Bold Run Creek Site
Wake County, North Carolina

Stream/Buffer Restoration Plan
Final

Contract No. D05067SD-05067S

State Project No.

North Carolina Ecosystem Enhancement Program

Ecosystem Enhancement PROGRAM

February 2006

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EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (NCEEP) intends to utilize the Bold Run Creek Site for a stream and buffer restoration project. This restoration plan presents detailed information regarding the existing site and watershed conditions, the morphological design criteria developed from a selected reference reach, and the project design parameters based upon natural channel restoration methodologies.

The project site is part of a 31-acre parcel owned by NCEEP formerly owned by Mr. Douglas Darch. It is located 5 miles northwest of the Town of Wake Forest on Bold Hill Run Road, approximately 1.5 miles east of the intersection with Mangum Dairy Road in Wake County, North Carolina. The property is an active pasture for cattle grazing. The primary land use on the property is rangeland. Bold Run Creek is a second order (becomes third order at the confluence with New Light Creek) perennial stream that flows southwest through the subject property before joining New Light Creek. The project site is within the Neuse 01 watershed cataloging unit (8-digit HUC: 03020201), in a portion of the NCDWQ Priority Sub-basin 03-04-08. The NCEEP identifies this HUC as a Targeted Local Watershed.

Based on the following existing and reference condition descriptions, the restoration goals and objectives for the Bold Run Creek Stream/Buffer Restoration project are as follows:

Restoration Goals:

- Restore a stable channel morphology that is capable of moving the flows and sediment provided by its watershed;
- Improve water quality and reduce land and riparian vegetation loss resulting from lateral erosion and bed degradation through the establishment of bank and riparian vegetation and,
- Enhance aquatic and terrestrial habitat through the improvements to the stream water quality (improved oxygen content, reduced sediment and nutrients, variable stream bed features).
- Improve water quality through approximately 27.1 acres of buffer restoration throughout the project site.

Restoration Objectives:

- Project success will be assessed utilizing measurements of stream dimension, pattern, and profile, site photographs, and vegetation sampling. These measurements should show little or no change from the as-built conditions.
- A stable channel is able to move the sediment supplied by its watershed without the channel aggrading or degrading. Through stream monitoring the stability of the restored stream will be evaluated.
- Riparian vegetation must meet a minimum survival success rate of 320 stems/acre after five years.

The design proposes constructing 1,629 linear feet of meandering channel based on Priority Level II and IV approaches (Table 1). Approximately 1,453.7 linear feet of Level II and 175.6 linear feet of Level IV will be restored. The Level II restoration will establish a bankfull channel with a new floodplain, a channel bed at its existing level in an existing gravel layer, and the cross section dimensions necessary to provide stable flow maintenance and sediment transport. The Level IV design proposes to stabilize the bed and banks while maintaining the existing channel pattern Bold Run Creek will be restored to Rosgen stream type C4. Riparian buffers associated with the Bold Run Creek restoration will extend between fifty (50) to two hundred (200) feet on both sides of the stream. Currently, there are small drainage features located throughout the project site, which deliver direct runoff to Bold Run Creek. To maintain the water quality of Bold Run Creek, an approximate 200' buffer will extend on either side of the features.

Table 1. Project Restoration Structure and Objectives Bold Run Creek Stream/Buffer Restoration					
Station Range	**Restoration Type**	**Priority Approach**	**Existing Linear Footage or Acreage**	**Designed Linear Footage or Acreage**	**Comment**
(12.75)-(27.60)	Stream	Priority II	1,600 Total Length	1,453.7 Linear Feet	
(11.00)-(12.75)	Stream	Priority IV	1,600 Total Length	175.6 Linear Feet	
	Buffer			27.1Acres	

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1.0 PROJECT SITE IDENTIFICATION AND LOCATION

The North Carolina Ecosystem Enhancement Program (NCEEP) intends to utilize the Bold Run Creek Site for a stream and buffer restoration project. This restoration plan presents detailed information regarding the existing site and watershed conditions, the morphological design criteria developed from a selected reference reach, and the project design parameters based upon natural channel restoration methodologies.

1.1 Directions to Project Site

The project site is part of a 31-acre parcel owned by NCEEP formerly owned by Mr. Douglas Darch. It is located 5 miles northwest of the Town of Wake Forest on Bold Hill Run Road, approximately 1.5 miles east of the intersection with Mangum Dairy Road in Wake County, North Carolina. The site is situated southwest of Bold Hill Run Road and south from the Granville/Wake County Line (Figure 1. Project Site Vicinity Map).

1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

Bold Run Creek is a second order (becomes third order at the confluence with New Light Creek) perennial stream that flows southwest through the subject property before joining New Light Creek.

The project site is situated within the Neuse 01 watershed cataloging unit (8-digit HUC: 03020201) and the 03020201065010 Local Watershed Unit (14-digit HUC). It also falls within the NCDWQ Subbasin 03-04-08. The NCEEP identifies this HUC as a Targeted Local Watershed. Targeted local watersheds are those that exhibit the need and opportunity for stream and riparian buffer restoration. The results benefit water quality, aquatic habitat and other vital watershed functions (NCEEP, 2002)

2.0 WATERSHED CHARACTERIZATION

The project site is located in a rural setting within the Northern Outer Piedmont ecoregion of the Piedmont physiographic province (Figure 2. North Carolina Ecoregions Map). Site topography is characterized as gently rolling hills with elevations ranging from 270 feet above mean sea level (AMSL) to 320 feet AMSL.

2.1 Drainage Area

The project watershed containing the study area, as seen in Figure 3 (Project Site Watershed Map), drains approximately 12 square miles (7,650 acres) and occupies the southwest corner of the headwaters of the Falls Lake Drainage area. The project watershed, which includes Bold Run Creek and New Light Creek, is located west off of US Highway 1 on the Wake and Granville County Line, with the majority of the watershed in Granville County.

2.2 Surface Water Classification/Water Quality

For the water resources classification, New Light Creek, as the receiving waters, was used to characterize Bold Run Creek.

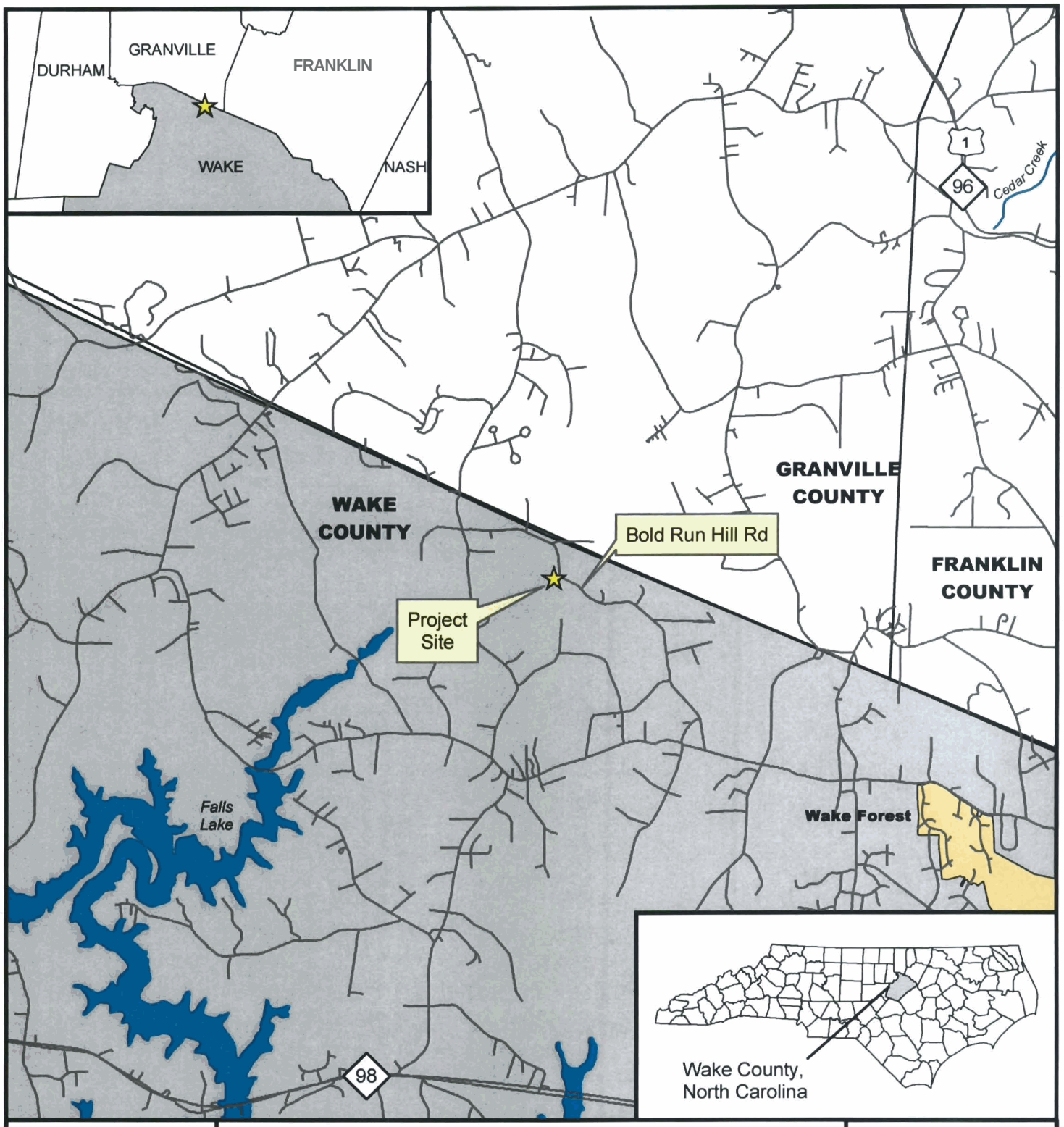

Figure 1. Project Site Vicinity Map

- Proposed Restoration Site
- Roads
- Municipalities
- County Boundaries
- Major Rivers
- Lakes and Reservoirs

N
W E
S

1:63,360
1 inch equals 1 miles

1 0.5 0 1 Miles

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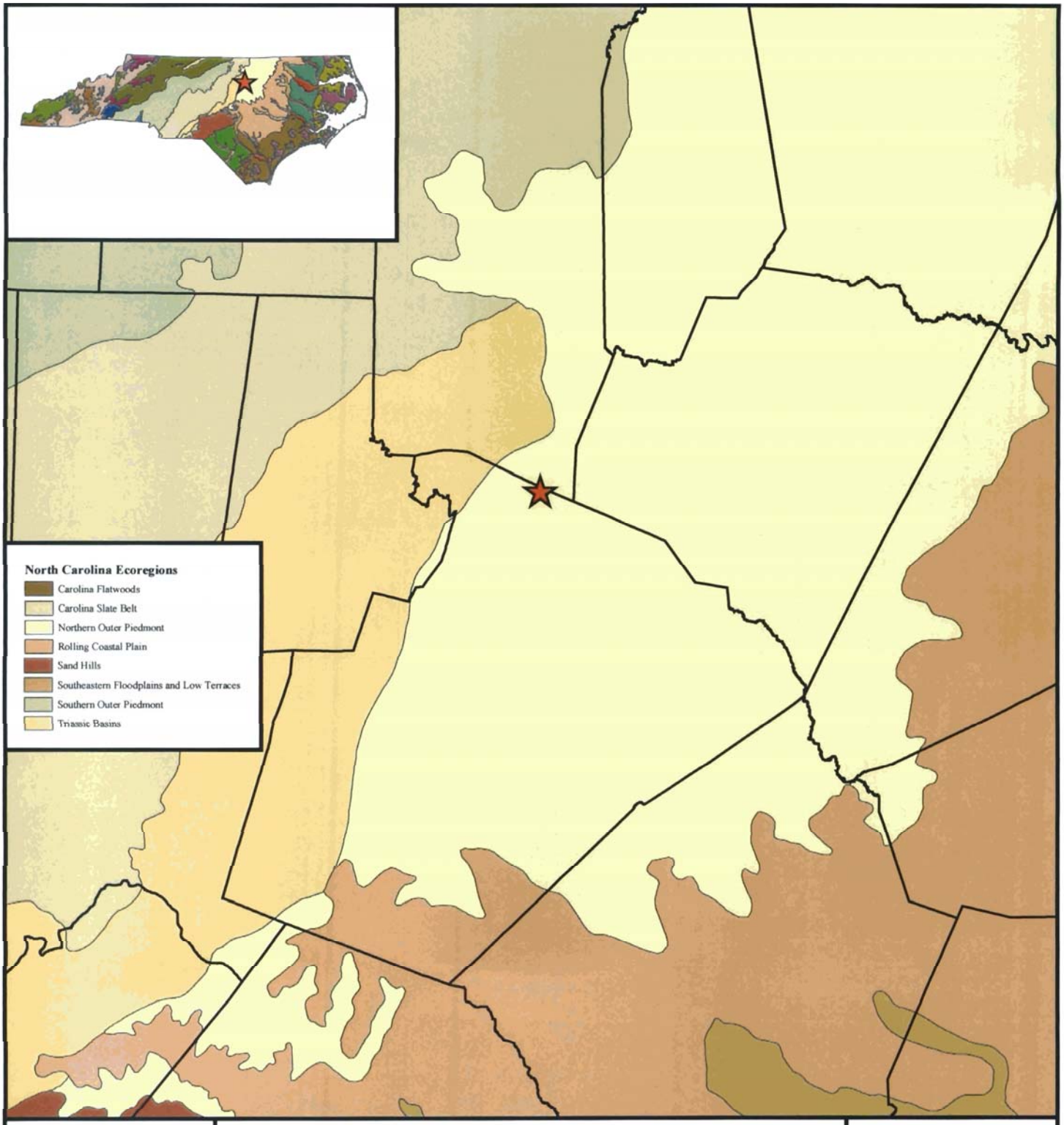

Figure 2. North Carolina Ecoregions Map

Proposed Restoration Site

County Boundaries

N
W E
S

1:633,600

1 inch equals 10 miles

10 5 0 10 Miles

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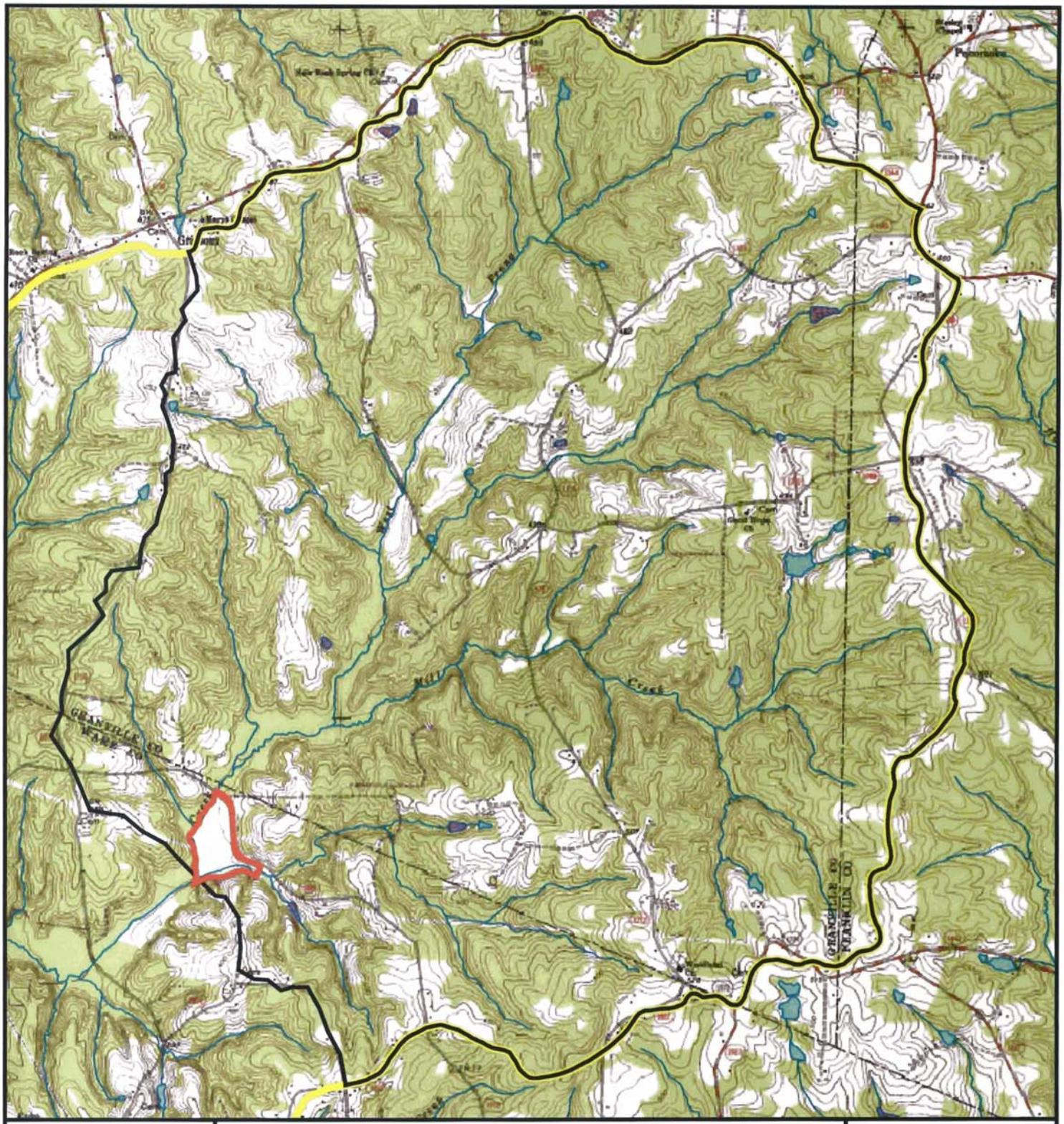

Figure 3. Project Site Watershed Map

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The NCDWQ assigns surface waters a classification in order to help protect, maintain, and preserve water quality. New Light Creek is designated as WS-IV, NSW, and CA. The project area (Bold Run Creek) is located upstream from this designated portion.

- **WS-IV** waters are used as sources of drinkable water, which are also protected for Class C uses. WS-IV waters are generally in moderately to highly developed watersheds or Protected Areas (NCDENR, 2005). Class C uses are "waters protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class C" (NCDENR, 2005).
- **Nutrient Sensitive Waters (NSW)** is a supplemental classification intended for waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation. In general, management strategies for point and nonpoint source pollution control require control of nutrients (nitrogen and/or phosphorus usually) such that excessive growths of vegetation are reduced or prevented and there is no increase in nutrients over target levels. Management strategies are site-specific (NCDENR, 2005).
- **Class CA** waters indicate a Critical Area within a water supply watershed (NCDENR, March 2005).

2.3 Physiography, Geology and Soils

Local geology consists of metamorphic rocks of the Raleigh Belt. These include metamorphosed biotite gneiss and schist, meta-ultramafic rock, and felsic mica gneiss.

According to the NRCS, Wake County Soil Survey, Chewacla (Cm), Wehadkee silt loam (Wn), Wehadkee and Bibb soils (Wo), Altavista fine sandy loam 0 to 4 percent slopes (AfA), Madison sandy laom 15 to 25 percent slopes, eroded (MdE2) and Wilkes soils 20 to 45 percent slopes (WwF) are the predominant soil types located within the project boundary (Figure 4. Project Site NRCS Soils Survey Map).

However, during a July 14, 2005 field investigation, Steven Stokes, LSS mapped the predominant soils as a Chewacla variant with inclusions of Riverview (Figure 5. Project Site Soil Classification Map). According to the Wake County Soil Survey, Chewacla (Cm) is described as a somewhat poorly drained soil. The Chewacla soils investigated on the project site were well to moderately well drained soils, therefore the Chewacla variant classification was selected to describe these soils. Riverview soils are currently not mapped by the Wake County NRCS.

2.4 Historical Land Use and Development Trends

2.4.1 Historical Resources

Historical aerial photographs were obtained from the Wake County Natural Resources Conservation Service (NRCS) office in order to enhance the assessment of existing site conditions. The intent of the review was to understand the chronology of land disturbance and aid in the evaluation of the site and the development of an appropriate restoration strategy. Aerial photographs of the site were obtained from 1949, 1954, 1965, 1971, 1981, 1988, and 1993 (Appendix A).

In 1949, the subject property closely resembled the existing conditions, however the area on the west of the project site appears to be forested.

In 1959, 1965, and 1971, the subject property resembles current conditions.

In 1981, the subject property appears to be reforested in the north section.

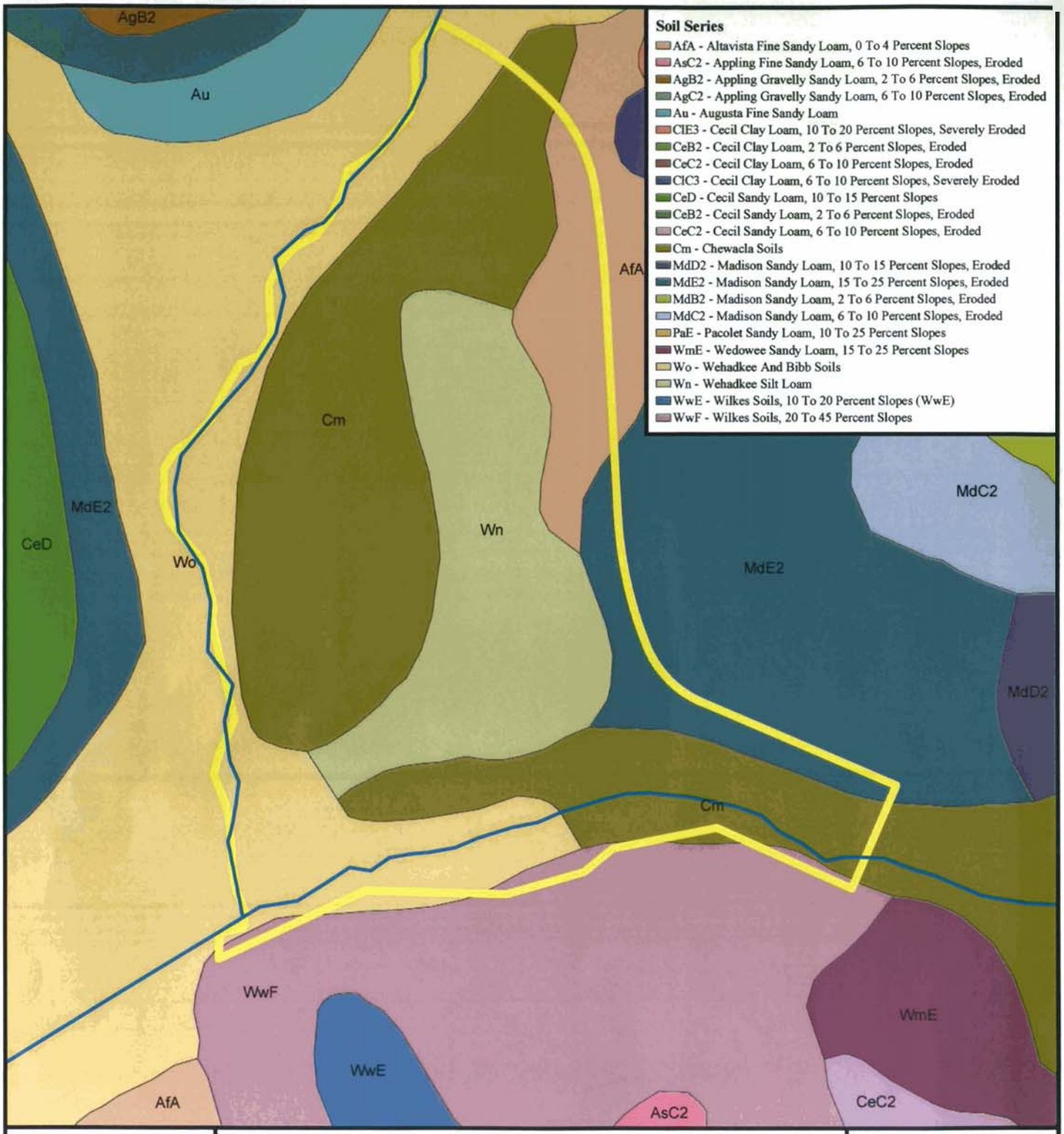

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Figure 4. Project Site NRCS Soils Survey Map

Project Site Boundary

Streams

N
W E
S

1:3,600
1 inch equals 300 feet

300 150 0 300 Feet

Source: Wake County Soil Survey

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Figure 5. Project Site Soil Classification Map

Chewacla
Chewacla Variant
Chewacla-Riverview

1:3,000
1 inch equals 250 feet

250 125 0 250 Feet

Image Source: Wake County GIS, Digital Orthophotography 1999

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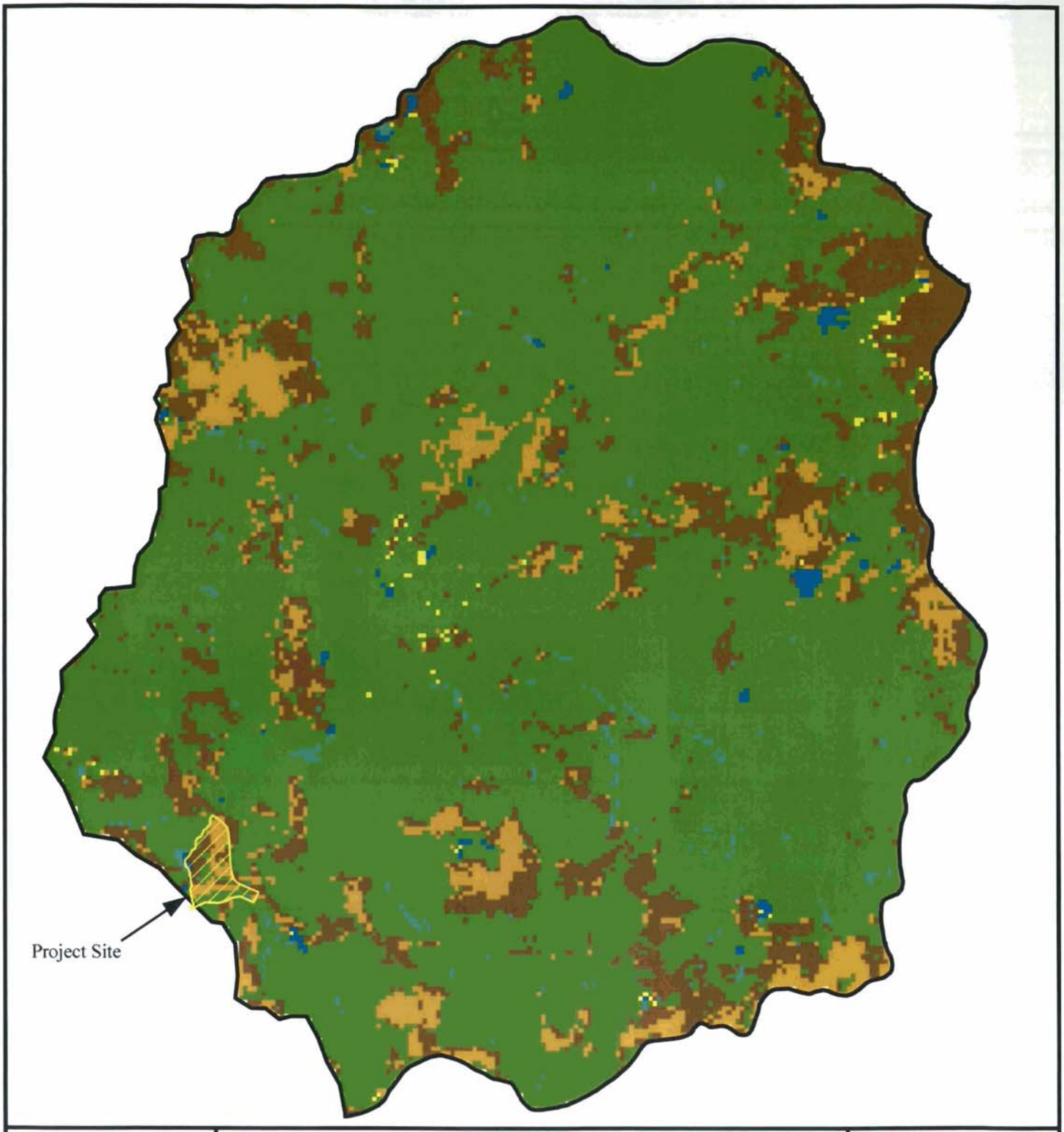

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Figure 6. Land Use and Land Cover Map

Land Use and Land Cover (Anderson I)

- Urban or Built-Up Land
- Agriculture
- Rangeland
- Forest Land
- Water
- Wetland
- Barren Land

Project Watershed

Project Site Boundary

Source: North Carolina GAP Land Cover Dataset Published 2003

1:36,000
1 inch equals 3,000 feet

3,000 1,500 0 3,000 Feet

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Figure 7. National Wetland Inventory Map

- Palustrine Emergent Persistent Semipermanently Flooded (PEM1F)
- Palustrine Forested Broad-leaved Deciduous Temporarily Flooded (PFO1A)
- Palustrine Forested Broad-leaved Deciduous Seasonally Flooded (PFO1C)
- Palustrine Unconsolidated Bottom, Permanenetly Flooded Diked/Impounded (PUBHh)
- Project Site Boundary

N W E S

1:6,000

1 inch equals 500 feet

500 250 0 500 Feet

SOURCE: Wake County GIS, Digital Orthophotography 1999

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2.8 Potential Constraints

The presence of conditions or characteristics that have the potential to hinder restoration activities on the project site were evaluated. Existing information regarding project site constraints was acquired and reviewed. In addition, any site conditions that have the potential to restrict the restoration design and implementation were documented during the field investigation. Table 2 summarizes the identified constraints related to the implementation of site restoration activities.

Table 2. Summary of Design Constraints

Fatal Flaw/Constraint	Nature of Constraint	Proposed Resolution
Current Land Use (Specify)	Pasture (livestock grazing)	Exclusion fencing as necessary
Adjacent Property Land Use	Forest, Agriculture, Low-Density Residential Development	
Deed Restrictions/Easements	Utility easement crosses project site	The stream has been relocated to minimize the impacts of the power lines on the stream/buffer restoration.
Project Constructibility/Access	None	
Utilities	Utility poles cross project site	Stream crossings have been proposed to provide continued maintenance access, post-restoration.
Structures	None	
Cultural (Historical/Archaeological)	State Historic Preservation Office (Appendix B) indicated no record of occurrences within one-mile radius of the project site	
Rare, Threatened, and Endangered Species	Natural Heritage Program Findings Letter (Appendix B) indicated no record of occurrences within one-mile radius of the project site	
Natural Features (Soils, Bedrock)	Bedrock outcrops in streambed and banks	Identified bedrock incorporated into the design.
FEMA Regulated Area	Project area within Zone X and AE	No-Rise Certification

2.8.1 Hazardous Materials

The presence or likely presence of hazardous substances on the subject property and surrounding area under conditions that indicate a past, present or potential release into the ground, groundwater, or surface water was evaluated. The evaluation included a review of public record environmental database information and a visual site inspection.

A report meeting ASTM E1527-00 Standards for records search requirements was obtained summarizing existing federal and state database information regarding known environmental conditions for the subject property and surrounding area. No conditions of environmental concern were identified on the Bold Run Project Site or within the specified search radii.

An Environmental Screening Inspection (ESI) was conducted on the subject property in June 2005. The purpose of the ESI was to visually evaluate the presence or evidence of any recognized environmental concerns on the study site and surrounding areas. The ESI identified no recognized environmental concerns that would have the potential to impact stream and buffer restoration on the project site. The findings of the field investigation were documented on an Environmental Screening Inspection Form with corresponding photographs (Appendix C).

2.8.2 Property Ownership and Boundary

KCI obtained copies of the property deed dating back to 1950 from the Wake County Register of Deeds in August 2005 (Table 3). The property deeds can be found on the CD included with the Restoration Report.

Table 3. Property Ownership History

Book	Page	Grantee (Buyer)	Grantor (Seller)	Date
9541	961	NC Capital Group Purnell Road	Douglas A. Darch and Helen C. Darch	8/14/2002
9485	157	Marvin E. Sykes, Jr.	Douglas A. Darch and Helen C. Darch	7/2/2002
8537	1861	John M. Rich, A. Melanie Murphy	Douglas A. Darch and Helen C. Darch	3/8/2002
8300	1508	Christopher J. Marek	Douglas A. Darch and Helen C. Darch	4/22/1999
8256	1188	Glen A. Darch, Susan K. Darch	Douglas A. Darch and Helen C. Darch	2/18/1999
8169	1569	NCDOT	Douglas A. Darch and Helen C. Darch	10/20/1998
8085	1493	William H. Steiner, Betty JoAnne Steiner	Douglas A. Darch and Helen C. Darch	6/11/1998
3685	265	State of North Carolina, Right of Agreement	Douglas A. Darch and Helen C. Darch	3/25/1997
6982	77	John Wade Stone, Shirley B. Stone	Douglas A. Darch and Helen C. Darch	4/16/1996
3015	568	David C. Darch, Carrie M. Darch	Douglas A. Darch and Helen C. Darch	2/28/1994
5922	405	C.M. Medlin Jr.	Douglas A. Darch and Helen C. Darch	12/7/1993
5918	351	Lee Arnold Darch, Alison Wood Darch	Douglas A. Darch and Helen C. Darch	12/7/1993
4701	923	Lee Arnold Darch, Alison Wood Darch	Douglas A. Darch and Helen C. Darch	5/3/1990
4490	703	Mildred P. Davis, Geneva P. Stephenson	Douglas A. Darch and Helen C. Darch	5/8/1989
3977	571	Glen A. Darch	Douglas A. Darch and Helen C. Darch	3/7/1987
3692	925	Jack L. Taylor, Jr., Patricia L. Taylor	Douglas A. Darch and Helen C. Darch	4/1/1986
3420	439	Edward Paschal, Beadie Bridges	Douglas A. Darch and Helen C. Darch	1/24/1985

3420	434	Edward Paschal, Martha M. Leonard	Douglas A. Darch and Helen C. Darch	1/21/1985
3232	459	Champion International Corporation	Douglas A. Darch and Helen C. Darch	1/30/1984
2848	845	C.M. Kirk	Douglas A. Darch and Helen C. Darch	7/25/1980
2831	53	Richard O. Gamble	Douglas A. Darch and Helen C. Darch, Lee A. Darch, Patty C. Darch	5/27/1980
2830	92	David C. Darch	Douglas A. Darch and Helen C. Darch	4/10/1980
2227	537	C.M. Kirk	Douglas A. Darch and Helen C. Darch	2/20/1974
2020	487	Edward Paschal, P.C. Bailey	Douglas A. Darch and Helen C. Darch	9/1/1971
1707	185	Donald Gulley, Central Carolina Bank and Trust Company	Douglas A. Darch and Helen C. Darch	4/1/1966
1587	661	Donald Gulley, Central Carolina Bank and Trust Company	Douglas A. Darch and Helen C. Darch	2/25/1964
1368	145	W.W. Sledge, Durham Bank & Trust Company	Douglas A. Darch and Helen C. Darch	5/21/1959
1335	535	W.W. Sledge, Durham Bank & Trust Company	Douglas A. Darch and Helen C. Darch	10/4/1958
1143	151	W.W. Sledge, Durham Bank & Trust Company	Douglas A. Darch and Helen C. Darch	2/12/1954
1061	344	Donald Gulley, P.V. Bailey, Lena S. Bailey	Douglas A. Darch and Helen C. Darch	12/8/1950
1061	332	Donald Gulley, Charles L. Wheelous	Douglas A. Darch and Helen C. Darch	12/8/1950

2.8.3 Site Access

There will be two access points to the project site. Both access points will be accessible from Bold Hill Run Road. The first access point currently exists off of Bold Hill Run Road located on the southeastern corner of the project site. The second access point will be established on the southeastern portion of the project, located northwest from the first access entrance. The accessible road will be approximately (170' x 14') which leads directly to the right of way for access to the utility line. During construction of the proposed stream, construction equipment will have access to the stream channel and will be able to maneuver up and down the channel, as necessary.

2.8.4 Utilities

A power line easement (Wake Electric) transects the subject property in a southeast-northwest orientation. The documentation for the power line easement can be found in Appendix D. Wake Electric has a 100 feet right of way along the utility line. During construction and post construction, Wake Electric will have access to the utility poles located on the project site. Wake Electric will access the site by way of the two existing entrances mentioned in section (2.8.3). Two stabilized riffle grade control crossings will be installed for machinery access to the utility lines located adjacent to the stream (Refer to Plan Sheet 4). Also no vegetation will be planted along the 100-foot utility easement and access road on the project site.

2.8.5 FEMA/Hydrologic Trespass

Bold Run Creek is located within the 100-year floodplain (Figure 8. Project Site Floodplain Map). As such, any modifications to the stream that would result in the increase of the 100-year flood elevation would require a Conditional Letter of Map Revision (CLOMR). It is the intent of the restoration design to maintain the 100-year flood elevation at the current level following restoration.

The FEMA provided an existing conditions HEC-2 model. The model parameters were reviewed to verify that the conditions represent a benchmark hydraulic condition that can be compared to post-restoration conditions. The existing conditions model will be revised to reflect changes to the channel and floodplain as a result of the restoration. A proposed hydrology and hydraulics (H&H) summary will be submitted with a letter indicating that an increase in the 100-year flood elevation is not anticipated (No-Rise Certification).

The proposed project reach is entirely contained within the Darch property. The restoration of the project reach is not anticipated to produce hydrologic trespass conditions on any adjacent properties.

3.0 PROJECT SITE STREAMS (EXISTING CONDITIONS)

A site field assessment was conducted in June 2005 to document existing conditions and evaluate the potential for stream and riparian buffer restoration. Observations and collected data are summarized below, illustrated in Figure 9 (Existing Channel or Site Conditions Map), and documented in the site photographs (Appendix E). The site was revisited several times from June to September 2005 to take further measurements, to install a stream gauge, and to collect hydrology data from the instruments (Figure 10. Project Site Hydrologic Features and Gauge Locations Map).

3.1 General Site Description

The Bold Run Creek project reach includes approximately 1,600 linear feet of perennial stream channel. The project reach begins at Station 11+00. Several stream bedrocks exist in the upper reach. The upstream portion of Bold Run Creek is a "B4c" and "F4" stream type, while the downstream portion is a "G4c" stream type. Severe bank erosion throughout the stream has resulted from poor grazing management. Bed degradation is evident and sedimentation from bank erosion is widespread.

One tributary (UT1) and one ephemeral channel enter Bold Run Creek. UT1 is a small, intermittent reach that joins Bold Run Creek near Station 12+00. The ephemeral channel is located near the downstream portion of Bold Run Creek. The channel starts at the bottom of a slope and runs parallel before connecting with Bold Run Creek at Station 23+00. The channel was ditched in the early 1960's to intercept runoff from the adjacent slope. Stream assessment forms were prepared for the channel; they are included in Appendix F.

Four (4) drainage features exist on the project site. Drainage 1 connects to the left bank of Bold Run Creek near the start of the project at Station 11+75. Drainage 2 starts at Bold Hill Run Road and directly connects to Bold Run Creek. Drainage 3 connects to the right bank of Bold Run Creek in the middle portion of the stream reach. Drainage 4 begins with two small drainage features beginning at the eastern portion of the project boundary, near Bold Hill Run Road. The two drainage features connect to a larger drainage feature in the middle of the project site, in the open field area, and runs south before connecting to New Light Creek on the left bank.

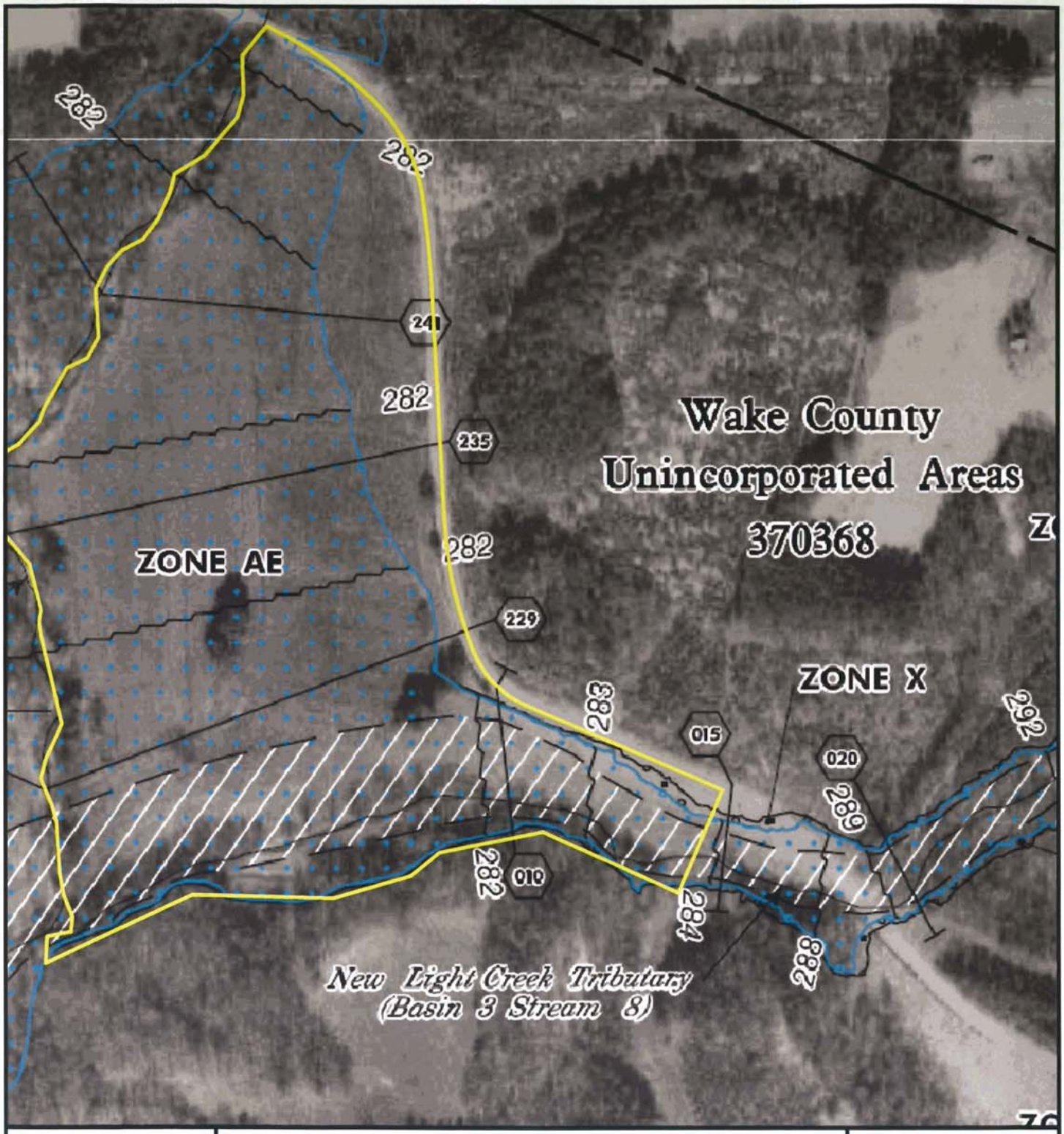

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Figure 8. Project Site Floodplain Map

Special Flood Hazard Area
(Subject to inundation by the 1% annual chance flood)

Floodway Areas in Zone AE

Project Site Boundary

Source: North Carolina Floodplain Mapping Program, FIRM Panel 1823

N
W E
S

1:3,600
1 inch equals 300 feet

300 150 0 300
Feet

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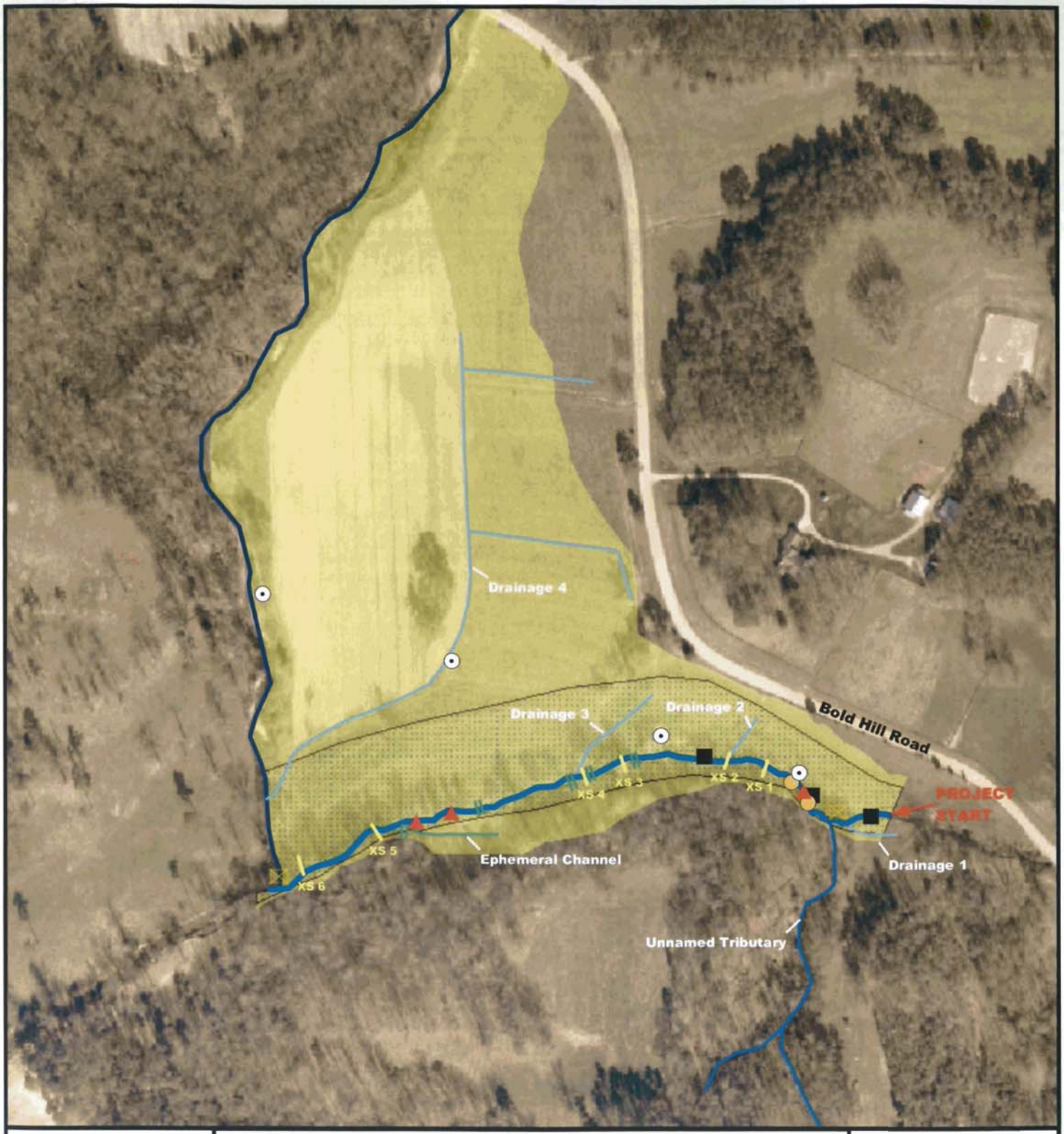

Figure 9. Existing Channel or Site Conditions Map

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- Bold Run Creek (Project Reach)
- Ephemeral Channel to Bold Run Creek
- Tributary to Bold Run Creek
- Ditches
- New Light Creek
- Stream Cross Section
- Bedrock
- Bank Rock Structure
- Fence
- Utility Pole
- Cattle Access
- Cattle Crossing
- Flood Hazard Zone AE
- Floodway Areas in Zone AE

Image Source: Wake County GIS, Digital Orthophotography 1999

1:3,600
1 inch equals 300 feet

300 150 0 300 Feet

N W E S

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Figure 10. Project Site Hydrological Features with Gauge Locations Map

Bold Run Creek (Project Reach)
Ephemeral Channel to Bold Run Creek
Tributary to Bold Run Creek
Stream Gauge
Non-project Streams

1:3,600
1 inch equals 300 feet

300 150 0 300 Feet

Image Source: Wake County GIS, Digital Orthophotography 1999

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A power line easement transects the project site with four (4) utility poles. The first utility pole is located approximately 20 feet from the right stream bank. The second utility pole is located approximately 40 feet from the right stream bank near Station 16+50. The third utility pole is centrally located in the project site and the fourth pole is situated adjacent to New Light Creek.

3.2 Channel Classification

The upstream portion of Bold Run Creek is classified as a "B4c" and "F4" stream type. The stream begins as a moderately entrenched channel (1.7) with a moderate width-to-depth ratio (12.6). Proceeding downstream, the channel becomes entrenched and widens as the stream transitions into an "F" type channel. Near Station 24+00, the channel narrows as Bold Run Creek changes to a "G4c" type stream. Low width-to-depth and entrenchment ratios and high bank height ratios are typical of "G" type streams.

3.3 Channel Morphology (Pattern, Dimension, and Profile)

A Rosgen Level III assessment was conducted to gather existing stream dimension, pattern, and profile data and determine the potential for restoration. Channel cross-sections and bed materials were surveyed at six representative locations along Bold Run Creek. Data developed from these surveys are summarized below (Table 4) with detailed data provided in Appendix G.

Table 4. Summary of Existing Channel Morphology

LOCATION / PARAMETER	XS-1	XS-2	XS-3	XS-4	XS-5	XS-6
Bankfull Cross-Sectional Area A_{bkf} (sq ft)	25.0	24.2	25.3	25.2	24.2	24.7
Bankfull Width W_{bkf} (ft)	17.8	26.5	15.7	17.2	18.3	14.8
Flood Prone Width W_{fpa} (ft)	30.0	34.3	18.3	19.4	21.3	18.5
Maximum Depth d_{mbkf} (ft)	1.9	2.1	1.9	1.9	1.9	2.3
Bankfull Mean Depth D_{bkf} (ft)	1.4	0.9	1.6	1.5	1.3	1.7
W/D ratio W_{bkf}/ d_{bkf}	12.6	29.1	9.7	11.7	13.8	8.8
Entrenchment Ratio	1.7	1.3	1.2	1.1	1.2	1.3
Bank Height Ratio	1.7	2.1	2.6	2.4	2.5	2.6
Local W. S. Slope (ft/ft)	0.007	0.007	0.007	0.007	0.007	0.007
Stream Type	B4c	F4	G4c	G4c	F4	G4c

3.4 Channel Stability Assessment

A qualitative stability assessment was performed to approximate the level of departure and determine the likely causes of the channel disturbance. This assessment facilitates the decision-making process with respect to restoration alternatives and establishing goals for successful restoration.

Bold Run Creek exhibits characteristics of an unstable channel, most notably bed degradation and bank erosion. Poor grazing management is the primary mechanism of disturbance, however the past removal of bank and riparian vegetation has exacerbated the bank erosion (eliminated rooting strength and cover protection). Bank height ratios in excess of 1.5, as well as the presence of several exposed bedrocks in Bold Run Creek, provide evidence of past bed degradation. Based on the field measurements, further degradation and widening can be expected in the lower section of the project before it will be aggrade and re-stabilize at the lowered base elevation.

3.5 Bankfull Verification

The standard methodology used in natural channel design is based on the ability to select the appropriate bankfull discharge and generate the corresponding bankfull hydraulic geometry from a stable reference system(s). Thus, the determination of bankfull stage is the most critical component of the natural channel design (NCD) process.

Bankfull can be defined as "the stage at which channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of the channels," (Dunne and Leopold, 1978). Several characteristics that commonly indicate the bankfull stage include: incipient point of flooding, breaks in slope, changes in vegetation, highest depositional features (i.e. point bars), and highest scour line. The identification of bankfull stage especially in a degraded system can be difficult. Therefore, verification measures must be taken to ensure the correct identification of the bankfull stage.

The three methods used to verify bankfull stage at Bold Run Creek were regional hydraulic geometry relationships (regional curves), a pressure transducer/data logger combination gauge that monitored actual water level in Bold Run Creek throughout the study period, and a hydrology/hydraulics model to evaluate flow and sediment transport.

Regional curves are typically utilized in ungauged areas to approximate bankfull discharge, area, width, and depth as a function of drainage area based on inter-related variables from other similar streams in the same hydrophysiographic province. Regional curves and corresponding equations from "Bankfull Hydraulic Geometry Relationships for North Carolina Streams" (Harman et al., 1999) were used to approximate bankfull in the project reach. Based on the regional curves, a bankfull discharge and cross-sectional area of 130 ft^3/s and 25 ft^2 would be anticipated.

Stream stage data (water levels) were collected from Bold Run Creek. Data was collected for four months (July through October) and water levels were correlated to an estimated discharge using a rating curve generated for the gauged section. During the gauging period, no significant storm events were recorded. The maximum discharge event was approximately 14 ft^3/s on October 8^{th}. KCI will continue to monitor the stage of Bold Run Creek in an attempt to validate the design discharge. Hydrograph data is provided in Appendix I.

Information from the regional curves and from the hydrologic monitoring was used in conjunction with the Hydrologic Engineering Center River Analysis System (HEC-RAS) software to refine the bankfull

determinations. The model allows for analysis of one-dimensional (1-D) steady state flow by solving for the energy equation. The approximate discharges calculated using the Manning open channel flow equation were run through the modeled reaches. The outputs corresponded well with the field indicators and to the subsequent calculations of the existing morphological variables. A summary data output developed from the model is provided below (Table 5).

Table 5. HEC-RAS Hydrologic Variables

Station	Profile	Q	Bed Elev.	WS Elev.	EG Elev.	EG Slope	Velocity	Area	Width	F.N.
Units		cfs	ft AMSL	ft AMSL	ft AMSL	ft/ft	fps	sf	ft	
XS1	BKF	120.0	275.46	277.60	277.95	0.010	4.74	25.34	19.9	0.74
XS2	BKF	120.0	274.80	276.78	276.55	0.010	4.63	25.89	22.69	0.76
XS3	BKF	120.0	272.34	274.73	274.93	0.005	3.59	33.46	22.94	0.52
XS4	BKF	120.0	271.53	273.78	274.17	0.009	5.06	23.8	15.74	0.72
XS5	BKF	120.0	268.29	270.73	271.08	0.008	4.74	25.3	16.96	0.68
XS6	BKF	120.0	267.11	269.32	268.86	0.007	4.65	25.81	15.83	0.64

3.6 Vegetation

The existing riparian area is predominantly in pasture. These areas are largely devoid of natural habitat communities. Mature trees sporadically line the channel throughout the project reach. Also mature trees are located along the hill slope bordering Bold Run on the left bank. It is the intent of the restoration project to salvage any valuable trees that may provide immediate shade to the restored channel.

On July 14, 2005, Steven Stokes and April Helms classified the existing natural communities in accordance with a "Classification of the Natural Communities of North Carolina, Third Approximation" (Schafale and Weakley, 1990). The flora, including dominant species per stratum, were identified and recorded.

Two community types were identified within the project area. The first community was classified as Piedmont/Mountain Bottomland Forest. This community is located in the southeastern portion of the project, near Bold Hill Run Road. The dominant species observed in this community are as follows: Sycamore *(Platanus occidentalis),* Green Ash *(Fraxinus pennsylvanica),* Black Walnut *(Juglans nigra),* Loblolly Pine *(Pinus taeda),* and Winged Elm *(Ulmus alata).*

The second community was classified as Piedmont/Mountain Levee Forest. This community is located along the levee of New Light Creek and the banks of Bold Run Creek. The dominant species observed along the levee of New Light Creek are as follows: American Elm *(Ulmus americana),* Sweet Gum *(Liquidambar styraciflua),* River Birch *(Betula nigra),* Japanese Honeysuckle *(Lonicera japonica),* and Chinese Privet *(Ligustrum sinense).* The dominant species observed along the banks of Bold Run Creek are as follows: Sycamore, Southern magnolia *(Magnolia grandiflora),* Vietnamese Stilt Grass *(Microstigium viminium),* River Birch, and Black Walnut.

4.0 REFERENCE STREAMS

A reference reach is a channel with a stable dimension, pattern, and profile within particular valley morphology. The reference reach is used to develop dimensionless morphological ratios (based on bankfull stage) that can be extrapolated to disturbed/unstable streams to restore a stream of the same type and disposition as the reference stream (Rosgen, 1998).

An upstream reach of Richland Creek located on the west side of the Town of Wake Forest was selected to serve as a reference reach for the restoration of Bold Run Creek. Richland Creek flows south from its headwaters in Franklin County towards its confluence with the Neuse River (Figure 11. Reference Site Vicinity Map). It drains approximately 4.8 square miles of low-density residential, agriculture, and forested lands. This selection was based on: location in the same hydrophysiographic province, similar valley morphology, and similar sediment regime as the project site. Both streams are found in the northern outer Piedmont ecoregion where local topography is relatively consistent with each other.

Approximately 400 linear feet of Richland Creek were surveyed in August 2004 and re-evaluated in August 2005 (Appendix H contains supporting documentation from the field assessment). This reach of Richland Creek was classified as a "C4" channel type. The dimensionless hydraulic geometry relationships were developed from stable channel dimensions to facilitate the design of the proposed channel cross-sections for the Bold Run Creek restoration reach.

4.1 Watershed Characterization

Richland Creek is situated within the northeastern portion of the Piedmont physiographic province, which is typified by rolling topography with broad ridges, sharply indented stream valleys, and narrow, low-gradient floodplains. The Richland Creek watershed (USGS 14-digit Hydrologic Unit 03020201070060) is located within sub-basin 03-04-02 of the Neuse River Basin. The headwaters of the Richland Creek form to the west and south of Youngsville, North Carolina. The watershed extends south-southwest to a point approximately 1.5 miles downstream of the Falls Reservoir Dam where Richland Creek joins the Neuse River.

The portion of Richland Creek evaluated for the reference survey is located between the Franklin/Wake County Line and Harris Road in Wake Forest, North Carolina. Capital Boulevard (US 1) roughly bounds the watershed to the west and the Seaboard Coast Railroad Line bounds it to the east (Figure 12. Reference Site Watershed Map). The topographic relief within the project reach is approximately 25 feet, ranging from approximately 282 feet above mean sea level (AMSL) at the upstream limits of Section 1 to 257 feet AMSL at the downstream limits at the Stadium Drive Bridge.

4.2 Channel Classification

Richland Creek is classified as a "C4" stream type. The majority of the cross-section calculations contain an entrenchment ratio greater than 2.2, for a "C" or "E" with a width to depth ratio slightly greater 12.

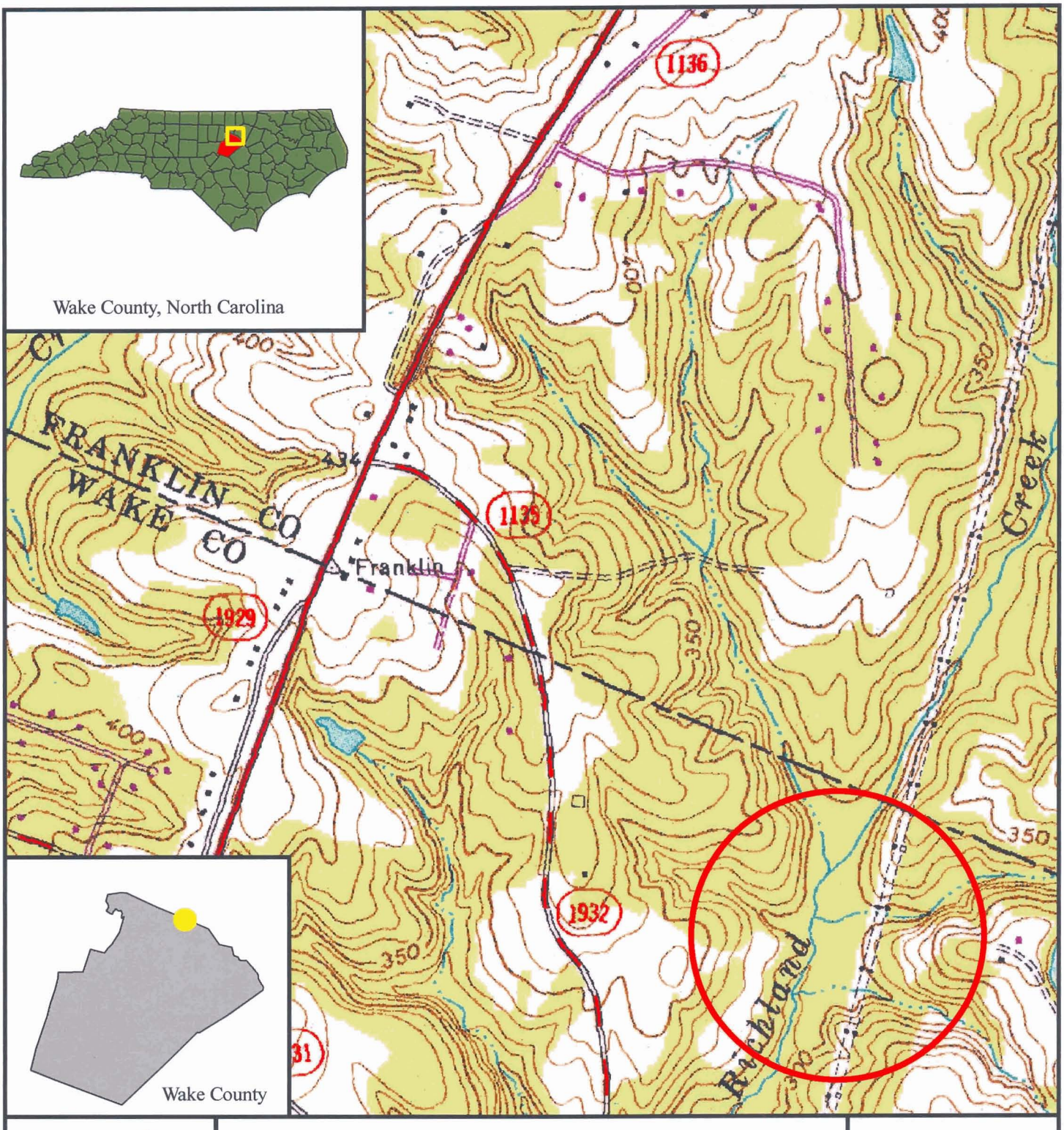

Figure 11. Reference Site Vicinity Map

Reference Reach on Richland Creek

1:12,000
1 inch equals 1,000 feet

1,000 500 0 1,000 Feet

Source: USGS Topographic Quadrangles Grissom and Franklinton

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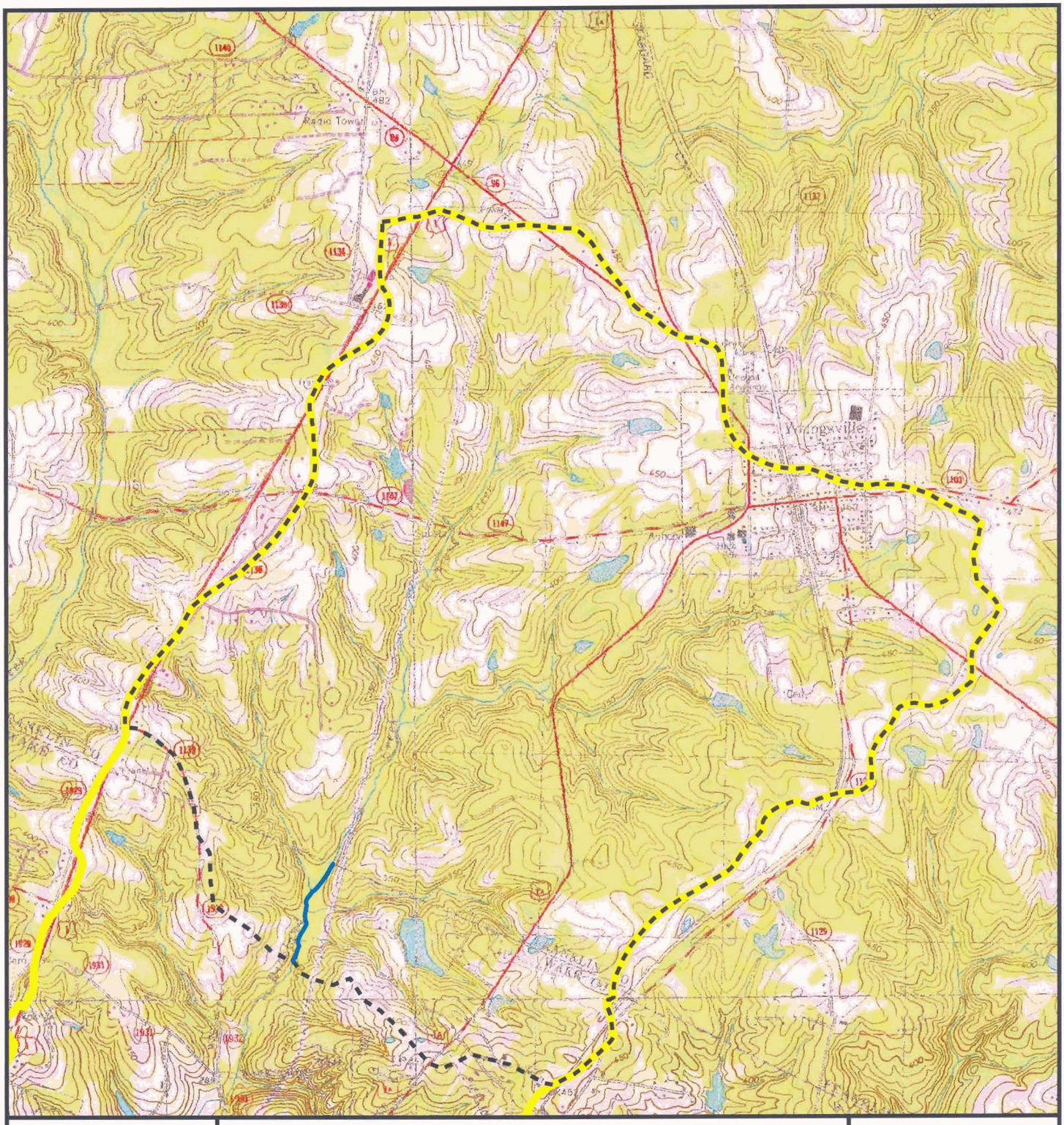

Figure 12. Reference Site Watershed Map

Reference Reach

Reference Site Watershed

14-digit HUC 03020201070060

1:30,000

1 inch equals 2,500 feet

2,500 1,250 0 2,500 Feet

Source: Franklin County DRG

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4.3 Discharge (Bankfull, Trends)

Following the field assessment, three methods were used to verify the bankfull stage at Richland Creek. These methods included regional hydraulic geometry relationships (regional curves), a pressure transducer / data logger combination gauge that monitored actual water level in Richland Creek throughout the study period, and a hydrology/hydraulics model (HEC-RAS) to evaluate flow and validate field calls.

Regional curves and corresponding equations from "Bankfull Hydraulic Geometry Relationships for North Carolina Streams" (Harman et al., 1999) were used to approximate bankfull in the project reach. Based on the regional curves, a bankfull discharge and cross-sectional area of 270 ft^3/s and 70 ft^2 would be anticipated at the Richland Creek Reference Reach.

Stream stage data (water levels) were collected downstream of the Richland Creek Reference Reach. Data was collected for five months and water levels were correlated to an estimated discharge using a rating curve generated for the gauged section. Three significant flow events occurred during the monitoring period. Richland Creek in the vicinity of the gauge discharged 309, 185, and 155 ft^3/s for each of these events, respectively. This corresponded to a maximum discharge of approximately 210 – 220 ft^3/s in the reference reach.

The hydrology/hydraulics model provided a water surface profile and cross-sectional depiction based on the sections surveyed during the reference reach assessment. This method provided a further means to validate the discharge approximated in the reference reach section, as well as verify the field-call bankfull stage.

4.4 Channel Morphology (Pattern, Dimension, Profile)

A Rosgen Level III assessment was conducted to gather existing stream dimension, pattern, and profile data and determine the potential for restoration. Channel cross-sections and bed materials were surveyed at five representative locations along Richland Creek. Data developed from these surveys are provided in Appendix H.

4.5 Vegetation

A field survey was conducted to identify and document the dominant plant communities in the project area. Several distinct community mosaics were recognized, and complete species lists with dominance were compiled. These lists were utilized to best fit the communities described in the Classification of Natural Communities of North Carolina (Schafale & Weakley, 1990). The natural community in the reference area was the Piedmont Levee Forest. Piedmont Levee Forests are prevalent along the active levee position of Richland Creek. Woody species of the canopy include *Fraxinus pennsylvanica* (green ash), *Platanus occidentalis* (sycamore), *Betula nigra* (river birch), *Liquidambar styraciflua* (sweet gum), *Acer negundo* (boxelder), and *Juglans nigra* (black walnut). Species in the overstory dominate those in the understory.

5.0 PROJECT SITE RESTORATION PLAN

5.1 Restoration Project Goals and Objectives

Based on the existing and reference condition descriptions, the restoration goals and objectives for the Bold Run Creek Stream/Buffer Restoration project are as follows:

Restoration Goals:

- Restore a stable channel morphology that is capable of moving the flows and sediment provided by its watershed;
- Improve water quality and reduce land and riparian vegetation loss resulting from lateral erosion and bed degradation through the establishment of bank and riparian vegetation and,
- Enhance aquatic and terrestrial habitat through the improvements to the stream water quality (improved oxygen content, reduced sediment and nutrients, variable stream bed features).
- Improve water quality through approximately 27.1 acres of buffer restoration throughout the project site.

Restoration Objectives:

- Project success will be assessed utilizing measurements of stream dimension, pattern, and profile, site photographs, and vegetation sampling. These measurements should show little or no change from the as-built conditions.
- A stable channel is able to move the sediment supplied by its watershed without the channel aggrading or degrading. Through stream monitoring the stability of the restored stream will be evaluated.
- Riparian vegetation must meet a minimum survival success rate of 320 stems/acre after five years.

5.1.1 Designed Channel Classification

The restoration design of Bold Run Creek will be restored to a Rosgen stream type "C4" and is based on Priority Level II and IV approaches, as described in "A Geomorphological Approach to Restoration of Incised Rivers", (Rosgen, 1997.) For clarity and convenience, definitions of the four restoration priorities are provided in Table 6.

The design proposes constructing 1,629 linear feet of meandering channel using a Priority Level II and IV approach. Approximately 1,453.7 linear feet of Level II and 175.6 linear feet of Level IV will be restored. The Level II restoration will establish a bankfull channel with a new floodplain, a channel bed at its existing level in an existing gravel layer, and the cross section dimensions necessary to provide stable flow maintenance and sediment transport. The Level IV design proposes to stabilize the bed and banks while maintaining the existing channel pattern (planform) (Figure 13. Proposed Planform). The design bankfull stage will equal the floodplain elevation in the new channel (bank height ratio = 1.0). The establishment of a stable bedform (i.e., riffle-pool sequence, pool spacing) will be addressed in the profiling of the design channel. The proposed stream dimension, pattern, and profile will be based on the detailed morphological criteria and hydraulic geometry relationships developed from the reference streams, see Table 7. Refer to the attached plan sheet drawings.

In-stream structures will be incorporated to reduce the burden of energy dissipation on the channel geometry. Cross Vanes and Rock Sill Grade Controls (Refer to Plan Sheet 2) will be used to stabilize the restored channel. These structures are designed to reduce bank erosion and the influence of secondary circulation in the near-bank region of stream bends. The structures further promote efficient sediment transport and produce/enhance in-stream habitat. Coir fiber matting will be used to provide temporary stabilization on the newly graded streambanks. The confluence of tributaries with the restored stream will

be stabilized with grade control structures where necessary to match the proposed grade of the restored main channel (Refer to Plan Sheet 4 where UT1 joins Bold Run).

The restoration project will also include other non-stream related components:

- Cattle exclusion fencing will be installed along the outer boundary of the restored riparian buffers and a permanent conservation easement will be recorded to protect the site in perpetuity.
- Two stabilized riffle grade control crossings will be installed to provide access to the utility power lines located on the project site.

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Figure 13. Proposed Planform

Priority II Restoration (1,453.7 linear feet)

Priority IV Restoration (175.6 linear feet)

1:1,500

1 inch equals 125 feet

125 62.5 0 125

Feet

Source: Wake County GIS, Digital Orthophotography 1999

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Table 6. Priority Levels of Incised River Restoration

Description	Methods	Advantages	Disadvantages
Priority 1 Convert G and/or F stream types to C or E at previous elevation with floodplain.	Re-establish channel on previous floodplain using relic channel or construction of new bankfull discharge channel. Design new channel for dimension, pattern, and profile characteristic of stable form. Fill in existing incised channel or with discontinuous oxbow lakes level with new floodplain elevation.	Re-establishment of floodplain and stable channel: 1) reduces bank height and streambank erosion, 2) reduces land loss, 3) raises water table, 4) decreases sediment, 5) improves aquatic and terrestrial habitats, 6) improves land productivity, and 7) improves aesthetics.	1) Floodplain re-establishment could cause flood damage to urban, agricultural, and industrial development. 2) Downstream end of project could require grade control from new to previous channel to prevent head-cutting.
Priority 2 Convert F and/or G stream types to C or E. Re-establishment of floodplain at existing level or higher, but not at original level.	If belt width provides for the minimum meander width ratio for C or E stream types, construct channel in bed of existing channel, convert existing bed to new floodplain. If belt width is too narrow, excavate streambank walls. End-haul material or place in streambed to raise bed elevation and create new floodplain in the deposition.	1) Decreases bank height and streambank erosion, 2) Allows for riparian vegetation to help stabilize banks, 3) Establishes floodplain to help take stress off of channel during flood, 4) Improves aquatic habitat, 5) Prevents wide-scale flooding of original land surface, 6) Reduces sediment, 7) Downstream grade transition for grade control is easier.	1) Does not raise water table back to previous elevation. 2) Shear stress and velocity higher during flood due to narrower floodplain. 3) Upper banks need to be sloped and stabilized to reduce erosion during flood.
Priority 3 Convert to a new stream type without an active floodplain, but containing a floodprone area. Convert G to B stream type, or F to Bc.	Excavation of channel to change stream type involves establishing proper dimension, pattern, and profile. To convert a G to B stream involves an increase in width/depth and entrenchment ratio, shaping upper slopes and stabilizing both bed and banks. A conversion from F to Bc stream type involves a decrease in width/depth ratio and an increase in entrenchment ratio.	1) Reduces the amount of land needed to return the river to a stable form. 2) Developments next to river need not be relocated due to flooding potential. 3) Decreases flood stage for same magnitude flood. 4) Improves aquatic habitat.	1) High cost of materials for bed and streambank stabilization. 2) Does not create the diversity of aquatic habitat. 3) Does not raise water table to previous levels.
Priority 4 Stabilize channel in place.	A long list of stabilization materials and methods have been used to decrease streambed and streambank erosion, including concrete, gabions, boulders, and bioengineering methods.	1) Excavation volumes are reduced. 2) Land needed for restoration is minimal.	1) High cost for stabilization. 2) High risk due to excessive shear stress and velocity. 3) Limited aquatic habitat depending on nature of stabilization methods used.

Source: Rosgen, 1997, "A Geomorphological Approach to Restoration of Incised Rivers".

Table 7. Morphological Design Criteria

Variables		Project Site Existing Channel	Reference Reach Richland Creek (Above Section 1)	Project Site Restored Reach
Rosgen Stream Type		B4/C4	C4	C4
Drainage Area (mi^2)		12	4.8	12
Bankfull Width (W_{bkf}) (ft)		15.7-26.5 (17.5)	28-32	17.7
Bankfull Mean Depth (d_{bkf}) (ft)		.9-1.7 (1.5)	2.3-2.4	1.4
Bankfull Cross Sectional area (A_{bkf}) (ft^2)		24.2-25.3 (24.9)	67-75	25
Width/depth Ratio (W_{bkf}/d_{bkf})		8.8-29.1 (12.2)	11.7-13.9	12.5
Maximum Depth (d_{mbkf}) (ft)		1.9-2.3 (1.9)	3.75	1.6
Width of flood prone area (W_{fpa}) (ft)		18.3-34.3 (20.4)	>100*	53.1
Entrenchment Ratio (ER)		1.1-1.7 (1.3)	>3.0*	>3.0
Water Surface Slope (S) (ft/ft)		0.007	0.004	0.007
Sinuosity (stream length/valley length) (K)		1.04	1.1	1.1
Dimension	Pool Depth (ft)	-	2.9	1.54
	Riffle Depth (ft)	9-1.17	2.3-2.4	1.4
	Pool Width (ft)	-	26-.5	19.0
	Riffle Width (ft)	15.7-26.5	28-32	17.7
	Pool XS Area (sf)	-	70-75	27.5
	Riffle XS Area (sf)	24.2-25.3	67-75	25
	Pool depth/mean riffle depth	-	1.2-1.3	1.2-1.3
	Pool width/riffle width	-	0.9-1.1	0.9-1.1
	Pool area/riffle area	-	0.9-1.1	0.9-1.1
	Max pool depth/d_{bkf}	-	1.9-2.0	1.9-2.0
	Low bank height/max bankfull depth	-	1.0-1.2	1.0-1.2
	Mean Bankfull Velocity (V) (fps)	3.1-4.6	3.6-5.0	
	Bankfull Discharge (Q) (cfs)	75-115	260-270	
Pattern	Meander length (L_m) (ft)	68-150	110-200	60-180
	Radius of curvature (Rd) (ft)	20-70	30-70	20-55
	Belt width (W_{blt}) (ft)	20-75	300	160-195
	Meander width ratio (w_{blt}/W_{bkf})	1.1-4.3	9.3-10.7	9-11
	Radius of curvature/bankfull width	1.1-4.0	1.0-2.5	1.1-3.0
	Meander length/bankfull width	3.8-8.6	3.5-7.1	35-10.0
Profile	Valley slope	0.0083	0.0045	0.0083
	Average water surface slope	0.0087*	0.004	0.007
	Riffle slope	0.004-0.021	0.0045-0.009	0.0088-0.0158
	Pool slope	0.0002-0.0009	0.000-0.0025	0.000-0.0044
	Pool to pool spacing	10-70	25-90	0-0.001
	Pool length	29-43	5-25	3-20
	Riffle slope/avg water surface slope	0.46-2.4	1.1-2.3	1.1-2.3
	Pool slope/avg water surface slope	0.023-0.103	0.0-0.6	0.0-0.6
	Run slope/avg water surface slope	-	0.7-1.2	0.7-1.2
	Run depth/d_{bkf}	-	1.0-1.1	1.0-1.1
	Pool length/bankfull width	1.7-2.5	0.2-0.9	0.2-0.9
	Pool to pool spacing/bankfull width	0.57-4.0	0.8-3.0	0.8-3.0

* This value is influenced by the level of incision of Bold Run Creek before its confluence with New Light Creek.

5.2 Natural Plant Community Restoration

Restoring natural vegetation will focus primarily on the buffer restoration areas and Bold Run Creek floodplain areas. These areas will receive species consistent with a Piedmont Levee Forest and Piedmont Bottomland Forest community. The typical Piedmont Levee Forest is seasonally to intermittently flooded. The vegetation may consist of mature climax forest, or may be in various stages of primary or secondary succession (Schafale and Weakley 1990). The typical Piedmont Bottomland Hardwood community is flooded at least occasionally. Bottomland Forests are believed to form a stable climax forest with uneven-aged canopy with primarily gap phase regeneration (Schafale and Weakley 1990).

5.2.1 Target Buffer Communities

The Neuse River Buffer Rule (15A NCAC 2B .0233) applies to 50-foot (15.24 m) wide buffers directly adjacent to surface waters in the Neuse River Basin (intermittent streams, perennial streams, lakes, ponds, and estuaries), excluding wetlands. The Neuse River Buffer Rules (NBR) is administered by the NCDWQ. The purpose of this rule is to protect and preserve existing riparian buffers in the Neuse River Basin and to maintain their nutrient removal functions. This rule is applicable to all streams identified on either the most recent local county soil survey or the most recent USGS topographic map. If stream features are not present on either map, the area is not subject to the rule, even if a stream is present.

The Neuse Riparian Buffer Rules were enacted to protect and preserve existing riparian buffers to maintain their function for protection of water quality (NCDWQ, 2002). Currently, there are small drainage features located throughout the project site, which deliver direct runoff to Bold Run Creek. To maintain the water quality of Bold Run Creek, an approximate 200' buffer will extend on either side of the features (Figure 14. Proposed Planting Plan).

5.2.2 Planting Zones

Two planting zones will be incorporated into the planting plan. Zone A is classified as a Levee Area; which runs along the levee of New Light Creek. Zone B is classified as a Bottomland Hardwood Area; which will border the streamside planting area along Bold Run Creek and run along the Levee area and the remaining portion of the site. Included in Zone A and B is a 20' streamside planting area bordering New Light Creek and Bold Run Creek, will also be planted with riparian vegetation. There is a small portion, approximately 1.30 acres, in the middle of Zone B that was classified during the field investigation with wetter soils (Chewacla) (Refer to Figure 5). This particular area will be planted with tolerable, higher moisture Bottomland Hardwood species. The planting plan in Figure 14 illustrates the two zones that will be used to target restoration vegetation.

5.2.3 Plant Sources

Field assessment observations, Guidelines for Riparian Buffer Restoration (NC Department of Environment and Natural Resources Ecosystems Enhancement Program 2004), and community descriptions from Classification of the Natural Communities of North Carolina (Schafale and Weakley 1990) were all used to develop the species to be planted on the site.

5.2.4 Plant Care and Installation

All hardwood species on site will be planted using bare root plants. Four hundred thirty-six (436) trees per acre (based on an average 10' x 10' spacing) will be planted in rows to achieve a mature survivability of three hundred twenty (320) trees per acre in the riparian zone (NCDENR, 2001).

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Figure 14. Proposed Planting Plan

Zone A - Levee Planting Area

Zone B - Bottomland Hardwood Planting Area

Zone B - High Moisture Planting Zone

Zone B - Streamside Planting Area

Proposed Thalweg

1:3,000

1 inch equals 250 feet

250 125 0 250 Feet

SOURCE: Wake County GIS
Digital Orthophotography 1999

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5.2.5 Plant List

The Bold Run Creek floodplain/levee in the project reach is predominantly forested with hardwood species (Refer to Section 3.5). Plantings shall consist of native species, which are available during the time of planting. The Bottomland Hardwood area will be vegetated with native woody and herbaceous plant materials. In general, the two planting zones will consist of the following species groupings:

Zone A: Levee Area		
Black Walnut	*Juglans nigra*	FACU
Willow Oak	*Quercus phellos*	FACW-
Overcup Oak	*Quercus lyrata*	FACW
Slippery Elm	*Ulmus rubra*	FAC
Streamside		
River Birch	*Betula nigra*	FACW
Boxelder	*Acer negundo*	FACW
American Sycamore	*Platanus occidentalis*	FACW-
Zone B: Bottomland Hardwood Area		
Tulip Poplar	*Liriodendron tulipifera*	FACW-
Cherrybark Oak	*Quercus pagoda*	FAC+
Willow Oak	*Quercus phellos*	FACW-
Swamp Chestnut Oak	*Quercus michauxii*	FACW-
High Moisture Area		
Green Ash	*Fraxinus pennsylvanica*	FACW
American Elm	*Ulmus Americana*	FACW
Silky Dogwood	*Cornus amomum*	FACW

Herbaceous vegetation shall consist of a native grass mix that may include:

Bluestem	*Andropogon glomeratus*
Deertongue	*Panicum clandestinum*
Orchardgrass	*Dactylis glomerata*
Switchgrass	*Panicum virgatum*
Virginia wildrye	*Elymus virginicus*

Rye grain (*Secale cereale*) and/or brown top millet (*Pennisetum glaucum*) will be used for temporary stabilization.

In addition to the native seed mix and stabilization seeding, live stakes shall be installed to assist in stabilizing the stream banks. The following species may be used for live staking:

Black Willow	*Salix nigra*
Elderberry	*Sambucus canadensis*
Silky Willow	*Salix sericea*
Silky Dogwood	*Cornus amomum*

5.2.6 Schedule

Woody vegetation planting will take place during the dormant season.

5.2.7 Site Preparation and Stabilization

The stream restoration project will generally utilize the same belt width as the existing channel, however some areas will require clearing to achieve the appropriate pattern outlined in the design criteria. The cleared areas will be re-vegetated with native woody and herbaceous plant materials. Following the re-vegetation, riparian buffers associated with the Bold Run Creek restoration will extend between fifty (50) to two hundred (200) feet on both sides of the stream.

The trees targeted for removal will be treated with herbicide in late summer when the trees have leafed out entirely or in the winter once the sap has stopped flowing. A glyphosate herbicide will be applied at this time. The trees will be left either downed or standing to provide habitat for terrestrial species.

5.2.8 Maintenance

A pre-emergent herbicide will be sprayed in mid-March following the planting of the bare root seedlings to control the herbaceous vegetation. This allows time for rainfall to settle the soil around the roots of the seedlings, newly planted during the dormant season, but before the buds begin to swell in the spring. Reducing competition from herbaceous vegetation is an important step to ensure maximum survivability of the planted seedlings.

Correspondingly, nurturing the site with regular management activities is considered necessary to ensure that the goals and objectives of the project are met. These activities will be conducted throughout the year. If the monitoring identifies failures in the project site, a remedial action plan will be developed to investigate the causes of the failure and propose actions to rectify the problem.

5.2.9 On-site Invasive Species Management

Part of the regular management activities will include invasive species control for the project site. Invasive species control will primarily focus on removing the existing invasive species, Chinese privet *(Ligustrum sinense)* and Vietnamese Stilt Grass *(Microstigium viminium)*. It is recommended that a glyphosate herbicide with a 2 to 3-percent solution be used as a foliar spray (Miller, 2004). The herbicidal treatment will be conducted during late summer, early fall. Herbicidal treatments will be conducted yearly if needed.

5.3 Sediment Transport Analysis

A stable channel is able to move the sediment supplied by its watershed without aggrading or degrading. This ability is evaluated through two parameters: competency and capacity. Competency is the channel's ability to move particles of a certain size, expressed as units of Pascals (Pa) or lbs/ft^2. Capacity is the channel's ability to move a specific volume of sediment (sediment discharge). Sediment discharge is the amount of sediment moving through a cross section over a specified period of time, expressed in dimensionless parameters or as mass or weight units of kg/sec or lbs/sec.

The flow associated with the threshold movement of the streambed is the reference condition that all sediment transport models are based upon. In natural streambeds there are particles of a wide range of sizes. At low, but significant flow levels, the smallest particles will move, while the larger particles resist

the flow of the stream. This is the condition of partial sediment transport. As the stream flow increases, eventually every particle on the streambed will show threshold movement, this is the condition of full sediment transport.

There is a wide range of sand-gravel streams that have the flow conditions necessary to significantly move particles greater than the D_{50}, but do not reach the full sediment transport condition. This condition is present in Bold Run Creek, and the model used for the sediment transport analysis was Wilcock-Crowe (2003). The Wilcock-Crowe model is a "sediment capacity" model; however, it also contains an entrainment predictor.

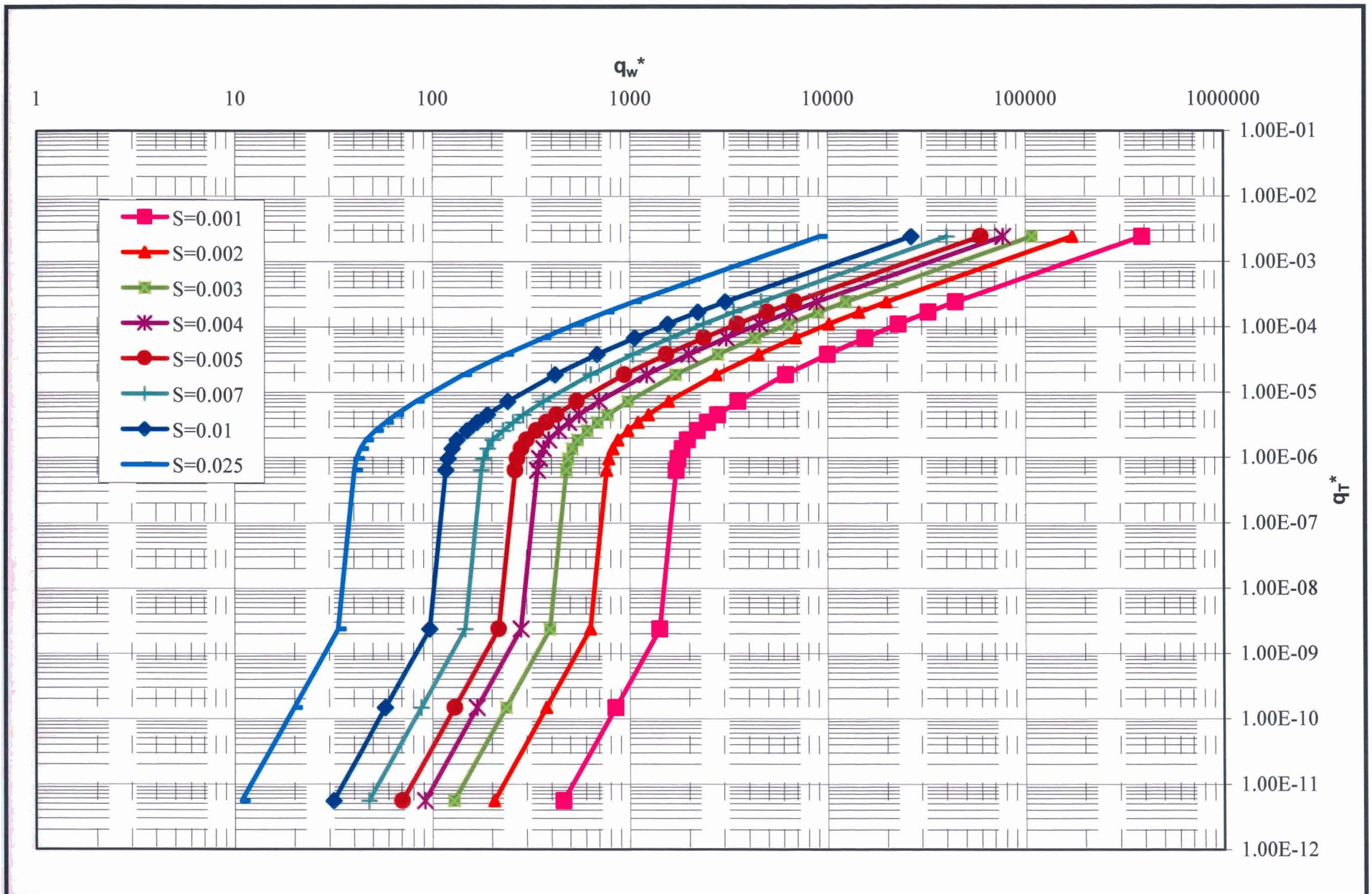
Entrainment is the condition that initiates the movement of a selected particle size in the presence of a mix grade channel bed. If the largest particle that moves during a bankfull event can be identified, then the flow conditions that produced this movement can be determined and this flow condition (the channel competency) is used in the design of the restored stream channel.

In basic terms, given the bed surface grain-size distribution and the bed shear velocity, the Wilcock-Crowe Surface-Based Transport Model (SBTM) calculates the bedload transport rate and the bedload grain-size distribution. Using a hydraulics model, one can predict the shear velocity and discharge characteristics that will provide the necessary sediment transport capacity. By making the sediment transport and discharge dimensionless, this analysis can be scaled to another stream channel, separate from the reference reach, that has a similar sediment distribution. In this case, it was applied to the Bold Run Creek design section.

In the Richland Creek Reference Reach, the approximate bankfull depth was 3.7 feet (1.1 m). The shear velocity (u*) associated with this discharge based on the hydraulics model was 0.17 meters per second (m/s). This shear velocity corresponded to a dimensionless sediment transport rate (q_T*) of 2.5E-05. A q_T* value of 2.5E-05 intersects with a dimensionless water discharge (q_W*) of approximately 750 for the Bold Run Creek design slope (0.007) on the Bold Run River State Diagram (Figure 15). The proposed design channel will discharge approximately 92 ft^3/s over the area subject to bedload transport with a u* = 0.14 m/s. The water discharge (q_W) for this event based on the Manning-Strickler Resistance Equation is 1.25, which correlates to a q_W* value of 595 (Δ = 20.7%). This is based on a d_{b50} (median diameter of the bedload) value of approximately 6.5 millimeters.

$$q_w^* = q_w / (((s-1)g)^{1/2} (d_{b50})^{3/2} = 1.252 / (((2.65 - 1) 9.81)^{1/2} (6.45E-03)^{3/2} = 595$$

Where: s is the specific gravity of sediment, g is the gravitational constant, and all other variables are as defined above. Refer to Figure 15. Bold Run Creek River State Diagram.



KCI ASSOCIATES OF NC

Figure 15. Bold Run Creek River State Diagram

Ecosystem Enhancement Program

6.0 PERFORMANCE CRITERIA

Monitoring 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, pattern, and profile, site photographs, and vegetation sampling.

6.1 Streams

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, 1994 and 1996), data collected will consist of detailed dimension and pattern measurements, a longitudinal profile, and bed materials sampling.

Dimension - Five permanent cross-sections, three riffle and two pools, will be established and used to evaluate stream dimension. Permanent monuments will be established by either conventional survey or GPS. The cross-section surveys shall provide a detailed measurement of the stream and banks, to include points on the adjacent floodplain, at the top of bank, bankfull, at all breaks in slope, the edge of water, and thalweg. Subsequently, width/depth ratios and entrenchment ratios will be calculated for each cross-section.

Cross-section measurements should show little or no change from the as-built cross-sections. 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.

Pattern - Measurements associated with the restored channel pattern will include belt width, meander length, and radius of curvature. Subsequently, sinuosity, meander width ratio and radius of curvature and meander length/bankfull width ratios will be calculated.

Profile – A longitudinal profile of the entire restored channel will be surveyed. Measurements will include slopes (average, pool, riffle), as well as calculations of pool-to-pool spacing. Annual measurements should indicate stable bedform features with little change from the as-built survey. The pools should maintain their depth with lower water surface slopes, while the riffles should remain shallower and steeper.

Bed Materials - Pebble counts will be conducted at each representative cross-section for the purpose of repeated classification and to evaluate sediment transport.

Photograph Reference Points

Photograph reference points (PRP) will be established to assist in characterizing the site and to allow qualitative evaluation of the site conditions. The location and bearing/orientation of each photo point will be permanently marked in the field and documented to allow for repeated use.

Cross-section Photograph Reference Points

Each cross-section will be photographed to show the form of the channel with the tape measure stretched over the channel for reference in each photograph. Effort will be made to consistently show the same area in each photograph.

Longitudinal Photograph Reference Points

Additional PRPs will be located, as needed, to document the condition of specific in-stream structures such as cross vanes, as well as infrastructure associated with the stream such as utility and road crossings.

6.2 Vegetation

The success of the riparian buffer plantings will be evaluated using 55 (5% of total buffer area) ten by ten meter (10m x 10m) vegetative sampling plots. The corners of each monitoring plot will be permanently marked in the field. The monitoring will consist of a physical inventory within each plot and a subsequent statistical analysis in order to determine the following: composition and number of surviving species, and total number of stems per acre. Additionally, a photograph will be taken of each plot that will be replicated each monitoring year. Riparian vegetation must meet a minimum survival success rate of 320 stems/acre after five years. 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.

6.3 Schedule/Reporting

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 (5) years.

Annual monitoring reports will be prepared and submitted after all monitoring tasks for each year are completed. Each report will provide the new monitoring data and compare the new data against previous findings. The monitoring report will follow the format described in the EEP document entitled "Content, Format, and Data Requirements for EEP Monitoring Reports."

7.0 REFERENCES

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STATE	STATE CONSTRUCTION PROJECT NO.	SHEET NO.	TOTAL SHEETS
N.C.	EP4284907	1	14

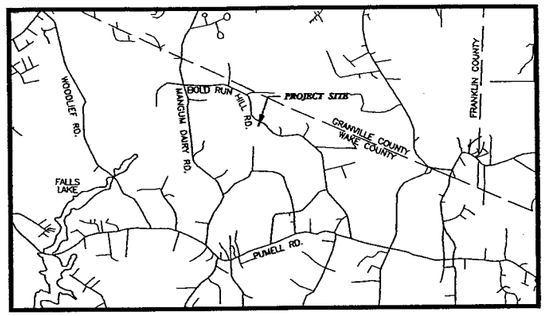
	SUBMITTED WITH RESTORATION PLAN	NOV. 2005	
	REVISIONS PER EEP COMMENTS	FEB. 2006	
STM.	DESCRIPTION	DATE	APPROVED
REVISIONS			

STATE OF NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

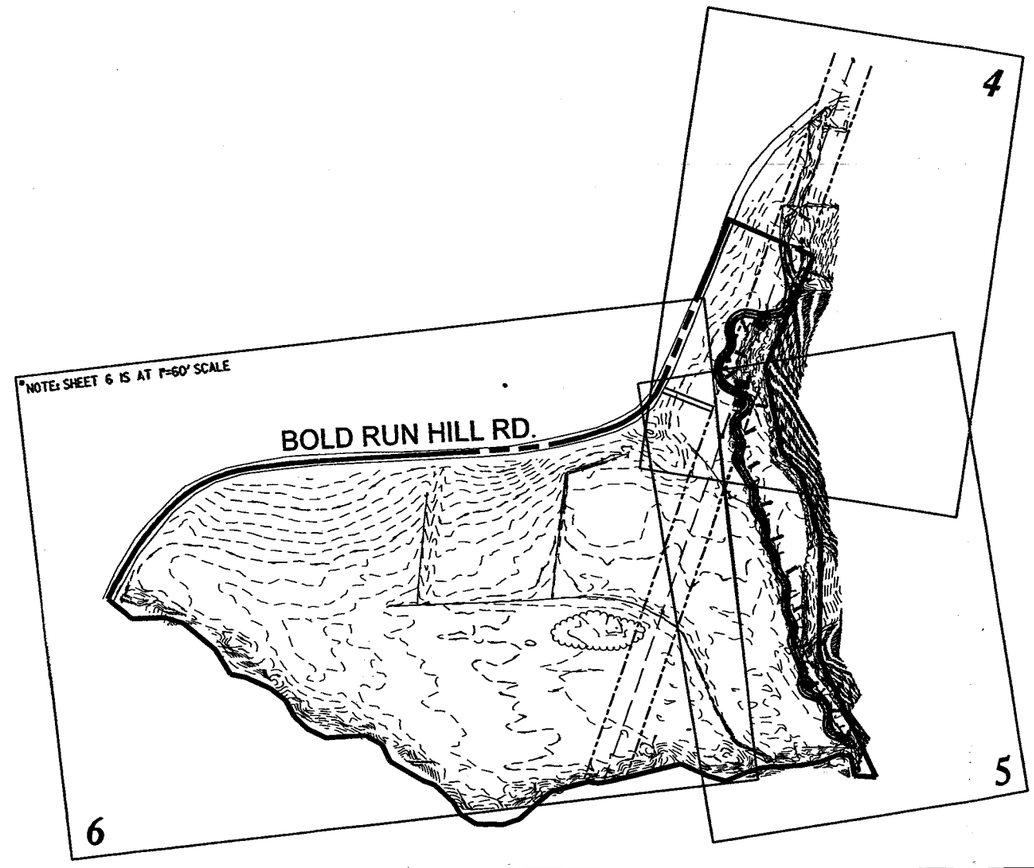
WAKE COUNTY

LOCATION: BOLD RUN CREEK
WAKE FOREST, NORTH CAROLINA

TYPE OF WORK: STREAM AND RIPARIAN BUFFER RESTORATION



VICINITY MAP
NOT TO SCALE



NC GRID
NAD '83

INDEX OF SHEETS

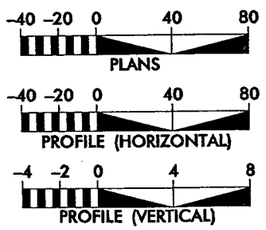
*1		TITLE SHEET
1-A		GENERAL NOTES/PROJECT LEGEND
*2		DETAILS: STABILIZATION
*2-A		DETAILS: TYPICAL CROSS-SECTIONS
3		SUMMARY SHEET
*4	THRU 5	PLAN AND PROFILE SHEETS
6	THRU 7	STREAM GEOMETRY
8	THRU 9	SEDIMENT & EROSION CONTROL PLAN
*10	THRU 12	PLANTING SHEETS

* = SUBMITTED AS PART OF RESTORATION PLAN.

SEMI FINAL DESIGN

PROJECT: EP4284907

GRAPHIC SCALES



PROJECT LENGTH

STREAM RESTORATION LENGTH = 1,629 FEET

RIPARIAN BUFFER – RESTORATION = 27.1 ACRES

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

LETTING DATE:

PROJECT ENGINEER

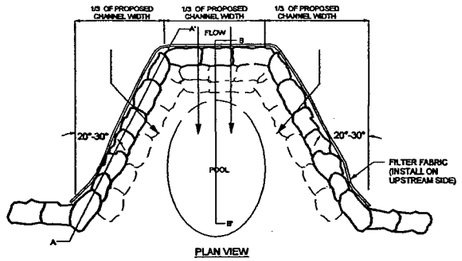
NATURAL CHANNEL DESIGN

PROJECT ENGINEER

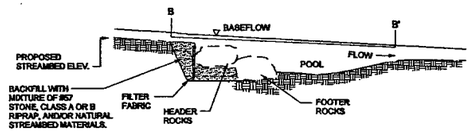
SIGNATURE: ***P.E.***

Prepared for:

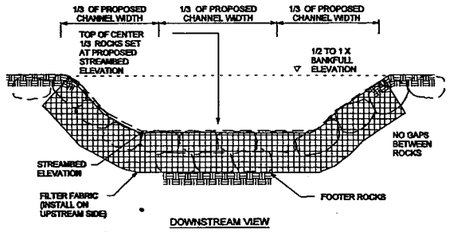
KRISTIE CORSON
NCEEP CONTACT



PLAN VIEW



SECTION B-B' (PROFILE VIEW)



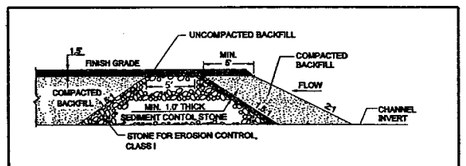
DOWNSTREAM VIEW

SECTION A-A'

ROCK CROSS VANE

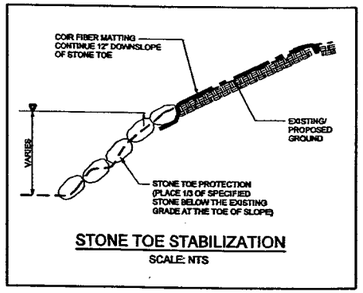
SCALE: NTS

NOTE: ALL ROCKS OR STONES IN THE VANE STRUCTURE ARE STONE, BOULDERS



CHANNEL BLOCK

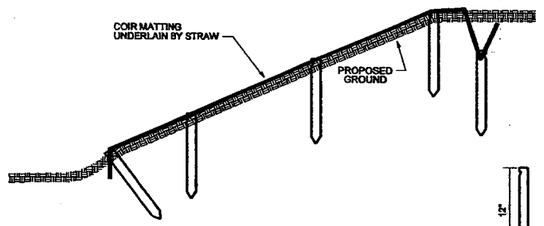
SCALE: NTS



STONE TOE STABILIZATION

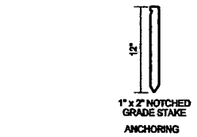
SCALE: NTS

NOTE: MATTING TO BE APPLIED AND STAKED IN ACCORDANCE WITH PROJECT SPECIAL PROVISIONS

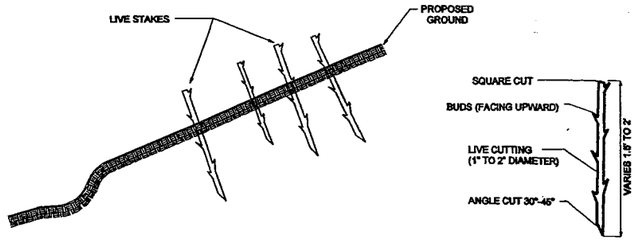


COIR MATTING

SCALE: NTS



ANCHORING



NOTE: LIVE STAKES TO BE INSTALLED IN ACCORDANCE WITH PROJECT SPECIAL PROVISIONS AND AS DIRECTED BY THE ENGINEER.

LIVE STAKES

SCALE: NTS

REVISIONS				
STNL	DESCRIPTION	DATE	APPROVED	
	SUBMITTED WITH RESTORATION PLAN	NOV. 2005		
	REVISIONS PER EEP COMMENTS	FEB. 2006		

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RALEIGH, NORTH CAROLINA 27609

Ecosystem Enhancement Program

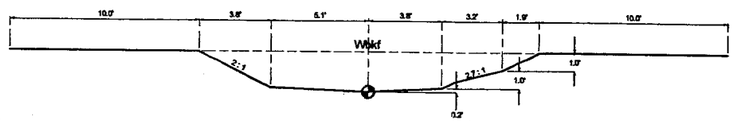
BOLD RUN CREEK
STREAM / BUFFER RESTORATION PROJECT
WAKE FOREST, WAKE COUNTY, NORTH CAROLINA
STATION 10+00.00 TO STATION 26+05

DATE: FEB. 2006
SCALE: NTS

DETAILS: STABILIZATION

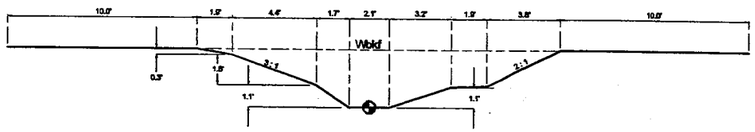
SHEET 2 OF 12

BOLD RUN CREEK STREAM RESTORATION
TYPICAL CROSS-SECTIONS
"C4" STREAM TYPE



TYPICAL RIFFLE

TYPICAL POOL - RIGHT MEANDER



TYPICAL POOL - LEFT MEANDER

⊗ - THALWEG LOCATION

-4 -2 0 4 8
GRAPHIC SCALE

REVISIONS			
DESCRIPTION	DATE	APPROVED
SUBMITTED WITH RESTORATION PLAN	NOV. 2005	
REVISIONS PER EEP COMMENTS	FEB. 2006	

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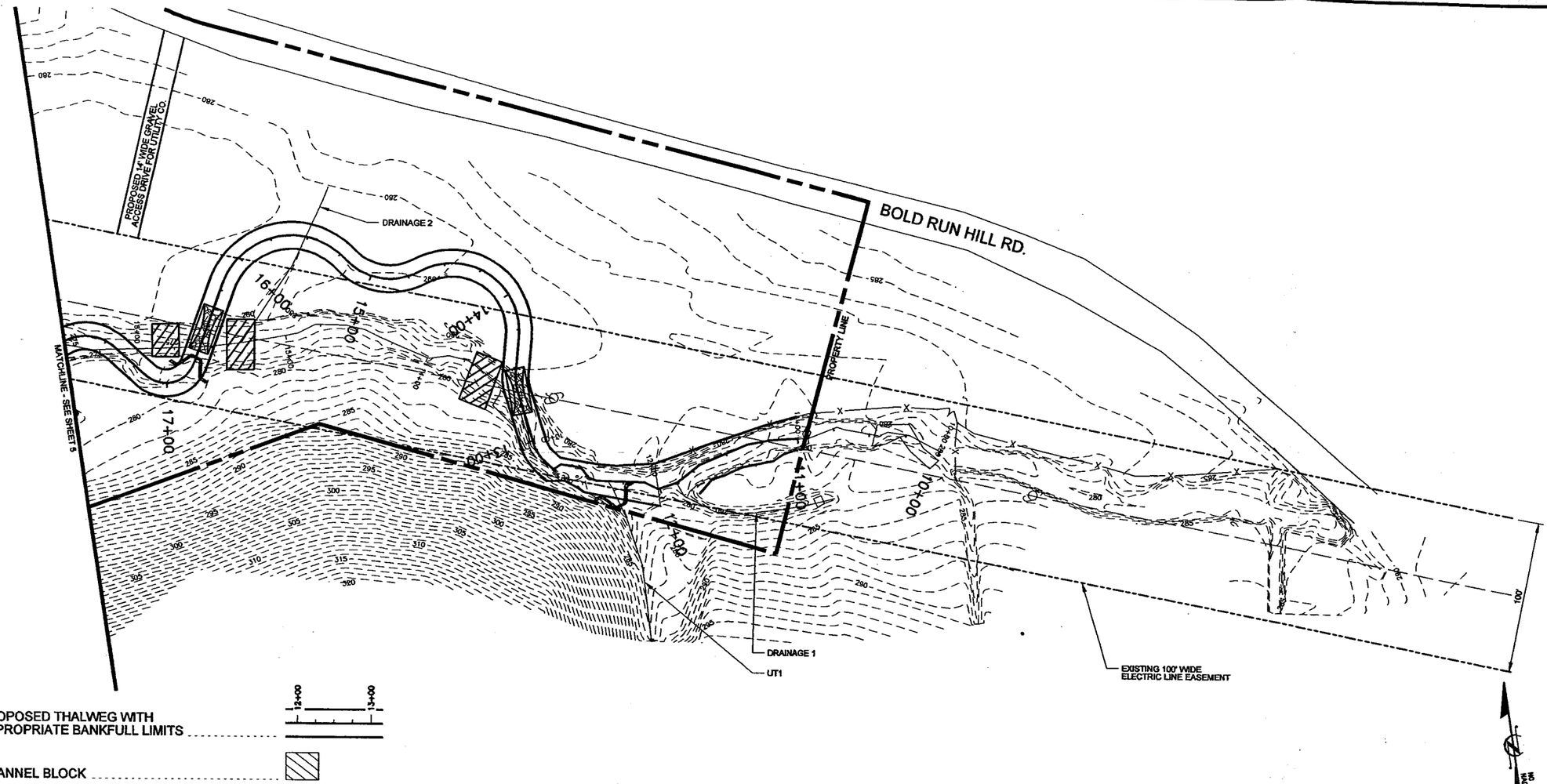
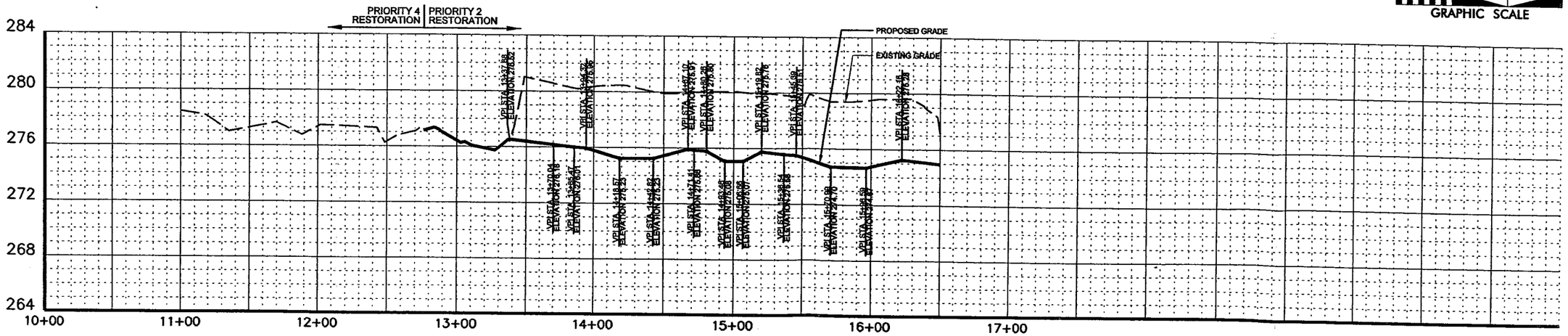
BOLD RUN CREEK
STREAM / BUFFER RESTORATION PROJECT
WAKE FOREST, WAKE COUNTY, NORTH CAROLINA
STATION 10+00.00 TO STATION 26+05

DATE: FEB. 2006
SCALE: 1" = 4'

DETAILS:
TYPICAL XS

SHEET 2A OF 12





REVISIONS			
STM.	DESCRIPTION	DATE	APPROVED
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	REVISIONS PER EEP COMMENTS	FEB. 2006	

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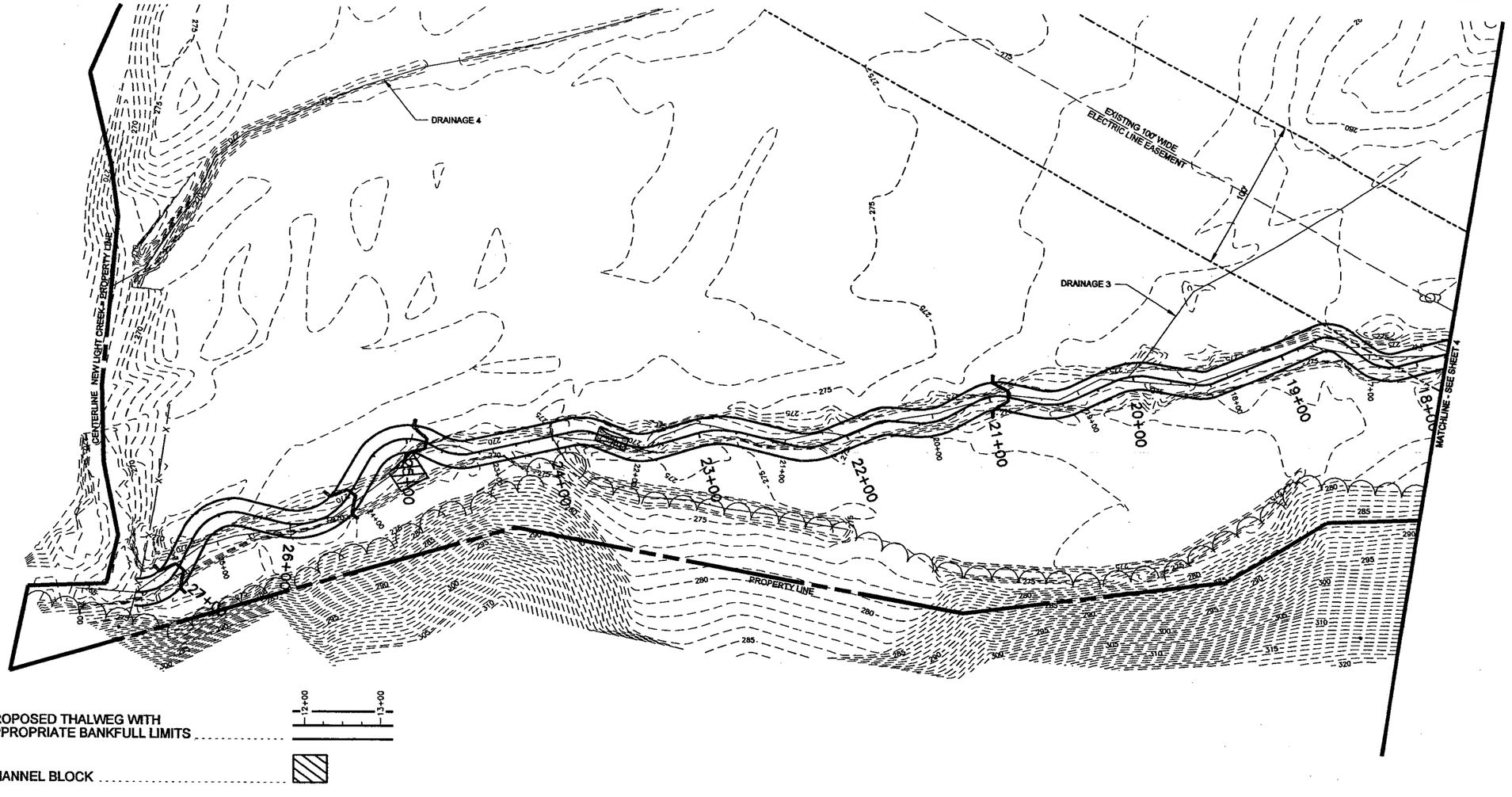
BOLD RUN CREEK
STREAM / BUFFER RESTORATION PROJECT
WAKE FOREST, WAKE COUNTY, NORTH CAROLINA
STATION 10+00.00 TO STATION 26+05

DATE: FEB. 2006
SCALE: 1"=40'

PLAN AND PROFILE

SHEET 4 OF 12



DTN.	DESCRIPTION	DATE	APPROVED
	REVISIONS		
	SUBMITTED WITH RESTORATION PLAN	NOV. 2005	
	REVISIONS PER EEP COMMENTS	FEB. 2006	

Ecosystem Enhancement Program

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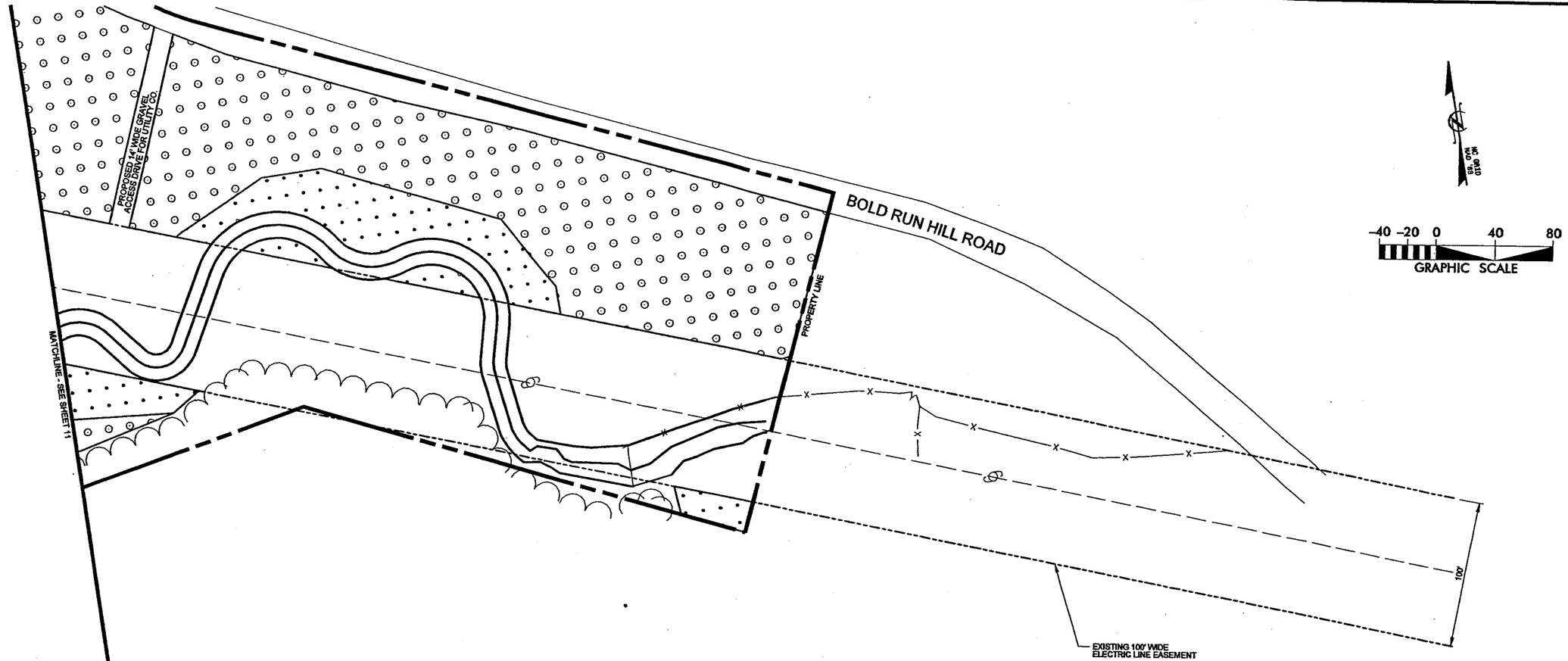
BOLD RUN CREEK
STREAM / BUFFER RESTORATION PROJECT
WAKE FOREST, WAKE COUNTY, NORTH CAROLINA
STATION 10+00.00 TO STATION 26+05

DATE: FEB. 2006
SCALE: 1"=40'

PLAN AND PROFILE

SHEET 5 OF 12



PLANTING PLAN AND SPECIES COMPOSITION

LEVEE PLANTING AREA = 7.0 ACRES

12" - 18" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

SCIENTIFIC NAME	COMMON NAME	% OF TOTAL	# OF PLANTS
JUGLANS NIGRA	BLACK WALNUT	25	770
QUERCUS PHELLOS	WILLOW OAK	20	610
QUERCUS LYRATA	OVERCUP OAK	30	920
ULMUS RUBRA	SLIPPERY ELM	25	770
		100	3,070

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

STREAMSIDE PLANTING AREA = 1.4 ACRES

12" - 18" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

SCIENTIFIC NAME	COMMON NAME	% OF TOTAL	# OF PLANTS
BETULA NIGRA	RIVER BIRCH	34	210
ACER NEGUNDO	BOXELDER	33	200
PLATANUS OCCIDENTALIS	AMERICAN SYCAMORE	33	200
		100	610

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

BOTTOMLAND HARDWOOD PLANTING AREA = 17.1 ACRES

12" - 18" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

SCIENTIFIC NAME	COMMON NAME	% OF TOTAL	# OF PLANTS
LIRIODENDRON TULIPIFERA	TULIP POPLAR	20	1,490
QUERCUS PAGODA	CHERRYBARK OAK	30	2,240
QUERCUS PHELLOS	WILLOW OAK	30	2,240
QUERCUS MICHAUXII	SWAMP CHESTNUT OAK	20	1,490
		100	7,460

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

HIGH MOISTURE PLANTING AREA = 1.3 ACRES

12" - 18" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

SCIENTIFIC NAME	COMMON NAME	% OF TOTAL	# OF PLANTS
FRAXINUS PENNSYLVANICA	GREEN ASH	34	200
ULMUS AMERICANA	AMERICAN ELM	33	190
CORNUS AMOMUM	SILKY DOGWOOD	33	190
		100	580

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

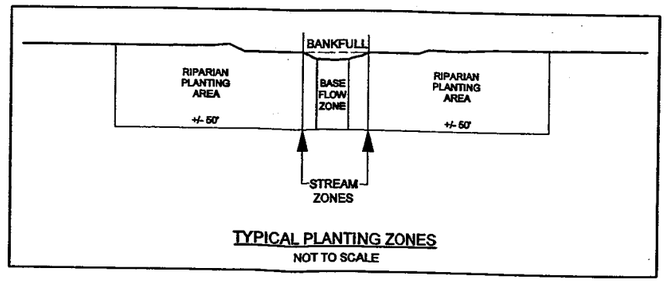
STREAM ZONE = 0.34 ACRES (1,629 LF x 9.2 FT BANK)

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

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

NOTE: NO SINGLE LIVE STAKING SPECIES SHALL COMPOSE MORE THAN 40% OF THE 1,770 TOTAL NUMBER OF LIVE STAKES TO BE INSTALLED

EXISTING TREE LINE



TYPICAL PLANTING ZONES
NOT TO SCALE

REVISIONS	DATE	APPROVED
SUBMITTED WITH RESTORATION PLAN	NOV. 2005	
REVISIONS PER EEP COMMENTS	FEB. 2006	

Ecosystem Enhancement Program

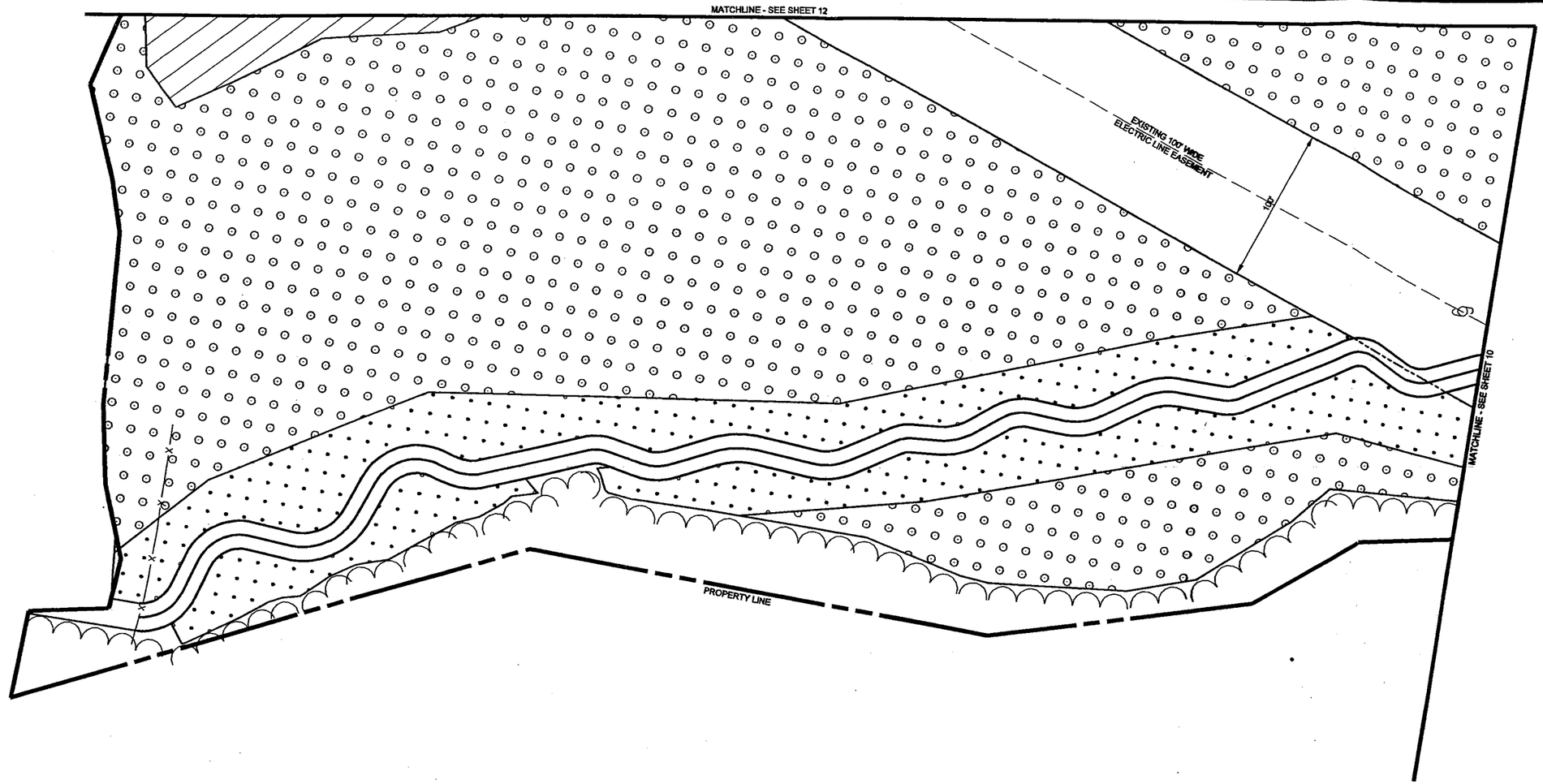
KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

BOLD RUN CREEK
STREAM / BUFFER RESTORATION PROJECT
WAKE FOREST, WAKE COUNTY, NORTH CAROLINA
STATION 10+00.00 TO STATION 26+05

DATE: FEB. 2006
SCALE: 1"=40'

PLANTING PLAN

SHEET 10 OF 12



RIPARIAN BUFFER - LEVEE PLANTING AREA

RIPARIAN BUFFER - STREAMSIDE PLANTING AREA

RIPARIAN BUFFER - BOTTOMLAND HARDWOOD PLANTING AREA

RIPARIAN BUFFER - HIGH MOISTURE PLANTING ZONE

RIPARIAN BUFFER - STREAM ZONE PLANTING AREA

EXISTING TREE LINE

-40 -20 0 40 80
GRAPHIC SCALE

REVISIONS				
DESCRIPTION	DATE	APPROVED
SUBMITTED WITH RESTORATION PLAN	NOV. 2005	
REVISIONS PER EEP COMMENTS	FEB. 2006	

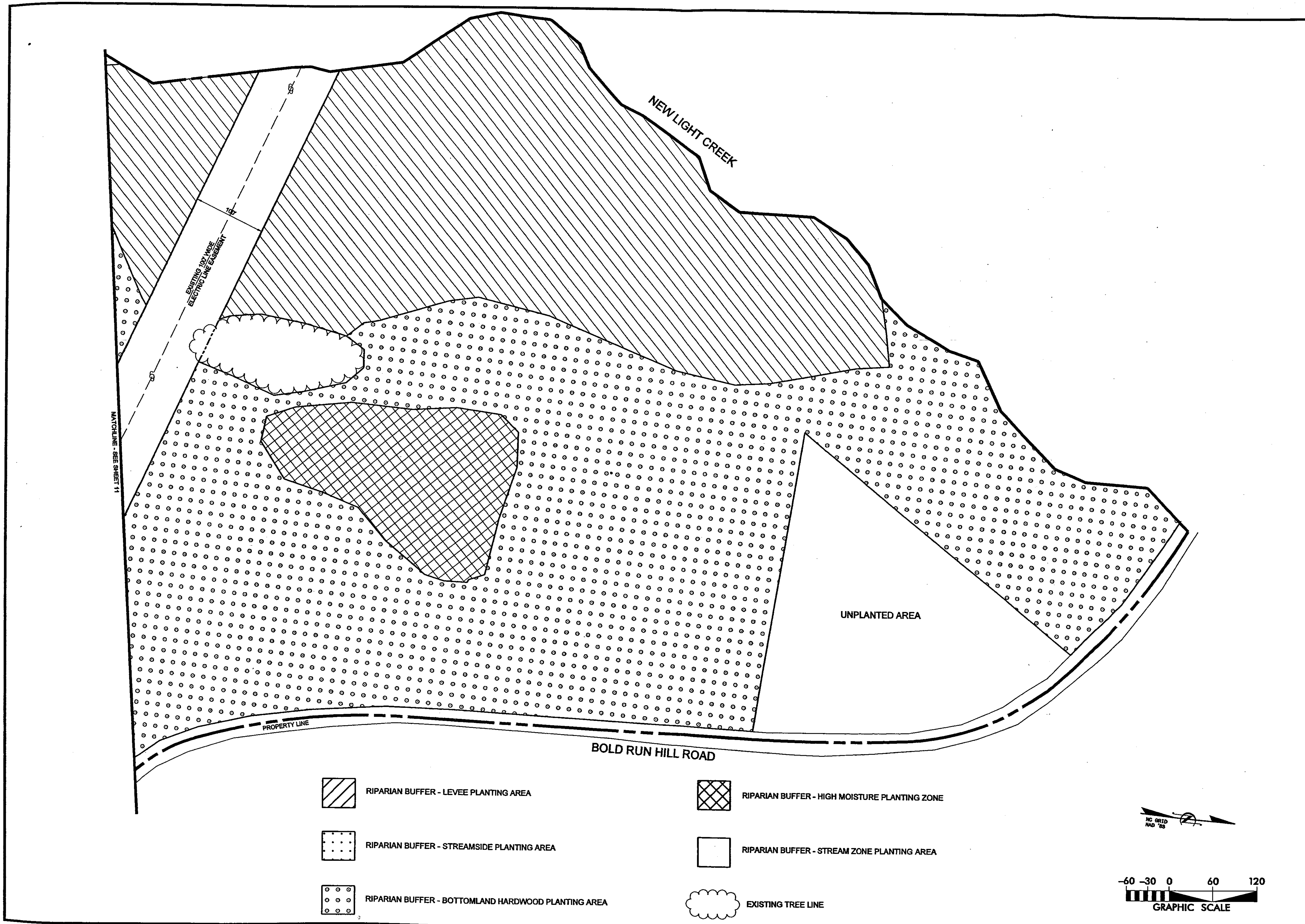
KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

BOLD RUN CREEK
STREAM / BUFFER RESTORATION PROJECT
WAKE FOREST, WAKE COUNTY, NORTH CAROLINA
STATION 10+00.00 TO STATION 28+05

DATE: FEB. 2006
SCALE:

PLANTING PLAN

SHEET 11 OF 12



SYM.	DESCRIPTION	DATE	APPROVED
	SUBMITTED WITH RESTORATION PLAN	NOV. 2005	
	REVISIONS PER EEP COMMENTS	FEB. 2006	

REVISIONS

Ecosystem Enhancement Program

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

BOLD RUN CREEK
STREAM / BUFFER RESTORATION PROJECT
WAKE FOREST, WAKE COUNTY, NORTH CAROLINA
STATION 10+00.00 TO STATION 26+05

DATE: FEB. 2006
SCALE: 1"=60'

PLANTING PLAN

SHEET 12 OF 12

Appendix A
Historic Aerial Photographs

KCI ASSOCIATES OF NORTH CAROLINA, PA

Historical Aerial Photograph - 1949

Project Location

Not Drawn to Specific Scale

Source: USDA Natural Resource Conservation Service

Ecosystem Enhancement PROGRAM

KCI
ASSOCIATES OF
NORTH CAROLINA, PA

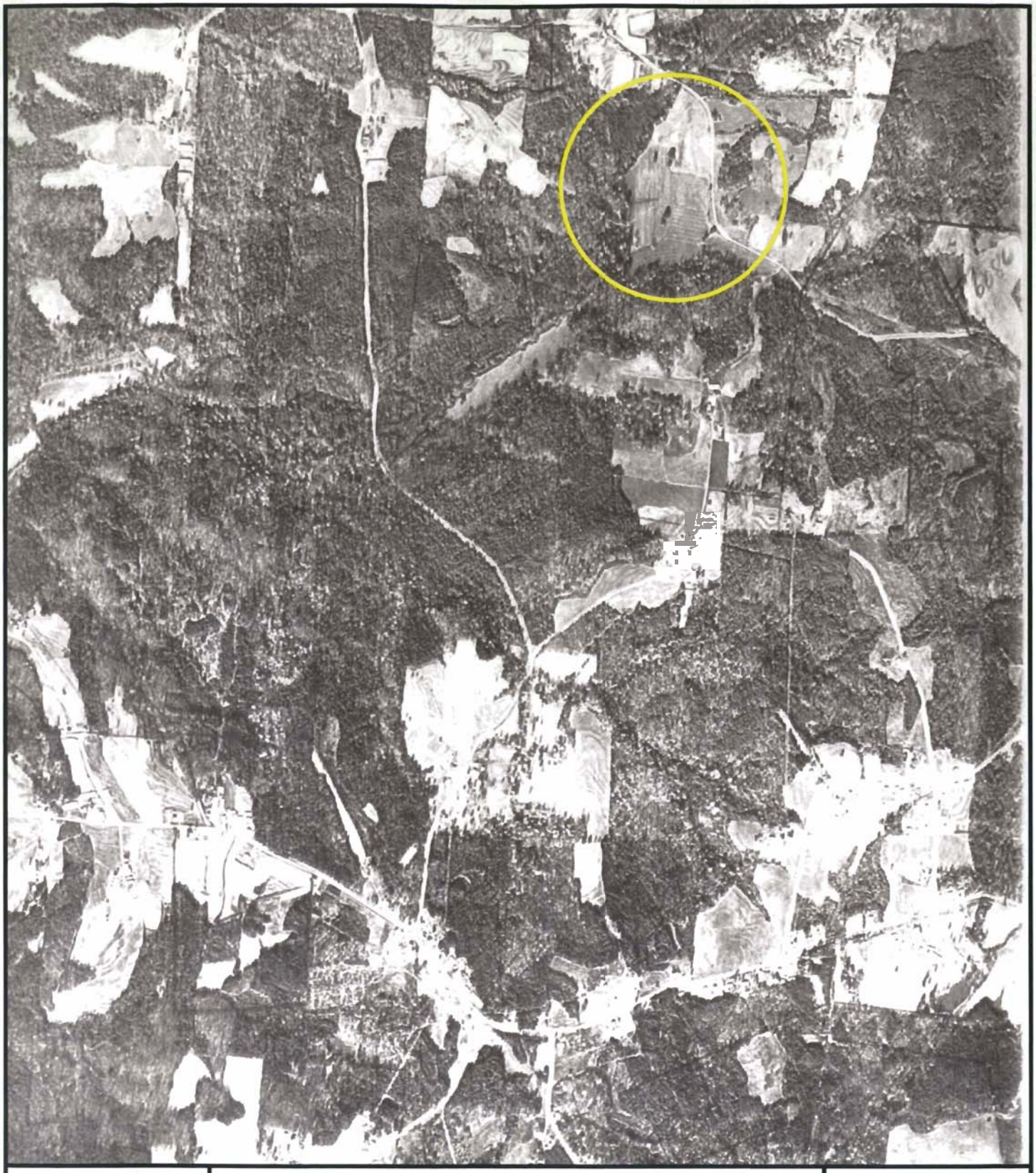
Historical Aerial Photograph - 1954

Project Location

Not Drawn to
Specific Scale

Source: USDA Natural Resource Conservation Service

Ecosystem
Enhancement
PROGRAM



KCI ASSOCIATES OF NORTH CAROLINA, PA

Historical Aerial Photograph - 1965

Project Location

Not Drawn to Specific Scale

Source: USDA Natural Resource Conservation Service

Ecosystem Enhancement PROGRAM

KCI
ASSOCIATES OF
NORTH CAROLINA, PA

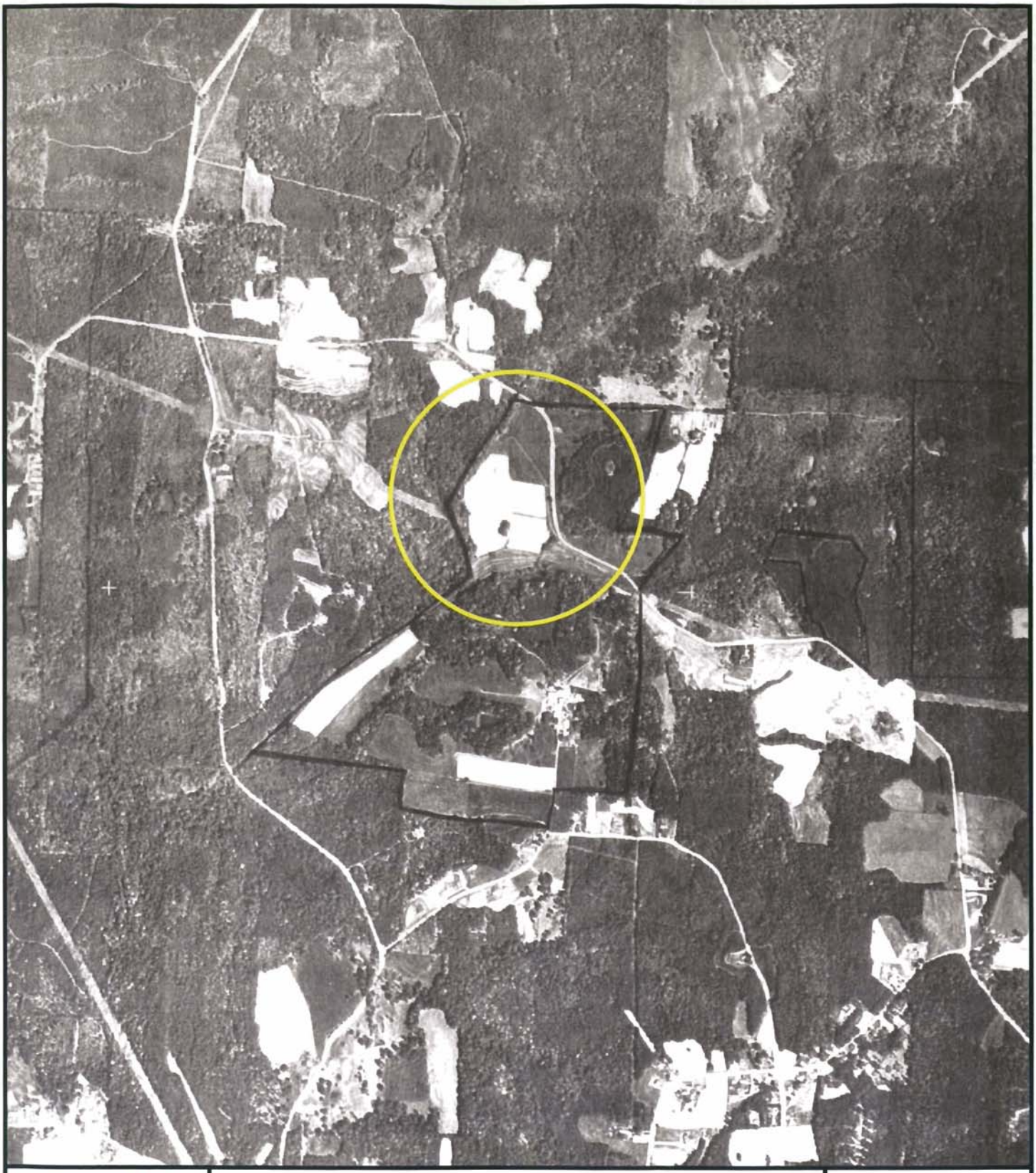
Historical Aerial Photograph - 1971

Project Location

Not Drawn to
Specific Scale

Source: USDA Natural Resource Conservation Service

Ecosystem
Enhancement
PROGRAM



KCI ASSOCIATES OF NORTH CAROLINA, PA

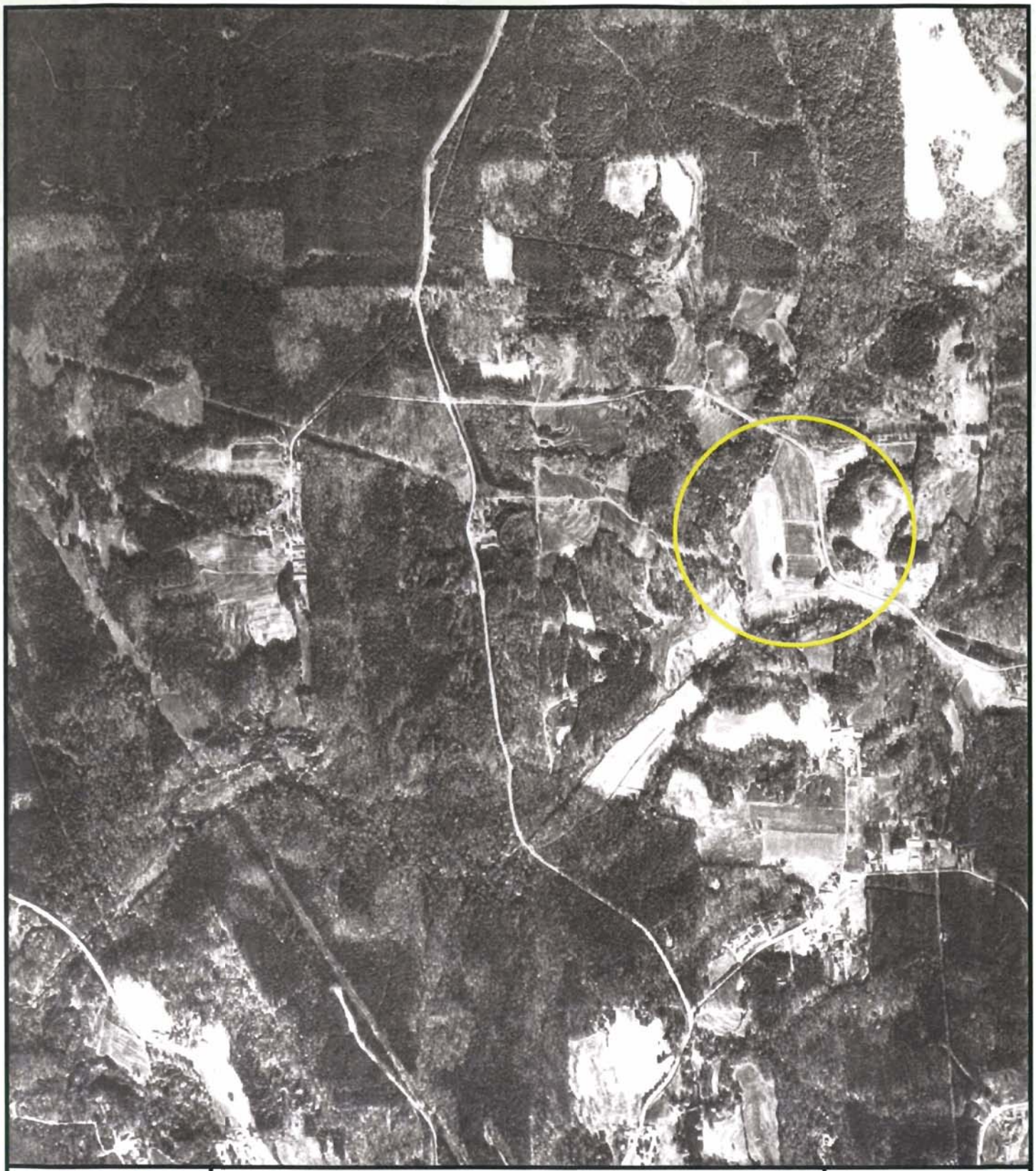
Historical Aerial Photograph - 1981

Project Location

Not Drawn to Specific Scale

Source: USDA Natural Resource Conservation Service

Ecosystem Enhancement PROGRAM



KCI
ASSOCIATES OF
NORTH CAROLINA, PA

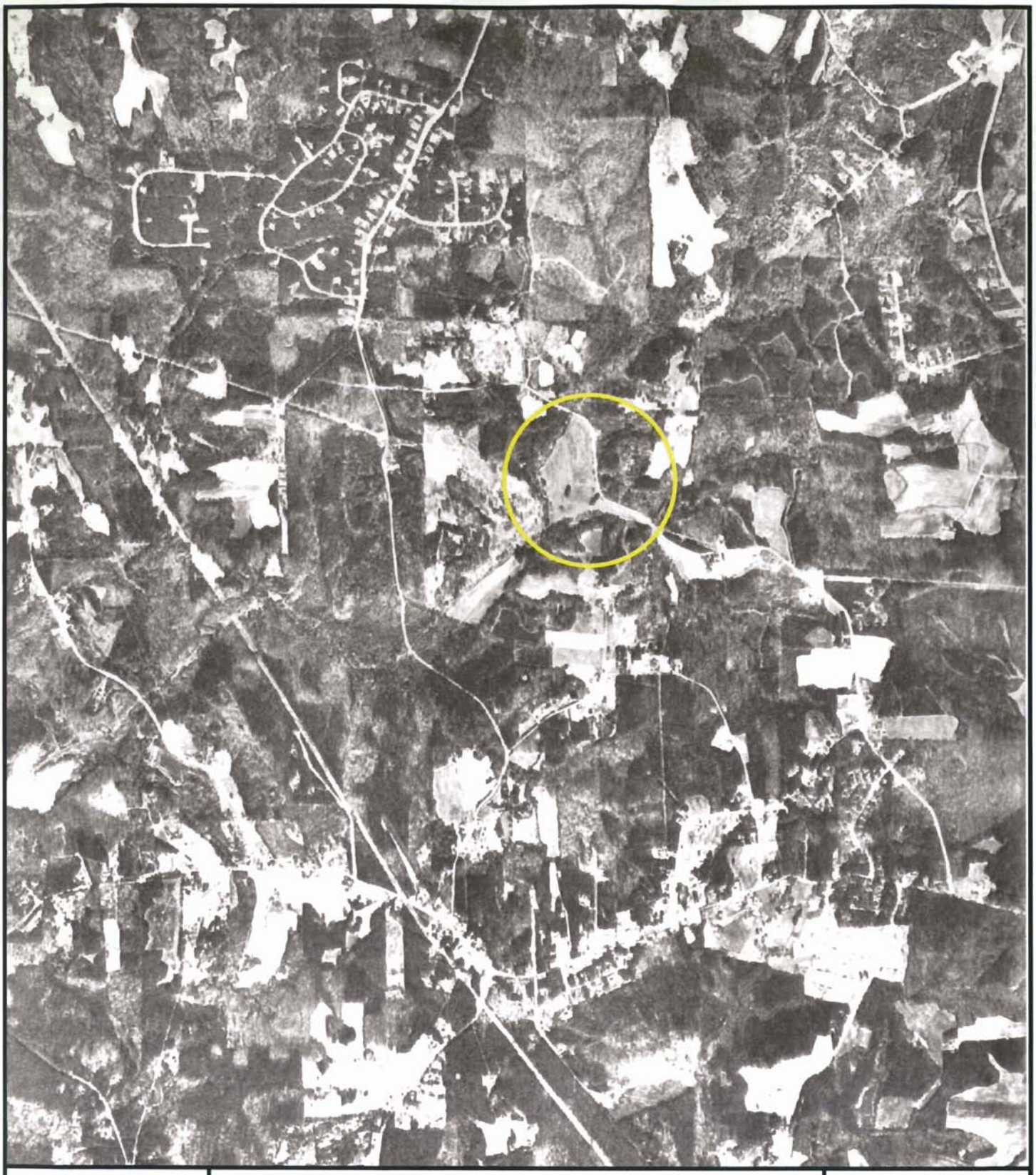
Historical Aerial Photograph - 1988

Project Location

Not Drawn to
Specific Scale

Source: USDA Natural Resource Conservation Service

Ecosystem
Enhancement
PROGRAM



KCI
ASSOCIATES OF
NORTH CAROLINA, PA

Historical Aerial Photograph - 1993

Project Location

Not Drawn to
Specific Scale

Source: USDA Natural Resource Conservation Service

Ecosystem
Enhancement
PROGRAM

Appendix B
State Agency Correspondence

KCI
ASSOCIATES OF NC

ENGINEERS • SURVEYORS • SCIENTISTS • CONSTRUCTION MANAGERS

LANDMARK CENTER II • SUITE 220 • 4601 SIX FORKS ROAD • RALEIGH • NC 27609 • 919-783-9214 • (FAX) 919-783-9266

July 25, 2005

Linda Pearsall, Program Head
North Carolina Natural Heritage Program
1601 Mail Service Center
Raleigh, NC 27529

Subject: Natural Heritage Review
Bold Run Creek Stream and Wetland Restoration Project
Project ID# 12053743B

Dear Ms. Pearsall:

Please accept this information pertaining to the proposed Bold Run Stream and Wetland Restoration Project, which is located approximately 5 miles northwest of the Town of Wake Forest on Bold Hill Run Road approximately 1.5 miles east of the intersection with Mangum Dairy Road in Wake County, as a submittal for natural area and rare species review by the North Carolina Natural Heritage Program.

A portion of this property (refer to attached layout) is currently under investigation as a stream and wetland restoration project for the North Carolina Ecosystem Enhancement Program (NCEEP). The stream work typically involves modifying stream channels to a natural stable form through minor grading, use of in-stream rock features, and establishment of vegetated riparian buffers. No impacts to any structures on the subject property are anticipated.

Following the review of the included documentation, please provide a determination regarding any potential impacts to rare species or natural areas associated with this project.

Please feel free to contact me at (919) 783-9214, ext. 133, should you have any questions or require any further information to process this request. Thank you for your assistance and attention.

Sincerely,

April L. Helms
Project Manager

NCDENR

North Carolina Department of Environment and Natural Resources

Michael F. Easley, Governor

William G. Ross Jr., Secretary

September 20, 2005

Ms. April L. Helms
KCI Associates of North Carolina, P.A.
Landmark Center II, Suite 220
4601 Six Forks Road
Raleigh, NC 27609

Subject: Bold Run Creek Stream and Wetland Restoration Project; Wake Forest, Wake County
Project ID# 12053743B

Dear Ms. Helms:

The Natural Heritage Program has no record of rare species, significant natural communities, or priority natural areas at the site nor within 0.7-mile of the project area. The U.S. Army Corps of Engineers's Falls Lake lands lie roughly 0.7 air-mile downstream of the project site. Thus, it is important that proper sedimentation controls be in place to avoid any downstream impacts to these Federal lands and their waters (Falls Lake).

You may wish to check the Natural Heritage Program database website at <www.ncsparks.net/nhp/search.html> for a listing of rare plants and animals and significant natural communities in the county and on the topographic quad map. Please do not hesitate to contact me at 919-715-8697 if you have questions or need further information.

Sincerely,

Harry E. LeGrand, Jr., Zoologist
Natural Heritage Program

HEL/hel

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-733-4984 • FAX: 919-715-3060 • Internet: www.enr.state.nc.us

KCI TECHNOLOGIES

ENGINEERS • SURVEYORS • SCIENTISTS • CONSTRUCTION MANAGERS

LANDMARK CENTER II • SUITE 220 • 4601 SIX FORKS ROAD • RALEIGH • NC 27609 • 919-783-9214 • FAX: 919-783-9266

July 25, 2005

Mr. Steve Woodruff, District Conservationist
USDA Natural Resource Conservation Service
Raleigh Service Center
4001 Carya Drive
Raleigh, NC 27610-2916

Subject: Farmland Conversion Impact Rating
Bold Run Stream and Wetland Restoration
Project Number 12053743B

Dear Mr. Woodruff:

Please accept this information pertaining to the proposed Bold Run Stream and Wetland Restoration Project, which is located approximately 5 miles northwest of the Town of Wake Forest on Bold Hill Run Road approximately 1.5 miles east of the intersection with Mangum Dairy Road in Wake County, as a submittal for farmland conversion impact rating by the USDA Natural Resource Conservation Service.

A portion of this property (refer to attached layout) is currently under investigation as a stream and wetland restoration project for the North Carolina Ecosystem Enhancement Program (NCEEP). The funding for this project comes from the USDOT Federal Highway Administration through NCDOT. The current land use in the project area includes predominantly Agricultural Pasture Fields. The restoration would improve water quality and provide greater protection for aquatic ecosystems from surrounding agricultural lands. This type of work typically involves enhancing streams to create more natural and stable channels through minor grading, use of in-stream rock features, and reforestation of riparian buffers.

A soil classification was performed on the site recently. The following soils were found on the project site; Chewacla- 1.3 acres, Chewacla variant- 16.3 acres, Chewacla Riverview- 7.6 acres.

Following the review of the included documentation, please provide a determination regarding any potential impacts from farmland conversion associated with this project.

Please feel free to contact me at (919) 783-9214, ext. 133, should you have any questions or require any further information to process this request. Thank you in advance for your assistance and attention.

Sincerely,

April Helms
Project Manager

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request
Name Of Project: Bold Run Stream and Wetland Restoration	Federal Agency Involved: USDOT-FHWA
Proposed Land Use: Stream and Wetland Restoration	County And State: Wake County, North Carolina
PART II *(To be completed by NRCS)*	Date Request Received By NRCS

Does the site contain prime, unique, statewide or local important farmland? (If no, the FPPA does not apply -- do not complete additional parts of this form) Yes ☑ No ☐

Acres Irrigated: 0	Average Farm Size: 110 ac.		
Major Crop(s): Corn	Farmable Land In Govt. Jurisdiction Acres: 467992 % 85.4	Amount Of Farmland As Defined in FPPA Acres: 446451 % 79.8	
Name Of Land Evaluation System Used: Wake County LE	Name Of Local Site Assessment System: None	Date Land Evaluation Returned By NRCS: 9/16/2005	

PART III *(To be completed by Federal Agency)*	Alternative Site Rating: Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly	31.2			
B. Total Acres To Be Converted Indirectly				
C. Total Acres In Site	31.2	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information				
A. Total Acres Prime And Unique Farmland	31.2			
B. Total Acres Statewide And Local Important Farmland				
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted	0.007			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value	48.6			
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*	87	0	0	0

PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b))*	Maximum Points				
1. Area In Nonurban Use	15				
2. Perimeter In Nonurban Use	10				
3. Percent Of Site Being Farmed	20				
4. Protection Provided By State And Local Government	20				
5. Distance From Urban Builtup Area	N/A				
6. Distance To Urban Support Services	N/A				
7. Size Of Present Farm Unit Compared To Average	0				
8. Creation Of Nonfarmable Farmland	0				
9. Availability Of Farm Support Services	5				
10. On-Farm Investments	20				
11. Effects Of Conversion On Farm Support Services	0				
12. Compatibility With Existing Agricultural Use	0				
TOTAL SITE ASSESSMENT POINTS	30 160	0	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	87 100	0	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	30 160	0	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	117 260	0	0	0	0

Site Selected: | Date Of Selection | Was A Local Site Assessment Used? Yes ☐ No ☑

Reason For Selection:

"Sites receiving a total score <160 need not be given further consideration for protection and no additional sites need to be evaluated." 7 CFR 658.4(c)(2)

(See Instructions on reverse side)

This form was electronically produced by National Production Services Staff

Form AD-1006 (10-83)

KCI
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ENGINEERS • SURVEYORS • SCIENTISTS • CONSTRUCTION MANAGERS

LANDMARK CENTER II • SUITE 220 • 4601 SIX FORKS ROAD • RALEIGH • NC 27609 • 919-783-9214 • (FAX) 919-783-9266

July 25, 2005

Ms. Juliana Hoekstra
Environmental Review Specialist - SHPO
4617 Mail Service Center
Raleigh, NC 27699-4617

Subject: Cultural Resources Review
Bold Run Creek Stream and Wetland Restoration Project
Project ID# 12053743B

Dear Ms. Hoekstra:

Please accept this information pertaining to the proposed Bold Run Creek Stream and Wetland Restoration Project, which is located approximately 5 miles northwest of the Town of Wake Forest on Bold Hill Run Road approximately 1.5 miles east of the intersection with Mangum Dairy Road in Wake County, as a submittal for cultural resources review by the State Historic Preservation Office.

A portion of this property (refer to attached layout) is currently under investigation as a stream and wetland restoration project for the North Carolina Ecosystem Enhancement Program (NCEEP). The stream work typically involves modifying stream channels to a natural stable form through minor grading, use of in-stream rock features, and establishment of vegetated riparian buffers. The wetland work typically involves minor grading and establishment of wetland vegetation. No impacts to any structures on the subject property are anticipated.

Following the review of the included documentation, please provide a determination regarding any potential impacts to cultural resources associated with this project.

Please feel free to contact me at (919) 783-9214, ext. 133, should you have any questions or require any further information to process this request. Thank you for your assistance and attention.

Sincerely,

April L. Helms
Project Manager

Potential Restoration Sites

JUN 29

I. Applicant Information

For North Carolina HPO Use Only

Preparer/Company KCI

Address: 4601 Six Forks Rd. ste 220 Raleigh, NC 27609

Phone/Fax/E-mail 919-783-9214

ER05-1496

II. Site Information: Attach copy of USGS map or photocopy of quad on reverse (include 1 and 2 mile radius around site)

Wetland Restoration Stream Restoration Applicant's Identification #

Other:

Address: Bold Run Rd. Wake Forest, NC 27587

County: Wake Quad Name: Grissom

III. Identification of Historic Properties:

List sites by site number and Status: NR = National Register listed; SL = Study List; DOE = Determination of Eligibility; LID = Local Designation; UA = Unassessed

Archeology

# of recorded sites in immediate area of site: Ø

Poorly drained soils; low probability for significant sites.

Architecture

# of recorded sites within 1 mile radius

1 site

- W.D. Bailey House
  - 1 mi. East of Project Site

IV. Additional Information or Investigation needed

No Survey Photo Reconnaissance

NO Testing of sites Balloon Test

Recommended by or on: dlsm 6/29/05 (Office of State Archaeology)

Recommended by or on (Survey & Planning Branch):

V. Recommendations/Final Determination

Recommendations for additional work are shown above

X The proposed restoration site will NOT affect historic properties in the area of potential effect.

Renee Gledhill-Earley

Renee Gledhill-Earley, Environmental Review Coordinator

6/29/05 Date

KCI
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LANDMARK CENTER II • SUITE 220 • 4601 SIX FORKS ROAD • RALEIGH • NC 27609 • 919-783-9214 • (FAX) 919-783-9266

July 25, 2005

Ms. Shannon Deaton
Habitat Conservation Program Manager
NC Wildlife Resources Commission
Division of Inland Fisheries
1721 Mail Service Center
Raleigh, NC 27699-1721

Subject: Fish and Wildlife Coordination Act
Bold Run Stream and Wetland Restoration Project
Project Number 12053743B

Dear Ms. Deaton:

Please accept this information pertaining to the proposed Bold Run Stream and Wetland Restoration Project, which is located approximately 5 miles northwest of the Town of Wake Forest on Bold Hill Run Road approximately 1.5 miles east of the intersection with Mangum Dairy Road in Wake County, as a submittal for the Fish and Wildlife Coordination Act review by the NC Wildlife Resources Commission.

A portion of this property (refer to attached layout) is currently under investigation as a stream and wetland restoration project for the North Carolina Ecosystem Enhancement Program (NCEEP). The current land use in the project area includes predominantly Agricultural Pasture Fields. The restoration would improve water quality and provide greater protection for aquatic ecosystems from surrounding agricultural lands. This type of work typically involves enhancing streams to create more natural and stable channels through minor grading, use of in-stream rock features, and reforestation of riparian buffers. As part of the environmental documentation process (Categorical Exclusion), coordination with the NCWRC and the USFWS is requested for compliance with the Fish and Wildlife Coordination Act.

Following the review of the included documentation, please provide a determination of the potential effects to wildlife associated with this project.

Please feel free to contact me at (919) 783-9214, ext. 133, should you have any questions or require any further information to process this request. Thank you in advance for your assistance and attention.

Sincerely,

April Helms
Project Manager

North Carolina Wildlife Resources Commission

Richard B. Hamilton, Executive Director

8 August 2005

Ms. April Helms, Project Manager
KCI Associates of North Carolina
Landmark Center II, Suite 220
4601 Six Forks Road
Raleigh, NC 27609

Subject: Fish and Wildlife Coordination Act, Bold Run Stream and Wetland Restoration Project, Wake County, North Carolina. Project Number 12053743B

Dear Ms Helms:

Biologists with the North Carolina Wildlife Resources Commission have reviewed the subject document. Our comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667d), and North Carolina General Statutes (G.S. 113-131 et seq.).

The North Carolina Ecosystem Enhancement Program is currently investigating a stream and wetland restoration site along New Light Creek, a headwater tributary to Falls-of-the-Neuse Reservoir in the Neuse River basin. There are records for the federal species of concern and state significantly rare pinewoods shiner (*Lythrurus matutinus*) and state significantly rare Carolina ladle crayfish (*Cambarus davidi*) in New Light Creek. Current land use is agricultural pasture. The project would involve minor grading to form natural, stable stream channels, use of instream rock features and reforestation of the riparian buffers.

The proposed restoration project should improve water quality and aquatic habitat. Additionally, establishing a forested riparian buffer should improve terrestrial habitat and provide a travel corridor for wildlife species. We do not anticipate significant adverse impacts to fish and wildlife resources from the proposed project.

Thank you for the opportunity to review this project. If you require further assistance, please contact our office at (336) 449-7625.

Mailing Address: Division of Inland Fisheries • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 733-3633 • **Fax:** (919) 715-7643

8 August 2005
Bold Run Stream and Wetland Restoration Site
Project No. 12053743B

Sincerely,

Shari L. Bryant
Piedmont Region Coordinator
Habitat Conservation Program

ec: Sarah McRae, NHP
Angie Rodgers, WRC

KCI
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LANDMARK CENTER II • SUITE 220 • 4601 SIX FORKS ROAD • RALEIGH • NC 27609 • 919-783-9214 • (FAX) 919-783-9266

July 25, 2005

Mr. Gary Jordan
US Fish and Wildlife Service
Raleigh Field Office
P.O. Box 33726
Raleigh, NC 27636

Subject: Endangered Species Act, Fish and Wildlife Coordination Act, Migratory Bird Treaty Act
Bold Run Stream and Wetland Restoration Project
Project Number 12053743B

Dear Mr. Jordan,

Please accept this information pertaining to the proposed Bold Run Stream and Wetland Restoration Project, which is located approximately 5 miles northwest of the Town of Wake Forest on Bold Hill Run Road approximately 1.5 miles east of the intersection with Mangum Dairy Road in Wake County, as a submittal for review of the Endangered Species Act, Fish and Wildlife Coordination Act, and Migratory Bird Treaty Act by the US Fish and Wildlife Service.

A portion of this property (refer to attached layout) is currently under investigation as a stream and wetland restoration project for the North Carolina Ecosystem Enhancement Program (NCEEP). The current land use in the project area includes predominantly Agricultural Pasture Fields. The restoration would improve water quality and provide greater protection for aquatic ecosystems from surrounding agricultural lands. This type of work typically involves enhancing streams to create more natural and stable channels through minor grading, use of in-stream rock features, and reforestation of riparian buffers. As part of the environmental documentation process (Categorical Exclusion), coordination with the USFWS is requested for compliance with the Endangered Species Act, Fish and Wildlife Coordination Act, and Migratory Bird Treaty Act.

Following the review of the included documentation, please provide a determination of the potential effects to endangered species, wildlife, or migratory birds associated with this project.

Please feel free to contact me at (919) 783-9214, ext. 133, should you have any questions or require any further information to process this request. Thank you in advance for your assistance and attention.

Sincerely,

April Helms
Project Manager

Appendix C
Environmental Screening Inspection Forms

ENVIRONMENTAL SCREENING INSPECTION (ESI) FORM

The objective of the ESI is to have an Inspector screen a property for the visual presence of the items listed on this form without making an evaluation of the conditions or history of the observed concerns.

This ESI Form defines the scope of work to be performed in a checklist format, and also serves as the report document once the Inspector has recorded the observations taken during the inspection, and has attached the site plan and photographs.

This form was completed in the field by an Inspector who conducted a non-destructive visual inspection of the subject property to document observations on-site and, to the extent possible, on the adjacent properties. The inspector did not disturb, dismantle or rearrange any materials, containers or equipment in performance of the inspection.

The entire subject property was covered in a manner conducive to observing and recording evidence of environmental concern. Photographs depicting the general overall condition of the site as well as each item of environmental concern are included.

I. Subject Site Description

Site Name: Bold Run Site

Address/Location: Bold Hill Run Road

City: Wake Forest County: Wake State: North Carolina

Size: _____ acres

Current Landuse(s): Rangeland (pasture) and livestock farming

Number of buildings: **0** ☐ occupied **0** ☐ unoccupied

Site Improvements: ☒ undeveloped land ☐ paving & utility improvements ☐ buildings ☒ fenced

Utilities Serving the Subject Property:

☐ city sewer ☐ septic system ☒ electricity ☐ gas

☐ city water ☐ well water ☐ telephone

II. On-Site Industrial/Manufacturing Activity Checklist:

The following observations were made of industrial/manufacturing activities currently in operation and/or evidence indicating such previous activities on the subject site:

1.	agricultural or horticultural production	☐	Yes	☒	No
2.	airport or aircraft maintenance	☐	Yes	☒	No
3.	analytical testing laboratories	☐	Yes	☒	No
4.	asphalt or cement plant	☐	Yes	☒	No
5.	chemical manufacturing or treatment	☐	Yes	☒	No
6.	dairy, meat or food processing	☐	Yes	☒	No
7.	dry cleaning facilities	☐	Yes	☒	No
8.	explosive manufacturing	☐	Yes	☒	No
9.	foundries, smelters or casting operations	☐	Yes	☒	No
10.	freight terminals	☐	Yes	☒	No
11.	gasoline station or convenience store	☐	Yes	☒	No
12.	herbicide or pesticide manufacturing	☐	Yes	☒	No
13.	incineration furnace or air emissions	☐	Yes	☒	No
14.	inks, dye and paint manufacturing or use	☐	Yes	☒	No
15.	junk or scrap yard	☐	Yes	☒	No
16.	landfill or open dump	☐	Yes	☒	No
17.	livestock feed lots or manure stockpiles	☒	Yes	☐	No
18.	machine shops	☐	Yes	☒	No
19.	metal fabrication or production	☐	Yes	☒	No
20.	metal plating or finishing	☐	Yes	☒	No
21.	military base	☐	Yes	☒	No
22.	mining or quarry activities	☐	Yes	☒	No
23.	motor vehicle maintenance or repairs	☐	Yes	☒	No
24.	oil and gas production or refining	☐	Yes	☒	No
25.	paper manufacturing	☐	Yes	☒	No
26.	pharmaceutical or medical production	☐	Yes	☒	No
27.	photochemical laboratories	☐	Yes	☒	No
28.	plastic or fiberglass fabrication or manufacturing	☐	Yes	☒	No
29.	power plant	☐	Yes	☒	No
30.	printing industries	☐	Yes	☒	No
31.	railroad yard or spur	☐	Yes	☒	No
32.	treatment, storage & disposal (TDS) facility	☐	Yes	☒	No
33.	vehicle or equipment de-greasing or washing	☐	Yes	☒	No
34.	waste treatment process	☐	Yes	☒	No
35.	wood preservation or finishing	☐	Yes	☒	No
36.	fertilizer manufacturing	☐	Yes	☒	No

Description of the overall appearance of the subject property and observed industrial/manufacturing activities (if any):

All open land on the subject property is utilized as rangeland for cattle kept on the property.

III. On-Site Inspection Checklist:

Evidence of the following operations/conditions was observed on the subject property:

1.	floor drains, septic systems	☐	Yes	☒	No
2.	damaged/leaking transformers	☐	Yes	☒	No
3.	heavy equipment, tankers, spray rigs, paint booths	☐	Yes	☒	No
4.	storage containers, drums	☐	Yes	☒	No
5.	chemical, petroleum, foul odors	☐	Yes	☒	No
6.	dumping, disturbed soil, direct burial activity, injection wells, other disposal activities	☐	Yes	☒	No
7.	surface impoundments/holding ponds (other than storm water retention)	☐	Yes	☒	No
8.	waste water discharges	☐	Yes	☒	No
9.	sumps, hydraulic lifts/equipment	☐	Yes	☒	No
10.	ASTs, USTs, fill pipes, vent pipes, vaults, UST manhole covers, pumping equipment, patched areas of asphalt or concrete indicative of previous UST locations or repairs	☐	Yes	☒	No
11.	monitoring wells, piezometers, other subsurface monitoring devices, remedial activities	☐	Yes	☒	No
12.	stained/discolored soil	☐	Yes	☒	No
13.	leachate or seeps	☐	Yes	☒	No
14.	chemically distressed, discolored, stained vegetation	☐	Yes	☒	No
15.	chemical spills/releases	☐	Yes	☒	No
16.	petroleum sheens on water (excluding parking lot ponding)	☐	Yes	☒	No
17.	other	☐	Yes	☐	No

Description of identified environmental concerns (if any):
There were no environmental hazards during the field investigation.

IV. Adjacent/Abutting Property Checklist:

The inspector has observed and documented land uses, business operations, and conditions of concern on all adjacent/abutting properties, from the boundaries of the subject property and from public streets, alleys, sidewalks, etc. An "abutting property" means those sites that share a common property boundary with the subject site, while "adjacent property" means those sites separated from the subject site by an easement, such as a street, highway, railroad, etc.

A. The adjacent property(s) to the north (direction) is:
☒ uphill from ☐ downhill from ☐ level with the subject site.

Current use(s) Rangeland/pasture, forest ☐ occupied ☒ unoccupied

Observed concerns:	☐ chemical spills/releases	☐ chemical odors
☐ underground storage tanks	☐ aboveground storage tanks	☐ stained soil
☐ impoundments/holding ponds	☐ drums/containers	☐ dumping
☐ remediation/clean-up activity	☐ landfill/burial activity	☐ monitoring wells
☐ industrial/manufacturing activity	☐ wastewater discharge	☐ air emissions

Comments: _____

B. The adjacent property(s) to the east (direction) is:
☒ uphill from ☐ downhill from ☐ level with, the subject site.

Current use(s) residential, rangeland/pasture ☒ occupied ☐ unoccupied

Observed concerns:	☐ chemical spills/releases	☐ chemical odors
☐ underground storage tanks	☐ aboveground storage tanks	☐ stained soil
☐ impoundments/holding ponds	☐ drums/containers	☐ dumping
☐ remediation/clean-up activity	☐ landfill/burial activity	☐ monitoring wells
☐ industrial/manufacturing activity	☐ wastewater discharge	☐ air emissions

Comments: _____

C. The adjacent property(s) to the west (direction) is:
☐ uphill from ☐ downhill from ☒ level with, the subject site.

Current use(s) forest, rangeland/pasture, residential ☒ occupied ☐ unoccupied

Observed concerns:

☐ chemical spills/releases	☐ chemical odors	
☐ underground storage tanks	☐ aboveground storage tanks	☐ stained soil
☐ impoundments/holding ponds	☐ drums/containers	☐ dumping
☐ remediation/clean-up activity	☐ landfill/burial activity	☐ monitoring wells
☐ industrial/manufacturing activity	☐ wastewater discharge	☐ air emissions

Comments: _____

_____

D. The adjacent property(s) to the south (direction) is:
☒ uphill from ☐ downhill from ☐ level with, the subject site.

Current use(s) forest, rangeland/pasture, residential ☒ occupied ☐ unoccupied

Observed concerns:

☐ chemical spills/releases	☐ chemical odors	
☐ underground storage tanks	☐ aboveground storage tanks	☐ stained soil
☐ impoundments/holding ponds	☐ drums/containers	☐ dumping
☐ remediation/clean-up activity	☐ landfill/burial activity	☐ monitoring wells
☐ industrial/manufacturing activity	☐ wastewater discharge	☐ air emissions

Comments: _____

_____

Environmental Screening Inspection (ESI) – Photograph Documentation

Photograph 1. View from the East on Bold Hill Run Road looking at the northern portion of the subject property. The land is used for cattle/pasture.

Photograph 2. View from the East on Bold Hill Run Road looking at the western portion of the subject property. The land is used for cattle/pasture.

Photograph 3. View from the East on Bold Hill Run Road looking at the southwestern portion of the subject property. The land is used for cattle/pasture.

Photograph 4. View looking west at the power line easement.

Photograph 5. View from the western portion of the subject property looking east. Adjacent property to the east is residential.

Photograph 6. View looking east on the right bank side of Bold Run Creek.

Photograph 7. View looking east, upstream at Bold Run Creek.

Photograph 8. View looking north along the ditch in the center of the site

Appendix D
Wake Electric Easement

BK001174PG00171

BOOK 1174 PAGE 171

Location Number _____

RIGHT-OF-WAY EASEMENT

KNOW ALL MEN BY THESE PRESENTS, That we, the undersigned _____

Joe Allen and James Allen

(unmarried) (husband and wife), in consideration of _____

Three Hundred and no/100 Dollars ($300.00)

and other valuable considerations and the additional consideration as hereinafter specified, the receipt of which is hereby acknowledged, do hereby grant unto WAKE ELECTRIC MEMBERSHIP CORPORATION, a cooperative corporation organized and existing under the laws of North Carolina, with its principal office and place of business in Wake Forest, Wake County and State of North Carolina, its successors and assigns, the right to enter upon the lands of the undersigned, situated in the County of Wake, State of North Carolina, and more particularly described as follows:

(A tract of land, approximately 6.1 acres in area, located 3 miles from the Town of Wake Forest, and bounded by lands owned by Doug Brack and D. C. Pickard, and _____).

to construct, reconstruct, repair, enlarge, operate and maintain on the above described lands and/or in or upon all streets, roads or highways abutting said lands, an electric transmission or distribution line or system, together with the right of ingress and egress over the lands of the undersigned to and from said lines in the exercise of the rights and privileges granted, provided, however, that in exercising such right of ingress and egress the Cooperative will, in so far as is practical to do so, use regularly established highways or farm roads; said right-of-way herein conveyed is to be one hundred (100) feet in width, fifty (50) feet from the said power line on each side thereof, and includes the right to cut and trim trees and shrubbery upon said right-of-way, and also includes the right to cut down from time to time all dead, weak, leaning or otherwise dangerous trees situated near enough to the above granted right-of-way to constitute a hazard to said power transmission lines.

~~The Cooperative agrees to pay to the undersigned for the privileges herein granted, when said line or system on said land of the undersigned has been completely constructed, Ten ($10.00) Dollars for each pole and Ten ($10.00) Dollars for anchor of said line or system located within the boundaries of said land from cultivated area, and Five ($5.00) Dollars for each pole and Five ($5.00) Dollars for each anchor of said line or system located within the boundaries of said land in areas cultivated area.~~

The undersigned agree that all poles, wires and other facilities installed on the above described land at the expense of said Cooperative shall remain the property of said Cooperative, removable at its option.

The undersigned covenant that they are the owners of the above described lands and that said lands are free and clear of all encumbrances and liens of whatsoever nature, except those held by the following persons:

_____

_____

IN WITNESS WHEREOF, the undersigned have hereunto set their hands and seals, this 15 day of December, 1964.

Joe Allen (SEAL)

James Allen (SEAL)

BK001174PG00172

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NORTH CAROLINA.

_____ County.

I, L. K. Stephens, notary public, do hereby certify that Lee Allen and Wm. D. Allen, his wife, personally appeared before me this day and acknowledged the due execution of the foregoing right-of-way easement.

Witness my hand and notarial seal, this 15 day of December, 19[illegible]

L. K. Stephens (Notary Public)

My Commission Expires _____

NORTH CAROLINA.

_____ County.

I, _____, notary public, do hereby certify that _____ and _____, his wife, personally appeared before me this day and acknowledged the due execution of the foregoing right-of-way easement.

Witness my hand and notarial seal, this _____ day of _____, 19____.

_____ (SEAL.)
(Notary Public)

My Commission Expires _____

NORTH CAROLINA,

_____ County.

I, _____, notary public, do hereby certify that _____ and _____, his wife, personally appeared before me this day and acknowledged the due execution of the foregoing right-of-way easement.

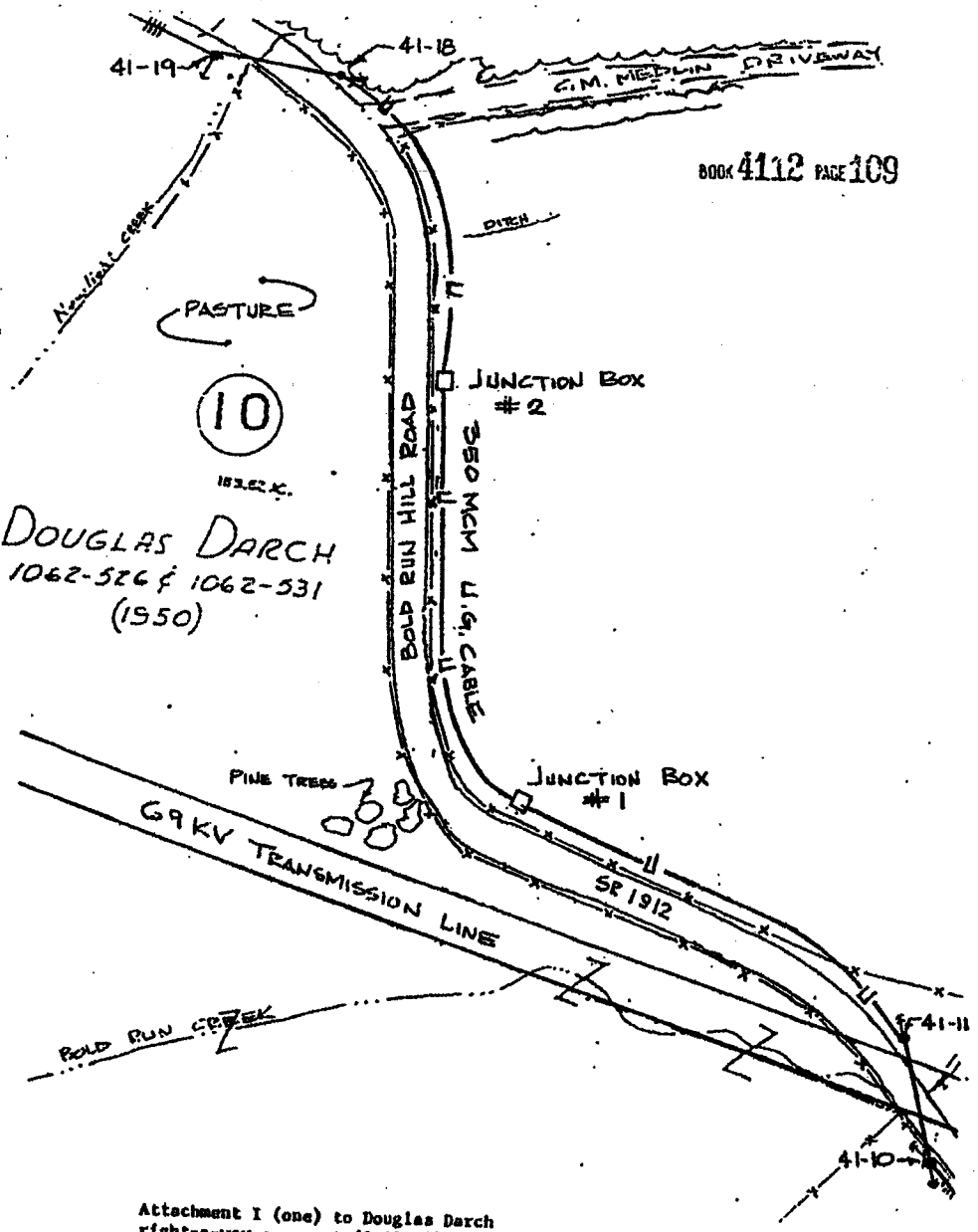
Witness my hand and notarial seal, this _____ day of _____, 19____.

_____ (SEAL.)
(Notary Public)

My Commission Expires _____

Filed for Registration at [illegible] M. Dec. 16 19[illegible]
Registered in the Office of the Register of Deeds, Wake County, North Carolina.
in Book 1174 Page 171 19[illegible]
Register of Deeds

ProSate 2.5 Paid
Registration $ No fee



Attachment I (one) to Douglas Darch right-a-way easement (3-12-87).

DARCHDALE FARM PROPERTY

Appendix E
Project Site Photographs

Environmental Screening Inspection (ESI) – Photograph Documentation

Photograph 1. View from the East on Bold Hill Run Road looking at the northern portion of the subject property. The land is used for cattle/pasture.

Photograph 2. View from the East on Bold Hill Run Road looking at the western portion of the subject property. The land is used for cattle/pasture.

Photograph 3. View from the East on Bold Hill Run Road looking at the southwestern portion of the subject property. The land is used for cattle/pasture.

Photograph 4. View looking west at the power line easement.

Photograph 5. View from the western portion of the subject property looking east. Adjacent property to the east is residential.

Photograph 6. View looking east on the right bank side of Bold Run Creek.

Photograph 7. View looking east, upstream at Bold Run Creek.

Photograph 8. View looking north along the ditch in the center of the site

Photograph L View from the East on Bold Hill Run Road looking at the northern portion of the subject property. The land is used for cattlelpasture.

Photograph 2. View from the East on Bold Hill Run Road looking at the western portion of the subject property. The land is used for cattlelpasture.

Photograph 3. View from the East on Bold Hill Run Road looking at the southwest portion of the subject property. The land is used for cattlelpasture.

Photograph 4. View from the East on Bold Hill Run Road looking at the southern portion of the subject property. The land is used for cattlelpasture.

Photograph 5. Looking northwest from the upstream portion of the stream at the utility line crossing in the middle of the project site.

Photograph 6. Looking north at Ditch 3 crossing the project site.

Photograph 7. Looking east toward Bold Hill Road at Ditch 3 on the project site.

Photograph 8. Looking east toward Bold Hill Road at a swale located parallel to Ditch 3 on the project site.

Photograph 9. Stream bedrock signifies start of project reach.

Photograph 10. Cattle fence bordering Bold Run Creek.

Photograph 11. Upstream portion of Bold Run Creek.

Photograph 12. Looking at Ditch 1, which joins the upstream portion of Bold Run Creek.

Photograph 13. Looking upstream at UT1.

Photograph 14. Looking upstream at UT1, note the confined valley.

Photograph 15. Cattle fence bordering UT1.

Photograph 16. Looking upstream at the upper portion of Bold Run Creek. Note the heavy cattle traffic on the right bank.

Photograph 17. Looking upstream at the upper portion of Bold Run Creek. Note the utility pole immediately adjacent to the stream.

Photograph 18. Looking upstream at the upper portion of Bold Run Creek.

Photograph 19. Heavy cattle traffic on the right bank of Bold Run Creek.

Photograph 20. Looking downstream, notice the heavy cattle traffic located on the right bank of Bold Run Creek.

Photograph 21. Looking upstream at Bold Run Creek.

Photograph 22. Looking upstream at the ephemeral channel, which connects to Bold Run Creek.

Photograph 23. Looking upstream at the downstream portion of Bold Run Creek. The ephemeral channel connects to Bold Run Creek on the left bank. Also, note the stable riffle in the foreground.

Photograph 24. Looking upstream from the downstream portion of Bold Run Creek.

Photograph 25. Looking upstream from the downstream portion of Bold Run Creek.

Photograph 26. Looking upstream from the downstream portion of Bold Run Creek at the confluence of New Light Creek.

Appendix F
Project Site Stream Classification Forms

Ephemeral channel E of Bold Run

USACE AID# _____ DWQ # _____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: _____ **2.** Evaluator's name: [illegible]

3. Date of evaluation: 9-1-05 **4.** Time of evaluation: _____

5. Name of stream: Trib **6.** River basin: Neuse

7. Approximate drainage area: _____ **8.** Stream order: _____

9. Length of reach evaluated: _____ **10.** County: Wake

11. Site coordinates (if known): prefer in decimal degrees **12.** Subdivision name (if any): _____

Latitude (ex. 34.872312): _____ Longitude (ex. -77.556611): _____

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other _____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): _____

Jones Bold Run Creek

14. Proposed channel work (if any): Possible channel fill

15. Recent weather conditions: [illegible]

16. Site conditions at time of visit: [illegible]

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area: _____

19. Does channel appear on USGS quad map? YES (NO) **20.** Does channel appear on USDA Soil Survey? YES (NO) ?

21. Estimated watershed land use: ✓% Residential ___% Commercial ___% Industrial ✓% Agricultural ✓% Forested ___% Cleared / Logged ___% Other (_____)

22. Bankfull width: 5' **23.** Bank height (from bed to top of bank): 3'-4'

24. Channel slope down center of stream: ___Flat (0 to 2%) ✓Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ___Straight ✓Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 32 **Comments:** _____

Evaluator's Signature: Paul Williams Date: 9-1-05

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	3
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	3
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	
	10	**Sediment input** (extensive deposition– 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	4
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	0
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	3
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	0
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						

* These characteristics are not assessed in coastal streams.

Ephemeral Channel L50 for Form

NCDWQ Stream Classification Form

Project Name: Bold Run | River Basin: Neuse | County: Wake | Evaluator: MH, HC

DWQ Project Number: | Nearest Named Stream: Neuse Loop | Latitude: | Signature: Paul Williams

Date: 9-1-05 | USGS QUAD: Garner | Longitude: | Location/Directions:

***PLEASE NOTE:** If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used**

Primary Field Indicators: (Circle One Number Per Line)

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Riffle-Pool Sequence?	(0)	1	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	(1)	2	3
3) Are Natural Levees Present?	0	(1)	2	3
4) Is The Channel Sinuous?	0	(1)	2	3
5) Is There An Active (Or Relic) Floodplain Present?	(0)	1	2	3
6) Is The Channel Braided?	(0)	1	2	3
7) Are Recent Alluvial Deposits Present?	0	(1)	2	3
8) Is There A Bankfull Bench Present?	(0)	1	2	3
9) Is A Continuous Bed & Bank Present? (*NOTE: If Bed & Bank Caused By Ditching And WITHOUT Sinuosity Then Score "0".)	0	(1)	2	3
10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map *And/Or* In Field) Present?	*Yes*=3		*No*=(0)	

PRIMARY GEOMORPHOLOGY INDICATOR POINTS: (5)

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is There A Groundwater Flow/Discharge Present?	(0)	1	2	3

PRIMARY HYDROLOGY INDICATOR POINTS: ____

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fibrous Roots Present In Streambed?	(3)	2	1	0
2) Are Rooted Plants Present In Streambed?	(3)	2	1	0
3) Is Periphyton Present?	(0)	1	2	3
4) Are Bivalves Present?	(0)	1	2	3

PRIMARY BIOLOGY INDICATOR POINTS: (6)

Secondary Field Indicators: (Circle One Number Per Line)

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Head Cut Present In Channel?	(0)	5	1	1.5
2) Is There A Grade Control Point In Channel?	(0)	5	1	1.5
3) Does Topography Indicate A Natural Drainage Way?	(0)	5	1	1.5

SECONDARY GEOMORPHOLOGY INDICATOR POINTS: (0)

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is This Year's (Or Last's) Leaflitter Present In Streambed?	1.5	(1)	5	0
2) Is Sediment On Plants (Or Debris) Present?	0	5	(1)	1.5
3) Are Wrack Lines Present?	(0)	5	1	1.5
4) Is Water In Channel *And* >48 Hrs Since Last *Known* Rain? (*NOTE: If Ditch Indicated In 9 Above Skip This Step And #5 Below*)	(0)	5	1	1.5
5) Is There Water In Channel During Dry Conditions *Or* In Growing Season?	(0)	5	1	1.5
6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)?	*Yes*=1.5		*No*=0	

SECONDARY HYDROLOGY INDICATOR POINTS: ____

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fish Present?	(0)	5	1	1.5
2) Are Amphibians Present?	(0)	5	1	1.5
3) Are Aquatic Turtles Present?	(0)	5	1	1.5
4) Are Crayfish Present?	(0)	5	1	1.5
5) Are Macrobenthos Present?	(0)	5	1	1.5
6) Are Iron Oxidizing Bacteria/Fungus Present?	(0)	5	1	1.5
7) Is Filamentous Algae Present?	(0)	5	1	1.5

8) Are Wetland Plants In Streambed? (*NOTE: If Data Absence Of All Plants In Streambed Is Noted Above, Skip This Step UNLESS SAV Present*)	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
	2	1	.75	.5	0	(0)

SECONDARY BIOLOGY INDICATOR POINTS: 0

TOTAL POINTS *(Primary + Secondary)*= 13 *(If Greater Than Or Equal To 19 Points The Stream Is At Least Intermittent)*

Appendix G
Existing Conditions

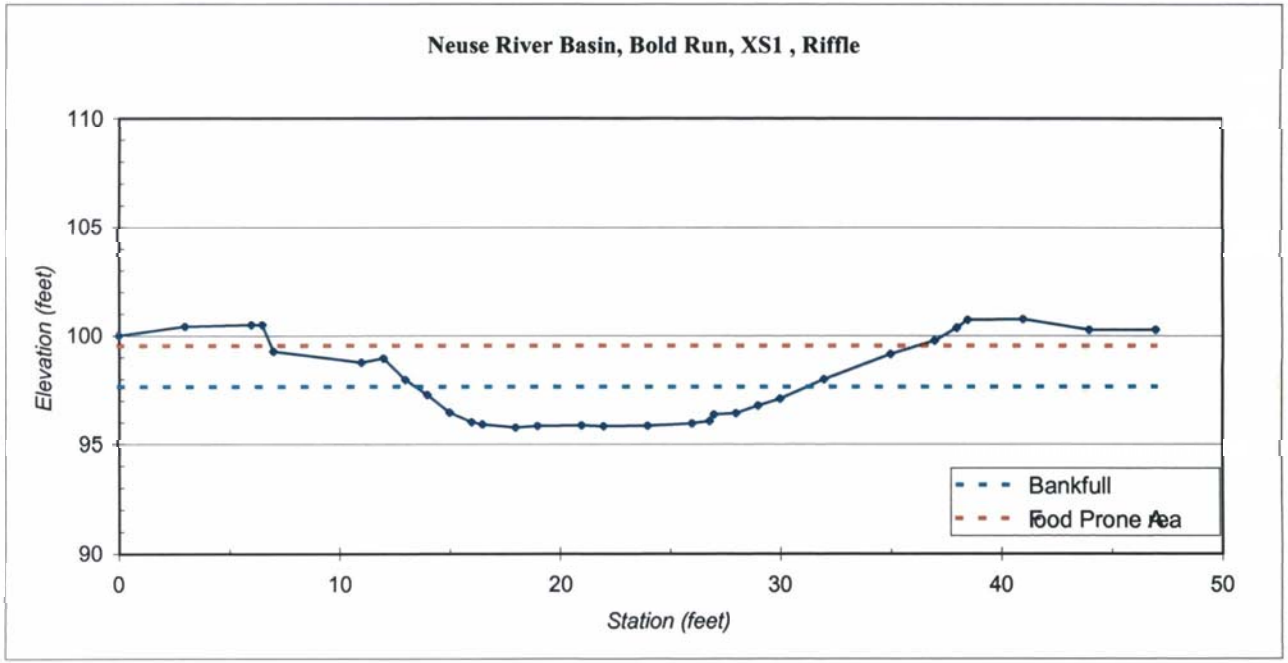
Bold Run Creek
Existing Conditions

River Basin:	Neuse
Watershed:	Bold Run
XS ID	XS1 , Riffle
Drainage Area (sq mi)	
Date:	9/2/2005
Field Crew	MB

Station	Rod Ht.	Elevation
0.0	5.04	100.00
3.0	4.63	100.41
6.0	4.55	100.49
6.5	4.56	100.48
7.0	5.77	99.27
11.0	6.29	98.75
12.0	6.10	98.94
13.0	7.08	97.96
14.0	7.78	97.26
15.0	8.59	96.45
16.0	9.02	96.02
16.5	9.13	95.91
18.0	9.28	95.76
19.0	9.20	95.84
21.0	9.17	95.87
22.0	9.21	95.83
24.0	9.19	95.85
26.0	9.09	95.95
26.8	8.98	96.06
27.0	8.67	96.37
28.0	8.62	96.42
29.0	8.26	96.78
30.0	7.95	97.09
32.0	7.06	97.98
35.0	5.90	99.14
37.0	5.28	99.76
38.0	4.68	100.36
38.5	4.32	100.72
41.0	4.29	100.75
44.0	4.8	100.3
47.0	4.8	100.3

SUMMARY DATA	
Bankfull Elevation:	97.64
Bankfull Cross-Sectional Area:	25.00
Bankfull Width:	17.78
Flood Prone Area Elevation:	99.52
Flood Prone Width:	30.00
Max Depth at Bankfull:	1.88
Mean Depth at Bankfull:	1.41
W / D Ratio:	12.6
Entrenchment Ratio:	1.68
Bank Height Ratio:	1.69
Slope (ft/ft):	0.007
Discharge (cfs)	108

Stream Type:	B4c



S-1 left bank looking right bank

S-1 right bank looking left bank

S-1 looking upstream

S-1 looking downstream

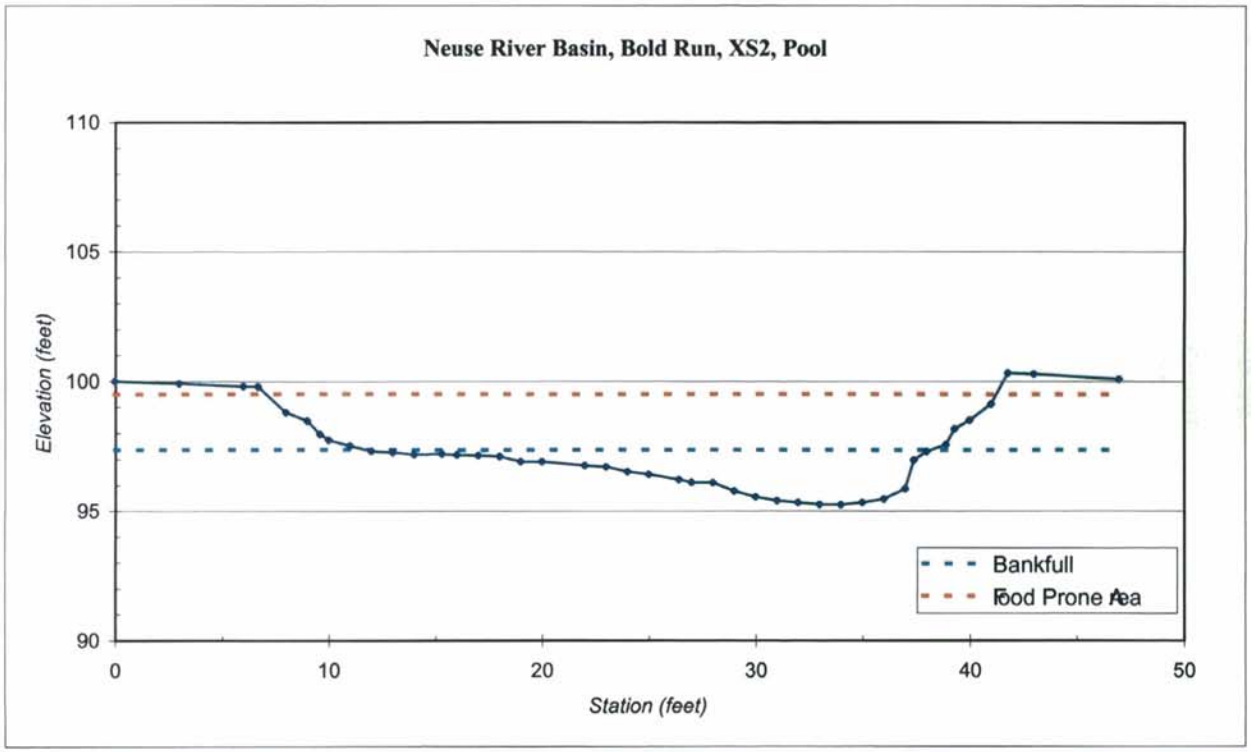
Bold Run Creek
Existing Conditions

River Basin:	Neuse
Watershed:	Bold Run
XS ID	XS2, Pool
Drainage Area (sq mi)	
Date:	9/2/2005
Field Crew	MB

SUMMARY DATA	
Bankfull Elevation:	97.36
Bankfull Cross-Sectional Area:	24.20
Bankfull Width:	26.53
Flood Prone Area Elevation:	99.48
Flood Prone Width:	34.30
Max Depth at Bankfull:	2.12
Mean Depth at Bankfull:	0.91
W / D Ratio:	29.1
Entrenchment Ratio:	1.29
Bank Height Ratio:	2.14
Slope (ft/ft):	0.007
Discharge (cfs)	75

Stream Type:	F4

Station	Rod Ht.	Elevation
0.0	5.36	100.00
3.0	5.45	99.91
6.0	5.57	99.79
6.7	5.58	99.78
8.0	6.57	98.79
9.0	6.89	98.47
9.6	7.41	97.95
10.0	7.63	97.73
11.0	7.85	97.51
12.0	8.07	97.29
13.0	8.12	97.24
14.0	8.19	97.17
15.3	8.17	97.19
16.0	8.20	97.16
17.0	8.23	97.13
18.0	8.27	97.09
19.0	8.46	96.90
20.0	8.46	96.90
22.0	8.61	96.75
23.0	8.66	96.70
24.0	8.85	96.51
25.0	8.94	96.42
26.4	9.14	96.22
27.0	9.25	96.11
28.0	9.27	96.09
29.0	9.59	95.77
30.0	9.81	95.55
31.0	9.96	95.40
32.0	10.04	95.32
33	10.11	95.25
34	10.12	95.24
35	10.03	95.33
36	9.9	95.46
37	9.5	95.86
37.4	8.4	96.96
38	8.06	97.3
38.9	7.81	97.55
39.3	7.2	98.16
40	6.86	98.5
41	6.25	99.11
41.8	5.05	100.31
43	5.08	100.28
47	5.28	100.08



S-2 left bank looking right bank

S-2 right bank looking left bank

S-2 looking upstream

S-2 looking downstream

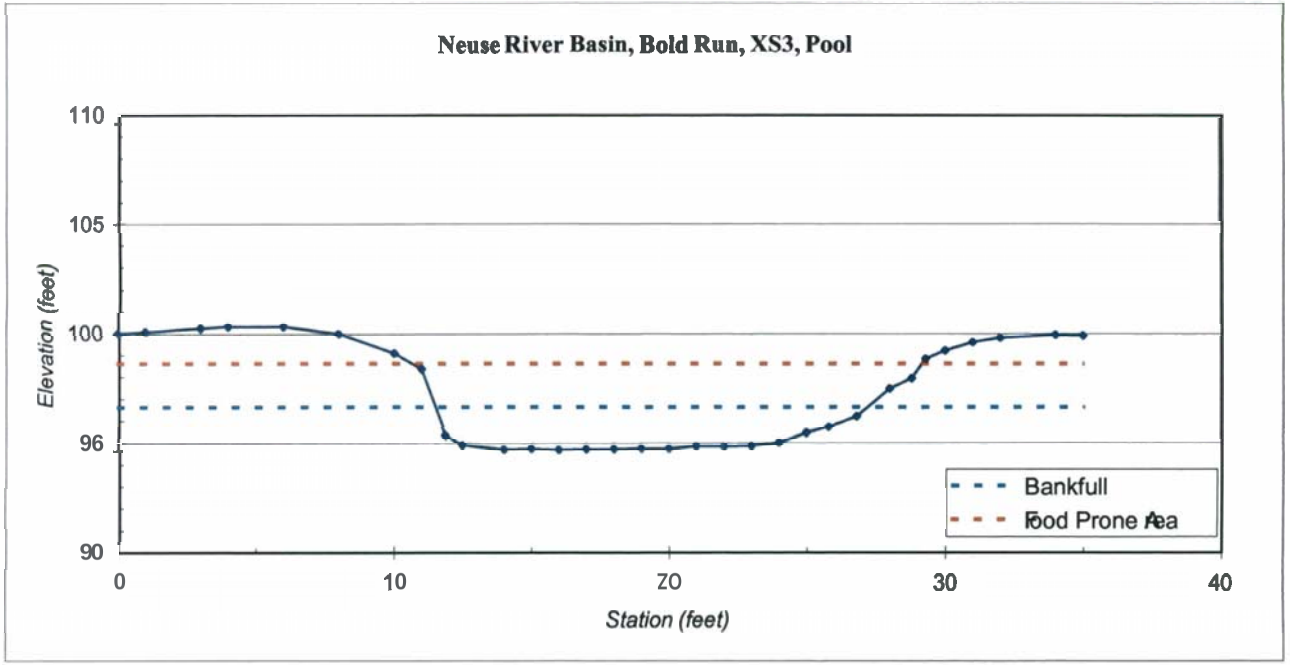
Bold Run Creek
Existing Conditions

River Basin:	Neuse
Watershed:	Bold Run
XS ID	XS3, Pool
Drainage Area (sq mi)	
Date:	7/27/2005
Field Crew	MB

Station	Rod Ht.	Elevation
0	5.03	100.00
1	4.96	100.07
3	4.81	100.22
4	4.73	100.30
6	4.73	100.30
8	5.05	99.98
10	5.95	99.08
11	6.66	98.37
11.9	9.69	95.34
12.5	10.14	94.89
14	10.35	94.68
15	10.32	94.71
16	10.37	94.66
17	10.34	94.69
18	10.33	94.70
19	10.3	94.73
20	10.3	94.73
21	10.19	94.84
22	10.2	94.83
23	10.17	94.86
24	10.03	95.00
25	9.57	95.46
25.8	9.31	95.72
26.8	8.82	96.21
28	7.56	97.47
28.8	7.09	97.94
29.3	6.19	98.84
30	5.81	99.22
31	5.43	99.60
32	5.23	99.80
34	5.1	99.93
35	5.13	99.90

SUMMARY DATA	
Bankfull Elevation:	96.63
Bankfull Cross-Sectional Area:	25.30
Bankfull Width:	15.68
Flood Prone Area Elevation:	98.60
Flood Prone Width:	18.30
Max Depth at Bankfull:	1.97
Mean Depth at Bankfull:	1.61
W / D Ratio:	9.7
Entrenchment Ratio:	1.16
Bank Height Ratio:	2.66
Slope (ft/ft):	0.007
Discharge (cfs)	115

Stream Type:	G4c



S-3 left bank looking right bank

S-3 right bank looking left bank

S-3 looking upstream

S-3 looking downstream

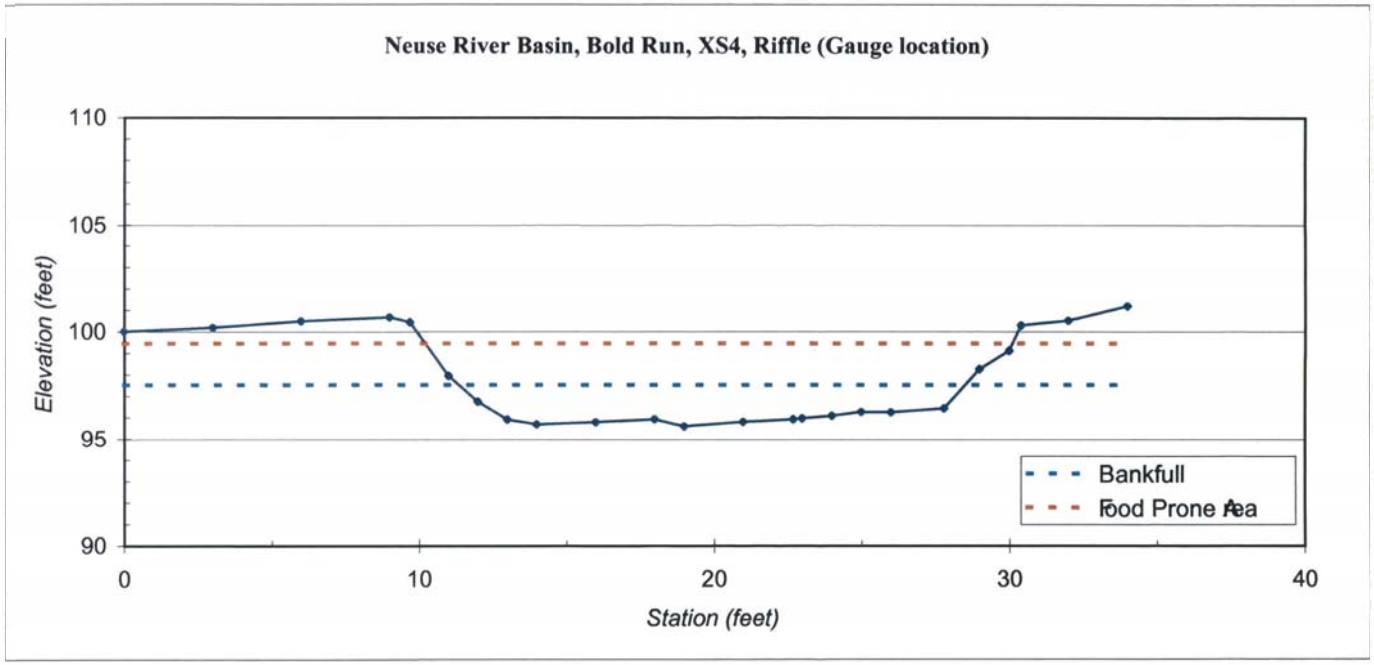
Bold Run Creek
Existing Conditions

River Basin:	Neuse
Watershed:	Bold Run
XS ID	XS4, Riffle (Gauge location)
Drainage Area (sq mi)	
Date:	7/27/2005
Field Crew	MB

Station	Rod Ht.	Elevation
0.0	5.82	100.00
3.0	5.64	100.18
6.0	5.34	100.48
9.0	5.17	100.65
9.7	5.39	100.43
11.0	7.88	97.94
12.0	9.07	96.75
13.0	9.91	95.91
14.0	10.12	95.70
16.0	10.03	95.79
18.0	9.89	95.93
19.0	10.22	95.60
21.0	10.01	95.81
22.7	9.89	95.93
23.0	9.84	95.98
24.0	9.72	96.10
25.0	9.55	96.27
26.0	9.56	96.26
27.8	9.38	96.44
29.0	7.56	98.26
30.0	6.72	99.10
30.4	5.53	100.29
32.0	5.31	100.51
34.0	4.64	101.18

SUMMARY DATA	
Bankfull Elevation:	97.52
Bankfull Cross-Sectional Area:	25.20
Bankfull Width:	17.16
Flood Prone Area Elevation:	99.44
Flood Prone Width:	19.40
Max Depth at Bankfull:	1.92
Mean Depth at Bankfull:	1.47
W / D Ratio:	11.7
Entrenchment Ratio:	1.13
Bank Height Ratio:	2.44
Slope (ft/ft):	0.007
Discharge (cfs)	110

Stream Type:	G4c



S-4 left bank looking right bank

S-4 right bank looking left bank

S-4 looking upstream

S-4 looking downstream

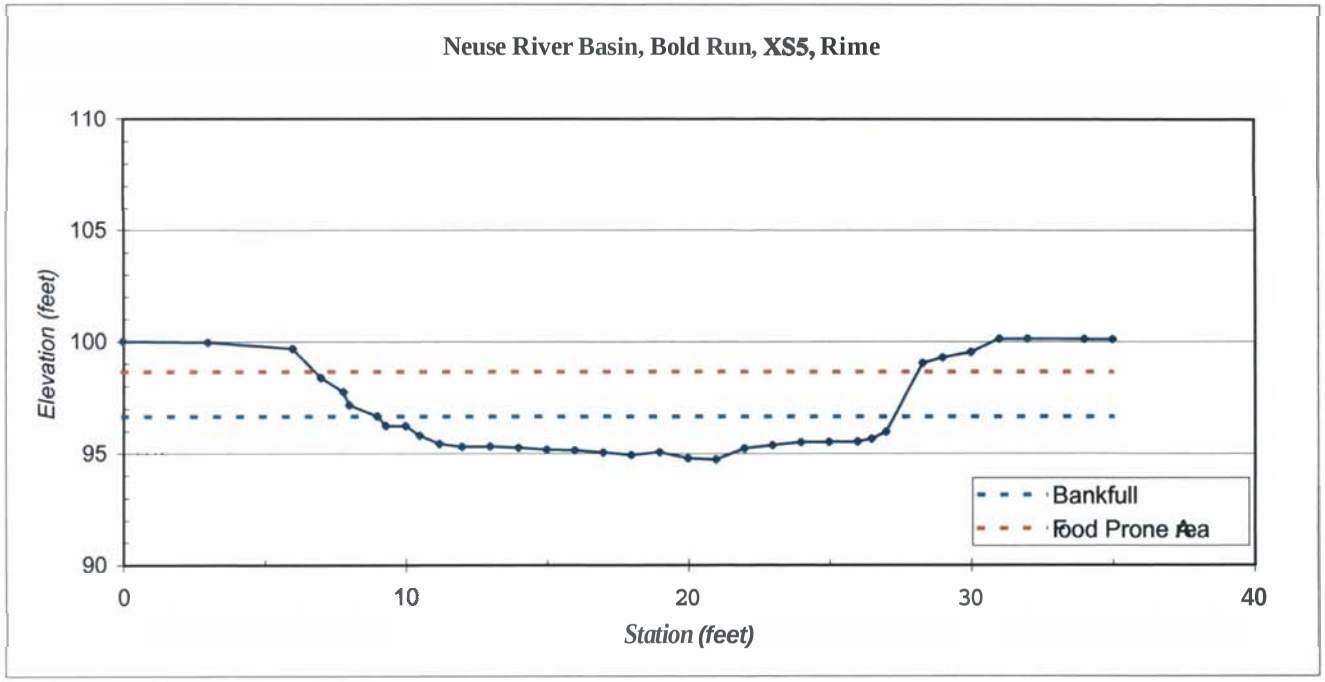
Bold Run Creek
Existing Conditions

River Basin:	Neuse
Watershed:	Bold Run
XS ID	XS5, Riffle
Drainage Area (sq mi)	
Date:	9/2/2005
Field Crew	MB

Station	Rod Ht.	Elevation
0.0	4.76	100.00
3.0	4.81	99.95
6.0	5.10	99.66
7.0	6.40	98.36
7.8	7.03	97.73
8.0	7.59	97.17
9.0	8.09	96.67
9.3	8.53	96.23
10.0	8.52	96.24
10.5	8.96	95.80
11.2	9.32	95.44
12.0	9.45	95.31
13.0	9.44	95.32
14.0	9.50	95.26
15.0	9.59	95.17
16.0	9.62	95.14
17.0	9.71	95.05
18.0	9.83	94.93
19.0	9.70	95.06
20.0	9.97	94.79
21.0	10.03	94.73
22.0	9.52	95.24
23.0	9.38	95.38
24.0	9.26	95.50
25.0	9.24	95.52
26.0	9.22	95.54
26.5	9.09	95.67
27.0	8.78	95.98
28.3	5.73	99.03
29.0	5.48	99.28
30.0	5.24	99.52
31.0	4.64	100.12
32.0	4.64	100.12
34.0	4.65	100.11
35.0	4.67	100.09

SUMMARY DATA	
Bankfull Elevation:	96.67
Bankfull Cross-Sectional Area:	24.20
Bankfull Width:	18.29
Flood Prone Area Elevation:	98.61
Flood Prone Width:	21.30
Max Depth at Bankfull:	1.94
Mean Depth at Bankfull:	1.32
W / D Ratio:	13.8
Entrenchment Ratio:	1.16
Bank Height Ratio:	2.54
Slope (ft/ft):	0.007
Discharge (cfs)	99

Stream Type:	F4



S-5 left bank looking right bank

S-5 right bank looking left bank

S-5 looking upstream

S-5 looking downstream

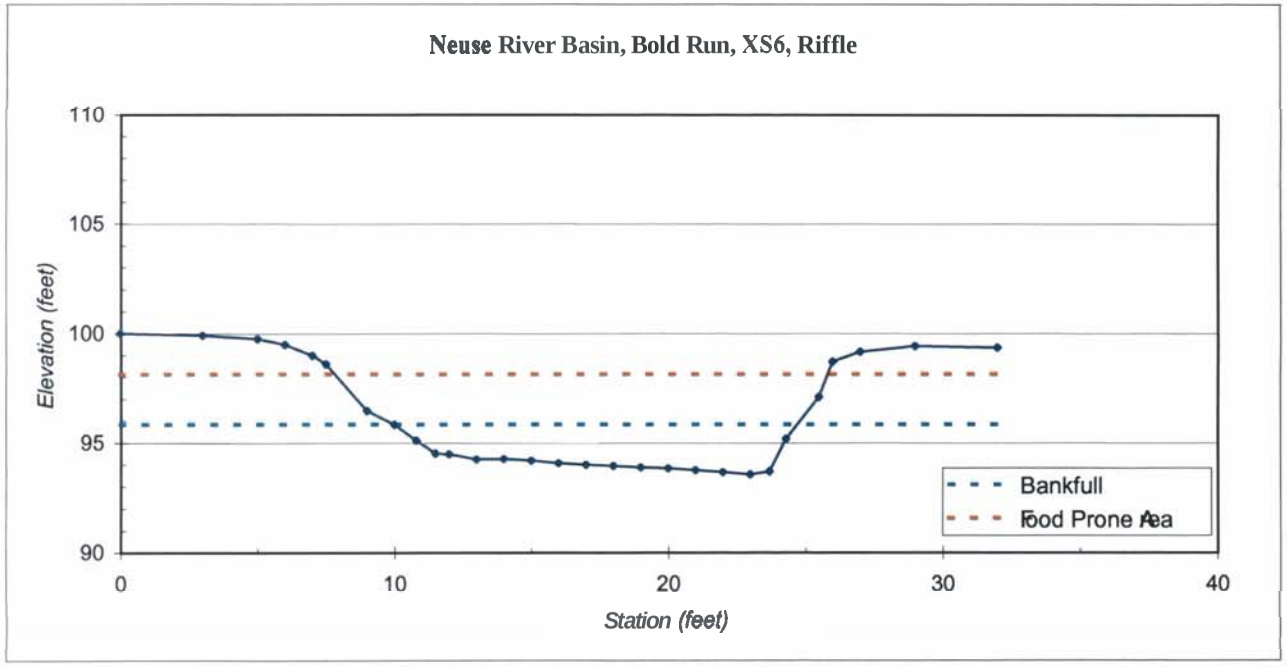
Bold Run Creek
Existing **Conditions**

River Basin:	Neuse
Watershed:	Bold Run
XS ID	XS6, Riffle
Drainage Area (sq mi)	
Date:	9/2/2005
Field Crew	MB

Station	Rod Ht.	Elevation
0.0	5.05	100.00
3.0	5.15	99.90
5.0	5.31	99.74
6.0	5.57	99.48
7.0	6.07	98.98
7.5	6.46	98.59
9.0	8.60	96.45
10.0	9.22	95.83
10.8	9.93	95.12
11.5	10.54	94.51
12.0	10.57	94.48
13.0	10.80	94.25
14.0	10.79	94.26
15.0	10.86	94.19
16.0	10.98	94.07
17.0	11.05	94.00
18.0	11.11	93.94
19.0	11.17	93.88
20.0	11.21	93.84
21.0	11.29	93.76
22.0	11.39	93.66
23.0	11.48	93.57
23.7	11.35	93.70
24.3	9.86	95.19
25.5	7.95	97.10
26.0	6.34	98.71
27.0	5.89	99.16
29.0	5.62	99.43
32.0	5.70	99.35

SUMMARY DATA	
Bankfull Elevation:	95.85
Bankfull Cross-Sectional Area:	24.70
Bankfull Width:	14.75
Flood Prone Area Elevation:	98.13
Flood Prone Width:	18.50
Max Depth at Bankfull:	2.28
Mean Depth at Bankfull:	1.67
W / D Ratio:	8.8
Entrenchment Ratio:	1.25
Bank Height Ratio:	2.57
Slope (ft/ft):	0.007
Discharge (cfs)	114

Stream Type:	G4c



S-6 left bank looking right bank

S-6 right bank looking left bank

S-6 looking upstream

S-6 looking downstream

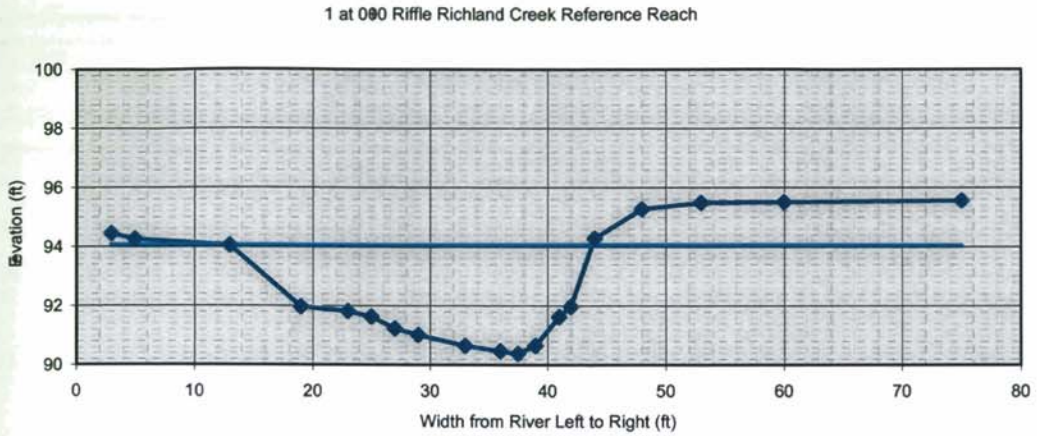
Appendix H
Reference Reach Data

Appendix H. Morphological Design Criteria

CLASSIFICATION DATA	Richland Creek Reference Reach
Rosgen Stream Type	C4
Drainage Area (sq mi)	4.8
Bankfull Width (W_{bkf}) (ft)	28-32
Bankfull Mean Depth (d_{bkf}) (ft)	2.3-2.4
Bankfull Cross Sectional area (A_{bkf}) (sf)	67-75
Width/depth Ratio (W_{bkf}/d_{bkf})	11.7-13.9
Maximum Depth (d_{mbkf}) (ft)	3.75
Width of flood prone area (W_{fpa}) (ft)	>100
Entrenchment Ratio (ER)	> 3.0
Water Surface Slope (S) (ft/ft)	0.004
Sinuosity (stream length/valleylength) (K)	1.1
DIMENSION DATA	
Pool Depth (ft)	2.9
Riffle Depth (ft)	2.3-2.4
Pool Width (ft)	26-35
Riffle Width (ft)	28-32
Pool XS Area (sf)	70-75
Riffle XS Area (sf)	67-75
Pool depth/mean riffle depth	1.2-1.3
Pool width/riffle width	0.9-1.1
Pool area/riffle area	0.9-1.1
Max pool depth/d_{bkf}	1.9-2.0
Low bank height/max bankfull depth	1.0-1.2
Mean Bankfull Velocity (V) (fps)	3.6-5.0
Bankfull Discharge (Q) (cfs)	260-270
PATTERN DATA	
Meander length (L_m) (ft)	110-200
Radius of curvature (Rd) (ft)	30-70
Belt width (W_{blt}) (ft)	300
Meander width ratio (w_{blt}/W_{bkf})	9.3-10.7
Radius of curvature/bankfull width	1.0-2.5
Meander length/bankfull width	3.5-7.1
PROFILE DATA	
Valley slope	0.0045
Average water surface slope	0.004
Riffle slope	0.005-0.009
Pool slope	0.000-0.0025
Pool to pool spacing	25-90
Pool length	5-25
Riffle slope/avg water surface slope	1.3-2.3
Pool slope/avg water surface slope	0.0-0.6
Run slope/avg water surface slope	0.7-1.2
Run depth/d_{bkf}	1.0-1.1
Pool length/bankfull width	0.2-0.9
Pool to pool spacing/bankfull width	0.8-3.0

Richland Creek
Reference Site

Cross Section



section:	1 at 0+00
	Riffle
	Richland Creek Reference Reach
	Richland Creek
description:	
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	Б (ft)	elevation
	☐	3	5.53	94.47
	☐	5	5.72	94.28
	☐	13	5.92	94.08
	☐	19	8	92
	☐	23	8.15	91.85
	☐	25	8.33	91.67
	☐	27	8.73	91.27
	☐	29	8.95	91.05
LEW	☐	33	9.32	90.68
	☐	36	9.5	90.5
BKW	☐	37.5	9.59	90.41
REW	☐	39	9.32	90.68
	☐	41	8.35	91.65
	☐	42	8	92
	☐	44	5.7	94.3
	☐	48	4.7	95.3
	☐	53	4.49	95.51
	☐	60	4.47	95.53
	☐	75	4.4	95.6
	☐			
	☐			
	☐			
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	☐			
	☐			

Б bankfull	Б top of bank	W fpa (ft)	channel slope (%)	Mannings n
5.92	5.53	300.0	0.3	0.035
94.08	94.47			

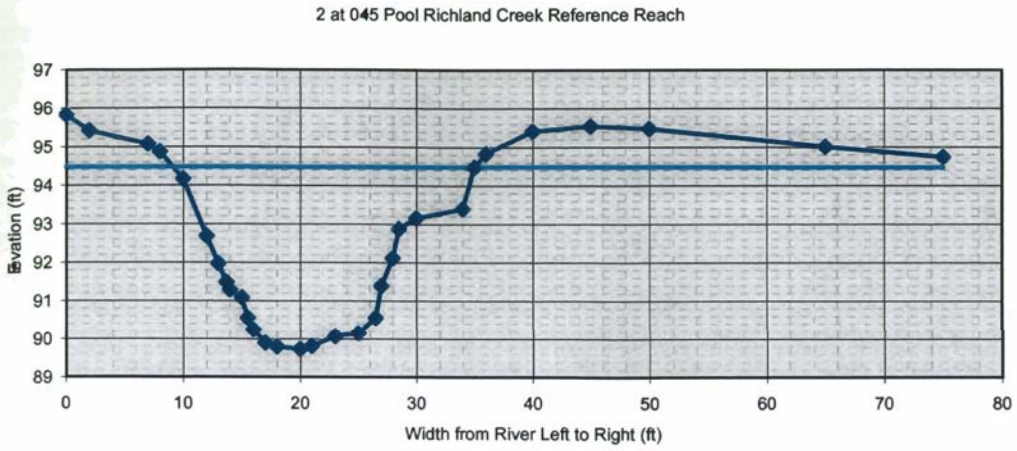
dimensions			
74.6	xsection area	2.4	d mean
30.8	width	32.5	wet P
3.7	d max	2.3	hyd radi
4.1	bank ht	12.7	w/d ratio
300.0	W flood prone area	9.7	ent ratio

hydraulics	
4.0	velocity (ft/sec)
301.8	discharge rate, Q cfs)
0.43	shear stress ((lbs/ft sq
0.47	shear velocity (ft/sec)
1.834	unit stream power (lbs/ft/sec)
0.21	Froude number
8.6	friction factor u/u*
25.9	threshold grain size (mm)

check from channel material			
9	measured D84 (mm)		
78.7	relative roughness	13.6	fric. factor
0.022	Mannings n from channel material		

Richland Creek
Reference Site

Cross Section



section:	2 at 0+45
	Pool
	Richland Creek Reference Reach
	Richland Creek
description:	
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	Б (ft)	elevation
	☐	0	4.14	95.86
	☐	2	4.55	95.45
	☐	7	4.9	95.1
	☐	8	5.1	94.9
	☐	10	5.81	94.19
	☐	12	7.29	92.71
	☐	13	8	92
	☐	13.7	8.48	91.52
	☐	14	8.68	91.32
	☐	15	8.88	91.12
LEW	☐	15.5	9.41	90.59
	☐	16	9.73	90.27
	☐	17	10.08	89.92
	☐	18	10.18	89.82
BKW	☐	20	10.24	89.76
	☐	21	10.16	89.84
	☐	23	9.9	90.1
	☐	25	9.82	90.18
REW	☐	26.5	9.41	90.59
	☐	27	8.58	91.42
	☐	28	7.86	92.14
	☐	28.5	7.1	92.9
	☐	30	6.82	93.18
	☐	34	6.58	93.42
	☐	35	5.5	94.5
	☐	36	5.15	94.85
	☐	40	4.57	95.43
	☐	45	4.44	95.56
	☐	50	4.5	95.5
	☐	65	4.96	95.04
	☐	75	5.23	94.77

Б bankfull	Б top of bank	W flood prone area (ft)	channel slope (%)	Manning's n
5.5	4.57			
94.5	95.43			

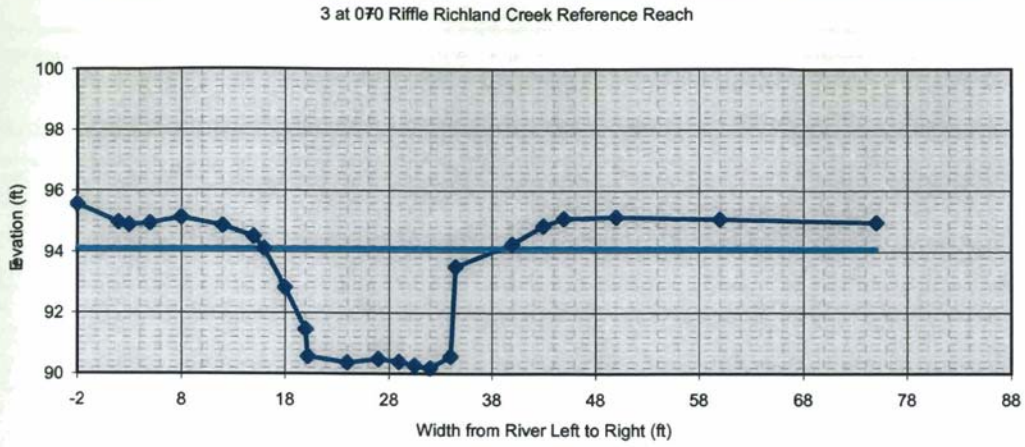
dimensions			
74.5	xsection area	2.9	d mean
25.9	width	29.0	wet P
4.7	d max	2.6	hyd radi
5.7	bank ht	9.0	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

0	measured D84 (mm)		
35.5	relative roughness	14.1	fric. factor
0.000	Mannings n from channel material		

Richland Creek Reference Site

Cross Section



section:	3 at 0+70
	Riffle
	Richland Creek Reference Reach
	Richland Creek
description:	
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	Б (ft)	elevation
	☐	-2	4.4	95.6
	☐	2	5	95
	☐	3	5.08	94.92
	☐	5	5.03	94.97
	☐	8	4.84	95.16
	☐	12	5.11	94.89
	☐	15	5.47	94.53
	☐	16	5.87	94.13
	☐	18	7.14	92.86
	☐	20	8.51	91.49
LEW	☐	20.2	9.4	90.6
	☐	24	9.6	90.4
	☐	27	9.49	90.51
	☐	29	9.58	90.42
	☐	30.5	9.71	90.29
TEW	☐	32	9.79	90.21
REW	☐	34	9.4	90.6
	☐	34.5	6.46	93.54
	☐	40	5.72	94.28
	☐	43	5.13	94.87
	☐	45	4.88	95.12
	☐	50	4.83	95.17
	☐	60	4.9	95.1
	☐	75	5	95
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

Б bankfull	Б top of bank	W fpa (ft)	channel slope (%)	Mannings n'
5.87	4.88	300.0	0.3	0.035
94.13	95.12			

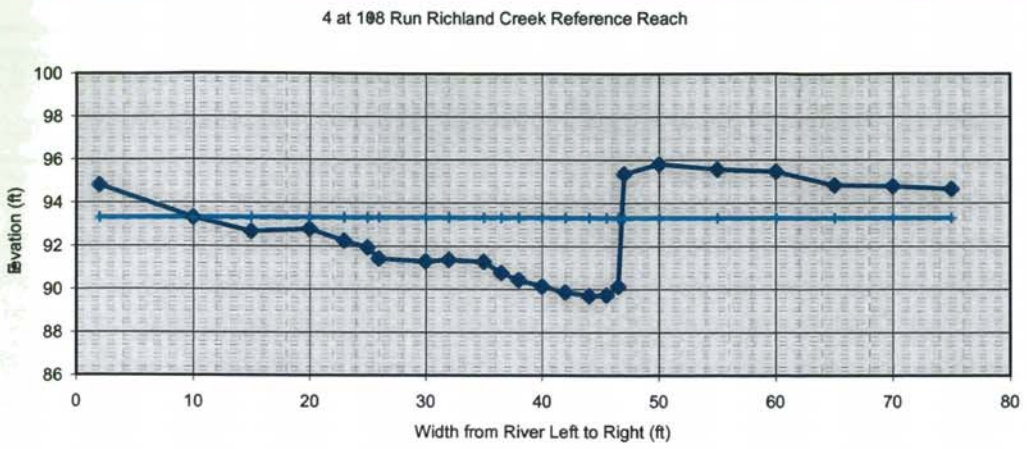
dimensions			
59.2	xsection area	2.6	d mean
22.9	width	27.0	wet P
3.9	d max	2.2	hyd radi
4.9	bank ht	8.8	w/d ratio
300.0	W flood prone area	13.1	ent ratio

hydraulics	
3.9	velocity (ft/sec)
232.5	discharge rate, Q cfs)
0.41	shear stress ((lbs/ft sq
0.46	shear velocity (ft/sec)
1.902	unit stream power (lbs/ft/sec)
0.19	Foude number
8.5	friction factor u/u*
24.7	threshold grain size (mm)

check from channel material			
9	measured D84 (mm)		
84.0	relative roughness	13.8	fric. factor
0.022	Mannings n from channel material		

Richland Creek
Reference Site

Cross Section



section:	4 at 1+08
	Run
	Richland Creek Reference Reach
	Richland Creek
description:	
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	Б (ft)	elevation
	☐	2	5.14	94.86
	☐	10	6.65	93.35
	☐	15	7.29	92.71
	☐	20	7.18	92.82
	☐	23	7.72	92.28
	☐	25	8.04	91.96
	☐	26	8.56	91.44
	☐	30	8.67	91.33
	☐	32	8.6	91.4
	☐	35	8.68	91.32
	☐	36.5	9.2	90.8
	☐	38	9.53	90.47
LEW	☐	40	9.83	90.17
	☐	42	10.1	89.9
BKW	☐	44	10.25	89.75
	☐	45.5	10.22	89.78
REW	☐	46.5	9.83	90.17
	☐	47	4.6	95.4
	☐	50	4.15	95.85
	☐	55	4.38	95.62
	☐	60	4.49	95.51
	☐	65	5.12	94.88
	☐	70	5.16	94.84
	☐	75	5.3	94.7
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

Б bankfull	Б top of bank	W fpa (ft)	channel slope (%)	Mannings h"
6.65	4.6	300.0	0.3	0.035
93.35	95.4			

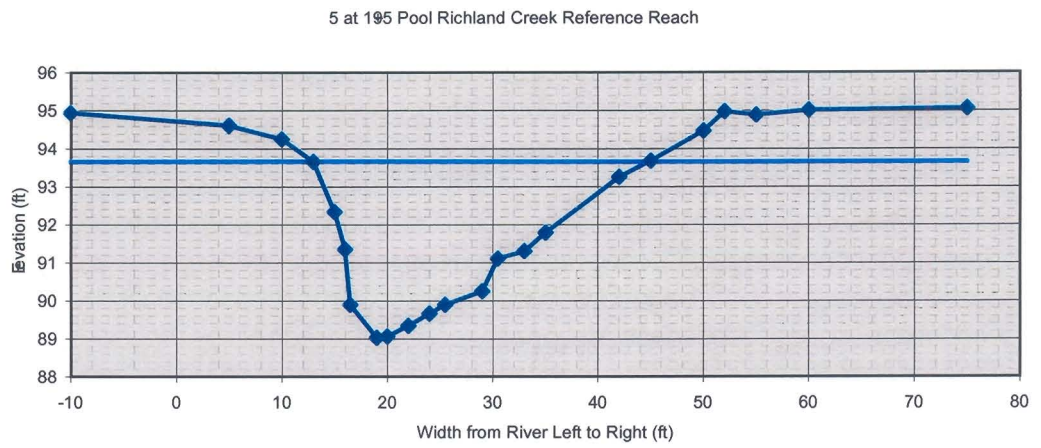
dimensions			
65.3	xsection area	1.8	d mean
36.8	width	40.2	wet P
3.6	d max	1.6	hyd radi
5.7	bank ht	20.7	w/d ratio
300.0	W flood prone area	8.2	ent ratio

hydraulics	
3.2	velocity (ft/sec)
210.0	discharge rate, Q cfs)
0.30	shear stress ((lbs/ft sq
0.40	shear velocity (ft/sec)
1.068	unit stream power (lbs/ft/sec)
0.18	Froude number
8.1	friction factor u/u*
17.7	threshold grain size (mm)

check from channel material			
9	measured D84 (mm)		
57.7	relative roughness	12.9	fric. factor
0.022	Mannings n from channel material		

Richland Creek
Reference Site

Cross Section



section:	5 at 1+95
	Pool
	Richland Creek Reference Reach
	Richland Creek
description:	
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	Б (ft)	elevation
	☐	-10	5.04	94.96
	☐	5	5.37	94.63
	☐	10	5.73	94.27
	☐	13	6.33	93.67
	☐	15	7.65	92.35
	☐	16	8.63	91.37
LEW	☐	16.5	10.08	89.92
BKW	☐	19	10.95	89.05
	☐	20	10.92	89.08
	☐	22	10.64	89.36
	☐	24	10.31	89.69
REW	☐	25.5	10.08	89.92
	☐	29	9.72	90.28
	☐	30.5	8.87	91.13
	☐	33	8.67	91.33
	☐	35	8.19	91.81
	☐	42	6.72	93.28
	☐	45	6.29	93.71
	☐	50	5.5	94.5
	☐	52	5	95
	☐	55	5.09	94.91
	☐	60	4.96	95.04
	☐	75	4.92	95.08
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

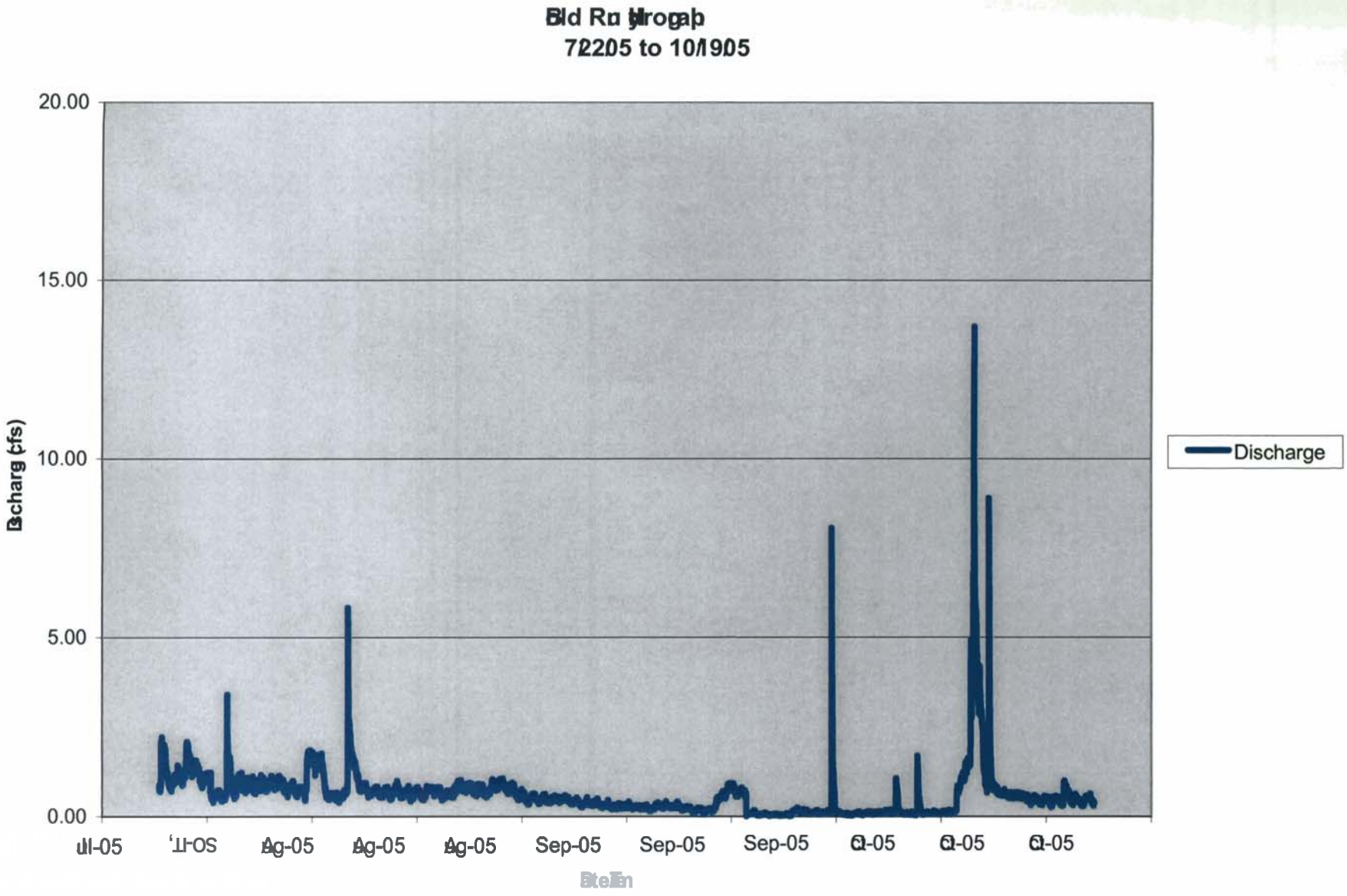
Б bankfull	Б top of bank	W.f.p.a. (ft)	channel slope (%)	Mannings n'
6.33	5		0.29	
93.67	95			

dimensions			
78.3	xsection area	2.5	d mean
31.7	width	34.3	wet P
4.6	d max	2.3	hyd radi
6.0	bank ht	12.8	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, (cfs)
0.41	shear stress ((lbs/ft sq)
0.46	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	froude number
0.0	friction factor u/u*
24.9	threshold grain size (mm)

check from channel material		
0	measured D84 (mm)	
80.2	relative roughness	13.7 fric. factor
0.022	Mannings n from channel material	

Appendix I
Sediment Transport


Bld Rn yhrogap
72205 to 10/1905
20.00
15.00
10.00
5.00
0.00
Discharg (fs)
Discharge

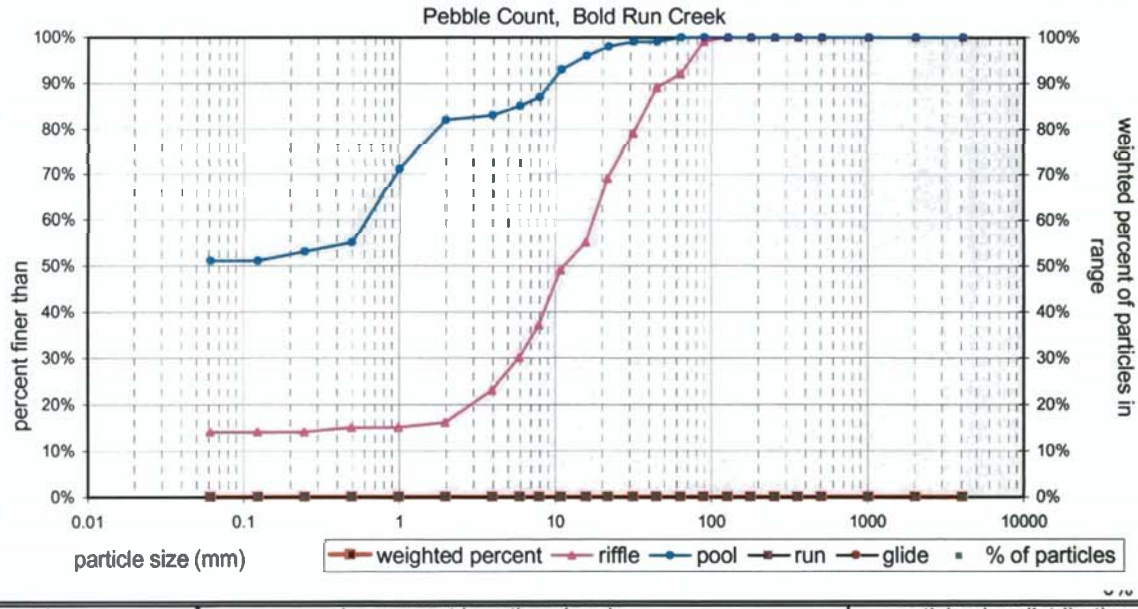
Bold Run Creek
Pebble Count

Pebble Count Weighted Channel Material

Percent Riffle:		Percent Run:	
Percent Pool:		Percent Glide:	

Pebble Count,
Bold Run Creek
New Light Creek
Wake County
Note: 0%

Material	Size Range (mm)		weighted	
silt/clay	0	0.062	0.0	#
very fine sand	0.062	0.13	0.0	#
fine sand	0.13	0.25	0.0	#
medium sand	0.25	0.5	0.0	#
coarse sand	0.5	1	0.0	#
very coarse sand	1	2	0.0	#
very fine gravel	2	4	0.0	#
fine gravel	4	6	0.0	#
fine gravel	6	8	0.0	#
medium gravel	8	11	0.0	#
medium gravel	11	16	0.0	#
coarse gravel	16	22	0.0	#
coarse gravel	22	32	0.0	#
very coarse gravel	32	45	0.0	#
very coarse gravel	45	64	0.0	#
small cobble	64	90	0.0	#
medium cobble	90	128	0.0	#
large cobble	128	180	0.0	#
very large cobble	180	256	0.0	#
small boulder	256	362	0.0	#
small boulder	362	512	0.0	#
medium boulder	512	1024	0.0	#
large boulder	1024	2048	0.0	#
very large boulder	2048	4096	0.0	#
weighted particle count:			0.0	



bedrock			0.0	
clay hardpan			0.0	
detritus/wood			0.0	
artificial			0.0	
weighted total count:			0	

based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	0.000	0.00	0.0	0	0	0	---	---	---

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	---	---	---	---	---	---	---	---	---

Bld Rn Creek
Pbe Cont

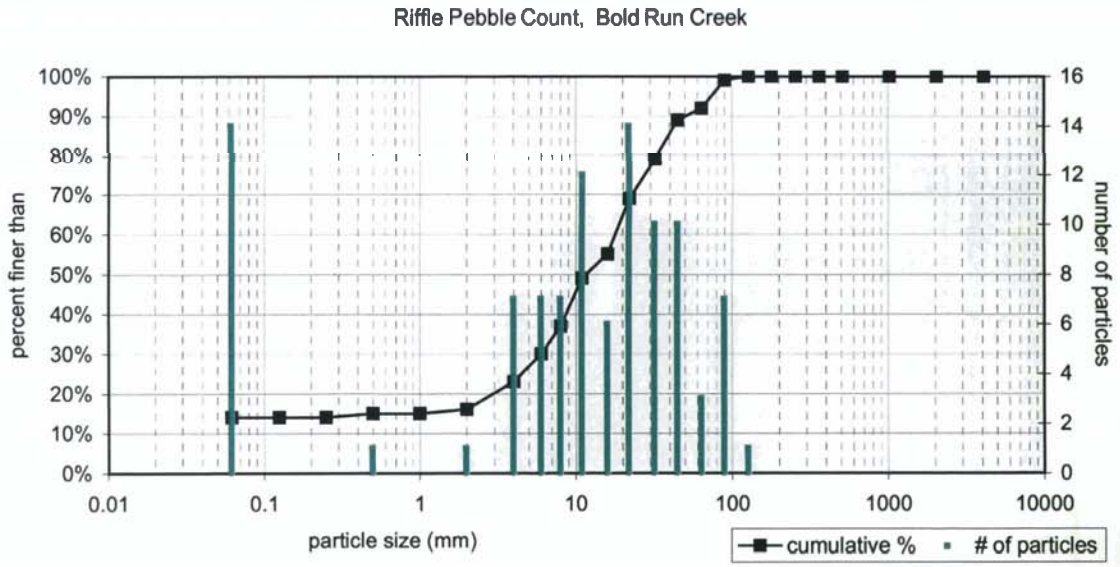
Riffle Pbe Cont

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**14**	#
very fine sand	0.062	0.13		#
fine sand	0.13	0.25		#
medium sand	0.25	0.5	**1**	#
coarse sand	0.5	1		#
very coarse sand	1	2	**1**	#
very fine gravel	2	4	**7**	#
fine gravel	4	6	**7**	#
fine gravel	6	8	**7**	#
medium gravel	8	11	**12**	#
medium gravel	11	16	**6**	#
coarse gravel	16	22	**14**	#
coarse gravel	22	32	**10**	#
very coarse gravel	32	45	**10**	#
very coarse gravel	45	64	**3**	#
small cobble	64	90	**7**	#
medium cobble	90	128	**1**	#
large cobble	128	180		#
very large cobble	180	256		#
small boulder	256	362		#
small boulder	362	512		#
medium boulder	512	1024		#
large boulder	1024	2048		#
very large boulder	2048	4096		#
	total particle count:		100	

bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	100

Riffle Pebble Count,

	Bold Run Creek
	New Light Creek
	Wake County
Note:	



based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	2.000	7.37	11.7	20	38	74	4.5	8.7	4.4

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	14%	2%	76%	8%	0%	0%	0%	0%	0%

Bld Ru Creek
Ple Cout

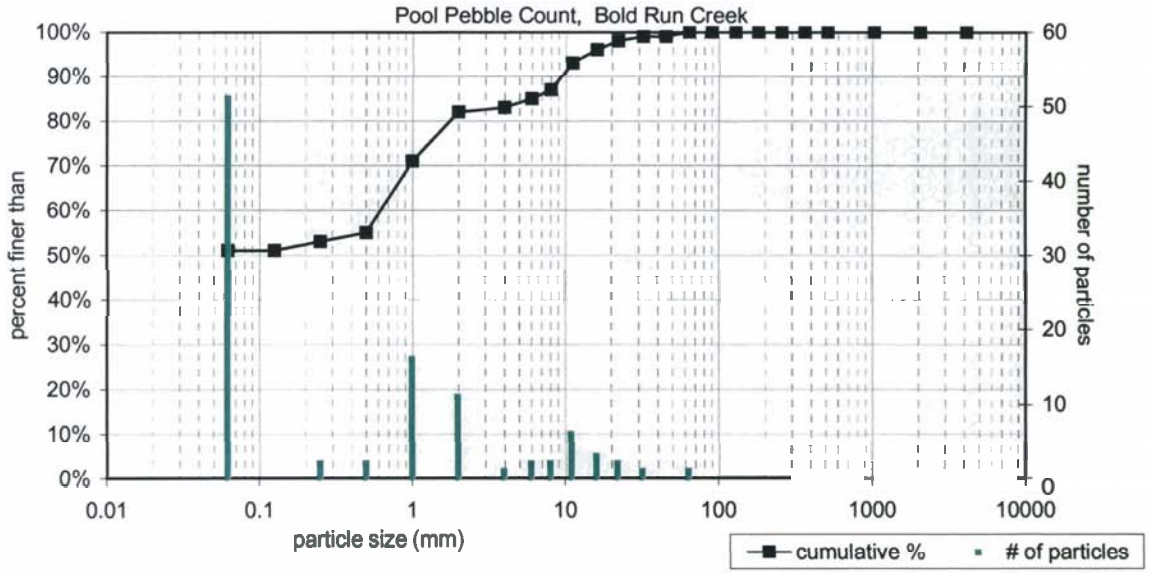
Bol Ple Cout

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**51**	#
very fine sand	0.062	0.13		#
fine sand	0.13	0.25	**2**	#
medium sand	0.25	0.5	**2**	#
coarse sand	0.5	1	**16**	#
very coarse sand	1	2	**11**	#
very fine gravel	2	4	**1**	#
fine gravel	4	6	**2**	#
fine gravel	6	8	**2**	#
medium gravel	8	11	**6**	#
medium gravel	11	16	**3**	#
coarse gravel	16	22	**2**	#
coarse gravel	22	32	**1**	#
very coarse gravel	32	45		#
very coarse gravel	45	64	**1**	#
small cobble	64	90		#
medium cobble	90	128		#
large cobble	128	180		#
very large cobble	180	256		#
small boulder	256	362		#
small boulder	362	512		#
medium boulder	512	1024		#
large boulder	1024	2048		#
very large boulder	2048	4096		#
	total particle count:		100	

bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	100

Pool Pebble Count,

	Bold Run Creek
	New Light Creek
	Wake County
Note:	



based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	0.062	0.06	0.1	1	5	14	40.0	0.6	8.9

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	51%	31%	18%	0%	0%	0%	0%	0%	0%

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis

Party: BH, AS

Location: Bold Run Site - Pavement 1

Date:15 Aug 2005

Notes:

Total Weight Before Sieving (oz)
51.00
51.00

SUB SAMPLES	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)
	< 2.0	2.0	4.0	8.0	16.0	31.5	64.0	128.0	256.0	>256.0
	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)
	29	42.5	45	47	49.5	48.5				
	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights
	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net
1	38.0 / 9.0	46.0 / 3.5	50.0 / 5.0	58.0 / 11.0	72.0 / 22.5	56.0 / 7.5				
2	/ 0.0									
3	/ 0.0									
4	/ 0.0									
5	/ 0.0									
6	/ 0.0									
7	/ 0.0									
8	/ 0.0									
9	/ 0.0									
10	/ 0.0									
11	/ 0.0									
12	/ 0.0									
13	/ 0.0									
14	/ 0.0									
15	/ 0.0									
Net Wt. Total	9.0	3.5	5.0	11.0	22.5	7.5	0.0	0.0	0.0	0.0	58.5
% Grand Tot.	15.4%	6.0%	8.5%	18.8%	38.5%	12.8%	0.0%	0.0%	0.0%	0.0%	
Accum. % =<	15.4% →	21.4% →	29.9% →	48.7% →	87.2% →	100.0% →	100.0% →	100.0% →	100.0% →	100.0%	

SURFACE MATERIALS DATA
(Two Largest Particles)

No.	Dia.	WT.
1	96.0	38.0
2	88.0	28.0

Bucket + Materials Weight_____

Bucket Tare Weight_____

Materials Weight_____

(Materials less than: _____mm.)

Be Sure to Add Separate Material Weights to Grand Total

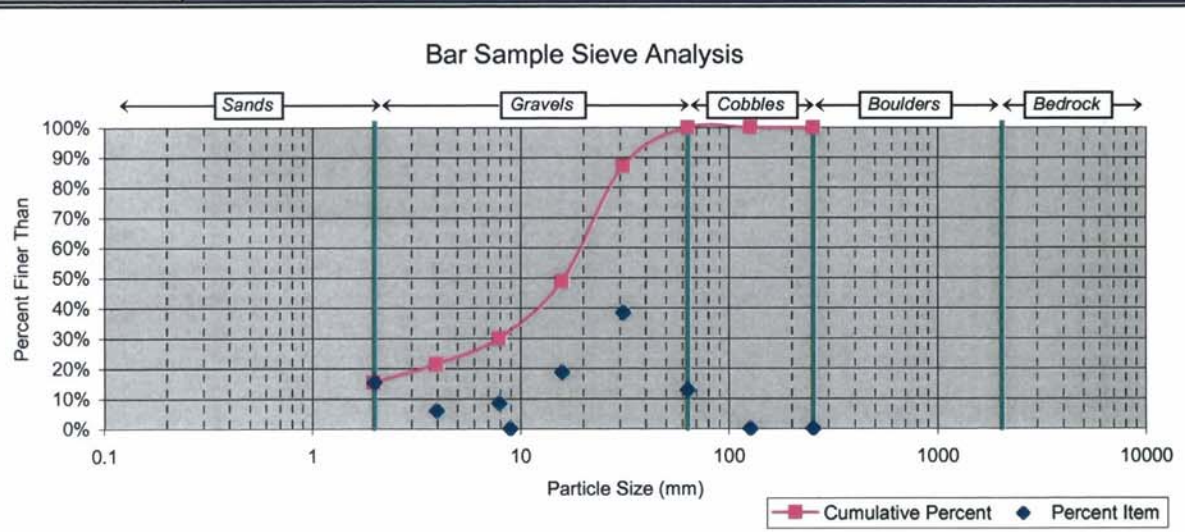
GRAND TOTAL SAMPLE WEIGHT

NOTES

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
2.0	9	15.4%	15.4%
4.0	3.5	6.0%	21.4%
8.0	5.0	8.5%	29.9%
16.0	11.0	18.8%	48.7%
31.5	22.5	38.5%	87.2%
64.0	7.5	12.8%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	58.5	100%	

Stream:	Bold Run Creek - Pavement #1
Watershed:	New Light Creek - Neuse River
Location:	Pavement #1
Note:	



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
2.1	9.6	16.4	29.8	48.5	0%	15%	85%	0%	---	---

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis | Party: BH, AS

Location: Bold Run Site-Bar 1 | Date: 15 Aug 2005 | Notes:

SUB SAMPLES

	Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)	
	< 2.0		2.0		4.0		8.0		16.0		31.5		54.0		64.0		70.0		90.0	
	Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)	
	29		42.5		45		47		49.5		48.5									
	Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights	
	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net
1	170.0	141.0	80.0	37.5	72.0	27.0	84.0	37.0	174.0	124.5	246.0	197.5								
2																				
3																				
4																				
5		0.0																		
6		0.0																		
7		0.0																		
8		0.0																		
9		0.0																		
10		0.0																		
11		0.0																		
12		0.0																		
13		0.0																		
14		0.0																		
15		0.0																		
Net Wt. Total	141.0		37.5		27.0		37.0		124.5		197.5		0.0		0.0		0.0		0.0	564.5
% Grand Tot.	25.0%		6.6%		4.8%		6.6%		22.1%		35.0%		0.0%		0.0%		0.0%		0.0%	
Accum. % =<	25.0%	→	31.6%	→	36.4%	→	43.0%	→	65.0%	→	100.0%	→	100.0%	→	100.0%	→	100.0%	→	100.0%	

Total Weight Before Sieving (oz)

367.00
367.00

SURFACE MATERIALS DATA
(Two Largest Particles)

No.	Dia.	WT.
1	133.0	78.0
2	133.0	68.0

Bucket + Materials Weight_____

Bucket Tare Weight_____

Materials Weight_____
(Materials less than: _____mm.)

Be Sure to Add Separate Material Weights to Grand Total

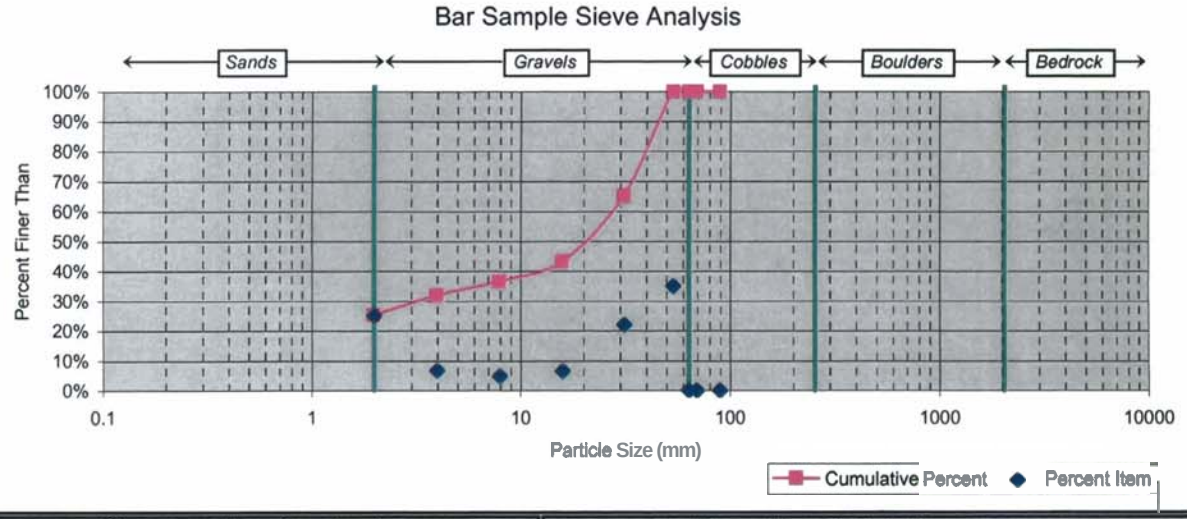
GRAND TOTAL SAMPLE WEIGHT

NOTES

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
2.0	141	25.0%	25.0%
4.0	37.5	6.6%	31.6%
8.0	27.0	4.8%	36.4%
16.0	37.0	6.6%	43.0%
31.5	124.5	22.1%	65.0%
54.0	197.5	35.0%	100.0%
64.0	0.0	0.0%	100.0%
70.0	0.0	0.0%	100.0%
90.0	0.0	0.0%	100.0%
Total:	564.5	100%	

Stream: Bold Run Creek - Bar #1
Watershed: New Light Creek - Neuse River
Location: Bar #1
Note:



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
6.5	6.5	19.9	42.2	50.0	0%	25%	75%	0%	---	---

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis | Party: BH, AS

Location: Bold Run Site - Pavement 2 | Date:15 Aug 2005 | Notes:

SUB SAMPLES

	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)	Sieve Size (mm)
	< 2.0	2.0	4.0	8.0	16.0	31.5	64.0	128.0	256.0	>256.0
	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)	Tare Weight (oz)
	29	42.5	45	47	49.5	48.5				
	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights	Sample Weights
	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net	Total / Net
1	40.0 / 11.0	48.0 / 5.5	52.0 / 7.0	60.0 / 13.0	60.0 / 10.5	92.0 / 43.5				
2	/ 0.0									
3	/ 0.0									
4	/ 0.0									
5	/ 0.0									
6	/ 0.0									
7	/ 0.0									
8	/ 0.0									
9	/ 0.0									
10	/ 0.0									
11	/ 0.0									
12	/ 0.0									
13	/ 0.0									
14	/ 0.0									
15	/ 0.0									
Net Wt. Total	11.0	5.5	7.0	13.0	10.5	43.5	0.0	0.0	0.0	0.0	90.5
% Grand Tot.	12.2%	6.1%	7.7%	14.4%	11.6%	48.1%	0.0%	0.0%	0.0%	0.0%	
Accum. % =<	12.2%	18.2%	26.0%	40.3%	51.9%	100.0%	100.0%	100.0%	100.0%	100.0%	

Total Weight Before Sieving (oz)
47.00
47.00

SURFACE MATERIALS DATA
(Two Largest Particles)

No.	Dia.	WT.
1	135.0	116.0
2	89.0	112.0

Bucket + Materials Weight_____

Bucket Tare Weight_____

Materials Weight_____
(Materials less than: _____mm.)

Be Sure to Add Separate Material Weights to Grand Total

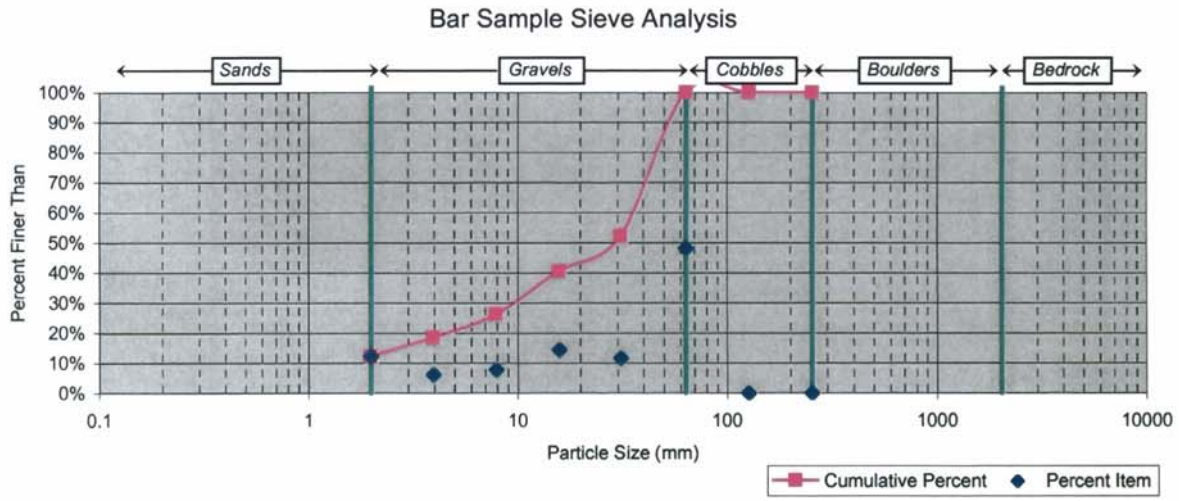
GRAND TOTAL SAMPLE WEIGHT

NOTES

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
2.0	11	12.2%	12.2%
4.0	5.5	6.1%	18.2%
8.0	7.0	7.7%	26.0%
16.0	13.0	14.4%	40.3%
31.5	10.5	11.6%	51.9%
64.0	43.5	48.1%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	90.5	100%	

Stream:	Bold Run Creek - Pavement #1
Watershed:	New Light Creek - Neuse River
Location:	Pavement #2
Note:	



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
3.1	12.4	28.1	50.5	59.5	0%	12%	88%	0%	---	---

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis | Party: BH, AS

Location: Bold Run Site - Sub-Pavement 1 | Date:15 Aug 2005 | Notes:

Total Weight Before Sieving (oz)
411.00
411.00

SUB SAMPLES

	Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)	
	< 2.0		2.0		4.0		8.0		16.0		31.5		64.0		128.0		256.0		≥256.0	
	Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)	
	29		42.5		45		47		49.5		48.5									
	Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights	
	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net
1	188.0	159.0	108.0	65.5	96.0	51.0	114.0	67.0	118.0	68.5	84.0	35.5								
2		0.0																		
3		0.0																		
4		0.0																		
5		0.0																		
6		0.0																		
7		0.0																		
8		0.0																		
9		0.0																		
10		0.0																		
11		0.0																		
12		0.0																		
13		0.0																		
14		0.0																		
15		0.0																		
Net Wt. Total	159.0		65.5		51.0		67.0		68.5		35.5		0.0		0.0		0.0		0.0	446.5
% Grand Tot.	35.6%		14.7%		11.4%		15.0%		15.3%		8.0%		0.0%		0.0%		0.0%		0.0%	
Accum. % =<	35.6%	→	50.3%	→	61.7%	→	76.7%	→	92.0%	→	100.0%	→	100.0%	→	100.0%	→	100.0%	→	100.0%	

SURFACE MATERIALS DATA
(Two Largest Particles)

No.	Dia.	WT.
1	96.0	38.0
2	88.0	28.0

Bucket + Materials Weight_____

Bucket Tare Weight_____

Materials Weight_____
(Materials less than: _____mm.)

Be Sure to Add Separate Material Weights to Grand Total

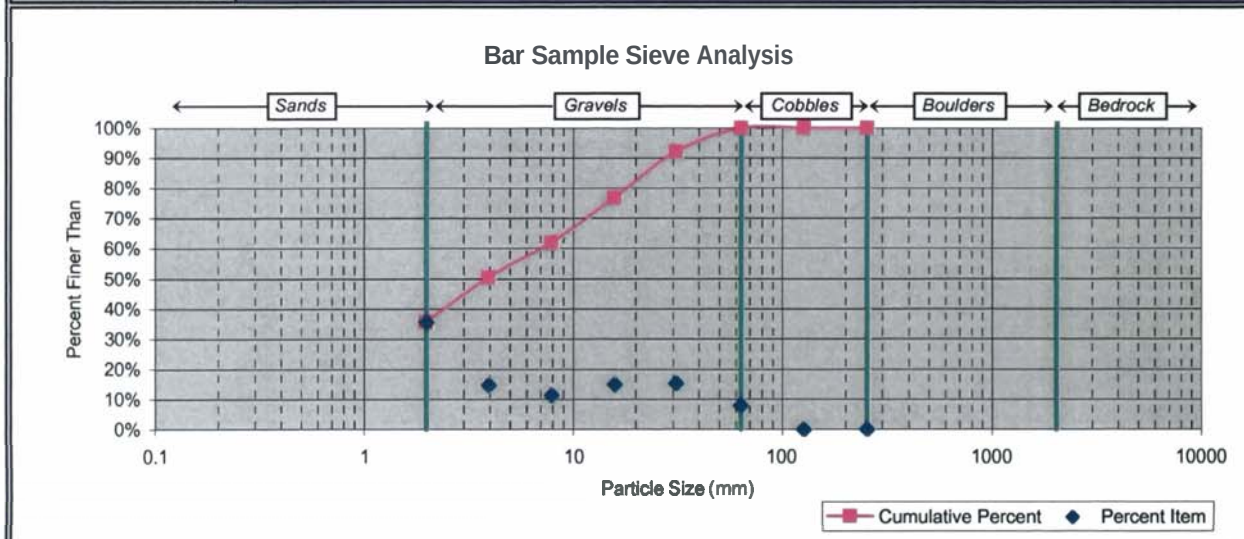
GRAND TOTAL SAMPLE WEIGHT

NOTES

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
2.0	159	35.6%	35.6%
4.0	65.5	14.7%	50.3%
8.0	51.0	11.4%	61.7%
16.0	67.0	15.0%	76.7%
31.5	68.5	15.3%	92.0%
64.0	35.5	8.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	446.5	100%	

Stream:	Bold Run Creek - Sub-Pavement #1
Watershed:	New Light Creek - Neuse River
Location:	Sub-Pavement #1
Note:	



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
3.9	3.9	3.9	22.1	41.0	0%	36%	64%	0%	---	---

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis

Party: BH, AS

Location: Bold Run Site - Sub-Pavement 2

Date:15 Aug 2005

Notes:

SUB SAMPLES

	Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)		Sieve Size (mm)	
	< 2.0		2.0		4.0		8.0		16.0		31.5		64.0		128.0		256.0		>256.0	
	Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)		Tare Weight (oz)	
	29		42.5		45		47		49.5		48.5									
	Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights	
	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net
1	76.0	47.0	56.0	13.5	54.0	9.0	72.0	25.0	78.0	28.5	104.0	55.5								
2		0.0																		
3		0.0																		
4		0.0																		
5		0.0																		
6		0.0																		
7		0.0																		
8		0.0																		
9		0.0																		
10		0.0																		
11		0.0																		
12		0.0																		
13		0.0																		
14		0.0																		
15		0.0																		
Net Wt. Total	47.0			13.5		9.0		25.0		28.5		55.5		0.0		0.0		0.0		0.0	178.5
% Grand Tot.	26.3%			7.6%		5.0%		14.0%		16.0%		31.1%		0.0%		0.0%		0.0%		0.0%	
Accum. % =<	26.3%		→	33.9%	→	38.9%	→	52.9%	→	68.9%	→	100.0%	→	100.0%	→	100.0%	→	100.0%	→	100.0%	

Total Weight Before Sieving (oz)

178.50

178.50

SURFACE MATERIALS DATA
(Two Largest Particles)

No.	Dia.	WT.
1	35.0	1.0
2	15.0	1.0

Bucket + Materials Weight_____

Bucket Tare Weight_____

Materials Weight_____

(Materials less than: _____mm.)

Be Sure to Add Separate Materia Weights to Grand Total

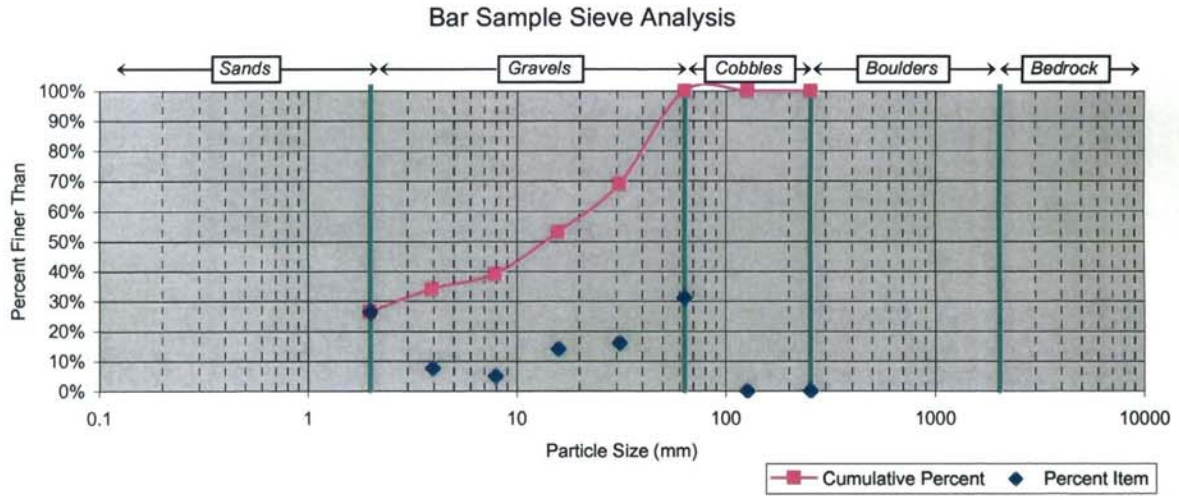
GRAND TOTAL SAMPLE WEIGHT

NOTES

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
2.0	47	26.3%	26.3%
4.0	13.5	7.6%	33.9%
8.0	9.0	5.0%	38.9%
16.0	25.0	14.0%	52.9%
31.5	28.5	16.0%	68.9%
64.0	55.5	31.1%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	178.5	100%	

Stream:	Bold Run Creek - Sub-Pavement #2
Watershed:	New Light Creek - Neuse River
Location:	Sub-Pavement #2
Note:	



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
4.7	4.7	13.8	44.4	57.1	0%	26%	74%	0%	---	---