Baseline Monitoring Document and As Built Baseline Report

FINAL

Jacob's Ladder Stream Restoration Site
Rowan County, North Carolina
EEP Contract 003983
EEP Project Number 95023

Submitted to:

Ecosystem Enhancement PROGRAM

NCEEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

Monitoring Data Collected: February/March 2014
Date Submitted: September 2014

Monitoring and Design Firm

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September 2014

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EXECUTIVE SUMMARY

The Jacob's Ladder Stream Restoration Site, completed in January 2014, restored a total of 4,971 linear feet and enhanced 446 linear feet along three tributaries to Irish Buffalo Creek in the Yadkin-Pee Dee River Basin. The completed project will return these tributaries to a stable stream ecosystem, lower the sediment supply entering Irish Buffalo Creek, and reduce incoming nutrients from livestock. This project also looks to expand aquatic and terrestrial habitat in the Rocky River Watershed (03040105). The project is located in the Irish Buffalo Creek Drainage (03040105020040), which the EEP has identified as a Targeted Local Watershed (TLW).

The site's 1.07-square mile watershed is comprised predominantly of pasture and mixed hardwoods, with an area of rural residential development in the northeastern corner. Prior to construction, the site was actively used for timber and cattle production for over five generations. The project streams became degraded primarily through a long history of logging, grazing, and channelization.

The site consists of three tributaries to Irish Buffalo Creek – Tributary 1 (T1), Tributary 2 (T2), and Tributary 1A (T1A). The pre-restoration assessment classified T1 and T2 as G4 stream types. The banks of T1 were impacted by the removal of riparian vegetation and grazing along the entire length of the project stream. The stream also lacked distinct pool and riffle features; erosion from unstable banks and the upper slopes contributed to an excess amount of sediment that had impacted these features. The upstream portion of T2 was in transition with initial forest cover becoming less dense and the banks beginning to experience more bank erosion when moving further downstream until a large bedrock feature. Downstream of the bedrock feature, T2 transitioned into a straightened, highly constrained channel. The upstream portion of T1A had a stable channel pattern, but the stream was experiencing bed degradation as it flowed down the valley. The lack of riparian vegetation exacerbated bank erosion. Further downstream, T1A became less steep and had more mature trees along its banks, with isolated areas of bank erosion. An old pond berm existed downstream where it became a dispersed channel with poorly defined banks and planform. After the stream flowed through the old pond berm, it began to quickly incise to reach the confluence with T1. The streams showed channel incision as indicated by bank height ratios ranging from 1.9 to 8.6.

The project goals and objectives are listed below.

Project Goals

- Restore a diverse riparian corridor that connects forested stream systems upstream and downstream of the project.
- Reduce the sediment supply entering Irish Buffalo Creek.

Project Objectives

- Restore stable channel planforms to streams that have been straightened and modified.
- Reshape and stabilize eroding stream banks.
- Plant the site with native trees to help reestablish a diverse riparian corridor.
- Install exclusion fencing and alternative watering options to keep livestock out of the project streams.

Project construction was completed in August 2013. The project restored 4,971 linear feet of stream, and enhanced 306 linear feet of stream with Enhancement I and 140 linear feet with Enhancement II. The overall approach to the design of Jacob's Ladder Stream Restoration Site was a Priority 1 approach, which involved creating the appropriate dimension, pattern, and profile and reconnecting the floodplain to an elevation at or similar to the historic floodplain elevation, while the existing channel was abandoned and filled (Rosgen, 1997). The streams at the Jacob's Ladder Stream Restoration Site were restored to a combination of C4 and B4c/C4 Rosgen stream types. Grade control, habitat structures, and constructed riffles were utilized to maintain the riffle and pool sequence in the newly constructed channels. Where feasible, the native riffle material from the existing channel was used to enhance the newly constructed riffles. The constructed and enhanced riffles were installed to provide protection from bed scour associated with the unstable, erosive soils at the site. The riparian buffer was planted as Piedmont Alluvial Forest and Mesic Mixed Hardwood Forest Communities (Schafale and Weakley 1990). Site activities provide 5,231 Stream Mitigation Units. The site is protected by a permanent conservation easement to be held by the State of North Carolina.

There were only limited modifications made to the design plan during construction. On T1, one step pool was relocated, and the riffle grade control at the end of the stream was extended to the confluence with Irish Buffalo Creek. Due to the extra structures and additional work required to stabilize the channel on the upper reach of T2 (T2-1 as shown in the original design), the mitigation type has been changed from Enhancement I as described in the mitigation plan to restoration. For photos of restored T2 see Photo Point 6 in Appendix B. Three drainage stabilizations were also added on T2. The baseline stream profile for T2 shows riffle and pool variation upstream of Station 110+78 when compared to the design profile, indicating that excess sand is still moving through the system from upstream or previous bank erosion. These stream features will continue to be monitored to make sure that any observed changes are within the range of variability found in stable stream systems.

The monitoring components were installed in February/March 2014. The monitoring plan includes two longitudinal profiles on T1 and T2 and ten cross-sections, seven in riffles and three in pools. Nine permanent photo points have been established with a total of nineteen photos to be taken annually. To determine the success of the planted buffer, sixteen permanent vegetation monitoring plots were established according to the CVS-EEP protocol. The site will be monitored for at least five years or until the success criteria are achieved. Reports will be submitted to the EEP each year. The first year of monitoring will take place in 2014.

The planted riparian buffer must meet the success criteria of a site average of 320 planted stems/acre at the end of the monitoring period based on the vegetation monitoring plots. The baseline monitoring counted an average of 589 stems/acre in the 16 stream 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 streams over the monitoring period in separate monitoring years.

1.0 PROJECT GOALS, BACKGROUND, AND ATTRIBUTES

1.1 Location and Setting

The North Carolina Ecosystem Enhancement Program (NCEEP) has completed the restoration and enhancement of 5,417 linear feet of stream at the Jacob's Ladder Stream Restoration Site (hereafter referred to as the "Site") to assist in fulfilling stream mitigation goals in the area. The Site is located west of China Grove and north of Kannapolis off of Saw Road (Figure 1, Appendix A). The Site is within the 03040105 Rocky River Watershed Cataloging Unit (8-digit HUC) and the 03040105020040 Irish Buffalo Creek Local Watershed Unit (14-digit HUC) (NCDENR, EEP 2009). In the North Carolina Ecosystem Enhancement Program's (EEP) most recent publication of excluded and Targeted Local Watersheds/Hydrologic Units, the 03040105020040 14-digit HUC has been identified as a Targeted Local Watershed. The Site is located in the Piedmont Physiographic Province and the project streams initiate as headwater systems out of moderately-sloped, forested hills before reaching the floodplain of Irish Buffalo Creek. The site's 1.07-square mile project watershed is comprised predominantly of pasture and mixed hardwoods, with an area of rural residential development in the northeastern corner. Prior to construction, the site was actively used for timber and cattle production for over five generations.

1.2 Project Goals and Objectives

The project goals and objectives are listed below.

Project Goals

- Restore a diverse riparian corridor that connects forested stream systems upstream and downstream of the project.
- Reduce the sediment supply entering Irish Buffalo Creek.

Project Objectives

- Restore stable channel planforms to streams that have been straightened and modified.
- Reshape and stabilize eroding stream banks.
- Plant the site with native trees to help reestablish a diverse riparian corridor.
- Install exclusion fencing and alternative watering options to keep livestock out of the project streams.

1.3 Project Structure, Restoration Type and Approach

1.3.1 Project Structure

The Site consists of three tributaries to Irish Buffalo Creek – Tributary 1 (T1), Tributary 2 (T2), and Tributary 1A (T1A). The mitigation work included 4,971 linear feet of restoration, 306 linear feet of Enhancement I, and 140 linear feet of Enhancement II for a total of 5,231 Stream Mitigation Units as shown in Figure 2 and described in Table 1 in Appendix A. T1 and T2 were both restored and each are considered as their own reaches due to the same design approach along their entire lengths. T2A was divided into three reaches: T1A-1 (306 lf Enhancement I), T1A-2 (140 lf Enhancement II), and T1A-3 (470 lf restoration).

Planting occurred within 15.9 acres of the 17.2-acre conservation easement, including the stream banks and floodplain. Target natural communities consist of Piedmont Alluvial Forest for the riparian areas for T1, T2, and T1A-3, and Mesic Mixed Hardwood Forest for the riparian areas for T1A-1 and T1A-2 (Schafale and Weakley 1990).

1.3.2 Project Restoration Type and Approach

Prior to construction, the project streams had become degraded primarily through a long history of logging, grazing, and channelization. The project streams showed evidence of bank erosion and undercutting along with channelization in portions of each reach; there were also high levels of channel incision as indicated by bank height ratios ranging from 1.9 to 8.6. Furthermore, most of the project streams did not have vegetation on the banks and consequently lacked the rooting strength and cover protection to prevent further bank erosion from occurring.

The pre-restoration assessment classified T1 and T2 as G4 stream types. The banks of T1 were impacted by the removal of riparian vegetation and grazing along the entire length of the project stream. The stream also lacked distinct pool and riffle features; erosion from unstable banks and the upper slopes contributed to an excess amount of sediment that had impacted these features. The approach used for T1 was Priority 1 restoration to bring up the stream to a floodplain elevation and to reestablish natural sinuosity. The upstream portion of T2 was in transition with forest cover becoming less dense and the banks beginning to experience bank erosion until moving further downstream and reaching a large bedrock feature. Downstream of the bedrock feature, T2 transitioned into a straightened, highly constrained channel. For T2, the design also employed Priority 1 restoration to recreate a meandering channel at a higher elevation to engage the floodplain. The upper portion of T2 was originally designed as Enhancement I, but the level of work needed to stabilize the stream during construction involved grade control and habitat structure installation, significant bank grading, and minor planform adjustments consistent with restoration. The upstream portion of T1A had a stable channel pattern, but the stream was experiencing bed degradation as it flowed down the valley. The lack of riparian vegetation increased bank erosion. Further downstream, it became less steep and had more mature trees along its banks, with isolated areas of bank erosion. An old pond berm existed downstream where it became a dispersed channel with poorly defined banks and planform. After the stream flowed through the old pond berm, it began to quickly incise to reach the confluence with T1. A combination approach was used for T1A: Enhancement I at the top 306 linear feet where there was more instability, Enhancement II for 140 linear feet where only minor bank adjustments and planting were needed, and restoration with a Priority 1 approach for the remaining 470 linear feet that had begun to incise severely after the pond berm.

1.4 Project History, Contacts and Attribute and Data

The project was first identified as a full-delivery mitigation project developed for the North Carolina Ecosystem Enhancement Program (EEP) restoration by KCI Associates of NC, PA. This project began in the planning phase in 2011 with the final mitigation plan completed in September 2012. Construction began in early 2013. Site construction was completed in August 2013 and it was planted in January 2014. Completed project activities, reporting history, completion dates, project contacts, and background information are summarized in Tables 2-4 (Appendix A).

2.0 SUCCESS CRITERIA

2.1 Morphologic Parameters and Channel Stability

Monitoring of the Site shall consist of the collection and analysis of stream stability and riparian/stream bank vegetation survivability data to support the evaluation of the project in meeting established restoration objectives. Specifically, project success will be assessed utilizing measurements of stream dimension and profile, site photographs, and vegetation sampling.

The purpose of monitoring is to evaluate the stability of the restored stream. Following the procedures established in the USDA Forest Service Manual, *Stream Channel Reference Sites* (Harrelson *et al*. 1994) and the methodologies utilized in the Rosgen stream assessment and classification system (Rosgen D.L. 1994 and 1996), data collected will consist of detailed dimension measurements, longitudinal profiles, and bed materials sampling.

2.1.1 Dimension

The cross-section surveys shall provide a detailed measurement of the stream and banks and will include points on the adjacent floodplain or valley, at the top of bank, bankfull, at all breaks in slope, the edge of water, and thalweg. Width/depth and entrenchment ratios will be calculated for each cross-section based on the survey data. Cross-section measurements should show little or no change from the as-built cross-sections. However, some change is natural and expected, indicating that the site is settling post-construction. Changes that may indicate destabilizing conditions include significant widening or deepening of the riffle section or a consistent trend of change over the course of the monitoring. For a pool cross-section, deepening is frequently a positive change while consistent filling of the pool may indicate destabilization. If changes do occur, they will be evaluated to determine whether they are minor adjustments associated with settling and increased stability or whether they indicate movement toward an unstable condition.

2.1.2 Pattern and Profile

For the profile, the reach under assessment should not demonstrate any trends in thalweg aggradation or degradation over any significant continuous portion of its length. The profile should also demonstrate contrasting bedform diversity against the pre-existing condition. Bedform distributions, riffle/pool lengths and slopes will vary, but should do so around design distributions. The majority of pools should be maintained at greater depths with lower water surface slopes while riffles should be shallow with greater water surface slopes. Pattern features should show little adjustment over the monitoring period.

2.1.3 Substrate

Substrate measurements, from annual pebble count data, should indicate the progression towards, or the maintenance of, the anticipated distributions from the design phase. While stream projects are designed to transport bedload in equilibrium and carry overall sediment loads at bankfull, fines can be transported even at low discharges and upstream instability beyond design projections can also lead to deposition as storm events recede in areas of energy dissipation such as restoration reaches. This can have the effect of obscuring bedform and fining of riffles especially in the first few years after the implementation of a stream project. In many cases subsequent narrowing and reduction of W/D ratios as a project develops/stabilizes can then increase transport efficiency and return bedform to intended distributions, but some fining can persist due to upstream disturbance.

2.1.4 Sediment Transport

Maintenance of sediment transport will be evident by stable features in the monitored cross-sections and profile. From these two indicators, there should be no evidence of any significant trend in aggradation or degradation throughout the channel.

2.2 Vegetation
Vegetation success is based on the criteria established in the USACE Stream Mitigation Guidelines (2003). This document states that vegetation monitoring results should have the following planted stem density minimums in the corresponding monitoring years: 320 stems/acre through Year Three, 288 stems/acre in Year Four, and 260 stems/acre in Year Five. If monitoring indicates that the specified survival rate is not being met, appropriate corrective actions will be developed to include invasive species control, the removal of dead/dying plants, and replanting.

2.3 Hydrology
Success criteria include documentation of a minimum of two bankfull events during the monitoring period. In addition, bankfull events must occur during separate monitoring years.

3.0 MONITORING PLAN

Annual monitoring will be conducted during the first full growing season following project completion. Monitoring of the Site's restoration efforts will be performed for stream, vegetation, and hydrology components of the Site until success criteria are fulfilled. The establishment, collection, and summarization of monitoring data shall be conducted in accordance with the EEP document entitled *Procedural Guidance and Content Requirements for EEP Monitoring Reports (version 1.5)* (NCEEP 2012). Permanent monuments, marking monitoring feature locations, were established on-site in February 2014. The locations of these monitoring features are shown in Figure 3 in Appendix A.

3.1 Stream Hydrology
Two automatic recording gauges have been installed along T1 and T2 to record water levels, indicating when bankfull events occur.

3.2 Stream Channel Stability and Geomorphology
Data to be collected consists of detailed dimension and pattern measurements, a longitudinal profile, and bed materials sampling. Stream data will be calculated from the monitored longitudinal profiles and cross-sections (Appendix B). Various morphological parameters will be calculated from this information such as bankfull slopes, pool-to-pool spacing, and feature lengths.

3.2.1 Dimension
Ten total permanent monitoring cross-sections have been established on the Site. Six riffle cross-sections and four pool cross-sections have been installed on the tributaries; locations are depicted on Figure 3 (Appendix A). Permanent monuments of rebar have been established at each end of these cross-sections. These cross-sections will be surveyed each year, with measurements occurring at bankfull, top of bank, edge of water, and other significant breaks in slope. Data will be used to calculate width-depth ratios, entrenchment ratios, and bank height ratios for each cross-section. Photographs will also be taken at each permanent cross-section annually.

3.2.2 Profile
Two longitudinal profiles have been established (approximately 1,500 linear feet each on T1 and T2) and will be used to evaluate stream pattern and longitudinal profile each monitoring year, (see Figure 3, Appendix A). The profiles will be surveyed in detail, documenting the elevations of the thalweg, water surface, and bankfull. Pool and riffle features will be called out to calculate feature slopes and lengths.

3.2.3 Pattern
Pattern measurements have been taken for the as-built condition and are documented in this report. Future pattern measurements will not be taken unless there is evidence that significant geomorphological adjustments have occurred.

3.2.4. Visual Assessment
A visual assessment of the stream to include an assessment of the bank (lateral stability), bed (vertical stability), the easement boundary, and vegetation will be completed each year to document the necessary parameters required for the EEP monitoring report.

3.2.5 Vegetation
Sixteen vegetation plots were set up and assessed for the baseline vegetation monitoring. The plots were installed with flagged metal conduit at each corner and a flagged PVC pipe was installed at the photo corner. Vegetation data collection must follow the CVS-EEP Protocol for Recording Vegetation (Lee et al. 2008, http://cvs.bio.unc.edu/methods.htm). The baseline vegetation monitoring was conducted as Level 1: Inventory of Planted Stems, as will the first-year monitoring. Beginning in Year Two and continuing throughout the rest of the monitoring period, the Site will be monitored using the Level 2 protocol. Baseline vegetation plot information can be found in Appendix C.

3.2.6 Digital Photos
Nine photograph reference points (PRPs) have been established as part of the baseline monitoring to assist in characterizing the Site and to allow qualitative evaluation of the Site conditions. Starting in the first monitoring year, these photos will be taken in late summer, so that vegetative conditions are similar at the Site between monitoring years.

3.2.7 Watershed Conditions
Yearly monitoring will document any evident changes in the watershed. Any large hydrologic events in the watershed, such as tropical storms or hurricanes, will also be documented in the yearly monitoring reports.

3.3 Monitoring Guidelines
The first scheduled monitoring will be conducted during the first full growing season following project completion. Monitoring shall subsequently be conducted annually for a total period of five years or until the project meets its success criteria. Annual monitoring reports will be prepared and submitted after all monitoring tasks for each year are completed. The report will document the monitored components and include all collected data, analyses, and photographs. Each report will provide the new monitoring data and compare the most recent results against previous findings. The monitoring report format will be similar to that set out in Version 1.5 (NCEEP 2012).

3.4 Maintenance and Contingency
KCI will monitor the Site on a regular basis and conduct a physical inspection of the Site a minimum of once per year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and 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.

4.0 BASELINE CONDITIONS

Baseline stream monitoring data were collected in February 2014. Any changes made to the design during construction are shown on the As-Built Site Plan in Appendix D. The majority of the restoration reaches were implemented as designed. On T1, one step pool was relocated, and the riffle grade control at the end of the stream was extended to the confluence with Irish Buffalo Creek. Due to the extra structures and additional work required to stabilize the channel on the upper reach of T2 (T2-1 as shown in the original design), the mitigation type has been changed from Enhancement I as described in the mitigation plan to restoration. For photos of restored T2 see Photo Point 6 in Appendix B. Three drainage stabilizations were also added on T2. The profile features along T2 were built as designed, but upstream of Station 110+78 they have become obscured by sand deposition from the surrounding watershed. This sediment is still working through the system and it is expected that riffle and pool features will develop over time. This part of the stream is stable and these stream features will continue to be monitored to make sure that any observed changes are within the range of variability found in stable stream systems.

Table 5 compares the designed morphological values and ratios to the as-built values and ratios of the restored streams (Appendix B). Overall, the Site was built as designed. The differences between the designed and as-built channels are minor. T1A is being monitored visually and therefore there are no as-built data included in Table 5.

The Site was planted with a total of nine different species of bare root trees in January 2014. Baseline vegetation monitoring data were collected in February 2014. The Level 1 CVS-EEP protocol (http://cvs.bio.unc.edu/methods.htm) was used to collect vegetation data. Plot photos from all the vegetation plots can be found in Appendix C.

The results of the vegetation baseline monitoring show an average of 589 stems per acre in the planted stream zone (Table 7. Appendix C). Additionally, stem counts within each individual plot were well-above the required 320 stems per acre except for plots 1 and 6. An attempt to identify all trees was made, but since monitoring was conducted during the dormant season, many were unidentifiable. All trees will be positively identified during the first year of monitoring.

5.0 REFERENCES

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APPENDIX A

General Tables and Figures

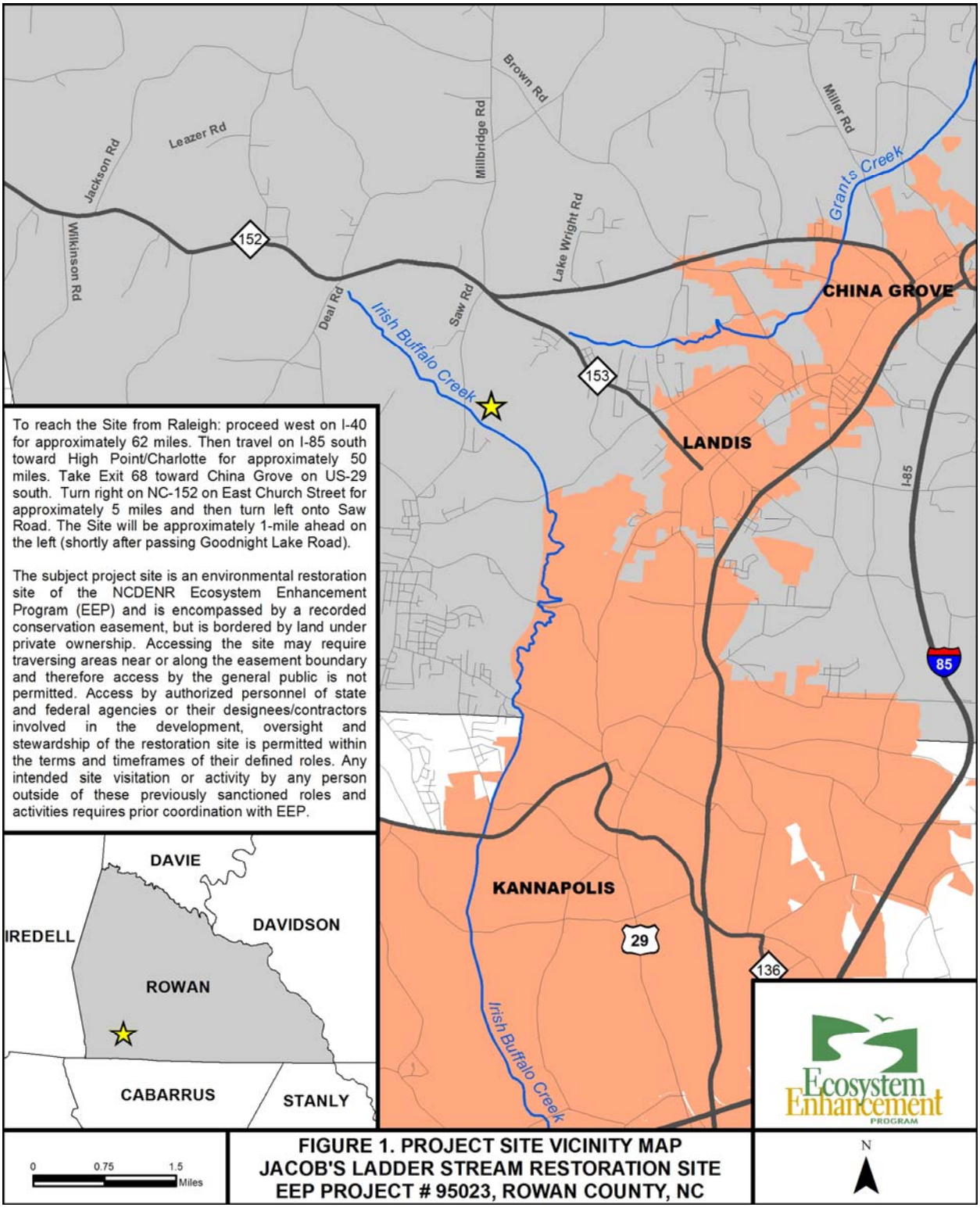

FIGURE 1. PROJECT SITE VICINITY MAP
JACOB'S LADDER STREAM RESTORATION SITE
EEP PROJECT # 95023, ROWAN COUNTY, NC

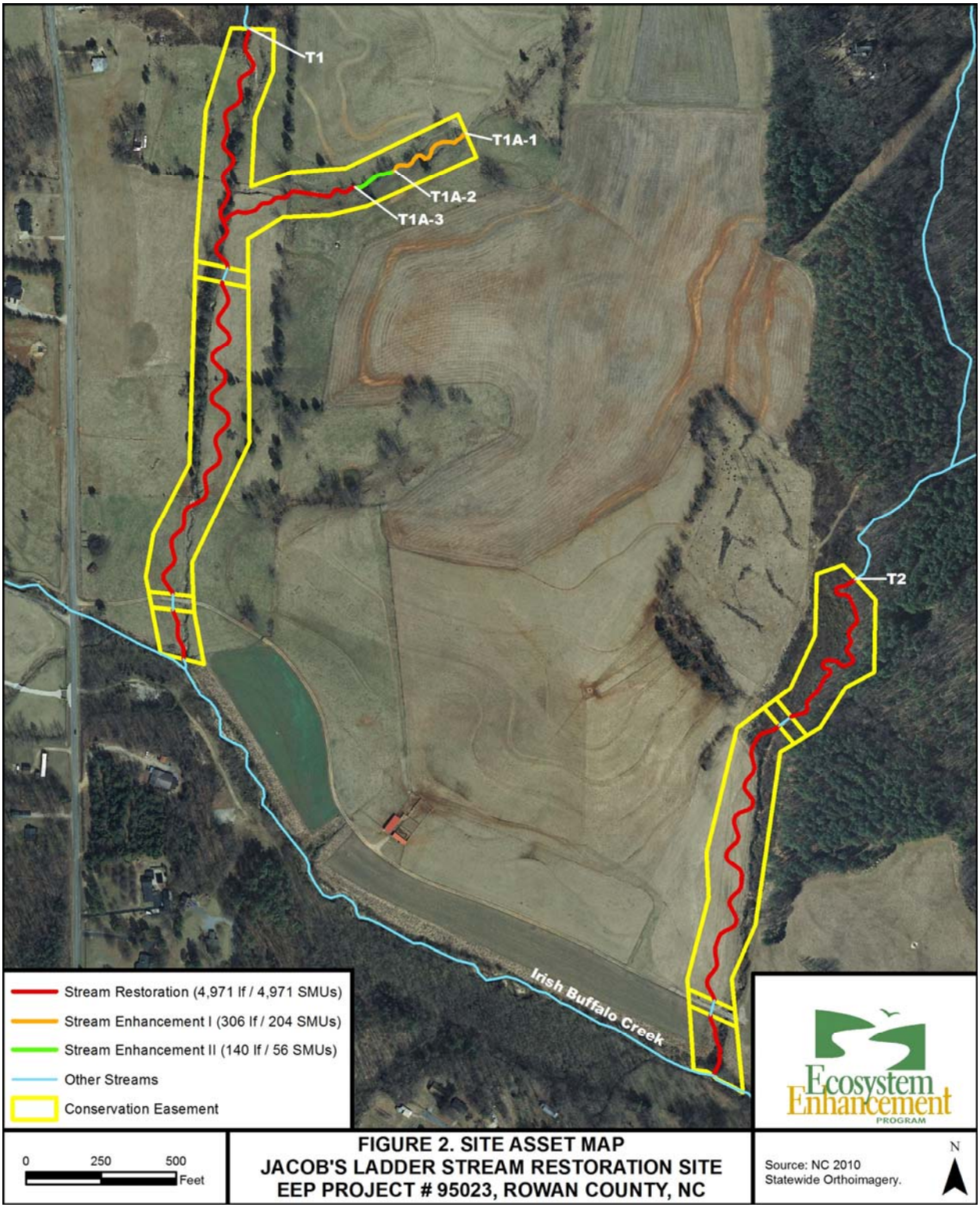
T1
T1A-1
T1A-2
T1A-3
T2
Irish Buffalo Creek
Stream Restoration (4,971 lf / 4,971 SMUs)
Stream Enhancement I (306 lf / 204 SMUs)
Stream Enhancement II (140 lf / 56 SMUs)
Other Streams
Conservation Easement
Ecosystem Enhancement PROGRAM
0 250 500 Feet
FIGURE 2. SITE ASSET MAP
JACOB'S LADDER STREAM RESTORATION SITE
EEP PROJECT # 95023, ROWAN COUNTY, NC
Source: NC 2010 Statewide Orthoimagery.
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Table 1. Project Components and Mitigation Credits
Jacob's Ladder Stream Restoration Site, EEP Project # 95023

Mitigation Credits

	Stream			Riparian Wetland	Non-riparian Wetland	Buffer	Nitrogen Nutrient Offset
Type	R	EI	EII				
Length	4,971	306	140				
Credits	4,971	204	56				
TOTAL CREDITS	5,231						

Project Components

Project Component -or- Reach ID	Design Stationing/ Location	Existing Footage	Approach (P1, P2 etc.)	Restoration -or- Restoration Equivalent	Restoration Footage	Mitigation Ratio
T1	10+00-34+89*	1,809	P1	Restoration	2,389*	1:1
T1A-1	50+00-53+06	306	-	Enhancement I	306	1:1.5
T1A-2	53+06-54+46	140	-	Enhancement II	140	1:2.5
T1A-3	54+46-59+44	470	P1	Restoration	498	1:1
T2	99+75-121+60*	1,246	P1	Restoration	2,084*	1:1

Component Summation

Restoration Level	Stream (linear feet)	Mitigation Units (SMU)
Restoration	4,971	4,971
Enhancement I	306	204
Enhancement II	140	56
TOTAL SMU		**5,231**

*Mitigation units have been calculated to exclude the easement exceptions and water utility easements.

There were no BMP elements included in this project.

Table 2. Project Activity & Reporting History Jacob's Ladder Stream Restoration Site		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Mitigation Plan		Sept 12
Final Design - Construction Plans		Dec 12
Construction		Aug 13
Planting		Jan 14
Baseline Monitoring/Report	Feb/March 14	April 14

Table 3. Project Contacts Jacob's Ladder Stream Restoration Site	
Design Firm	KCI Associates of North Carolina, PC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Tim Morris Phone: (919) 278-2512 Fax: (919) 783-9266
Construction Contractor	Wright Contracting, LLC 160 Walker Road Lawndale, NC 28090 Contact: Mr. Stephen James Phone: (704) 692-4633
Planting Contractor	Forestree Management Co. 1280 Maudis Road Bailey, NC 27807 Contact: Mr. Tony Cortez Phone: (252) 243-2513
Monitoring Performers	
MY-00	KCI Associates of North Carolina, PC 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 Information **Jacob's Ladder Stream Restoration Site**			
Project Name	Jacob's Ladder Stream Restoration Site		
County	Rowan County		
Project Area (acres)	17.2 acres		
Project Coordinates (lat. and long.)	35.552956 N, 80.653116 W		
Project Watershed Summary Information			
Physiographic Province	Piedmont		
River Basin	Yadkin-Pee Dee		
USGS Hydrologic Unit 8-digit	03040105	USGS Hydrologic Unit 14-digit	03040105020040
DWQ Sub-basin	13-17-09		
Project Drainage Area	682 acres/1.06 square miles		
Project Drainage Area Percentage of Impervious Area	1.1%/8 acres		
CGIA Land Use Classification	15.8% Cultivated, 35.1% Managed Herbaceous Cover, 41.6% Mixed Upland Hardwoods, 6.9% Mixed Hardwoods/Conifers, and 0.5% Southern Yellow Pine		
Reach Summary Information (Post-Restoration)			
Parameters	**T1**	**T1A-1, T1A-2, T1A-3**	**T2**
Length of reach (linear feet)	2,389	944	2,084
Valley classification	VIII	VIII	VIII
Drainage area (acres)	231.6 acres	34.5 acres	450.1 acres
NCDWQ Water Quality Classification	Class C, WSIII	Class C, WSIII	Class C, WSIII
Morphological Description (stream type)	C4	B4c/C4	C4
Evolutionary trend	Stage II (Constructed)	Stage II (Constructed)	Stage II (Constructed)
Mapped Soil Series	Chewacla loam	Pacolet sandy loam	Pacolet sandy loam & Chewacla loam
Drainage class	Poorly drained	Well drained	Well drained
Soil Hydric status	Non hydric	Non hydric	Non hydric
Slope	0-2%	0-2%	0-2%
FEMA classification	AE (portion in backwater of Irish Buffalo Creek only)	N/A	AE (portion in backwater of Irish Buffalo Creek only)
Native vegetation community	Piedmont Alluvial Forest	Mesic Mixed Hardwood Forest & Piedmont Alluvial Forest	Piedmont Alluvial Forest
Percent composition of exotic invasive vegetation	0%	0%	0%

Regulatory Considerations			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	Yes, received 404 permit	N/A
Waters of the United States – Section 401	Yes	Yes, received 401 permit	N/A
Endangered Species Act*	No	N/A	N/A
Historic Preservation Act*	No	N/A	N/A
Coastal Zone Management Act * (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	Yes	Floodplain development permit completed through Rowan County	N/A
Essential Fisheries Habitat*	No	N/A	N/A

LEGEND

- CONSERVATION EASEMENT
- CROSS-SECTION (XS)
- VEGETATION PLOT (VP)
- PHOTO POINT (PP)
- GAUGE LOCATION

NC GRID
NAD '83

–80' –40' 0' 80' 160'
GRAPHIC SCALE

VP8 VP9 VP10 VP11 VP12 VP13 VP14 VP15 VP16

PP1 PP2 PP3 PP4 PP5

XS1 XS2 XS3 XS4 XS5 (GAUGE 1)

10+00 11+00 12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00 20+00 21+00 22+00 23+00 24+00 25+00 26+00 27+00 28+00 29+00 30+00 31+00 32+00 33+00 34+00 50+00 51+00 52+00 53+00 54+00 55+00 56+00 57+00 58+00 59+00

BEGIN PROFILE T1

50 FEET EASEMENT EXCEPTION

END PROFILE T1

50 FEET EASEMENT EXCEPTION

IRISH BUFFALO CREEK

SAW ROAD S.R. 1350

REVISIONS

NO.	DESCRIPTION	DATE

Ecosystem Enhancement Program

KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

JACOB'S LADDER STREAM MITIGATION PROJECT

CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA

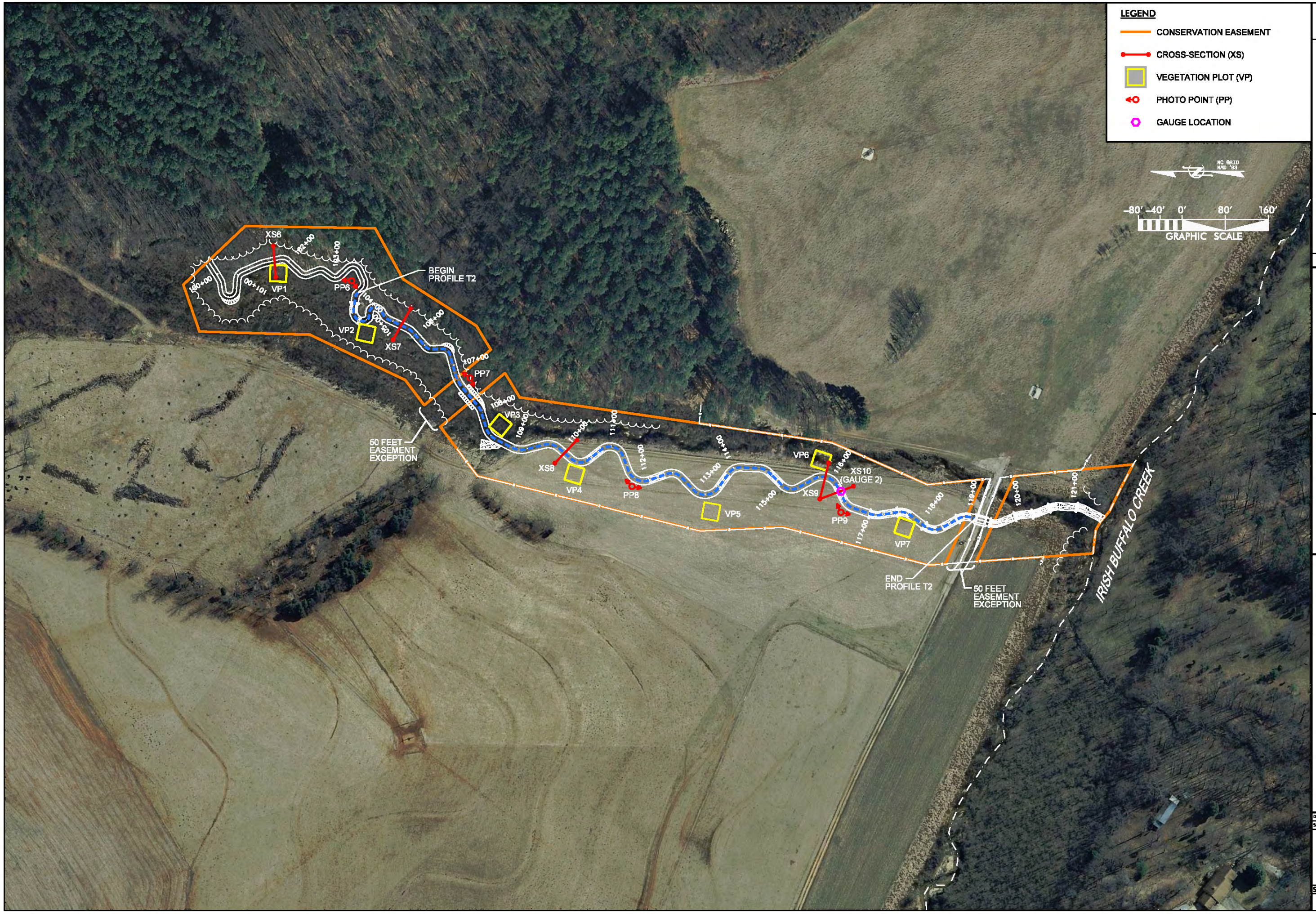
REACH T1

DATE: FEB 2014
SCALE: GRAPHIC

MONITORING PLAN VIEW

SHEET 1 OF 2

FIGURE 3



REVISIONS

NO.	DESCRIPTION	DATE

Ecosystem Enhancement Program

KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

JACOB'S LADDER STREAM MITIGATION PROJECT

CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA

REACH T2

DATE: FEB 2014
SCALE: GRAPHIC

MONITORING PLAN VIEW

SHEET 2 OF 2

FIGURE 3

APPENDIX B

Morphological Summary Data and Plots

Table 5a. T1 Baseline Stream Data Summary
Jacob's Ladder 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)	6.7	8.2		9.6	2	6.9				1	10.3	11.5	10.8	11.3	12.4	3
Floodprone Width (ft)	12	14		16	2	23				1	23	70	>45	>48	>50	3
Bankfull Mean Depth (ft)	1.1	1.3		1.5	2	1.1				1	0.9	1.0	0.8	0.9	1.0	3
Bankfull Max Depth (ft)	1.7	2.1		2.4	2	1.6				1	1.4	1.5	1.3	1.5	1.7	3
Bankfull Cross-Sectional Area (ft^2)	9.8	10.2		10.5	2	7.4				1	9.0	11.0	8.8	10.3	11.6	3
Width/Depth Ratio	4.6	6.7		8.8	2	6.4				1	12.0	12.0	11.2	12.6	13.3	3
Entrenchment Ratio	1.3	1.8		2.2	2	3.4				1	2.2	6.0	3.6	4.3	4.6	3
Bank Height Ratio	2.3	2.8		3.3	2	1.0				1	1.0	1.0	1.0	1.0	1.0	3
Pattern																
Channel Beltwidth (ft)	*					14	26		38	2	25	70	25	48	70	
Radius of Curvature (ft)	*					12	19		25	2	20	45	20	33	45	
Rc:Bankfull width (ft/ft)	*					1.7	2.7		3.6	2	2	4	2	3	4	
Meander Wavelength (ft)	*					43	73		102	2	65	140	65	103	140	
Meander Width Ratio	*					2.0	3.8		5.5	2	2.4	5.8	2.4	4.0	5.8	
Profile																
Riffle Length (ft)													20	31	40	21
Riffle Slope (ft/ft)	0.010			0.035		0.011			0.025	2	0.004	0.017	0.003	0.015	0.022	21
Pool Length (ft)						16			23		12	40	18	28	49	19
Pool Spacing (ft)						28			57		47	95	54	76	95	19
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	0% / 21% / 79% / 0% / 0% / 0%												0% / 4% / 44% / 52% / 0% / 0%			
d16 / d35 / d50 / d84 / d95 (mm)	1 / 6 / 8 / 11 / 17 / 22												27 / 49 / 65 / 89/ 123 / 163			
Additional Reach Parameters																
Channel length (ft)	2,179										2,361		2,389			
Drainage Area (SM)	0.36					0.16					0.36		0.36			
Rosgen Classification	G4					E4					C4		C4			
Sinuosity	1.03					1.18					1.14-1.18		1.14-1.18			
Water Surface Slope (ft/ft)	0.011					0.007					0.011		0.008			

*Not a meandering channel and mostly composed of riffles and runs; therefore no pattern data or pool data was shown.

Table 5b. T2 Baseline Stream Data Summary
Jacob's Ladder 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)	10.6	12.6		16.5	3	6.9				1	13.5	13.5	14.6	14.9	15.2	4
Floodprone Width (ft)	16	24		35	3	23				1	30	70	33	34	66	4
Bankfull Mean Depth (ft)	1.2	1.7		2.3	3	1.1				1	1.1	1.1	0.9	1.1	1.1	4
Bankfull Max Depth (ft)	2.1	2.6		3.4	3	1.6				1	1.8	1.8	1.7	1.7	1.8	4
Bankfull Cross-Sectional Area (ft^2)	18.5	21.4		25.0	3	7.4				1	15.3	15.3	13.9	15.4	16.3	4
Width/Depth Ratio	4.7	8.0		13.2	3	6.4				1	12.0	12.0	13.9	14.4	15.5	4
Entrenchment Ratio	1.5	1.8		2.1	3	3.4				1	2.2	5.2	2.2	3.3	4.4	4
Bank Height Ratio	1.9	2.0		2.0	3	1.0				1	1.0	1.0	1.0	1.0	1.0	4
Pattern																
Channel Beltwidth (ft)	20	40		60	3	14	26		38	2	20	70	20	45	70	
Radius of Curvature (ft)	5	10		15	3	12	19		25	2	20	54	20	37	54	
Rc:Bankfull width (ft/ft)	0.5	1.0		1.4	3	1.7	2.7		3.6	2	2	4	2	3	4	
Meander Wavelength (ft)	23	87		150	3	43	73		102	2	58	140	58	99	140	
Meander Width Ratio	1.8	3.8		5.8	3	2.0	3.8		5.5	2	2.2	5.2	2.2	4.0	5.2	
Profile																
Riffle Length (ft)													5	15	23	23
Riffle Slope (ft/ft)	0.004			0.018	3	0.011			0.025	2			0.001	0.011	0.041	23
Pool Length (ft)						16			23				13	26	49	16
Pool Spacing (ft)						28			57				52	69	92	16
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	4% / 21% / 75% / 0% / 0% / 0%												0% / 20% / 76% / 5% / 0% / 0%			
d16 / d35 / d50 / d84 / d95 (mm)	1 / 2 / 3 / 6 / 11 / 19												1 / 5 / 10 / 22 / 36 / 57			
Additional Reach Parameters																
Channel length (ft)	2,083										2,084		2,084			
Drainage Area (SM)	0.70					0.16					0.70		0.70			
Rosgen Classification	G4					E4					C4		C4			
Sinuosity	1.00-1.47					1.18					1.16-1.45		1.16-1.45			
Water Surface Slope (ft/ft)	0.006-0.013					0.007					0.007-0.012		0.008			

Table 5c. T1A-1, T1A-2 Baseline Stream Data Summary
Jacob's Ladder 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)	12.7				1	7.7	9.3		10.8	2	7.0					
Floodprone Width (ft)	30				1	13	15		16	2	0.9					
Bankfull Mean Depth (ft)	0.4				1	0.7	0.8		0.9	2	0.6					
Bankfull Max Depth (ft)	0.9				1	1.3	1.5		1.7	2	0.9					
Bankfull Cross-Sectional Area (ft^2)	4.5				1	6.1	7.5		8.8	2	3.9					
Width/Depth Ratio	35.8				1	8.5	9.9		11.4	2	12.5					
Entrenchment Ratio	2.4				1	1.6	1.8		2.1	2	2.2					
Bank Height Ratio	1.0				1	1.0				1	1.0					
Pattern																
Channel Beltwidth (ft)	*					22				1	10	30				
Radius of Curvature (ft)	*					11			23	2	12	25				
Rc:Bankfull width (ft/ft)	*					1			3	2	2	4				
Meander Wavelength (ft)	*					49			59	2	55	95				
Meander Width Ratio	*					2			3	2	1.0	4.3				
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)	0.013			0.018	2	0.012			0.028	2	0.006	0.020				
Pool Length (ft)						5			9		7	11				
Pool Spacing (ft)											22	63				
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%						0%, 18%, 82%, 1%, 0%, 0%										
d16 / d35 / d50 / d84 / d95 (mm)						3, 7, 9, 13, 17, 25										
Additional Reach Parameters																
Channel length (ft)	446										446					
Drainage Area (SM)	0.05					0.15					0.05					
Rosgen Classification	C4					B4c					B4c/C4					
Sinuosity	1.11					1.20					1.11					
Water Surface Slope (ft/ft)	0.015					0.012					0.012					

*Not a meandering channel and mostly composed of riffles and runs; therefore no pattern data or pool data was shown.

Table 5d. T1A-3 Baseline Stream Data Summary
Jacob's Ladder 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)	9.3				1	9.0	9.5		10.0	2	6.0					
Floodprone Width (ft)	10				1	13	17		21	2	14					
Bankfull Mean Depth (ft)	0.5				1	1.1	1.1		1.2	2	0.5					
Bankfull Max Depth (ft)	0.7				1	1.3	1.4		1.5	2	0.9					
Bankfull Cross-Sectional Area (ft^2)	4.3				1	10.4	10.5		10.7	2	3.2					
Width/Depth Ratio	20.1				1	8.0	9.0		10.0	2	11.2					
Entrenchment Ratio	1.1				1	1.3	1.8		2.3	2	2.2					
Bank Height Ratio	8.6				1	1.0				1	1.0					
Pattern																
Channel Beltwidth (ft)	*					45				1	15	30				
Radius of Curvature (ft)	*					13			42	2	12	27				
Rc:Bankfull width (ft/ft)	*					1.3			4.4	2	2.0	4.5				
Meander Wavelength (ft)	*					93			136	2	50	80				
Meander Width Ratio	*					4.5			5.0	2	2.5	5.0				
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)						0.013			0.028	2	0.020	0.030				
Pool Length (ft)						3			25	2	6	12				
Pool Spacing (ft)						30			39	2	20	40				
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%																
d16 / d35 / d50 / d84 / d95 (mm)																
Additional Reach Parameters																
Channel length (ft)	470										498					
Drainage Area (SM)	0.05					0.40					0.05					
Rosgen Classification	F4					B4c					B4c/C4					
Sinuosity	1.06					1.20					1.09					
Water Surface Slope (ft/ft)	0.018					0.013					0.017					

*Not a meandering channel and mostly composed of riffles and runs; therefore no pattern data or pool data was shown.

Table 6. Cross-Section Morphology Data Tables
Jacob's Ladder Stream Restoration Site

Dimension and Substrate	Cross-Section 1 (T1-Riffle) Station 14+75							Cross-Section 2 (T1-Pool) Station 16+40							Cross-Section 3 (T1-Riffle) Station 24+88							Cross-Section 4 (T1-Pool) Station 26+98							Cross-Section 5 (T1-Riffle) Station 28+75						
Based on fixed baseline elevation	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	10.4							11.5							11.6							17.0							10.8						
Floodprone Width (ft)	>50							-							>45							-							>50						
Bankfull Mean Depth (ft)	1.0							1.3							0.9							1.3							0.8						
Bankfull Max Depth (ft)	1.6							2.2							1.7							3.0							1.3						
Bankfull Cross-Sectional Area (ft^2)	10.8							9.1							12.4							21.4							8.8						
Bankfull Width/Depth Ratio	11.2							-							13.3							-							13.3						
Bankfull Entrenchment Ratio	4.6							-							3.6							-							4.6						
Bankfull Bank Height Ratio	1.0							-							1.0							-							1.0						
d50 (mm)	91							-							46							-							59						

	Cross-Section 6 (T2-Riffle) Station 101+73							Cross-Section 7 (T2-Riffle) Station 105+67							Cross-Section 8 (T2-Riffle) Station 110+00							Cross-Section 9 (T2-Pool) Station 115+88							Cross-Section 10 (T2-Riffle) Station 116+28						
Based on fixed baseline elevation	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	13.9							15.2							14.6							17.5							15.0						
Floodprone Width (ft)	35.0							33.0							>60							-							>66						
Bankfull Mean Depth (ft)	0.9							1.1							1.0							1.5							1.1						
Bankfull Max Depth (ft)	1.8							1.7							1.7							3.2							2.0						
Bankfull Cross-Sectional Area (ft^2)	14.7							16.3							15.2							26.5							16.2						
Bankfull Width/Depth Ratio	15.5							14.2							14.0							-							13.9						
Bankfull Entrenchment Ratio	2.4							2.2							4.1							-							4.4						
Bankfull Bank Height Ratio	1.0							1.0							1.0							-							1.0						
d50 (mm)	21							5							4							-							10						

Photo Reference Points

PP1U – MY-00 – 3/11/14

PP1D – MY-00 – 3/11/14

PP2U – MY-00 – 3/11/14

PP2D – MY-00 – 3/11/14

PP3 Tributary – MY-00 – 3/11/14

PP3U – MY-00 – 3/11/14

PP3D – MY-00 – 3/11/14

PP4U – MY-00 – 3/11/14

PP4D – MY-00 – 3/11/14

PP5U – MY-00 – 3/11/14

PP5D – MY-00 – 3/11/14

PP6U – MY-00 – 3/11/14

PP6D – MY-00 – 3/11/14

PP7U – MY-00 – 3/11/14

PP7D – MY-00 – 3/11/14

PP8U – MY-00 – 3/11/14

PP8D – MY-00 – 3/11/14

PP9U – MY-00 – 3/11/14

PP9D – MY-00 – 3/11/14

APPENDIX C

Vegetation Data

Table 7. CVS Stem Count Total and Planted by Plot and Species

Jacobs Ladder Stream Restoration Site (EEP Project Code 95023)			Current Plot Data (MY0 2014)																								
			95023-01-0001			95023-01-0002			95023-01-0003			95023-01-0004			95023-01-0005			95023-01-0006			95023-01-0007			95023-01-0008			95023-01-0009		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Betula nigra	river birch	Tree	1	1	1	8	8	8	5	5	5				2	2	2	2	2	2							5	5	5
Diospyros virginiana	common persimmon	Tree																											
Liriodendron tulipifera	tuliptree	Tree							5	5	5				3	3	3	2	2	2							7	7	7
Platanus occidentalis	American sycamore	Tree							2	2	2	15	15	15	5	5	5				9	9	9	3	3	3	2	2	2
Quercus	oak	Tree																											
Quercus nigra	water oak	Tree	1	1	1																								
Quercus phellos	willow oak	Tree	1	1	1													1	1	1	1	1	1	5	5	5	1	1	1
Salix nigra	black willow	Tree				3	3	3	2	2	2				4	4	4				4	4	4						
Unknown		Shrub or Tree	4	4	4	2	2	2	1	1	1							1	1	1	1	1	1	8	8	8	2	2	2
		Stem count	7	7	7	13	13	13	15	15	15	15	15	15	14	14	14	6	6	6	15	15	15	16	16	16	17	17	17
		size (ares)	1			1			1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	4	4	4	3	3	3	5	5	5	1	1	1	4	4	4	4	4	4	4	4	4	3	3	3	5	5	5
		Stems per ACRE	283	283	283	526	526	526	607	607	607	607	607	607	567	567	567	243	243	243	607	607	607	647	647	647	688	688	688

Jacobs Ladder Stream Restoration Site (EEP Project Code 95023)			Current Plot Data (MY0 2014)																					Annual Means		
			95023-01-0010			95023-01-0011			95023-01-0012			95023-01-0013			95023-01-0014			95023-01-0015			95023-01-0016			MY0 (2014)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Betula nigra	river birch	Tree				4	4	4							4	4	4	6	6	6	2	2	2	39	39	39
Diospyros virginiana	common persimmon	Tree	1	1	1																			1	1	1
Liriodendron tulipifera	tuliptree	Tree	5	5	5	1	1	1	7	7	7							3	3	3	7	7	7	40	40	40
Platanus occidentalis	American sycamore	Tree				5	5	5	2	2	2	13	13	13	2	2	2	4	4	4				62	62	62
Quercus	oak	Tree	2	2	2																			2	2	2
Quercus nigra	water oak	Tree																						1	1	1
Quercus phellos	willow oak	Tree	6	6	6	1	1	1	4	4	4				2	2	2	2	2	2				24	24	24
Salix nigra	black willow	Tree																						13	13	13
Unknown		Shrub or Tree	6	6	6	1	1	1	4	4	4	5	5	5	8	8	8	2	2	2	6	6	6	51	51	51
		Stem count	20	20	20	12	12	12	17	17	17	18	18	18	16	16	16	17	17	17	15	15	15	233	233	233
		size (ares)	1			1			1			1			1			1			1			16		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.40		
		Species count	5	5	5	5	5	5	4	4	4	2	2	2	4	4	4	5	5	5	3	3	3	9	9	9
		Stems per ACRE	809	809	809	486	486	486	688	688	688	728	728	728	647	647	647	688	688	688	607	607	607	589	589	589

Vegetation Monitoring Plot Photos

Vegetation Plot 1 – MY-00 – 2/19/14

Vegetation Plot 2 – MY-00 – 2/19/14

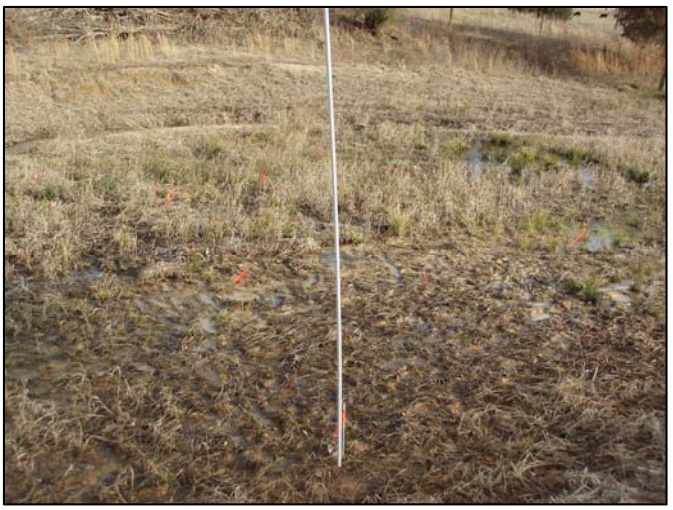
Vegetation Plot 3 – MY-00 – 2/19/14

Vegetation Plot 4 – MY-00 – 2/19/14

Vegetation Plot 5 – MY-00 – 2/19/14

Vegetation Plot 6 – MY-00 – 2/19/14

Vegetation Plot 7 – MY-00 – 2/19/14



Vegetation Plot 8 – MY-00 – 2/19/14

Vegetation Plot 9 – MY-00 – 2/19/14

Vegetation Plot 10 – MY-00 – 2/19/14

Vegetation Plot 11 – MY-00 – 2/19/14

Vegetation Plot 12 – MY-00 – 2/19/14

Vegetation Plot 13 – MY-00 – 2/20/14

Vegetation Plot 14 – MY-00 – 2/20/14

Vegetation Plot 15 – MY-00 – 2/19/14

Vegetation Plot 16 – MY-00 – 2/19/14

APPENDIX D

As-Built Plan Sheets

KCI JOB# : 20110669

CONTRACT #: 003983

STATE OF NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

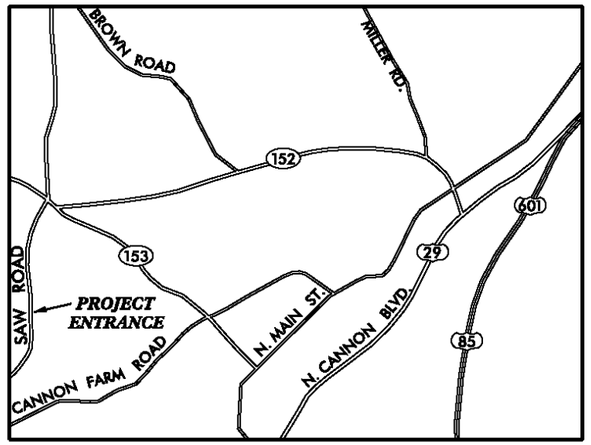
STATE	CONTRACT NUMBER	SHEET NO.	TOTAL SHEETS
N.C.	003983	1	10

NO.	DESCRIPTION	DATE
	REVISIONS	

ROWAN COUNTY

LOCATION: JACOB'S LADDER
CHINA GROVE, NORTH CAROLINA

TYPE OF WORK: STREAM MITIGATION

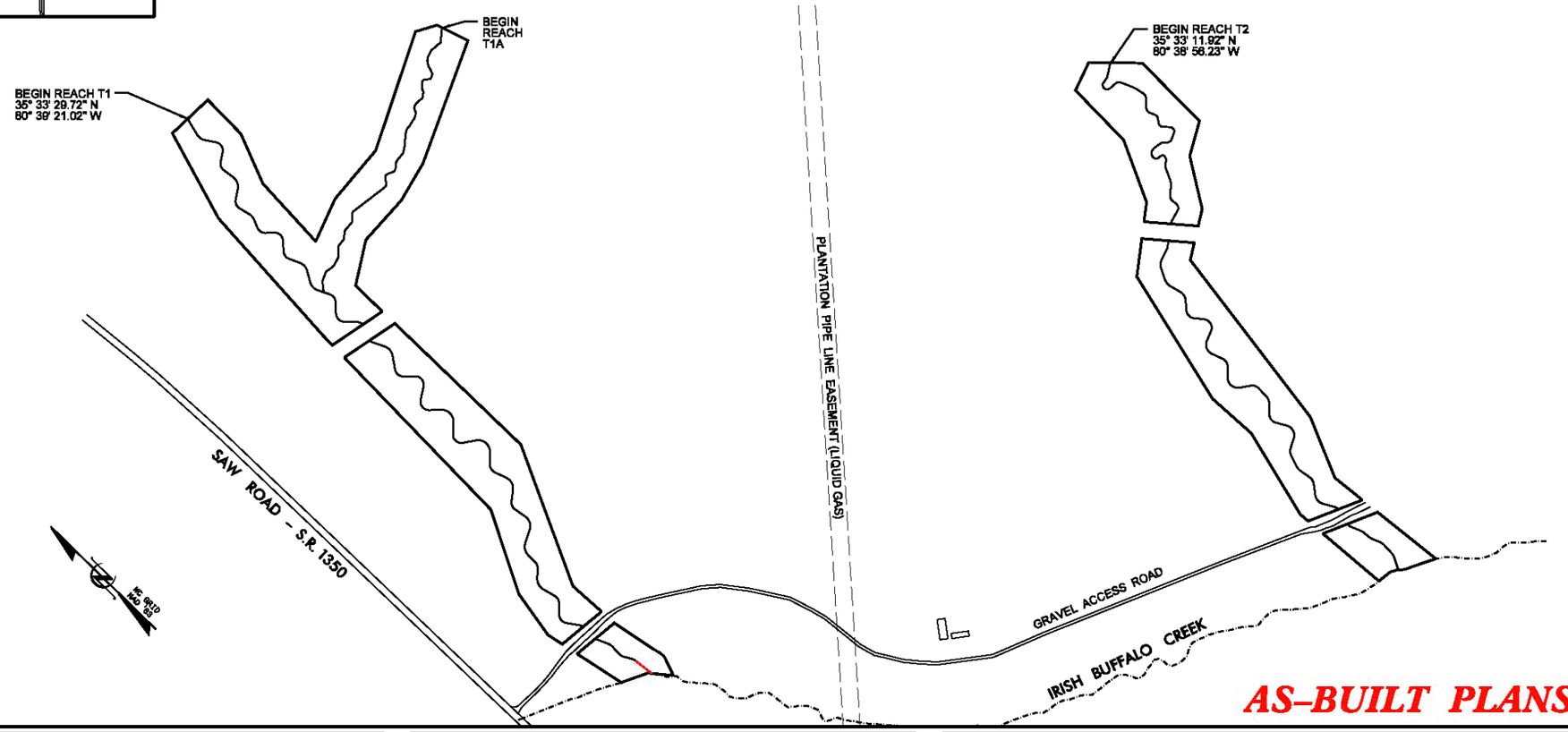


VICINITY MAP
NOT TO SCALE

DIRECTIONS TO SITE

FROM RALEIGH, TAKE I-40 WEST. SLIGHT LEFT ONTO I-85 BUS S/US-29 S/US-70 W (signs for High Point/Charlotte). FOLLOW I-85 SOUTH TO EXIT 68. MERGE ONTO US-29 CONNECTOR SOUTH. TURN RIGHT ONTO NORTH CAROLINA 152 W/CHURCH STREET. TURN LEFT ONTO SAW ROAD. THE SITE WILL BE ON THE LEFT IN APPROX 1.5 MILES, JUST BEFORE THE IRISH BUFFALO CREEK BRIDGE.

INDEX OF SHEETS



AS-BUILT PLANS

GRAPHIC SCALES

–150'–75' 0' 150' 300'
AS-BUILT SITE PLAN (OVERVIEW)

–40'–20' 0' 40' 80'
AS-BUILT SITE PLAN

–80'–40' 0' 80' 160'
PLANTING PLAN

PROJECT DATA

STREAM RESTORATION LENGTH = 4,971 FEET

STREAM ENHANCEMENT I LENGTH = 306 FEET

STREAM ENHANCEMENT II LENGTH = 140 FEET

Prepared in the Office of:

KCI Associates of North Carolina, P.A.
SUITE 220 LANDMARK CENTER II, 4601 SIX FORKS RD., RALEIGH, NC
ENGINEERS • PLANNERS • ECOLOGISTS

ALEX FRENCH
NATURAL CHANNEL DESIGN

PROJECT ENGINEER

GARY M. MRYNCZA, P.E.

SIGNATURE: *P.E.*

Prepared for:

Ecosystem PROGRAM

GUY PEARCE
CONTRACT ADMINISTRATOR

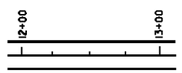
GENERAL NOTES:

1. THIS PLAT DOES NOT REPRESENT A BOUNDARY SURVEY OF THE PARENT TRACTS. THE PARENT TRACT BOUNDARIES ADJACENT TO THIS EASEMENT ARE NOT CHANGED BY THIS PLAT. BOUNDARY INFORMATION SHOWN HEREON WAS DERIVED FROM DEEDS AND MAPS OF THE ROWAN COUNTY AND MONUMENTATION FOUND IN THE FIELD.
2. DISTANCES SHOWN ARE HORIZONTAL GROUND DISTANCES IN U.S. SURVEY FEET UNLESS OTHERWISE NOTED.
3. THE BASIS OF THE MERIDIANS AND COORDINATES FOR THIS PLAT IS THE NORTH CAROLINA STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM 1983 (NAD 83), BASED ON DIFFERENTIAL GPS OBSERVATIONS PERFORMED IN SEPTEMBER 2013.
4. VERTICAL DATA SHOWN HEREON BASED ON NAVD '88.
5. DEED REFERENCES:
   - DB 1200 PG 471
   - DB 1200 PG 470
   - DB 875 PG 742
   - DB 915 PG 687
6. SUBJECT PROPERTIES KNOWN AS TAX NUMBER:
   - #236 00901
   - #236 061
   - #236 006
   - #236 011
7. SUBJECT PROPERTIES PARTIALLY LIE WITHIN THE AREA DESIGNATED AS ZONE "AE", BASED ON FEDERAL FLOOD INSURANCE RATE MAP 3710560600J EFFECTIVE JUNE 16, 2009 AND 3710560500J EFFECTIVE JUNE 16, 2009.
6. NO UNDERGROUND UTILITIES LOCATED DURING THE COURSE OF THIS SURVEY.

CONTROL POINTS

POINT	NORTHING	EASTING	ELEV
KCI#200	660187.98	1507242.72	752.49
KCI#201	660562.91	1507406.56	755.82
KCI#202	660971.39	1507344.85	766.37
KCI#203	661348.28	1507516.64	766.42
KCI#204	661801.87	1507392.85	776.44
KCI#205	662176.86	1507619.34	782.90
KCI#206	661591.88	1507734.70	782.39
KCI#207	661796.49	1507969.13	796.08
KCI#208	661776.39	1508264.75	798.10
KCI#209	658829.41	1509161.35	748.26
KCI#210	659187.37	1509044.57	744.55
KCI#211	659476.09	1509073.94	746.95
KCI#212	659863.29	1509174.30	753.51
KCI#213	660114.71	1509612.70	774.32
KCI#214	660371.22	1509527.41	759.10
KCI#215	660068.47	1509513.35	756.43
KCI#216	660337.35	1509561.17	758.21
KCI#217	660563.04	1507406.33	755.07
KCI#218	660095.14	1507357.49	750.47

PROJECT LEGEND:

Thalweg with Approximate Bankfull Limits ..... 

Step Pool ..... 

Riffle Grade Control ..... 

Soil Lift ..... 

Riffle Enhancement ..... 

Existing Woods Line ..... 

Minor Contour Line .....

Major Contour Line .....

New Woven Wire Fence .....

Overhead Power Line .....

REVISIONS

STAL	DESCRIPTION	DATE

Ecosystem

KCI ASSOCIATES OF NC
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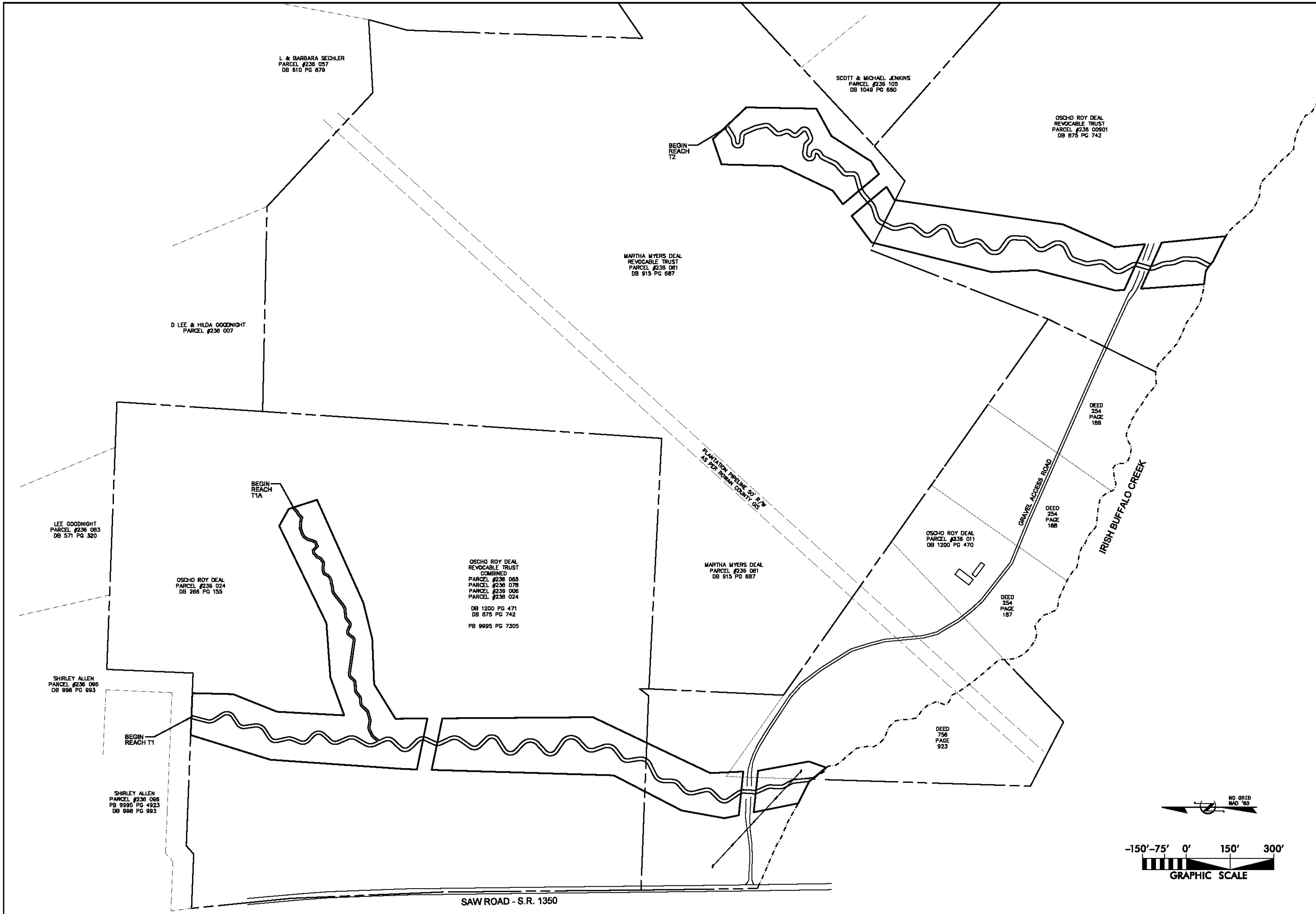
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

JACOB'S LADDER
STREAM MITIGATION PROJECT
CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA

DATE: MARCH 2014
SCALE: N.T.S.

PROJECT LEGEND & NOTES



REVISIONS

SYM.	DESCRIPTION	DATE

Ecosystem

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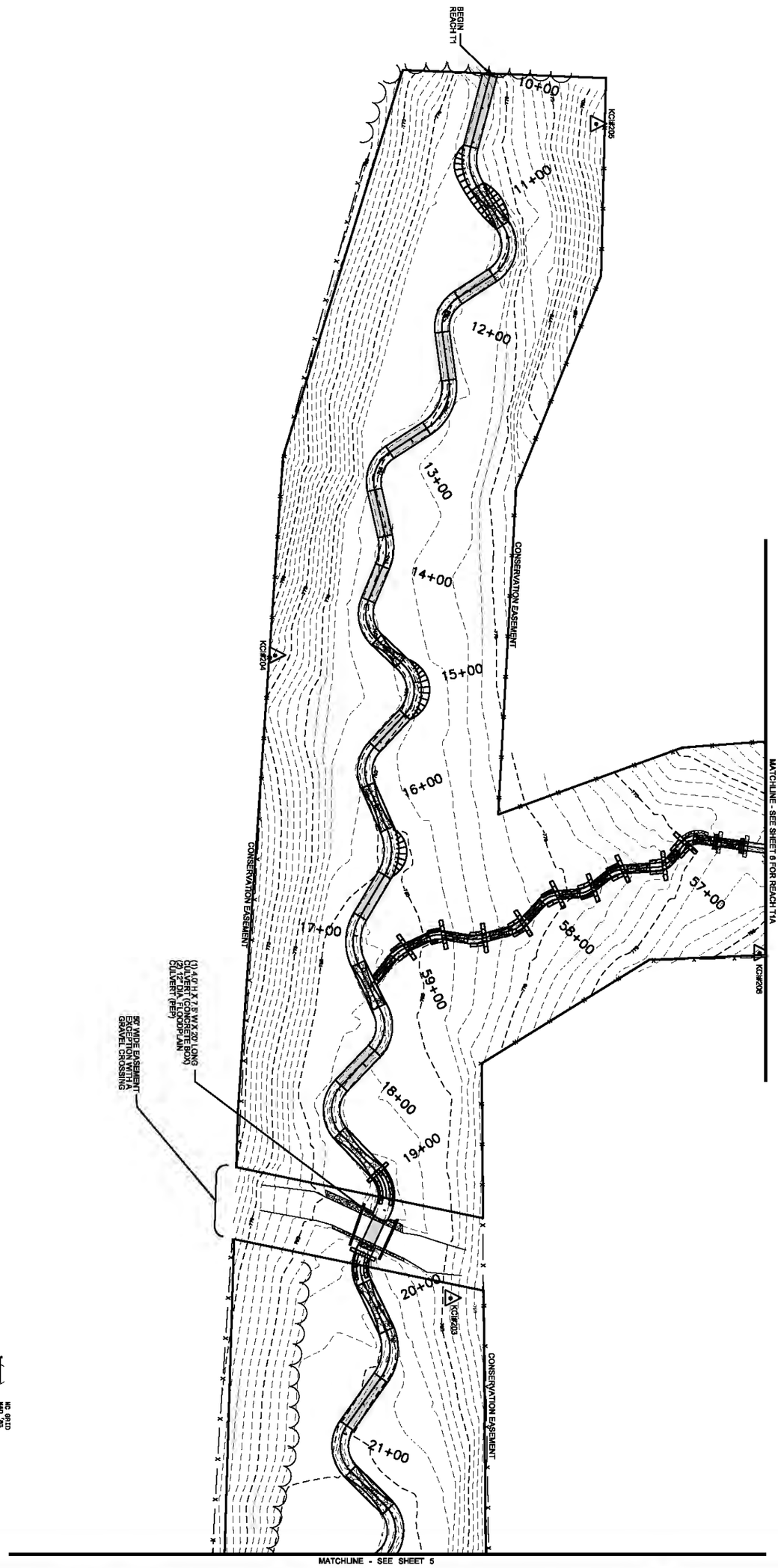
JACOB'S LADDER
STREAM MITIGATION PROJECT
CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA
REACHES T1, T1A AND T2

DATE: MARCH 2014
SCALE: GRAPHIC

AS-BUILT
SITE PLAN
(OVERVIEW)

SHEET 3 OF 10



SHEET 4 OF 10

AS-BUILT SITE PLAN

DATE: MARCH 2014
SCALE: GRAPHIC

JACOB'S LADDER
STREAM MITIGATION PROJECT

CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA

REACH T1

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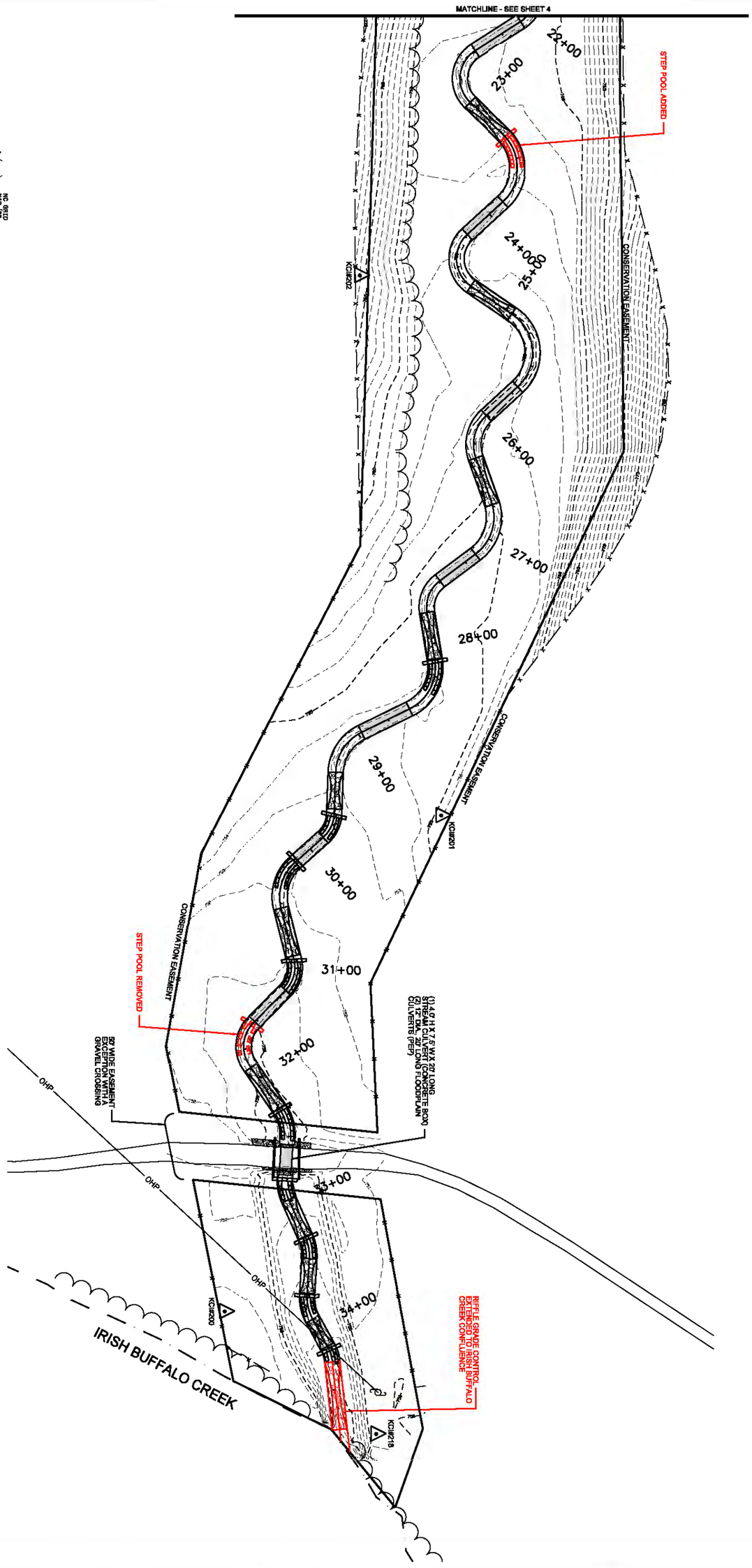
Ecosystem Enhancement

SYM.	DESCRIPTION	DATE
	REVISIONS	



SHEET 5 OF 10

AS-BUILT SITE PLAN

DATE: MARCH 2014

SCALE: GRAPHIC

JACOB'S LADDER STREAM MITIGATION PROJECT

CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA

REACH T1

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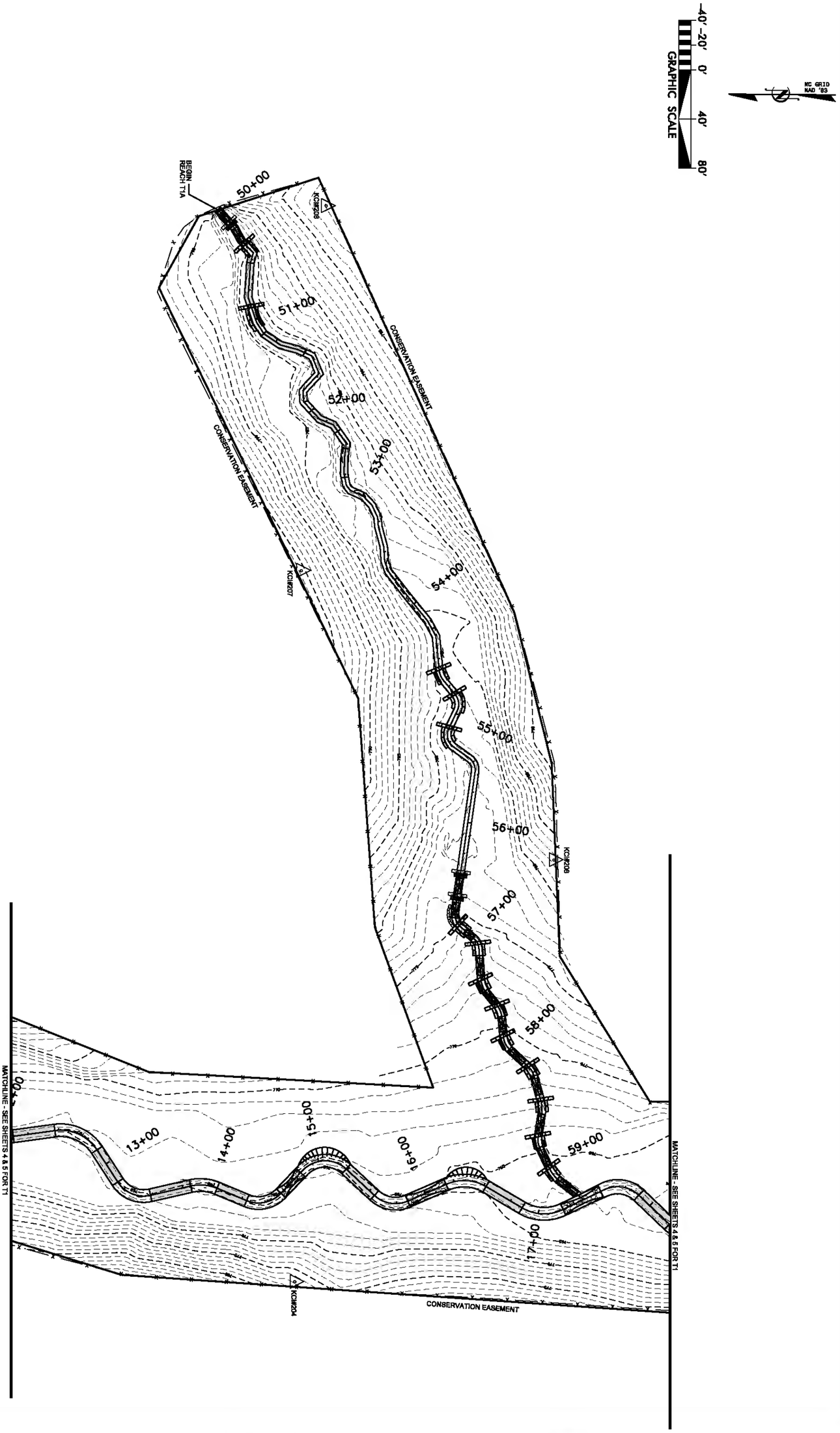
Ecosystem Enhancement

SYM.	DESCRIPTION	DATE
	REVISIONS	



SHEET 6 OF 10

AS-BUILT SITE PLAN

DATE: MARCH 2014
SCALE: GRAPHIC

JACOB'S LADDER
STREAM MITIGATION PROJECT

CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA

REACH T1A

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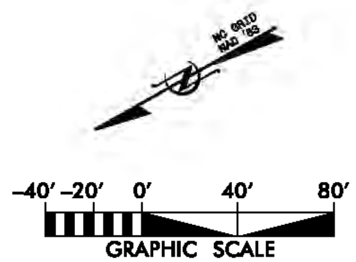
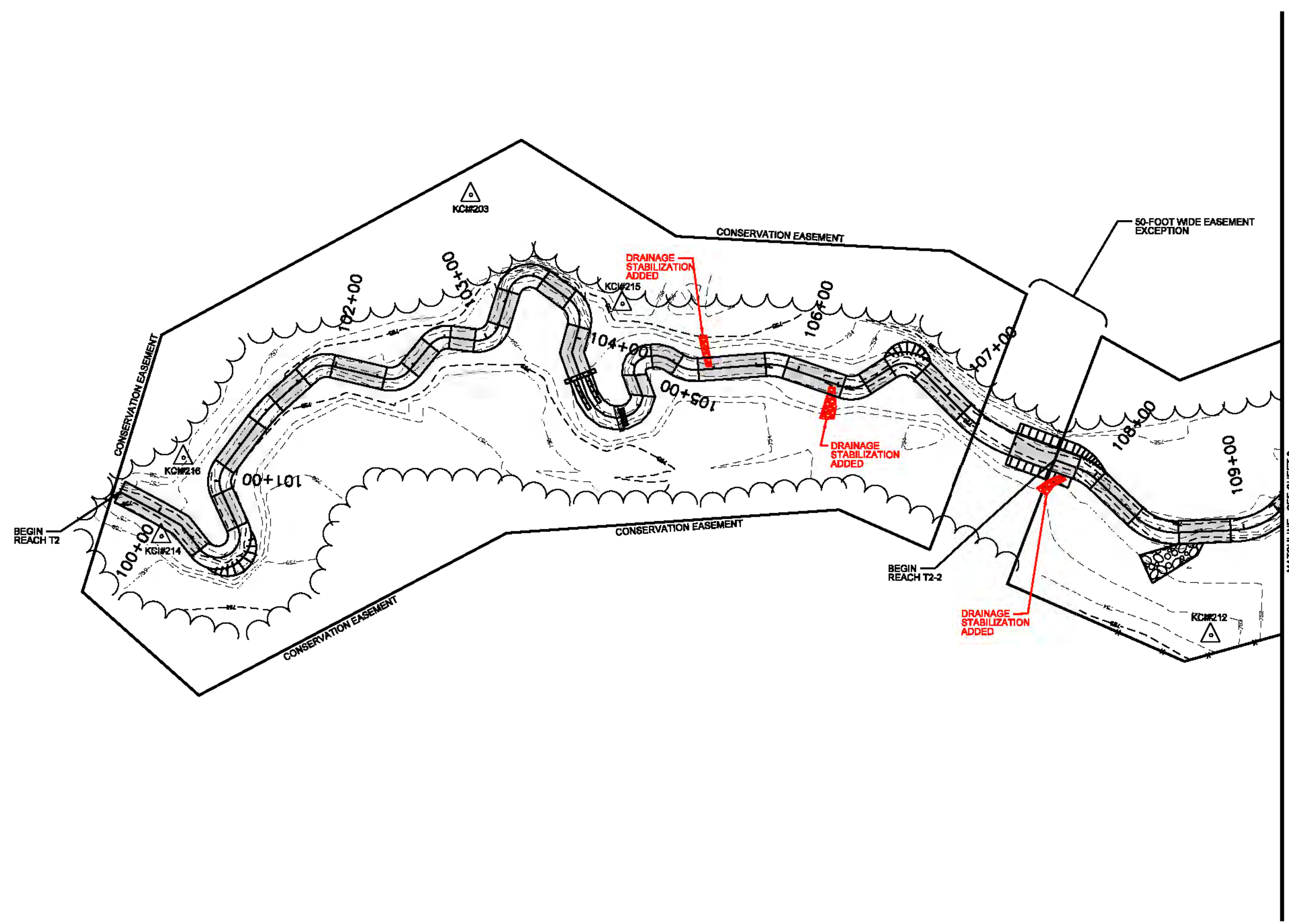
Ecosystem Enhancement

SYM.	DESCRIPTION	DATE
	REVISIONS	





REVISIONS

Ecosystem Enhancement

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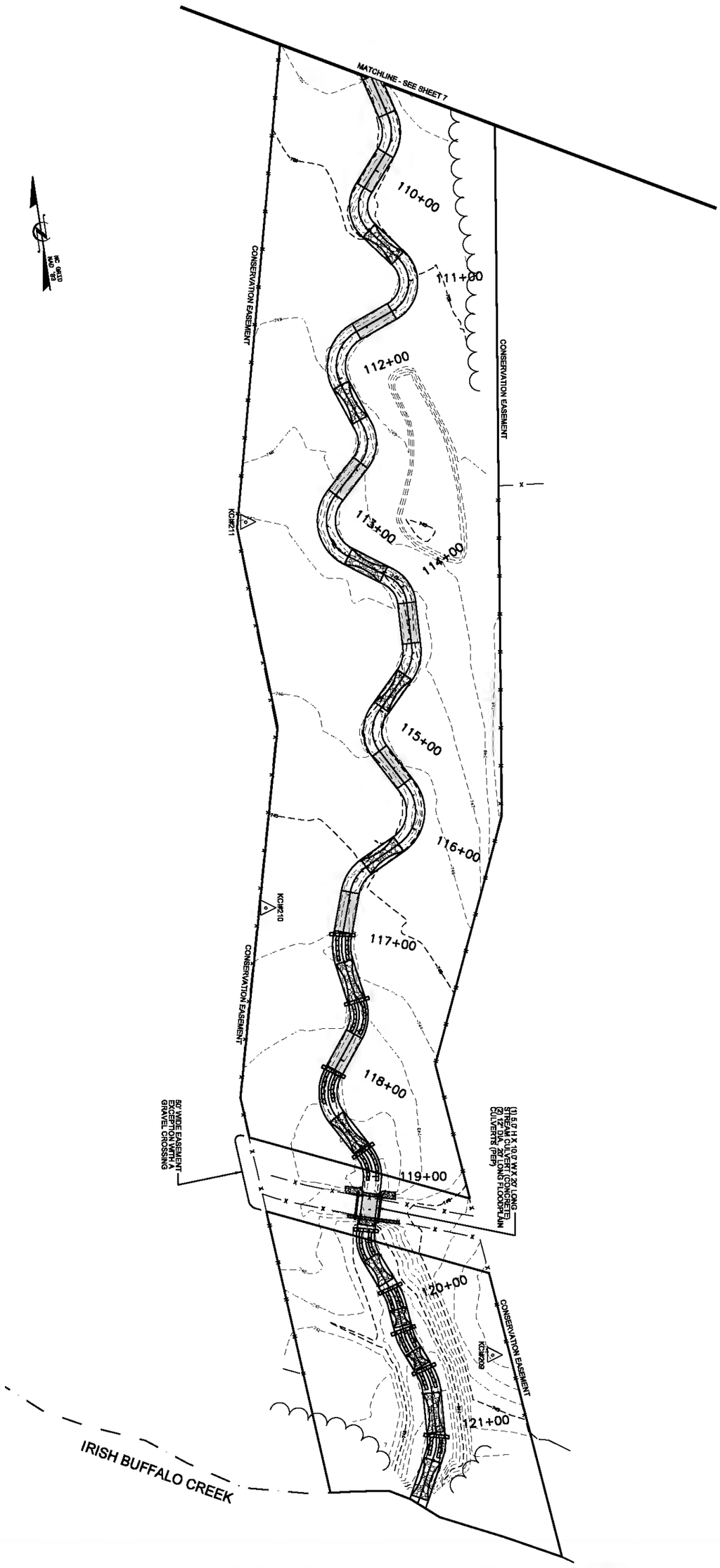
JACOB'S LADDER
STREAM MITIGATION PROJECT
CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA
REACH T2

DATE: MARCH 2014
SCALE: GRAPHIC

AS-BUILT
SITE PLAN

SHEET 7 OF 10



SHEET 8 OF 10

AS-BUILT SITE PLAN

DATE: MARCH 2014
SCALE: GRAPHIC

JACOB'S LADDER STREAM MITIGATION PROJECT

CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA

REACH T2

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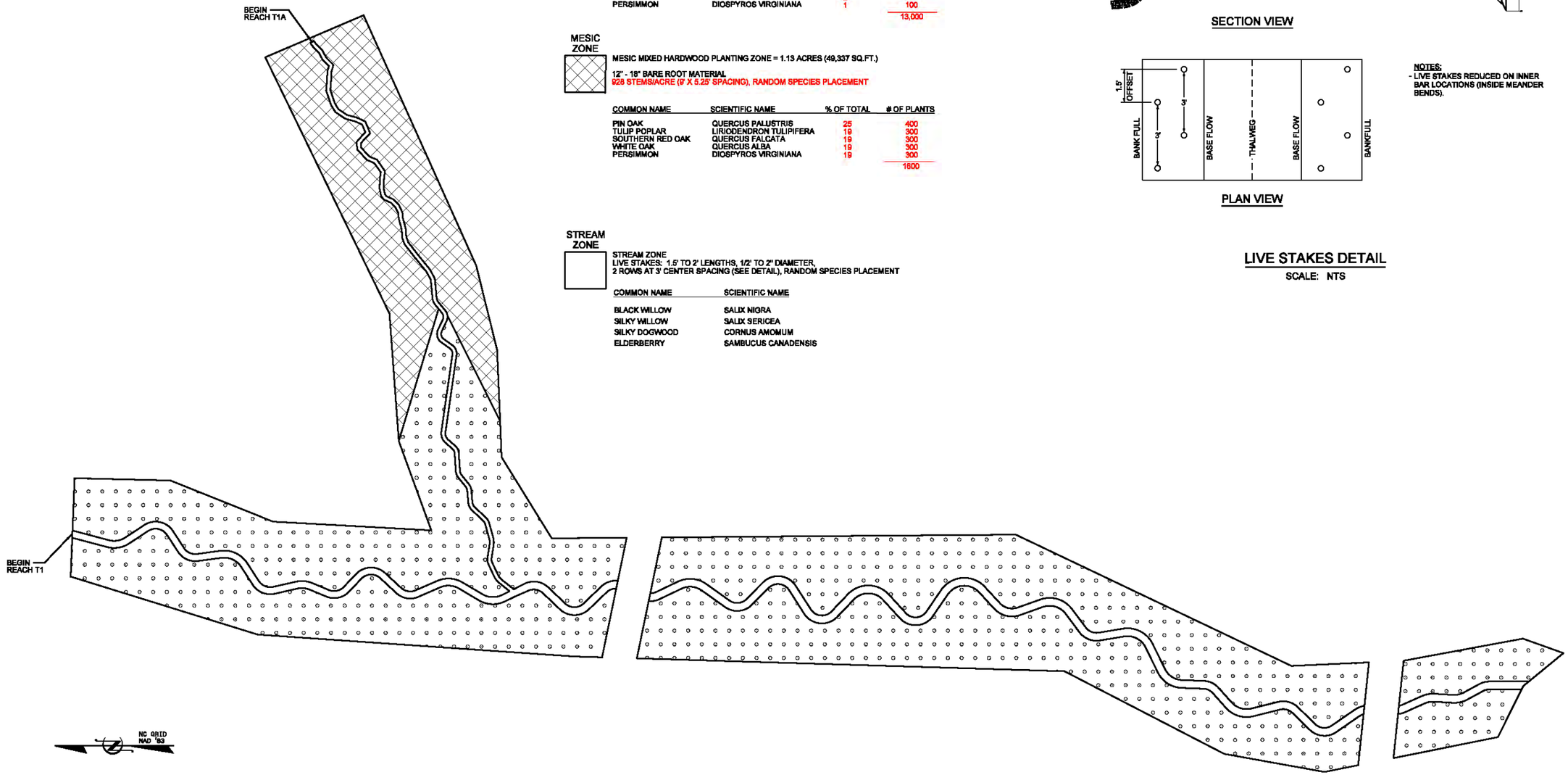
Ecosystem Enhancement

SYM.	DESCRIPTION	DATE
	REVISIONS	



RIPARIAN ZONE

PIEDMONT ALLUVIAL PLANTING ZONE = 14.2 ACRES (617,579 SQ.FT.)

12" - 18" BARE ROOT MATERIAL
928 STEMS/ACRE (9' X 5.25' SPACING), RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME	% OF TOTAL	# OF PLANTS
RIVER BIRCH	BETULA NIGRA	17	2200
GREEN ASH	FRAXINUS PENNSYLVANICA	15	1900
TULIP POPLAR	LIRIODENDRON TULIPIFERA	12	1600
SYCAMORE	PLATANUS OCCIDENTALIS	13	1700
WILLOW OAK	QUERCUS PHELLOS	15	2000
BEAUTYBERRY	CALLICARPA AMERICANA	17	2200
TAG ALDER	ALNUS SERRULATA	8	1100
SOUTHERN RED OAK	QUERCUS FALCATA	1	100
WHITE OAK	QUERCUS ALBA	2	200
PERSIMMON	DIOSPYROS VIRGINIANA	1	100
			13,000

MESIC ZONE

MESIC MIXED HARDWOOD PLANTING ZONE = 1.13 ACRES (49,337 SQ.FT.)

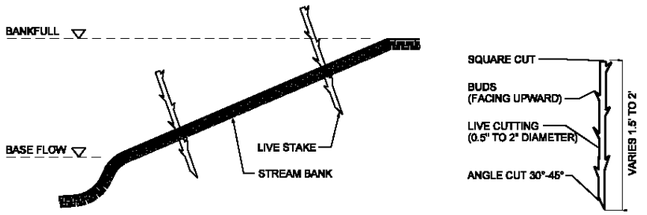
12" - 18" BARE ROOT MATERIAL
928 STEMS/ACRE (9' X 5.25' SPACING), RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME	% OF TOTAL	# OF PLANTS
PIN OAK	QUERCUS PALUSTRIS	25	400
TULIP POPLAR	LIRIODENDRON TULIPIFERA	19	300
SOUTHERN RED OAK	QUERCUS FALCATA	19	300
WHITE OAK	QUERCUS ALBA	19	300
PERSIMMON	DIOSPYROS VIRGINIANA	19	300
			1600

STREAM ZONE

STREAM ZONE
LIVE STAKES: 1.5' TO 2' LENGTHS, 1/2' TO 2" DIAMETER,
2 ROWS AT 3' CENTER SPACING (SEE DETAIL), RANDOM SPECIES PLACEMENT

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



SECTION VIEW

PLAN VIEW

NOTES:
- LIVE STAKES REDUCED ON INNER BAR LOCATIONS (INSIDE MEANDER BENDS).

LIVE STAKES DETAIL

SCALE: NTS

NO.	DESCRIPTION	DATE
	REVISIONS	

Ecosystem Planning & Restoration

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RALEIGH, NORTH CAROLINA 27609

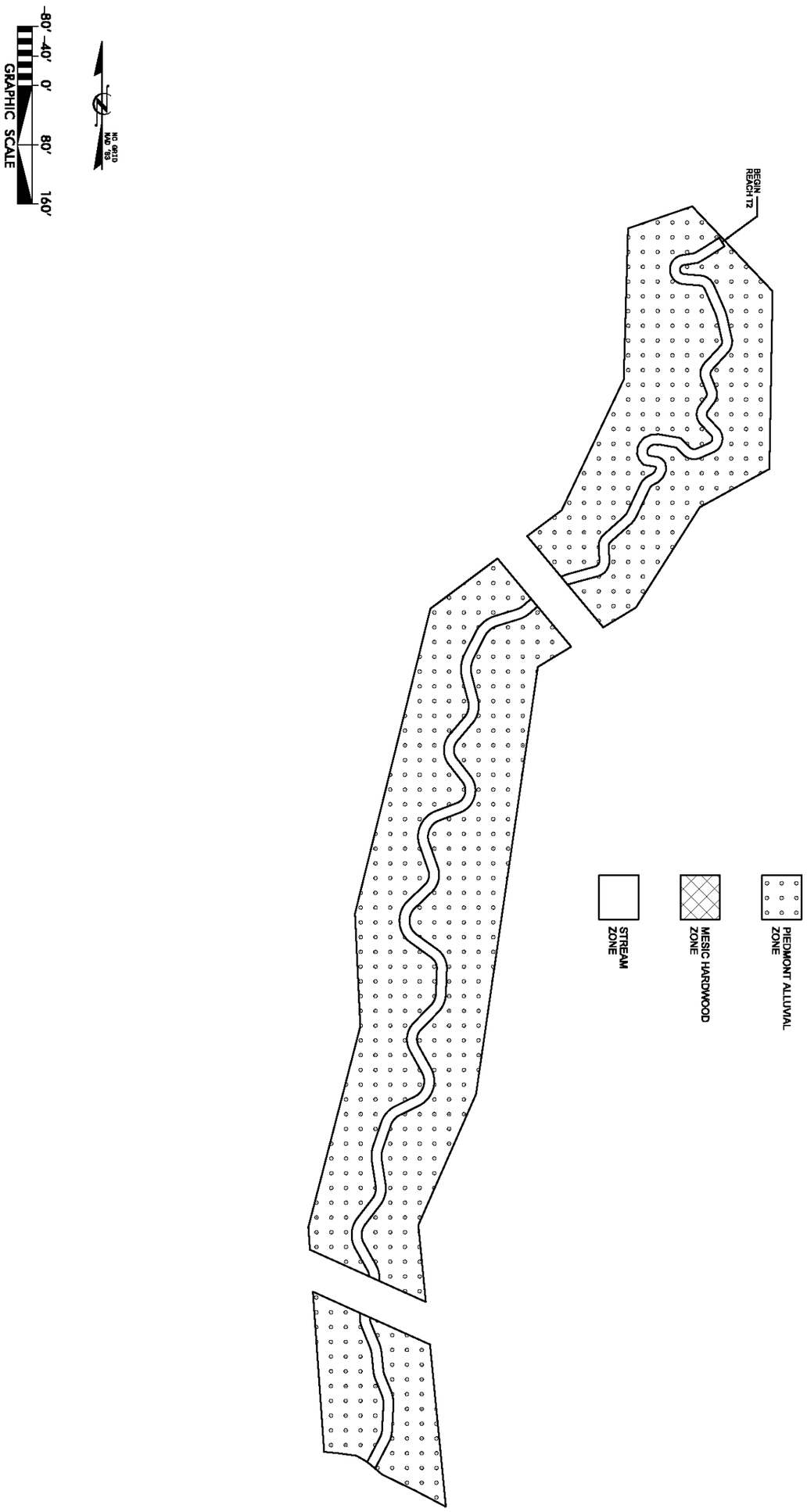
JACOB'S LADDER STREAM MITIGATION PROJECT

CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA

REACHES T1-1, T1-2, T1A-1, T1A-2, AND T1A-3

DATE: MARCH 2014
SCALE: GRAPHIC

PLANTING PLAN



PLANTING PLAN

SHEET 10 OF 10

DATE: MARCH 2014
SCALE: GRAPHIC

JACOB'S LADDER
STREAM MITIGATION PROJECT

CHINA GROVE, ROWAN COUNTY, NORTH CAROLINA

REACHES T2-1 AND 2-2

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Ecosystem

SYM.	DESCRIPTION	DATE
	REVISIONS	