Step, Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock; dip = max pve, dlo = max subave

2 = Enrichment Class - Assign the reach footage into the classes indicated and provide the percentage of the total reach footage in each class in the table. This will result from the measured cross-sections as well as visual estimates

3 = Assign the reach footage into the classes indicated and provide the percentage of the total reach footage in each class in the table. This will result from the measured cross-sections as well as the longitudinal profile

Footnote 2.3 - These classes are loosely built around the Roegen classification and toward making breaks, but were adjusted slightly to make for easier assignment to somewhat coarser line based on visual estimates in the field such that measurement of every segment for ER would not be necessary.

The intent here is to provide the reader/consumer of design and monitoring information with a good general sense of the extent of hydrologic containment in the pre-existing and the rehabilitated states as well as comparators to the reference distribution. ER and BHR have been addressed in prior submissions as a subsample (cross-sections as part of the design survey), however, these subsamples have often focused entirely on facilitating design without providing a thorough pre-construction distribution of these parameters, leaving the reader/consumer with a sample that is weighted heavily on the stable sections of the reach. This means that the distributions for these parameters should include data from both the cross-section surveys and the longitudinal profile and in the case of ER, visual estimates. For example, the typical longitudinal profile permits sampling of the BHR at riffles beyond those subject to cross-sections and therefore can be readily integrated and provide a more complete sample distribution for these parameters, thereby providing the distributive/coverage necessary to provide meaningful comparisons.

Table 10b. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
McKee Creek Project #92573

Parameter	Pre-Existing Condition		Reference Reach(es) Data				Design		As-built/Baseline	
	16% / 50% / 84% / 95%	100% / 100%	16% / 50% / 84% / 95%	100% / 100%	16% / 50% / 84% / 95%	100% / 100%	16% / 50% / 84% / 95%	100% / 100%	16% / 50% / 84% / 95%	100% / 100%
16% / 50% / 84% / 95%										
100% / 100%										
16% / 50% / 84% / 95%										
100% / 100%										
16% / 50% / 84% / 95%										
100% / 100%										
16% / 50% / 84% / 95%										
100% / 100%										
16% / 50% / 84% / 95%										
100% / 100%										

Shaded cells indicate that these will typically not be filled in.
 1 = Riffle, Run, Pool, Gully, Step, Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock, dip = max, avgs, dip = max, subavg
 2 = Entrenchment Class - Assign into the reach footage into the classes indicated and provide the percentage of the total reach footage in each class in the table. This will result from the measured cross-sections as well as visual estimates
 3 = Assign into the reach footage into the classes indicated and provide the percentage of the total reach footage in each class in the table. This will result from the measured cross-sections as well as the longitudinal profile

Footnotes 2.3 - These classes are locally built around the Rozen classification and hazard rating levels, but were adjusted slightly to make for easier assignment to somewhat coarser bins based on visual estimates in the field such that measurement of ER and BHR have been addressed in prior submissions as a subsample (cross-sections as part of the design survey); however, these subsamples have often focused entirely on facilitating design without providing a thorough pre-construction distribution of the reach. This means that the distributions for these parameters should include data from both the cross-section surveys and the longitudinal profile and in the case of ER, visual estimates. For example, the typical longitudinal profile permits sampling a more complete sample distribution for these parameters, thereby providing the distribution/coverage necessary to provide meaningful comparisons.

Table 11a. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)

McKee Creek Project # 92573

	Cross Section 1 (Riffle-1)					Cross Section 2 (Pool-1)					Cross Section 3 (Riffle-2)											
	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	
Based on fixed baseline bankfull elevation¹																						
Record elevation (datum) used	583.4	581.0						582.7	580.0						580.8	580.5						
Bankfull Width (ft)	24.27	22.00						22.5	23.00						18.00	13.00						
Floodprone Width (ft)	160.0	33.00						160.0	36.0						150.0	150.0						
Bankfull Mean Depth (ft)	1.89	1.98						2.45	2.37						1.36	1.05						
Bankfull Max Depth (ft)	2.76	2.85						3.90	3.69						2.43	1.75						
Bankfull Cross Sectional Area (ft ²)	53.00	51.40						63.68	58.50						30.61	13.40						
Bankfull Width/Depth Ratio	12.82	11.11						9.20	9.70						13.23	12.33						
Bankfull Entrenchment Ratio	6.59	1.50						7.10	1.57						8.82	11.54						
Bankfull Bank Height Ratio	2.53	2.23						1.84	1.81						1.00	1.20						
Based on current/developing bankfull features²																						
Record elevation (datum) used																						
Bankfull Width (ft)																						
Floodprone Width (ft)																						
Bankfull Mean Depth (ft)																						
Bankfull Max Depth (ft)																						
Bankfull Cross Sectional Area (ft ²)																						
Bankfull Width/Depth Ratio																						
Bankfull Entrenchment Ratio																						
Bankfull Bank Height Ratio																						
Cross Sectional Area between and pins (ft ²)																						
d50 (mm)																						
Based on fixed baseline bankfull elevation¹																						
Record elevation (datum) used	580.2	580.4						579.9	579.6						579.1	578.3						
Bankfull Width (ft)	17.00	14.30						17.00	13.88						15.00	13.20						
Floodprone Width (ft)	150.0	150.0						250.0	200.0						250.0	200.0						
Bankfull Mean Depth (ft)	2.55	2.62						1.11	0.96						1.70	1.68						
Bankfull Max Depth (ft)	3.97	3.82						1.96	1.84						3.46	3.17						
Bankfull Cross Sectional Area (ft ²)	30.61	31.60						21.02	14.73						27.27	21.35						
Bankfull Width/Depth Ratio	6.66	5.46						15.37	14.51						8.80	7.87						
Bankfull Entrenchment Ratio	8.82	10.49						14.71	14.41						16.67	15.15						
Bankfull Bank Height Ratio	1.18	1.00						1.00	1.01						1.00	1.00						
Based on current/developing bankfull features²																						
Record elevation (datum) used																						
Bankfull Width (ft)																						
Floodprone Width (ft)																						
Bankfull Mean Depth (ft)																						
Bankfull Max Depth (ft)																						
Bankfull Cross Sectional Area (ft ²)																						
Bankfull Width/Depth Ratio																						
Bankfull Entrenchment Ratio																						
Bankfull Bank Height Ratio																						
Cross Sectional Area between and pins (ft ²)																						
d50 (mm)																						

1 = Widths and depths for monitoring resurvey will be based on the baseline bankfull datum regardless of dimensional/depositional development. Input the elevation used as the datum, which should be consistent and based on the baseline of prior years this must be discussed with EEP. If this cannot be resolved in time for a given years report submission a footnote in this should be included that states: "It is uncertain if the monitoring datum has been confirmed or performer is being acquired to provide confirmation. Values will be recalculated in a future submission based on a consistent datum if determined to be necessary."
 2 = Based on the elevation of any dominant depositional feature that develops and is observed at the time of survey. If the baseline datum remains the only significant depositional feature then these two sets of dimensional parameters will be equal, however, if another depositional feature of significance develops above or below the baseline bankfull datum then this should be tracked and quantified in these cells.

Exhibit Table 11b. Monitoring Data - Stream Reach Data Summary
McKee Creek Project # 92573 McKee Creek-Reach 1

Parameter	Baseline										MY-1					MY-2					MY-3					MY-4					MY-5								
	Min	Mean	Med	Max	SD4	n	Min	Mean	Med	Max	SD4	n	Min	Mean	Med	Max	SD4	n	Min	Mean	Med	Max	SD4	n	Min	Mean	Med	Max	SD4	n	Min	Mean	Med	Max	SD4	n			
Dimension and Substrate - Riffle only																																							
Bankfull Width (ft)																																							
Floodprone Width (ft)																																							
Bankfull Mean Depth (ft)																																							
Bankfull Max Depth (ft)																																							
Bankfull Cross Sectional Area (ft ²)																																							
Width/Depth Ratio																																							
Entrenchment Ratio																																							
Bank Height Ratio																																							
Profile																																							
Riffle Length (ft)							15	24	20	38	8	18																											
Riffle Slope (ft/ft)							0	0	0	0	0	18																											
Pool Length (ft)							10	43	32	132	33	15							17.47																				
Pool Max depth (ft)							2	3	3	4	1	6							0.7																				
Pool Spacing (ft)							59	84	66	103	19	4																											
Pattern																																							
Channel Belwidth (ft)							42	91	64	170	58	5																											
Radius of Curvature (ft)							22	49	46	80	19	7																											
Rc:Bankfull width (ft/ft)																																							
Meander Wavelength (ft)							138	437	280	1070	387	5																											
Meander Width Ratio							1.615	3.515	2.462	6.538	2.149	5																											
Additional Reach Parameters																																							
Roqgen Classification																																							
Channel Throat length (ft)																																							
Sinuosity (ft)																																							
Water Surface Slope (Channel) (ft/ft)																																							
BF slope (ft/ft)																																							
3R% / Ru% / P% / G% / S%																																							
3SC% / Sa% / G% / C% / B% / Be%																																							
3d16 / d35 / d50 / d84 / d85 /																																							
2% of Reach with Eroding Banks																																							
Channel Stability or Habitat Metric																																							
Biological or Other																																							
Shaded cells indicate that these will typically not be filled in.																																							
1 = The distributions for these parameters can include information from both the cross-section surveys and the longitudinal profile																																							
2 = Proportion of reach exhibiting banks that are eroding based on the visual survey from visual assessment table																																							
3 = Riffle, Run, Pool, Glide, Step, Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock, dip = max pave, disp = max subpave																																							

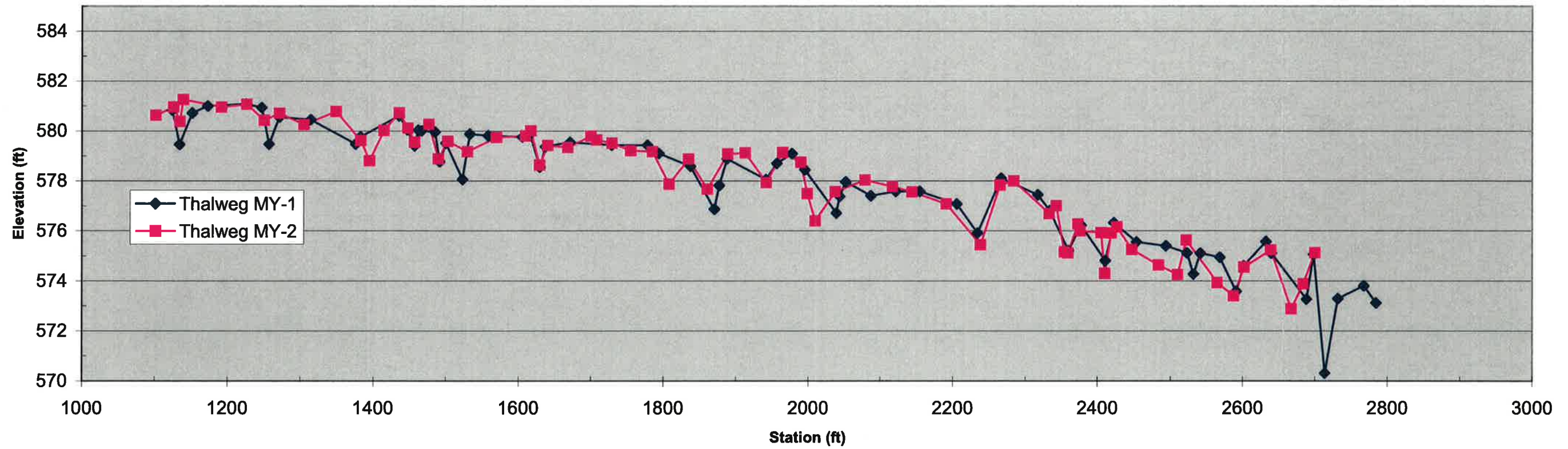
Exhibit Table 11b. Monitoring Data - Stream Reach Data Summary
McKee Creek Project # 92573 McKee Creek - Reach 2

Parameter	Baseline										MY-1					MY-2					MY-3					MY-4					MY-5					
	Min	Mean	Med	Max	SD4	n	Min	Mean	Med	Max	SD4	n	Min	Mean	Med	Max	SD4	n	Min	Mean	Med	Max	SD4	n	Min	Mean	Med	Max	SD4	n	Min	Mean	Med	Max	SD4	n
Dimension and Substrate - Riffle only																																				
Bankfull Width (ft)		24.7				1						1		22.00																						
Floodprone Width (ft)		160				1						1		33.00																						
Bankfull Mean Depth (ft)		1.89				1						1		1.98																						
Bankfull Max Depth (ft)		2.76				1						1		2.85																						
Bankfull Cross Sectional Area (ft ²)		53				1						1		51.40																						
Width/Depth Ratio		12.82				1						1		11.11																						
Entrenchment Ratio		6.59				1						1		1.50																						
Bank Height Ratio		2.53				1						1		2.23																						
Profile																																				
Rifle Length (ft)		10	32.2	34	44	13.54	5					45		53.5	62									2												
Rifle Slope (ft/ft)		-0.049	-0.003	0.012	0.028	0.035	5					0.002	0.005	0.005	0.008									2												
Pool Length (ft)		24	36.6	39	65	12.74	5					15		27.8	30	40	12.32	5																		
Pool Max depth (ft)		1.282	2.386	2.187	3.287	0.623	5					0.442	1.498	1.683	2.46	0.88	5																			
Pool Spacing (ft)		45	178.8	206	267	87.81	5					0		141	162.5	239	101.2	4																		
Pattern																																				
Channel Belwidth (ft)		97	101	101	105	5.657	2																													
Radius of Curvature (ft)		65	128.3	120	200	67.88	3																													
Rc:Bankfull width (ft/ft)		282	322	322	362	56.57	2																													
Meander Wavelength (ft)		4.042	4.208	4.208	4.375	0.236	2																													
Meander Width Ratio																																				
Additional Reach Parameters																																				
Resgen Classification																																				
Channel Thalweg length (ft)																																				
Sinuosity (ft)																																				
Water Surface Slope (Channel) (ft/ft)																																				
BF slope (ft/ft)																																				
3R ₁ % / R _u % / P% / G% / S%																																				
3SC% / S ₈ % / G% / C% / B% / Be%																																				
3d16 / d35 / d50 / d84 / d95 / d																																				
2% of Reach with Eroding Banks																																				
Channel Stability or Habitat Metric																																				
Biological or Other																																				

Shaded cells indicate that there will typically not be data in:
 1 = The distributions for these parameters can include information from both the cross-section surveys and the longitudinal profile
 2 = Proportion of reach exhibiting banks that are eroding based on the visual survey from visual assessment table
 3 = Rifle, Run, Pool, Glide, Step, SH/Clay, Sand, Gravel, Cobble, Boulder, Bedrock, dip = max pave, disp = max subpara
 4 = Of values/headers only if the n exceeds 3

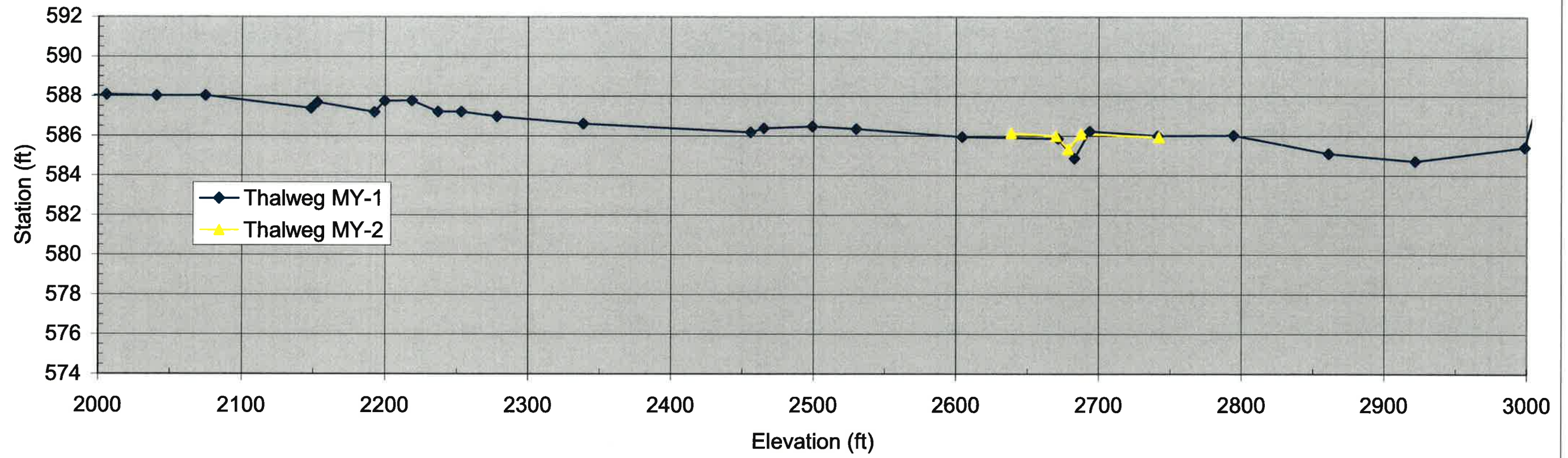
Longitudinal Profile Plot

Clear Creek



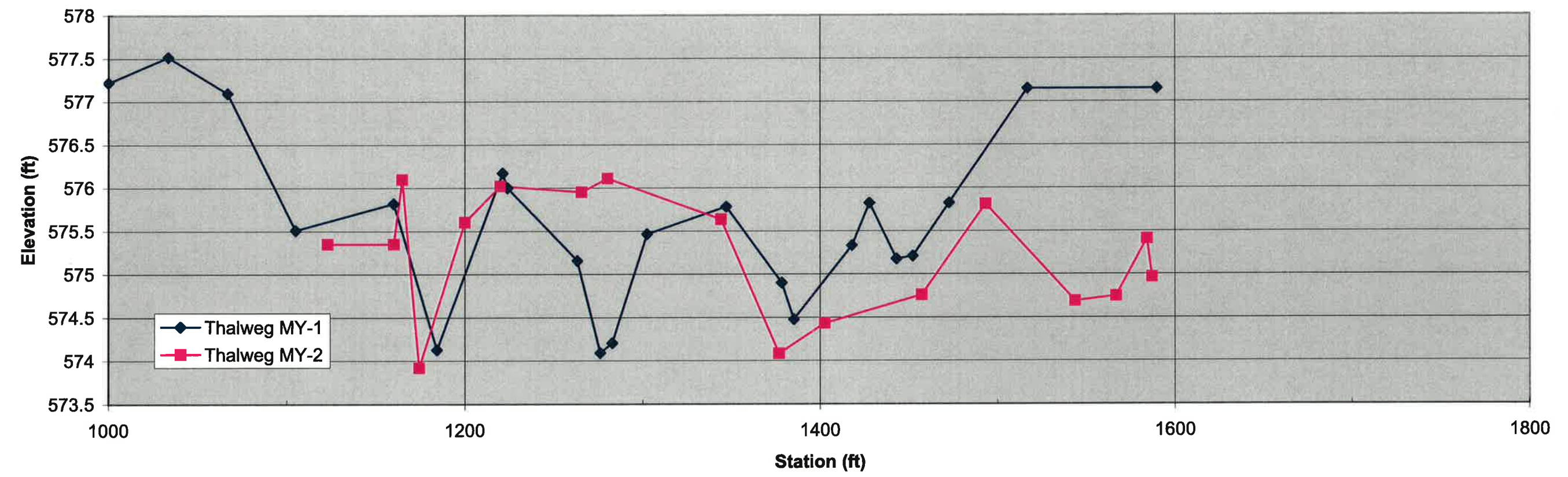
Longitudinal Profile Plot

McKee Reach 1



Longitudinal Profile Plot

McKee Reach 2



Cross-section Plot Exhibit

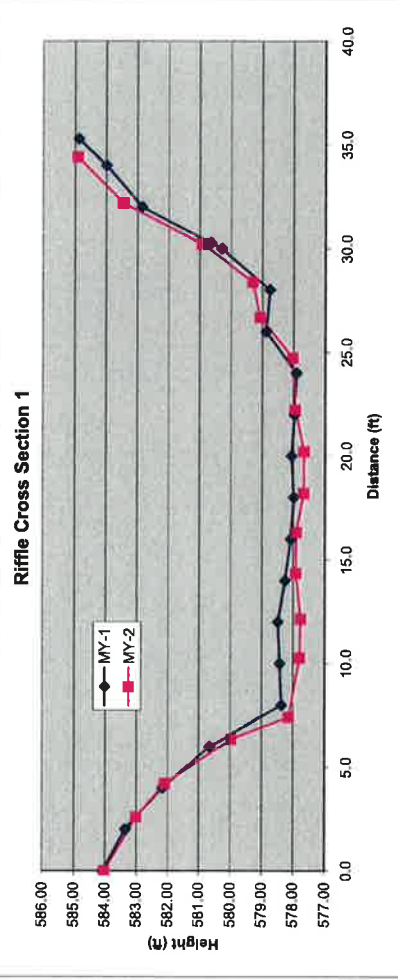
River Basin	Yadkin Pee-Dee
Watershed	McKee MY-02
XS-ID	RX-1
Drainage Area	6.42 sq. mi
Date	10/16/2013
Field Crew	D. Wiebke, J. Burley

Station	Elevation
0	584.019
2.6	583.005
4.22	582.092
6.35	579.969
7.42	578.125
10.27	577.778
12.16	577.747
14.35	577.901
16.32	577.891
18.21	577.658
20.23	577.651
22.24	577.926
24.74	578.017
26.7	579.058
28.39	579.3
30.23	580.925
32.2	583.443
34.42	584.9

Summary Data	
Bankfull Elevation	581
Bankfull Cross-Sectional Area	51.4
Bankfull Width	22
Flood Prone Area Elevation	584.05
Flood Prone Width	33
Max Depth at Bankfull	2.849
Mean Depth at Bankfull:	1.98
W/D Ratio:	11.11
Entrenchment Ratio:	1.50
Bank Height Ratio:	2.23



Left Bank to Right Bank



Cross-section Plot Exhibit

River Basin	Yadkin Pee-Dee
Watershed	McKee MY-02
XS-ID	PXS-1
Drainage Area	6.42 sq. mi
Date	10/16/2013
Field Crew	D. Wiebke, J. Burley

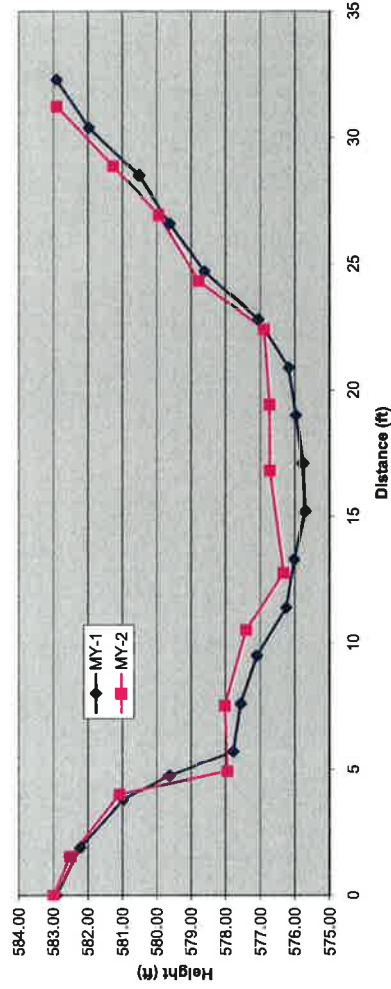
Station	Elevation
0	582.994
1.55	582.502
4.01	581.08
4.923	577.933
7.523	578.009
10.523	577.393
12.783	576.31
16.823	576.706
19.443	576.723
22.423	576.882
24.343	578.773
26.943	579.922
28.883	581.257
31.253	582.9

Summary Data	
Bankfull Elevation	580
Bankfull Cross-Sectional Area	58.5
Bankfull Width	23
Flood Prone Area Elevation	583.7
Flood Prone Width	36
Max Depth at Bankfull	3.69
Mean Depth at Bankfull:	2.37
W/D Ratio:	9.70
Entrenchment Ratio:	1.57
Bank Height Ratio:	1.81



Left Bank to Right Bank

Pool Cross Section 1



Cross-section Plot Exhibit

River Basin	Yadkin Pee-Dee
Watershed	Clear MY-02
XS-ID	RXS-2
Drainage Area	0.95
Date	10/16/2013
Field Crew	D. Wiebke, J. Burley

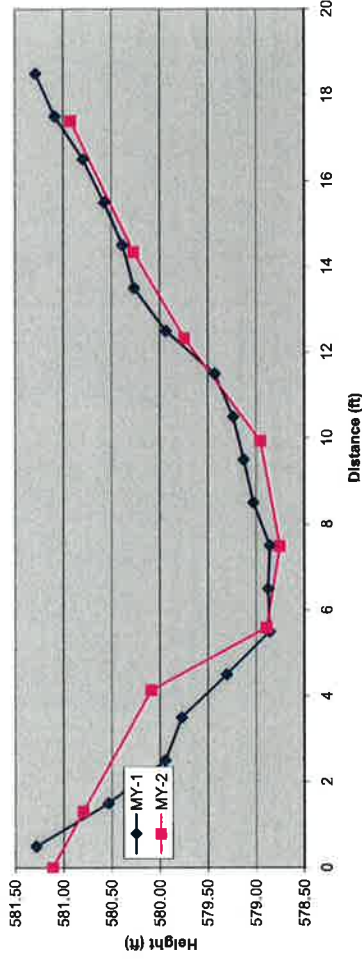
Station	Elevation
0	581.11
1.32	580.79
4.14	580.09
5.59	578.89
7.49	578.75
9.94	578.95
12.33	579.74
14.35	580.27
17.4	580.92

Summary Data	
Bankfull Elevation	580.5
Bankfull Cross-Sectional Area	13.4
Bankfull Width	13
Flood Prone Area Elevation	382.25
Flood Prone Width	150
Max Depth at Bankfull	1.75
Mean Depth at Bankfull:	1.05
W/D Ratio:	12.33
Entrenchment Ratio:	11.54
Bank Height Ratio:	1.20



Left Bank to Right Bank

Riffle Cross Section 2



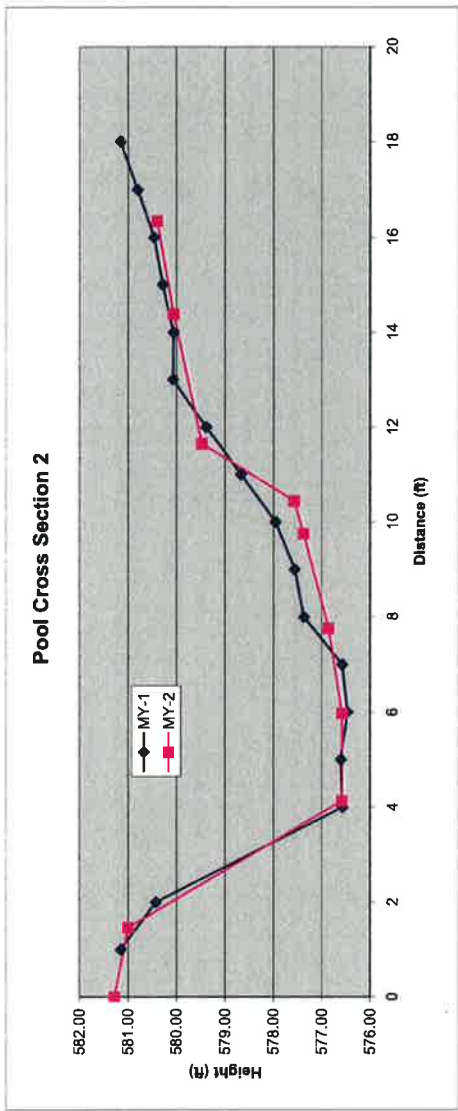
Cross-section Plot Exhibit	
River Basin	Yadkin Pee-Dee
Watershed	Clear MY-02
XS-ID	PXS-1
Drainage Area	0.95
Date	10/16/2013
Field Crew	D. Wiebke, J. Burley

Summary Data	
Bankfull Elevation	580.39
Bankfull Cross-Sectional Area	31.6
Bankfull Width	14.3
Flood Prone Area Elevation	584.2
Flood Prone Width	150
Max Depth at Bankfull	3.82
Mean Depth at Bankfull	2.62
W/D Ratio:	5.46
Entrenchment Ratio:	10.49
Bank Height Ratio:	1.00



Left Bank to Right Bank

Station	Elevation
0	581.28
1.463	581.00
4.133	576.57
5.973	576.57
7.763	576.85
9.763	577.36
10.4483	577.56
11.6583	579.47
14.3883	580.05
16.3483	580.39



Cross-section Plot Exhibit

River Basin	Yadkin Pee-Dee
Watershed	Clear MY-02
XS-ID	RXS-3
Drainage Area	0.95
Date	10/16/2013
Field Crew	D. Wiebke, J. Burley

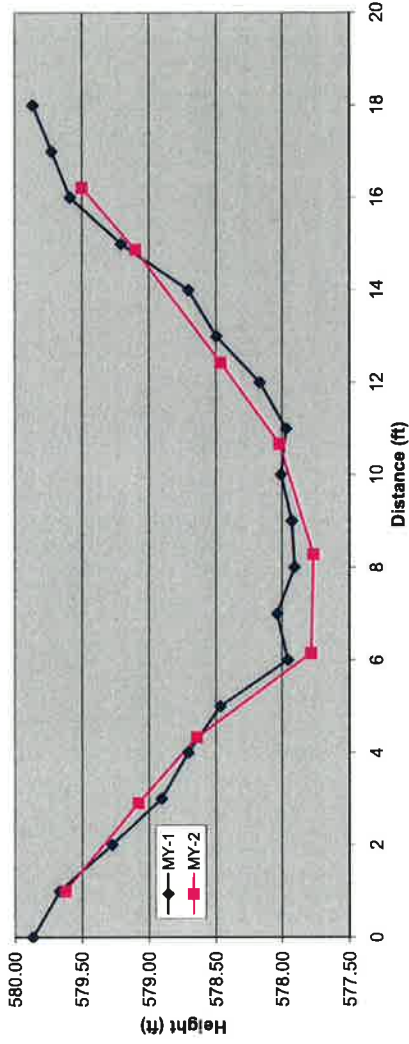
Station	Elevation
1	579.625
2.91	579.077
4.33	578.639
6.15	577.779
8.29	577.764
10.68	578.018
12.44	578.463
14.88	579.1
16.22	579.50

Summary Data	
Bankfull Elevation	579.6
Bankfull Cross-Sectional Area	14.73
Bankfull Width	13.88
Flood Prone Area Elevation	581.43
Flood Prone Width	200
Max Depth at Bankfull	1.84
Mean Depth at Bankfull:	0.96
W/D Ratio:	14.51
Entrenchment Ratio:	14.41
Bank Height Ratio:	1.01



Left Bank to Right Bank

Riffle Cross Section 3



Cross-section Plot Exhibit

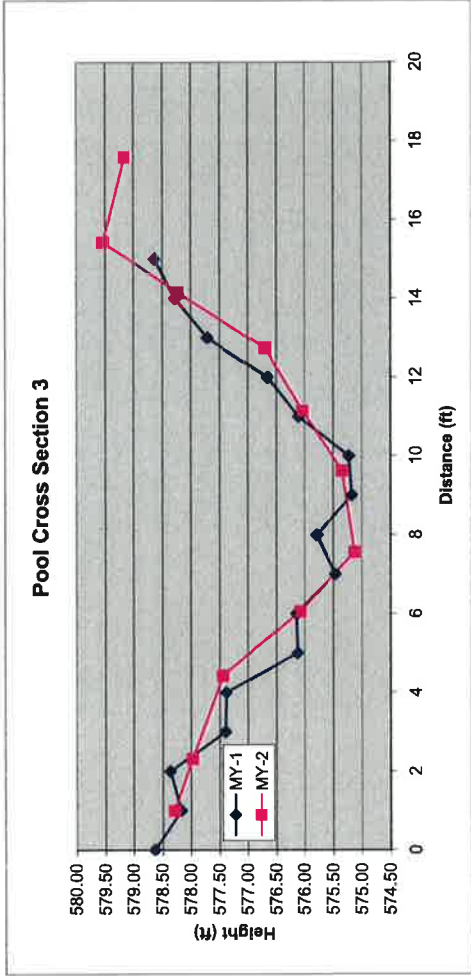
River Basin	Yadkin Pee-Dee
Watershed	Clear MY-02
XS-ID	PXS-3
Drainage Area	0.95
Date	10/16/2013
Field Crew	D. Wiebke, J. Burley

Station	Elevation
1	578.29
2.32	577.97
4.43	577.44
6.06	576.07
7.57	575.12
9.64	575.34
11.16	576.03
12.74	576.698
14.16	578.227
15.45	579.534
17.6	579.167

Summary Data	
Bankfull Elevation	578.29
Bankfull Cross-Sectional Area	21.35
Bankfull Width	13.2
Flood Prone Area Elevation	581.46
Flood Prone Width	200
Max Depth at Bankfull	3.17
Mean Depth at Bankfull:	1.678125
W/D Ratio:	7.87
Entrenchment Ratio:	15.15
Bank Height Ratio:	1.00



Left Bank to Right Bank



Appendix E
Hydrology Data

Table 12 Crest Gauge Readings

Gauge	Year	WSE	Bankfull
CG1	MY2-2013	581.5	Yes
CG2	MY2-2013	580.4	Yes
CG3	MY2-2013	578.2	Yes

Harrisburg Rainfall Data

