Collins Creek Stream Restoration Site
Mitigation Plan
Contract # D05011

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EXECUTIVE SUMMARY

The Collins Creek Stream Restoration Site is located in the Piedmont physiographic province in Orange County, North Carolina. The project will provide mitigation for stream impacts within the 8-digit hydrologic cataloging unit 03030002 in the Cape Fear River Basin by restoring and enhancing 9,453 linear feet on an Unnamed Tributary to Collins Creek (UTCC) and other associated tributaries, generating 8,933 stream mitigation units (SMU's.) The goals of the project include improving water quality in this agricultural stream system and creating high-quality aquatic and terrestrial habitat along an interconnected forested riparian corridor. In order to reach these goals, the project objectives included restoring and enhancing 9,453 linear feet of stable stream channel with the appropriate pattern, profile, and dimension that can handle the hydrologic input from the surrounding drainages, planting a functional Piedmont Alluvial Forest floodplain community along with Mesic Mixed Hardwood Forest to develop an effective riparian buffer, and removing cattle and horses from the riparian areas through livestock exclusion fencing.

The project watershed drains toward the west with a contributing area of approximately 2.6 square miles at the downstream limits of the site. The project watershed is rural and faces moderate development pressure from the nearby Chapel Hill/Carrboro area. The stream design and the restoration plan were completed in November 2007, construction began in December 2007 and the stream was planted prior to the 2008 growing season.

The stream restoration included ten separate reaches, which were enhanced and restored based on a combination of Priority 2 and 3 approaches. Rock cross vanes, step pools, and riffle grade controls were used to control grade throughout the profile. The streams were restored to B4c and C4 stream types. The as-built survey and baseline monitoring found that there were minimal deviations from the designed cross-sections and profile. Due to conflicts with bedrock, small sections of the stream planform and profile were altered and some structures were moved, added, or not installed. These changes have been recorded on the as-built site plan. During construction and immediately after construction, several large rain events caused minor problem areas on the restored stream channels. These areas were repaired immediately after major stream construction was complete. The structures that were added during these repairs have been noted on the as-built site plan. Since construction, the site has become well vegetated and has remained stable throughout the storm events that have occurred since construction was completed.

The site was planted with bare root trees and shrubs and live stakes in March 2008. A total of 21 different species were planted at the site. In addition to the species originally specified in the planting plan, possum haw (*Viburnum nudum*), Virginia sweetspire (*Itea virginica*) and deciduous holly (*Ilex decidua*) were planted at the site to make up for shortages of some of the species. Since construction and the as-built survey, woven wire fence has been erected along most of the easement boundary. The fence is still in the process of being installed and will end up encompassing approximately 75% of the easement. All of the livestock on the property have been excluded from the conservation easement.

The site will be monitored for at least five years beginning in 2008 through 2012 or until the success criteria are achieved. Reports will be submitted to the EEP each year. The planted riparian buffer must meet the success criteria of 260 planted stems/acre at the end of the monitoring period. The baseline monitoring counted an average of 867 stems/acre in the 15 vegetation monitoring plots. Stream success will be assessed utilizing measurements of stream dimension, pattern, and profile as well as through site photographs. Two bankfull events also must occur on the restored stream over the monitoring period in separate monitoring years.

1.0 PROJECT BACKGROUND

1.1 Location and Setting

The Collins Creek Stream Restoration Site is spread over three different parcels of private property. The three parcels are owned by: Melvin Whitfield, Lyndon and Karen Whitfield; and Greg Britz and Elizabeth Brown. The site is located off of Dodsons Crossroads 6 miles west of Carrboro, North Carolina in Orange County. Specifically, the site is approximately 800 feet north of the intersection of Dodsons Crossroads and NC 54 (Figure 1). The project is centered at approximately 35.9313 degrees north and 79.1788 degrees west (WGS84). To reach the site from Raleigh, proceed west on Interstate 40. Take Exit 273 and travel west on NC 54. Continue west on NC 54 as it joins NC 15-501 and then later splits off from NC 15-501. Approximately 7.5 miles after splitting off from NC 15-501, turn right onto Dodsons Crossroads. The project is accessible from the Whitfield property driveway approximately 0.3-mile on the left.

1.2 Project Goals and Objectives

The goals and objectives of the restoration project are as follows:

Restoration Goals:

- Improve water quality by reducing nutrient and sediment inputs.
- Create high-quality aquatic and terrestrial habitat along an interconnected forested riparian corridor.

Restoration Objectives:

- Plant a functional Piedmont Alluvial Forest floodplain community along with Mesic Mixed Hardwood Forest to develop an effective riparian buffer.
- Restore stable stream reaches that can handle the hydrologic input from the surrounding drainages.
- Remove cattle and horses from the riparian areas through livestock exclusion fencing.

1.3 Project Structure, Restoration Type and Approach

The project streams had become degraded primarily through poor grazing management and vegetation removal. Historic aerial photographs show that the land surrounding the streams has been in rangeland for at least 65 years and cattle and horses have had access to the stream up until the restoration construction. The streams had experienced bank erosion, which led to excessive sediment throughout the site. Bed degradation and aggradation were also evident throughout the different project reaches. All of the reaches exhibited areas of vertical instability. Restoration and enhancement of 9,453 linear feet of channel was accomplished utilizing a combination of Priority 2 and 3 approaches (Table 1). UTCC-1 (Station 10+00 to 15+00) was enhanced and UTCC-2 (Station 15+00 to 24+00) and UTCC-3 (Station 24+00 to 33+49) were restored using a Priority 2 approach. The enhancement and restoration of a C4 channel with a sinuosity of 1.34 was accomplished by building a bankfull channel with a higher width/depth ratio than the existing stream, connecting it to a floodplain (bank height ratio=1.0), and creating distinct bed features by adding pools and riffles to the profile. UTCC-1 was enhanced by altering the stream cross-section and profile. UTCC-2 and UTCC-3 were restored by altering the stream cross-section, profile, and planform. In some instances, restoration was accomplished within the same belt-width and in the location of the pre-restoration channel. In the locations where the stream stayed on-line, the stream had been so drastically degraded that there was no form to the channel and the design was able to preserve one streambank and create a new bank and pattern on the opposite side of the stream.

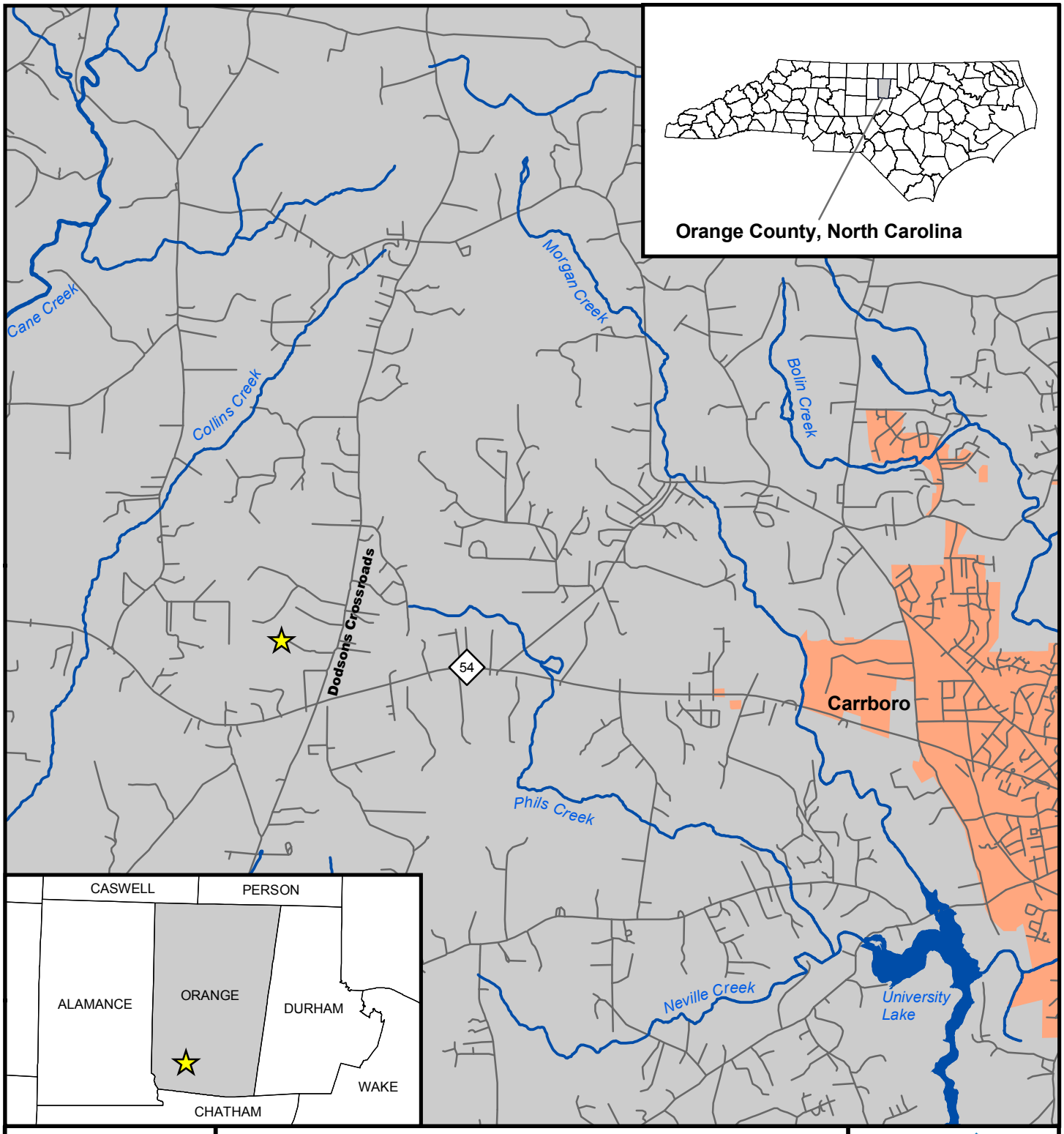

Figure 1. Vicinity Map

- Project Site Location
- Streams
- Lakes and Reservoirs
- Major Roads
- Cities and Towns
- Orange County
- County Boundaries

N
W E
S

1:63,360
1 inch equals 1 miles

1 0.5 0 1 Miles

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There are two main tributaries to UTCC on the property. The first (T1) has two tributaries that flow to it (T1A and T1B), while the second (T2) does not have any additional tributaries. T1 is divided into three reaches (T1-1 Station 40+00 to 45+19, T1-2 Station 45+19 to 53+60, and T1-3 Station 53+60 to 73+70), which are divided at the confluences of T1 with T1A and T1B. T1A is further divided into two reaches (T1A-1 Station 80+00 to 82+40 and T1A-2 Station 82+40 to 88+00), that are separated by a culvert and different valley types. T1B (Station 100+00 to 111+00) is composed of a single reach. T1, T1B, and T1A-1 were restored using a Priority 2 approach to create stable C4 channels. The restoration established a bankfull channel with a new floodplain where the designed bankfull stage equals the new floodplain elevation (bank height ratio=1.0). Due to the variable valley topography of T1A-2, this reach was restored using a combination of Priority 2 and 3 approaches and the resulting stream type alternates between a stable C4 and a stable B4c channel. T2 (Station 120+00 to 138+33) was restored to a stable B4c stream type using a Priority 3 approach. The locations of all of these reaches are shown in Figure 2.

Table 1 below provides the linear footage for existing and as-built stream length as well as the total stream mitigation units by reach. For this table, the existing linear footage was calculated from the existing stream centerline. In some instances, the linear footage is less for the as-built conditions than for the existing conditions. This situation can arise when the design changes the exact location of tributary confluences. In other locations, the pattern of the existing stream created a more meandering thalweg where the channel was widening or there were debris blockages. The pattern is more clearly defined in the as-built stream, but the actual length may be shorter than the pre-restoration conditions.

Table 1. Project Restoration Components
Collins Creek Stream Restoration Site

Project Segment / Reach ID	Existing Linear Footage	Type	Approach	As - Built Footage	Stationing	Stream Mitigation Units*
UTCC-1	500 lf	EI	P2	500 lf	10+00 - 15+00	334 SMU
UTCC-2	909 lf	R	P2	900 lf	15+00 - 24+00	851 SMU*
UTCC-3	1,034 lf	R	P2	949 lf	24+00 - 33+49	898 SMU*
T1-1	637 lf	R	P2	519 lf	40+00 - 45+19	519 SMU
T1-2	604 lf	R	P2	841 lf	45+19 - 53+60	774 SMU*
T1-3	1,932 lf	R	P2	2,010 lf	53+60 - 73+70	1,894 SMU*
T1A-1	192 lf	R	P2	240 lf	80+00 - 82+40	240 SMU
T1A-2	533 lf	R	P2/P3	560 lf	82+40 - 88+00	506 SMU*
T1B	1,102 lf	R	P2	1,100 lf	100+00 - 111+00	1,100 SMU
T2	1,879 lf	R	P3	1,833 lf	120+00 - 138+33	1,817 SMU*

R = Restoration P2 = Priority 2 P2/P3 = Combination of Priorities 2 and 3
EI = Enhancement I P3 = Priority 3

* These SMUs have been calculated by excluding the easement exceptions. These exceptions include ford and culverted crossings for the landowner and culverted crossings under private driveways.

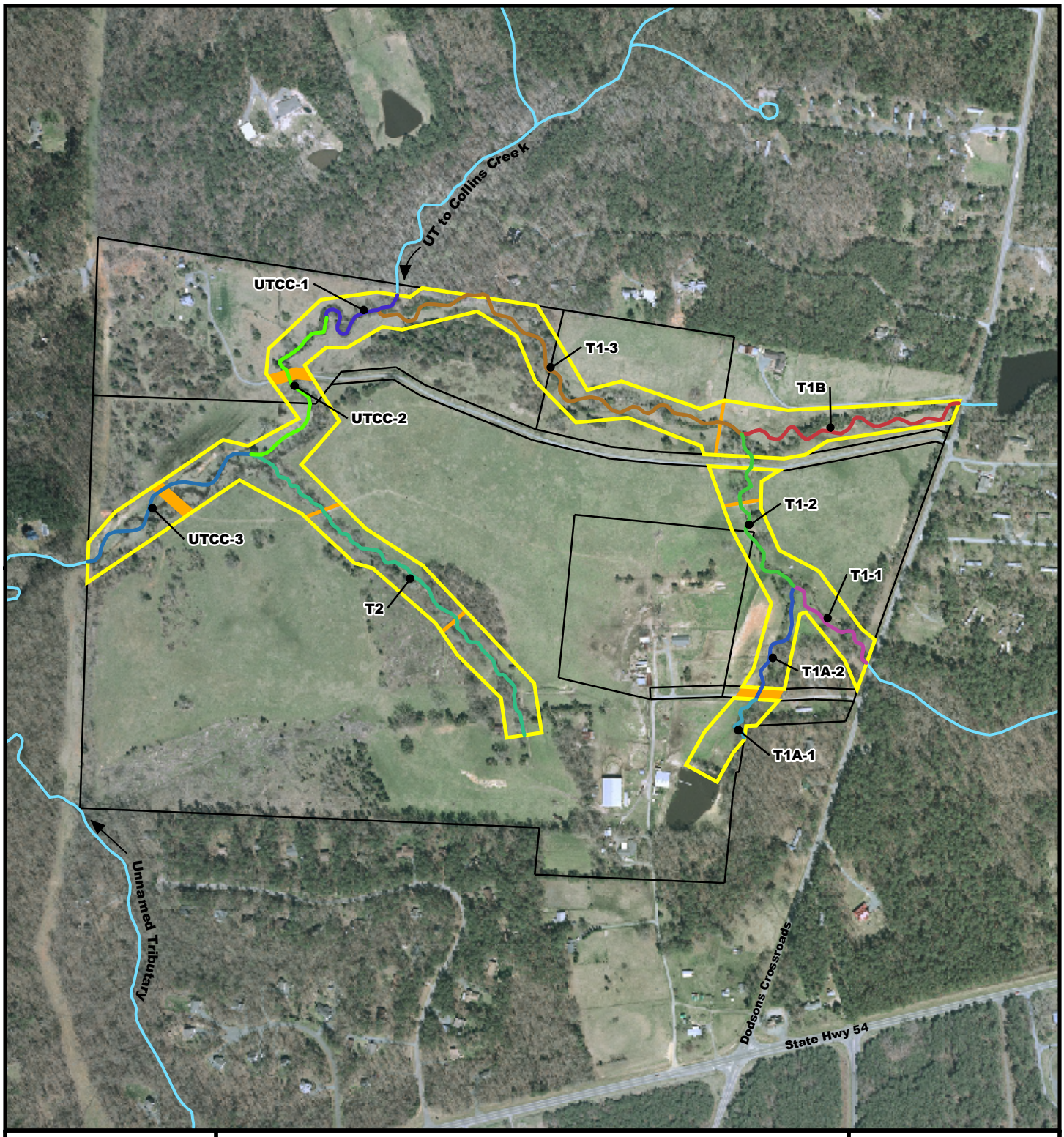

Figure 2. Project Reaches

Project Easement
Easement Exceptions
Other Streams
Project Parcel Boundaries

N
W E
S

1:7,200
1 inch equals 600 feet

600 300 0 600
Feet

Image Source: Orange County Land Records/GIS Orthoimagery 2003

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1.4 Project History, Contacts and Data

Table 2. Project Activity and Reporting History Collins Creek Stream Restoration Site		
Activity or Report	**Data Collection Complete**	**Completion or Delivery**
Restoration Plan	2005 - 2006	Nov 07
Final Design	2005 - 2006	Nov 07
Construction	N/A	Mar 08
Planting - Stream	N/A	Mar 08
Mitigation Plan / As-Built (Year 0 Monitoring - Baseline)	May - July 2008	Oct 08

Table 3. Project Contact Table Collins Creek Stream Restoration Site	
Design Firm	KCI Technologies, Inc. Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Gary Mryncza Phone: (919) 783-9214 Fax: (919) 783-9266
Construction Contractor	Environmental Technologies and Construction Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Ryan McDavitt Phone: (919) 278-2518 Fax: (919) 783-9266
Planting Contractor	H & J Forest Services PO Box 458 Holly Ridge, NC 28445 Phone: (910) 512-6754
Monitoring Performers	
MY-00 - MY-05	KCI Technologies, Inc. Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 278-2514 Fax: (919) 783-9266

Table 4. Project Background Table **Collins Creek Stream Restoration Site**	
Project County	Orange County
Physiographic Region	Piedmont
Ecoregion	Carolina Slate Belt
Project River Basin	Cape Fear
USGS HUC for Project and Reference	03030002050060 (UT to Collins Creek)
	03030002050060 (Collins Creek - reference)
	03040103050050 (UT Back Creek - reference)
	03030002060110 (Long Branch - reference)
	03030003050010 (UT to Richland Creek - ref)
	03040101090010 (UT Fisher River - reference)
NCDWQ Sub-basin for Project and Reference	03-06-04 (UT to Collins Creek)
	03-06-04 (Collins Creek - reference)
	03-07-09 (UT Back Creek - reference)
	03-06-05 (Long Branch - reference)
	03-06-10 (UT to Richland Creek - reference)
	03-07-02 (UT Fisher River - reference)
Drainage Area	2.6 sq. mi.
Stream Order	First, Second, and Third Order
Watershed Type (Rural, Urban, Developing, etc.)	Rural
Watershed LULC Distribution Urban	1%
Ag-Row Crop	5%
Ag-Livestock	5%
Forested	88%
Water/Wetlands	1%
Watershed impervious cover (%)	3%
Rosgen Classification of As-built (Stream)	C4 (UTCC, T1, T1A-1, T1B)
	B4c (T2)
NCDWQ Classification for Project	Class C, NSW
Within EEP Watershed Plan?	No
Any portion of the project segment upstream of a 303d listed segment?	Yes
Reasons for 303d Listing or Stressor	biological integrity impaired, potentially due to agriculture
Total project acreage of easement	27.8 Acres
Total planted acreage	23.0 Acres
WRC Class (Warm, Cool, Cold)	Warm
Species of concern, endangered etc.	None
Pre-construction Beaver activity?	Yes
Dominant Soil Types	Congaree fine sandy loam series
% of Project Easement Fenced	80%

2.0 PROJECT MONITORING / AS-BUILT CONDITIONS

2.1 Monitoring Features

Permanent monuments, marking monitoring feature locations, were established on-site. The beginning and end of each permanent cross-section was marked with rebar set in concrete monuments. Vegetation plots were installed with flagged metal conduit at each corner and a flagged PVC pipe was installed at the photo corner. Two crest gauges and one automatic recording gauge were installed along the stream to record water levels indicating when bankfull events occur. The locations of these monitoring features and the permanent photo points are marked in the As-Built Plan (Appendix A).

2.2 Monitoring Guidelines

Stream data will be calculated from the monitored longitudinal profiles and cross-sections (Tables 5 and 6). Sixteen permanent cross-sections were established and will be used to evaluate stream dimension: one riffle and one pool cross-section on UTCC-1 and 2, two riffle and one pool cross-section on UTCC-3, one riffle cross-section on T1-1, one riffle and one pool cross-section on T1-2, two riffle and one pool cross-section on T1-3, one riffle cross-section on T1A-1, one riffle cross-section on T1A-2, one riffle cross-section on T1B, and one riffle and one pool cross-section on T2. Pebble counts will be performed at each cross-section (Appendix B). Cross-sections will be surveyed each year using a total station and data such as area and width to depth ratio will be calculated. A total of over 3,000 linear feet of longitudinal profile will be surveyed. The monitored longitudinal profile will be split into five representative portions, one in each tributary. The profiles for UTCC, T1, T1A, T1B, and T2 will be 1,080, 1,080, 280, 250, and 440 linear feet, respectively. The profile will be surveyed with a total station and will record elevations of bed features, water surface levels, and bankfull elevations (Appendix C). Various morphological parameters will be calculated from this information such as, bankfull slopes, pool-to-pool spacing, and feature lengths. Stem counts of planted trees and shrubs will be conducted in fifteen 10 meter x 10 meter vegetation monitoring plots (Appendix D). The vegetation monitoring will be conducted as per the CVS-EEP vegetation monitoring guidelines. The stream gauges on-site will be checked and/or downloaded every other month and analyzed to ascertain whether bankfull events have occurred. Visual monitoring of the stream and riparian buffer will be conducted with annual site walks and site photos will be taken from 31 permanent photo points located throughout the site (Appendix E).

2.3 As-Built Conditions

2.3.1 Stream

Baseline stream monitoring data were collected throughout May, June and July 2008.

Any changes made to the design during construction are shown on the As-Built Site Plan in Appendix A. Most of the project was implemented as designed, but unexpected field conditions caused small adjustments to be made during construction. Unexpected bedrock in the field was the most frequent cause for changes to the design. In some instances, this caused the designed channel alignment to be adjusted, while in other cases the profile was modified. Bedrock also provided grade control in the new channel alignments, which allowed some structures to be eliminated. Towards the end of construction, several large rain events occurred at the site before the project was well stabilized by vegetation. This caused damage to the various reaches, necessitating repair. Additional structures were added as necessary to ensure stability. These repairs are also indicated on the As-Built Site Plan. The tributary that required the most attention was T1A. This was also one of the tributaries that was most impacted by unforeseen bedrock.

Because some of the stabilizing structures and the designed profile were altered due to bedrock, it was vulnerable to destabilization from large storm events. After the repairs were completed T1A has remained stable. The condition of the reach will continue to be monitored. If there are any signs of instability, corrective actions will be taken.

Table 5 below compares the designed morphological values and ratios to the as-built values and ratios. There are differences between the design and as-built conditions, but they represent the changes made due to site constraints, not a deviation from the proposed design. The table also shows that all of the reaches were restored to streams with a bank height ratio of 1.0 and a stable width to depth ratio. A few of the pre-restoration reaches also had bank height ratios of close to 1.0 and were classified as B4c, E4, and C4 stream types. Although these stream types are not inherently unstable, as is the case with G and F stream types, these project streams were having other instability problems such as bedform and lateral instabilities. The project restored and enhanced these streams, creating stable C4 and B4c streams.

Table 5a. UTCC-1&2 Baseline Stream Summary
Collins Creek Stream Restoration Site

Parameter	Pre-Existing Condition					Reference Reach(es) Data					Design		As-built			
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Mean	Max	n
Bankfull Width (ft)	15.4	16.0		16.5	2	11.9	16		20.1	2	24.0			21.2		1
Floodprone Width (ft)	>54			>55	2		>60			1	54			>65		1
Bankfull Mean Depth (ft)	2.4	2.8		3.1	2	1.7	2.2		2.7	2	2.0			2.0		1
Bankfull Max Depth (ft)	3.3	4.0		4.6	2	3.3	3.8		4.2	2	2.9			3.1		1
Bankfull Cross-Sectional Area (ft^2)	40.4	43.8		47.1	2	32.4	32.9		33.4	2	47.0			42.5		1
Width/Depth Ratio	5.0	6.0		6.9	2	4.4	16.5		12.1	2	12.0			10.6		1
Entrenchment Ratio	>3.3			>3.5	2		>3			1	2.3			>3.1		1
Bank Height Ratio	1.0	1.0		1.0	2	1	1.1		1.1	2	1.0			1.0		1
Pattern																
Channel Beltwidth (ft)	55			136		50			60		59	120	47		130	
Radius of Curvature (ft)	18			38		24			31		28	62	25		70	
Rc:Bankfull width (ft/ft)	1.1			2.5		1.2			2.6		1.2	2.6	1.2		3.3	
Meander Wavelength (ft)	79			286		77			138		91	275	70		270	
Meander Width Ratio	3.3			8.8		2.5			5.0		2.5	5.0	2.2		6.2	
Profile																
Riffle Length (ft)													27	55	82	5
Riffle Slope (ft/ft)						0.0030			0.0080		0.0020	0.0050	0.0009	0.0019	0.0037	5
Pool Length (ft)						13			21		11	32	11	38	57	8
Pool Spacing (ft)						32			80		40	200	88	139	175	7
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	48% / 17% / 30% / 5% / 0% / 0%					0% / 52% / 48% / 0% / 0% / 0%							7% / 57% / 32% / 3% / 0% / 1%			
d16 / d35 / d50 / d84 / d95 (mm)	0.062 / 0.06 / 0.1 / 20 / 61					0.656 / 1.17 / 1.9 / 16 / 26							0.12 / 0.28 / 0.42 / 11 / 45			
Additional Reach Parameters																
Channel length (ft)	1,409					304					1,391		1,400			
Drainage Area (SM)	2.51					1.68					2.51		2.51			
Rosgen Classification	E4					C4/E4					C4		C4			
Sinuosity	1.27					1.25					1.25		1.28			
Water Surface Slope (ft/ft)	0.0020					0.0030					0.0019		0.0015			

Table 5b. UTCC-3 Baseline Stream Summary
Collins Creek Stream Restoration Site

Parameter	Pre-Existing Condition					Reference Reach(es) Data					Design		As-built			
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Mean	Max	n
Bankfull Width (ft)	20.5				1	11.9	16		20.1	2	25.0		25.5	26.3	27.0	2
Floodprone Width (ft)	>60				1		>60			1	55		>76	>75	>74	2
Bankfull Mean Depth (ft)	2.4				1	1.7	2.2		2.7	2	2.0		1.9	2.0	2.1	2
Bankfull Max Depth (ft)	3.5				1	3.3	3.8		4.2	2	2.9		2.8	3.1	3.3	2
Bankfull Cross-Sectional Area (ft^2)	49.7				1	32.4	32.9		33.4	2	49.5		48.0	51.8	55.5	2
Width/Depth Ratio	8.5				1	4.4	16.5		12.1	2	12.5		13.5	13.3	13.1	2
Entrenchment Ratio	>2.9				1		>3			1	2.3		>3.0	>2.9	>2.7	2
Bank Height Ratio	1.1				1	1	1.1		1.1	2	1.0		1.0	1.0	1.0	2
Pattern																
Channel Beltwidth (ft)	53			73		50			60		85	100	85		100	
Radius of Curvature (ft)	16			126		24			31		40	70	40		70	
Rc:Bankfull width (ft/ft)	0.8			6.1		1.2			2.6		1.6	2.8	1.5		2.7	
Meander Wavelength (ft)	96			164		77			138		205	260	205		260	
Meander Width Ratio	2.6			3.6		2.5			5.0		3.4	4.0	3.2		3.8	
Profile																
Riffle Length (ft)													27	55	82	5
Riffle Slope (ft/ft)						0.0030			0.0080		0.0020	0.0050	0.0009	0.0019	0.0037	5
Pool Length (ft)						13			21		35	56	11	38	57	8
Pool Spacing (ft)						32			80		115	165	88	139	175	7
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	48% / 17% / 30% / 5% / 0% / 0%					0% / 52% / 48% / 0% / 0% / 0%							21% / 45% / 31% / 2% / 0% / 0%			
d16 / d35 / d50 / d84 / d95 (mm)	0.062 / 0.06 / 0.1 / 20 / 61					0.656 / 1.17 / 1.9 / 16 / 26							0.062 / 0.11 / 0.32 / 17 / 35			
Additional Reach Parameters																
Channel length (ft)	1,034					304					956		949			
Drainage Area (SM)	2.62					1.68					2.62		2.62			
Rosgen Classification	C4/E4					C4/E4					C4		C4			
Sinuosity	1.17					1.25					1.20		1.15			
Water Surface Slope (ft/ft)	0.0020					0.0030					0.0019		0.0017			

Table 5c. T1-1 Baseline Stream Summary
Collins Creek Stream Restoration Site

Parameter	Pre-Existing Condition					Reference Reach(es) Data					Design		As-built			
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Mean	Max	n
Bankfull Width (ft)	5.8	7.8	7.3	10.8	4	10.4	13.3		16.1	2	10.4			11.1		1
Floodprone Width (ft)	10			>38	4		150			2	>37			41.3		1
Bankfull Mean Depth (ft)	1.1	1.2	1.2	1.5	4	0.9	1.1		1.2	2	0.8			0.8		1
Bankfull Max Depth (ft)	1.6	2.0	2.0	2.3	4	1.4	1.6		1.7	2	1.2			1.3		1
Bankfull Cross-Sectional Area (ft^2)	8.6	8.9	8.8	9.3	4	12.5	13.5		14.4	2	8.2			8.4		1
Width/Depth Ratio	3.9	7.3	5.4	9.8	4	11.6	12.5		13.4	2	13.3			14.7		1
Entrenchment Ratio	1.0			>6.5	4	9.3	11.9		14.4	2	>3.6			3.7		1
Bank Height Ratio	2.0	2.2	2.2	2.4	4	1.0	1.1		1.1	2	1.0			1.0		1
Pattern																
Channel Beltwidth (ft)	44			78		135					20	50	25		40	
Radius of Curvature (ft)	18			110		15			26		20	30	20		30	
Rc:Bankfull width (ft/ft)	1.7			19.0		1.4			1.6		2.0	3.0	1.8		2.7	
Meander Wavelength (ft)	135			250		70			120		70	125	75		115	
Meander Width Ratio	4.1			13.4		10.2			13.0		2.0	5.0	2.3		10.4	
Profile																
Riffle Length (ft)													19	41	83	13
Riffle Slope (ft/ft)	0.044					0.010			0.040		0.010	0.012	0.0039	0.0111	0.0214	13
Pool Length (ft)	10			20		31			108		10	30	8	22	44	13
Pool Spacing (ft)	32			43		43			181		40	90	48	88	169	12
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	31% / 31% / 37% / 0% / 0% / 0%					0% / 0% / 52% / 42% / 0% / 6%							8% / 20% / 72% / 0% / 0% / 0%			
d16 / d35 / d50 / d84 / d95 (mm)	0.062 / 0.14 / 0.24 / 12 / 21					12.3 / 35.5 / 53.7 / 114 / 172							0.41 / 3.2 / 7.4 / 20 / 27			
Additional Reach Parameters																
Channel length (ft)	637					712					595		519			
Drainage Area (SM)	0.12					0.63					0.12		0.12			
Rosgen Classification	G4c/E4					E4/C4					C4		C4			
Sinuosity	1.15					>1.5					1.25		1.15			
Water Surface Slope (ft/ft)	0.0073					0.0068					0.0075		0.0084			

Table 5d. T1-2 Baseline Stream Summary
Collins Creek Stream Restoration Site

Parameter	Pre-Existing Condition					Reference Reach(es) Data					Design		As-built			
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Mean	Max	n
Bankfull Width (ft)	5.7	7.9		10.1	2	10.4	13.3		16.1	2	12.0			11.7		1
Floodprone Width (ft)	11.1	13.5		16.0	2		150			2	>40			41.6		1
Bankfull Mean Depth (ft)	1.1	1.3		1.4	2	0.9	1.1		1.2	2	0.9			1.0		1
Bankfull Max Depth (ft)	1.4	1.6		1.8	2	1.4	1.6		1.7	2	1.4			1.5		1
Bankfull Cross-Sectional Area (ft^2)	8.2	9.5		10.8	2	12.5	13.5		14.4	2	11.2			11.5		1
Width/Depth Ratio	4.1	6.7		9.2	2	11.6	12.5		13.4	2	13.3			11.9		1
Entrenchment Ratio	1.1	2.0		2.8	2	9.3	11.9		14.4	2	>3.3			3.6		1
Bank Height Ratio	2.0	2.1		2.1	2	1.0	1.1		1.1	2	1.0			1.0		1
Pattern																
Channel Beltwidth (ft)	42			83		135					40	60	45		66	
Radius of Curvature (ft)	17			34		15			26		20	30	20		30	
Rc:Bankfull width (ft/ft)	1.7			6		1.4			1.6		1.7	2.5	1.2		1.8	
Meander Wavelength (ft)	106			148		70			120		80	140	80		175	
Meander Width Ratio	4.2			14.6		10.2			13.0		3.3	5.0	2.7		4.0	
.																
Riffle Length (ft)													19	41	83	13
Riffle Slope (ft/ft)	0.006			0.009		0.010			0.040		0.005	0.011	0.0039	0.0111	0.0214	13
Pool Length (ft)	7					31			108		12	35	8	22	44	13
Pool Spacing (ft)						43			181		40	90	48	88	169	12
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	29% / 42% / 30% / 0% / 0% / 0%					0% / 0% / 52% / 42% / 0% / 6%							13% / 64% / 23% / 0% / 0% / 0%			
d16 / d35 / d50 / d84 / d95 (mm)	0.062 / 0.15 / 0.2 / 9 / 17					12.3 / 35.5 / 53.7 / 114 / 172							0.07 / 0.14 / 0.29 / 8.6 / 15			
Additional Reach Parameters																
Channel length (ft)	604					712					767		841			
Drainage Area (SM)	0.18					0.63					0.18		0.18			
Rosgen Classification	G4c/E4					E4/C4					C4		C4			
Sinuosity	1.21					>1.5					1.23		1.22			
Water Surface Slope (ft/ft)	0.0075					0.0068					0.0059		0.0072			

Table 5e. T1-3 Baseline Stream Summary
Collins Creek Stream Restoration Site

Parameter	Pre-Existing Condition					Reference Reach(es) Data					Design		As-built			
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Mean	Max	n
Bankfull Width (ft)	7.7	10.2	10.9	11.9	3	14.8	16.8		18.8	2	15.0		14.8	17.8	20.8	2
Floodprone Width (ft)	>55		>63	>70	3			>40		2	>40		49	57	65	2
Bankfull Mean Depth (ft)	1.3	1.5	1.3	2.0	3	1.3	1.6		1.8	2	1.1		1.0	1.0	1.0	2
Bankfull Max Depth (ft)	2.5	2.6	2.6	2.7	3	1.9	2.2		2.4	2	1.6		1.4	1.7	1.9	2
Bankfull Cross-Sectional Area (ft^2)	14.5	15.0	15.1	15.5	3	25	25.1		25.1	2	16.9		14.3	17.2	20.0	2
Width/Depth Ratio	3.9	7.2	8.2	9.4	3	8.8	11.3		13.8	2	13.3		15.3	18.5	21.6	2
Entrenchment Ratio	>5.0		>5.9	>8.2	3			>2.5		2	>2.5		3.1	3.2	3.3	2
Bank Height Ratio	1.2	1.2	1.2	1.3	3	1.2	1.4		1.5	2	1.0		1.0	1.0	1.0	2
Pattern																
Channel Beltwidth (ft)	39			86				60			30	75	35		85	
Radius of Curvature (ft)	14			55		16			87		30	70	30		60	
Rc:Bankfull width (ft/ft)	1.2			7.1		0.9			5.9		2.0	4.7	1.7		3.4	
Meander Wavelength (ft)	60			476		66			191		115	250	110		240	
Meander Width Ratio	3.3			11.2				4.1			2.0	5.0	2.0		4.8	
Profile																
Riffle Length (ft)													19	41	83	13
Riffle Slope (ft/ft)			0.011			0.013			0.035		0.007	0.009	0.0039	0.0111	0.0214	13
Pool Length (ft)	8			16		14			33		16	55	8	22	44	13
Pool Spacing (ft)	23			100		50			105		70	140	48	88	169	12
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	56% / 30% / 14% / 0% / 0% / 0%					1% / 27% / 73% / 0% / 0% / 0%							5% / 63% / 31% / 1% / 0% / 0%			
d16 / d35 / d50 / d84 / d95 (mm)	0.062 / 0.06 / 0.06 / 1.3 / 9.5					0.73 / 2.7 / 4.6 / 9.2 / 15							0.13 / 0.29 / 0.43 / 12 / 30			
Additional Reach Parameters																
Channel length (ft)	1,932					432					2,010		2,010			
Drainage Area (SM)	0.49					1.49					0.49		0.49			
Rosgen Classification	E4					C4					C4		C4			
Sinuosity	1.19										1.14		1.17			
Water Surface Slope (ft/ft)	0.0052					0.0099					0.0050		0.0057			

Table 5f. T1A-1 Baseline Stream Summary
Collins Creek Stream Restoration Site

Parameter	Pre-Existing Condition					Reference Reach(es) Data					Design		As-built			
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Mean	Max	n
Bankfull Width (ft)	4.5	5.7		6.8	2	14.8	21.0		27.1	2	7.0			7.9		1
Floodprone Width (ft)	6.0	26		45	2			200		2	>16			>40		1
Bankfull Mean Depth (ft)	0.3	0.8		1.2	2	0.8	1.2		1.5	2	0.5			0.3		1
Bankfull Max Depth (ft)	0.5	1.1		1.6	2	1.9	2.0		2.0	2	0.7			0.6		1
Bankfull Cross-Sectional Area (ft^2)	2.0	3.8		5.5	2	21.2	21.8		22.3	2	3.4			2.5		1
Width/Depth Ratio	3.6	13.4		23.1	2	18.1	18.3		18.5	2	14.4			25.0		1
Entrenchment Ratio	1.5	4.1		6.6	2	7.4	10.5		13.5	2	>2.3			>5		1
Bank Height Ratio	2.3	3.5		4.6	2	1.0	1.1		1.1	2	1.0			1.0		1
Pattern																
Channel Beltwidth (ft)								75			15	40	20		40	
Radius of Curvature (ft)						16			26		7	21	10		20	
Rc:Bankfull width (ft/ft)						1			1.1		1.0	3.0	1.0		2.1	
Meander Wavelength (ft)						108			148		40	75	44		73	
Meander Width Ratio						3.6			5.1		2.1	5.7	2.1		4.1	
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)						0.003			0.076		0.001	0.024				
Pool Length (ft)						28			89		9	21				
Pool Spacing (ft)						38			147		25	52				
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	7% / 19% / 57% / 4% / 0% / 13%					0% / 52% / 48% / 0% / 0% / 0%							22% / 76% / 3% / 0% / 0% / 0%			
d16 / d35 / d50 / d84 / d95 (mm)	0.564 / 5.31 / 9.9 / 35 / 62					0.656 / 1.17 / 1.9 / 16 / 26							0.062 / 0.079 / 0.1 / 0.22 / 0.44			
Additional Reach Parameters																
Channel length (ft)	192					525					251		240			
Drainage Area (SM)	0.04					0.90					0.04		0.04			
Rosgen Classification	C4					C4					C4		C4			
Sinuosity	1.05					1.50					1.40		1.35			
Water Surface Slope (ft/ft)	0.0115					0.0120					0.0100		0.0110			

Table 5g. T1A-2 Baseline Stream Summary
Collins Creek Stream Restoration Site

Parameter	Pre-Existing Condition					Reference Reach(es) Data					Design		As-built			
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Mean	Max	n
Bankfull Width (ft)			4.5		1	9.0	9.5		10.0	2	7.6			9.7		1
Floodprone Width (ft)			6.7		1	13	17		20	2	15			>40		1
Bankfull Mean Depth (ft)			1.2		1	1.1	1.2		1.2	2	0.8			0.5		1
Bankfull Max Depth (ft)			1.6		1	1.3	1.4		1.5	2	1.0			1.0		1
Bankfull Cross-Sectional Area (ft^2)			5.5		1	10.4	10.6		10.7	2	6.0			5.2		1
Width/Depth Ratio			3.8		1	8.0	9.0		10.0	2	9.6			18.1		1
Entrenchment Ratio			1.5		1	1.3	1.8		2.3	2	2.0			>4		1
Bank Height Ratio			2.3		1			1.0		2	1.0			1.0		1
Pattern																
Channel Beltwidth (ft)								45			34	38	30		60	
Radius of Curvature (ft)						13			42		10	33	20		30	
Rc:Bankfull width (ft/ft)						1.3			4.4		1.3	4.4	2.5		3.8	
Meander Wavelength (ft)						93			136		68	114	90		150	
Meander Width Ratio						4.5			5.0		4.5	5.0	3.8		7.6	
Profile																
Riffle Length (ft)													9	27	57	5
Riffle Slope (ft/ft)	0.019			0.077		0.013			0.028		0.016	0.035	N/A*	N/A*	N/A*	-
Pool Length (ft)	4			9		3			25		9	26	2	6	9	6
Pool Spacing (ft)	8			34		30			59		40	104	8	49	81	5
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	7% / 19% / 57% / 4% / 0% / 13%					0% / 15% / 78% / 7% / 0% / 0%							32% / 58% / 10% / 0% / 0% / 0%			
d16 / d35 / d50 / d84 / d95 (mm)	0.564 / 5.31 / 9.9 / 35 / 62					2.0 / 4.2 / 6.9 / 30 / 70							0.062 / 0.071 / 0.14 / 0.48 / 11			
Additional Reach Parameters																
Channel length (ft)	533					297					565		560			
Drainage Area (SM)	0.05					0.38					0.05		0.05			
Rosgen Classification	G4					B4c					B4c		C4/B4c			
Sinuosity	1.05					1.20					1.15		1.17			
Water Surface Slope (ft/ft)	0.0218					0.0130					0.0160		0.0135			

*Riffle slope not available, stream was dry when survey was completed.

Table 5h. T1B Baseline Stream Summary
Collins Creek Stream Restoration Site

Parameter	Pre-Existing Condition					Reference Reach(es) Data					Design		As-built			
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Mean	Max	n
Bankfull Width (ft)	5.9	6.0		6.0	2	10.4	13.3		16.1	2	10.4			11.1		1
Floodprone Width (ft)			>70		2		150	150		2	>37			42.7		1
Bankfull Mean Depth (ft)	1.4	1.6		1.7	2	0.9	1.1		1.2	2	0.8			0.8		1
Bankfull Max Depth (ft)	2.0	2.1		2.1	2	1.4	1.6		1.7	2	1.2			1.4		1
Bankfull Cross-Sectional Area (ft^2)	8.4	9.2		9.9	2	12.5	13.5		14.4	2	8.2			8.4		1
Width/Depth Ratio	3.5	3.9		4.3	2	11.6	12.5		13.4	2	13.3			14.7		1
Entrenchment Ratio			>11.7		2	9.3	11.9		14.4	2	>3.6			3.8		1
Bank Height Ratio	1.0	1.4		1.7	2	1	1.1		1.1	2	1.0			1.0		1
Pattern																
Channel Beltwidth (ft)			110					135			30	80	25		70	
Radius of Curvature (ft)	54			125		14			25		20	40	20		40	
Rc:Bankfull width (ft/ft)	9			21.2		1.4			1.6		1.9	3.8	1.9		3.8	
Meander Wavelength (ft)			400			70			120		110	150	120		160	
Meander Width Ratio	18.3			18.6		10.2			13.0		2.9	7.7	2.4		6.7	
Profile																
Riffle Length (ft)													42	49	55	3
Riffle Slope (ft/ft)	0.0060			0.0080		0.0100			0.0400		0.0080	0.0200	0.0059	0.0141	0.0219	3
Pool Length (ft)	9			17		31			108		12	35	14	20	29	3
Pool Spacing (ft)	13			18		43.5			181		61	111	80	86	93	2
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	8% / 66% / 26% / 0% / 0% / 0%					0% / 0% / 52% / 42% / 0% / 6%							17% / 60% / 23% / 0% / 0% / 0%			
d16 / d35 / d50 / d84 / d95 (mm)	0.151 / 0.23 / 0.4 / 7 / 28					12.3 / 35.5 / 53.7 / 114 / 172							0.062 / 0.11 / 0.22 / 5.5 / 9.2			
Additional Reach Parameters																
Channel length (ft)	1,102					712					1,134		1,100			
Drainage Area (SM)	0.24					0.63					0.24		0.24			
Rosgen Classification	E4					C4					C4		C4			
Sinuosity	1.12					>1.50					1.20		1.18			
Water Surface Slope (ft/ft)	0.0084					0.0070					0.0077		0.0083			

Table 5i. T2 Baseline Stream Summary
Collins Creek Stream Restoration Site

Parameter	Pre-Existing Condition					Reference Reach(es) Data					Design		As-built			
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Mean	Max	n
Bankfull Width (ft)	4.2	5.5	5.4	7.2	4	7.7	7.9	7.7	8.3	3	7.0			7.4		1
Floodprone Width (ft)	8	13	9	28	4	13	15	16	16	3	13			14		1
Bankfull Mean Depth (ft)	0.9	1.0	1.0	1.1	4	0.7	0.8	0.8	0.9	3	0.6			0.7		1
Bankfull Max Depth (ft)	1.3	1.4	1.5	1.5	4	1.1	1.3	1.3	1.4	3	1.0			1.2		1
Bankfull Cross-Sectional Area (ft^2)	4.0	5.3	5.4	6.4	4	6.1	6.4	6.2	7.0	3	4.8			5.2		1
Width/Depth Ratio	3.8	5.8	5.6	8.0	4	8.5	9.8	9.6	11.4	3	11.0			10.5		1
Entrenchment Ratio	1.3	2.4	1.8	4.6	4	1.6	1.9	2.1	2.1	3	1.9			1.8		1
Bank Height Ratio	1.3	2.1	2.3	2.8	4						1.0			1.0		1
Pattern																
Channel Beltwidth (ft)	22			50				22			14	20	25		40	
Radius of Curvature (ft)	14			78		11			23		7	21	10		20	
Rc:Bankfull width (ft/ft)	1.9			18.7		1.0			3.0		1.0	3.0	1.4		2.7	
Meander Wavelength (ft)	50			306		49			59		32	54	50		65	
Meander Width Ratio	3.1			15.0		2.0			2.9		2.0	2.9	3.4		5.4	
Profile																
Riffle Length (ft)													11	18	26	5
Riffle Slope (ft/ft)	0.0160			0.0540		0.0250			0.0470		0.0170	0.0470	0.0186	0.0271	0.0413	3
Pool Length (ft)	3			8		3			15		3	20	5	11	21	9
Pool Spacing (ft)	16			96		21			72		21	72	6	25	47	8
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	7% / 12% / 76% / 5% / 0% / 0%					1% / 27% / 64% / 6% / 1% / 0%							2% / 50% / 46% / 2% / 0% / 0%			
d16 / d35 / d50 / d84 / d95 (mm)	0.47 / 8.4 / 14 / 33 / 66					0.36 / 3.2 / 6.2 / 16 / 150							0.26 / 0.53 / 1.4 / 14 / 35			
Additional Reach Parameters																
Channel length (ft)	1,879					205					1,830		1,833			
Drainage Area (SM)	0.07					0.16					0.07		0.07			
Rosgen Classification	B4/E4/G4/G4c					B4c					B4/B4c		B4/B4c			
Sinuosity	1.1-1.16					1.20					1.1-1.2		1.09			
Water Surface Slope (ft/ft)	0.0147-0.0250					0.0120					0.0170-0.0250		0.0197			

Table 6. Morphology and Hydraulic Monitoring Summary Collins Creek Stream Restoration Site								
Parameter	X-Section 1 Riffle	X-Section 2 Pool	X-Section 3 Pool	X-Section 4 Riffle	X-Section 5 Riffle	X-Section 6 Riffle	X-Section 7 Riffle	X-Section 8 Pool
Reach	UTCC-1	UTCC-1	UTCC-3	UTCC-3	UTCC-3	T1-1	T1-2	T1-2
Dimension								
Bankfull Width (ft)	21.2	35.9	25.3	25.5	27.0	11.1	16.4	13.1
Floodprone Width (ft)	>65	-	-	>76	>74	41.3	41.6	-
Bankfull Mean Depth (ft)	2.0	2.4	1.9	1.9	2.1	0.8	0.7	0.8
Bankfull Max Depth (ft)	3.1	4.3	3.6	2.8	3.3	1.3	1.5	1.8
Bankfull Cross-Sectional Area (ft^2)	42.5	86.7	49.1	48.0	55.5	8.4	11.6	10.9
Bankfull Width/Depth Ratio	10.6	-	-	13.5	13.1	14.7	23.2	-
Bankfull Entrenchment Ratio	>3.1	-	-	>3.0	>2.7	3.7	2.5	-
Bankfull Bank Height Ratio	1.0	-	-	1.0	1.0	1.0	1.0	-
Substrate								
d50 (mm)	0.39	0.43	0.22	2.0	0.16	7.4	0.78	0.11
d84 (mm)	17.0	4.9	16.0	23.0	1.0	20.0	13.0	0.33
Parameter	X-Section 9 Riffle	X-Section 10 Pool	X-Section 11 Riffle	X-Section 12 Riffle	X-Section 13 Riffle	X-Section 14 Riffle	X-Section 15 Pool	X-Section 16 Riffle
Reach	T1-3	T1-3	T1-3	T1A-1	T1A-2	T1B	T2	T2
Dimension								
Bankfull Width (ft)	20.8	22.3	14.8	7.9	9.7	11.1	10.4	7.4
Floodprone Width (ft)	>65	-	49	>40	>40	42.7	-	13.5
Bankfull Mean Depth (ft)	1.0	1.4	1.0	0.3	0.5	0.8	0.9	0.7
Bankfull Max Depth (ft)	1.9	2.9	1.4	0.6	0.9	1.4	1.9	1.2
Bankfull Cross-Sectional Area (ft^2)	20.0	31.4	14.3	2.5	5.2	8.4	9.8	5.2
Bankfull Width/Depth Ratio	21.6	-	15.3	25.0	18.1	14.7	-	10.5
Bankfull Entrenchment Ratio	>3.1	-	3.3	>5.1	>4.1	3.8	-	1.8
Bankfull Bank Height Ratio	1.0	-	1.0	1.0	1.0	1.0	-	1.0
Substrate								
d50 (mm)	1.3	0.23	0.66	0.14	0.1	0.22	2.2	0.9
d84 (mm)	24.0	0.49	9.5	0.48	0.22	5.5	19.0	11.0

2.3.2 Vegetation

Baseline vegetation monitoring data were collected in May 2008. Plot photos from all the vegetation plots can be found in Appendix D.

The results of the baseline monitoring show an average of 867 stems per acre along the stream (Table 7). An attempt to identify all trees was made, but since monitoring was conducted before some trees had leafed out many were unidentifiable. All trees will be positively identified during first year monitoring.

Table 7. Stem Density and Species Count by Plot
Collins Creek Stream Restoration Site

	Plot Numbers															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
Chokeberry *Aronia arbutifolia*	1	4	4	2	7	9	2					2				31
River Birch *Betula nigra*	2	6	1		3	1	1				2	1				17
Beautyberry *Callicarpa americana*		1		3			1									5
Shagbark Hickory *Carya ovata*									1	1	3		3		1	9
Silky Dogwood *Cornus amomum*	4			3	6			9	1	3			2	2		30
Persimmon *Diospyros virginiana*	2	2	5		3		2	2	1	5	5	7	2	3	2	41
Green Ash *Fraxinus pennsylvanica*				1			1									2
Possumhaw *Ilex decidua*						2	1		1	3	1				1	9
Winterberry *Ilex verticillata*		1	1				1	2				1				6
Virginia Sweetspire *Ilex virginica*												1	1	1		3
Black Walnut *Juglans nigra*						3		4	11	2	5	4	5	2	6	42
Spicebush *Lindera benzoin*	1		1							1						3
Sycamore *Platanus occidentalis*	2	4		1	2	3	4				1	5				22
Southern Red Oak *Quercus falcata*	1	1	1		1				1		3	2	2		3	15
Swamp Chestnut Oak *Quercus michauxii*	1		2		1	1	4			3				3		15
Cherrybark Oak *Quercus pagoda*													2	1	1	4
Willow Oak *Quercus phellos*	1		1	4												6
Quercus sp.				2						3		1		1	1	8
Black Willow *Salix nigra*	1							2						3		6
Silky Willow *Salix sericea*	7									1						8
Elderberry *Sambucus canadensis*	4				5			5		8				4		26
Coralberry *Symphoricarpus orbicultas*			1					2	1		1	1	1	1		8
Unknown								1		1	3	2			2	9
Total	27	19	17	16	28	19	17	27	17	31	24	27	18	21	17	325
Density	1080	760	680	640	1120	760	680	1080	680	1240	960	1080	720	840	680	867

3.0 SUCCESS CRITERIA

3.1 Stream Stability

Cross-section measurements should show little or no change from the as-built cross-sections. Annual measurements of the longitudinal profile should indicate a stable bedform with little change from the as-built survey. Sediment transport should remain relatively unchanged with respect to aggradation and deposition of sediments. Any observed variation in the yearly monitoring of the cross-sections and longitudinal profiles will be evaluated to determine whether they are minor adjustments associated with normal sediment transport and increasing stability or whether they indicate movement toward an unstable condition. If any changes occur, they will be discussed within the yearly monitoring reports.

3.2 Vegetation

Riparian vegetation must meet a minimum survival success rate of 260 stems/acre after five years. If monitoring indicates that the specified survival rate is not being met, appropriate corrective actions will be developed, which could include invasive species control, the removal of dead/dying plants, and replanting.

3.3 Hydrology

Within the five-year monitoring period a minimum of two bankfull events must occur in separate years of the restored stream. If stream gauge data reveal that this criterion is not met, probable causes for this will be determined.

4.0 MAINTENANCE AND CONTINGENCY PLAN

The site will be monitored for any problem areas that could arise and any such issues will be dealt with according to severity. Site maintenance may include reinstallation of coir matting, removal of debris from the channel, stabilization of bank erosion with protective structures, or adjustments to in-stream structures. Any maintenance activities will be documented in the yearly monitoring reports.

Appendix A

As-Built Plans

KCI JOB# : 12054130–01

CONTRACT #: D05011

STATE OF NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

STATE	CONTRACT NUMBER	SHEET NO.	TOTAL SHEETS
N.C.	D05011	1	20

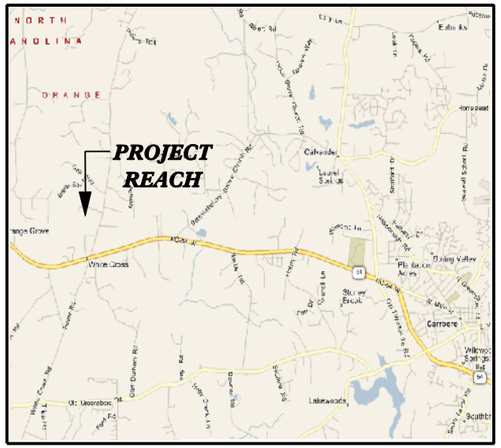
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	
SYM.	DESCRIPTION	DATE	APPROVED

REVISIONS

ORANGE COUNTY

LOCATION: COLLINS CREEK SITE
UNNAMED TRIBUTARIES TO COLLINS CREEK
CHAPEL HILL, NORTH CAROLINA

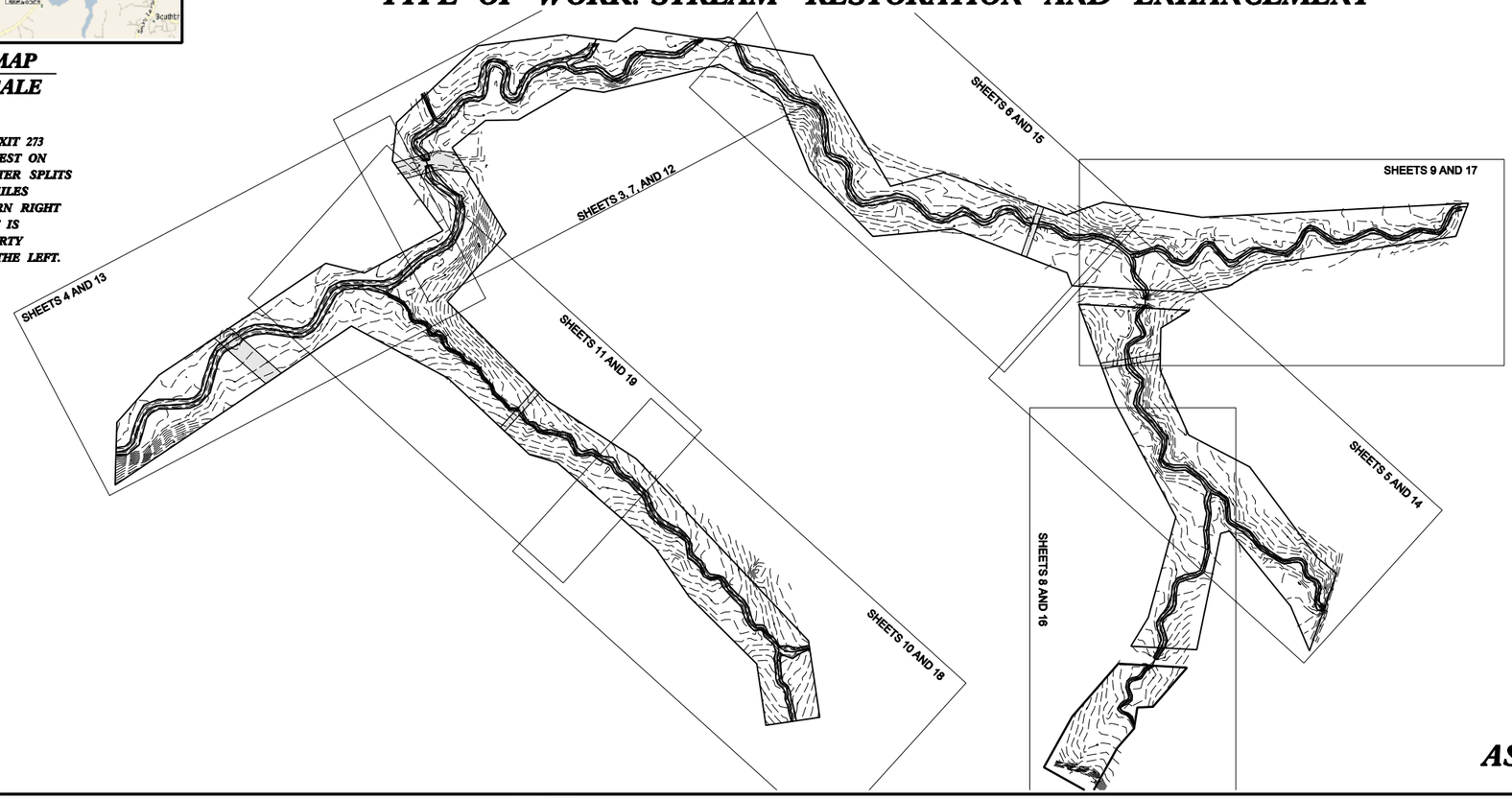
TYPE OF WORK: STREAM RESTORATION AND ENHANCEMENT



VICINITY MAP
NOT TO SCALE

DIRECTIONS TO SITE

PROCEED WEST ON INTERSTATE 40. TAKE EXIT 273 AND TRAVEL WEST ON NC 54. CONTINUE WEST ON NC 54 AS IT JOINS NC 15–501 AND THEN LATER SPLITS OFF FROM NC 15–501. APPROXIMATELY 7.5 MILES AFTER SPLITTING OFF FROM NC 15–501, TURN RIGHT ONTO DODSONS CROSSROADS. THE PROJECT IS ACCESSIBLE FROM THE WHITFIELD PROPERTY DRIVEWAY APPROXIMATELY 0.3 MILES ON THE LEFT.



AS–BUILT PLAN

INDEX OF SHEETS

GRAPHIC SCALE

–40 –20 0 40 80
PLANS

PROJECT DATA

STREAM RESTORATION LENGTH = 8,952 FEET

STREAM ENHANCEMENT LENGTH = 500 FEET

CONSTRUCTION COMPLETED: APRIL 2008

Prepared in the Office of:

KCI TECHNOLOGIES
ENGINEERS•PLANNERS•ECOLOGISTS
SUITE 220 LANDMARK CENTER II
4601 SIX FORKS RD., RALEIGH, NC

GARY M. MRYNCZA, PE
PROJECT ENGINEER

ALEX FRENCH / ADAM SPILLER
NATURAL CHANNEL DESIGN

PROJECT ENGINEER

SIGNATURE: ***P.E.***

Prepared for:

Ecosystem Enhancement PROGRAM

GUY PEARCE
CONTRACT ADMINISTRATOR

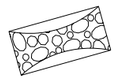
PROJECT LEGEND

STREAM RESTORATION

As–Built Thalweg, Stationing, and Top of Bank

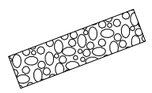
As–Built Cross Vane

As–Built Riffle Grade Control/Constructed Riffle

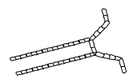


As–Built Stone Toe Protection

As–Built Ford Crossing



As–Built Channel Constrictor



As–Built Stabilized Plunge Pool

As–Built Step Pool

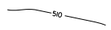
AS–BUILT NOTE:

THE AS–BUILT SITE PLAN (SHEETS 3–11) DEPICTS THE AS–BUILT CONDITIONS. ANY DEVIATIONS FROM THE DESIGN PLANS ARE SPECIFICALLY CALLED OUT WITH NOTES. IF THERE ARE NOT ASSOCIATED NOTES WITH A SPECIFIC SECTION THEN THAT SECTION HAS BEEN BUILT AS DESIGNED.

TOPOGRAPHY

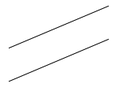
Minor Contour Line

Major Contour Line

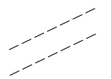


MISCELLANEOUS

Paved Road



Unpaved Road



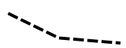
MONITORING

Cross–Section

Photo Point

Vegetation Plots

Longitudinal Profile



REVISIONS			
DESCRIPTION	DATE	APPROVED
A SUBMITTED WITH MITIGATION PLAN	OCT 2008	

Ecosystem Enhancement Program

KCI TECHNOLOGIES
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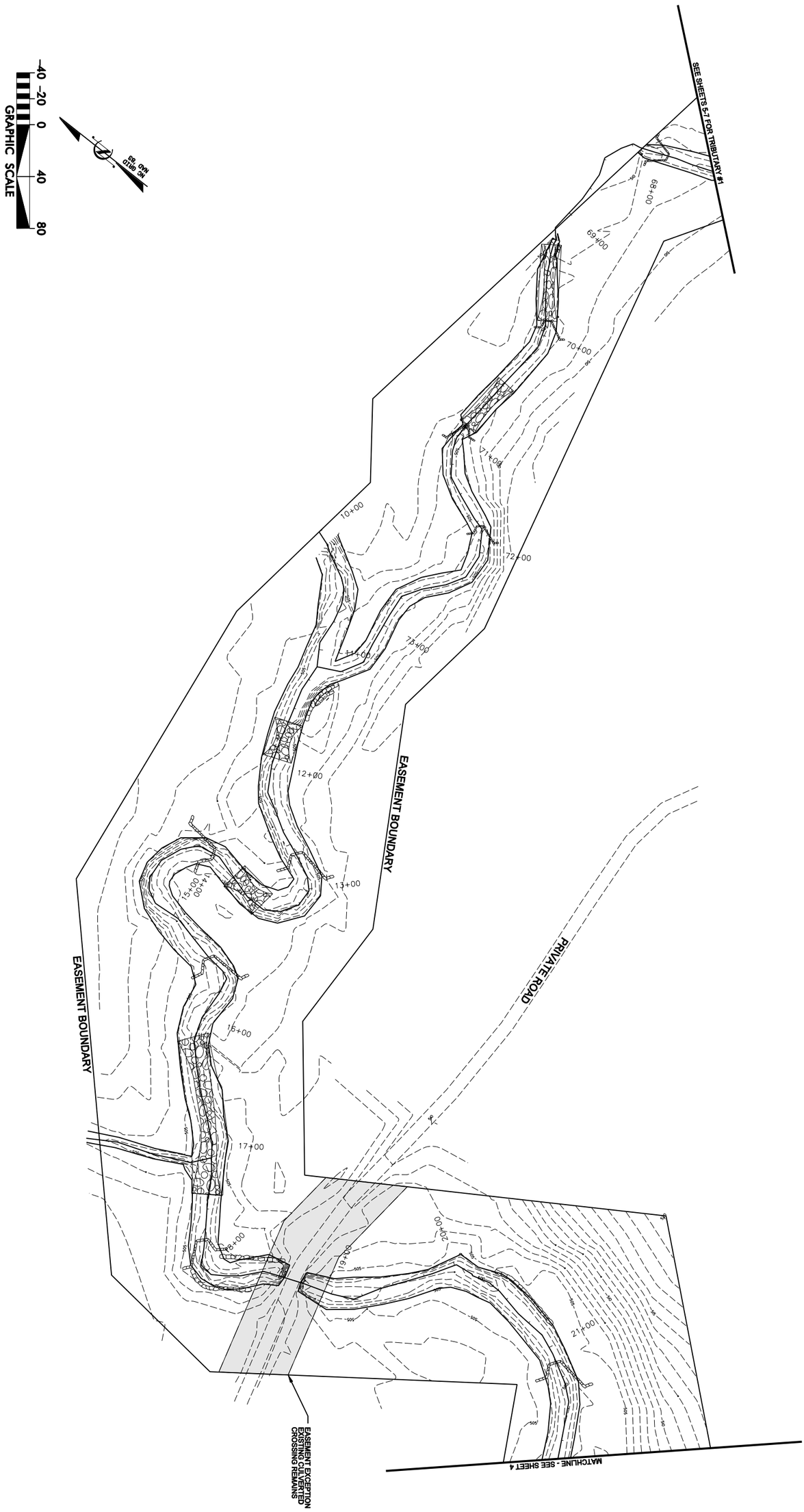
460 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

COLLINS CREEK
STREAM RESTORATION PROJECT
CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

DATE: OCTOBER 2008
SCALE: N.T.S.

AS-BUILT LEGEND



SHEET 3 OF 20

AS-BUILT
SITE PLAN

DATE: OCTOBER 2008
SCALE: 1"=40'

COLLINS CREEK
STREAM RESTORATION PROJECT

CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

UTCC-1 AND UTCC-2: STATION 10+00 TO STATION 21+90

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Ecosystem Enhancement Program

SYM.	DESCRIPTION	DATE	APPROVED
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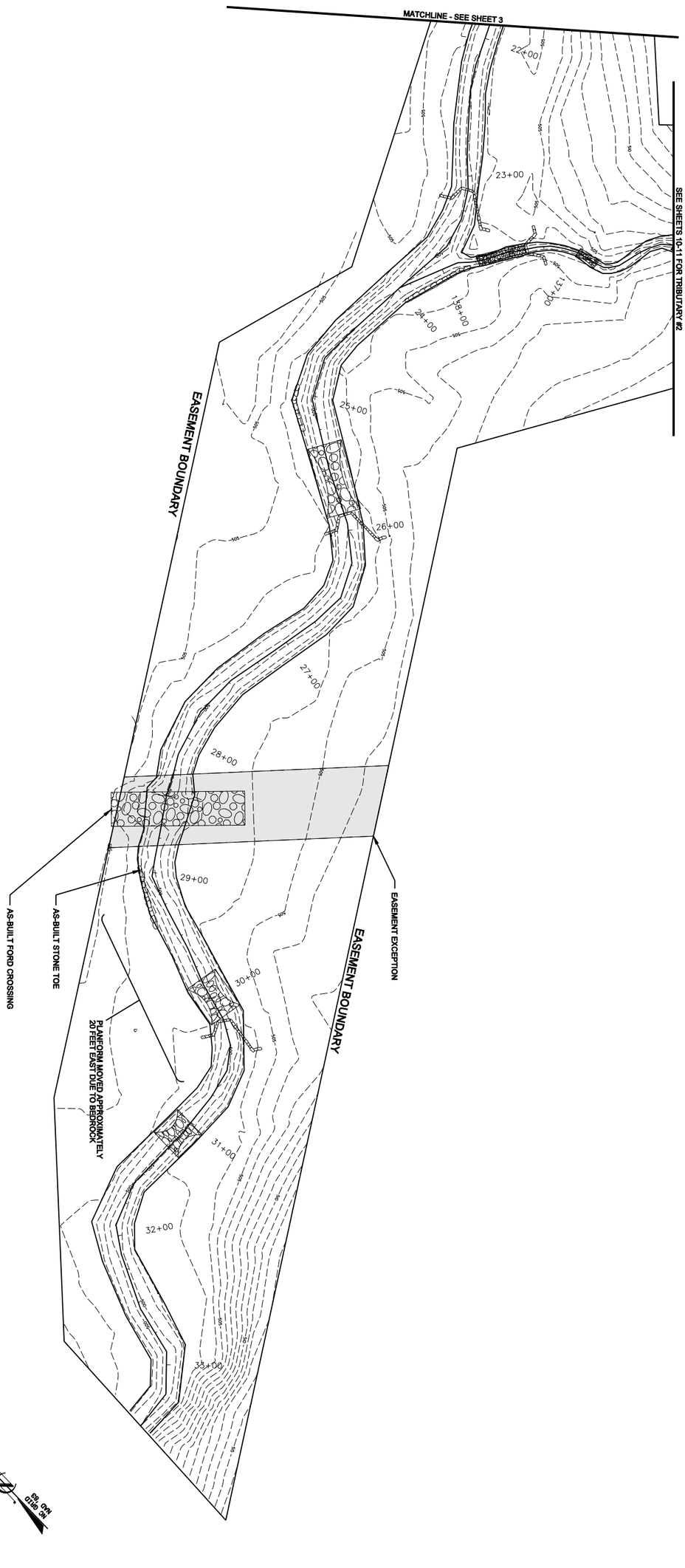
REVISIONS



SHEET 4 OF 20

AS-BUILT SITE PLAN

DATE: OCTOBER 2008
SCALE: 1"=40'

COLLINS CREEK STREAM RESTORATION PROJECT

CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

UTCC-2 AND UTCC-3: STATION 21+90 TO STATION 33+50

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Ecosystem Enhancement Program

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

REVISIONS

SEE SHEET 8 FOR TRIBUTARY #1A

DESIGNED SILL AND VANE NOT INSTALLED. AREA IS STABLE WITHOUT THESE STRUCTURES.

CONSTRUCTED RIFFLE INSTALLED TO STABILIZE RIFFLE POST CONSTRUCTION.

CONSTRUCTED RIFFLES INSTALLED TO STABILIZE RIFFLES POST CONSTRUCTION.

DUE TO BEDROCK GRADE CONTROL, DESIGNED CONSTRUCTED RIFFLES AND CROSS VANE WERE NOT INSTALLED.

DUE TO BEDROCK THE PLANFORM WAS SHIFTED APPROXIMATELY 15 FT TO THE NORTHEAST FROM STATION 47+75 TO 48+75.

INSTALLED FORD CROSSING

EASEMENT EXCEPTION

CONSTRUCTED RIFFLE INSTALLED TO STABILIZE RIFFLE POST CONSTRUCTION.

DODSONS CROSSROADS

EASEMENT BOUNDARY

DUE TO LARGE BEDROCK OUTCROPS, DESIGNED CROSS VANES WERE NOT INSTALLED. CONSTRUCTED RIFFLES AND STONE TOE PROTECTION WERE INSTALLED INSTEAD AROUND THE BEDROCK.

CONSTRUCTED RIFFLE INSTALLED TO STABILIZE RIFFLE POST CONSTRUCTION.

CROSS VANE INSTALLED TO STABILIZE DESIGNED PATTERN CHANGE.

EASEMENT BOUNDARY

PRIVATE ROAD

MATCHLINE - SEE SHEET 6

SEE SHEET 9 FOR TRIBUTARY #1B

NC GRID NAD 83

–40 –20 0 40 80

GRAPHIC SCALE

A	SUBMITTED WITH MITIGATION PLAN					OCT 2008	
					STM.	DATE	APPROVED

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COLLINS CREEK STREAM RESTORATION PROJECT

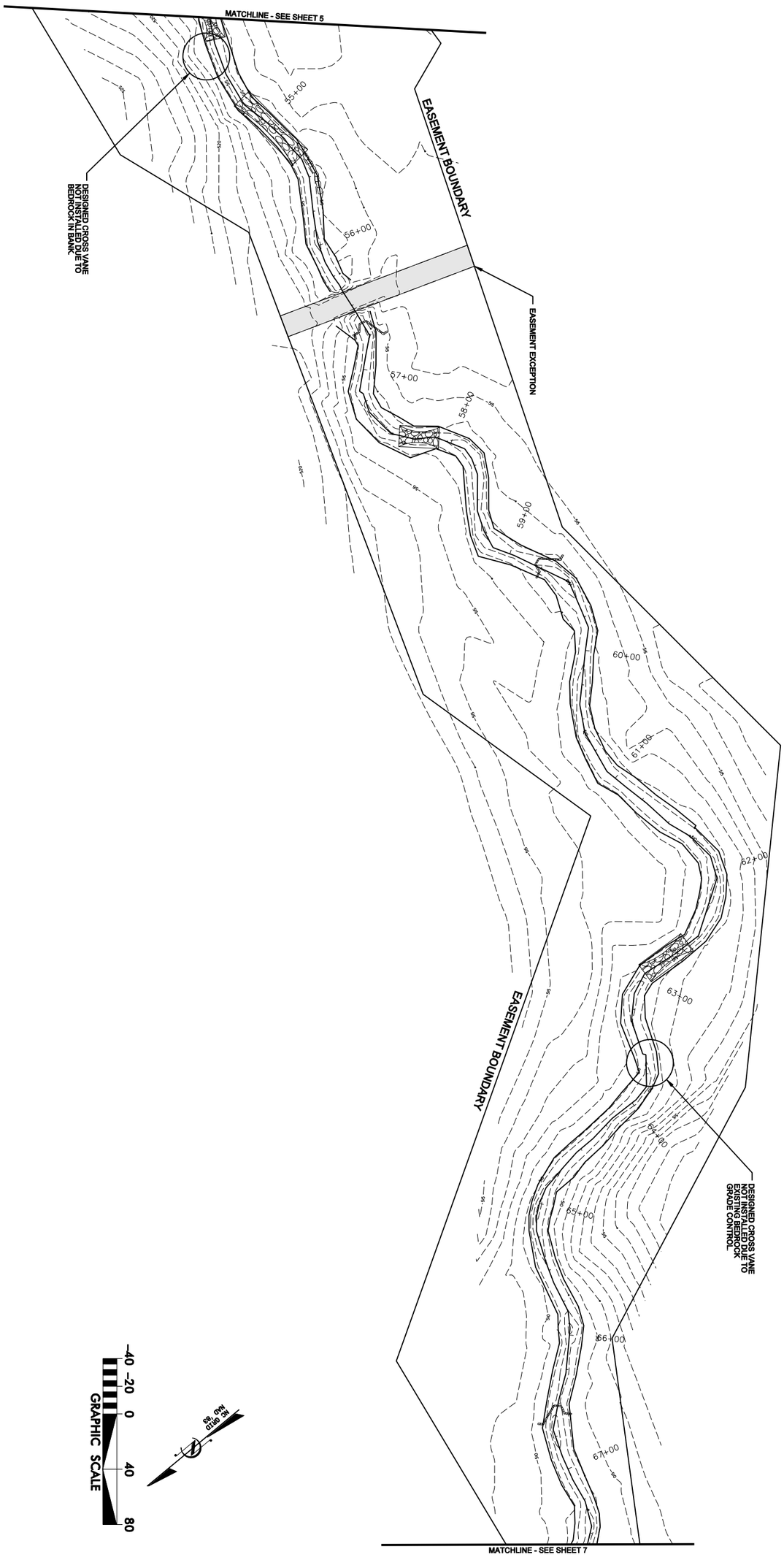
CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

T1-1 AND T1-2: STATION 40+00 TO STATION 54+10

DATE: OCTOBER 2008

SCALE: 1"=40'

AS-BUILT SITE PLAN



SHEET 6 OF 20	AS-BUILT SITE PLAN	DATE: OCTOBER 2008 SCALE: 1"=40'	COLLINS CREEK STREAM RESTORATION PROJECT CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA T1-3: STATION 54+10 TO STATION 67+60

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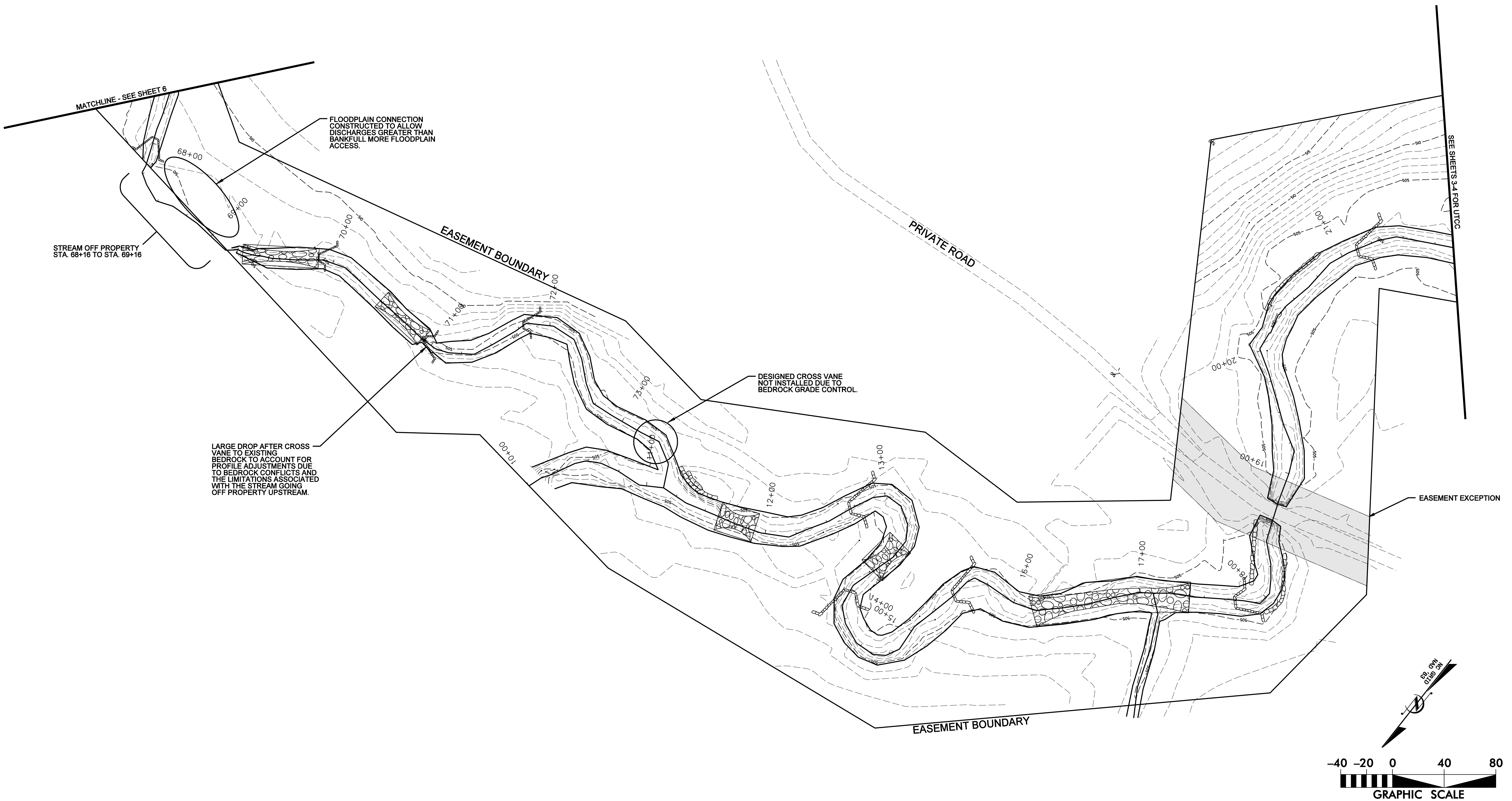
Ecosystem Enhancement Program

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

REVISIONS



SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

REVISIONS

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COLLINS CREEK
STREAM RESTORATION PROJECT
CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA
T1-3: STATION 67+60 TO STATION 73+70

DATE: OCTOBER 2008
SCALE: 1"=40'

AS-BUILT
SITE PLAN

SHEET 7 OF 20

NC GRID
NAD '83

–40 –20 0 40 80
GRAPHIC SCALE

REVISIONS

	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

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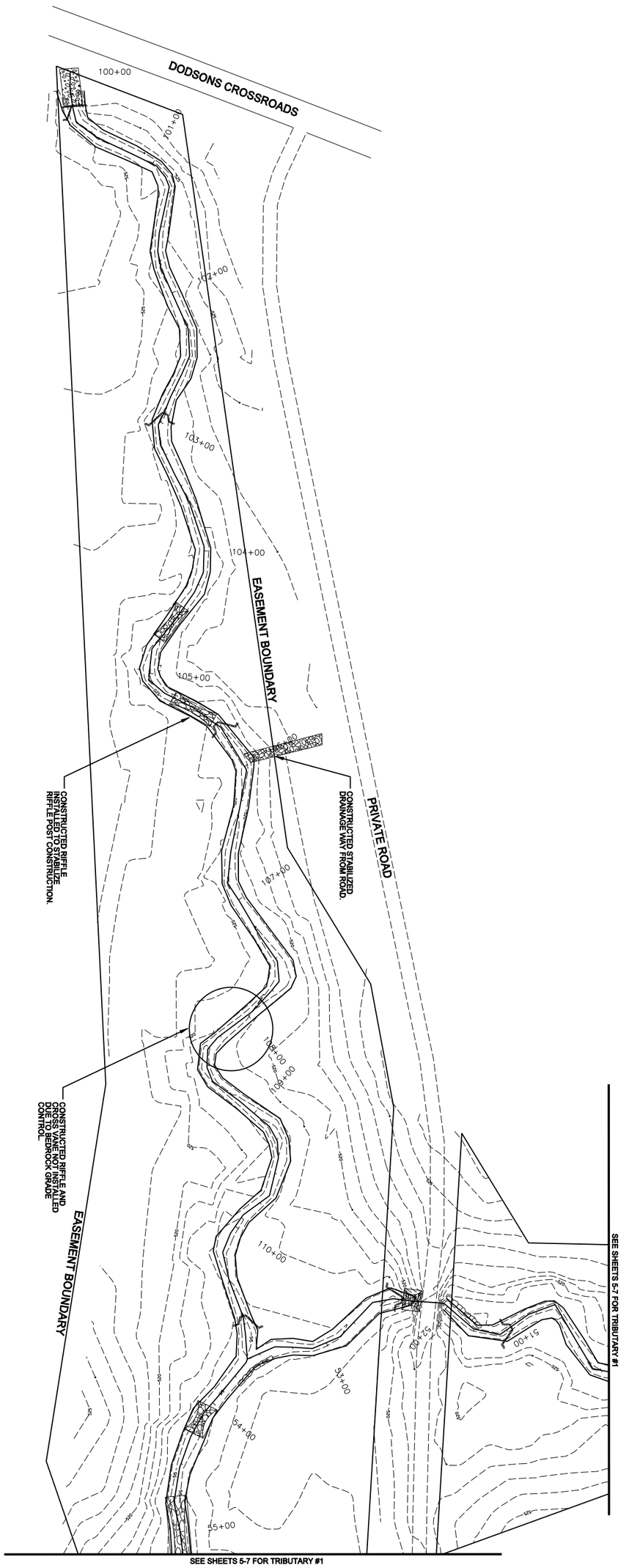
COLLINS CREEK STREAM RESTORATION PROJECT

CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

T1A-1 AND T1A-2: STATION 80+00 TO STATION 87+75

DATE: OCTOBER 2008
SCALE: 1"=40'

AS-BUILT SITE PLAN



SHEET 9 OF 20

AS-BUILT SITE PLAN

DATE: OCTOBER 2008

SCALE: 1"=40'

COLLINS CREEK STREAM RESTORATION PROJECT

CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

T1B: STATION 100+00 TO STATION 111+00

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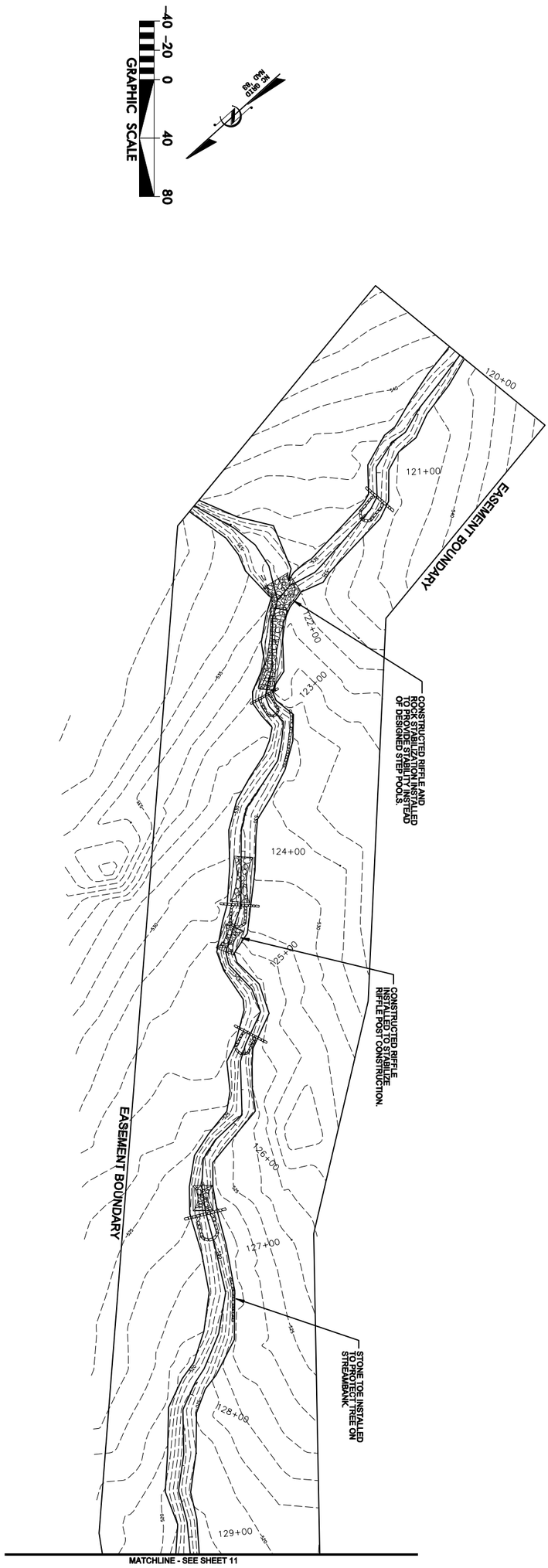
Ecosystem Enhancement Program

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

REVISIONS



SHEET 10 OF 20

AS-BUILT SITE PLAN

DATE: OCTOBER 2008

SCALE: 1"=40'

COLLINS CREEK STREAM RESTORATION PROJECT

CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

T2: STATION 120+00 TO STATION 129+12

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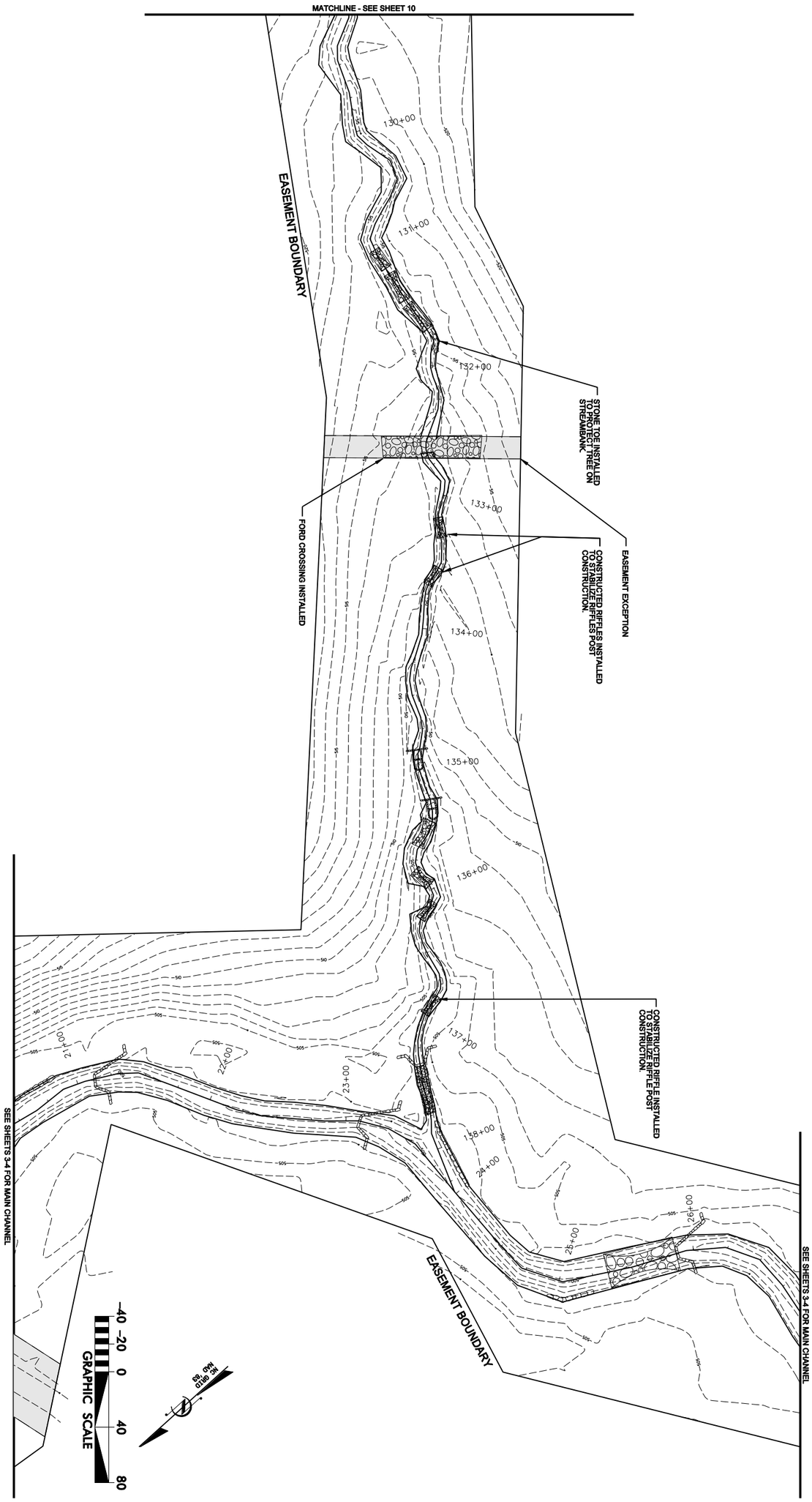
Ecosystem Enhancement Program

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

REVISIONS



SHEET 11 OF 20

AS-BUILT SITE PLAN

DATE: OCTOBER 2008

SCALE: 1"=40'

COLLINS CREEK STREAM RESTORATION PROJECT

CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

UT2: STATION 129+12 TO STATION 138+33

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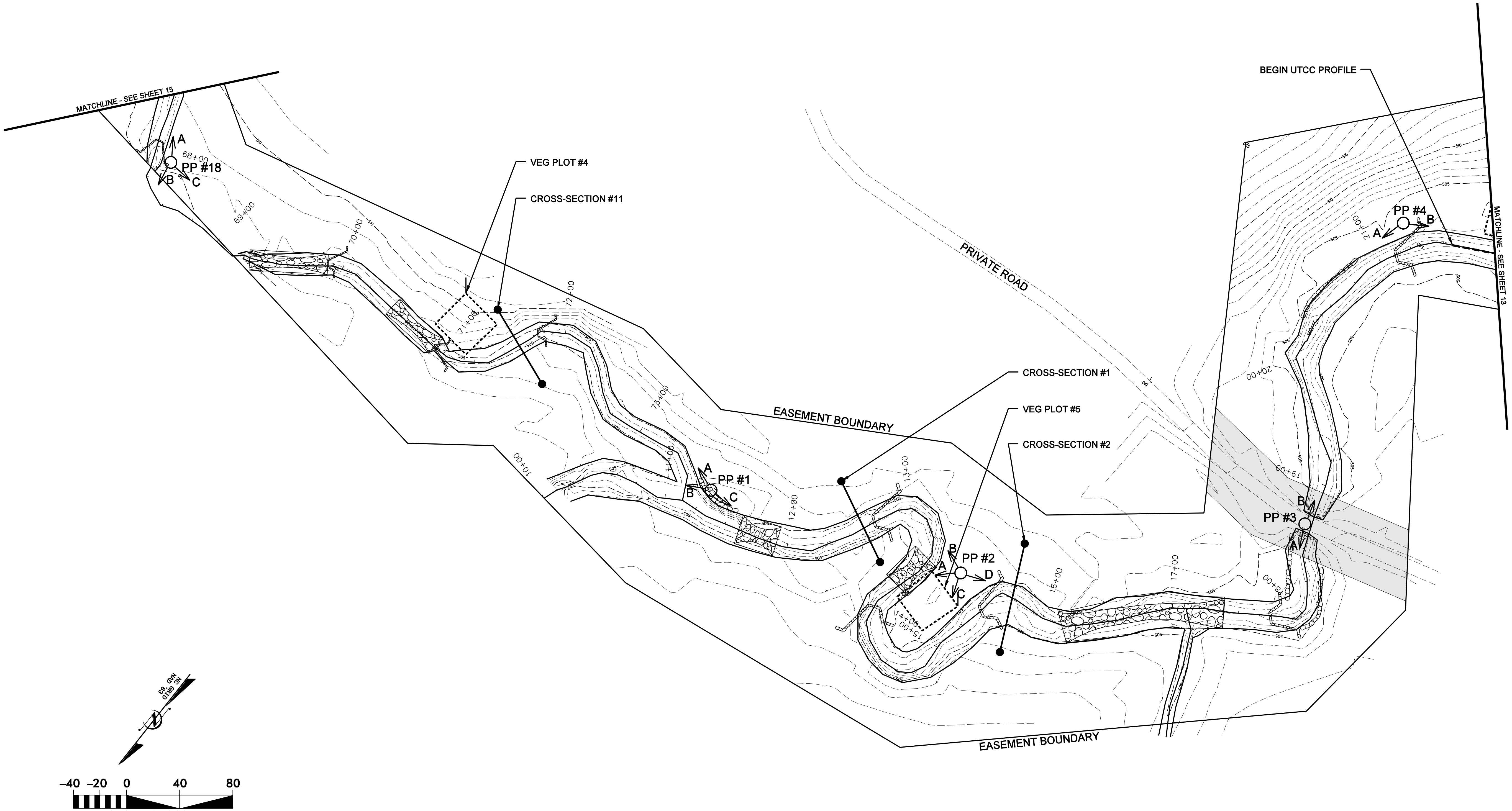
Ecosystem Enhancement Program

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

REVISIONS



SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

REVISIONS

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COLLINS CREEK STREAM RESTORATION PROJECT

CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

UTCC-1 AND UTCC-2: STATION 10+00 TO STATION 21+90

DATE: OCTOBER 2008
SCALE: 1"=40'

MONITORING PLAN VIEW

SHEET 12 OF 20

SEE SHEETS 18-19 FOR TRIBUTARY #2

END T2 PROFILE

CROSS-SECTION #3

CROSS-SECTION #4

CROSS-SECTION #5

VEG PLOT #8

END UTCC PROFILE

MATCHLINE - SEE SHEET 12

PP #5

PP #6

PP #7

VEG PLOT #6

VEG PLOT #7

EASEMENT BOUNDARY

EASEMENT BOUNDARY

–40 –20 0 40 80

GRAPHIC SCALE

REVISIONS				
DESCRIPTION	DATE	APPROVED
A SUBMITTED WITH MITIGATION PLAN	OCT 2008	

Ecosystem Enhancement Program

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RALEIGH, NORTH CAROLINA 27609

COLLINS CREEK
STREAM RESTORATION PROJECT
CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA
UTCC-2 AND UTCC-3: STATION 21+90 TO STATION 33+50

DATE: OCTOBER 2008
SCALE: 1"=40'

MONITORING
PLAN VIEW

SHEET 13 OF 20

SEE SHEET 16 FOR TRIBUTARY #1A

CROSS-SECTION #13

END T1A PROFILE

PP #8

PP #9

PP #10

PP #11

PP #12

PP #13

VEG PLOT #12

DODSONS CROSSROADS

EASEMENT BOUNDARY

CROSS-SECTION #6

VEG PLOT #11

CROSS-SECTION #7

EASEMENT BOUNDARY

PRIVATE ROAD

CROSS-SECTION #8

BEGIN T1 PROFILE

MATCHLINE - SEE SHEET 15

SEE SHEET 17 FOR TRIBUTARY #1B

NO GRID NO GS

–40 –20 0 40 80

GRAPHIC SCALE

REVISIONS			
	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

Ecosystem Enhancement Program

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RALEIGH, NORTH CAROLINA 27609

COLLINS CREEK STREAM RESTORATION PROJECT

CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

T1-1 AND T1-2: STATION 40+00 TO STATION 54+10

DATE: OCTOBER 2008

SCALE: 1"=40'

MONITORING PLAN VIEW

SHEET 14 OF 20

CROSS-SECTION #10

END T1 PROFILE

VEG PLOT #2

CROSS-SECTION #9

VEG PLOT #3

PP #16

PP #15

PP #17

PP #14

EASEMENT BOUNDARY

EASEMENT BOUNDARY

MATCHLINE - SEE SHEET 12

MATCHLINE - SEE SHEET 14

No grid
No dig

–40 –20 0 40 80

GRAPHIC SCALE

A	SUBMITTED WITH MITIGATION PLAN	OCT 2008		
		DESCRIPTION	DATE	APPROVED

REVISIONS

Ecosystem Enhancement Program

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4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

COLLINS CREEK
STREAM RESTORATION PROJECT

CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

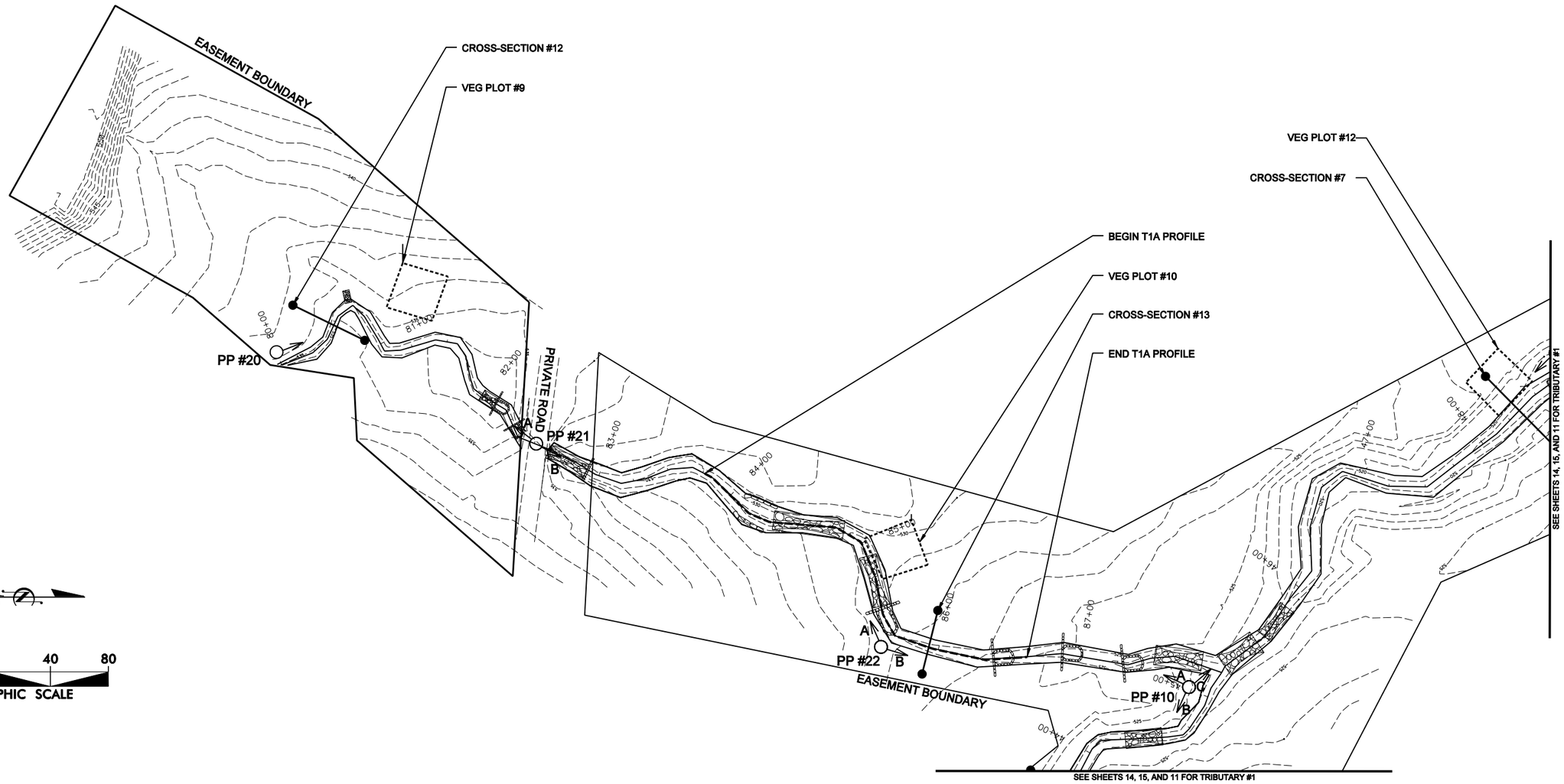
T1-3: STATION 54+10 TO STATION 67+60

DATE: OCTOBER 2008

SCALE: 1"=40'

MONITORING PLAN VIEW

SHEET 15 OF 20



NC GRID
NAD '83

–40 –20 0 40 80
GRAPHIC SCALE

A	SUBMITTED WITH MITIGATION PLAN	OCT 2008		
		DESCRIPTION	DATE	APPROVED
	STM.	REVISIONS		

Ecosystem Enhancement Program

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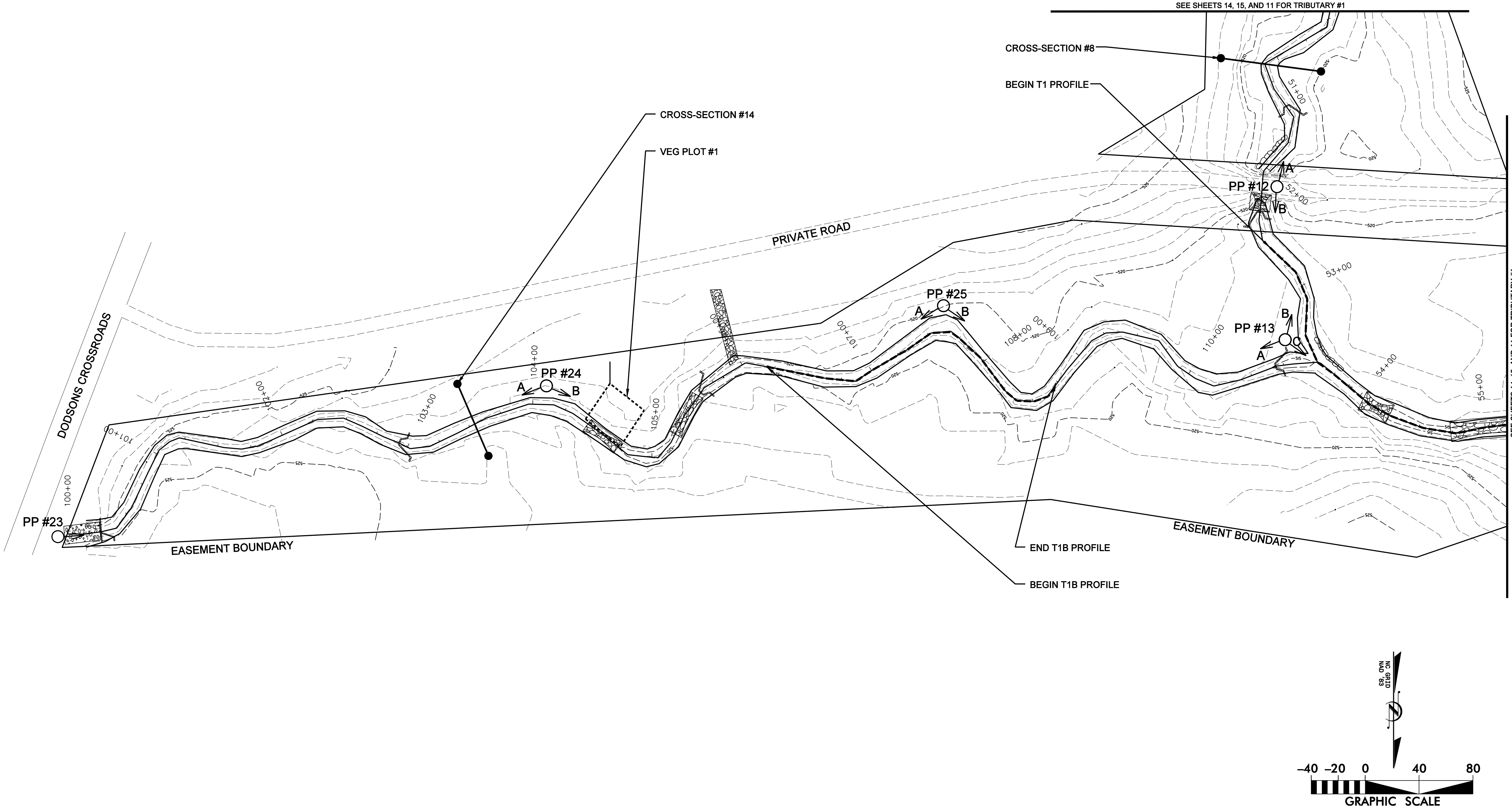
RALEIGH, NORTH CAROLINA 27609

COLLINS CREEK
STREAM RESTORATION PROJECT
CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA
T1A-1 AND TIA-2: STATION 80+00 TO STATION 87+75

DATE: OCTOBER 2008
SCALE: 1"=40'

MONITORING
PLAN VIEW

SHEET 16 OF 20



SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

REVISIONS

Ecosystem Enhancement PROGRAM

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RALEIGH, NORTH CAROLINA 27609

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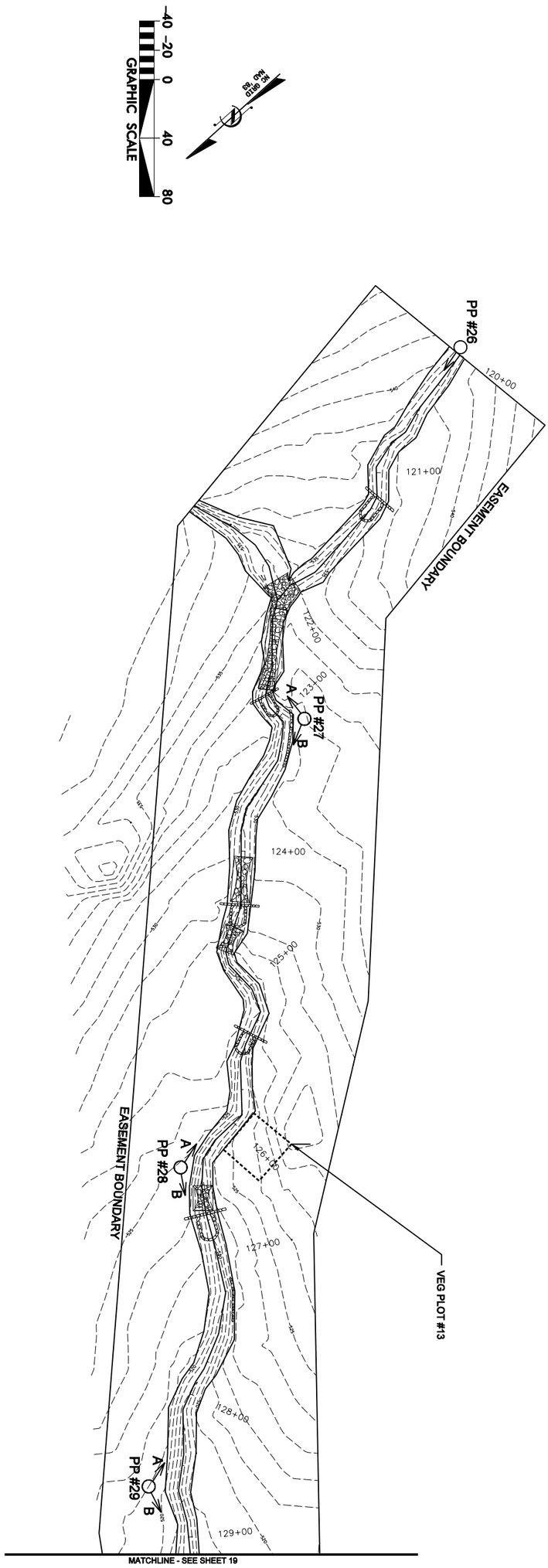
STREAM RESTORATION PROJECT
CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA
T1B: STATION 100+00 TO STATION 111+00

DATE: OCTOBER 2008
SCALE: 1"=40'

MONITORING
PLAN VIEW

SHEET 17 OF 20



SHEET 18 OF 20

MONITORING PLAN VIEW

DATE: OCTOBER 2008

SCALE: 1"=40'

COLLINS CREEK STREAM RESTORATION PROJECT

CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

T2: STATION 120+00 TO STATION 129+12

KCI TECHNOLOGIES
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

Ecosystem Enhancement Program

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	

REVISIONS

A	SUBMITTED WITH MITIGATION PLAN	OCT 2008		
		SYM.	DESCRIPTION	DATE	APPROVED

REVISIONS

Ecosystem Enhancement Program

KCI TECHNOLOGIES
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

COLLINS CREEK
STREAM RESTORATION PROJECT
CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA
T2: STATION 129+12 TO STATION 138+33

DATE: OCTOBER 2008
SCALE: 1"=40'

MONITORING
PLAN VIEW

SHEET 19 OF 20

AS-BUILT PLANTING PLAN AND SPECIES COMPOSITION

THERE ARE TWO DISTINCT PLANTING ZONES ON THE RESTORATION SITE. THE FIRST IS THE STREAM ZONE, WHICH OCCURS FROM THE BOTTOM OF THE BANK TO THE TOP OF THE BANK WITHIN THE LIMITS OF THE RESTORED BANKFULL CHANNEL. THE SECOND PLANTING ZONE IS THE RIPARIAN BUFFER, WHICH STARTS AT THE TOP OF THE BANK OF THE BANKFULL CHANNEL AND CONTINUES TO THE CONSERVATION EASEMENT BOUNDARY. THIS ZONE CONSISTS OF A GRADATION FROM A PIEDMONT ALLUVIAL FOREST COMMUNITY TYPE CLOSE TO THE STREAM TO A MESIC MIXED HARDWOOD FOREST COMMUNITY TYPE AS THE ELEVATION INCREASES WITHIN THE CONSERVATION EASEMENT. THE LIVE STAKES WERE INSTALLED ON THREE FOOT CENTERS AND THE RIPARIAN BUFFER WAS PLANTED AT A DENSITY OF 680 STEMS PER ACRE. THE SPECIES PLANTED IN EACH ZONE ARE DESCRIBED BELOW, WITH THE RIPARIAN BUFFER SPECIES DIVIDED BY COMMUNITY TYPE THAT THEY WOULD COMMONLY OCCUR IN.

STREAM ZONE = 1.5 ACRES

LIVE STAKES: 1.5' TO 2' LENGTHS, 1/2' TO 2" DIAMETER
3' CENTER SPACING, RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME
BLACK WILLOW	SALIX NIGRA
SILKY WILLOW	SALIX SERICEA
SILKY DOGWOOD	CORNUS AMOMUM
ELDERBERRY	SAMBUCUS CANADENSIS

NOTE: NO SINGLE LIVE STAKING SPECIES COMPOSES MORE THAN 40% OF THE TOTAL NUMBER OF LIVE STAKES INSTALLED

RIPARIAN BUFFER PLANTING ZONE = 25.0 ACRES

12" - 18" BARE ROOT MATERIAL
680 STEMS/ACRE (8' X 8' SPACING), RANDOM SPECIES PLACEMENT

PIEDMONT ALLUVIAL FOREST COMMUNITY

COMMON NAME	SCIENTIFIC NAME
CORALBERRY	SYMPHORICARPOS ORBICULATAS
GREEN ASH	FRAXINUS PENNSYLVANICA
SPICEBUSH	LINDERA BENZOIN
WINTERBERRY	ILEX VERTICILLATA
BEAUTYBERRY	CALLICARPA AMERICANA
SYCAMORE	PLATANUS OCCIDENTALIS
RIVER BIRCH	BETULA NIGRA
SWAMP CHESTNUT OAK	QUERCUS MICHAUXII
WILLOW OAK	QUERCUS PHELLOS
PERSIMMON	DIOSPYROS VIRGINIANA
CHOKEBERRY	ARONIA ARBUTIFOLIA
POSSUMHAW	VIBURNUM NUDUM
VIRGINIA SWEETSPIRE	ITEA VIRGINICA
DECIDUOUS HOLLY	ILEX DECIDUA

MESIC MIXED HARDWOOD FOREST COMMUNITY

COMMON NAME	SCIENTIFIC NAME
CORALBERRY	SYMPHORICARPOS ORBICULATAS
SPICEBUSH	LINDERA BENZOIN
PERSIMMON	DIOSPYROS VIRGINIANA
SHAGBARK HICKORY	CARYA OVATA
S. RED OAK	QUERCUS FALCATA
BLACK WALNUT	JUGLANS NIGRA

A	SUBMITTED WITH MITIGATION PLAN	OCT 2008	APPROVED
		DATE	
	DESCRIPTION		
	REVISIONS		

Ecosystem Enhancement Program

KCI TECHNOLOGIES
ENGINEERS • PLANNERS • SCIENTISTS
460 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

COLLINS CREEK
STREAM RESTORATION PROJECT
CHAPEL HILL, ORANGE COUNTY, NORTH CAROLINA

DATE: OCTOBER 2008
SCALE: 1"=40'

AS-BUILT PLANTING PLAN

SHEET 20 OF 20

Appendix B

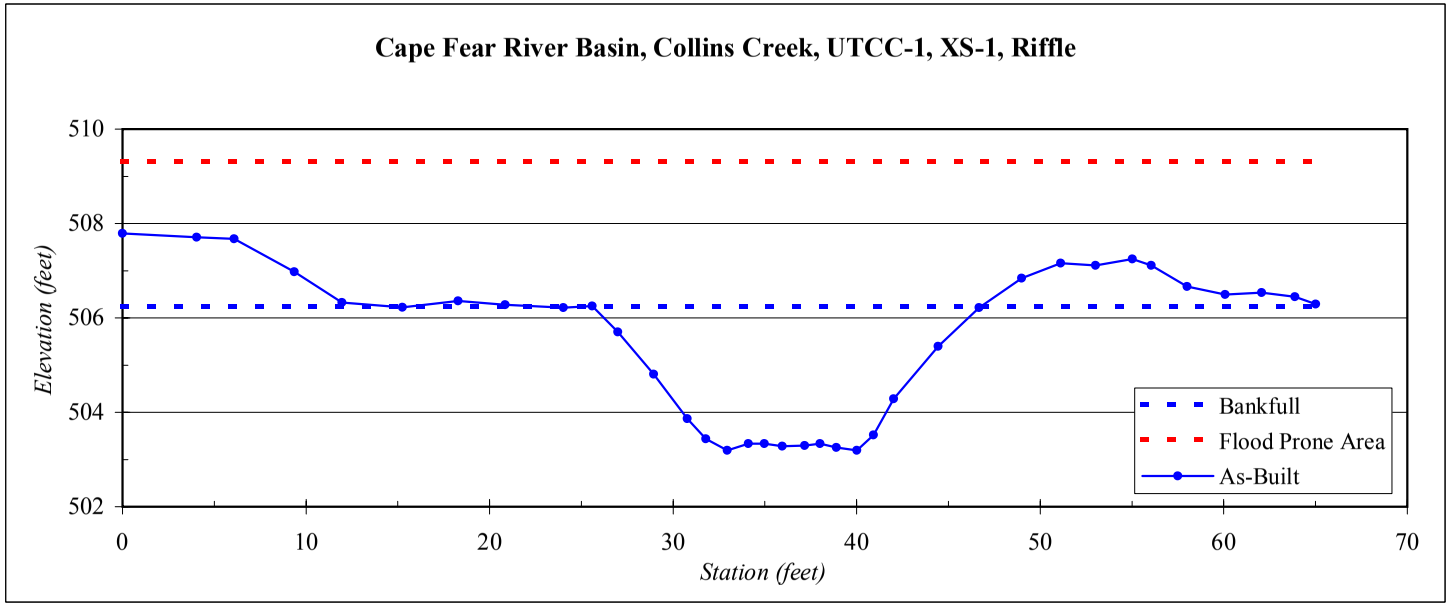
Cross-Section Plots and Pebble Counts

River Basin:	Cape Fear
Watershed:	Collins Creek, UTCC-1
XS ID	XS-1, Riffle
Drainage Area (sq mi):	2.51
Date:	7/2/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	507.79
4.1	507.71
6.1	507.68
9.4	506.98
12.0	506.33
15.3	506.23
18.3	506.36
20.8	506.28
24.0	506.22
25.6	506.25
27.0	505.70
28.9	504.81
30.8	503.87
31.8	503.44
33.0	503.19
34.1	503.33
35.0	503.33
36.0	503.28
38.0	503.34
38.9	503.25
40.0	503.19
40.9	503.52
42.0	504.29
44.4	505.40
46.7	506.22
49.0	506.84
51.1	507.16
53.0	507.11
55.0	507.25
56.1	507.11
58.0	506.66
60.1	506.49
62.1	506.54
63.9	506.45
65.0	506.29

SUMMARY DATA	
Bankfull Elevation:	506.3
Bankfull Cross-Sectional Area:	42.4
Bankfull Width:	21.2
Flood Prone Area Elevation:	509.3
Flood Prone Width:	>65
Max Depth at Bankfull:	3.1
Mean Depth at Bankfull:	2.0
W / D Ratio:	10.6
Entrenchment Ratio:	>3
Bank Height Ratio:	1.0

Stream Type	C4

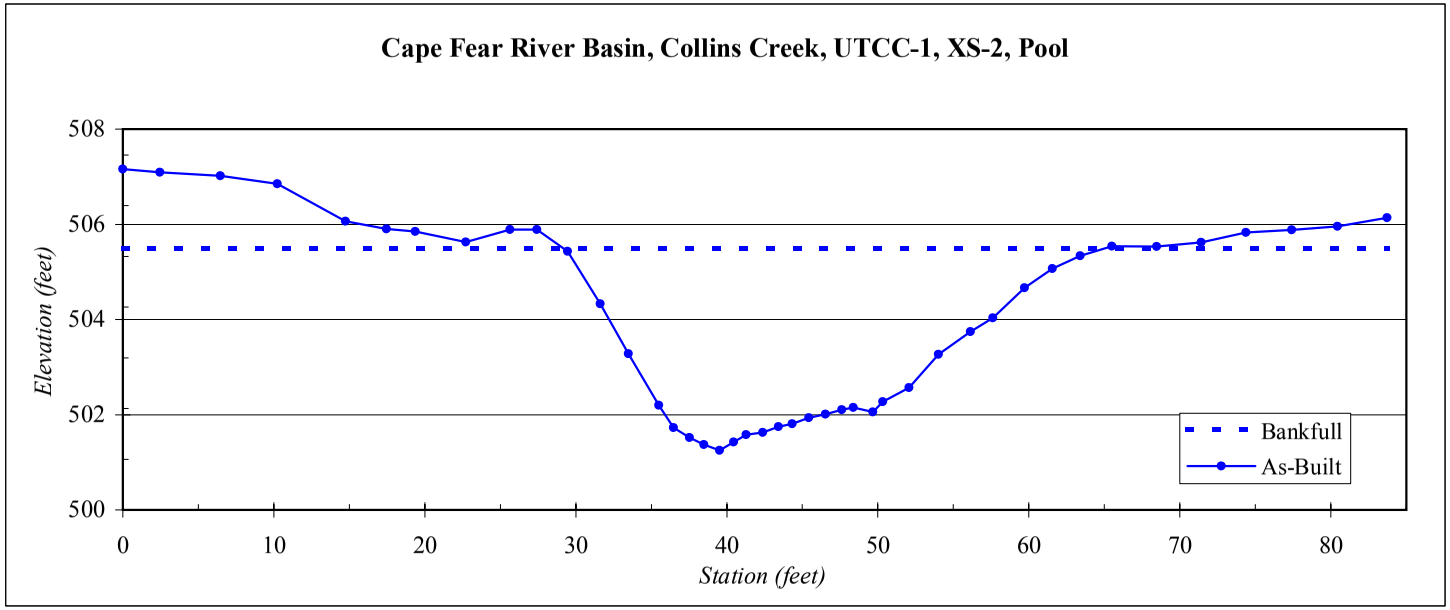


River Basin:	Cape Fear
Watershed:	Collins Creek, UTCC-1
XS ID	XS-2, Pool
Drainage Area (sq mi):	2.51
Date:	7/2/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	507.16
2.5	507.09
6.5	507.02
10.2	506.85
14.7	506.06
17.5	505.90
19.4	505.85
22.7	505.62
25.6	505.89
27.4	505.89
29.5	505.43
31.6	504.33
33.5	503.28
35.5	502.20
36.5	501.73
37.5	501.52
38.5	501.37
39.5	501.25
40.5	501.43
41.3	501.58
42.4	501.62
47.6	502.10
48.4	502.15
50.3	502.27
52.1	502.57
54.0	503.27
56.1	503.75
57.6	504.03
59.7	504.67
61.6	505.07
63.4	505.34
65.5	505.54
68.5	505.53
71.4	505.62
83.7	506.13

SUMMARY DATA	
Bankfull Elevation:	505.5
Bankfull Cross-Sectional Area:	86.7
Bankfull Width:	35.9
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.3
Mean Depth at Bankfull:	2.4
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	C4

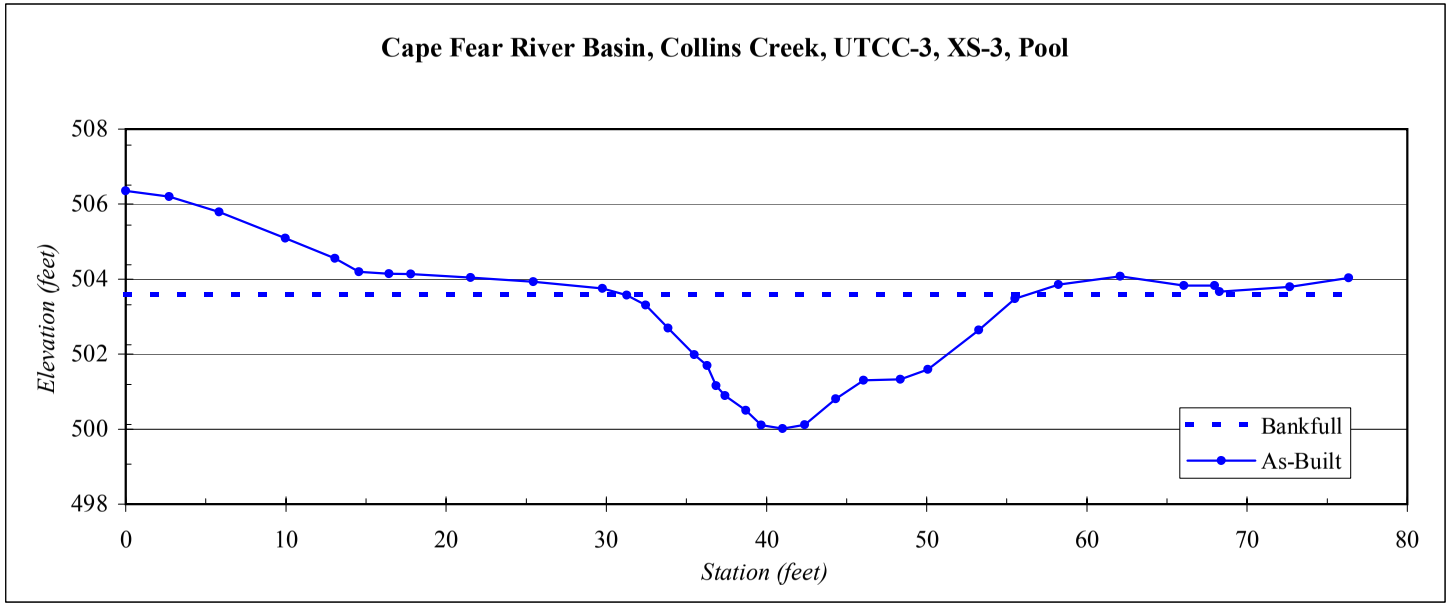


River Basin:	Cape Fear
Watershed:	Collins Creek, UTCC-3
XS ID	XS-3, Pool
Drainage Area (sq mi):	2.62
Date:	7/11/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	506.35
2.7	506.20
5.8	505.79
10.0	505.09
13.1	504.55
14.6	504.20
16.4	504.14
17.8	504.13
21.5	504.04
25.4	503.93
29.8	503.75
31.3	503.57
32.5	503.30
33.9	502.70
35.5	501.99
36.3	501.69
36.9	501.16
37.4	500.89
38.7	500.50
39.7	500.11
41.0	500.01
42.4	500.11
44.3	500.81
46.1	501.30
48.4	501.33
50.1	501.59
53.3	502.64
55.5	503.47
58.2	503.85
62.1	504.08
66.1	503.83
68.0	503.83
68.3	503.67
72.7	503.80
76.3	504.04

SUMMARY DATA	
Bankfull Elevation:	503.6
Bankfull Cross-Sectional Area:	49.1
Bankfull Width:	25.3
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.6
Mean Depth at Bankfull:	1.9
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	C4

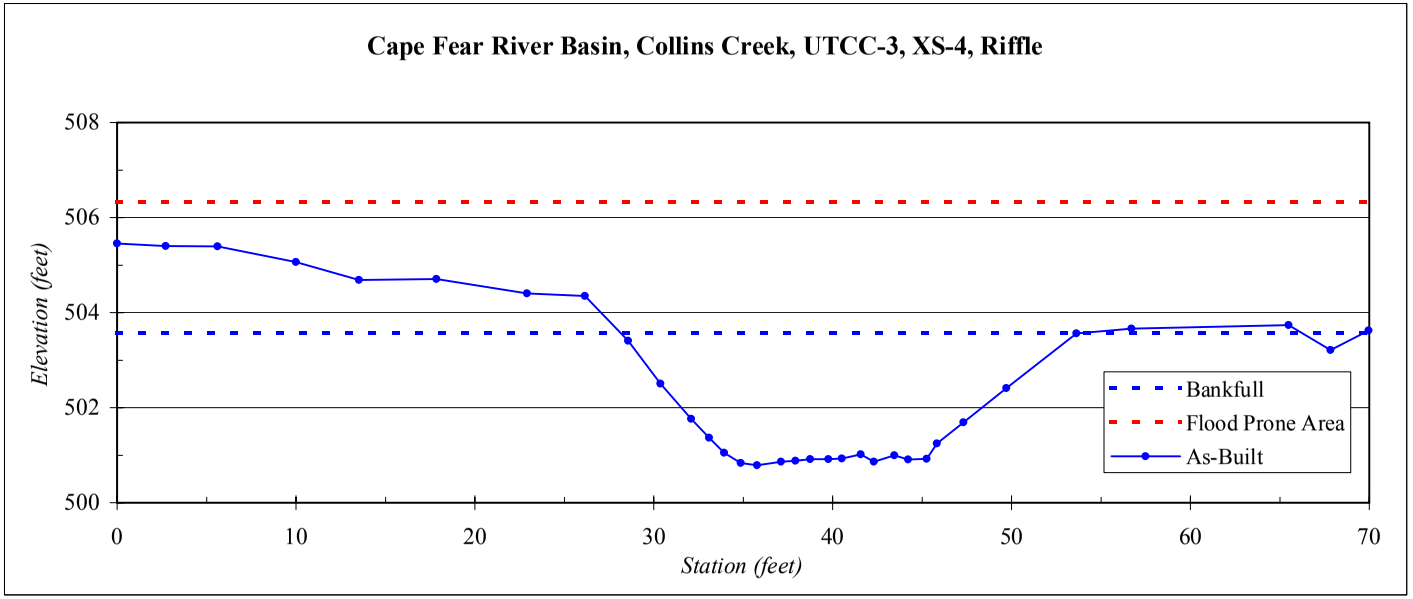


River Basin:	Cape Fear
Watershed:	Collins Creek, UTCC-3
XS ID	XS-4, Riffle
Drainage Area (sq mi):	2.62
Date:	7/11/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	505.45
2.7	505.40
5.6	505.39
10.0	505.07
13.5	504.68
17.9	504.71
22.9	504.40
26.1	504.35
28.6	503.41
30.4	502.50
32.1	501.77
33.1	501.36
33.9	501.05
34.9	500.83
35.8	500.79
37.1	500.86
37.9	500.88
38.7	500.92
39.8	500.91
40.5	500.93
41.6	501.02
42.3	500.86
43.5	501.00
44.2	500.91
45.3	500.92
45.8	501.24
47.3	501.69
49.7	502.41
53.6	503.56
56.7	503.66
65.5	503.73
67.8	503.21
70.0	503.62
73.2	503.61
74.3	503.93
76.0	503.65

SUMMARY DATA	
Bankfull Elevation:	503.6
Bankfull Cross-Sectional Area:	48.0
Bankfull Width:	25.5
Flood Prone Area Elevation:	506.3
Flood Prone Width:	>76
Max Depth at Bankfull:	2.8
Mean Depth at Bankfull:	1.9
W / D Ratio:	13.5
Entrenchment Ratio:	>3
Bank Height Ratio:	1.0

Stream Type	C4

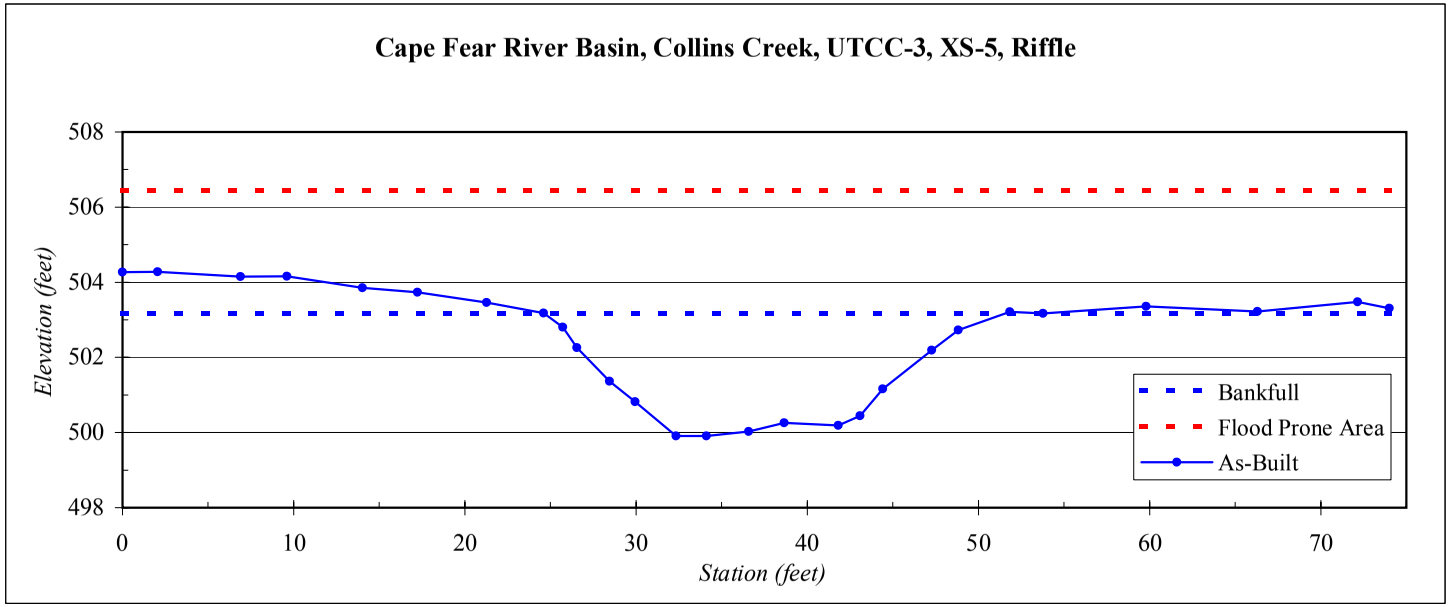


River Basin:	Cape Fear
Watershed:	Collins Creek, UTCC-3
XS ID	XS-5, Riffle
Drainage Area (sq mi):	2.62
Date:	7/11/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	504.27
2.0	504.28
6.9	504.15
9.6	504.16
14.0	503.85
17.2	503.74
21.3	503.46
24.6	503.18
25.7	502.81
26.5	502.26
28.4	501.36
29.9	500.82
32.3	499.91
34.1	499.91
36.6	500.03
38.7	500.26
41.8	500.19
43.1	500.45
44.4	501.16
47.3	502.19
48.8	502.73
51.8	503.21
53.8	503.17
59.8	503.36
66.3	503.22
72.2	503.48
74.0	503.30

SUMMARY DATA	
Bankfull Elevation:	503.2
Bankfull Cross-Sectional Area:	55.5
Bankfull Width:	27.0
Flood Prone Area Elevation:	506.5
Flood Prone Width:	>74
Max Depth at Bankfull:	3.3
Mean Depth at Bankfull:	2.1
W / D Ratio:	13.1
Entrenchment Ratio:	>3
Bank Height Ratio:	1.0

Stream Type	C4

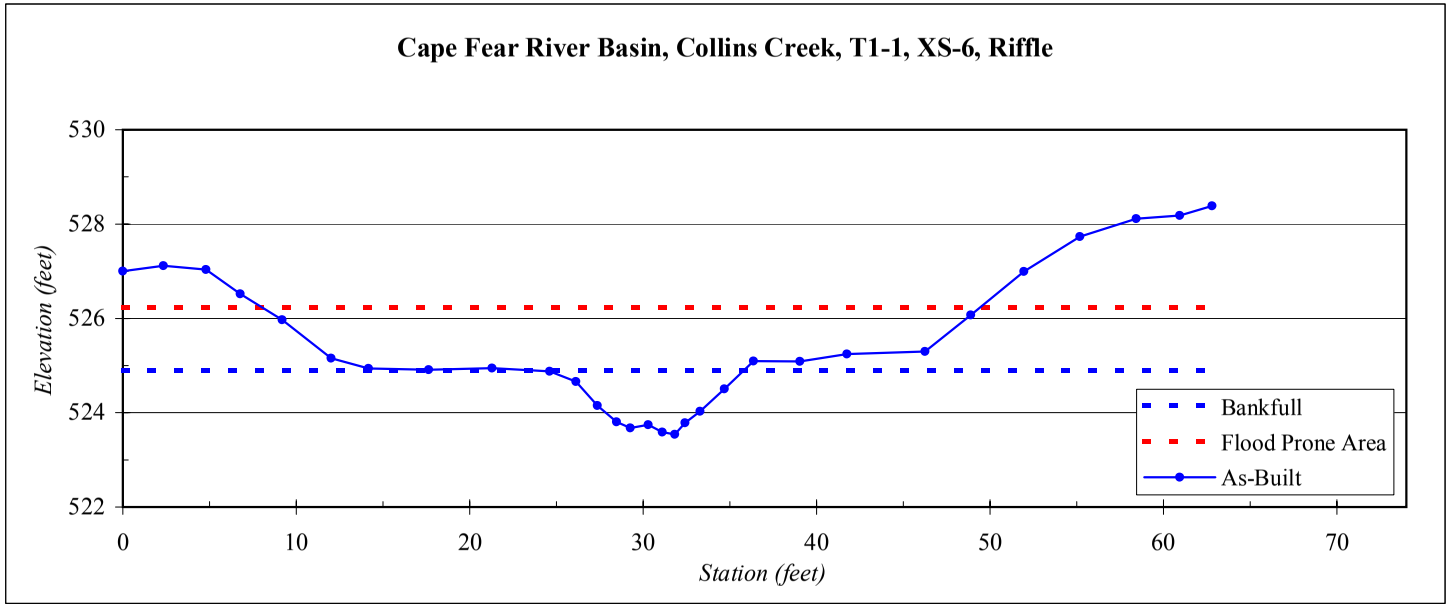


River Basin:	Cape Fear
Watershed:	Collins Creek, T1-1
XS ID	XS-6, Riffle
Drainage Area (sq mi):	0.12
Date:	6/26/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	527.00
2.3	527.11
4.8	527.03
6.8	526.52
9.2	525.97
12.0	525.15
14.2	524.94
17.6	524.91
21.3	524.95
24.6	524.88
26.1	524.66
27.4	524.15
28.5	523.81
29.3	523.67
30.3	523.74
31.1	523.59
31.8	523.54
32.4	523.79
33.3	524.03
34.7	524.50
36.4	525.09
39.0	525.08
41.8	525.25
46.3	525.30
48.9	526.07
51.9	526.99
55.2	527.73
58.4	528.12
60.9	528.18
62.8	528.39

SUMMARY DATA	
Bankfull Elevation:	524.9
Bankfull Cross-Sectional Area:	8.4
Bankfull Width:	11.1
Flood Prone Area Elevation:	526.2
Flood Prone Width:	41
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.8
W / D Ratio:	14.7
Entrenchment Ratio:	3.7
Bank Height Ratio:	1.0

Stream Type	C4

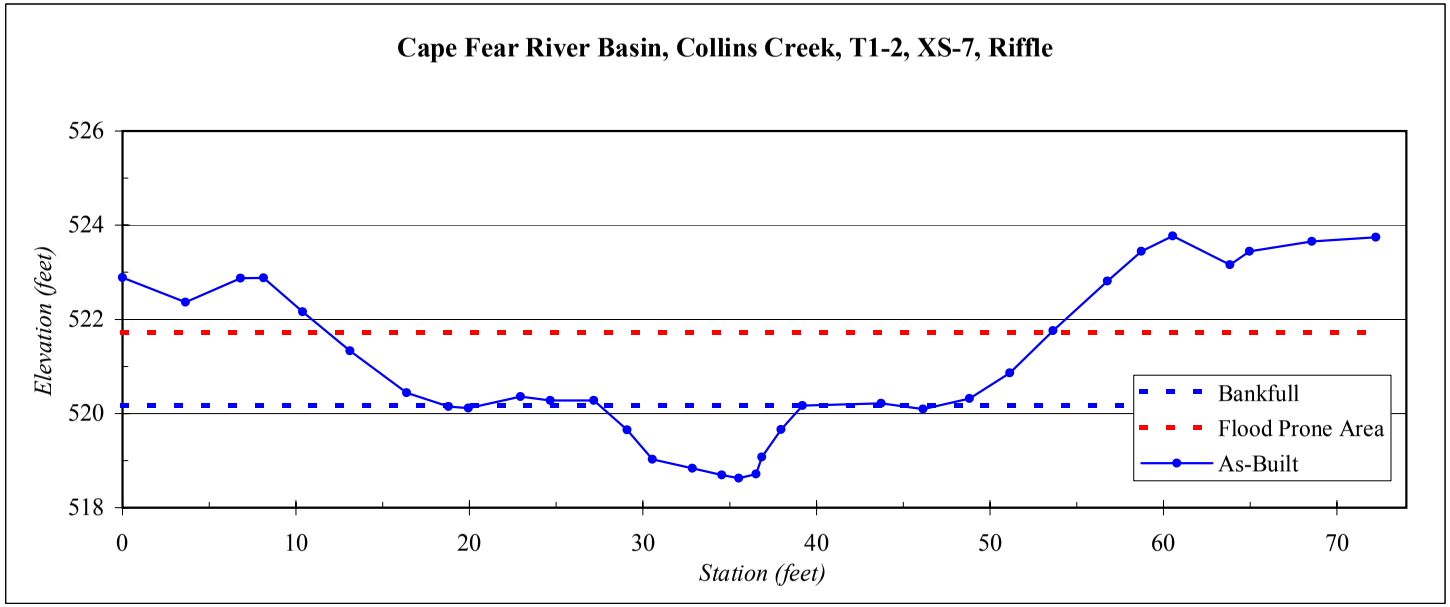


River Basin:	Cape Fear
Watershed:	Collins Creek, T1-2
XS ID	XS-7, Riffle
Drainage Area (sq mi):	0.18
Date:	7/1/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	522.89
3.6	522.37
6.8	522.87
8.1	522.88
10.4	522.16
13.1	521.33
16.4	520.44
18.8	520.15
19.9	520.12
22.9	520.36
24.7	520.28
27.2	520.27
29.1	519.65
30.5	519.03
32.8	518.84
34.6	518.69
35.5	518.63
36.5	518.71
36.9	519.07
38.0	519.66
39.2	520.17
43.7	520.22
46.2	520.10
48.8	520.32
51.1	520.86
53.6	521.76
56.8	522.81
58.7	523.45
60.5	523.77
63.8	523.16
65.0	523.44
68.6	523.65
72.2	523.74

SUMMARY DATA	
Bankfull Elevation:	520.2
Bankfull Cross-Sectional Area:	11.5
Bankfull Width:	11.7
Flood Prone Area Elevation:	521.7
Flood Prone Width:	42
Max Depth at Bankfull:	1.5
Mean Depth at Bankfull:	1.0
W / D Ratio:	11.9
Entrenchment Ratio:	3.6
Bank Height Ratio:	1.0

Stream Type	C4

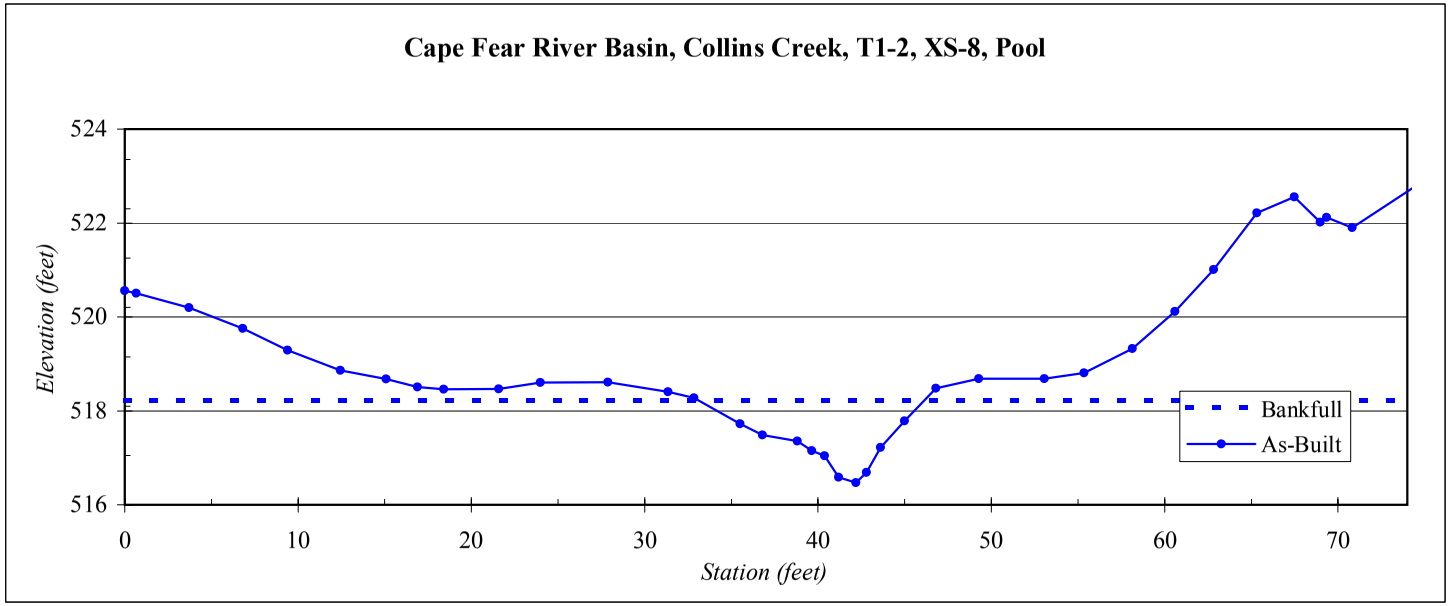


River Basin:	Cape Fear
Watershed:	Collins Creek, T1-2
XS ID	XS-8, Pool
Drainage Area (sq mi):	0.18
Date:	6/30/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	520.56
0.7	520.51
3.7	520.20
6.8	519.75
9.4	519.29
12.5	518.86
15.1	518.68
16.9	518.51
18.4	518.46
21.6	518.47
24.0	518.61
27.9	518.61
31.4	518.40
32.9	518.27
35.5	517.72
36.8	517.48
38.8	517.35
39.6	517.15
40.4	517.04
41.2	516.59
42.2	516.47
42.8	516.69
43.6	517.22
45.0	517.79
46.8	518.48
49.3	518.68
53.1	518.68
55.4	518.81
58.1	519.33
60.6	520.12
69.0	521.01
69.3	522.21
70.8	522.55
74.4	522.02
74.9	522.12

SUMMARY DATA	
Bankfull Elevation:	518.2
Bankfull Cross-Sectional Area:	10.9
Bankfull Width:	13.1
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	1.8
Mean Depth at Bankfull:	0.8
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	C4

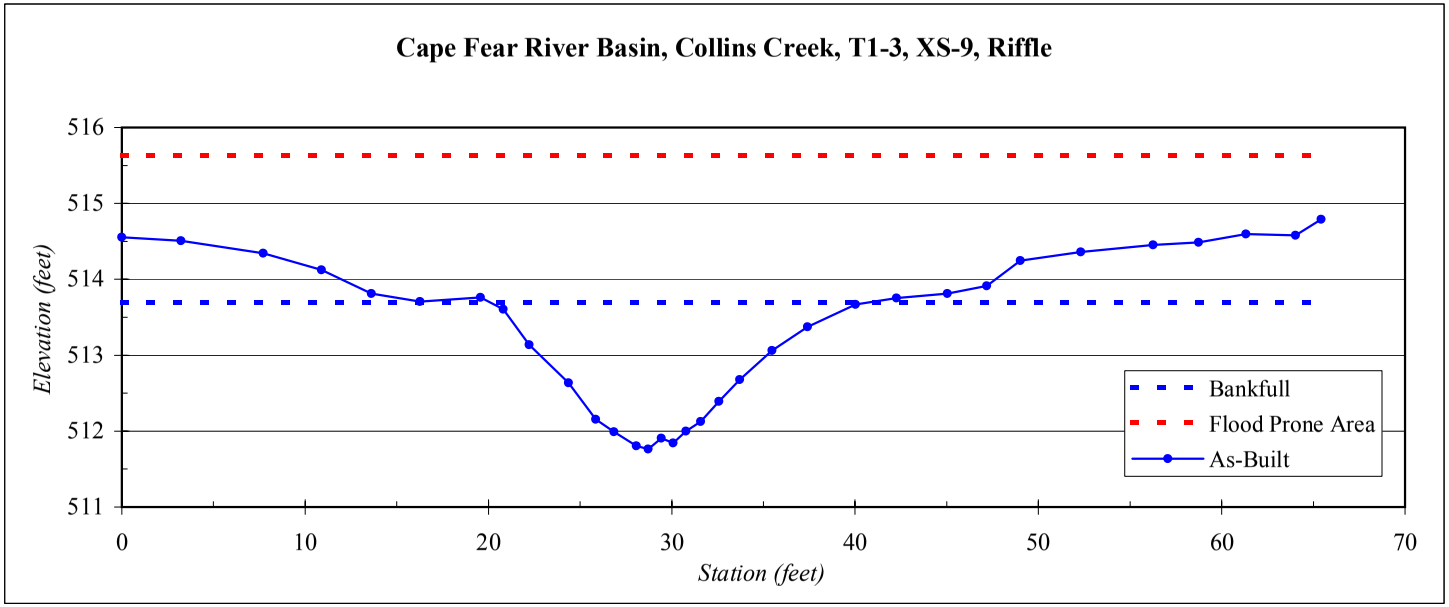


River Basin:	Cape Fear
Watershed:	Collins Creek, T1-3
XS ID	XS-9, Riffle
Drainage Area (sq mi):	0.49
Date:	7/1/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	514.56
3.2	514.51
7.7	514.34
10.9	514.12
13.6	513.81
16.3	513.71
19.6	513.76
20.8	513.60
22.2	513.14
24.4	512.63
25.9	512.15
26.8	511.99
28.1	511.80
28.7	511.76
29.4	511.91
30.1	511.84
30.8	512.00
31.6	512.13
32.6	512.39
33.7	512.68
35.5	513.06
37.4	513.37
40.0	513.67
42.3	513.75
45.0	513.81
47.2	513.91
49.0	514.24
52.3	514.36
56.3	514.45
58.7	514.49
61.3	514.60
64.0	514.58
65.4	514.79

SUMMARY DATA	
Bankfull Elevation:	513.7
Bankfull Cross-Sectional Area:	20.0
Bankfull Width:	20.8
Flood Prone Area Elevation:	515.6
Flood Prone Width:	>65
Max Depth at Bankfull:	1.9
Mean Depth at Bankfull:	1.0
W / D Ratio:	21.6
Entrenchment Ratio:	>3
Bank Height Ratio:	1.0

Stream Type	C4

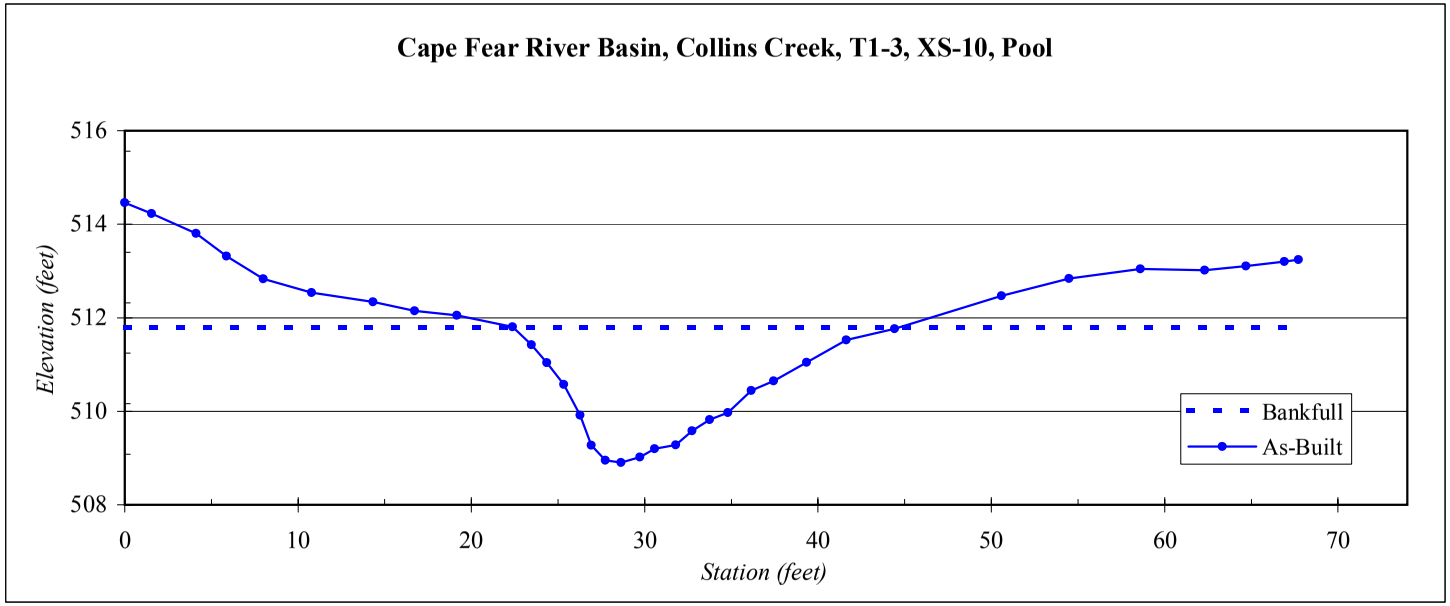


River Basin:	Cape Fear
Watershed:	Collins Creek, T1-3
XS ID	XS-10, Pool
Drainage Area (sq mi):	0.49
Date:	7/1/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	514.46
1.5	514.23
4.1	513.80
5.9	513.32
8.0	512.83
10.8	512.54
14.3	512.34
16.7	512.15
19.2	512.05
22.4	511.80
23.5	511.42
24.3	511.04
25.3	510.57
26.3	509.92
26.9	509.27
27.7	508.95
28.6	508.90
29.7	509.02
30.6	509.20
31.8	509.28
32.7	509.58
33.7	509.82
34.8	509.97
36.2	510.44
37.4	510.65
39.3	511.05
41.6	511.52
44.4	511.77
50.6	512.47
54.5	512.84
58.6	513.04
62.3	513.01
64.7	513.11
66.9	513.20
67.7	513.24

SUMMARY DATA	
Bankfull Elevation:	511.8
Bankfull Cross-Sectional Area:	31.4
Bankfull Width:	22.3
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.9
Mean Depth at Bankfull:	1.4
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	C4

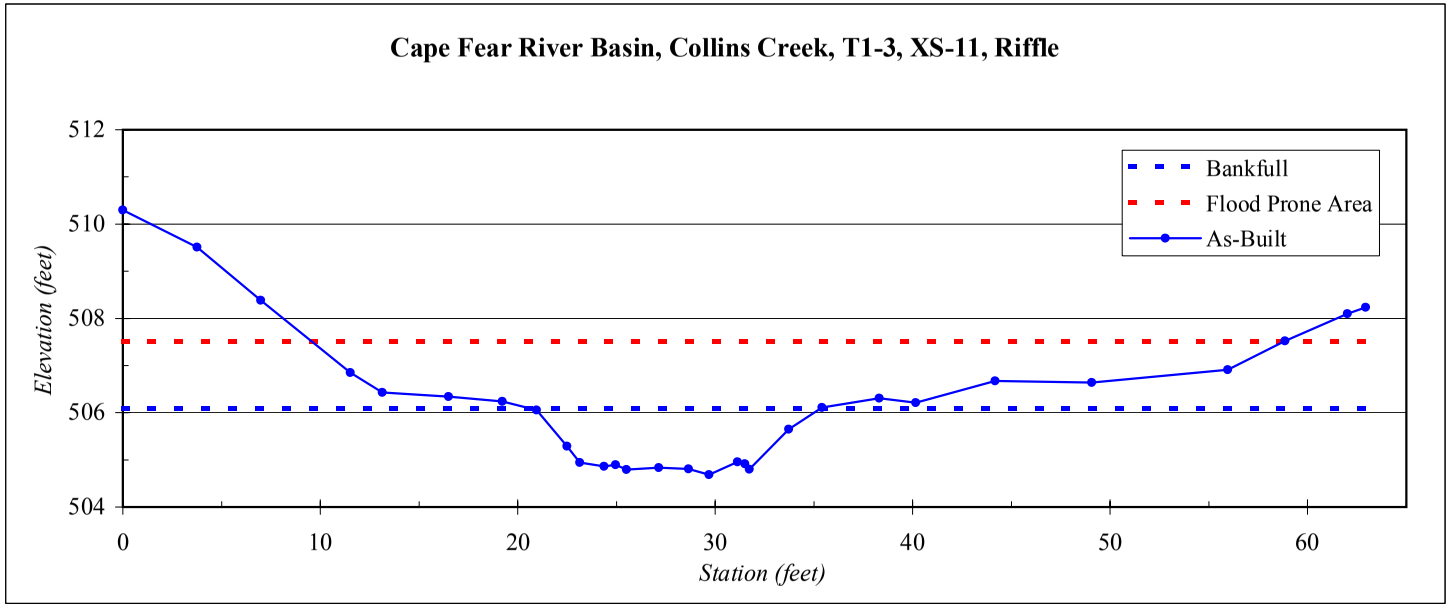


River Basin:	Cape Fear
Watershed:	Collins Creek, T1-3
XS ID	XS-11, Riffle
Drainage Area (sq mi):	0.49
Date:	7/1/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	510.29
3.8	509.51
7.0	508.39
11.5	506.85
13.1	506.43
16.5	506.34
19.2	506.24
20.9	506.05
22.5	505.29
23.1	504.94
24.4	504.86
25.0	504.90
25.5	504.80
27.1	504.84
28.6	504.81
29.7	504.69
31.1	504.96
31.5	504.92
31.7	504.80
33.7	505.65
35.4	506.11
38.3	506.31
40.2	506.21
44.2	506.67
49.1	506.64
56.0	506.91
58.9	507.52
62.0	508.10
62.9	508.23

SUMMARY DATA	
Bankfull Elevation:	506.1
Bankfull Cross-Sectional Area:	14.3
Bankfull Width:	14.8
Flood Prone Area Elevation:	507.5
Flood Prone Width:	49
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	1.0
W / D Ratio:	15.3
Entrenchment Ratio:	3.3
Bank Height Ratio:	1.0

Stream Type	C4

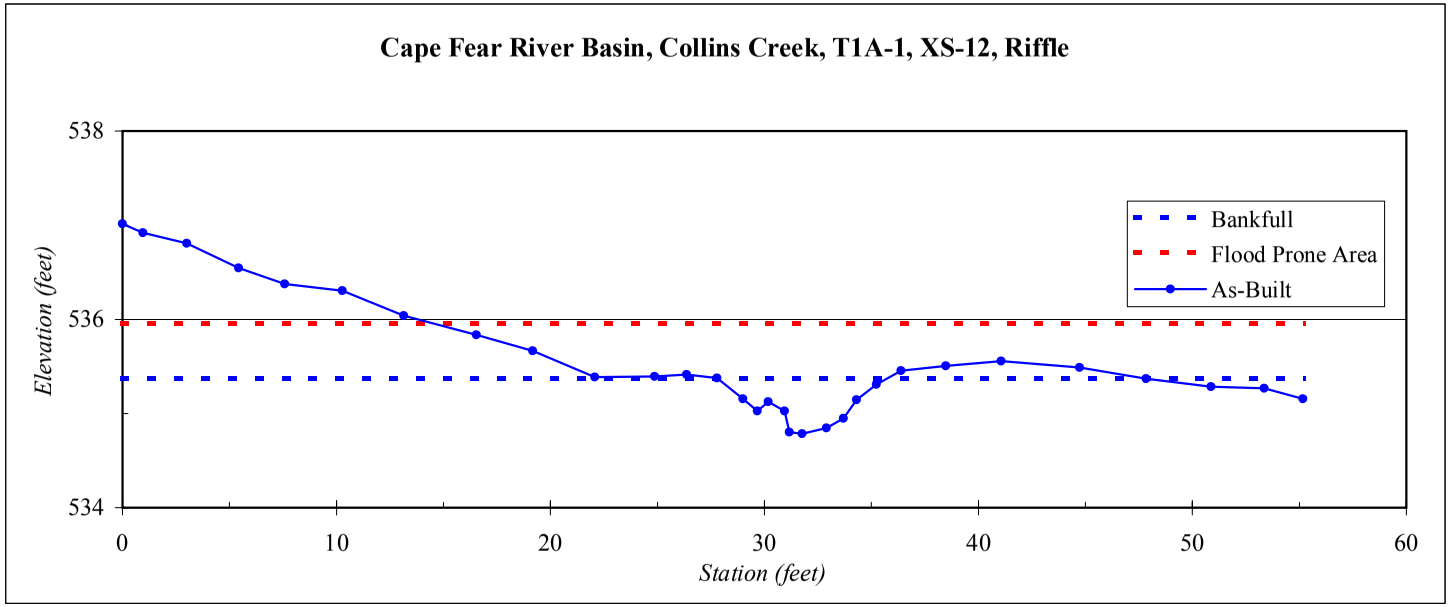


River Basin:	Cape Fear
Watershed:	Collins Creek, T1A-1
XS ID	XS-12, Riffle
Drainage Area (sq mi):	0.04
Date:	6/26/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	537.01
1.0	536.92
3.0	536.81
5.4	536.54
7.6	536.37
10.3	536.30
13.1	536.04
16.5	535.84
19.2	535.66
22.1	535.39
24.9	535.39
26.4	535.41
27.8	535.38
29.0	535.15
29.7	535.03
30.2	535.12
30.9	535.03
31.2	534.80
31.8	534.79
32.9	534.85
33.7	534.95
34.3	535.14
35.2	535.31
36.4	535.45
38.5	535.51
41.1	535.56
44.7	535.49
47.8	535.37
50.9	535.28
53.4	535.27
55.2	535.15

SUMMARY DATA	
Bankfull Elevation:	535.4
Bankfull Cross-Sectional Area:	2.5
Bankfull Width:	7.9
Flood Prone Area Elevation:	536.0
Flood Prone Width:	>40
Max Depth at Bankfull:	0.6
Mean Depth at Bankfull:	0.3
W / D Ratio:	25.0
Entrenchment Ratio:	>5
Bank Height Ratio:	1.0

Stream Type	C4

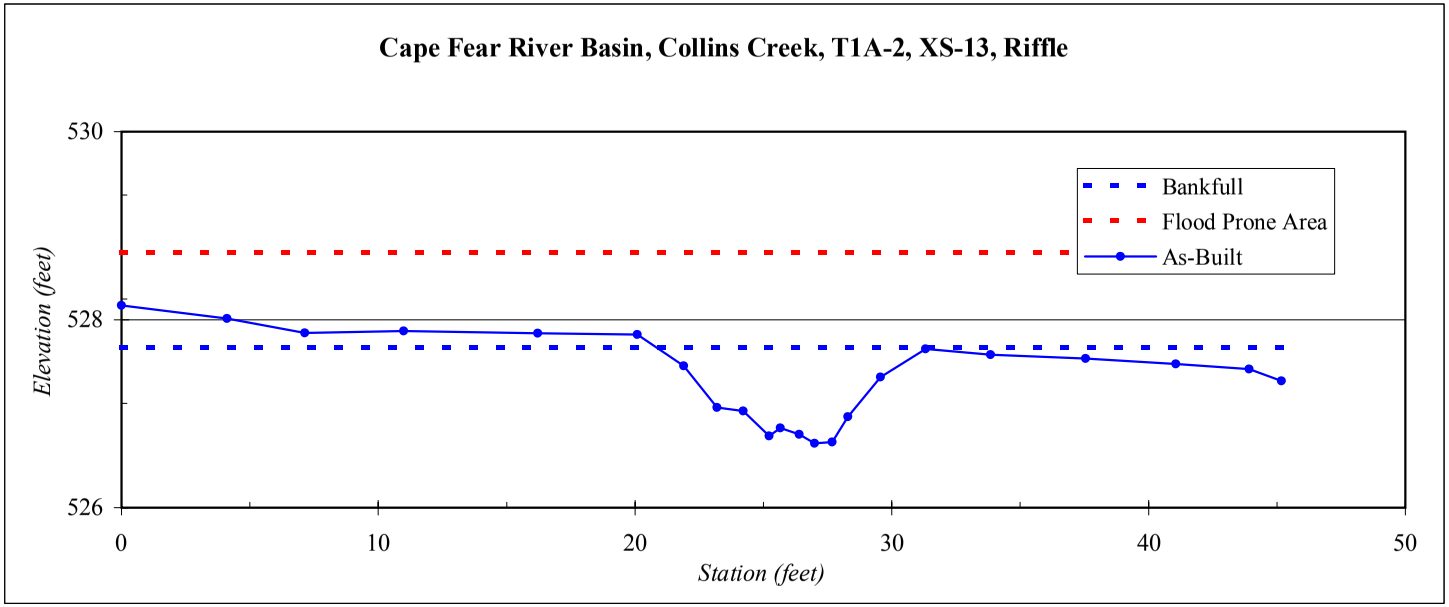


River Basin:	Cape Fear
Watershed:	Collins Creek, T1A-2
XS ID	XS-13, Riffle
Drainage Area (sq mi):	0.05
Date:	6/26/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	528.15
4.1	528.01
7.1	527.86
11.0	527.88
16.2	527.86
20.1	527.84
21.9	527.51
23.2	527.06
24.2	527.03
25.2	526.76
25.7	526.85
26.4	526.78
27.0	526.68
27.7	526.70
28.3	526.97
29.6	527.39
31.3	527.69
33.8	527.63
37.5	527.59
41.1	527.53
43.9	527.47
45.2	527.35

SUMMARY DATA	
Bankfull Elevation:	527.7
Bankfull Cross-Sectional Area:	5.2
Bankfull Width:	9.7
Flood Prone Area Elevation:	528.7
Flood Prone Width:	>40
Max Depth at Bankfull:	1.0
Mean Depth at Bankfull:	0.5
W / D Ratio:	18.1
Entrenchment Ratio:	>4
Bank Height Ratio:	1.0

Stream Type	C4

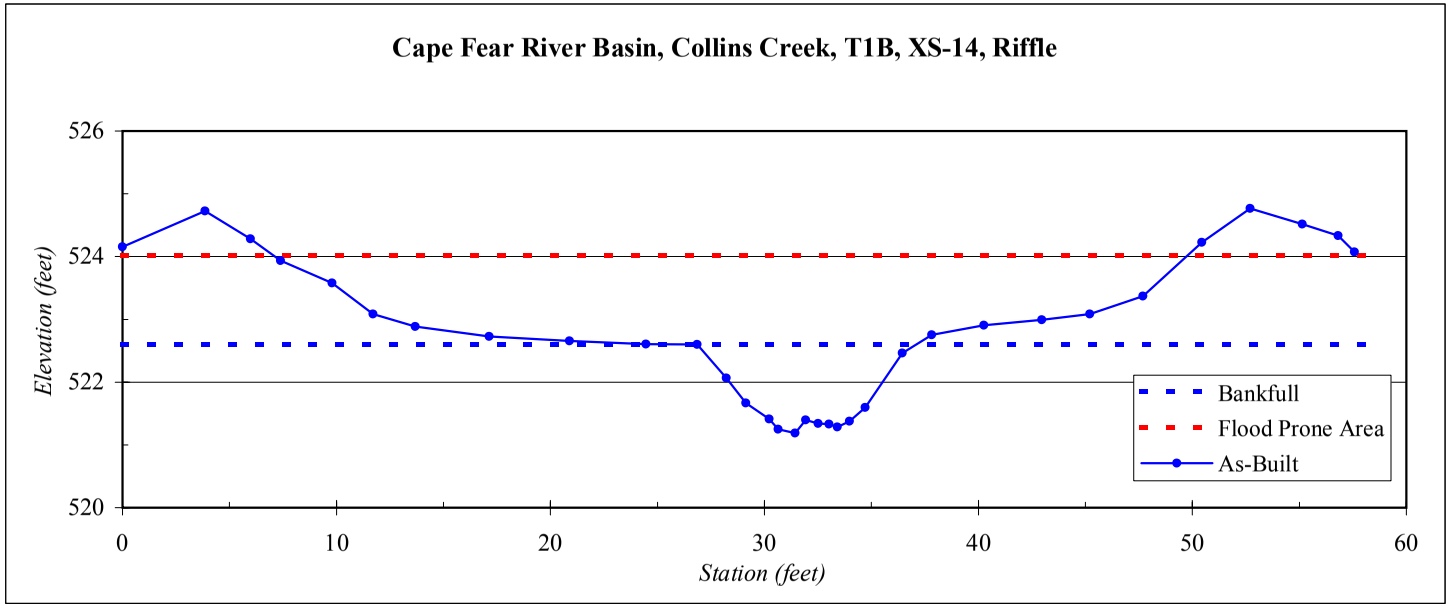


River Basin:	Cape Fear
Watershed:	Collins Creek, T1B
XS ID	XS-14, Riffle
Drainage Area (sq mi):	0.24
Date:	6/30/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	524.16
3.9	524.72
6.0	524.28
7.4	523.93
9.8	523.58
11.7	523.08
13.7	522.88
17.1	522.73
20.9	522.65
24.5	522.60
26.9	522.60
28.2	522.07
29.1	521.67
30.2	521.41
30.6	521.25
31.4	521.19
31.9	521.40
32.5	521.34
33.0	521.33
33.4	521.28
34.0	521.38
34.7	521.60
36.4	522.46
37.8	522.75
40.3	522.91
43.0	522.99
45.2	523.09
47.7	523.37
50.4	524.22
52.7	524.77
55.1	524.51
56.8	524.33
57.6	524.07
58.2	524.01

SUMMARY DATA	
Bankfull Elevation:	522.6
Bankfull Cross-Sectional Area:	8.4
Bankfull Width:	11.1
Flood Prone Area Elevation:	524.0
Flood Prone Width:	43
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	0.8
W / D Ratio:	14.7
Entrenchment Ratio:	3.8
Bank Height Ratio:	1.0

Stream Type	C4

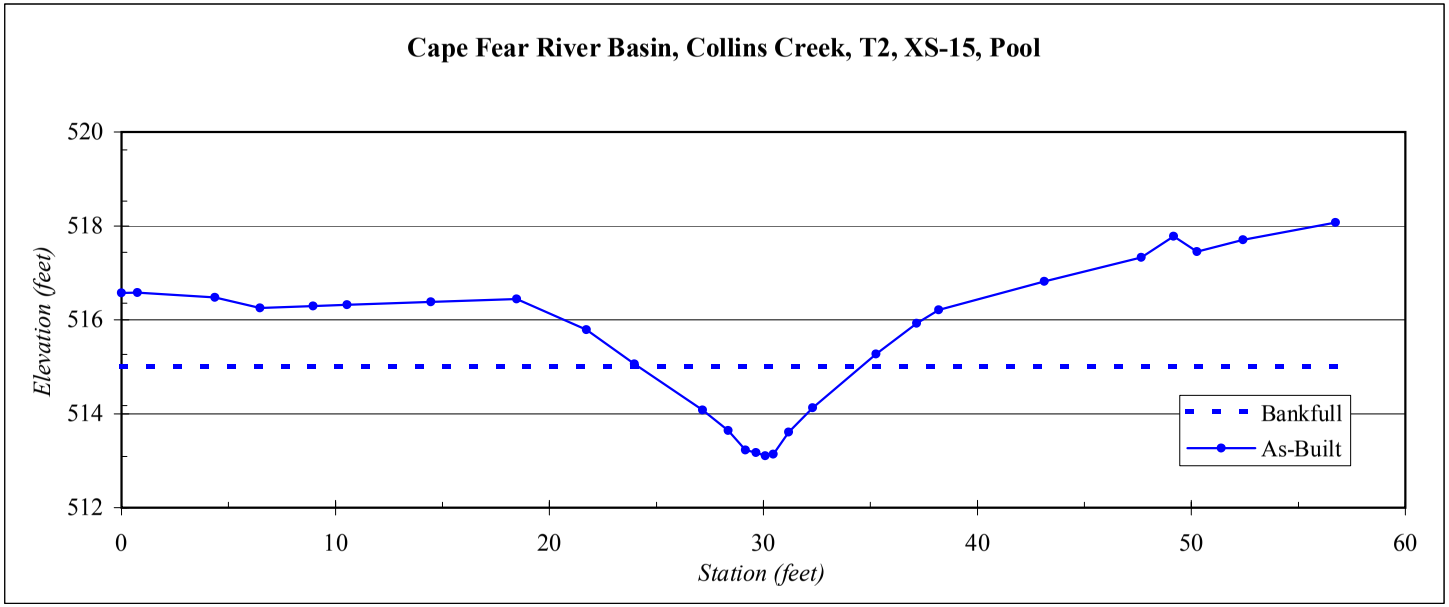


River Basin:	Cape Fear
Watershed:	Collins Creek, T2
XS ID	XS-15, Pool
Drainage Area (sq mi):	0.07
Date:	7/11/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	516.57
0.7	516.58
4.4	516.47
6.5	516.25
9.0	516.29
10.5	516.32
14.5	516.38
18.5	516.44
21.7	515.79
24.0	515.06
27.2	514.08
28.3	513.65
29.2	513.22
29.7	513.17
30.1	513.10
30.5	513.14
31.2	513.61
32.3	514.12
35.3	515.27
37.2	515.93
38.2	516.21
43.1	516.82
47.7	517.33
49.2	517.78
50.3	517.45
52.4	517.71
56.7	518.07

SUMMARY DATA	
Bankfull Elevation:	515.0
Bankfull Cross-Sectional Area:	9.8
Bankfull Width:	10.4
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	1.9
Mean Depth at Bankfull:	0.9
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	B4c

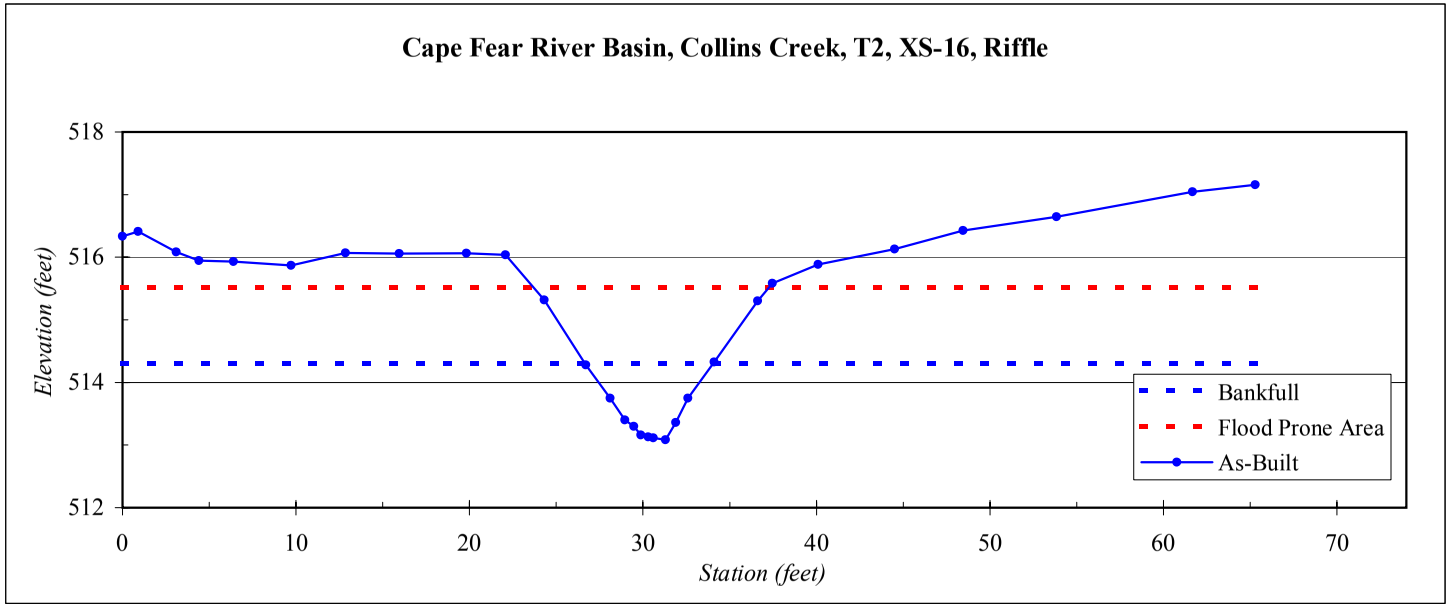


River Basin:	Cape Fear
Watershed:	Collins Creek, T2
XS ID	XS-16, Riffle
Drainage Area (sq mi):	0.07
Date:	7/11/2008
Field Crew:	B. Roberts and K. Vaughan

Station	Elevation
0.0	516.33
0.9	516.41
3.1	516.08
4.4	515.94
6.4	515.93
9.7	515.87
12.9	516.07
15.9	516.06
19.8	516.06
22.1	516.04
24.3	515.32
26.7	514.28
28.1	513.75
29.0	513.40
29.5	513.30
29.9	513.16
30.3	513.13
30.6	513.11
31.3	513.09
31.9	513.36
32.6	513.75
34.1	514.32
36.6	515.30
37.5	515.58
40.1	515.89
44.5	516.13
48.5	516.42
53.8	516.65
61.7	517.04
65.3	517.16

SUMMARY DATA	
Bankfull Elevation:	514.3
Bankfull Cross-Sectional Area:	5.2
Bankfull Width:	7.4
Flood Prone Area Elevation:	515.5
Flood Prone Width:	14
Max Depth at Bankfull:	1.2
Mean Depth at Bankfull:	0.7
W / D Ratio:	10.5
Entrenchment Ratio:	1.8
Bank Height Ratio:	1.0

Stream Type	B4c



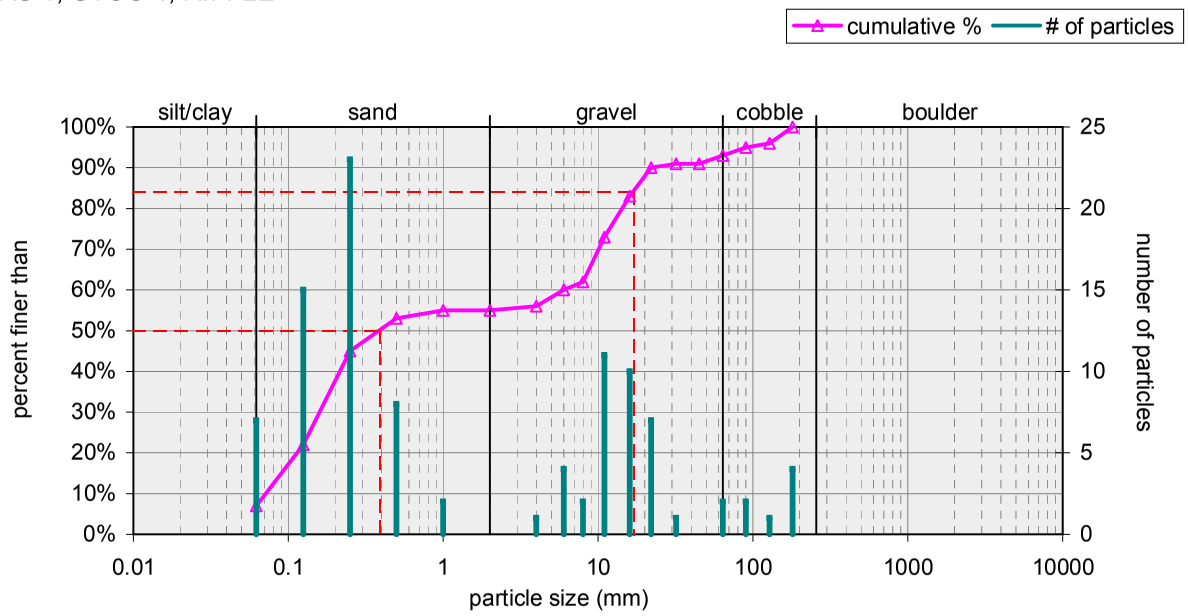
Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**7**
very fine sand	0.062 - 0.125	**15**
fine sand	0.125 - 0.25	**23**
medium sand	0.25 - 0.5	**8**
coarse sand	0.5 - 1	**2**
very coarse sand	1 - 2	
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**11**
medium gravel	11 - 16	**10**
coarse gravel	16 - 22	**7**
coarse gravel	22 - 32	**1**
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	**2**
small cobble	64 - 90	**2**
medium cobble	90 - 128	**1**
large cobble	128 - 180	**4**
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	100

Note:

XS 1, UTCC-1, RIFFLE



Size (mm)	
D16	0.094
D35	0.18
D50	0.39
D65	8.7
D84	17
D95	90

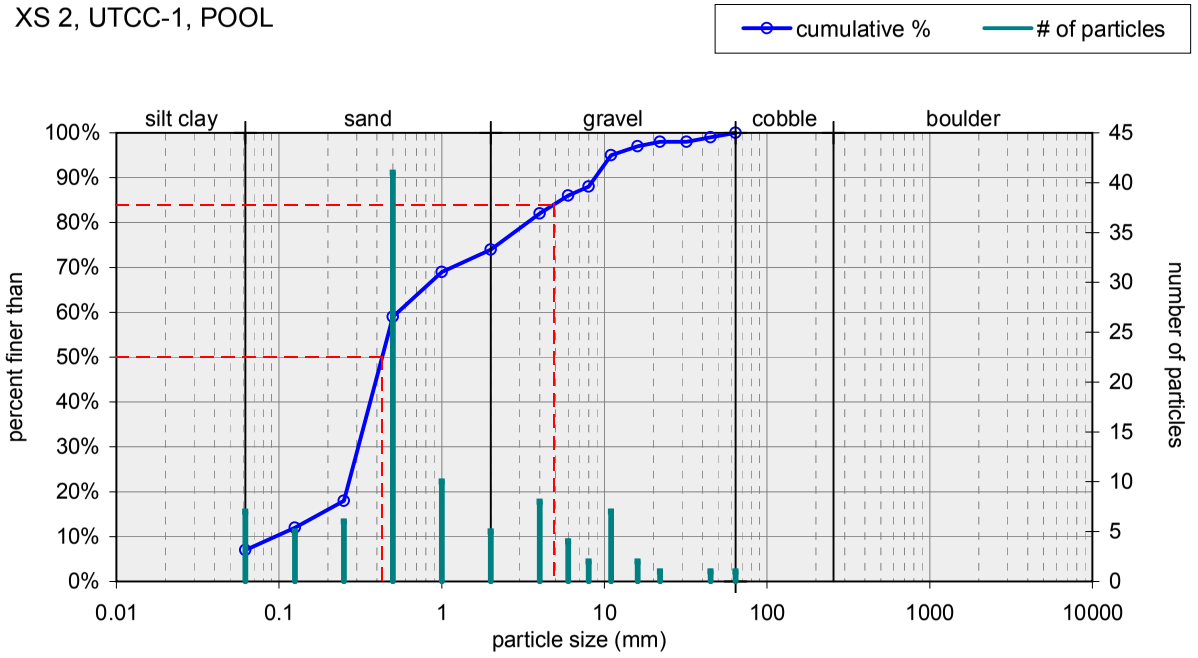
Size Distribution	
mean	1.3
dispersion	23.9
skewness	0.34

Type	
silt/clay	7%
sand	48%
gravel	38%
cobble	7%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**7**
very fine sand	0.062 - 0.125	**5**
fine sand	0.125 - 0.25	**6**
medium sand	0.25 - 0.5	**41**
coarse sand	0.5 - 1	**10**
very coarse sand	1 - 2	**5**
very fine gravel	2 - 4	**8**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**7**
medium gravel	11 - 16	**2**
coarse gravel	16 - 22	**1**
coarse gravel	22 - 32	
very coarse gravel	32 - 45	**1**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock		**3**
clay hardpan		
detritus/wood		
artificial		
total count:		103

Note:



Size (mm)	
D16	0.2
D35	0.33
D50	0.43
D65	0.76
D84	4.9
D95	11

Size Distribution	
mean	1.0
dispersion	6.8
skewness	0.31

Type			
silt/clay	7%	bedrock	3%
sand	65%		
gravel	25%		
cobble	0%		
boulder	0%		

Pool

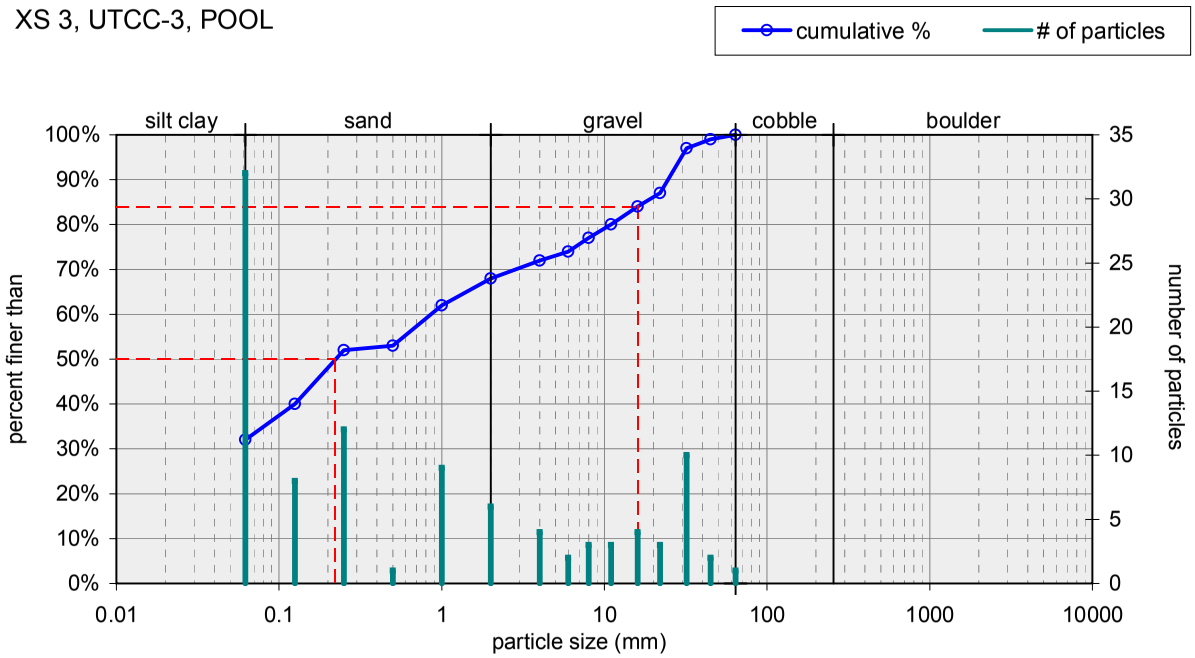
Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**32**
very fine sand	0.062 - 0.125	**8**
fine sand	0.125 - 0.25	**12**
medium sand	0.25 - 0.5	**1**
coarse sand	0.5 - 1	**9**
very coarse sand	1 - 2	**6**
very fine gravel	2 - 4	**4**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**3**
medium gravel	8 - 11	**3**
medium gravel	11 - 16	**4**
coarse gravel	16 - 22	**3**
coarse gravel	22 - 32	**10**
very coarse gravel	32 - 45	**2**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 4096	
very large boulder	2048 - 4096	

total particle count: 100

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	

total count: 100

Note:



Size (mm)	
D16	0.062
D35	0.081
D50	0.22
D65	1.4
D84	16
D95	30

Size Distribution	
mean	1.0
dispersion	38.1
skewness	0.42

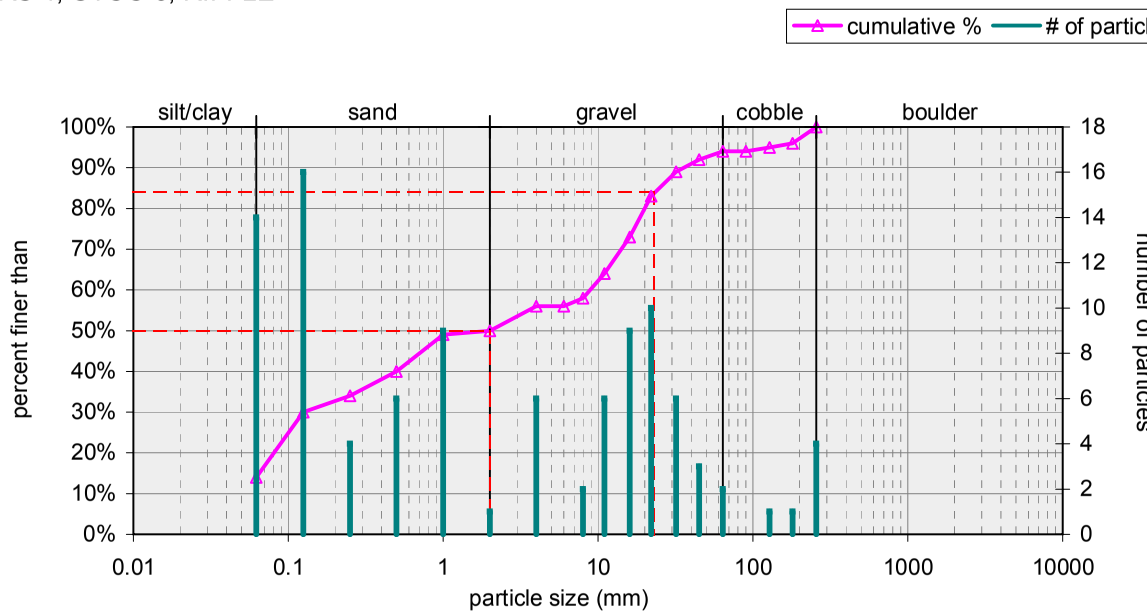
Type	
silt/clay	32%
sand	36%
gravel	32%
cobble	0%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**14**
very fine sand	0.062 - 0.125	**16**
fine sand	0.125 - 0.25	**4**
medium sand	0.25 - 0.5	**6**
coarse sand	0.5 - 1	**9**
very coarse sand	1 - 2	**1**
very fine gravel	2 - 4	**6**
fine gravel	4 - 6	
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**6**
medium gravel	11 - 16	**9**
coarse gravel	16 - 22	**10**
coarse gravel	22 - 32	**6**
very coarse gravel	32 - 45	**3**
very coarse gravel	45 - 64	**2**
small cobble	64 - 90	
medium cobble	90 - 128	**1**
large cobble	128 - 180	**1**
very large cobble	180 - 256	**4**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	100

Note:



Size (mm)	
D16	0.068
D35	0.28
D50	2
D65	11
D84	23
D95	130

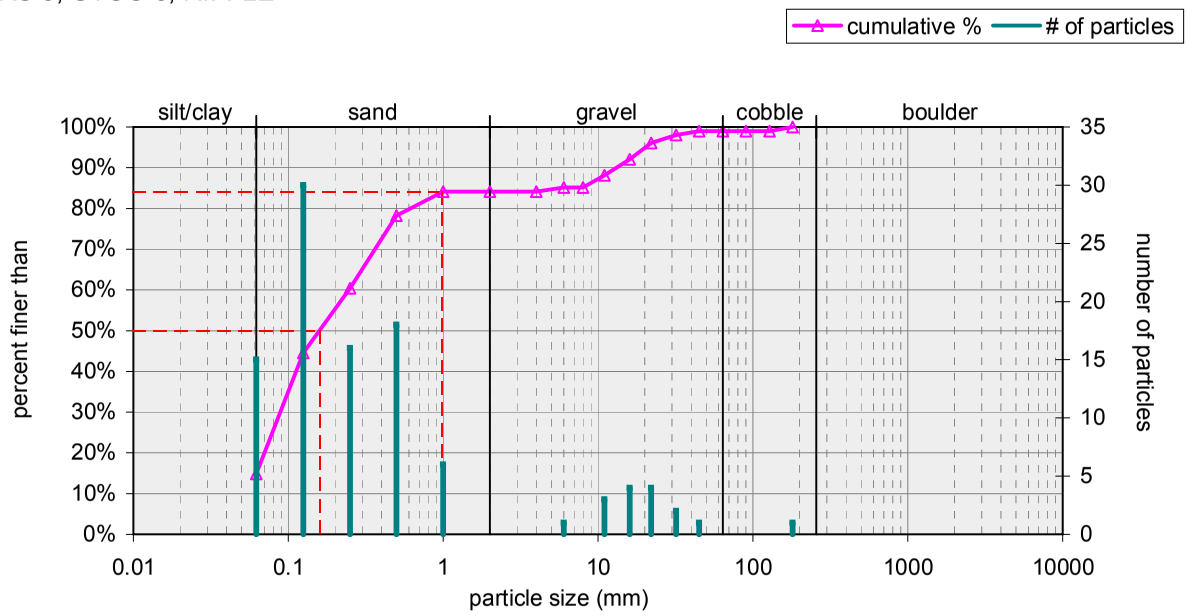
Size Distribution	
mean	1.3
dispersion	20.5
skewness	-0.13

Type	
silt/clay	14%
sand	36%
gravel	44%
cobble	6%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**15**
very fine sand	0.062 - 0.125	**30**
fine sand	0.125 - 0.25	**16**
medium sand	0.25 - 0.5	**18**
coarse sand	0.5 - 1	**6**
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	**1**
fine gravel	6 - 8	
medium gravel	8 - 11	**3**
medium gravel	11 - 16	**4**
coarse gravel	16 - 22	**4**
coarse gravel	22 - 32	**2**
very coarse gravel	32 - 45	**1**
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	**1**
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		101
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		101

Note:



Size (mm)	
D16	0.064
D35	0.1
D50	0.16
D65	0.3
D84	0.98
D95	20

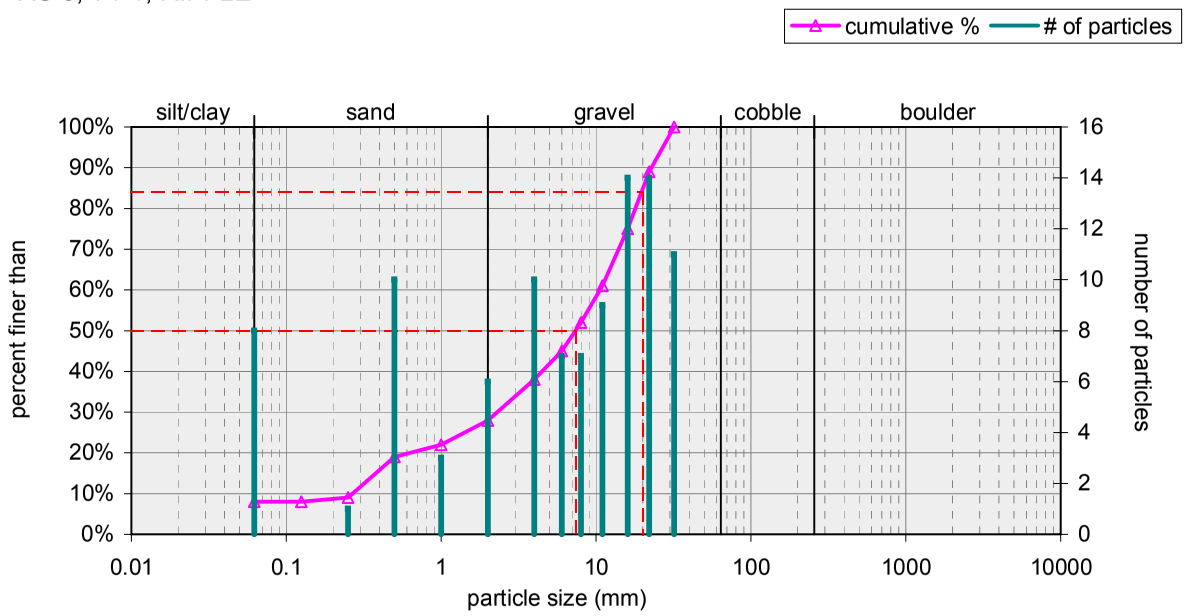
Size Distribution	
mean	0.3
dispersion	4.3
skewness	0.18

Type	
silt/clay	15%
sand	69%
gravel	15%
cobble	1%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**8**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**1**
medium sand	0.25 - 0.5	**10**
coarse sand	0.5 - 1	**3**
very coarse sand	1 - 2	**6**
very fine gravel	2 - 4	**10**
fine gravel	4 - 6	**7**
fine gravel	6 - 8	**7**
medium gravel	8 - 11	**9**
medium gravel	11 - 16	**14**
coarse gravel	16 - 22	**14**
coarse gravel	22 - 32	**11**
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:



Size (mm)	
D16	0.41
D35	3.2
D50	7.4
D65	12
D84	20
D95	27

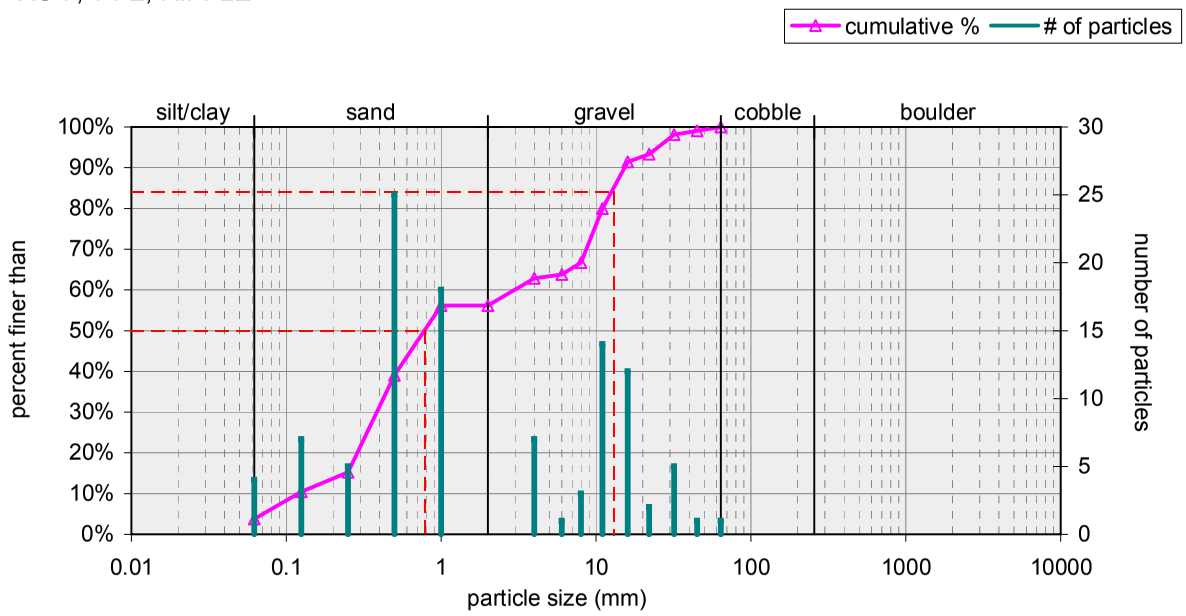
Size Distribution	
mean	2.9
dispersion	10.4
skewness	-0.32

Type	
silt/clay	8%
sand	20%
gravel	72%
cobble	0%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**4**
very fine sand	0.062 - 0.125	**7**
fine sand	0.125 - 0.25	**5**
medium sand	0.25 - 0.5	**25**
coarse sand	0.5 - 1	**18**
very coarse sand	1 - 2	
very fine gravel	2 - 4	**7**
fine gravel	4 - 6	**1**
fine gravel	6 - 8	**3**
medium gravel	8 - 11	**14**
medium gravel	11 - 16	**12**
coarse gravel	16 - 22	**2**
coarse gravel	22 - 32	**5**
very coarse gravel	32 - 45	**1**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		105
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		105

Note:



Size (mm)	
D16	0.26
D35	0.44
D50	0.78
D65	6.8
D84	13
D95	25

Size Distribution	
mean	1.8
dispersion	9.8
skewness	0.29

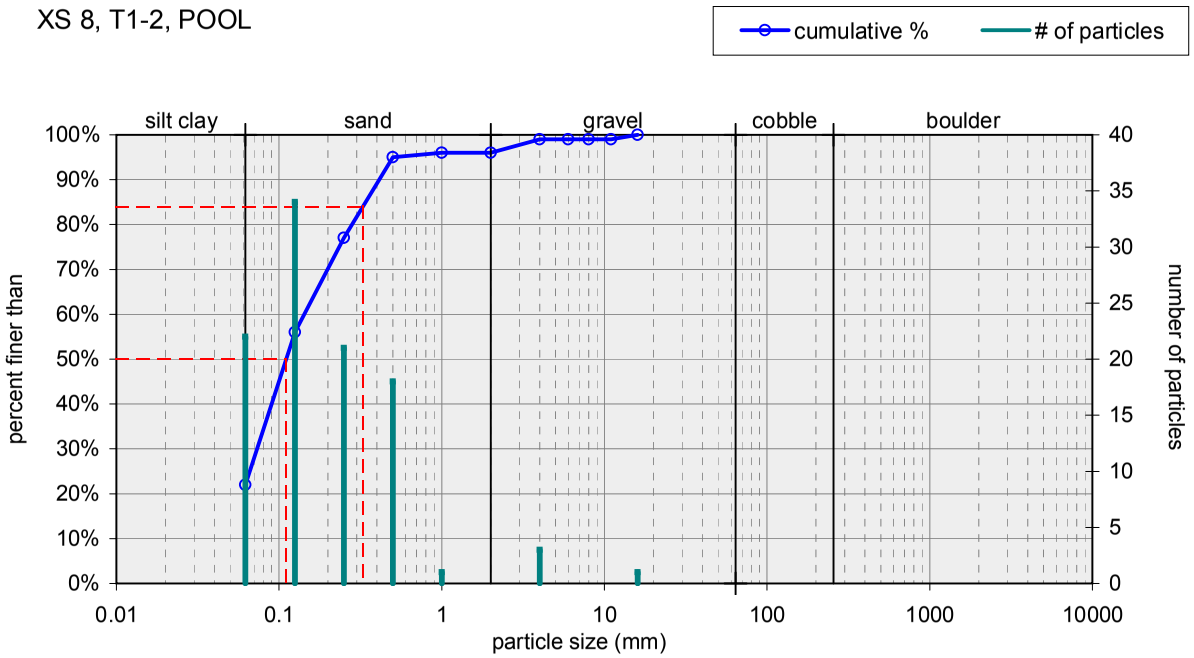
Type	
silt/clay	4%
sand	52%
gravel	44%
cobble	0%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**22**
very fine sand	0.062 - 0.125	**34**
fine sand	0.125 - 0.25	**21**
medium sand	0.25 - 0.5	**18**
coarse sand	0.5 - 1	**1**
very coarse sand	1 - 2	
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	
medium gravel	11 - 16	**1**
coarse gravel	16 - 22	
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	100

Note:



Size (mm)	
D16	0.062
D35	0.081
D50	0.11
D65	0.17
D84	0.33
D95	0.5

Size Distribution	
mean	0.1
dispersion	2.4
skewness	0.13

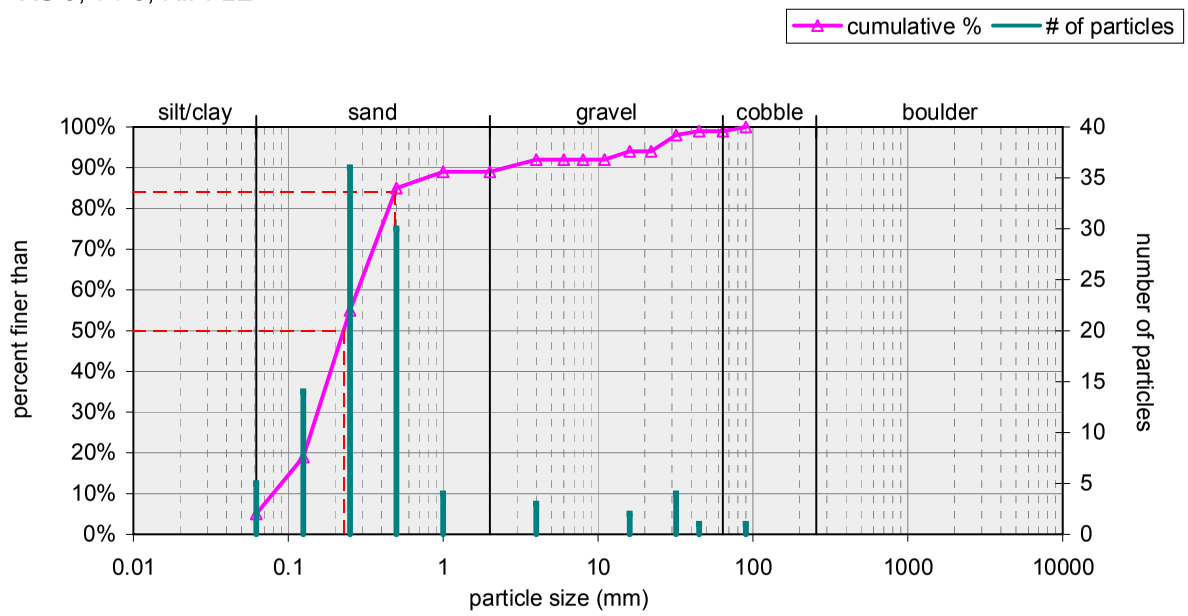
Type	
silt/clay	22%
sand	74%
gravel	4%
cobble	0%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**5**
very fine sand	0.062 - 0.125	**14**
fine sand	0.125 - 0.25	**36**
medium sand	0.25 - 0.5	**30**
coarse sand	0.5 - 1	**4**
very coarse sand	1 - 2	
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	
medium gravel	11 - 16	**2**
coarse gravel	16 - 22	
coarse gravel	22 - 32	**4**
very coarse gravel	32 - 45	**1**
very coarse gravel	45 - 64	
small cobble	64 - 90	**1**
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	100

Note:



Size (mm)	
D16	0.11
D35	0.17
D50	0.23
D65	0.31
D84	0.49
D95	24

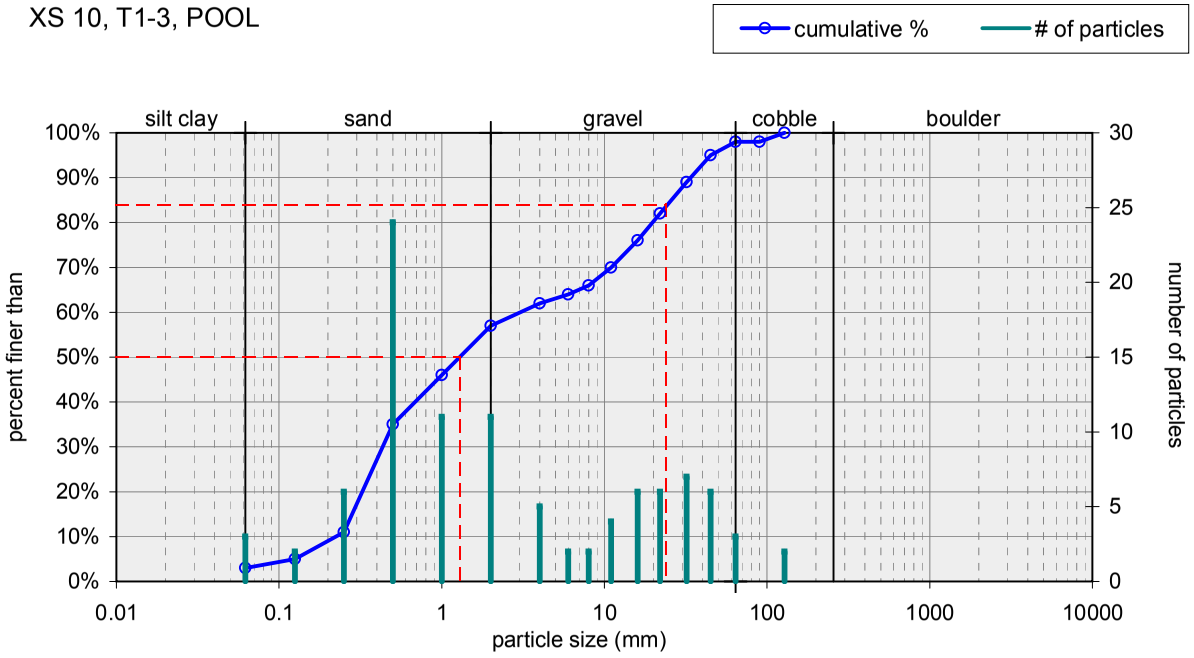
Size Distribution	
mean	0.2
dispersion	2.1
skewness	0.01

Type	
silt/clay	5%
sand	84%
gravel	10%
cobble	1%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**3**
very fine sand	0.062 - 0.125	**2**
fine sand	0.125 - 0.25	**6**
medium sand	0.25 - 0.5	**24**
coarse sand	0.5 - 1	**11**
very coarse sand	1 - 2	**11**
very fine gravel	2 - 4	**5**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**6**
coarse gravel	16 - 22	**6**
coarse gravel	22 - 32	**7**
very coarse gravel	32 - 45	**6**
very coarse gravel	45 - 64	**3**
small cobble	64 - 90	
medium cobble	90 - 128	**2**
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:



Size (mm)	
D16	0.29
D35	0.5
D50	1.3
D65	6.9
D84	24
D95	45

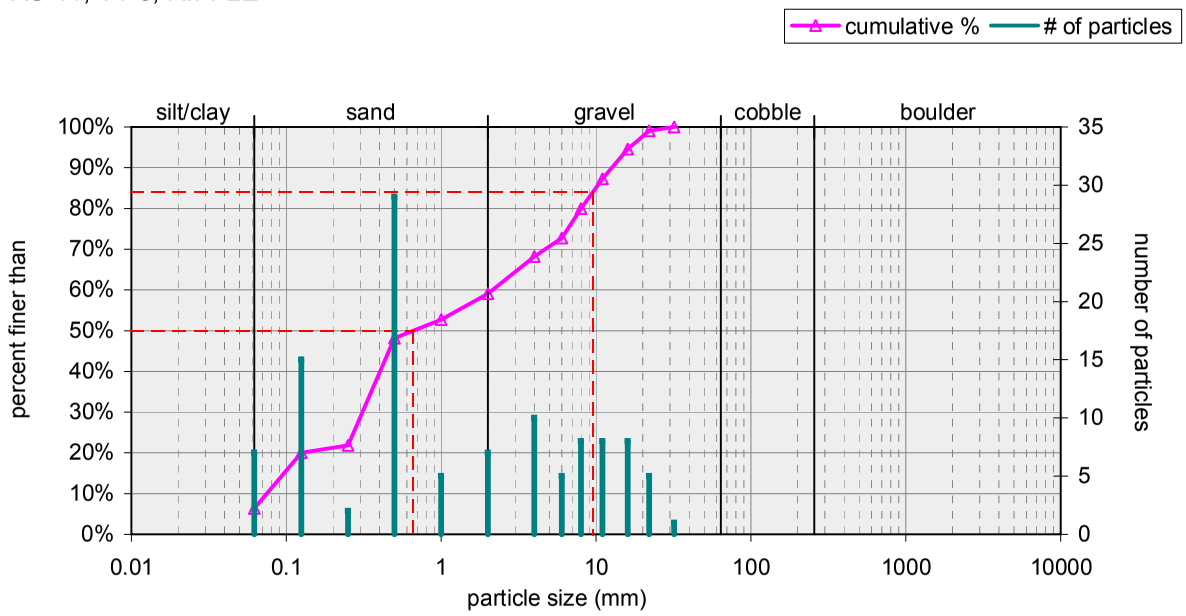
Size Distribution	
mean	2.6
dispersion	11.5
skewness	0.22

Type	
silt/clay	3%
sand	54%
gravel	41%
cobble	2%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**7**
very fine sand	0.062 - 0.125	**15**
fine sand	0.125 - 0.25	**2**
medium sand	0.25 - 0.5	**29**
coarse sand	0.5 - 1	**5**
very coarse sand	1 - 2	**7**
very fine gravel	2 - 4	**10**
fine gravel	4 - 6	**5**
fine gravel	6 - 8	**8**
medium gravel	8 - 11	**8**
medium gravel	11 - 16	**8**
coarse gravel	16 - 22	**5**
coarse gravel	22 - 32	**1**
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		110
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		110

Note:



Size (mm)	
D16	0.1
D35	0.35
D50	0.66
D65	3.1
D84	9.5
D95	17

Size Distribution	
mean	1.0
dispersion	10.5
skewness	0.12

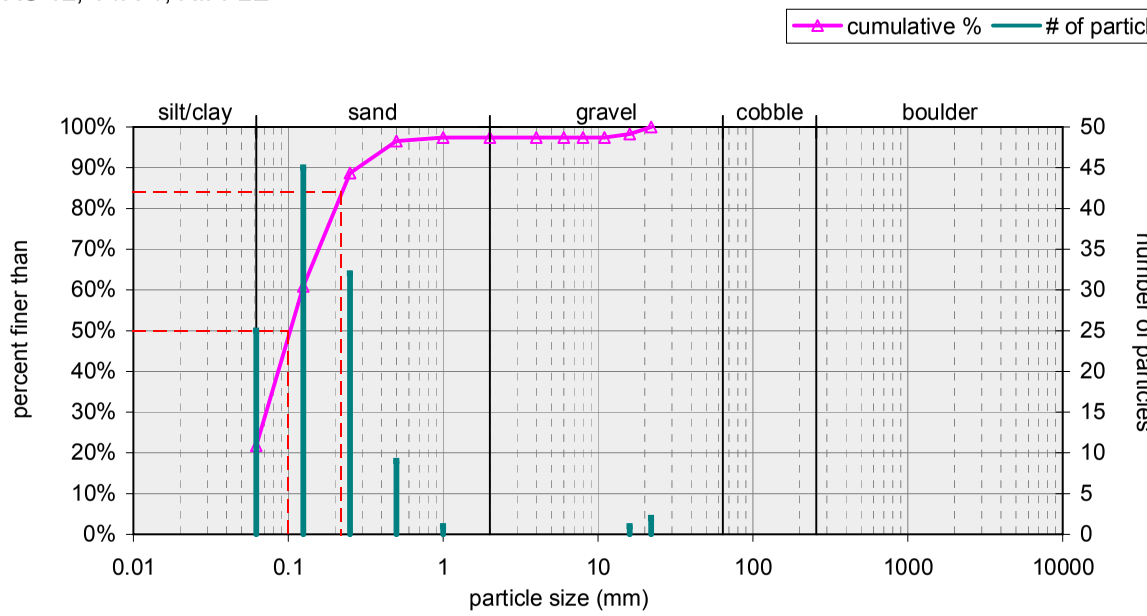
Type	
silt/clay	6%
sand	53%
gravel	41%
cobble	0%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**25**
very fine sand	0.062 - 0.125	**45**
fine sand	0.125 - 0.25	**32**
medium sand	0.25 - 0.5	**9**
coarse sand	0.5 - 1	**1**
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	
medium gravel	11 - 16	**1**
coarse gravel	16 - 22	**2**
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		115

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	115

Note:



Size (mm)	
D16	0.062
D35	0.079
D50	0.1
D65	0.14
D84	0.22
D95	0.44

Size Distribution	
mean	0.1
dispersion	1.9
skewness	0.09

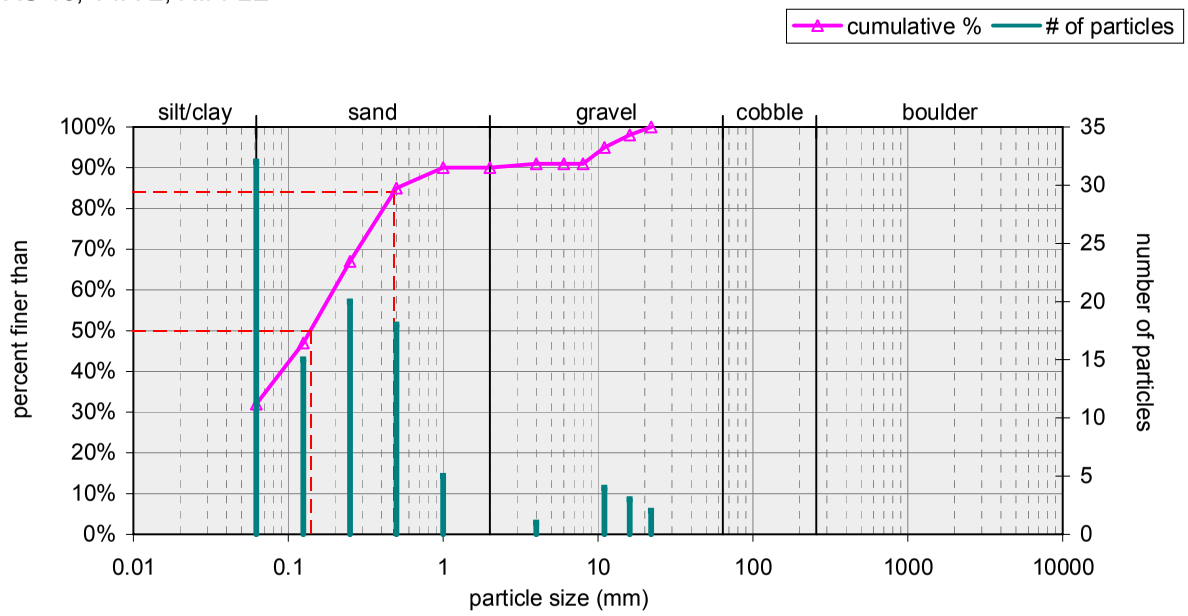
Type	
silt/clay	22%
sand	76%
gravel	3%
cobble	0%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**32**
very fine sand	0.062 - 0.125	**15**
fine sand	0.125 - 0.25	**20**
medium sand	0.25 - 0.5	**18**
coarse sand	0.5 - 1	**5**
very coarse sand	1 - 2	
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**3**
coarse gravel	16 - 22	**2**
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	100

Note:



Size (mm)	
D16	0.062
D35	0.071
D50	0.14
D65	0.23
D84	0.48
D95	11

Size Distribution	
mean	0.2
dispersion	2.8
skewness	0.10

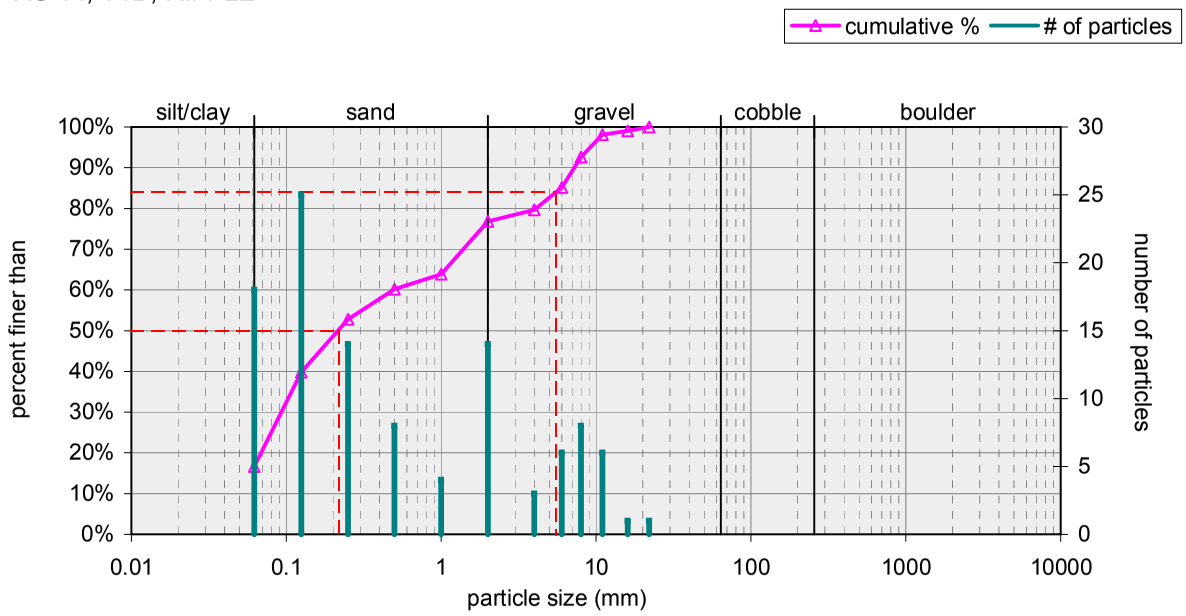
Type	
silt/clay	32%
sand	58%
gravel	10%
cobble	0%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**18**
very fine sand	0.062 - 0.125	**25**
fine sand	0.125 - 0.25	**14**
medium sand	0.25 - 0.5	**8**
coarse sand	0.5 - 1	**4**
very coarse sand	1 - 2	**14**
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	**6**
fine gravel	6 - 8	**8**
medium gravel	8 - 11	**6**
medium gravel	11 - 16	**1**
coarse gravel	16 - 22	**1**
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		108

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	108

Note:



Size (mm)	
D16	0.062
D35	0.11
D50	0.22
D65	1.1
D84	5.5
D95	9.2

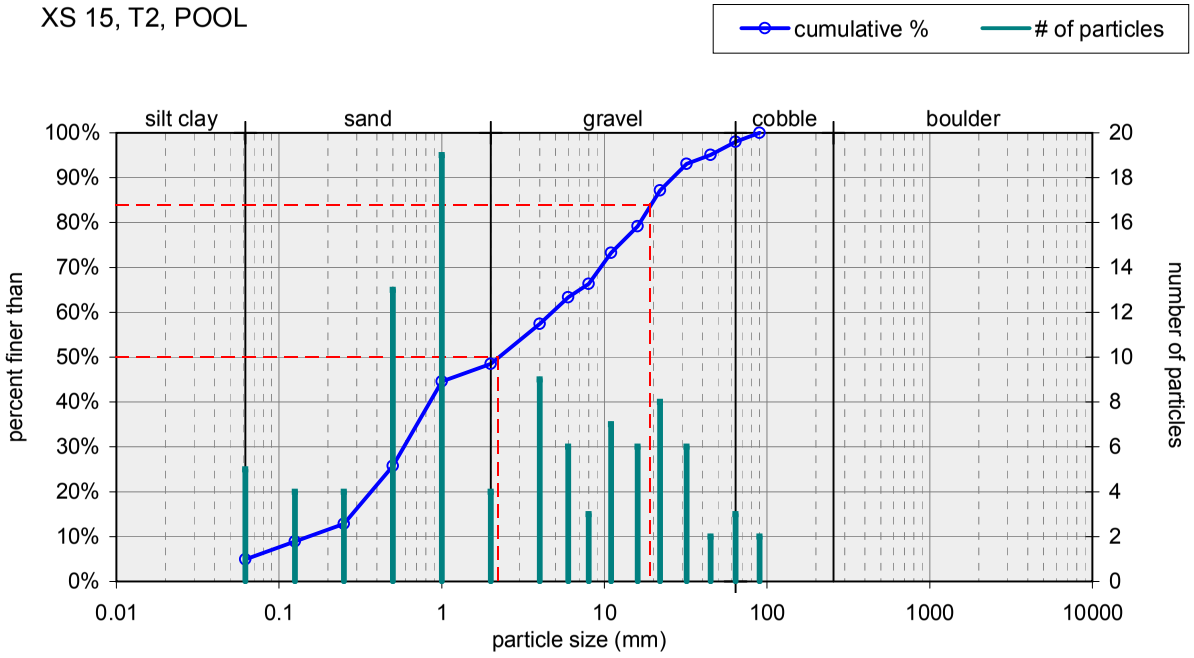
Size Distribution	
mean	0.6
dispersion	14.3
skewness	0.30

Type	
silt/clay	17%
sand	60%
gravel	23%
cobble	0%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**5**
very fine sand	0.062 - 0.125	**4**
fine sand	0.125 - 0.25	**4**
medium sand	0.25 - 0.5	**13**
coarse sand	0.5 - 1	**19**
very coarse sand	1 - 2	**4**
very fine gravel	2 - 4	**9**
fine gravel	4 - 6	**6**
fine gravel	6 - 8	**3**
medium gravel	8 - 11	**7**
medium gravel	11 - 16	**6**
coarse gravel	16 - 22	**8**
coarse gravel	22 - 32	**6**
very coarse gravel	32 - 45	**2**
very coarse gravel	45 - 64	**3**
small cobble	64 - 90	**2**
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		101
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		101

Note:



Size (mm)	
D16	0.3
D35	0.7
D50	2.2
D65	7
D84	19
D95	45

Size Distribution	
mean	2.4
dispersion	8.0
skewness	0.03

Type	
silt/clay	5%
sand	44%
gravel	50%
cobble	2%
boulder	0%

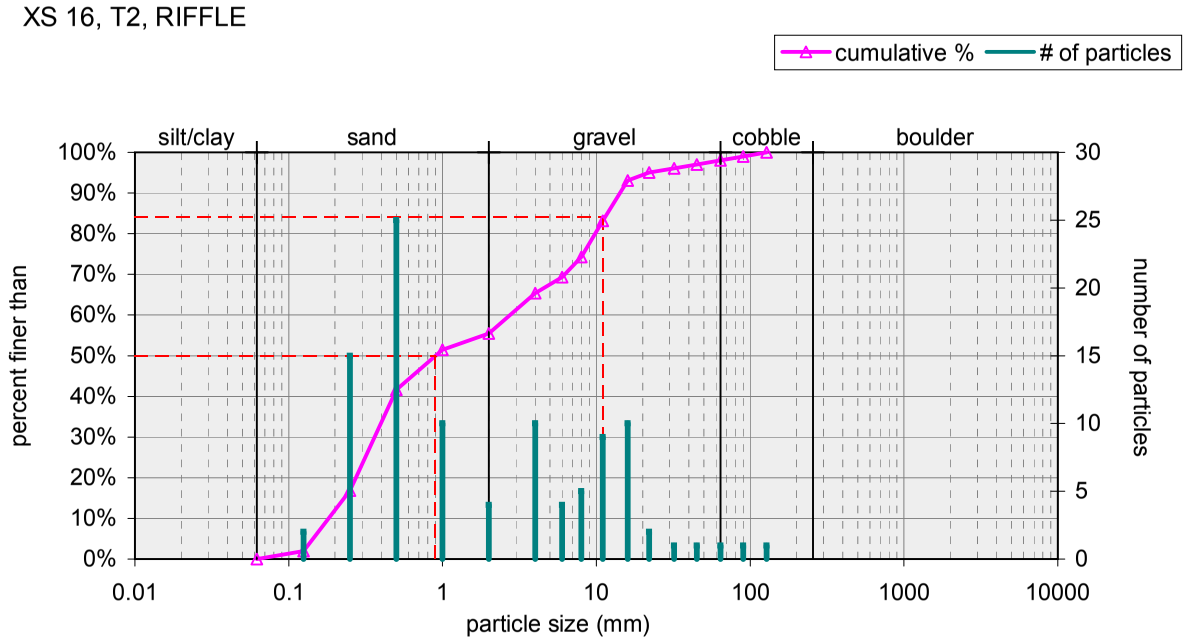
Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	**2**
fine sand	0.125 - 0.25	**15**
medium sand	0.25 - 0.5	**25**
coarse sand	0.5 - 1	**10**
very coarse sand	1 - 2	**4**
very fine gravel	2 - 4	**10**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**9**
medium gravel	11 - 16	**10**
coarse gravel	16 - 22	**2**
coarse gravel	22 - 32	**1**
very coarse gravel	32 - 45	**1**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	**1**
medium cobble	90 - 128	**1**
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		101

bedrock	
clay hardpan	
detritus/wood	
artificial	

total count:	101

Note:



Size (mm)	
D16	0.24
D35	0.42
D50	0.9
D65	3.9
D84	11
D95	22

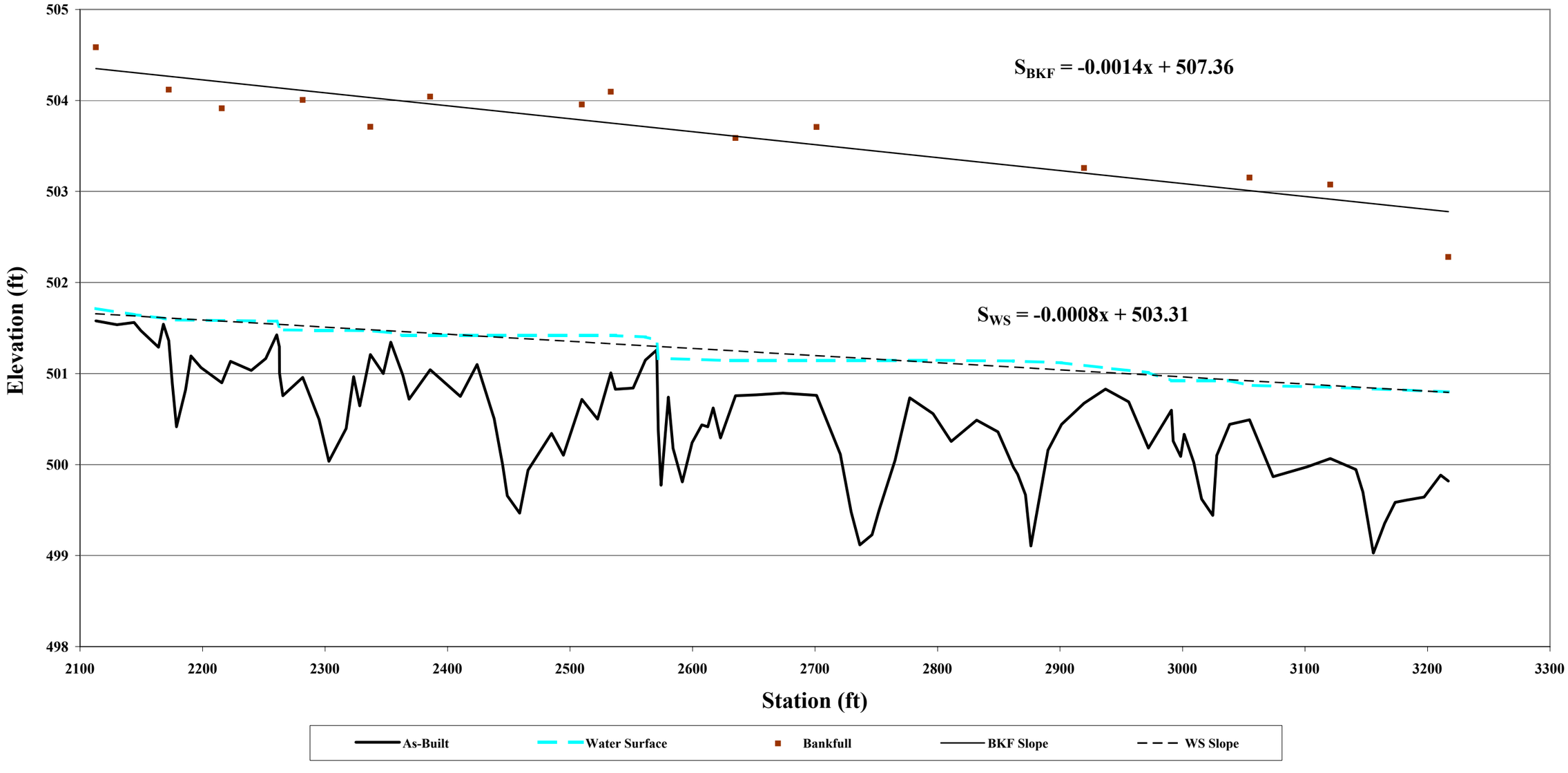
Size Distribution	
mean	1.6
dispersion	8.0
skewness	0.20

Type	
silt/clay	0%
sand	55%
gravel	43%
cobble	2%
boulder	0%

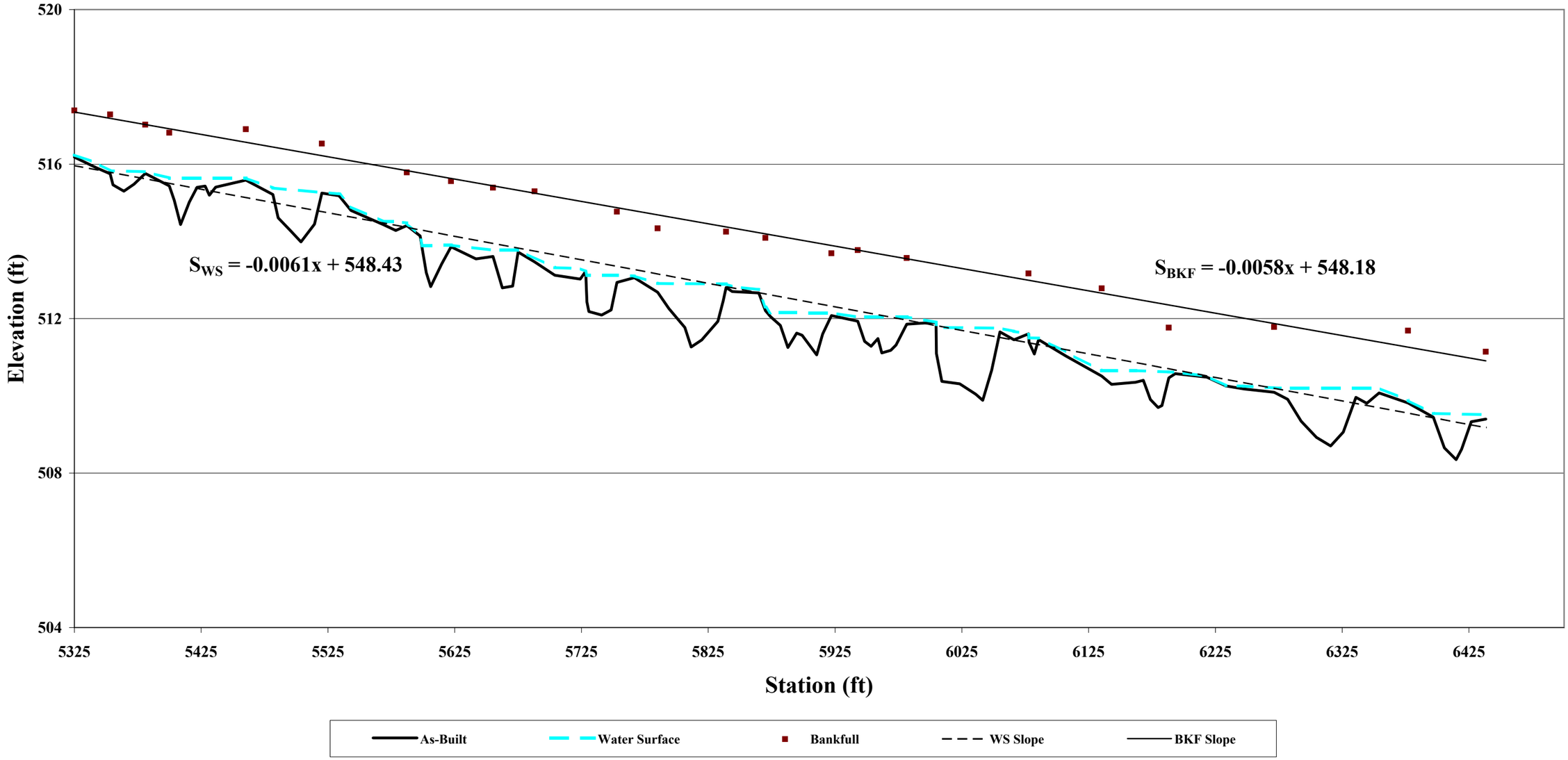
Appendix C

Longitudinal Profiles

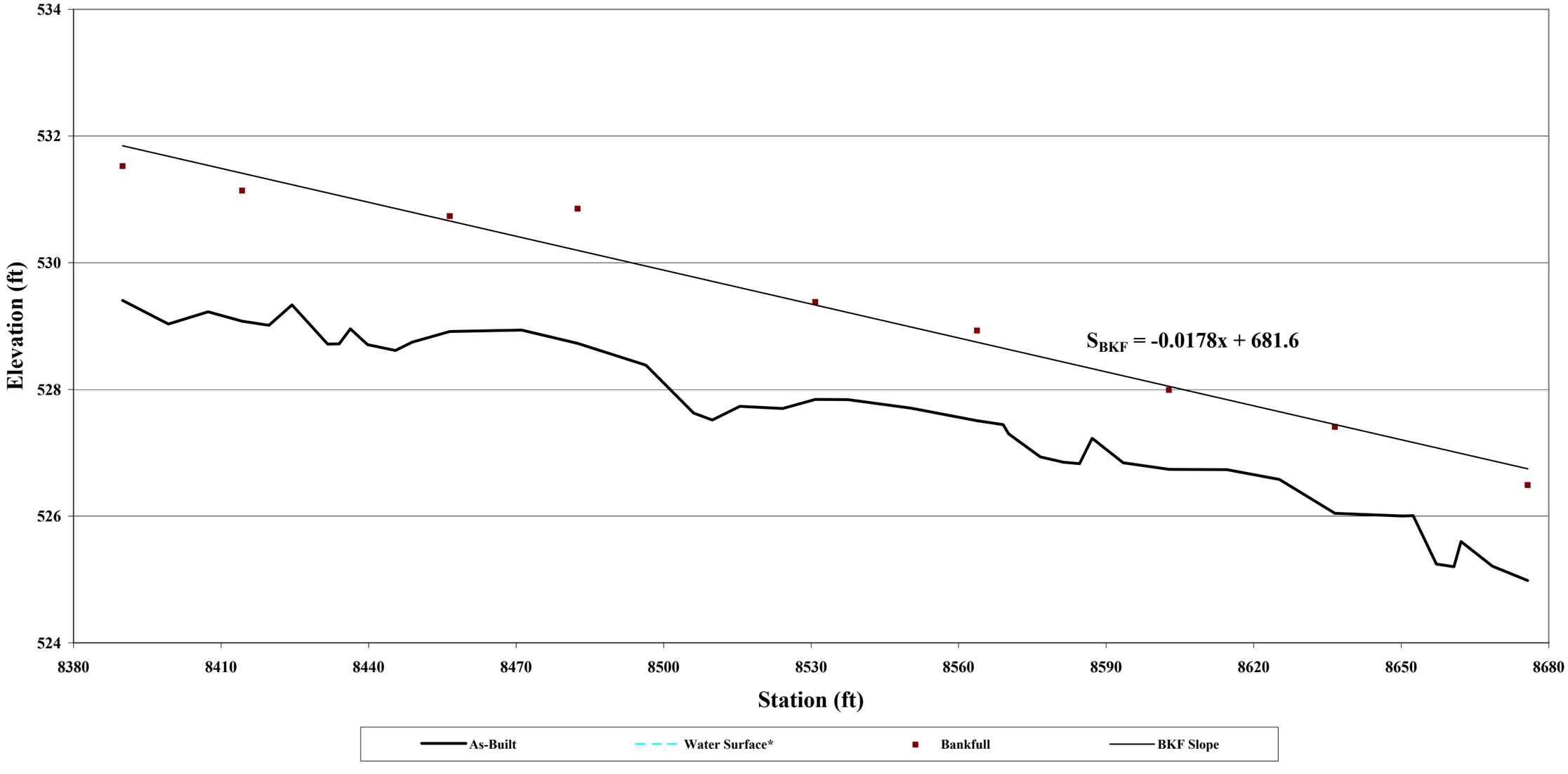
Longitudinal Profile
UTCC, As-Built
Stations 21+13 - 32+17



Longitudinal Profile
Tributary 1, As-Built
Stations 53+25 - 65+00

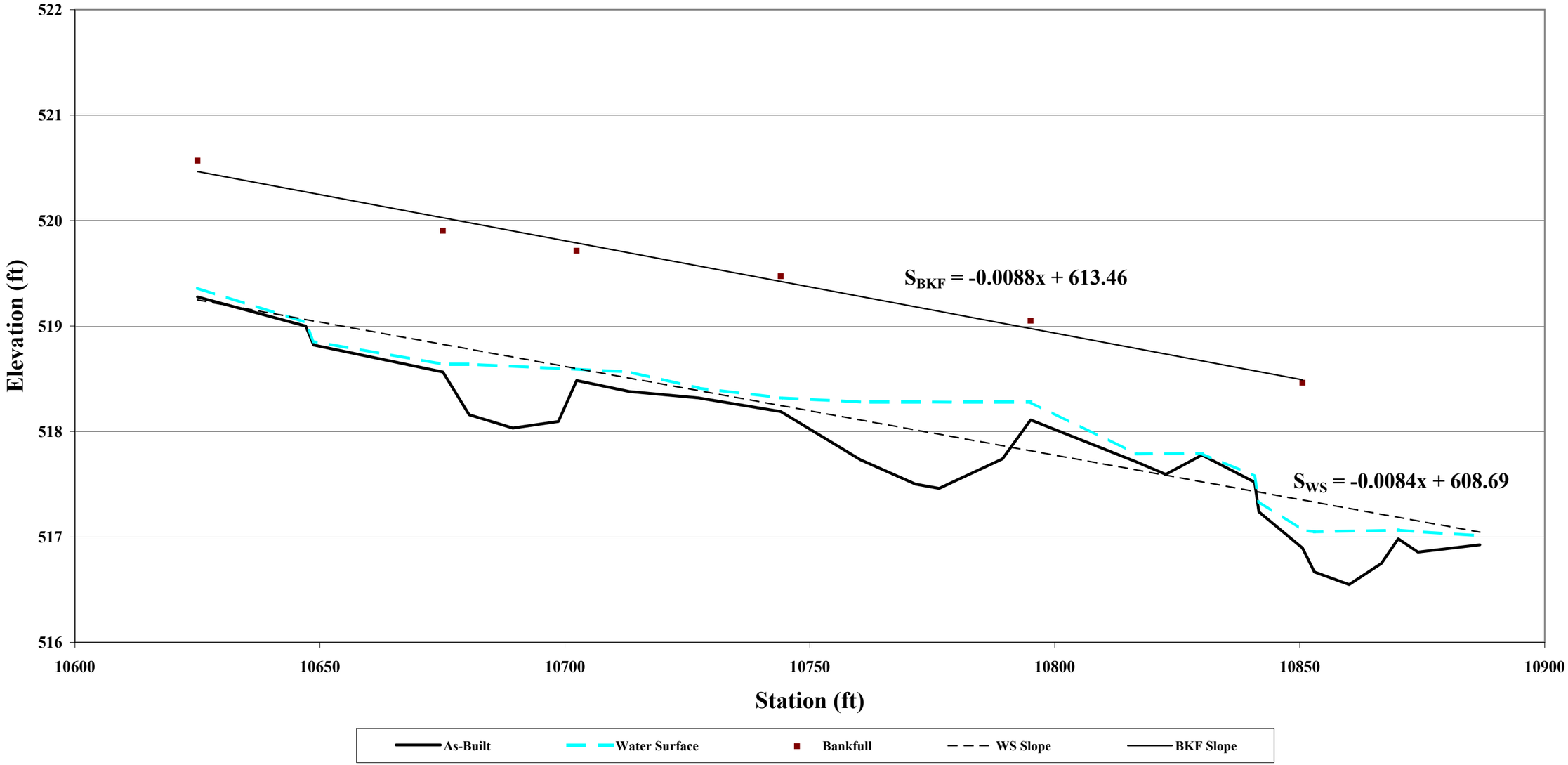


Longitudinal Profile
Tributary 1A, As-Built
Stations 83+80 - 86+80

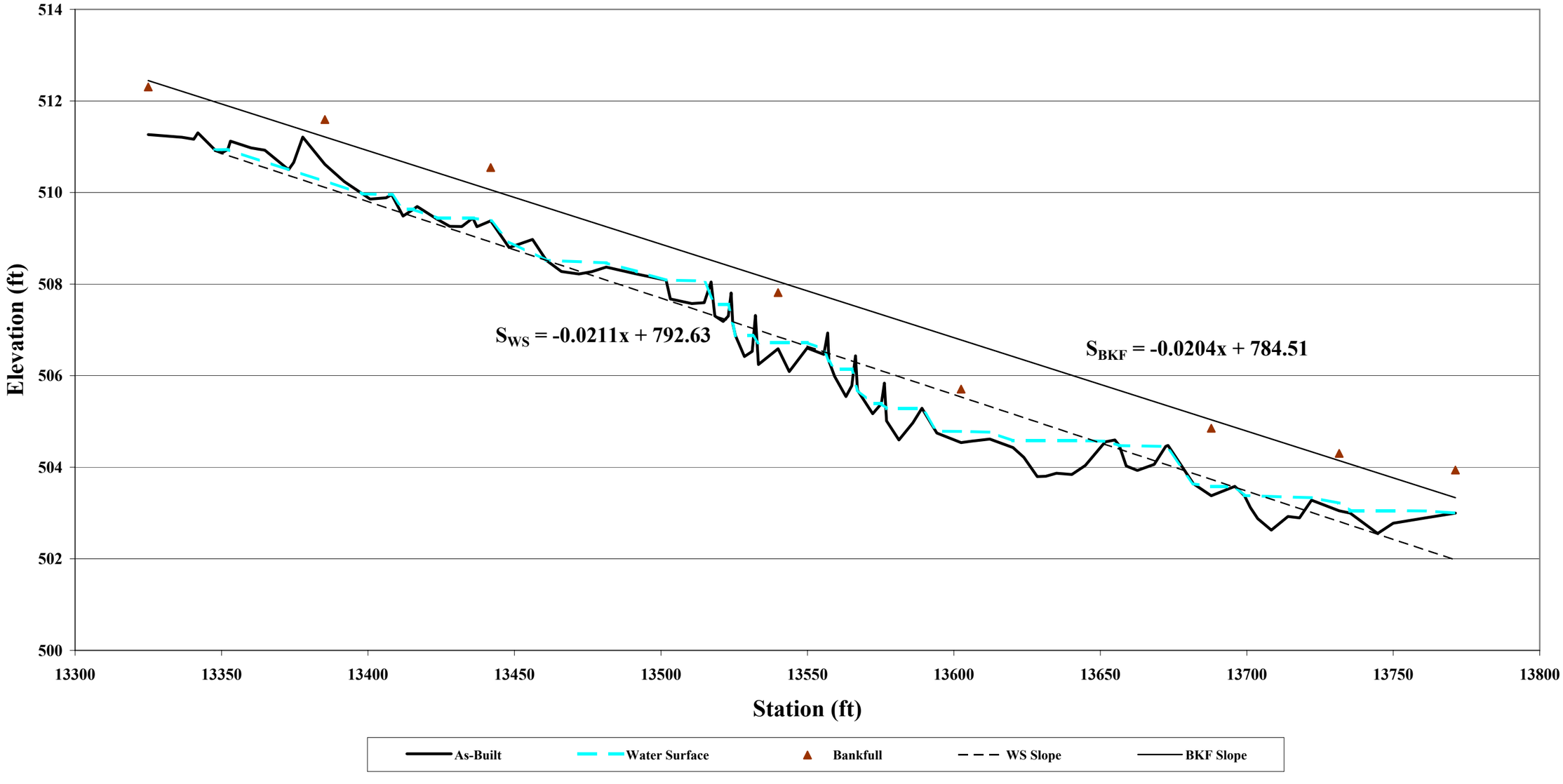


*No WS due to no flow in channel during survey.

Longitudinal Profile
Tributary 1B, As-Built
Stations 106+00 - 109+00



Longitudinal Profile
Tributary 2, As-Built
Stations 132+50 - 138+50



Appendix D

Vegetation Data

Table D1. Vegetation Metadata
Project Name: Collins Creek (UTCC)

Report Prepared By	Brian Roberts
Date Prepared	10/24/2008 10:54
Database Name	cvs-eep-entrytool-v2.2.5.mdb
Database Location	M:\2005\F_EEPMon0607\Vegetation database\cvs-eep-entrytool-v2.2.5

PROJECT SUMMARY----------

Project Code	Project Name	Description	Length (ft)	Stream-to-Edge Width (ft)	Area (sq m)	Required Plots (calculated)	Sampled Plots
UTCC	Collins Creek	Stream Restoration in Orange County, North Carolina	6808	50	63,242	15	15

Table D2. Vegetation Vigor by Species
Project Name: Collins Creek (UTCC)

	Species	4	3	2	1	0	Missing	Unknown
	Aronia arbutifolia	22	9					
	Betula nigra	13	4					
	Callicarpa americana	2	3					
	Carya ovata	3	6					
	Cornus amomum	17	13					
	Diospyros virginiana	10	31	1				
	Fraxinus pennsylvanica		1		1			
	Ilex verticillata	3	1					
	Itea virginica	3						
	Juglans nigra	27	15					
	Quercus falcata	5	15					
	Quercus michauxii	7	2					
	Quercus pagoda		4					
	Quercus phellos		6					
	Salix nigra	4	2					
	Salix sericea	8						
	Sambucus canadensis	18	8					
	Symphoricarpos orbiculatus	8						
	Ilex decidua	10	1					
	Quercus		7					
	Lindera benzoin	1	2					
	Platanus occidentalis	21	1					
	Unknown		10					
TOT:	**23**	**182**	**141**	**1**	**1**			

Table D3. Vegetation Damage by Species
Project Name: Collins Creek (UTCC)

	Species	All Damage Categories	No Damage	Livestock
	Aronia arbutifolia	31	31	
	Betula nigra	17	17	
	Callicarpa americana	5	5	
	Carya ovata	9	9	
	Cornus amomum	30	30	
	Diospyros virginiana	42	41	1
	Fraxinus pennsylvanica	2	1	1
	Ilex decidua	11	11	
	Ilex verticillata	4	4	
	Itea virginica	3	3	
	Juglans nigra	42	42	
	Lindera benzoin	3	3	
	Platanus occidentalis	22	22	
	Quercus	7	7	
	Quercus falcata	20	20	
	Quercus michauxii	9	9	
	Quercus pagoda	4	4	
	Quercus phellos	6	6	
	Salix nigra	6	6	
	Salix sericea	8	8	
	Sambucus canadensis	26	26	
	Symphoricarpos orbiculat	8	8	
	Unknown	10	10	
TOT:	**23**	**325**	**323**	**2**

Table D4. Vegetation Damage by Plot
Project Name: Collins Creek (UTCC)

	Plot	All Damage Categories	No Damage	Livestock
	UTCC-A-0001	27	27	
	UTCC-A-0002	19	19	
	UTCC-A-0003	17	17	
	UTCC-A-0004	16	16	
	UTCC-A-0005	28	28	
	UTCC-A-0006	19	19	
	UTCC-A-0007	17	16	1
	UTCC-A-0008	27	27	
	UTCC-A-0009	17	17	
	UTCC-A-0010	31	31	
	UTCC-A-0011	24	24	
	UTCC-A-0012	27	26	1
	UTCC-A-0013	18	18	
	UTCC-A-0014	21	21	
	UTCC-A-0015	17	17	
TOT:	**15**	**325**	**323**	**2**

Table D5. Stem Count by Plot and Species
Project Name: Collins Creek (UTCC)

	Species	Total Planted Stems	# plots	avg# stems	plot UTCC-A-0001	plot UTCC-A-0002	plot UTCC-A-0003	plot UTCC-A-0004	plot UTCC-A-0005	plot UTCC-A-0006	plot UTCC-A-0007	plot UTCC-A-0008	plot UTCC-A-0009	plot UTCC-A-0010	plot UTCC-A-0011	plot UTCC-A-0012	plot UTCC-A-0013	plot UTCC-A-0014	plot UTCC-A-0015
	Aronia arbutifolia	31	8	3.88	1	4	4	2	7	9	2					2			
	Betula nigra	17	8	2.12	2	6	1		3	1	1				2	1			
	Callicarpa americana	5	3	1.67		1		3			1								
	Carya ovata	9	5	1.80									1	1	3		3		1
	Cornus amomum	30	8	3.75	4			3	6			9	1	3			2	2	
	Diospyros virginiana	42	13	3.23	2	3	5		3		2	2	1	5	5	7	2	3	2
	Fraxinus pennsylvanica	2	2	1.00				1			1								
	Ilex decidua	11	7	1.57						2	1	2	1	3	1				1
	Ilex verticillata	4	4	1.00		1	1				1					1			
	Itea virginica	3	3	1.00												1	1	1	
	Juglans nigra	42	9	4.67						3		4	11	2	5	4	5	2	6
	Lindera benzoin	3	3	1	1		1							1					
	Platanus occidentalis	22	8	2.75	2	4		1	2	3	4				1	5			
	Quercus	7	4	1.75				2						3		1			1
	Quercus falcata	20	10	2	1		1		1				1	3	3	2	2	3	3
	Quercus michauxii	9	5	1.8	1		2		1	1	4								
	Quercus pagoda	4	3	1.33													2	1	1
	Quercus phellos	6	3	2	1		1	4											
	Salix nigra	6	3	2	1							2						3	
	Salix sericea	8	2	4	7									1					
	Sambucus canadensis	26	5	5.2	4				5			5		8				4	
	Symphoricarpos orbiculatus	8	7	1.14			1					2	1		1	1	1	1	
	Unknown	10	6	1.67								1		1	3	2		1	2
TOT:	**23**	**325**	**23**		**27**	**19**	**17**	**16**	**28**	**19**	**17**	**27**	**17**	**31**	**24**	**27**	**18**	**21**	**17**

Vegetation Plot 1: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 2: Photo missing, will be taken in MY-01.

Vegetation Plot 3: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 4: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 5: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 6: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 7: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 8: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 9: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 10: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 11: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 12: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 13: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 14: View looking toward plot center from origin corner. 5/1/08 – As-Built

Vegetation Plot 15: View looking toward plot center from origin corner. 5/1/08 – As-Built