Tarlton Stream and Wetland Restoration Project

Contract #:	D05013-1
County:	Cumberland
Cataloging Unit:	Cape Fear 03030004
Monitoring Firm POC:	Mid-Atlantic Mitigation, LLC Rich Mogensen (704) 782-4133 Kimley-Horn Associates, Inc. Will Wilhelm (704) 333-5131
Prepared For:	EEP Project Manager, Guy Pearce

Mitigation Report

Kimley-Horn
and Associates, Inc.

Mid-Atlantic
Mitigation, LLC
AN EARTHMARK COMPANY

EXECUTIVE SUMMARY

Pre-Construction Site Conditions

The Tarlton Stream and Wetland Restoration Site (Tarlton Site) is located at the intersection of Clearwater Drive and US 401 Bypass (Country Club Drive) in Cumberland County, Fayetteville, N.C. The property was historically impounded by a dam built in the 1970s, creating Country Club Lake by impounding about 4,500 feet of two perennial prongs of unnamed tributaries to Cross Creek. The impoundment was breached by a storm on September 15, 1989, rebuilt in June of 1990, and breached again on March 5, 1994 completely draining the lake. After the second failure in 1994 the dam was never rebuilt nor was the failed dam and spillway ever completely removed. Since 1994, the site has been hydrologically influenced by beaver activity with fluctuating lake levels. The footprint of the open water area of the lake and the extent of functioning stream channel fluctuated with the level of beaver dam development, periodic dam removal or maintenance, and storm events blowing out the structure. Therefore, the streams within the project area have been in constant adjustment (pattern and profile) and sediment transport capacity given the alternating periods of deposition and incision. Prior to October 2005, the site existing conditions consisted of approximately 1,420 linear feet of stream, 5.1 acres of riverine wetland, and 10.3 acres of open water (impounded area from the beaver dams and the relic/failed dam spillway).

The project site contained jurisdictional wetlands and open waters, however with the dynamic nature of the site's hydrology (i.e. impoundment, dam failure, and beaver impoundments/water level fluctuations) the water balance and vegetation communities have been unstable. Limited areas of existing dead scrub-shrub wetlands and remnant areas where wetland hydrology has recently been removed met jurisdictional wetland criteria, however the project goals are to stabilize these communities and to restore natural stream-riverine wetland-floodplain hydrodynamics and functions as noted in the reference. The project watershed area is approximately 2.6 sq. mi. flowing into Cross Creek, a 303(d)-listed stream for impaired biological activity.

Restoration Plan

The objective of the restoration approach is to plan, design, and construct a dynamically stable stream/riparian floodplain and bottomland hardwood riverine wetland community providing an ecological improvement for the entire site and watershed. This project is designed to provide a stream channel that neither aggrades nor degrades while maintaining its dimension, pattern, and profile with the capacity to transport the watershed's water and sediment load. Also, the Tarlton Site aims to reestablish the primary stream and wetland functions associated with nutrient removal and transport, sediment retention, wildlife (both aquatic and terrestrial) habitat, and to provide restoration of riparian zones that have been historically a lakebed. The restoration approach, due to the existing condition (fluctuating open water levels) and varied historical conditions of the site (lake, dry lake bed, beaver impoundments, etc.), involved an "adaptive" management phased process as noted below (Table 1).

Table 1. Timeline of construction sequences

EVENT	DATE
Phase 1:	
~Removal of beaver dam & beavers	November 2005
~200' of priority 1 restoration with grade control structures and BMP installation	December 2005
~Dewater lake bed w/ new channel development	Dec. 2005-March 2006
Phase 2:	
~Livestake new channel	March 2006
~Temporary/permanent seeding	March 2006
~Containerized planting	March 2006
~Bare root planting	March 2006
~ Additional containerized planting	June 2006
~As-Built survey	July 2006

Post Construction Site Conditions

The project was constructed in two phases. The restoration approach established a stable grade control, which maintains the elevation of the entire stream thalweg and the floodplain by controlling the downstream end of the project area. The floodplain elevation below the dam was set by installing several rock-cross vanes and a contructed riffle to hold the grade of the existing lake bottom which is now the floodplain area above the dam. This design provides both secondary water quality and primary flood storage benefits. The Tarlton Site (both streams and wetlands) underwent a natural adjustment to a more stable aquatic ecosystem. The streams continued to re-establish natural channel function. This adaptive management approach allowed the streams to naturally seek equilibrium and appropriate dimension, pattern, and profile as the Tarlton Site stabilizes. The primary restoration approach is to determine whether the stream adjustments trend towards the design criteria and restoration goals based on up-stream reference morphology and vegetation communities.

The riverine wetland and buffer vegetation community will transition as the system seeks hydrologic equilibrium. The sediments were unconsolidated and mucky with saturation. It was anticipated that settling and subsidence would occur throughout the initial growing season, first through evaporation and then through transpiration as the herbaceous cover (seeded and natural propagation) established, this did occur and continues to progress. Areas that were not saturated/ponded (i.e. fringe areas and/or headwater wetlands) were intially planted with bare root seedlings and containerized plants to establish a bottomland hardwood riparian wetland community. Later, thousands of containerized,

bottomland hardwood trees & shrubs were planted throughout the stream and wetland areas.

The Restoration Summary in Section 1 of this Mitigation Report describes the restoration approach and site conditions in greater detail. Based on the Restoration Plan and As-built drawing, the total area of restored riverine wetland is 6.6 acres, and the total area of enhanced wetland is 2.7 acres. The Tarlton Site yields 3,930 stream mitigation units and 8 acres of restored and enhanced wetland mitigation units (3,465 X 1= 3,465, 596 X .666= 397, 341 X .2= 68, 3,465 +397 + 68 = 3, 930 and 6.6 X 1= 6.6, 2.7 X 0.5 =1.4, 6.6 + 1.4 =8).

Table 2. Summary of Mitigation Types

MITIGATION SUMMARY						
MITIGATION TYPE		**RESTORATION (1:1)**	**ENHANCEMENT (1:1.5)**	**PRESERVATION (1:5)**	**TOTAL MUs**	**% RESTORATION**
STREAM	LENGTH (FEET)	3,465	596	341	3,930	88%
	MITIGATION UNITS	3,465	397	68		
RIVERINE WETLAND	AREA (ACRES)	6.6	2.7	-	8.0	83%
	MITIGATION	6.6	1.4	-		

Monitoring Plan

The Monitoring Plan will be discussed in detail in Section 3 of this Mitigation Report. Strategies and methodologies laid out in the Monitoring Plan will be followed for a minimum of five years of monitoring. The stream will be monitored for stability of dimension, pattern, and profile using standard practices including permanent cross ections, riffle-run-pool analysis, and pebble counts. Wetland hydrology and vegetation success will be monitored using self-reading ground water monitoring gages and standardized, randomly placed permanent vegetation plots which will be monitored for species diversity and survival. Monitoring data will be analyzed to determine what remedial actions if any are required and any remedial actions proposed will be detailed in the annual monitoring reports.

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1.0 INTRODUCTION

Project Background

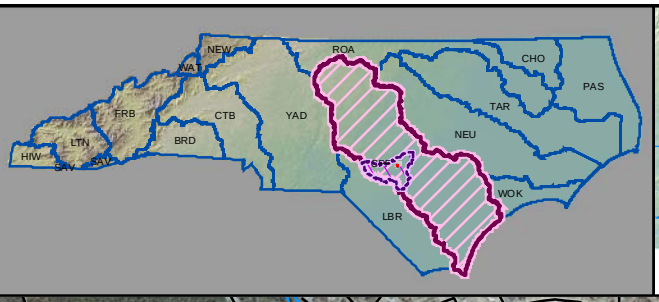
The Tarlton Stream and Wetland Restoration Site (Tarlton Site) is located in the City of Fayetteville, Cumberland County, North Carolina on the corner of Clearwater Drive and US 401 Bypass (Country Club Drive). A location map is included in Figure 1. The project site is located in the Upper Cape Fear River Watershed (USGS 8-digit Hydrologic Unit 03030004, and NCDWQ River Basin 03-06-15), and is within the NC Ecosystem Enhancement Program (EEP) Cross Creek Targeted Local Watershed (00050). The Site was historically impounded by a dam built in the 1970s, creating Country Club Lake by impounding about 4,500 feet of two perennial prongs of the stream. The project drainage area is approximately 2.6 sq. mi. flowing into Cross Creek, a 303(d)-listed stream for impaired biological activity. The eastern prong of the project which is named UT to Cross Creek near Rosehill Road has a drainage area of 1.0 square miles. The western prong which is also a UT to Cross Creek has a drainage area of 1.6 square miles. The project area conservation easement consist of 17.8 acres.

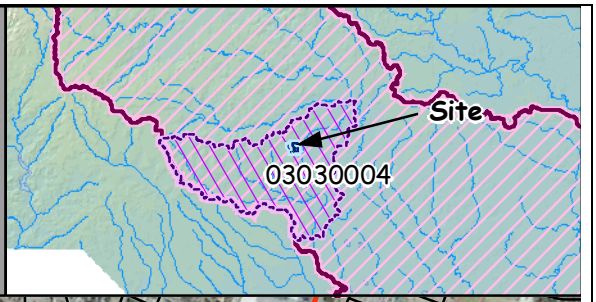
Restoration Summary

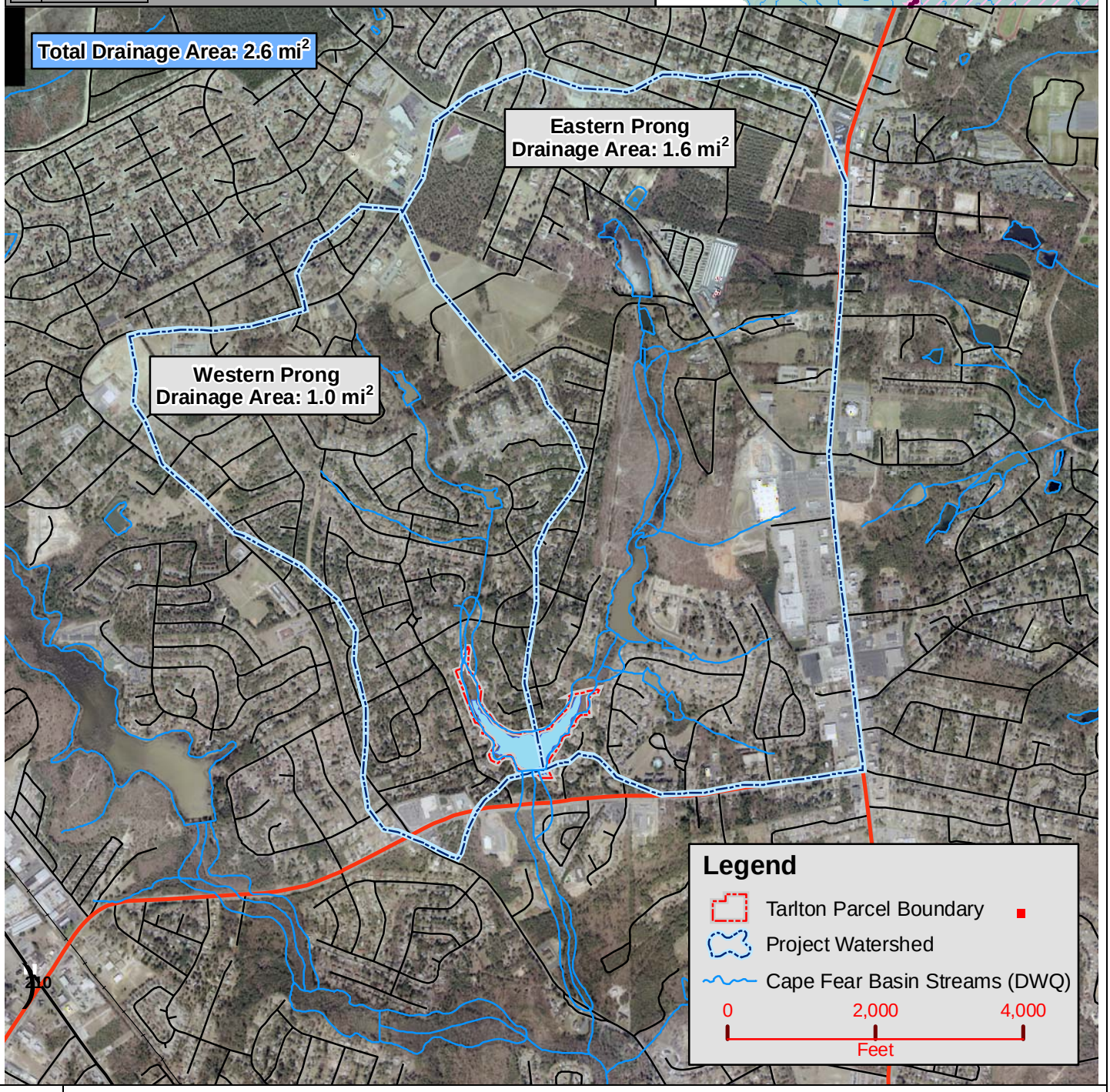
The total area of restored riverine wetland is 6.6 acres, and the total area of enhanced riverine wetland is 2.7 acres. The Tarlton Site yields 3,930 stream mitigation units and 8 riverine wetland mitigation units. The goals and objectives of the Tarlton Stream and Wetland Restoration Project are to restore a naturally stable stream and riparian wetland community; to restore a bottomland hardwood wetland community; and to provide stormwater management from residential run-off. In addition, water quality will be improved, flood storage will be increased, wildlife and aquatic habitat will be restored and the threat of flooding of downstream areas will be eliminated. A Project Map is provided in Attachment B.

Phase I (completed Fall 2005): A beaver management plan was incorporated to remove all the beavers from the project site. The removal of the old dam debris was completed in November and December 2005 making it more difficult for the beavers to re-establish a dam at its existing location. A beaver control program which includes regular site visits to the former dam area has been implemented and will continue throughout the monitoring period. In mid-November 2005, the lake water level was lowered over a 3-5 day period slowly releasing the water downstream to prevent flooding or erosion. In conjunction with removing the beaver dams, the stream section through the area of the historical dam and beaver dams was restored. The channel in this section (approximately 175 feet) was restored using a Priority I (Rosgen) restoration approach. The stream restoration included establishing a bankfull channel and active floodway through the relic spillway/dam and providing a variety of in-stream structures (rock vanes, constructed riffle, and step pool structures) to provide grade control, stability, and improve aquatic habitat diversity. The natural channel design was based on the upstream reference reach. The restoration project was transitioned through and under an existing aerial sanitary

NEW	NEW
PAS	PASQUOTANK
YAD	YADKIN
CHO	CHOWAN
ROA	ROANOKE
TAR	TAR-PAMLICO
NEU	NEUSE
WAT	WATAUGA
CPF	CAPE FEAR
FRB	FRENCH BROAD
CTB	CATAWBA
LTN	LITTLE TENNESSEE
BRD	BROAD
HIW	HIWASSEE
LBR	LUMBER
SAV	SAVANNAH
WOK	WHITE OAK







Title	Project Site Watershed Map (Cumberland County 2001 Aerial)

Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Cumberland County, North Carolina	
	Date	**Project Number**	**Figure**
	11/28/07	012857003	1

sewer crossing that is just beyond the easement limit. In addition to the stream restoration, a BMP (level spreader / pre-formed scour hole) was constructed in this area at the outlet of a stormwater drainage pipe. This restoration establishes a stable grade control, which maintains the elevation of the entire stream thalweg and the floodplain by controlling downstream end of the project area. The floodplain elevation below the dam was set to hold the grade of the existing lake bottom which is now the floodplain area above the dam. This also prevented any sediment that was in the old lake from being washed downstream and to provide a natural "pinch-point" corresponding with existing topography. This pinch-point will help re-establish and control natural hydrology in the proposed riparian wetland during events above bankfull.

Phase II (completed in July 2006): Once the beavers, beaver dams, and impounded water were removed, and the downstream grade control established, the Tarlton Site (both streams and wetlands) underwent a natural adjustment to a more stable aquatic ecosystem. The stream segments found their hydrologic equilibrium and re-established bed and bank features. In addition, the site soils gradually dewatered allowing the deposited sediments to consolidate and subside. During the first growing season the Tarlton Site soils stabilized through evapotranspiration and subsidence processes. The streams continued to re-establish natural channel function, and were evaluated for necessary adjustments. This adaptive management approach allowed the streams to naturally seek equilibrium and appropriate dimension, pattern, and profile as compared to the upstream reference reach. The primary restoration approach is to determine whether the stream adjustments trend towards the design criteria and restoration goals based on reference morphology and vegetation communities. The eastern and western prongs are designed as Rosgen C5->E5 channels. During each monitoring year, where the channel slope and/or dimension are found to be unstable, structures such as rock cross vanes, log cross vanes, log vanes, log sills, and constructed riffles may be utilized to match the channel to the reference morphology.

The riparian wetland and buffer vegetation community will transition as the system seeks hydrologic equilibrium. The initial planting/seeding of the site was completed in March-April 2006 to establish herbaceous cover of exposed bare soils with the expectation that the initial growing season will allow for evapotranspiration to dewater lake bottom sediments. These sediments were initially unconsolidated and mucky with saturation. It was anticipated that settling and subsidence would occur throughout the initial growing season, first through evaporation and then through transpiration as the herbaceous cover (seeded and natural propagation) established. This has occurred as proposed. Areas that are not saturated/ponded (i.e. fringe areas and/or headwater wetlands) were planted with bare root seedlings and containerized plants to establish a bottomland hardwood riparian wetland community. Additional plantings may occur as needed, as the site continues to consolidate and settle.

In order to stabilize the newly constructed stream channel and flood plain areas both temporary and permanent grass seed as well as wetland herbaceous seed were applied to all restored areas. The types of seeds used were: *Leersia oryzoides* (Rice Cut grass); *Panicum clandestinum* (Deertongue grass); *Panicum virgatum* (Switchgrass): *Trisacum*

dactyloides (Gama grass), and *Secale cereale* (Annual rye). Also, a Southeast Wildflower mix was applied throughout the project. Five hardwood planting zones were established as follows: Zone 1 – Stream Channel, Zone 2- Stream Bank, Zone 3 – Bottomland Hardwood wetland, Zone 4 – Swamp Wetland, and Zone 5- Upland fringe. Livestakes were installed along the new constructed channel (approx. 175') within Zone 2. They were planted randomly spaced approximately 3 feet apart and differed in sizes ranging from .25" to 2" in diameter and 2' to 3' in length. Further livestaking may be necessary as the new stream channels stabilize. Zone 3 –5 consists of bareroot seedlings and 1 gallon containerized plants, which were planted randomly 3' to 12' apart throughout the project. A summary showing approximate number of species planted and types of plant material are presented in Table 3, below. For details on plant species and number for each zone see the Planting Zone map in Attachment D.

Table 3: Approximate Number of Planted Species

Tarlton Stream and Wetland Restoration Project			
Scientifice name	**Indicator Status**	**Number of Species Planted**	**Type of material**
Fraxinus pennsylvanica:	FACW	600	1 gallon
Nyssa biflora:	OBL	650	1gallon
Nyssa aquatica:	OBL	75	1gallon
Nyssa slyvatica	FAC	150	1 gallon
Quercus michauxii:	FACW-	100	bareroot
Quercus nigra:	FAC	275	bareroot
Quercus phellos:	FACW-	50/200	1gallon/bareroot
Quercus falcata var. pagodafolia	FAC+	100	bareroot
Quercus shumardii:	FACW-	100	bareroot
Taxodium distichium:	OBL	500	1gallon
Betula nigra:	FACW	500	1gallon
Chamaecyparis thyoides:	OBL	100	1gallon
Cornus amomum:	FACW+	300/100	bareroot/livestake
Salix nigra	OBL	100	livestake
Liriodendron tulipifera:	FAC	75	bareroot
		Total: 3,975	

It is likely that there will be or pockets of ponded and/or saturated areas that will remain throughout the initial growing season. These areas will be identified after the initial growing season and will likely remain as herbaceous emergent wetland vegetation, or will be planted with supplemental containerized plants as necessary prior to the second growing season. These emergent areas will increase the overall diversity of the restored ecosystem and will be noted in the monitoring report.

2.0 MONITORING PLAN

The Tarlton Site will be monitored annually for the next five years (October 2006 through October 2010) by Mid-Atlantic Mitigation, LLC (MAM) and/or Kimley-Horn and Associates, Inc (KHA). The monitoring period should include two separate years with bankfull events. MAM and KHA will be monitoring the Tarlton Site every year and will submit a monitoring report to the NCEEP by December 31st of each calendar year. The Tarlton Site will be monitored in regard to hydrology, overall channel stability (Dimension, Pattern, and Profile), bed material, and vegetative survival. Included in this report are 51 photographs taken at the time of the As-built survey and can be found in Attachment C. Photo locations are included on the As-built plans (Attachment A) and will be included in the annual monitoring reports.

The stream geometry will be considered successful if the cross-section geometry, profile, and sinuosity are stable and reach a dynamic equilibrium as well as being in the geomorphic ranges of the reference reach. It is expected that there will be minimal changes in the resultant cross sections, profile, and/or substrate composition. Changes that may occur during the monitoring period will be evaluated to determine if they represent a movement toward a more unstable condition (e.g. down cutting, erosion, etc.) or are minor changes that represent an increase in stability (e.g. settling, vegetative changes, coarsening of bed material, etc.). An initial, though not exclusive, indicator of success will be adherence to design or reference ratios of stream geometry found in the morphological table (Attachment A) or are comparable to the stable reference system. Deviation from the design ratios will not necessarily denote failure as it is possible to maintain stability and not stay within the exact design geometry. Additionally, determination of true bankfull will be difficult until the stream has had adequate flooding events to create strong bankfull indicators. The following key indicators of stability provide a more complete picture of stream restoration success:

Stream Type: Maintenance of the design stream type or progression or conversion to stable stream type such as C or E will indicate stability;

Bank Height Ratio: Bank height ratio between 1.0 and 1.1 will indicate flood flows have access to the active floodplain and that higher flows do not apply excessive stresses to stream banks.

The nature of the watershed presents challenges to stream restoration. The contributing watersheds lie within a rapidly developing as well as already developed region. The urbanizing watershed's runoff character will continue to change as the nature of the land cover shifts to less permeable surfaces. The hydrograph will shift such that bankfull flooding events will become more frequent and peak discharges will be higher. The cross sections have been designed to account for some shifting in bankfull discharges. Upstream construction activities driven by land development likely will lead to episodic sediment pulses sent downstream through the stream and wetland network. Additionally, erosion of upstream unstable stream banks will persistently contribute sediment to the

project reaches. The plan goals anticipate that the excess sediment will either be routed through the project area or deposited in target areas such as point bars and the floodplain. Minor sedimentation of pools and glides may occur. Ultimately, stream success will be determined by stable channel geomorphology as well as structure integrity and riparian vegetative success.

MAM will ask the NCEEP for written concurrence for each annual monitoring report and a final acceptance at the end of the monitoring period if all success criteria have been achieved.

Hydrology

The minimum requirement to judge establishment of successful wetland hydrology will be adherence to USACE guidelines (United States Army Corps of Engineers 1987) including saturation within the upper 12 inches of the surface of the soils for a period of approximately 24 consecutive days during the growing season (239 days). Further success of the restoration and enhancement of wetland hydrology will be measured by improvements to the frequency and duration of flood flows, groundwater levels, flood storage, and surface water infiltration. Hydrology will be measured using Infinities self-reading groundwater monitoring gages that were installed at the beginning of the restoration efforts. The gages will monitor water table elevations on a daily basis using continuous recorder dataloggers through the monitoring period. There are seven (7) gages located on the Tarlton Site and two (2) reference gages. The data will be downloaded at least 6 times annually. In addition, a stream water level gage will be monitored in relation to a wetland gage within the restoration area for comparison to the wetland reference site. A rain gage is also on-site to monitor the amount of rainfall for comparison to both groundwater and stream levels. In addition, a crest stage gage will be installed below the confluence of the West and East prongs in the area of the old dam(s) to aid in documenting over bank flow events.

Profile

The survey of the longitudinal profiles will monitor the riffle-run-pool-glide sequences and overall stability of the restored stream. The entire length of the restored stream will be monitored for channel stability and in-stream structural integrity. Any evidence of channel instability will be identified, mapped and photographed. Permanent photo reference points will be marked on the As-built plan and will be included in the photo log along with any additional photos of problem areas that may be taken during monitoring. Baseline/year 1 data was collected using traditional surveying techniques. Survey of the longitudinal profile in consecutive years will be done using the same method to track the riffle-run-pool-glide spacing and location, and thalweg elevations for comparison to previous and consecutive years.

Pattern

Evaluation of overall success and stability of the stream will include close observation and photo documentation of all in-stream structures, and any changes to stream pattern such as point bar formation, development of head-cutting, down-cutting, and significant bank degradation or aggradation. Photos of each structure will be included in the Photo

Log along with permanent photo reference points marked on the As-built plan and any additional photos of problem areas that may be taken during monitoring period.

Dimension
There are 5 sets of 2 permanent cross-sections throughout the Tarlton Site for a total of 10 sections. Cross-sections will represent 50% riffles and 50% pools. Each permanent cross-section is shown on the As-built Plan and will be surveyed each year for inclusion in the monitoring report and compared with data from previous years. Each cross-section will be photographed from left and right bank and from both the upstream and downstream direction for inclusion in the Photo Log.

Bed Material
A pebble count will be done in each cross-section that contains a riffle and any unacceptable increase in sand or finer substrate material will be noted in the monitoring report.

Vegetation
The prevalent vegetation should consist of macrophytes that typically are adapted for life in saturated soil conditions. These species should have the ability to grow, compete, reproduce, and persist in anaerobic soil conditions. A reduction in the percentage of nuisance vegetation in wetland areas with existing vegetation to less than 15% will indicate establishment of native wetland vegetation. Study plots showing that the composition and density of vegetation in the restoration areas compares closely to the reference areas will indicate restoration success for vegetation. The initial success of riparian and wetland vegetation planting will be evaluated based on herbaceous cover as the site is stabilized in the initial growing season. At the year-two growing season, success will be gauged by stem counts of planted species. Stem counts of over 320 trees per acre after 3 years, and 260 trees per acre after 5 years will be considered successful. Photos taken at established photo points should indicate maturation of riparian vegetation community. Photographs will help to capture the health of the planted vegetation and the severity of the invasive or exotic species that establish within the site. Permanent vegetative plots have been established at 3 random locations. The success of vegetation plantings will be measured through stems counts. These plots will be used to sample both the riparian buffer and restored wetlands. Each plot will cover 100 square meters for tree counts. Within each plot, a 1 meter plot will be sampled to measure herbaceous coverage. During the counts, the health of the vegetation will be noted. In addition to stem counts, the samples will inventory species diversity to allow for comparison between the reference and restoration wetlands and track the percent cover of nuisance species. The vegetation survey will occur during the growing season. Vegetative plots are shown on the As-built Plan.

Other Features
All storm water BMPs (as noted on the as-builts) will be monitored for stability and signs of erosion problems. Photo point one as shown on the as-builts and included in the Photo Log (Attachment C) will be included in consecutive years as will any additional pictures of any problems that develop.

3.0 MAINTENANCE AND CONTINGENCY PLANS

Because streams are a dynamic system, restoration is achieved by restoring the channel to a stable dimension, pattern, and profile such that, over time, the stream features (riffle-run-pool-glide) are maintained and the channel does not aggrade or degrade significantly. Minor morphological adjustments from the designed stream are anticipated based on the correlation of reference reach data, excessive sediment deposition from upstream sources, and on-going changes in land use within the watershed. All of the proposed 3,930 linear feet of stream mitigation and 8.0 acres of riverine wetlands have been generated through project implementation. A summary of the deliverables are presented in Table 2. If standards are not met as indicated in the Monitoring Plan of this Mitigation Report appropriate remedial activities to satisfy USACE and NCEEP will be developed, approved, and performed. The site will be monitored for longer than five years should success criteria not be met within the original monitoring period. The site will be monitored for at least 5 years and through at least 2 bankfull events in separate years.

4.0 REFERENCES

Coastal Plain Conservation Nursery, Inc. "Strategic Plants for Environmental Professionals, 2005".

Hall, Karen. 2001. North Carolina Stream Restoration Institute NCSU, "Recommended Native Plant Species for Stream Restoration in North Carolina."

North Carolina Department of Environment and Natural Resources Ecological Enhancement Program. Guidelines for Riparian Buffer Restoration, Raleigh, NC. January 2001.

North Carolina Division of Water Quality, North Carolina Surface Water Classification http://h2o.enr.state.nc.us/bims/reports/reportsWB.html, February 2006.

North Carolina Stream Restoration Institute. Regional Curves. "Mountain-Rural Regional Curves". February 2005. <http://www.bae.ncsu.edu/programs/extension/wqg/sri/mountain.htm>

North Carolina Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report). Public Review Draft, 2006

Rosgen, David L. 1996. Applied River Morphology. Wildland Hydrology Books, Pagosa Springs, CO.

Rosgen, David L. "A Stream Channel Stability Assessment Methodology."

Schafale, Michael P. and Alan D. Weakley. 1990. Classification of the Natural Communities of North Carolina, Third Approximation. NC Natural Heritage Program, Division of Parks and Recreation, NC Department of Environment, Health, and Natural Resources.

The Division of Land Resources (DLR) and The Division of Water Quality (DWQ), 2001 v.3.0. "Internal Technical Guide for Stream Work in North Carolina."

CU: 03030004

REFERENCE STREAM AND WETLAND GAGES

35.10975 N
-78.89638 W

35.10808 N
-78.89136 W

35.10555 N
-78.89530 W

35.10489 N
-78.89292 W

CE2
CEC10
CEC6
CC3
CE5
CC2
REEDS4
RIVERBEND ROAD

CC6
REFERENCE
WETLAND GAGE

CEC4
REFERENCE
STREAM GA

WESTE
PRONG

GRID

SITE LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- PROPERTY BOUNDARY
- WETLAND ENHANCEMENT
- WETLAND RESTORATION
- STREAM RESTORATION
- STREAM ENHANCEMENT
- STREAM PRESERVATION
- MONITORING GAGE

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)
1 inch = 200 ft.

REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 – RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050

CLIENT: MID-ATLANTIC MITIGATION

TITLE: PROJECT MAP

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 028484 ENGINEER WILLIAM R. WISNER

DATE: 07/11/08
HORIZONTAL SCALE:
VERTICAL SCALE:
DRAWN BY: JLD
DESIGNED BY: JLD
CHECKED BY: WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

ATTACHED REFERENCE FILES:
S.C.O. NUMBER: D05013-1
FIGURE NUMBER: 1

CU: 03030004

35.10975 N
-78.89638 W

35.10808 N
-78.89136 W

35.10555 N
-78.89530 W

35.10489 N
-78.89292 W

RIVERBEND ROAD

SITE LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- PROPERTY BOUNDARY
- WETLAND ENHANCEMENT
- WETLAND RESTORATION
- STREAM RESTORATION
- STREAM ENHANCEMENT
- STREAM PRESERVATION

GRID

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)
1 inch = 200 ft.

REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

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CLIENT: MID-ATLANTIC MITIGATION

TITLE: PROJECT MAP

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 028484 ENGINEER WILLIAM R. WILHELM

DATE: 07/11/06
HORIZONTAL SCALE:
VERTICAL SCALE:
DRAWN BY: JLD
DESIGNED BY: JLD
CHECKED BY: WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

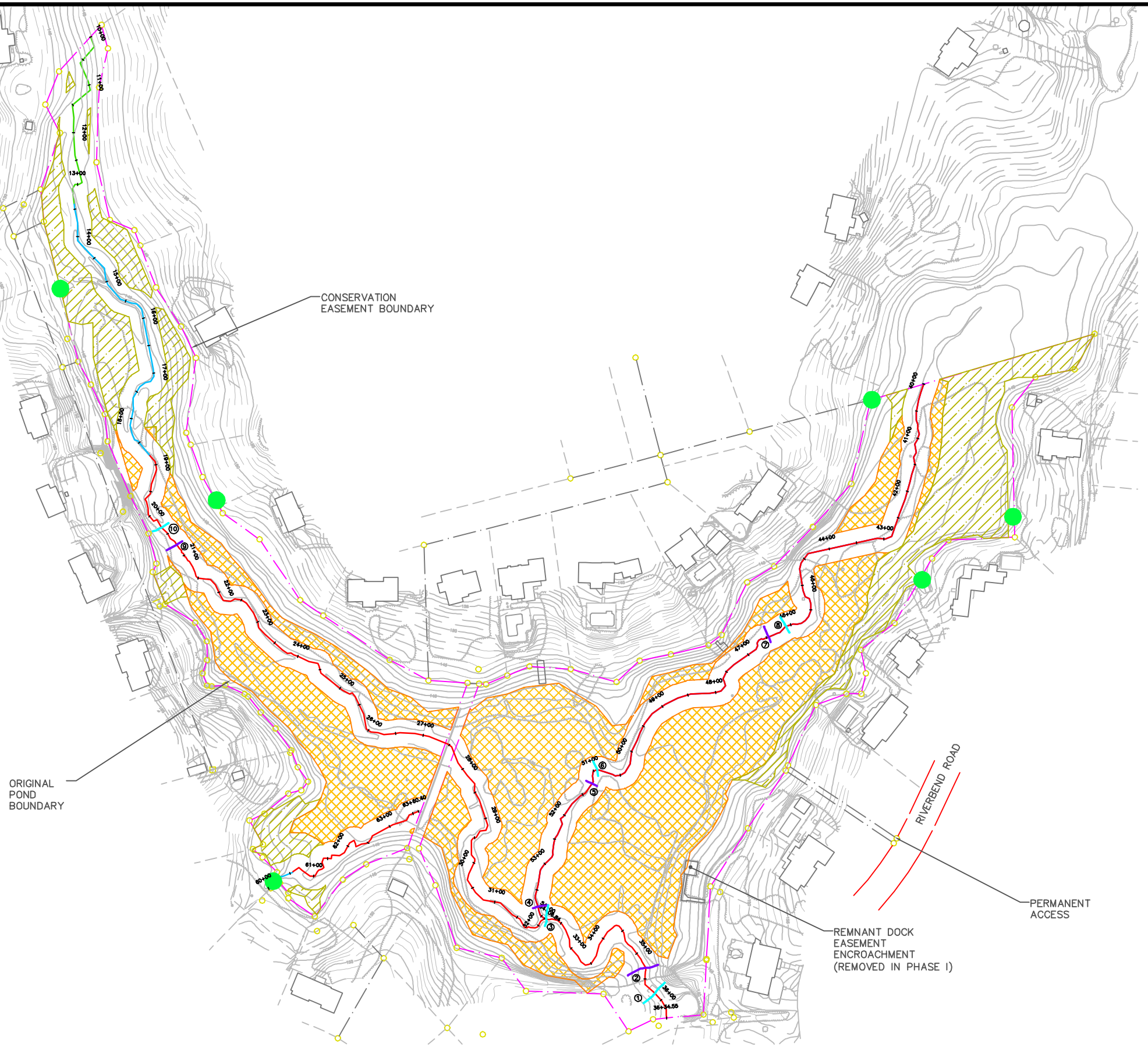
ATTACHED REFERENCE FILES:
S.C.O. NUMBER: D05013-1
FIGURE NUMBER: 1

Restoration Table I: MORPHOLOGY CHARACTERISTICS
Tarlton Stream and Wetland Restoration
Cumberland County, North Carolina

7/12/2006

VARIABLES	Existing Reach Western Prong	Restoration Goals Western Prong	As-Built Western Prong[3]	Existing Reach Eastern Prong	Restoration Goals Eastern Prong	As-Built Eastern Prong	Restoration Goals UT to Western Prong	As-Built Lower Phase 1 Section	Coastal Plain Rural Regional Curves (DRAFT)	Reference Reach Upper Western Prong	Reference Reach Johannah Creek (NC CRI)	Reference Reach Little Doe Creek (NC SRI)	Reference Reach Flat Creek (NC SRI)
1. Stream Type	NA[1]	C5	E5	NA[1]	C5	E5	C5	C5		C5	C5	C5	E
(Rosgen)													
2. Drainage Area (sq. mile)	NA[1]	0.8 - 1.0	0.8 - 1.0	NA[1]	1.5 - 1.6	1.5 - 1.6	0.07 - 0.09	2.6	2.6 Valid Range 0.2 161.0	0.8	1.0	2.0	7.6
3. Bankfull Width	Mean: NA[1]	Mean: 6.5	Mean: 5.3	Mean: NA[1]	Mean: 9.0	Mean: 6.6	Mean: 3.2	Mean: 15.1	Mean: 15.5	Mean: 6.9	Mean: 10.4	Mean: 19.6	Mean: 22.0
(W_{bkf})	Range: NA[1] NA[1]	Range: 6.0 7.0	Range: 3.6 7.0	Range: NA[1] NA[1]	Range: 8.5 9.5	Range: 3.4 9.3	Range: 2.5 3.5	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
4. Bankfull Mean	Mean: NA[1]	Mean: 0.4	Mean: 0.7	Mean: NA[1]	Mean: 0.5	Mean: 0.9	Mean: 0.2	Mean: 1.8	Mean: 1.7	Mean: 0.5	Mean: 0.8	Mean: 1.5	Mean: 2.3
depth (d_{bkf})	Range: NA[1] NA[1]	Range: 0.3 0.4	Range: 0.3 1.0	Range: NA[1] NA[1]	Range: 0.4 0.5	Range: 0.8 1.0	Range: 0.1 0.3	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
5. Width/Depth Ratio	Mean: NA[1]	Mean: 18.1	Mean: 8.2	Mean: NA[1]	Mean: 18.8	Mean: 7.6	Mean: 15.8	Mean: *8.4*	Mean: *9.1*	Mean: 13.8	Mean: *13.0*	Mean: *13.1*	Mean: *9.6*
(W_{bkf}/d_{bkf})	Range: NA[1] NA[1]	Range: 17.0 20.7	Range: 7.0 12.0	Range: NA[1] NA[1]	Range: 18.3 19.3	Range: 4.3 9.3	Range: 14.6 17.1	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
6. Bankfull cross-sectional	Mean: NA[1]	Mean: 3.2	Mean: 4.4	Mean: NA[1]	Mean: 6.1	Mean: 5.9	Mean: 0.9	Mean: 14.8	Mean: 27.3	Mean: 3.4	Mean: 8.6	Mean: 29.0	Mean: 51.4
Area (Abkf)	Range: NA[1] NA[1]	Range: 2.7 3.7	Range: 1.1 7.7	Range: NA[1] NA[1]	Range: 5.3 6.9	Range: 2.8 9.1	Range: 0.5 1.1	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
7. Bankfull Mean Velocity	Mean: NA[1]	Mean: 3.4	Mean: 2.4	Mean: NA[1]	Mean: 2.6	Mean: 2.6	Mean: 2.2	Mean: 1.5	Mean: 1.2	Mean: 3.9	Mean: 1.7	Mean: 1.2	Mean: 2.0
(V_{bkf})	Range: NA[1] NA[1]	Range: 2.6 4.2	Range: 2.2 2.6	Range: NA[1] NA[1]	Range: 2.2 3.0	Range: 2.5 2.7	Range: 1.6 4.2	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
8. Bankfull Discharge, cfs	Mean: NA[1]	Mean: 10.4	Mean: 10.4	Mean: NA[1]	Mean: 15.4	Mean: 15.4	Mean: 2.0	Mean: *22.1*	Mean: *32.9*	Mean: 13.5	Mean: *14.2*	Mean: *34.5*	Mean: *105.0*
(Q_{bkf})	Range: NA[1] NA[1]	Range: 9.5 11.3	Range: 9.5 11.3	Range: NA[1] NA[1]	Range: 15.0 15.7	Range: 15.0 15.7	Range: 1.8 2.1	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
9. Bankfull Maximum Depth	Mean: NA[1]	Mean: 0.8	Mean: 1.0	Mean: NA[1]	Mean: 1.0	Mean: 1.3	Mean: 0.4	Mean: --	Mean: --	Mean: 1.1	Mean: --	Mean: --	Mean: --
(d_{max})	Range: NA[1] NA[1]	Range: 0.7 0.8	Range: 0.6 1.4	Range: NA[1] NA[1]	Range: 0.9 1.1	Range: 1.1 1.6	Range: 0.3 0.5	Range: -- --	Range: -- --	Range: 1.0 1.3	Range: -- --	Range: -- --	Range: -- --
10. Max d_{max}/d_{bkf}	Mean: NA[1]	Mean: 2.1	Mean: 1.5	Mean: NA[1]	Mean: 2.1	Mean: 1.5	Mean: 2.2	Mean: --	Mean: --	Mean: 2.1	Mean: --	Mean: --	Mean: --
ratio	Range: NA[1] NA[1]	Range: 2.0 2.3	Range: 1.4 2.0	Range: NA[1] NA[1]	Range: 2.0 2.3	Range: 1.4 1.6	Range: 2.0 2.3	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
11. Low Bank Height to max	Mean: NA[1]	Mean: 1.0	Mean: 1.0	Mean: NA[1]	Mean: 1.0	Mean: 1.0	Mean: 1.0	Mean: --	Mean: --	Mean: 1.1	Mean: --	Mean: --	Mean: --
d_{bkf} ratio	Range: NA[1] NA[1]	Range: 1.0 1.2	Range: 1.0 1.1	Range: NA[1] NA[1]	Range: 1.0 1.2	Range: -- --	Range: 1.0 1.2	Range: -- --	Range: -- --	Range: 1.0 1.2	Range: -- --	Range: -- --	Range: -- --
12. Width of Flood Prone	Mean: NA[1]	Mean: 150.0	Mean: 225.0	Mean: NA[1]	Mean: 200.0	Mean: 550.0	Mean: 130.0	Mean: --	Mean: --	Mean: 47.6	Mean: --	Mean: --	Mean: --
Area (W_{fpa})	Range: NA[1] NA[1]	Range: 60.0 205.0	Range: 50.0 400.0	Range: NA[1] NA[1]	Range: 145.0 245.0	Range: 200.0 900.0	Range: 100.0 160.0	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
13. Entrenchment Ratio	Mean: NA[1]	Mean: 23.1	Mean: 42.5	Mean: NA[1]	Mean: 22.2	Mean: 83.8	Mean: 41.3	Mean: --	Mean: --	Mean: 6.9	Mean: --	Mean: --	Mean: --
(W_{fpa}/W_{bkf})	Range: NA[1] NA[1]	Range: 10.0 29.3	Range: 9.4 75.5	Range: NA[1] NA[1]	Range: 17.1 25.8	Range: 58.8 96.8	Range: 40.8 45.7	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
14. Meander Length	Mean: NA[1]	Mean: 74.8	Mean: 73.6	Mean: NA[1]	Mean: 103.5	Mean: 85.7	Mean: 36.2	Mean: --	Mean: --	Mean: 47.0	Mean: --	Mean: --	Mean: --
(L_m)	Range: NA[1] NA[1]	Range: 54.0 98.0	Range: 14.4 202.2	Range: NA[1] NA[1]	Range: 76.5 133.0	Range: 19.3 281.6	Range: 22.1 49.0	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
15. Ratio of Meander Length to	Mean: NA[1]	Mean: 11.5	Mean: 13.9	Mean: NA[1]	Mean: 11.5	Mean: 13.0	Mean: 11.5	Mean: --	Mean: --	Mean: 6.8	Mean: --	Mean: --	Mean: --
Bankfull Width (L_m/W_{bkf})	Range: NA[1] NA[1]	Range: 9.0 14.0	Range: 2.7 38.2	Range: NA[1] NA[1]	Range: 9.0 14.0	Range: 2.9 42.9	Range: 9.0 14.0	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
16. Radius of Curvature	Mean: NA[1]	Mean: 19.5	Mean: 21.1	Mean: NA[1]	Mean: 27.0	Mean: 24.5	Mean: 9.5	Mean: --	Mean: --	Mean: 13.0	Mean: --	Mean: --	Mean: --
(R_c)	Range: NA[1] NA[1]	Range: 15.0 28.0	Range: 4.2 108.5	Range: NA[1] NA[1]	Range: 22.5 36.0	Range: 7.4 84.3	Range: 7.9 12.6	Range: -- --	Range: -- --	Range: 11.0 16.0	Range: -- --	Range: -- --	Range: -- --
17. Ratio of Radius of Curvature	Mean: NA[1]	Mean: 3.0	Mean: 4.0	Mean: NA[1]	Mean: 3.0	Mean: 3.7	Mean: 3.0	Mean: --	Mean: --	Mean: 1.9	Mean: --	Mean: --	Mean: --
to Bankfull Width (R_c/W_{bkf})	Range: NA[1] NA[1]	Range: 2.5 4.0	Range: 0.8 20.5	Range: NA[1] NA[1]	Range: 2.5 4.0	Range: 1.1 12.8	Range: 2.5 4.0	Range: -- --	Range: -- --	Range: 1.6 2.3	Range: -- --	Range: -- --	Range: -- --
18. Belt Width	Mean: NA[1]	Mean: 100.0	Mean: 95.1	Mean: NA[1]	Mean: 150.0	Mean: 124.8	Mean: 40.0	Mean: --	Mean: --	Mean: 20.2	Mean: --	Mean: --	Mean: --
(W_{blt})	Range: NA[1] NA[1]	Range: 50.0 130.0	Range: 55.4 150.8	Range: NA[1] NA[1]	Range: 110.0 180.0	Range: 112.4 143.2	Range: 30.0 50.0	Range: -- --	Range: -- --	Range: 18.0 22.2	Range: -- --	Range: -- --	Range: -- --
19. Meander Width Ratio	Mean: NA[1]	Mean: 14.4	Mean: 17.9	Mean: NA[1]	Mean: 16.4	Mean: 19.0	Mean: 12.7	Mean: --	Mean: --	Mean: 2.9	Mean: --	Mean: --	Mean: --
(W_{blt}/W_{bkf})	Range: NA[1] NA[1]	Range: 7.1 21.7	Range: 10.5 28.5	Range: NA[1] NA[1]	Range: 11.6 21.2	Range: 17.1 21.8	Range: 8.6 20.4	Range: -- --	Range: -- --	Range: 2.6 3.2	Range: -- --	Range: -- --	Range: -- --
20. Sinuosity (k)	Mean: NA[1]	Mean: 1.2	Mean: 1.2	Mean: NA[1]	Mean: 1.2	Mean: 1.6	Mean: 1.2	Mean: --	Mean: --	Mean: 1.3	Mean: --	Mean: --	Mean: --
(Stream Length / Valley Length)	Range: NA[1] NA[1]	Range: 1.2 1.5	Range: -- --	Range: NA[1] NA[1]	Range: 1.2 1.5	Range: -- --	Range: 1.2 1.5	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
21. Valley Slope (Sv_{alley})	Mean: NA[1]	Mean: 0.0055	Mean: 0.0055	Mean: NA[1]	Mean: 0.0045	Mean: 0.0045	Mean: 0.0200	Mean: --	Mean: --	Mean: 0.0079	Mean: --	Mean: --	Mean: --
(ft/ft)	Range: NA[1] NA[1]	Range: -- --	Range: -- --	Range: NA[1] NA[1]	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
22. Average Stream Slope	Mean: NA[1]	Mean: 0.0045	Mean: 0.0045	Mean: NA[1]	Mean: 0.0039	Mean: 0.0029	Mean: 0.0166	Mean: --	Mean: --	Mean: 0.0099	Mean: --	Mean: --	Mean: --
(S_{avg}) = (S_{valley}/k)	Range: NA[1] NA[1]	Range: 0.0037 0.0048	Range: -- --	Range: NA[1] NA[1]	Range: 0.0030 0.0042	Range: -- --	Range: 0.0133 0.0167	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
23. Riffle Slope	Mean: NA[1]	Mean: 0.0079	Mean: NA[2]	Mean: NA[1]	Mean: 0.0068	Mean: NA[2]	Mean: 0.0290	Mean: --	Mean: --	Mean: 0.0135	Mean: --	Mean: --	Mean: --
(S_{rifl})	Range: NA[1] NA[1]	Range: 0.0068 0.0090	Range: NA[2] NA[2]	Range: NA[1] NA[1]	Range: 0.0059 0.0078	Range: NA[2] NA[2]	Range: 0.0249 0.0332	Range: -- --	Range: -- --	Range: 0.0036 0.0310	Range: -- --	Range: -- --	Range: -- --
24. Ratio of Riffle Slope to Avg.	Mean: NA[1]	Mean: 1.8	Mean: NA[2]	Mean: NA[1]	Mean: 1.8	Mean: NA[2]	Mean: 1.8	Mean: --	Mean: --	Mean: 1.4	Mean: --	Mean: --	Mean: --
Slope (S_{rifle}/S_{avg})	Range: NA[1] NA[1]	Range: 1.5 2.0	Range: NA[2] NA[2]	Range: NA[1] NA[1]	Range: 1.5 2.0	Range: NA[2] NA[2]	Range: 1.5 2.0	Range: -- --	Range: -- --	Range: 0.4 3.1	Range: -- --	Range: -- --	Range: -- --
25. Pool Slope	Mean: NA[1]	Mean: 0.0018	Mean: NA[2]	Mean: NA[1]	Mean: 0.0016	Mean: NA[2]	Mean: 0.0066	Mean: --	Mean: --	Mean: 0.0035	Mean: --	Mean: --	Mean: --
(S_{pool})	Range: NA[1] NA[1]	Range: 0.0009 0.0023	Range: NA[2] NA[2]	Range: NA[1] NA[1]	Range: 0.0008 0.0020	Range: NA[2] NA[2]	Range: 0.0033 0.0083	Range: -- --	Range: -- --	Range: 0.0020 0.0050	Range: -- --	Range: -- --	Range: -- --
26. Ratio of Pool Slope to Avg.	Mean: NA[1]	Mean: 0.4	Mean: NA[2]	Mean: NA[1]	Mean: 0.4	Mean: NA[2]	Mean: 0.4	Mean: --	Mean: --	Mean: 0.4	Mean: --	Mean: --	Mean: --
Slope (S_{pool}/S_{avg})	Range: NA[1] NA[1]	Range: 0.2 0.5	Range: NA[2] NA[2]	Range: NA[1] NA[1]	Range: 0.2 0.5	Range: NA[2] NA[2]	Range: 0.2 0.5	Range: -- --	Range: -- --	Range: 0.2 0.5	Range: -- --	Range: -- --	Range: -- --
27. Maximum Pool	Mean: NA[1]	Mean: 1.4	Mean: 1.1	Mean: NA[1]	Mean: 1.9	Mean: 1.5	Mean: 0.8	Mean: *3.9*	Mean: --	Mean: 2.1	Mean: --	Mean: --	Mean: --
Depth (d_{pool})	Range: NA[1] NA[1]	Range: 0.7 1.8	Range: -- --	Range: NA[1] NA[1]	Range: 1.0 2.4	Range: 1.2 1.8	Range: 0.4 1.0	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
28. Ratio of Pool Depth to Avg.	Mean: NA[1]	Mean: 4.0	Mean: 1.7	Mean: NA[1]	Mean: 4.0	Mean: 1.7	Mean: 4.0	Mean: 2.2	Mean: --	Mean: 4.1	Mean: --	Mean: --	Mean: --
Depth (d_{pool}/d_{avg})	Range: NA[1] NA[1]	Range: 2.0 5.0	Range: -- --	Range: NA[1] NA[1]	Range: 2.0 5.0	Range: 1.5 1.8	Range: 2.0 5.0	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
29. Pool Width	Mean: NA[1]	Mean: 9.8	Mean: 13.5	Mean: NA[1]	Mean: 13.5	Mean: 7.3	Mean: 4.7	Mean: *17.3*	Mean: --	Mean: 7.2	Mean: --	Mean: --	Mean: --
(W_{pool})	Range: NA[1] NA[1]	Range: 6.5 11.1	Range: -- --	Range: NA[1] NA[1]	Range: 9.0 15.3	Range: 4.3 9.3	Range: 3.2 5.4	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
30. Ratio of Pool Width to	Mean: NA[1]	Mean: 1.5	Mean: 2.5	Mean: NA[1]	Mean: 1.5	Mean: 1.1	Mean: 1.5	Mean: 1.1	Mean: --	Mean: 1.0	Mean: --	Mean: --	Mean: --
Bankfull Width (W_{pool}/W_{bkf})	Range: NA[1] NA[1]	Range: 1.0 1.7	Range: -- --	Range: NA[1] NA[1]	Range: 1.0 1.7	Range: 1.3 1	Range: 1.0 1.7	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
31. Pool Area	Mean: NA[1]	Mean: 8.4	Mean: 7.5	Mean: NA[1]	Mean: 15.9	Mean: 8.1	Mean: 2.3	Mean: *38.8*	Mean: --	Mean: 8.9	Mean: --	Mean: --	Mean: --
(A_{pool})	Range: NA[1] NA[1]	Range: 5.9 10.4	Range: -- --	Range: NA[1] NA[1]	Range: 11.7 19.3	Range: 4.1 13.0	Range: 1.1 3.1	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
32. Ratio of Pool Area to	Mean: NA[1]	Mean: 2.6	Mean: 1.7	Mean: NA[1]	Mean: 2.6	Mean: 1.4	Mean: 2.6	Mean: *2.6*	Mean: --	Mean: 2.6	Mean: --	Mean: --	Mean: --
Bankfull Area (A_{pool}/A_{bkf})	Range: NA[1] NA[1]	Range: 2.2 2.8	Range: -- --	Range: NA[1] NA[1]	Range: 2.2 2.8	Range: 1.4 1.5	Range: 2.2 2.8	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --	Range: -- --
33. Pool to Pool Spacing	Mean: NA[1]	Mean: 33	Mean: 55	Mean: NA[1]	Mean: 45	Mean: 75	Mean: 16	Mean: --	Mean: --	Mean: 34	Mean: --	Mean: --	Mean: --
(p - p)	Range: NA[1] NA[1]	Range: 20 46	Range: 13 136	Range: NA[1] NA[1]	Range: 27 63	Range: 17 209	Range: 9 22	Range: -- --	Range: -- --	Range: 21 48	Range: -- --	Range: -- --	Range: -- --
34. Ratio of Pool to Pool Spacing	Mean: NA[1]	Mean: 5.0	Mean: 10.4	Mean: NA[1]	Mean: 5.0	Mean: 11.4	Mean: 5.0	Mean: --	Mean: --	Mean: 5.0	Mean: --	Mean: --	Mean: --
to Bankfull Width (p-p/Wbkf)	Range: NA[1] NA[1]	Range: 3.0 7.0	Range: 2.5 25.6	Range: NA[1] NA[1]	Range: 3.0 7.0	Range: 2.6 31.9	Range: 3.0 7.0	Range: -- --	Range: -- --	Range: 3.0 7.0	Range: -- --	Range: -- --	Range: -- --

[1] Prior to construction the Eastern and Western Prongs were delineated as Open Water
[2] An water surface profile was not recorded due to site conditions, ie highly saturated bed and banks. Visual observations verify that the streams appear to be trending towards a more stable system including riffle-pool sequences.
[3] Data from the permanent cross section locations was supplemented with additional cross section measurements observed at separate locations along the reach.



MITIGATION SUMMARY						
MITIGATION TYPE		RESTORATION	ENHANCEMENT	PRESERVATION	TOTAL MUs	% RESTORATION
STREAM	PRE-EXISTING LENGTH (FEET)	3,221	826	255		
	AS-BUILT LENGTH (FEET)	3,465	596	341		
	MITIGATION UNITS	3,465	397	68	3,930	88%
RIVERINE WETLAND	PRE-EXISTING LENGTH (FEET)	6.8	2.4	-		
	AS-BUILT AREA (ACRES)	6.6	2.7	-		
	MITIGATION UNITS	6.6	1.4	-	8.0	83%

NOTE: WETLAND MITIGATION AREAS DO NOT INCLUDE THE ADJACENT 50' STREAM BUFFER AREA THAT SURROUNDS STREAM MITIGATION AREAS.

TOTAL CONSERVATION EASEMENT AREA = 17.8 ACRES

SITE LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- PROPERTY BOUNDARY
- WETLAND ENHANCEMENT
- WETLAND RESTORATION
- STREAM RESTORATION
- STREAM ENHANCEMENT
- STREAM PRESERVATION
- STABLE PIPE OUTFALL

PERMANENT CROSS SECTIONS

- RIFFLE
- POOL

GRID

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)

1 inch = 200 ft.

REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 - RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050

CLIENT: MID-ATLANTIC MITIGATION

TITLE: MITIGATION CREDIT SUMMARY

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 029484 ENGINEER WILLIAM R. WISNER

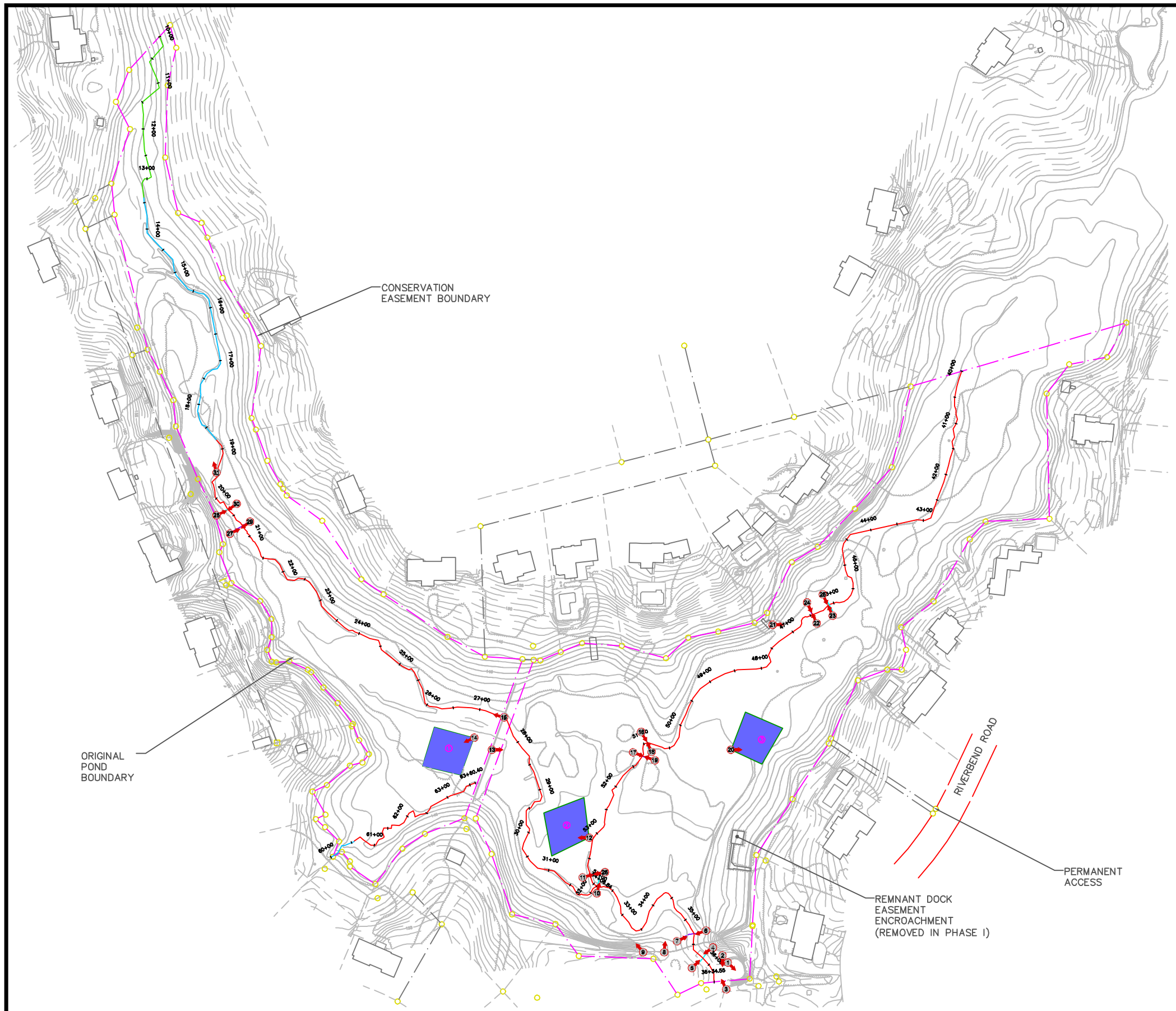
DATE: 07/11/08
HORIZONTAL SCALE:
VERTICAL SCALE:
DRAWN BY: JLD
DESIGNED BY: JLD
CHECKED BY: WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

ATTACHED REFERENCE FILES:

S.C.O. NUMBER: D05013-1

FIGURE NUMBER: 1



SITE LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- PROPERTY BOUNDARY
- STREAM RESTORATION
- STREAM ENHANCEMENT
- STREAM PRESERVATION
- PHOTO POINTS (20)
- VEGETATION PLOTS (100 SQ. METERS)

PERMANENT CROSS SECTIONS

- RIFFLE
- POOL

GRID

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)

1 inch = 200 ft.

REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 - RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050

CLIENT: MID-ATLANTIC MITIGATION

TITLE: MITIGATION CREDIT SUMMARY

NORTH CAROLINA PROFESSIONAL SEAL 028484 ENGINEER WILLIAM R. WILKERN

SEAL:

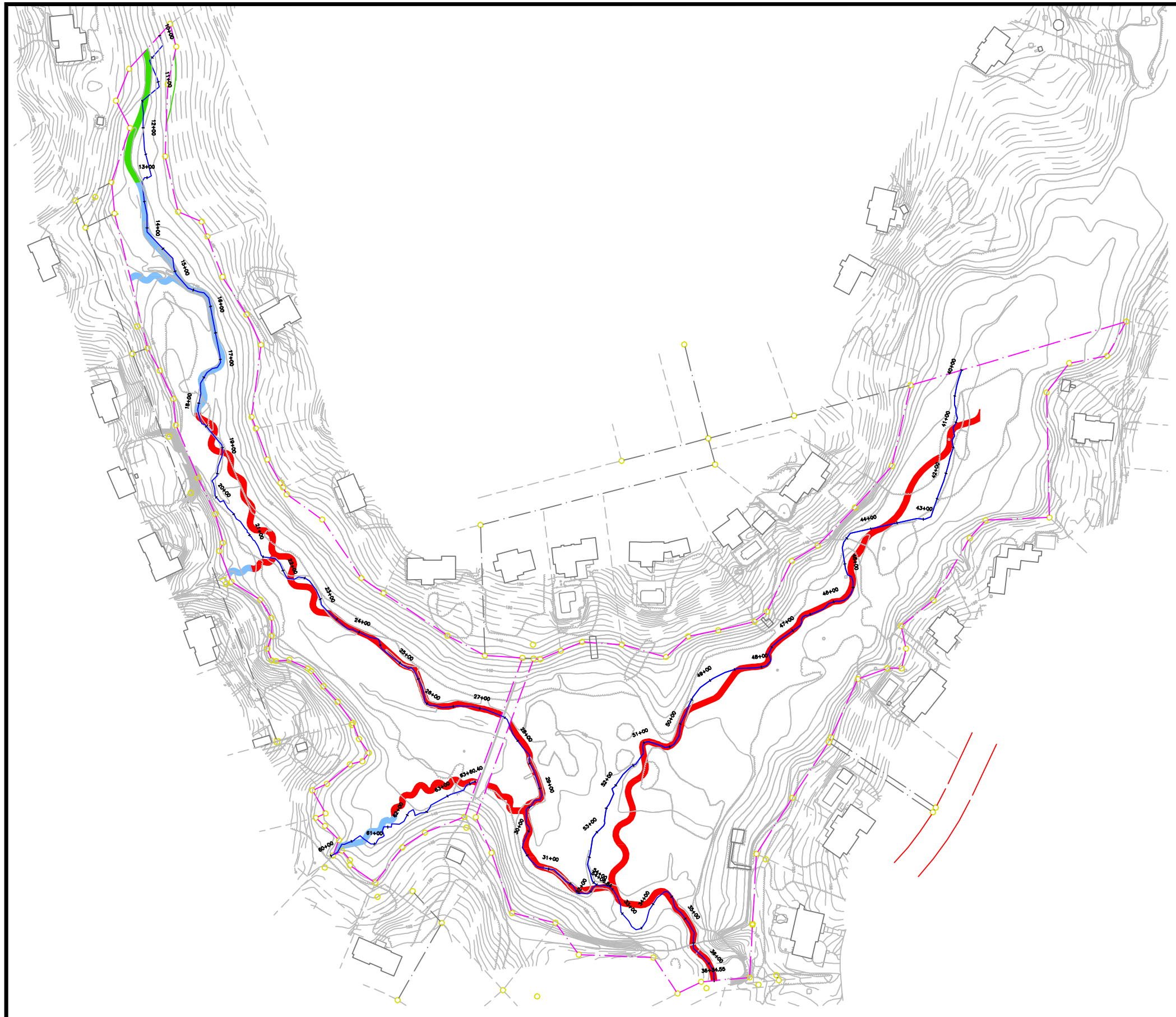
DATE: 08/07/06
HORIZONTAL SCALE:
VERTICAL SCALE:
DRAWN BY: JLD
DESIGNED BY: JLD
CHECKED BY: WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

ATTACHED REFERENCE FILES:

S.C.O. NUMBER: D05013-1

FIGURE NUMBER: 2



TOTAL CONSERVATION EASEMENT AREA = 17.8 ACRES

SITE LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- PROPERTY BOUNDARY
- WETLAND ENHANCEMENT
- WETLAND RESTORATION
- STREAM RESTORATION (DESIGN)
- STREAM ENHANCEMENT (DESIGN)
- STREAM PRESERVATION (DESIGN)
- AS-BUILT

PERMANENT CROSS SECTIONS

- RIFFLE
- POOL

GRID

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)

1 inch = 200 ft.

REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 - RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050

CLIENT: MID-ATLANTIC MITIGATION

TITLE: MITIGATION CREDIT SUMMARY

NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM R. WILHELM

SEAL:

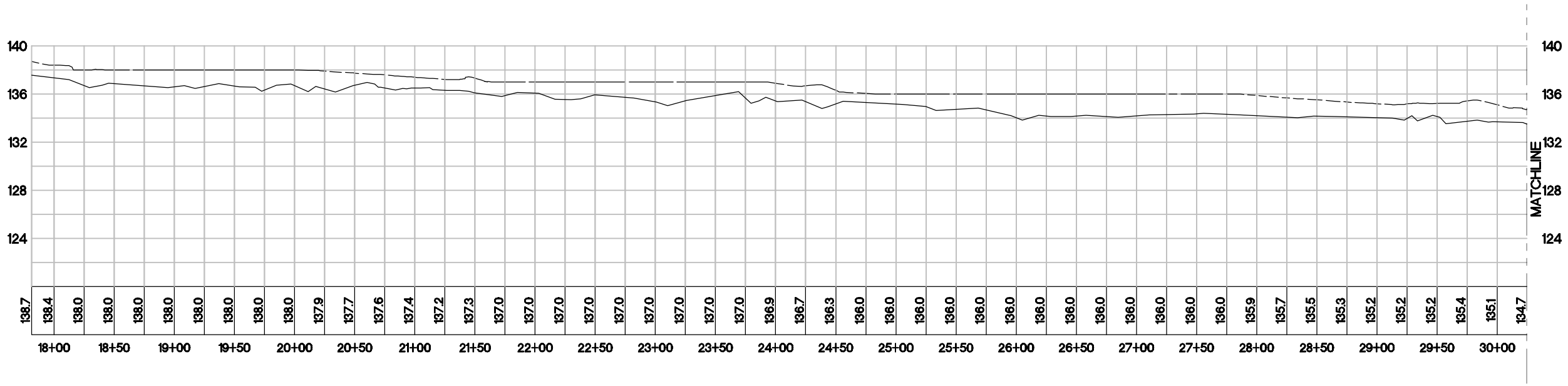
DATE: 08/07/06
HORIZONTAL SCALE:
VERTICAL SCALE:
DRAWN BY: JLD
DESIGNED BY: JLD
CHECKED BY: WRW

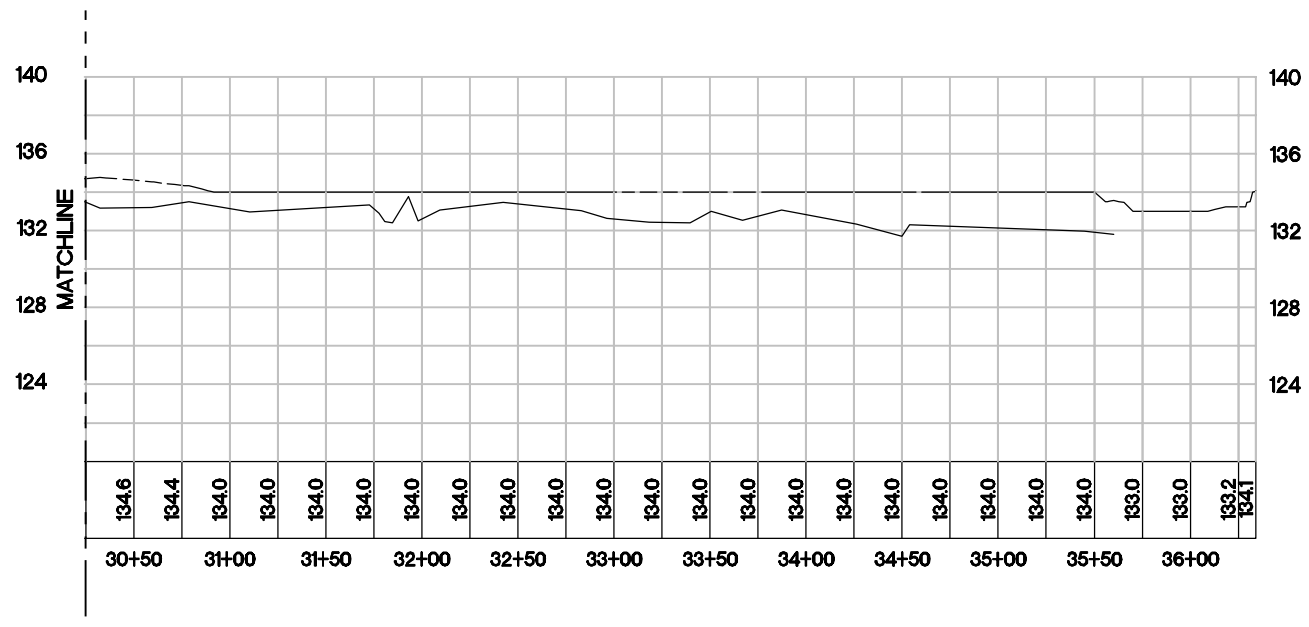
PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

ATTACHED REFERENCE FILES:

S.C.O. NUMBER: D05013-1

FIGURE NUMBER: 3





LEGEND

PRIOR TO CONSTRUCTION

POST CONSTRUCTION

WESTERN PRONG

REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 - RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050

CLIENT: MID-ATLANTIC MITIGATION

TITLE: PROFILES

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 029484 ENGINEER WILLIAM R. WILKINS

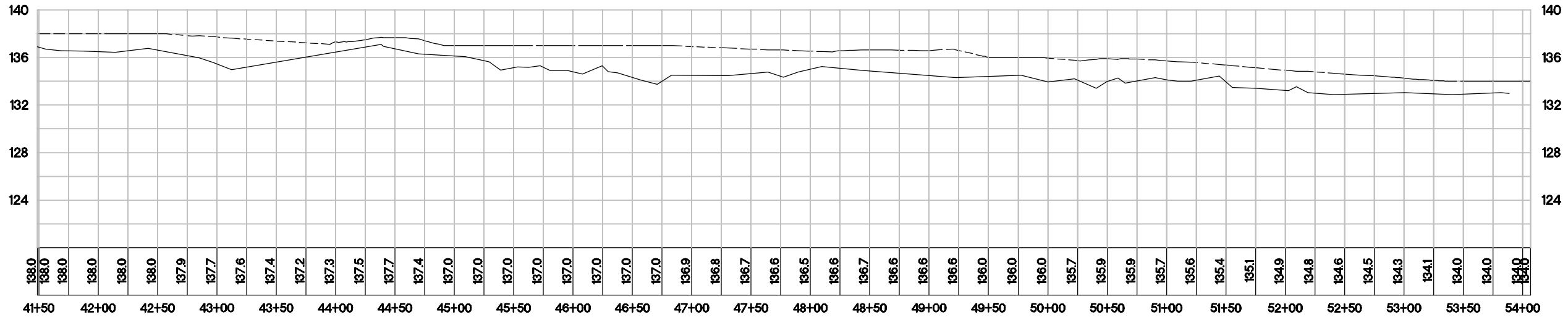
DATE: 07/11/06
HORIZONTAL SCALE:
VERTICAL SCALE:
DRAWN BY: JLD
DESIGNED BY: JLD
CHECKED BY: WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

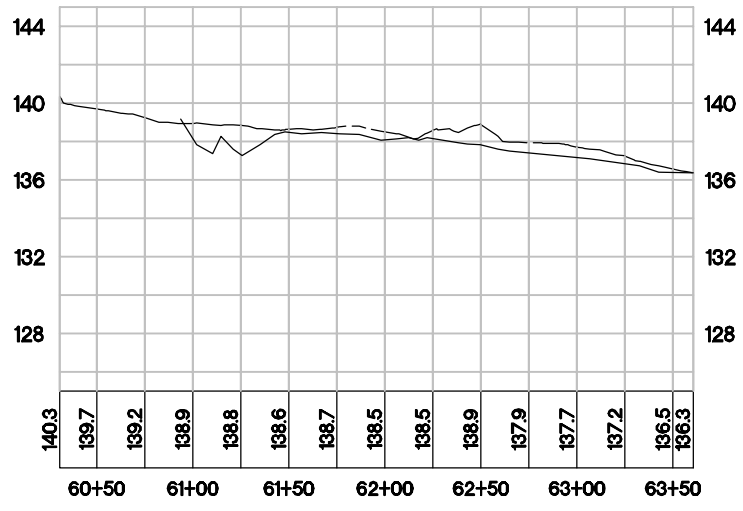
ATTACHED REFERENCE FILES:

S.C.O. NUMBER: D05013-1

FIGURE NUMBER: 4a



EASTERN PRONG



UT TO WESTERN PRONG

LEGEND

PRIOR TO CONSTRUCTION

POST CONSTRUCTION

REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

PREPARED IN THE OFFICE OF:
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CLIENT: MID-ATLANTIC MITIGATION

TITLE: PROFILES

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM R. WILKUM

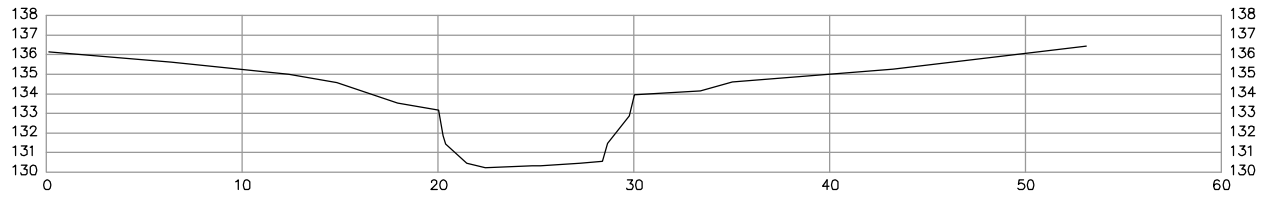
DATE: 07/11/06
HORIZONTAL SCALE:
VERTICAL SCALE:
DRAWN BY: JLD
DESIGNED BY: JLD
CHECKED BY: WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

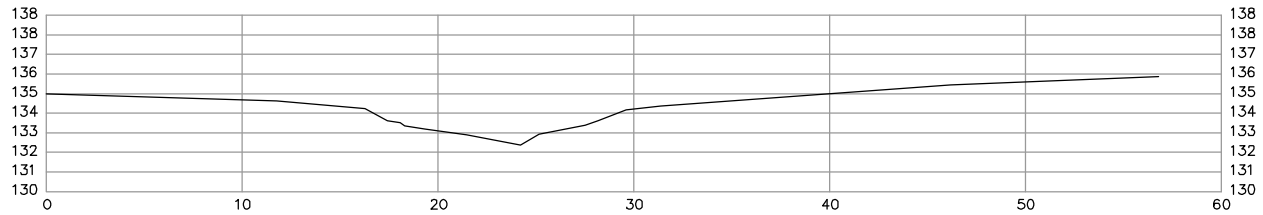
ATTACHED REFERENCE FILES:

S.C.O. NUMBER: D05013-1

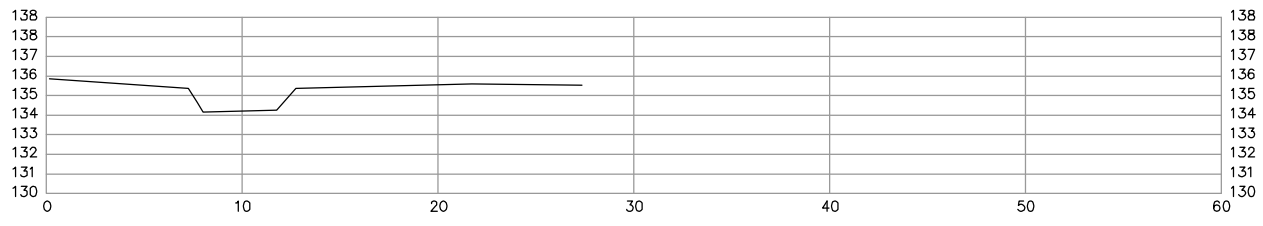
FIGURE NUMBER: 4b



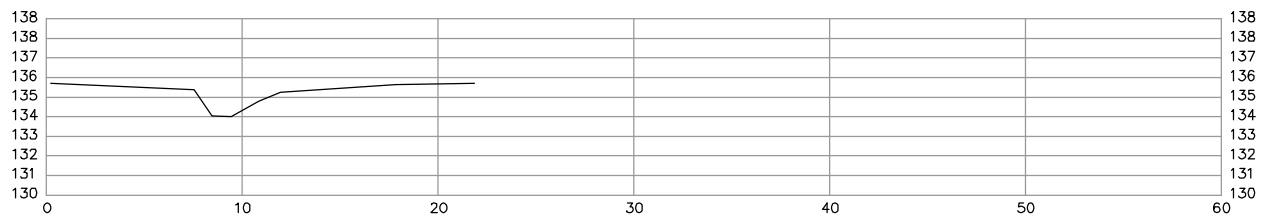
CROSS SECTION 1 POOL



CROSS SECTION 2 RIFFLE



CROSS SECTION 3 POOL



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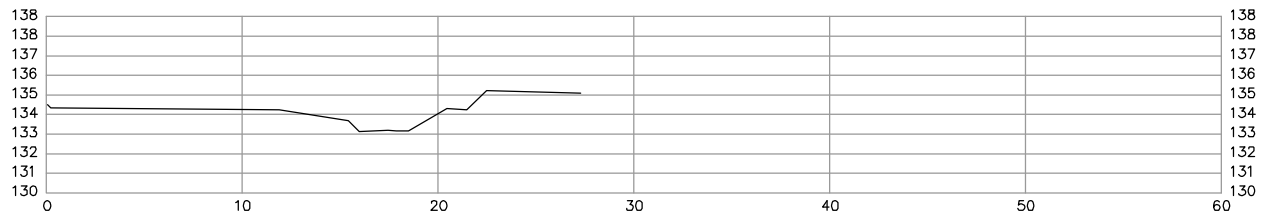

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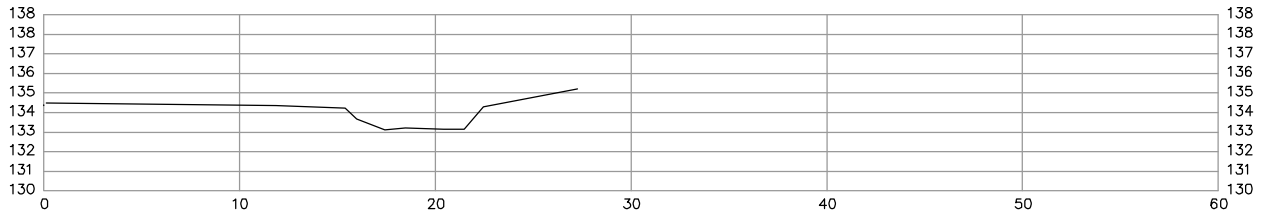
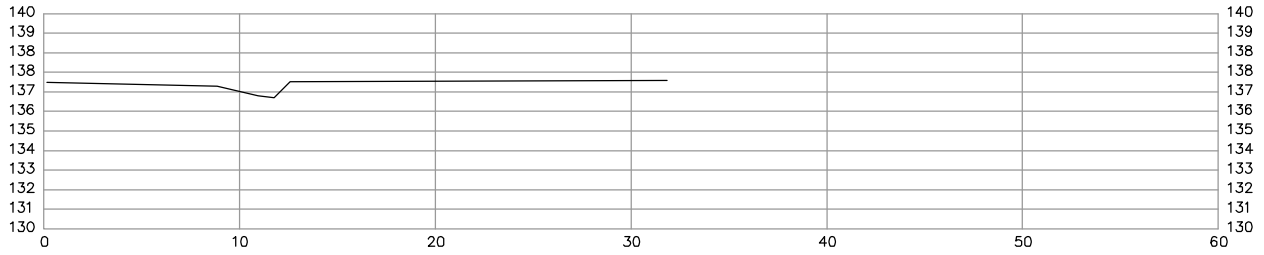
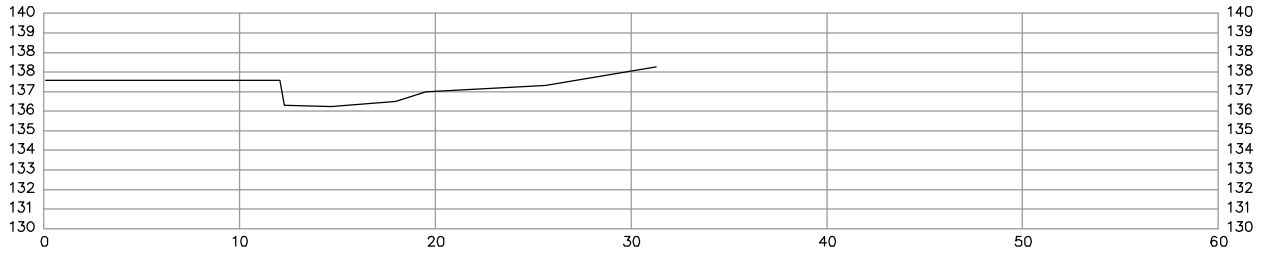


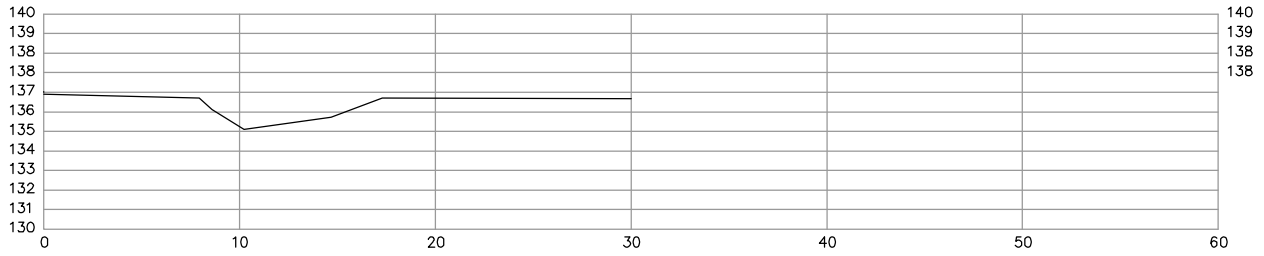
CROSS SECTION 6 POOL



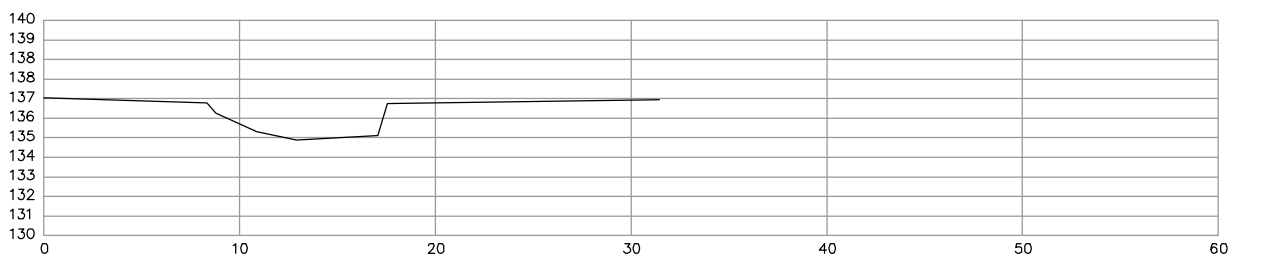
CROSS SECTION 7 RIFFLE



CROSS SECTION 8 POOL



CROSS SECTION 9 RIFFLE



CROSS SECTION 10 POOL

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CLIENT: MID-ATLANTIC MITIGATION

TITLE: PERMANENT CROSS SECTIONS

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM R. WILBURN

DATE: 02/24/06
HORIZONTAL SCALE:
VERTICAL SCALE:
DRAWN BY: JIK
DESIGNED BY: JLD
CHECKED BY: WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

ATTACHED REFERENCE FILES:
S.C.O. NUMBER: D05013-1
FIGURE NUMBER: 5

MITIGATION SUMMARY						
MITIGATION TYPE		RESTORATION	ENHANCEMENT	PRESERVATION	TOTAL MUs	% RESTORATION
STREAM	LENGTH (FEET)	3,465	596	341	3,930	88%
	MITIGATION UNITS	3,465	397	68		
RIVERINE WETLAND	AREA (ACRES)	6.6	2.7	-	8.0	83%
	MITIGATION	6.6	1.4	-		

NOTE: WETLAND MITIGATION AREAS DO NOT INCLUDE THE ADJACENT 50' STREAM BUFFER AREA THAT SURROUNDS STREAM MITIGATION AREAS.

TOTAL CONSERVATION EASEMENT AREA = 17.8 ACRES

SITE LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- PROPERTY BOUNDARY
- WETLAND ENHANCEMENT
- WETLAND RESTORATION
- STREAM RESTORATION
- STREAM ENHANCEMENT
- STREAM PRESERVATION
- STABLE PIPE OUTFALL

GRID

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)

1 inch = 200 ft.

REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 - RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050

CLIENT: MID-ATLANTIC MITIGATION

TITLE: MITIGATION CREDIT SUMMARY

SEAL:

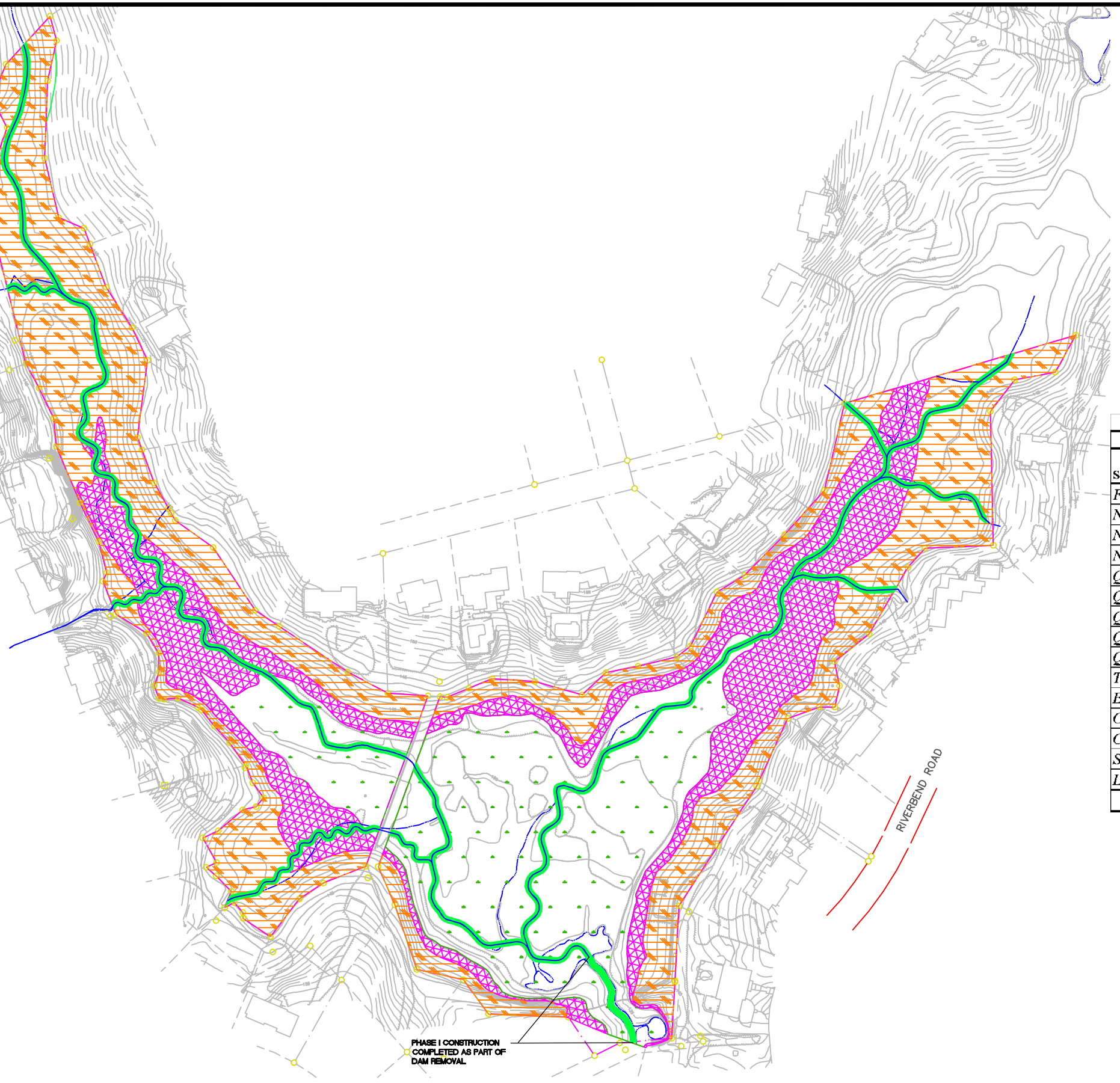
DATE: 07/07/06
HORIZONTAL SCALE:
VERTICAL SCALE:
DRAWN BY: JLD
DESIGNED BY: JLD
CHECKED BY: WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

ATTACHED REFERENCE FILES:

JOB NUMBER: 012857003

FIGURE NUMBER:



SITE LEGEND

- ZONE 1 - STREAM CHANNEL
- ZONE 2 - STREAM BANK
- ZONE 3 - BOTTOMLAND HARDWOOD WETLANDS
- ZONE 4 - SWAMP WETLAND
- ZONE 5 - UPLAND FRINGE AREA

Table 1. Aprroximate Number of Planted Species Per Zone

Scientific name	Zone 2	Zone 3	Zone 4	Zone 5	Number of Species Planted
Fraxinus pennsylvanica:	100	225	200	75	600
Nyssa biflora:		300	300	50	650
Nyssa aquatica:		40	35		75
Nyssa slyvantica		75	75		150
Quercus michauxii:				100	100
Quercus nigra:		50	150	75	275
Quercus phellos:			150	100	250
Quercus falcata var. pagodafolia		50	50		100
Quercus shumardii:			25	75	100
Taxodium distichium:		250	250		500
Betula nigra:	50	150	200	100	500
Chamaecyparis thyoides:		45	55		100
Cornus amomum:	100	150	150		400
Sailx nigra	100				100
Liriodendron tulipifera:				75	75
	350	1335	1640	650	**Total: 3,975**

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)

1 inch = 200 ft.

GRID

REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

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Kimley-Horn and Associates, Inc.
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PHONE: (919) 677-2000 FAX: (919) 677-2050

CLIENT: MID-ATLANTIC MITIGATION

TITLE: VEGETATION PLAN

SEAL:

DATE: 09/13/06
HORIZONTAL SCALE:
VERTICAL SCALE:
DRAWN BY: JJK
DESIGNED BY: JLD
CHECKED BY: WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

ATTACHED REFERENCE FILES:

JOB NUMBER: 012857003

FIGURE NUMBER: ii