FINAL
RESTORATION PLAN

HOLLY GROVE RESTORATION SITE
GUILFORD COUNTY, NORTH CAROLINA
CAPE FEAR RIVER BASIN CATALOGING UNIT 03030002
EEP Contract No.: D06028-B

Prepared for:

North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina

Prepared by:

Restoration Systems, LLC
1101 Haynes Street, Suite 107
Raleigh, North Carolina 27604

And

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road, Suite 203
Asheville, North Carolina
828-505-2186

June 6, 2007

EXECUTIVE SUMMARY

Restoration Systems, LLC is planning to restore and enhance degraded reaches of Buckhorn Creek and several unnamed tributaries at a site in northeast Guilford County. Other stream reaches and a riparian wetland will be preserved. The work is under contract to the North Carolina Ecosystem Enhancement Program (EEP). The Holly Grove Restoration Site (SITE) encompasses approximately 21,000 linear feet of degraded channels, 1.11 acres of existing wetlands, and 42 acres of impacted riparian buffers.

General Site Conditions

The Holly Grove Restoration Site (SITE) is situated within approximately 226 acres of predominately agricultural land located approximately five miles northwest of Greensboro, NC. The SITE is located within the Cape Fear River Basin in Cataloging Unit 03030002.

Historic land use at the SITE has consisted primarily of agriculture and livestock grazing. The streams within the SITE were historically accessible to livestock, resulting in local disturbances to stream banks and wetland soil surfaces. Additional land use practices, including the maintenance and removal of riparian vegetation, and relocating, dredging, and straightening of on-site streams have contributed to the degraded water quality and unstable channel characteristics.

Goals and Objectives

The primary objectives of the project focus on improving local water quality, contributing to improvement of the water quality in the watershed, and restoring aquatic and riparian habitat. Restoration and enhancement practices proposed for this project have been designed with the intent to minimize unnecessary disturbance to adjacent land and to protect mature riparian vegetation where it exists. Specifically, the project goals consist of the following:

- Restore natural stable channel morphology and proper sediment transport capacity.
- Reduce non-point sources of sedimentation and nutrient inputs.
- Restore approximately 14,084 linear feet of stream through Priority 1 and 2 restoration methodologies.
- Enhance approximately 5,588 linear feet of stream.
- Preserve approximately 1,734 linear feet of stream.
- Preserve approximately 1.11 acres of wetlands.
- Restore approximately 42 acres of riparian buffers.

Note: Once implemented, the activities described above will ultimately provide approximately 16,666 stream mitigation units (SMUs).

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

DESIGN SHEETS

1.0 SITE IDENTIFICATION AND LOCATION

1.1 Directions to SITE

The Holly Grove Restoration Site (SITE) is located in Guilford County northeast of Greensboro, NC, approximately twelve miles southeast of Reidsville (Figure 1). To reach the SITE from Raleigh, take I-40 west approximately 62 miles, take NC-61 north, turn right on Tickle Road and proceed west for approximately one mile to the bridge crossing of Buckhorn Creek. The Tickle Road bridge crossing of Buckhorn Creek is located at a latitude/longitude of 36° 11' 46" North and 79° 34' 25" West.

1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designation

The SITE is located in the Haw River watershed of the Cape Fear River Basin, United States Geological Survey (USGS) 14-digit Hydrologic Unit 03030002020070, within the North Carolina Division of Water Quality (DWQ) sub-basin 03-06-02. Buckhorn Creek drains into Reedy Fork Creek approximately ¾ miles downstream of the SITE, which in turn flows to the Haw River eight miles downstream. These portions of Reedy Fork Creek and the Haw River have been assigned the Stream Index Numbers 16-11-9 and 16-(1), respectively, by DWQ.

2.0 WATERSHED CHARACTERIZATION

The SITE is located in a rural watershed within the Piedmont hydrophysiographic region of North Carolina. The SITE watershed is characteristic of the Piedmont region with moderate rainfall and moderately steep valley walls. Annual precipitation within Guilford County averages 45 inches and elevations within the SITE range from 615 ft. to 720 ft. (NGVD). The SITE encompasses approximately 21,000 linear feet of streams including an approximately 9,000 linear feet reach of **Buckhorn Creek**, and six tributaries named for the purposes of this project as **West Branch**, **Middle Branch**, **East Branch**, **Little Branch**, **SW Creek**, and **SE Creek**. There is also one associated floodplain wetland within the project limits (Figure 4).

2.1 Drainage Areas

The drainage area of Buckhorn Creek is 2.72 mi^2 at the upstream end of the SITE and 4.27 mi^2 at the downstream end. At their respective confluences with Buckhorn Creek, the drainage areas of the tributaries are: West Branch, 0.20 mi^2; Middle Branch, 0.20 mi^2; East Branch, 0.20 mi^2; Little Branch, 0.02 mi^2; SW Creek, 0.19 mi^2; and SE Creek, 0.14 mi^2. See Table II for a complete listing of the drainage areas.

2.2 Surface Water Classification / Water Quality

Reedy Fork Creek in the vicinity of the SITE is assigned a best usage classification of C, NSW by the NCDWQ and as such there are no restrictions on watershed development or types of discharge. These waters are suitable for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture. Secondary recreation includes wading, boating, and other

uses not involving human body contact with water on an organized or frequent basis. The supplemental classification, NSW (Nutrient Sensitive Waters) includes areas with water quality problems associated with excessive plant growth resulting from nutrient enrichment.

The portion of Reedy Fork Creek to which Buckhorn Creek drains and the portion of the Haw River that is approximately two miles east of the SITE are listed on the DWQ final 2004 and draft 2006 303(d) lists. Streams which are included in the 303(d) list do not meet water quality standards or have impaired uses. Listing of these streams likely results from non-point agricultural and urban runoff and potentially from industrial point source discharges.

2.3 Physiography, Geology, and Soils

The SITE is located in the Southern Outer Piedmont ecoregion of North Carolina. This ecoregion consists of dissected, irregular plains with moderate to steep side slopes and low to moderate gradient streams with mostly gravel and cobble substrates. Underlying geology typically consists of gneiss, schist, and granite covered by deep saprolite and mostly red clayey subsoils.

The valleys throughout the SITE are moderately sloped colluvial valleys with cross-slopes ranging from 4% to 40% and longitudinal slopes typically ranging from 0.4% to 2.0%. See Table III for a listing of the valley slopes within the SITE.

The Guilford County Soil Survey (NRCS, 1977) indicates the SITE is underlain by six soil series; Appling, Cecil, Chewacla, Congaree, Coronaca, Wilkes, and Vance. (Figure 3). Table IV lists the drainage class and hydric classification for each of these soils.

2.4 Historic Land Use and Development Trends

The watershed upstream from the SITE is characterized mainly by agricultural and forested land (See Table V). Residential land use accounts for only a small percentage of the watershed. Some developmental pressure can be anticipated in the future from growth associated with accelerating development and expansion of the Greensboro metropolitan area; however, dramatic changes in the land use in the immediate future are not likely. Currently residential land use makes up approximately 3 percent of the watershed and impervious area covers approximately 1 percent of the total watershed. On-site land uses include pastureland, agriculture, and several small pine/hardwood forest stands. Grazing livestock have historically had access to the on-site stream reaches and the adjacent floodplains. The lack of exclusionary barriers appears to have contributed to the degradation of stream banks. Pastureland and row crop areas are subject to broadcast application of animal waste from on-site lagoons.

2.5 Plant Communities

The SITE is characterized by agricultural land, a mixed pine/hardwood forest stand, and poorly developed/disturbed riparian buffers. The SITE was historically grazed by livestock, and presently receives regular vegetative maintenance, and is plowed for row crops. In addition, soils within the agricultural land and along the stream banks are disturbed and exposed with little vegetation.

Agricultural land dominates the majority of the SITE adjacent to the stream reaches and is characterized by native grasses as well as invasive species including multiflora rose (*Rosa multiflora*), blackberry (*Rubus* spp.), and milkweed (*Asclepias* sp.) Isolated patches and individual hardwood species occur within the floodplain and adjacent to the stream channels. Tree and sapling layers include tulip tree (*Liriodendron tulipifera*), sweet-gum (*Liquidambar styraciflua*), American sycamore (*Platanus occidentalis*), black walnut (*Juglans nigra*), ironwood (*Carpinus caroliniana*), green ash (*Fraxinus pennsylvanica*), and various oak species (*Quercus* spp.) The shrub and vine layers are dominated by multiflora rose and also contain Chinese privet (*Ligustrum sinense*) and greenbrier (*Smilax rotundifolia*). Additionally, an area of mature, old-growth American holly (*Ilex opaca*) occurs within the southern portion of the SITE.

2.6 Federally Protected Species

The Endangered Species Act (ESA) of 1973, as amended, obligates federal actions to consult with the Fish and Wildlife Service (FWS) should proposed actions potentially conflict with listed species or their habitat. The only federally protected species listed for Guilford County is the Bald Eagle (*Haliaeetus leucocephalus*) which has a status of threatened. A review of the habitat requirements confirms that the project activities will not disturb nesting or foraging habitat for the Bald Eagle. The closest habitat suitable for the Bald Eagle occurs over five miles northwest of the SITE at Washburn Lake. Based on the absence of suitable habitat for the bald eagle, it is reasonable to conclude that the project will have **No Effect** on the listed species.

Additionally, the Carolina Darter (*Etheostoma collis lepidinion*) is considered rare and is listed as a Federal Species of Concern (FSC). The Carolina Darter inhabits warm pools and slow runs in streams, over sand and gravel. Their primary forage includes insects and other invertebrates and largely resides in the Yadkin, Pee Dee and Catawba drainages in North and South Carolina. Organisms assigned the FSC status are not protected by the ESA.

2.7 Cultural Resources

The North Carolina Department of Cultural Resources, State Historic Preservation Office (SHPO) conducted a review of the SITE and provided a concurrence letter dated September 25, 2006 which concluded that there are no known historic resources that will be affected by the proposed project pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations.

2.8 Potential Constraints

Potential constraints considered during design development include the potential for hydrologic trespass, the presence of existing utilities, the landowner's need for stream crossings, and existing bedrock outcrops.

The potential for hydrologic trespass exists only upstream of Buckhorn Creek. The proposed Priority II restoration provides for equal conveyance of bankfull discharge and greater conveyance of flood discharges as compared to the existing channel properties. As such, hydrologic trespass will not be a concern.

The primary existing utility of concern is the Williams natural gas pipeline. This pipeline crosses Buckhorn Creek in three locations and also crosses Little Branch and SE Creek. Where the pipeline crosses Buckhorn Creek it passes below the channel bed approximately five feet and the channel has been lined with riprap. The proposed design will maintain the existing horizontal and vertical alignment through these existing crossings, however adjustments to the banks and removal of the riprap are proposed. Coordination with the Williams Company has included discussion of proposed channel alterations with their engineering staff and will include transmittal of plans for their review, pre-construction sub-surface location of the pipeline, and on-site presence of Williams' staff during construction activities within their right-of-way.

The stream crossings required for access by the property owner do not propose a significant constraint. These crossings will be used primarily for agricultural equipment and will consist of stream fords constructed on hardened riffle sections.

The existing bedrock outcrops provide two potential constraints. First, where bedrock is present in the stream bed and banks it creates a fixed point that the horizontal and/or vertical alignment must pass through. To the extent feasible these features have been identified in the topographic survey and incorporated into the design alignment. Second, where the bedrock is present but not visible it may be encountered during construction. This is a likely occurrence along the entire reach of Buckhorn Creek and the proposed design attempts to mitigate this concern by limiting excessive channel realignment. Where bedrock is encountered during construction a determination will be made in the field by the engineer as to the effect on the channel alignment and what adjustments are appropriate.

3.0 SITE STREAMS

On-site streams have been characterized based on fluvial geomorphic principles (Rosgen 1996a). A topographic survey was conducted of the entire SITE to provide information for the development of construction plans and to provide sufficient detail to assess existing geomorphic conditions throughout the SITE.

3.1 Channel Morphology and Classification

Buckhorn Creek has been realigned and dredged throughout the project reach, resulting in a channel form that is incised with low sinuosity. The channel classifies as a Type F stream under the Rosgen classification system throughout most of the upper reach with some portions classifying as Type G. The lower reaches classify primarily as a Type G stream. The entrenchment ratios range from 1.1 to 1.4 and the bank-height ratios typically range from 1.7 to 2.3. The low entrenchment ratios and high bank-height ratios combine to increase the stress on the banks. Although the bed profile is vertically stable due to occasional bedrock outcrops, the resultant bed form consists of relatively short riffles with excessively long pool features which limit the habitat value. Bed material exhibits a strong bimodal distribution with larger cobble material associated with the bedrock outcrops and gravel size material composing the majority of the movable bed. Some reaches that consist of excessively long pools are dominated by silt and sand.

The tributary reaches generally fall into two categories: 1) reaches which are classified primarily as Type G streams and require restoration, and 2) reaches which are classified as Type B, C, and E and which require enhancement. The reaches that require restoration include the lower reaches of West Branch, Middle Branch, and East Branch; the entire reach of Little Branch; and the upper reach of SE Creek and SW Creek. These reaches have low width-depth ratios that range from 7 to 9 and entrenchment ratios that range from 1.2 to 1.4. The entrenchment and bank height ratios indicate that the channel flows rarely access the historic floodplain.

The reaches that require enhancement include the upper reaches of West Branch and East Branch and the lower reaches of SE Creek and SW Creek. The upper reach of West Branch has width-depth ratios that range from 14 to 18 with entrenchment ratios that range from 1.5 to 2.4. The upper reach of East Branch and portions of SW Creek have width-depth ratios from 8 to 11 with entrenchment ratios from 3 to 9. These reaches classify as Type E streams. Some portions of SW Creek classify as Type B Streams with entrenchment ratios of 1.4 to 1.9.

3.2 Discharge and Bankfull Verification

Bankfull identification on degraded reaches is subject to a significant amount of interpretation since the features can often be difficult to distinguish and even misleading. Verification of bankfull was accomplished by plotting the bankfull cross sectional area for each reach against the regional curve data. Also included in this plot are the bankfull cross sectional areas for the reference reaches. The graph indicates that the bankfull elevation identified in the surveyed reaches is consistent with the regional curve data.

After verification of bankfull cross sectional area, bankfull discharge was calculated for each surveyed reach using a single-section analysis. Manning's 'n' was estimated from relative roughness calculations of the bed material and from observation of the channel flow conditions. Water surface slope was assumed to be consistent with the slope of the bed profile. Discharges were then plotted against a graph of the regional curve data and bankfull discharges from the reference reaches. The graphing of these data indicated that the calculated bankfull discharges were consistent with the regional curve data.

3.3 Channel Stability Assessment

The current channel stability was analyzed by evaluating existing width-depth ratios, bank height ratios, and sediment transport.

Width-depth ratios within the SITE range from 13 to 19 on reaches classified as Type F streams and 7 to 9 on reaches classified as Type G streams. The width-depth ratios for the reference reaches were from 6 to 11 for the Type E stream and 12 to 14 for the Type B stream. The lower width-depth ratios found within the SITE on Type G reaches will result in a higher mean depth during bankfull events and subsequent increased shear stress on the bed. The higher width-depth ratios on the Type F reaches will result in higher stress on the banks, especially along the toe of the banks.

Bank height ratios within the SITE range from 1.3 to 2.4 with typical ratio at a value of 1.9. The bank height ratios for the reference reaches were typically at 1.2. The higher ratios found within the SITE result in significantly increased shear stress during greater-than-bankfull flow events.

3.4 Vegetation

Dominant riparian vegetation adjacent to SITE streams consists of Chinese privet (*Ligustrum sinense*), multiflora rose (*Rosa multiflora*), American sycamore (*Platanus occidentalis*), iron wood (*Carpinus caroliniana*), and tulip poplar (*Liriodendron tulipifera*).

4.0 REFERENCE STREAMS

Two reference reaches were identified and surveyed to assist in the design of the SITE streams. The first reference is located on a UT to Polecat Creek in Randolph County, northeast of Randleman. The second reference is located on Fork Creek in Randolph County, south of Asheboro.

4.1 Watershed Characterization

Both reference reaches are located in the Piedmont hydrophysiographic region of North Carolina. The watersheds are similar in many ways to the character of the SITE watershed including average rainfall, elevation ranges, and valley types. Both watersheds are predominately rural with land use consisting of agriculture, pasture, and forested stands. The drainage area for the UT to Polecat Creek is 0.4 square miles and for Fork Creek is 2.2 square miles.

4.2 Channel Morphology and Classification

The two reference reaches were selected to represent the probable configurations for the proposed stream restorations. Detailed geomorphic surveys and Level II Rosgen classification were conducted on each of the reference reaches (See Appendix E and Table VI).

The UT to Polecat Creek is representative of a meandering E channel in a moderately confined valley with a well developed floodplain, and Fork Creek is representative of a low sinuosity B stream in a moderately sloped colluvial valley. Bed material, channel slope, and valley form of both streams are consistent with the SITE and provide reasonable models for the potential channel forms that can be expected at the SITE.

4.3 Discharge and Bankfull Verification

Bankfull was readily identified on each of these streams as they exhibited consistent indicators throughout the reaches. Verification of bankfull was accomplished by plotting the bankfull cross sectional area for each reach against the regional curve data. The graph indicates that the bankfull identified in the surveyed reaches is consistent with the regional curve data.

After verification of bankfull cross sectional area, bankfull discharge was calculated for each surveyed reach using a single-section analysis. Manning's 'n' was estimated from relative roughness calculations of the bed material and from observation of the channel flow conditions. Water surface slope was assumed to be consistent with the slope of the bed profile. Discharges were then plotted against a graph of the regional curve data. The graphing of these data indicated that the calculated bankfull discharges were consistent with the regional curve data.

4.4 Channel Stability Assessment

A detailed channel stability assessment was not performed for these reaches since the bank and bed stability was obvious from observation. Subsequent review of the surveyed dimensions confirmed that width-depth ratios and bank height ratios were within the appropriate range for stable, self maintaining streams. Additional observations included significant upstream and downstream reconnaissance to identify any past, present, or future signs or sources of degradation. The existence of grade controlling bedrock was identified beyond the resurveyed reaches.

4.5 Vegetation

A mature Mesic Mixed Hardwood Forest (Piedmont Subtype) community was present at both reference stream sites (Schafale and Weakley 1990). Canopy species observed include American beech (*Fagus grandifolia*), red maple (*Acer rubrum*), southern red oak (*Quercus falcata* var. *falcata*), sweet gum (*Liquidambar styraciflua*), and tulip poplar (*Liriodendron tulipifera*). The observed shrub/sapling species include American beech, American holly (*Ilex opaca*), black cherry (*Prunus serotina*), Chinese privet (*Ligustrum sinense*), ironwood (*Carpinus caroliniana*), mountain laurel (*Kalmia latifolia*), red maple, and tag alder (*Alnus serrulata*). Observed herbaceous and woody vine species include Christmas fern (*Polystichum acrostichoides*), common greenbrier (*Smilax rotundifolia*), running cedar (*Lycopodium clavatum*), and sphagnum moss (*Sphagnum* spp.). Although some woody riparian species were observed, their presence was not sufficiently dominant to separate out a riparian community type form the Mesic Mixed Hardwood Forest (Piedmont Subtype).

5.0 SITE WETLANDS

5.1 Jurisdictional Wetlands

One jurisdictional wetland was delineated within the SITE on September 27, 2006 (Appendix H). The wetland is located in a relatively flat area of a remnant pond bottom at the downstream end of Middle Branch. This pond was apparently breached in the past and no longer has a maintained pool. The wetland area is bounded by the remnant earthen berm and relatively steep valley slopes. The wetland can be characterized as a PSS01C Wetland, although subsets of the complex exhibit characteristics of PFO1C and even PEM1E (Cowardin 1979) and has a saturated hydrology driven primarily by inflow of a perennial stream and topographic entrainment of the surface hydrology. A surveyed plat of the wetland boundary and the data sheets are included in Appendix H.

5.2 Plant Community Characterization

Plant community associated with the palustrine wetland that exists along Middle Branch is a mixed deciduous forest (PFO1C)/scrub-shrub (PSS1C)/emergent (PEM1E) community. Ecotones between the emergent and forested/scrub-shrub components of the community are fairly sharp and distinct. Less distinction exists between the forested and scrub-shrub elements. The dominant canopy species in the PFO component is overwhelmingly American ash (*Ulmus Americana*) and black willow (*Salix nigra*), but sweet gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), sycamore (*Platanus occidentalis*) and box elder (*Acer negundo*) are also represented in much smaller numbers. Cattail (Typha latifolia) and beard-grass (Scirpus sp.) dominate the emergent components of the wetland. Needle rush (*Juncus effusus*) is very apparent in the herbaceous/shrub layer, as is false nettle (Boehmeria cylindrical). Common vines found in this community include honeysuckle (*Lonicera japonica*), trumpet creeper (*Campsis radicans*) and poison ivy (*Toxicodendron toxicodendron*). Blackberry (*Rubus* spp.), red cedar (*Juniperus virginiana*), smartweed (*Polygonum* sp.) and goldenrod (*Solidago* spp.) occur in various concentrations throughout the riparian landscape adjacent to and within the wetland. Goldenrod and blackberry is profusely distributed along slopes above the wetland, although blackberry is occasionally seen within the wetland. Red cedar tends to occupy these same slopes above the saturated soil line. Canopy species reach to heights of 12-16 feet with a few specimens a little taller.

6.0 SITE RESTORATION PLAN

6.1 Restoration Goals and Objectives

The primary objectives of the project focus on improving local water quality, contributing to improvement of the water quality of the overall watershed, and restoring aquatic and riparian habitat. Specifically these goals consist of the following:

- Restore natural stable channel morphology and proper sediment transport capacity.
- Reduce non-point source sedimentation and nutrient inputs.
- Restore approximately 14,084 linear feet of stream through Priority 1 and 2 restoration.
- Enhance approximately 5,588 linear feet of stream.
- Preserve approximately 1,734 linear feet of stream.
- Preserve approximately 1.11 acres of wetlands.
- Restore approximately 42 acres of riparian buffers.

Once implemented, the activities described above will ultimately provide approximately 16,666 stream mitigation units (SMUs).

6.1.1 Proposed Channel Design and Classification

Restoration and enhancement practices proposed for this project have been designed with the intent to minimize unnecessary disturbance to adjacent land and to protect mature riparian vegetation where it exists. Consideration was given to the potential functional lift provided by restoration activities in comparison to the functional lift that could be realized through the natural process of channel evolution. Included in this consideration was an attempt to determine the disturbance and sedimentation that could occur as a result of this natural process. In the absence

of established methodology, best professional judgment has been used to determine which channel reaches could potentially benefit most from preservation or enhancement over full restoration. Where restoration was determined to be warranted, consideration was given to which reaches could best be served by maintaining as much of the existing channel pattern as possible.

The proposed channels of Buckhorn Creek and its tributaries are designed as Type B4c streams with the exception of the lower reach of Middle Branch. This channel configuration provides the most stable and natural form in the moderately sloping colluvial valleys that are found throughout the SITE. Not only does it effectively convey bankfull discharge and sediment load but also conforms to the natural conveyance of flood flows. Additionally, since broad alluvial valleys are generally not found within the SITE, the lower sinuosity of the Type B4c streams will result in minimizing grading and earthwork activities. The proposed channel dimensions, patterns, and profiles are based on hydraulic relationships and morphologic dimensionless ratios of the reference reaches (See Table VI). The proposed typical sections and channel alignments are shown in the Design Sheets.

6.1.2 Proposed Buckhorn Creek

The existing entrenched and channelized condition of Buckhorn Creek along with the many locations of unstable and vertical banks provided justification for consideration of full reconstruction and restoration of the stream. The original design concept also included realignment of portions of the stream offset from the existing channel alignment and raising the channel grade through Priority I restoration to reconnect the channel to the floodplain. Subsequent field investigations resulted in modifications to the original restoration concept. Significant occurrence of bedrock outcrops in the channel bed confirms that although the stream is entrenched, it has become vertically stable by these frequent grade controls. The bedrock outcrops now represent fixed nick points in the profile which are identified in the field as excessively short riffles followed by considerably long flat pools. Additionally, the existence of outcrops in the bed suggests that bedrock may also be present at shallow depths below the surface in many locations throughout the valley which could complicate channel realignment efforts.

The revised design concept consists of Priority II restoration, which will incorporate the existing bedrock features into the final channel profile. Adjustment to the existing channel pattern and dimensions are necessary to address problems associated with bank stability and sediment transport. However, in order to minimize disturbance, the proposed alignment will conform to the current valley position and where possible existing channel pattern features will be incorporated into the alignment. The proposed B4c stream type will have a narrow sloping bench which will provide relief above the bankfull stage while minimizing the extent of excavation required on the adjacent land. Where mature trees exist they will be protected and remain in place where possible. Mature trees that cannot be preserved will be incorporated into the proposed channel as log vanes and woody debris. The bed profile will be reconstructed to conform to the proposed pattern and to provide for riffles and pools of appropriate length.

6.1.3 Proposed West Branch

The entire length of West Branch was considered for full restoration due to its entrenched condition, the presence of vertical banks, and the erratic channel pattern. However, much of West Branch has a relatively high width-depth ratio indicating that the channel has progressed considerably through the channel evolutionary process. It does not appear that the channel will continue to widen significantly and as a result bank stress will not continue to increase. Additionally, there is a substantial riparian buffer containing many mature trees. It was determined that Priority I restoration would involve an unacceptable level of disturbance for a questionable level of functional lift throughout the majority of West Branch. The lower reach of West Branch, however, has a much lower width-depth ratio and only a sparse vegetative buffer. In addition to significant entrenchment, the profile along this lower reach steepens as it approaches Buckhorn Creek, which could eventually result in the formation of a headcut and subsequent channel rejuvenation.

The design concept for West Branch consists of providing enhancement along the majority of the stream with full restoration planned only for the downstream portion. The enhancement will include targeted bank stabilization through minimal regrading and log-vane installation. Construction access to the channel will be limited to a few routes across the existing riparian buffer which will be selected to minimize disturbance to mature vegetation. Enhancement will also include removal of invasive species, supplemental planting of the riparian buffer with native vegetation, and exclusion of livestock. The lower reach of West Branch will involve Priority II restoration and will include adjustment to the dimension and pattern of the channel along with installation of rock and log structures. The overall profile grade will be held, however, the riffle-pool sequence will be reconstructed to conform to the pattern.

6.1.4 Proposed Middle Branch

Priority I restoration is proposed for the majority of Middle Branch. Consideration was given to pursuing a passive approach and allowing the channel to evolve towards its preferred natural state, however, on-site conditions dissuaded this approach. Observations of the existing channel provide analogs of the natural evolutionary process that suggest the stream will evolve from a low width-depth, entrenched channel to a moderate width-depth, low sinuosity channel as the vegetative canopy matures. This process will likely involve the removal and displacement of significant sediment into Buckhorn. This observation along with a relatively sparse riparian buffer and few mature trees provided validation for a full restoration approach.

The lower reach of Middle Branch passes through a wetland area that has formed in the bottom of a former pond bottom. The proposed design will leave the wetland intact by terminating stream restoration work at the upstream boundary of the wetlands and lowering the existing pond dam to an elevation slightly above the existing wetland. A new channel will be constructed at the outfall of the wetlands with the channel invert set at the existing wetland elevation.

6.1.5 Proposed East Branch and SE Creek

Similar consideration and rational, as discussed for Middle Branch, was used in evaluation of East Branch. As such, only the reach downstream of Tickle Road which exhibits a low width-

depth ratio, entrenched, channel with sparse and early successional vegetation is proposed for full channel reconstruction and restoration. Upstream of Tickle Road where a more mature canopy has allowed for the development of a channel with moderate width-depth ratio, enhancement is proposed to address locations of bank instability and deficiencies in the riparian buffer.

Likewise, restoration is proposed for the upper reach of SE Creek where there is no substantial riparian vegetation. Preservation is planned for all reaches of SE Creek and UT to SE Creek that are contained within the mature forested areas.

6.1.6 Proposed SW Creek

The upper reach of SW Creek is significantly degraded, exhibiting vertical unstable banks, toe-of-bank scour, headcuts, and a high sediment load. The channel appears to be in the early stages of rejuvenation, with much of the remnant Type B4 channel pattern intact and the profile incising to form a Type G channel. It is likely that significant sediment removal will occur through the normal process of channel evolution. The riparian buffer, however, is well established and presents a deterrence to restoration since reconstruction of the channel would involve significant disturbance. Along the remainder of SW Creek the riparian buffer is well established with a mature canopy. The channel is generally stable despite being incised, with the exception that there are several locations of unstable banks and channel migrations that are contributing to sedimentation.

The proposed design consists of utilizing the remnant channel pattern by raising the channel bed in place. Restoration efforts will involve installing constructed riffles and rock cross vanes to lift the channel profile, adjusting selected potions of the pattern, and reshaping the cross sectional geometry where necessary. This approach is favored along the upper reach of SW Creek since it will involve significantly less disturbance to the existing riparian vegetation. The remainder of SW Creek is proposed for enhancement that will involve addressing bank instability in specific locations. Access to these areas through the riparian buffer has been evaluated and determined to be feasible with limited disturbance.

6.1.7 Proposed Little Branch

Similar consideration and rational, as discussed for Middle Branch, was used in evaluation of Little Branch. As such, the entire reach, which exhibits a low width-depth ratio, entrenched, channel with sparse and early successional vegetation is proposed for full channel reconstruction and restoration.

6.2 Sediment Transport Analysis

The design sections were evaluated for their competency to transport the sediment supplied by the watershed. Critical shear stress was calculated for each design section and related to particle sizes expected to be mobilized. These predicted particle sizes were compared to the caliber of the bed material found in the existing channels. Generally, bed material throughout the SITE is composed of particles with a D_{50} of 20 mm and a D_{84} of 30 mm to 50 mm. The proposed

channels were designed to mobilize particles in the 20 mm to 30 mm range and the target critical shear stress was 0.45 lb/ft^2 with a range of 0.4 to 0.6 lb/ft^2 (See Table VIII).

6.3 Hydraulic Analysis

The proposed channel sections were evaluated for their ability to convey the bankfull flows and the flood flows of the watershed by performing a hydraulic analysis. Additionally, Buckhorn Creek is currently a FEMA floodplain designation of Zone A with a proposed designation of Zone AE when the Flood Insurance Rate Maps (DFIRM) become effective in June of 2007. As such the hydraulic analysis has been conducted to verify that there will be no impact on the Base Flood Elevations (BFE) which is the 1% annual chance flood event.

The analysis consisted of first modeling the existing conditions with the HEC-RAS water surface profile model. During the development of this restoration plan the NCDOT Bridge Maintenance Division removed the bridge at the Tickle Road crossing and began construction of a new bridge. It is anticipated that construction on this structure will not be completed until April of 2007. For the purpose of the hydraulic analysis and in order to accurately assess the effect of proposed channel modifications, the plan dimensions for the bridge under construction were utilized in the development of the existing model. Cross sections were taken through the channel and the adjacent valley at locations that approximated the FEMA approximate study.

Secondly, proposed conditions were analyzed by revising the existing sections based on the proposed channel geometry and revising the model to reflect proposed pattern conditions and anticipated future roughness coefficients. Comparison of the existing and proposed HEC-RAS models demonstrated that the BFE's are slightly lower in the proposed model and that there will be no hydraulic trespass onto adjacent properties.

6.4 Natural Plant Community Restoration

Buffer restoration activities will provide surface water storage, nutrient cycling, removal of imported elements and compounds, and will create a variety and abundance of wildlife habitat.

Riparian vegetation will be restored within approximately 42 acres of the SITE. Planting vegetation on the stream banks is proposed to re-establish vegetation community patterns within the stream corridor, associated side slopes, and transition areas. Replanting the floodplain and stream banks is expected to provide stream bank stability, shade and cool surface waters, filter pollutants from adjacent runoff, and provide habitat for area wildlife. The vegetated stream buffer will extend 50 feet on both sides of the stream.

Throughout the majority of the SITE the target community will be a Mesic Mixed Hardwood Forest (Piedmont Subtype). Bare root seedling will be planted within specified areas at a density of 436 stems per acre. To provide structural diversity, native shrubs will also be incorporated in the buffers at a density of 681 stems per acre. Shrubs will be installed in small groups of 2 to 3 individuals with random placement of groups to establish a more natural appearance. On the stream banks, live stakes and/or bare root stock will be used along with native herbaceous seed mix. Live stakes and/or seedlings will be placed at a density of 2 to 4 stakes per square yard. See Table IX for the list of plant species according to planting zones.

6.4.1 On-Site Invasive Species Management

Prior to re-vegetation of the SITE, non-native invasive species will be removed from the SITE within the conservation easement boundary. Invasive species management will continue through the 5-year monitoring period. Management procedures will conform to the recommendation in the Southeast Exotic Pest Plant Council Invasive Plant Manual. Non-native invasive species currently present on the SITE include multifloral rose, blackberry, privet, and honeysuckle.

7.0 MONITORING AND EVALUATION

The stream restoration monitoring will be in accordance with the EEP SITE Specific Mitigation Plan and the U. S. Army Corps of Engineers (USACE) Stream Mitigation Guidelines. Monitoring will consist of collection and analysis of stream stability and vegetation survival data on an annual basis for at least five years. Monitoring will include measurement of channel dimension and bed material, evaluation of photographs, vegetation sampling, and monitoring of bankfull occurrences.

7.1 Streams

Data collected for monitoring will be evaluated to determine whether significant deviation from the as-built condition has occurred and if the channel adjustments are trending toward greater stability. Data collection will consist of detailed dimension and pattern measurements, longitudinal profile, and bed material samples. Data evaluation will include calculation and comparison of dimensionless ratios. Bed material should indicate a reduction in the percentage of fine sediments and a particle distribution in the target range of D_{50} of 15 mm to 25 mm. Permanent photo station will be established to provide a visual record of channel development.

7.2 Vegetation

Quantitative sampling plots for vegetation will be established in the riparian buffer restoration areas. Vegetation plots will be inventoried following the first growing season after installation. Permanent photo stations will be established for each sampling plot to provide a visual record of vegetation development.

7.3 Schedule / Reporting

As-built plans will be submitted within 90 days following the completion of construction. Monitoring will occur annually following the growing season for at least five consecutive years. The monitoring period will also include the occurrence of at least two bankfull events. A monitoring report will be prepared annually and will include tabulation of the collected data, comparisons to previously collected data, and an evaluation of the stability and success of the project. Each report will be submitted no later than December 31st of each monitoring year.

8.0 REFERENCES

Cowardin LM, Carter V, Golet FC, and LaRoe ET. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service. U.S. Government Printing Office, Washington D.C.

Division of Water Quality. 2005. Identification Methods for the Origins of Intermittent and Perennial Streams, Version 3.1. North Carolina Department of Environment and Natural Resources.

Division of Water Quality, Planning Section, Classification and Standards Unit. July 2006. NC Stream Classification Schedules. http://h2o.enr.state.nc.us/bims/reports/reportsWB.html North Carolina Department of Environment and Natural Resources.

Harmon, W.H. et al. 1999. Bankfull Hydraulic Geometry Relationships for North Carolina Streams. AWRA Wildland Hydrology Symposium Proceedings. Edited by: D.S. Olsen and J.P. Potyondy. AWRA Summer Symposium. Boxeman, MT.

North Carolina Natural Heritage Program. May 2006. Guide to Federally Listed Endangered and Threatened Species of North Carolina. http://207.4.179.38/nhp/ North Carolina Department of Environment and Natural Resources.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology.

Schafale MP and Weakley AS. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Department of Environmental Management, Division of Parks and Recreation, Natural Heritage Program.

Southeast Regional Climate Center (SERCC). 2006. Historical Climate Summaries for North Carolina. http://www.sercc.com/climateinfo/historical/historical_nc.html

U.S. Department of Agriculture, Natural Resources Conservation Service in Cooperation with the North Carolina Agricultural Experiment Station. Soil Survey of Guilford County, North Carolina. http://websoilsurvey.nrcs.usda.gov/app/

TABLES

Table I. Restoration Structures and Objectives						
Restoration Reach / Area	Station Range/ Location	Mitigation Type	Priority Approach	Existing LF or AC	Designed LF or AC	Note
Buckhorn Cr.	100+00 – 191+50	Restoration	P2	9091	9150	
West Branch	300+00 – 308+00	Enhancement	E2	870	894	
West Branch	308+00 – 312+30	Restoration	P2	390	390	
Middle Branch	400+00 – 401+00	Enhancement	E2	110	110	
Middle Branch	401+00 – 418+50	Restoration	P1	1730	1740	
Middle Branch	418+50 – 423+00	Enhancement	E2	475	475	
Middle Branch	423+00 – 425+40	Restoration	P1	90	250	Day-lighting
East Branch	500+00 – 518+80	Enhancement	E2	1880	1880	
East Branch	519+50 – 527+00	Restoration	P1	744	780	
Little Branch	200+00 – 206+00	Restoration	P1	564	600	
SW Creek	600+00 – 607+34	Restoration	P1	732	734	
SW Creek	608+26 – 630+55	Enhancement	E2	2229	2229	
UT to SW Cr.	650+00 – 653+50	Preservation		325	325	
SE Creek	702+00 – 706+25	Restoration	P1	425	440	
SE Creek	706+25 – 715+06	Preservation		881	881	
UT to SE Cr.	750+00 – 755+28	Preservation		528	528	
Wetland A	Back Cr. Sta 10+00	Enhancement	*NA*	1.11	1.11	

Table II. Drainage Areas	
Reach	**Drainage Area (mi^2)**
Buckhorn Creek – Reach 1 (U/s End to D/s of UT2)	2.78
Buckhorn Creek – Reach 2 (D/s of UT2 to West Branch)	3.04
Buckhorn Creek – Reach 3 (D/s of West Branch to Midddle Brnach)	3.24
Buckhorn Creek – Reach 4 (D/s of Middle Branch to East Branch)	3.51
Buckhorn Creek – Reach 5 (D/s of East Branch to SW Creek)	3.76
Buckhorn Creek – Reach 6 (D/s of SW Creek to D/s End)	4.02
West Branch – D/s End	0.20
Middle Branch – U/s End	0.09
Middle Branch – D/s End	0.20
East Branch – D/s End	0.20
Little Branch – D/s End	0.02
SW Creek – U/s End	0.09
SW Creek – D/s End	0.19
SE Creek – U/s End	0.14
SE Creek – D/s End	0.18

Table III. Valley Slopes		
Stream Reach	**Valley Longitudinal Slope (%)**	**Valley Cross Slope (%)**
Buckhorn Creek – Reach 1	0.4 – 0.5	10 – 20
Buckhorn Creek – Reach 2	0.4	8 – 20
Buckhorn Creek – Reach 3	0.45	4 – 15
Buckhorn Creek – Reach 4	0.5 – 0.6	7 – 15
Buckhorn Creek – Reach 5	0.6 – 0.7	4 – 18
Buckhorn Creek – Reach 6	0.4	5 – 40
West Branch	1.4	7 – 15
Middle Branch	1.4 – 2.1	4 – 20
East Branch	1.5	5 – 12
Little Branch	3 – 4	5 – 30
SW Creek	2 – 3	6 – 20
SE Creek	0.8	5 - 17

Table IV. Mapped Soils				
Soil Name	**Map Symbol**	**Percent Slope**	**Drainage Class**	**Hydric Class**
Appling	Ap	2 to 10	Well drained	Non-Hydric
Cecil	Cc	2 to 15	Well drained	Non-Hydric
Chewacla	Ch	0 to 2	Somewhat Poorly drained	Hydric Inclusions
Congaree	Co	0 to 2	Well drained	Non-Hydric
Coronaca	Cr	2 to 10	Well drained	Non-Hydric
Vance	Va	2 to 10	Well drained	Non-Hydric
Wilkes	Wk	15 to 45	Well drained	Non-Hydric

Table V. Land Use of Watershed		
Land Use	**Acres**	**Percent of Total Area**
Agricultural	1500	55
Forested	1040	38
Residential	80	3
Roadway	110	4
Total	**2730**	**100**

Table VIa. Morphologic Table					
	Existing Conditions	Reference Reach	Design		
Stream Reach	Buckhorn Creek Upper	Fork Creek	Buckhorn Reach 1	Buckhorn Reach 2	Buckhorn Reach 3
Stream Type	F4	B4c	B4c	B4c	B4c
Drainage Area (mi^2)	2.78	2.2	2.78	3.04	3.24
Bankfull Width (ft)	26	20.1	22	23	23
Mean Depth (ft)	1.6	1.73	1.69	1.76	1.78
Bankfull XS_{AREA} (ft^2)	42	34.8	37	40	41
Bankfull Discharge (cfs)	186	163	186	198	207
Bkf Mean Velocity (ft/s)	3.3	4.7	4.5	4.5	4.5
Width/Depth Ratio	16	12	13	13	13
Max. Riffle Depth (ft)	2.3	2.0	2.3	2.4	2.4
Riffle Depth Ratio	1.4	1.2	1.36	1.36	1.35
Max. Pool Depth (ft)	2.8	2.6	3.4	3.5	3.6
Pool Depth Ratio	1.7	1.5	2.0	2.0	2.0
Flood Prone Width (ft)	32	63	30 – 66	32 – 69	32 – 69
Entrenchment Ratio	1.2	2.7 – 3.1	1.4 – 3.0	1.4 – 3.0	1.4 – 3.0
Bank Height Ratio	2.3	1.2	1.0	1.0	1.0
Meander Length (ft)	110 – 210	37 – 172	44 – 198	46 – 207	46 – 207
Meander Length Ratio	4 – 8	1.8 – 8.6	2 – 9	2 – 9	2 – 9
Radius of Curvature (ft)	50 – 120	47 – 318	44 – 66	46 – 69	46 – 69
Rc Ratio	1.9 – 4.6	2.3 – 16	2 – 3	2 – 3	2 – 3
Belt Width (ft)	45 – 120	33 – 40	33 – 66	34 – 69	34 – 69
Meander Width Ratio	1.7 – 4.6	1.6 – 2.0	1.5 – 3.0	1.5 – 3.0	1.5 – 3.0
Sinuosity	1.17	1.05	1.2	1.2	1.2
Channel Slope (ft/ft)	0.0041	0.0079	0.005	0.004	0.004
Valley Slope (ft/ft)	0.005	-	0.006	0.005	0.005
Riffle Slope (ft/ft)	0.006	0.013	0.005	0.004	0.004
Riffle Slope Ratio	1.5	1.6	1.0	1.0	1.0
Pool Slope (ft/ft)	0.0	0.001	0.0	0.0	0.0
Pool Slope Ratio	0.0	0.1	0.0	0.0	0.0
Pool Width (ft)	24	19.9	22	23	23
Pool Width Ratio	0.9	1.0	1.0	1.0	1.0
Pool Spacing (ft)	60 – 160	71 – 134	88 – 132	92 – 138	92 – 138
Pool Spacing Ratio	2.3 – 6.2	3.5 – 6.7	4 – 6	4 – 6	4 – 6
D_{50} (mm)	14	28	20	20	20
D_{84} (mm)	29	81	40	40	40

Table VIb. Morphologic Table					
	Existing Conditions	Reference Reach	Design		
Stream Reach	Buckhorn Creek Lower	Fork Creek	Buckhorn Reach 4	Buckhorn Reach 5	Buckhorn Reach 6
Stream Type	G4	B4c	B4c	B4c	B4c
Drainage Area (mi^2)	3.76	2.2	3.51	3.76	4.02
Bankfull Width (ft)	24	20.1	24	24.5	25
Mean Depth (ft)	2.3	1.73	1.83	1.90	1.91
Bankfull XS_{AREA} (ft^2)	55	34.8	44	47	48
Bankfull Discharge (cfs)	230	163	220	230	240
Bkf Mean Velocity (ft/s)	4.0	4.7	4.5	4.5	4.5
Width/Depth Ratio	10	12	13	13	13
Max. Riffle Depth (ft)	3.0	2.0	2.5	2.6	2.6
Riffle Depth Ratio	1.3	1.2	1.36	1.36	1.35
Max. Pool Depth (ft)	3.9	2.6	3.7	3.8	3.8
Pool Depth Ratio	1.7	1.5	2.0	2.0	2.0
Flood Prone Width (ft)	32	63	33 – 72	34 – 74	35 – 75
Entrenchment Ratio	1.3	2.7 – 3.1	1.4 – 3.0	1.4 – 3.0	1.4 – 3.0
Bank Height Ratio	2.0	1.2	1.0	1.0	1.0
Meander Length (ft)	250 – 340	37 – 172	48 – 216	49 – 220	50 – 225
Meander Length Ratio	10 – 14	1.8 – 8.6	2 – 9	2 – 9	2 – 9
Radius of Curvature (ft)	140 – 240	47 – 318	48 – 72	49 – 74	50 – 75
Rc Ratio	6 – 10	2.3 – 16	2 – 3	2 – 3	2 – 3
Belt Width (ft)	40 – 80	33 – 40	36 – 72	37 – 74	37 – 75
Meander Width Ratio	1.7 – 3.3	1.6 – 2.0	1.5 – 3.0	1.5 – 3.0	1.5 – 3.0
Sinuosity	1.04	1.05	1.2	1.2	1.2
Channel Slope (ft/ft)	0.0054	0.0079	0.005	0.006	0.004
Valley Slope (ft/ft)	0.006	-	0.006	0.007	0.005
Riffle Slope (ft/ft)	0.008	0.013	0.005	0.006	0.004
Riffle Slope Ratio	1.5	0.1	1.0	1.0	1.0
Pool Slope (ft/ft)	0.0	0.001	0.0	0.0	0.0
Pool Slope Ratio	0.0	0.1	0.0	0.0	0.0
Pool Width (ft)	25	19.9	24	24.5	25
Pool Width Ratio	1.04	1.0	1.0	1.0	1.0
Pool Spacing (ft)	60 – 140	71 – 134	96 – 144	98 – 147	100 – 150
Pool Spacing Ratio	2.5 – 6	3.5 – 6.7	4 – 6	4 – 6	4 – 6
D_{50} (mm)	14	28	20	20	20
D_{84} (mm)	29	81	40	40	40

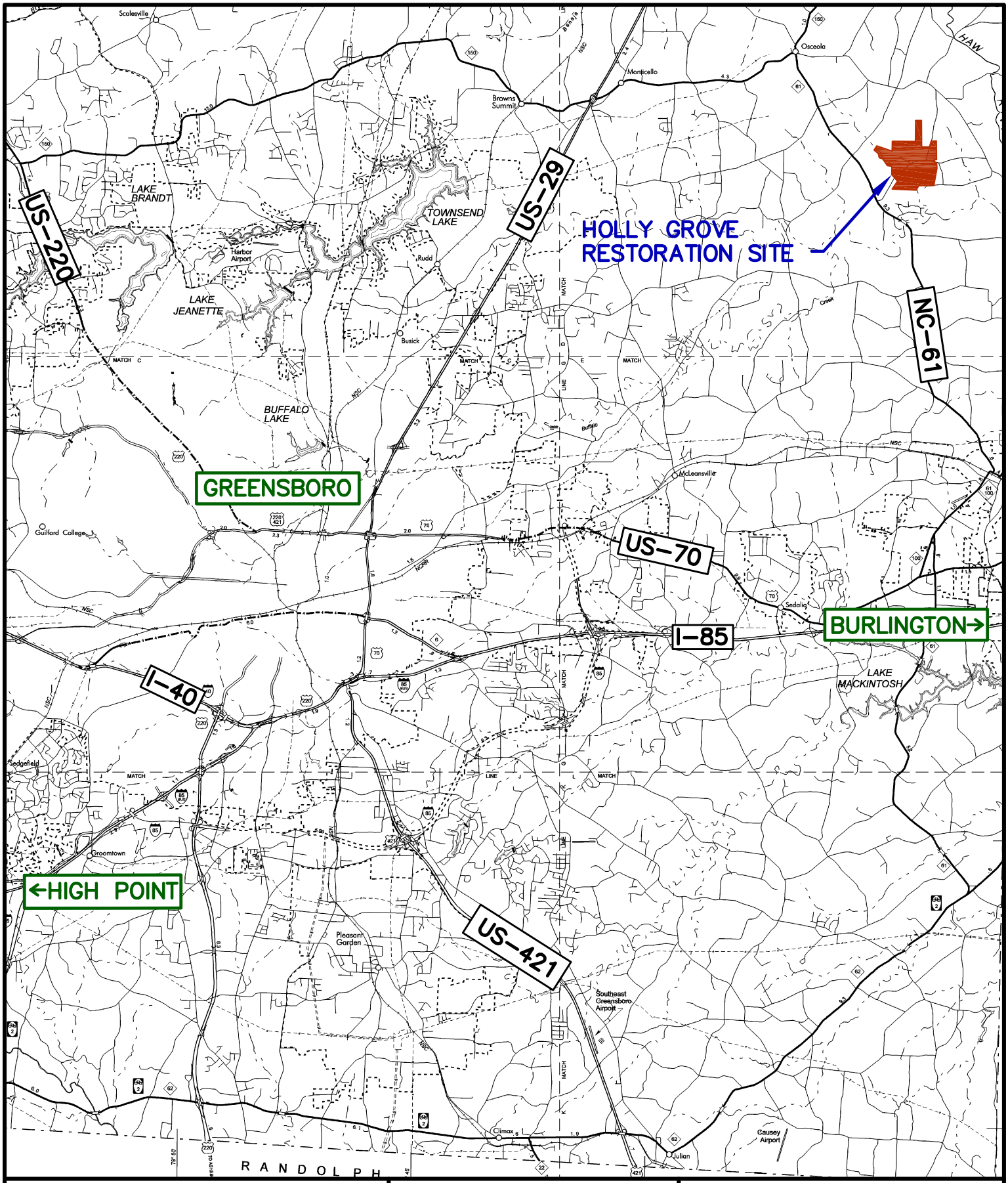
Table VIc. Morphologic Table					
	Existing Conditions	Reference Reach	Design		
Stream Reach	Middle Branch	Fork Creek	West Branch	Middle Br.	East Branch
Stream Type	G4	B4c	B4c	B4c	B4c
Drainage Area (mi^2)	0.2	2.2	0.2	0.2	0.2
Bankfull Width (ft)	6.3	20.1	9	9	9
Mean Depth (ft)	0.9	1.73	0.7	0.7	0.7
Bankfull XS_{AREA} (ft^2)	5.5	34.8	6.3	6.3	6.3
Bankfull Discharge (cfs)	28	163	28	28	28
Bkf Mean Velocity (ft/s)	3.9	4.7	4.5	4.5	4.5
Width/Depth Ratio	7	12	13	13	13
Max. Riffle Depth (ft)	1.2	2.0	0.95	0.95	0.95
Riffle Depth Ratio	1.3	1.2	1.3	1.3	1.3
Max. Pool Depth (ft)	1.4	2.6	1.4	1.4	1.4
Pool Depth Ratio	1.5	1.5	2.0	2.0	2.0
Flood Prone Width (ft)	7.5	63	12 – 27	12 – 27	12 – 27
Entrenchment Ratio	1.2	2.7 – 3.1	1.4 – 3.0	1.4 – 3.0	1.4 – 3.0
Bank Height Ratio	1.7	1.2	1.0	1.0	1.0
Meander Length (ft)	55 – 100	37 – 172	18 – 81	18 – 81	18 – 81
Meander Length Ratio	9 – 16	1.8 – 8.6	2 – 9	2 – 9	2 – 9
Radius of Curvature (ft)	45 – 150	47 – 318	18 – 27	18 – 27	18 – 27
Rc Ratio	7 – 23	2.3 – 16	2 – 3	2 – 3	2 – 3
Belt Width (ft)	40 – 60	33 – 40	13 – 27	13 – 27	13 – 27
Meander Width Ratio	6 – 10	1.6 – 2.0	1.5 – 3.0	1.5 – 3.0	1.5 – 3.0
Sinuosity	1.06	1.05	1.2	1.2	1.2
Channel Slope (ft/ft)	0.014	0.0079	0.013	0.013	0.014
Valley Slope (ft/ft)	0.015	-	0.015	0.015	0.017
Riffle Slope (ft/ft)	0.02	0.013	0.013	0.013	0.013
Riffle Slope Ratio	1.4	0.1	1.0	1.0	1.0
Pool Slope (ft/ft)	0.0	0.001	0.0	0.0	0.0
Pool Slope Ratio	0.0	0.1	0.0	0.0	0.0
Pool Width (ft)	8	19.9	9	9	9
Pool Width Ratio	1.3	1.0	1.0	1.0	1.0
Pool Spacing (ft)	30 – 100	71 – 134	36 – 54	36 – 54	36 – 54
Pool Spacing Ratio	4.7 – 16	3.5 – 6.7	4 – 6	4 – 6	4 – 6
D_{50} (mm)	-	28	20	20	20
D_{84} (mm)	-	81	40	40	40

Table VId. Morphologic Table					
	Existing Conditions	Reference Reach	Design		
Stream Reach	Middle Branch	Fork Creek	Little Branch	SW Creek	SE Creek
Stream Type	G4	B4c	B4c	B4c	B4c
Drainage Area (mi^2)	0.2	2.2	0.02	0.09	0.14
Bankfull Width (ft)	6.3	20.1	4	7.5	8
Mean Depth (ft)	0.9	1.73	0.3	0.6	0.6
Bankfull XS_{AREA} (ft^2)	5.5	34.8	1.2	4.2	4.9
Bankfull Discharge (cfs)	28	163	5	15	21
Bkf Mean Velocity (ft/s)	3.9	4.7	4.5	4.5	4.5
Width/Depth Ratio	7	12	13	13	13
Max. Riffle Depth (ft)	1.2	2.0	0.4	0.75	0.85
Riffle Depth Ratio	1.3	1.2	1.3	1.3	1.3
Max. Pool Depth (ft)	1.4	2.6	0.6	1.1	1.3
Pool Depth Ratio	1.5	1.5	2.0	2.0	2.0
Flood Prone Width (ft)	7.5	63	6 – 12	10– 23	11 – 24
Entrenchment Ratio	1.2	2.7 – 3.1	1.4 – 3.0	1.4 – 3.0	1.4 – 3.0
Bank Height Ratio	1.7	1.2	1.0	1.0	1.0
Meander Length (ft)	55 – 100	37 – 172	8 – 36	15 – 68	16 – 72
Meander Length Ratio	9 – 16	1.8 – 8.6	2 – 9	2 – 9	2 – 9
Radius of Curvature (ft)	45 – 150	47 – 318	8 – 12	15 – 23	16 – 24
Rc Ratio	7 – 23	2.3 – 16	2 – 3	2 – 3	2 – 3
Belt Width (ft)	40 – 60	33 – 40	6 – 12	11 – 23	12 – 24
Meander Width Ratio	6 – 10	1.6 – 2.0	1.5 – 3.0	1.5 – 3.0	1.5 – 3.0
Sinuosity	1.06	1.05	1.2	1.2	1.2
Channel Slope (ft/ft)	0.014	0.0079	0.020	0.016	0.007
Valley Slope (ft/ft)	0.015	-	0.024	0.019	0.008
Riffle Slope (ft/ft)	0.02	0.013	0.020	0.016	0.007
Riffle Slope Ratio	1.4	0.1	1.0	1.0	1.0
Pool Slope (ft/ft)	0.0	0.001	0.0	0.0	0.0
Pool Slope Ratio	0.0	0.1	0.0	0.0	0.0
Pool Width (ft)	8	19.9	4	7.5	8
Pool Width Ratio	1.3	1.0	1.0	1.0	1.0
Pool Spacing (ft)	30 – 100	71 – 134	16 – 24	30 – 45	32 – 48
Pool Spacing Ratio	4.7 – 16	3.5 – 6.7	4 – 6	4 – 6	4 – 6
D_{50} (mm)	-	28	20	20	20
D_{84} (mm)	-	81	40	40	40

Table VIII. Sediment Transport Analysis					
Location	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Channel Slope (ft/ft)	Shear Stress (lb/ft^2)	Predicted Particle Range (mm)
Buckhorn Creek – Reach 1	23.6	1.57	0.005	0.49	22 – 83
Buckhorn Creek – Reach 2	24.7	1.64	0.004	0.41	19 – 89
Buckhorn Creek – Reach 3	24.8	1.65	0.004	0.41	19 – 89
Buckhorn Creek – Reach 4	25.8	1.71	0.005	0.53	24 – 98
Buckhorn Creek – Reach 5	26.4	1.77	0.006	0.66	31– 144
Buckhorn Creek – Reach 6	26.9	1.78	0.004	0.44	20 – 97
West Branch	9.7	0.65	0.013	0.53	24 – 96
Middle Branch – U/s End	7.5	0.49	0.019	0.58	27 – 115
Middle Branch – D/s End	9.6	0.62	0.013	0.50	23 – 88
East Branch	9.6	0.62	0.014	0.54	25 – 102
Little Branch	4.3	0.28	0.02	0.35	16 – 74
SW Creek	8.0	0.53	0.016	0.53	24 – 96
SE Creek	8.6	0.57	0.007	0.25	11 – 50

Table IX. Designed Vegetative Communities (by zone)		
Streamside		
Shrubs	Herbs/Seed Mixture	
Black willow (*Salix nigra*) Elderberry (*Sambucus canadensis*) Silky dogwood (*Cornus amomum*) Silky willow (*Salix sericea*)	Swamp sunflower (*Helianthus angustifolius*) Ironweed (*Vernonia noveboracensis*) Swamp milkweed (*Asclepias incarnata*) Joe-pye-weed (*Eupatorium fistulosum*) Tearthumb (*Polygonum sagittatum*) Broomstraw (*Andropogon virginicus*) Deertongue (*Panicum clandestimum*) Switchgrass (*Panicum virgatum*)	
Floodplain		
Trees	Shrubs	Herb/Seed Mixture
American sycamore(*Platanus occidentalis*) American elm (*Ulmus americana*) Green ash (*Fraxinus pennsylvanica*) River birch (*Betula nigra*) Hackberry (*Celtis laevigata*) Willow oak (*Quercus phellos*) Water oak (*Quercus nigra*) Tulip poplar (*Liriodendron tulipifera*) Black walnut (*Juglans nigra*) Shagbark hickory (*Carya ovata*) Bitternut hickory (*Carya cordiformis*) Swamp chestnut oak (*Quercus michauxii*)	Spicebush (*Lindera benzoin*) Witch hazel (*Hamamelis virginiana*) Tag alder (*Alnus serrulata*) Buttonbush (*Cephalanthus occidentalis*) Strawberry bush (*Euonymus americanus*) American beautyberry (*Callicarpa americana*) Waxmyrtle (*Myrica cerifera*) Highbush blueberry (*Vaccinium corymbosum*) American hazelnut (*Corylus americana*)	Swamp sunflower (*Helianthus angustifolius*) Ironweed (*Vernonia noveboracensis*) Swamp milkweed (*Asclepias incarnata*) Joe-pye-weed (*Eupatorium fistulosum*) Tearthumb (*Polygonum sagittatum*) Broomstraw (*Andropogon virginicus*) Deertongue (*Panicum clandestimum*) Switchgrass (*Panicum virgatum*)
Upland Slope		
Trees	Shrubs	Herb/Seed Mixture
American beech (*Fagus grandifolia*) American elm (*Ulmus americana*) White ash (*Fraxinus americana*) Bitternut hickory (*Carya cordiformis*) Black gum (*Nyssa sylvatica*) Northern red oak (*Quercus rubra*) White oak (*Quercus alba*) Persimmon (*Diospyros virginiana*)	Serviceberry (*Amerlanchier arborea*) Redbud (*Cercis canadensis*) Flowering dogwood (*Cornus florida*) Hazelnut (*Corylus americana*) Deciduous holly (*Ilex decidua*) Southern arrow-wood (*Viburnum dentatum*)	Big blue stem (*Andropogon gerardii*) Ironweed (*Vernonia noveboracensis*) Joe-pye-weed (*Eupatorium fistulosum*) Indian grass (*Sorghastrum nutans*) Switchgrass (*Panicum virgatum*) Eastern gama grass (*Tripsacum dactyloides*)

Figures 1-5



PREPARED FOR: PREPARED BY: AND BY:

Ecosystem Enhancement Program

Restoration Systems, LLC

Wolf Creek Engineering

SCALE

1/2 0 1 3

MILES

SITE VICINITY MAP

HOLLY GROVE RESTORATION SITE
GUILFORD COUNTY, NORTH CAROLINA

FIGURE 1

HOLLY GROVE RESTORATION SITE
WATERSHED AREA

PROJECT SITE

DRAINAGE AREA = 4.27 SQ MI

PREPARED FOR:

Ecosystem Enhancement Program

PREPARED BY:

RESTORATION SYSTEMS, LLC

AND BY:

Wolf Creek ENGINEERING

SCALE

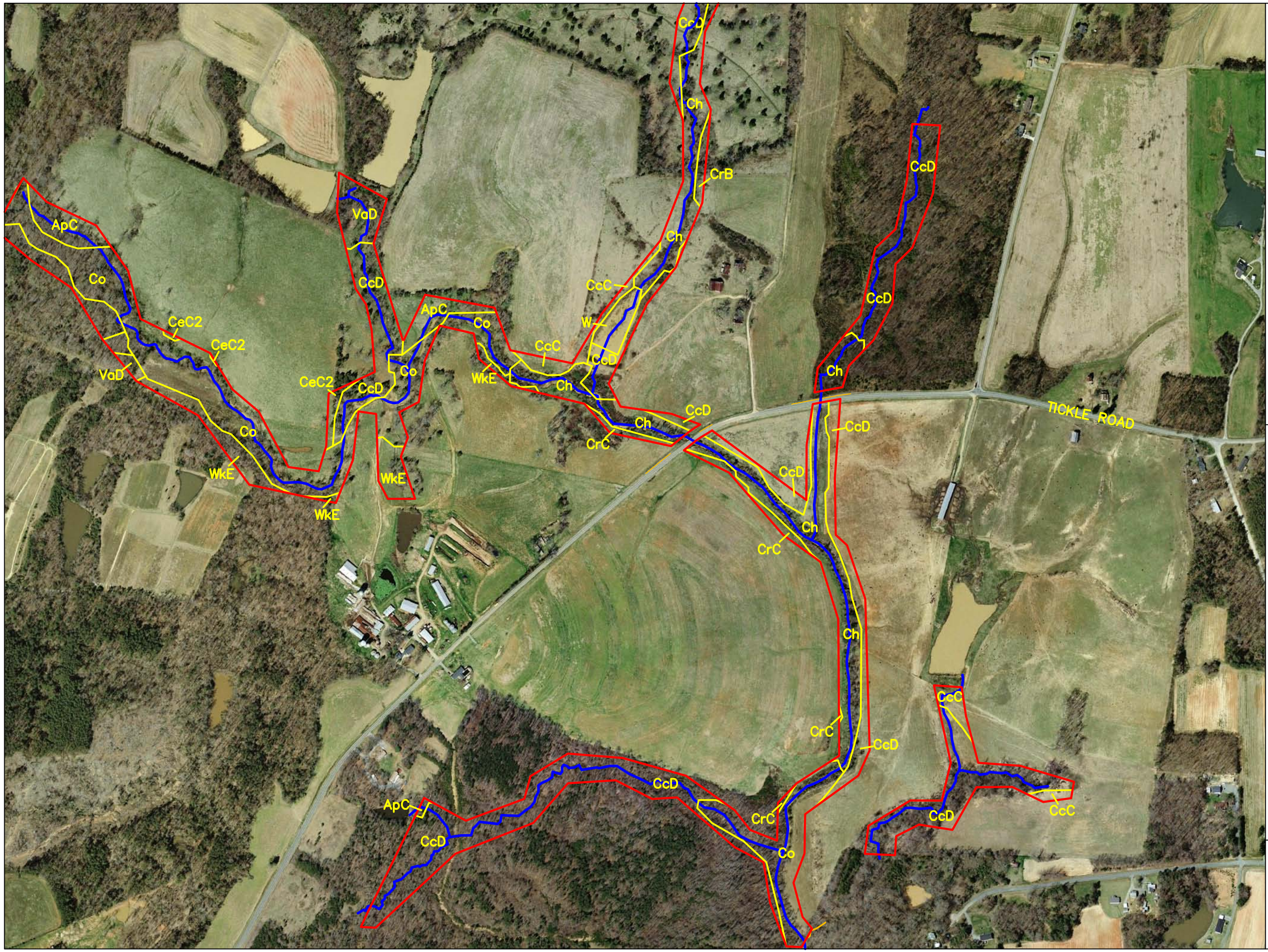
1/8 0 1/4 1/2

MILES

WATERSHED MAP

HOLLY GROVE RESTORATION SITE
GUILFORD COUNTY, NORTH CAROLINA

FIGURE 2



PREPARED FOR:

Ecosystem Enhancement Program

PREPARED BY:

RESTORATION SYSTEMS, LLC

AND BY:

Wolf Creek Engineering

LEGEND

STREAM

APPROXIMATE PROJECT BOUNDARY

SOIL BOUNDARY

ApC	APPLING SANDY LOAM
CcC	CECIL SANDY LOAM
CcD	CECIL SANCY LOAM
CeC2	CECIL SANDY CLAY LOAM
Ch	CHEWACLA SANDY LOAM
Co	CONGAREE LOAM
CrB	CORONACA CLAY LOAM
CrC	CORONACA CLAY LOAM
VaD	VANCE SANDY LOAM
WkE	WILKES LOAM
W	WATER

SCALE

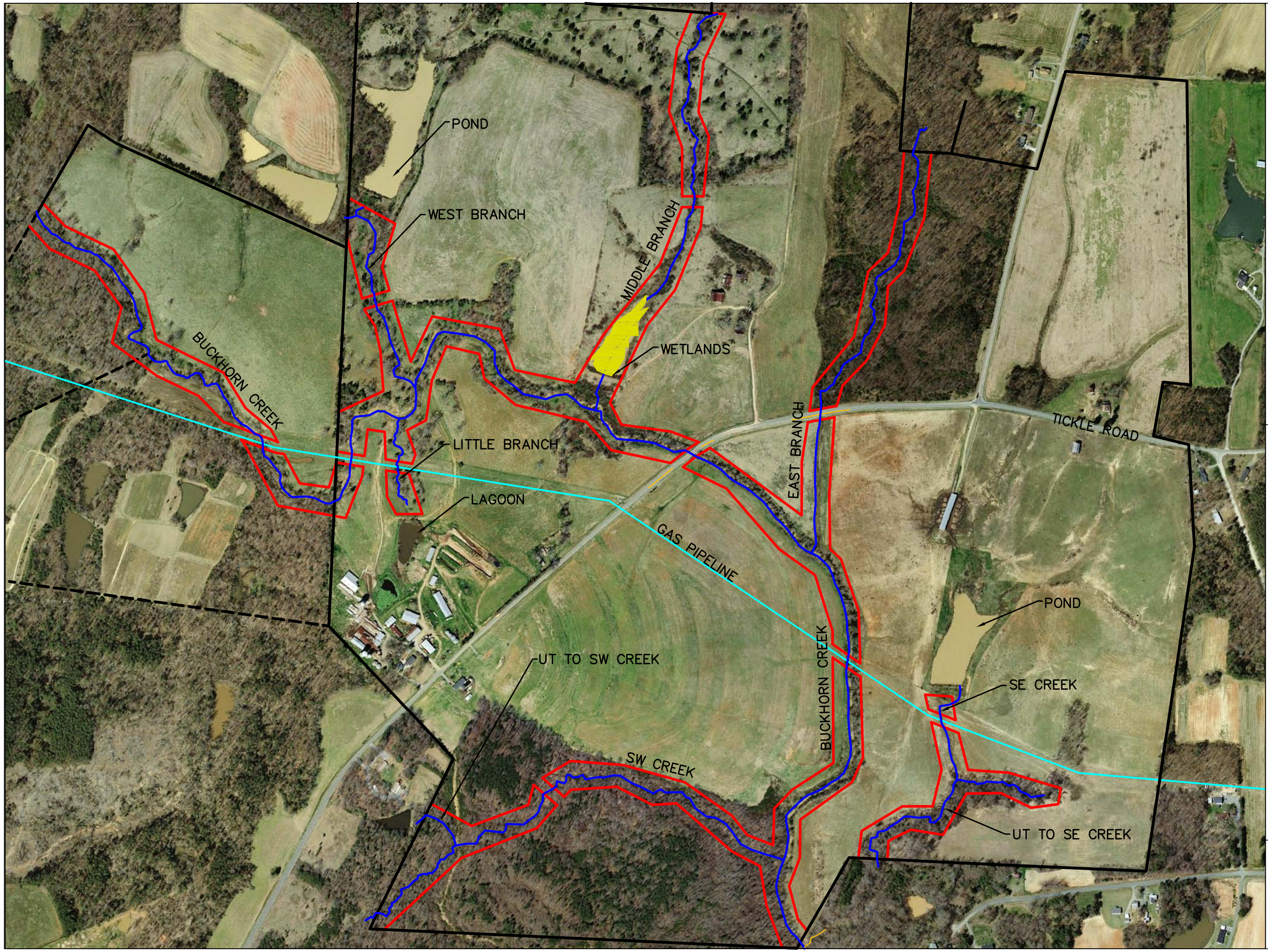
200 0 200 400 600 800

FEET

SOIL MAP

HOLLY GROVE RESTORATION SITE
GUILFORD COUNTY, NORTH CAROLINA

FIGURE 3



PREPARED FOR:

Ecosystem Enhancement Program

PREPARED BY:

Restoration Systems, LLC

AND BY:

Wolf Creek Engineering

LEGEND

- EXISTING STREAM
- WETLANDS
- CONSERVATION EASEMENT
- PROPERTY BOUNDARY
- GAS PIPELINE

SCALE

200 0 200 400 600 800

FEET

EXISTING HYDROLOGIC FEATURES

HOLLY GROVE RESTORATION SITE
GUILFORD COUNTY, NORTH CAROLINA

FIGURE 4a

POND
WEST BRANCH
MIDDLE BRANCH
WETLANDS
BUCKHORN CREEK
LITTLE BRANCH
LAGOON
EAST BRANCH
TICKLE ROAD
GAS PIPELINE
BUCKHORN CREEK
POND
UT TO SW CREEK
SW CREEK
SE CREEK
UT TO SE CREEK

PREPARED FOR:

Ecosystem Enhancement Program

PREPARED BY:

RESTORATION SYSTEMS, LLC

AND BY:

Wolf Creek Engineering

LEGEND

- STREAM RESTORATION
- STREAM PRESERVATION
- STREAM ENHANCEMENT
- WETLANDS
- FORD
- CONSERVATION EASEMENT
- PROPERTY BOUNDARY
- GAS PIPELINE

SCALE

200 0 200 400 600 800

FEET

PROPOSED HYDROLOGIC FEATURES

HOLLY GROVE RESTORATION SITE
GUILFORD COUNTY, NORTH CAROLINA

FIGURE 4b

Appendix A.
SITE Photographs

Buckhorn Creek: STA 103+50

Buckhorn Creek: STA 104+50

Buckhorn Creek: STA 110+50

Buckhorn Creek: STA 115+00

Buckhorn Creek: STA 121+25

Buckhorn Creek: STA 132+00

Buckhorn Creek: STA 134+00

Buckhorn Creek: STA 145+00

Buckhorn Creek: STA 156+00

Buckhorn Creek: D/S of Bridge

Buckhorn Creek

Buckhorn Creek

Little Branch: U/S End

Little Branch: D/S End

West Branch

West Branch: STA 308+00

West Branch: STA 310+50

Middle Creek: Wetlands

Middle Creek: Pond Outfall

Middle Creek: STA 401+25

Middle Creek: STA 407+00

East Branch: D/S of Road

South West Creek

South West Creek

Appendix B.
Existing SITE Stream Data

South East Creek: STA 702+00

South East Creek: STA 704+00

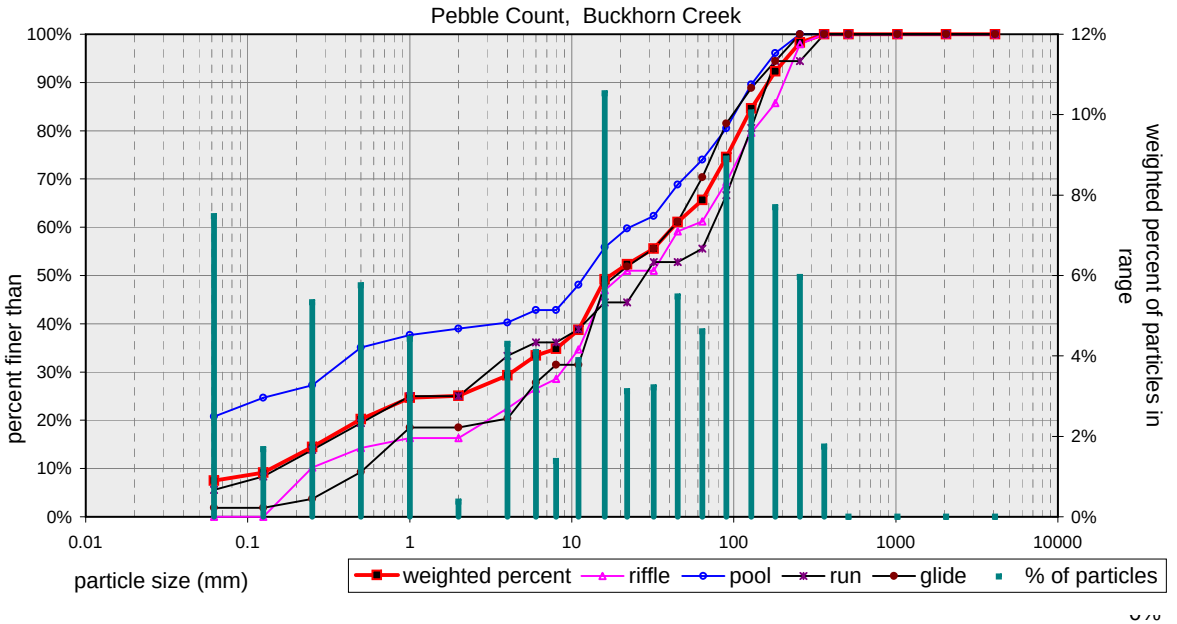
Pebble Count Weighted by Channel Feature

Percent Riffle:	**30**	Percent Run:	**20**		
Percent Pool:	**30**	Percent Glide:	**20**	Pebble Count,	

Material	Size Range (mm)		weighted	
silt/clay	0	0.062	6.8	#
very fine sand	0.062	0.13	1.5	#
fine sand	0.13	0.25	4.8	#
medium sand	0.25	0.5	5.2	#
coarse sand	0.5	1	4.0	#
very coarse sand	1	2	0.3	#
very fine gravel	2	4	3.9	#
fine gravel	4	6	3.7	#
fine gravel	6	8	1.3	#
medium gravel	8	11	3.5	#
medium gravel	11	16	9.5	#
coarse gravel	16	22	2.8	#
coarse gravel	22	32	2.9	#
very coarse gravel	32	45	5.0	#
very coarse gravel	45	64	4.2	#
small cobble	64	90	8.1	#
medium cobble	90	128	9.1	#
large cobble	128	180	7.0	#
very large cobble	180	256	5.4	#
small boulder	256	362	1.6	#
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:	90.6	

bedrock		9.4
clay hardpan		0.0
detritus/wood		0.0
artificial		0.0
	weighted total count:	100

	Buckhorn Creek
	Holly Grove Restoration Site
Note:	7%



based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	0.300	8.13	17.3	61	125	211	32.5	6.1	20.4

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	7%	16%	37%	30%	2%	9%	0%	0%	0%

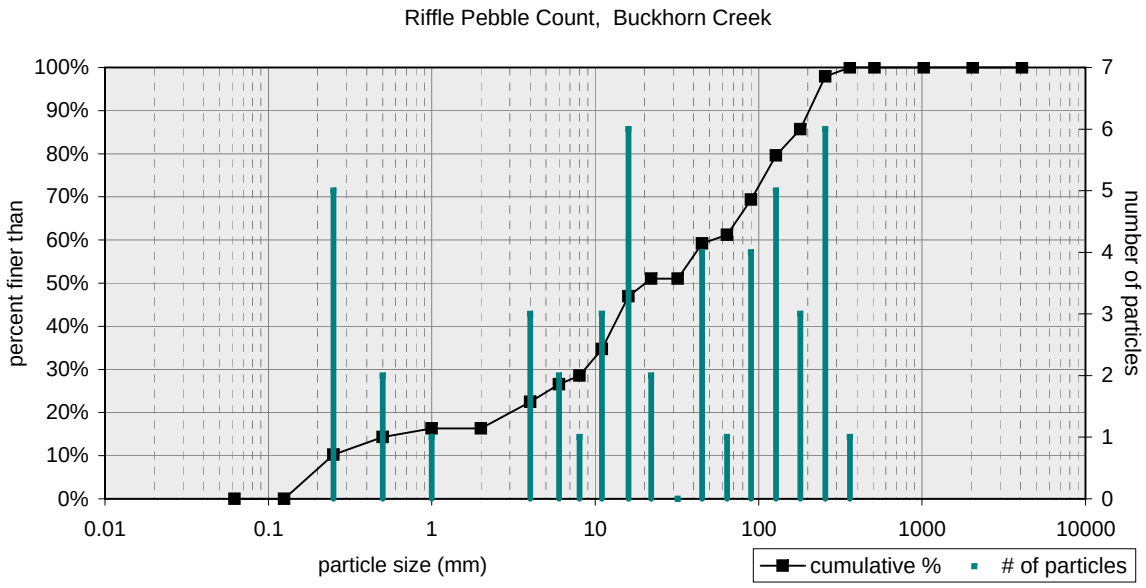
Riffle Pebble Count

Material	Size Range (mm)		Count	
silt/clay	0	0.062		#
very fine sand	0.062	0.13		#
fine sand	0.13	0.25	**5**	#
medium sand	0.25	0.5	**2**	#
coarse sand	0.5	1	**1**	#
very coarse sand	1	2		#
very fine gravel	2	4	**3**	#
fine gravel	4	6	**2**	#
fine gravel	6	8	**1**	#
medium gravel	8	11	**3**	#
medium gravel	11	16	**6**	#
coarse gravel	16	22	**2**	#
coarse gravel	22	32	**0**	#
very coarse gravel	32	45	**4**	#
very coarse gravel	45	64	**1**	#
small cobble	64	90	**4**	#
medium cobble	90	128	**5**	#
large cobble	128	180	**3**	#
very large cobble	180	256	**6**	#
small boulder	256	362	**1**	#
small boulder	362	512		#
medium boulder	512	1024		#
large boulder	1024	2048		#
very large boulder	2048	4096		#
		total particle count:	49	

bedrock		**5**
clay hardpan		
detritus/wood		
artificial		
	total count:	54

Riffle Pebble Count,

	Buckhorn Creek
	Holly Grove Restoration Site
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
	0.895	11.10	20.3	75	164	235	15.4	12.1	13.5

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	0%	15%	41%	33%	2%	9%	0%	0%	0%

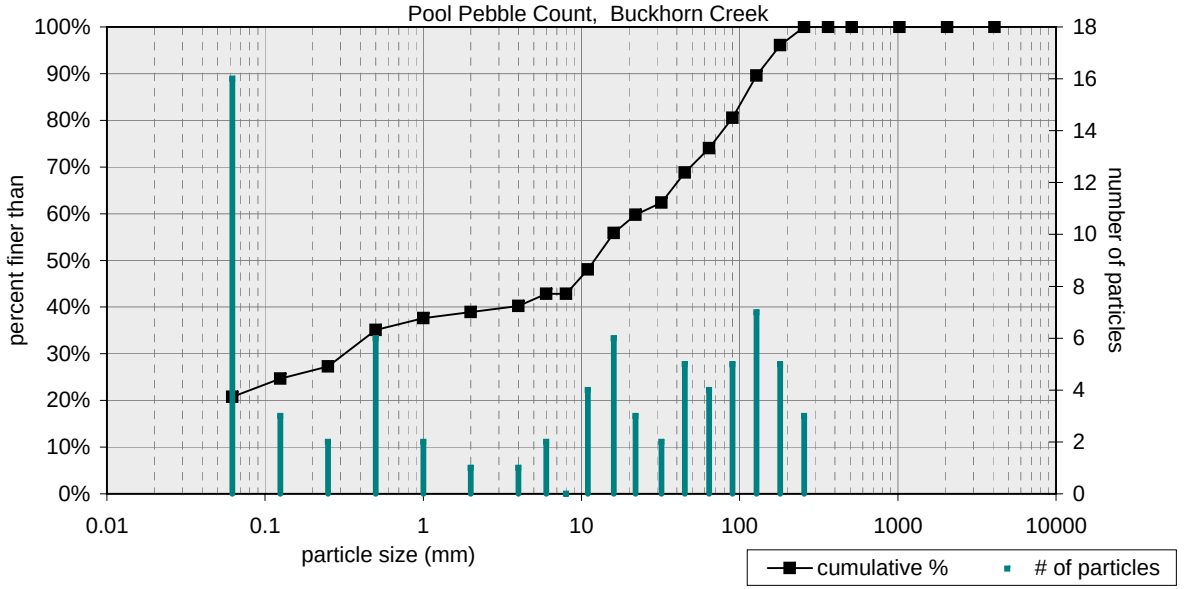
Pool Pebble Count

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**16**	#
very fine sand	0.062	0.13	**3**	#
fine sand	0.13	0.25	**2**	#
medium sand	0.25	0.5	**6**	#
coarse sand	0.5	1	**2**	#
very coarse sand	1	2	**1**	#
very fine gravel	2	4	**1**	#
fine gravel	4	6	**2**	#
fine gravel	6	8	**0**	#
medium gravel	8	11	**4**	#
medium gravel	11	16	**6**	#
coarse gravel	16	22	**3**	#
coarse gravel	22	32	**2**	#
very coarse gravel	32	45	**5**	#
very coarse gravel	45	64	**4**	#
small cobble	64	90	**5**	#
medium cobble	90	128	**7**	#
large cobble	128	180	**5**	#
very large cobble	180	256	**3**	#
small boulder	256	362		#
small boulder	362	512		#
medium boulder	512	1024		#
large boulder	1024	2048		#
very large boulder	2048	4096		#
		total particle count:	77	

bedrock		**12**	
clay hardpan			
detritus/wood			
artificial			
	total count:	89	

Pool Pebble Count,

	Buckhorn Creek
	Holly Grove Restoration Site
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	0.50	12.1	37	103	170	101.7	2.5	40.8

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	18%	16%	30%	22%	0%	13%	0%	0%	0%

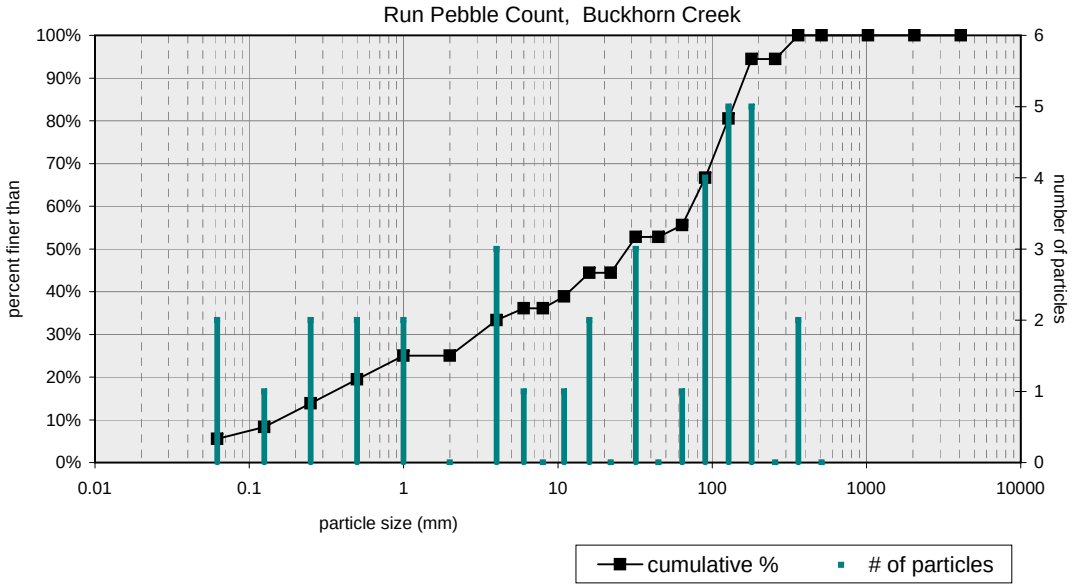
Run Pebble Count

Run Pebble Count,

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**2**	#
very fine sand	0.062	0.13	**1**	#
fine sand	0.13	0.25	**2**	#
medium sand	0.25	0.5	**2**	#
coarse sand	0.5	1	**2**	#
very coarse sand	1	2	**0**	#
very fine gravel	2	4	**3**	#
fine gravel	4	6	**1**	#
fine gravel	6	8	**0**	#
medium gravel	8	11	**1**	#
medium gravel	11	16	**2**	#
coarse gravel	16	22	**0**	#
coarse gravel	22	32	**3**	#
very coarse gravel	32	45	**0**	#
very coarse gravel	45	64	**1**	#
small cobble	64	90	**4**	#
medium cobble	90	128	**5**	#
large cobble	128	180	**5**	#
very large cobble	180	256	**0**	#
small boulder	256	362	**2**	#
small boulder	362	512	**0**	#
medium boulder	512	1024		#
large boulder	1024	2048		#
very large boulder	2048	4096		#
	total particle count:		36	

bedrock			**3**
clay hardpan			
detritus/wood			
artificial			
	total count:		39

	Buckhorn Creek
	Holly Grove Restoration Site
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
	0.325	5.10	28.2	86	139	265	45.9	6.7	20.7

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	5%	18%	28%	36%	5%	8%	0%	0%	0%

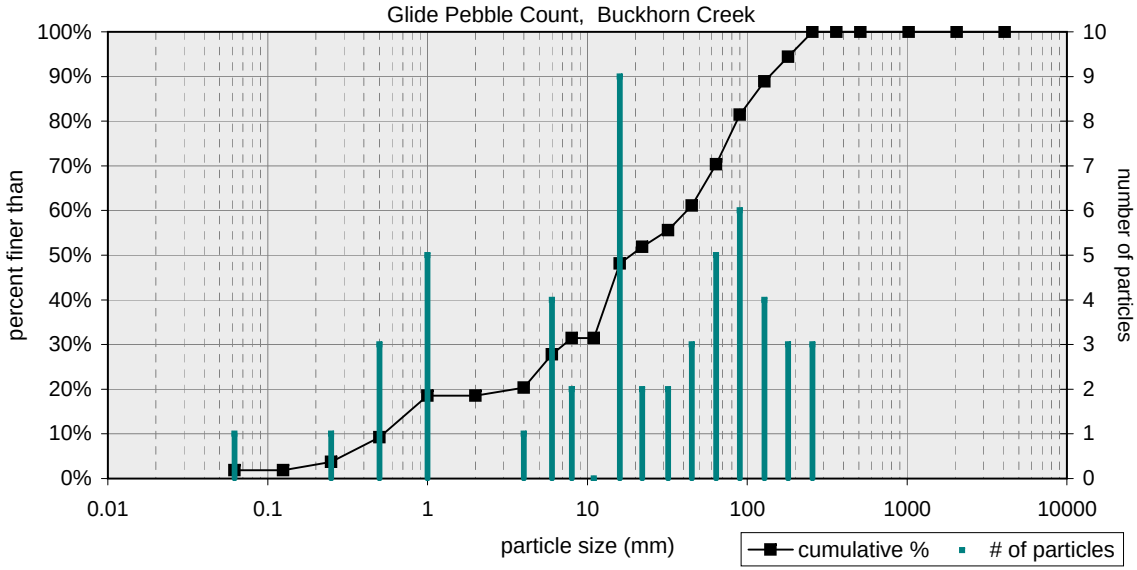
Glide Pebble Count

Glide Pebble Count,

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**1**	#
very fine sand	0.062	0.13		#
fine sand	0.13	0.25	**1**	#
medium sand	0.25	0.5	**3**	#
coarse sand	0.5	1	**5**	#
very coarse sand	1	2		#
very fine gravel	2	4	**1**	#
fine gravel	4	6	**4**	#
fine gravel	6	8	**2**	#
medium gravel	8	11	**0**	#
medium gravel	11	16	**9**	#
coarse gravel	16	22	**2**	#
coarse gravel	22	32	**2**	#
very coarse gravel	32	45	**3**	#
very coarse gravel	45	64	**5**	#
small cobble	64	90	**6**	#
medium cobble	90	128	**4**	#
large cobble	128	180	**3**	#
very large cobble	180	256	**3**	#
small boulder	256	362		#
small boulder	362	512		#
medium boulder	512	1024		#
large boulder	1024	2048		#
very large boulder	2048	4096		#
	total particle count:		54	

bedrock			**3**
clay hardpan			
detritus/wood			
artificial			
	total count:		57

	Buckhorn Creek
	Holly Grove Restoration Site
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
	0.828	11.91	18.8	52	101	186	14.0	9.2	11.1

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	2%	16%	49%	28%	0%	5%	0%	0%	0%

Pebble Count of Channel Reach

Pebble Count,

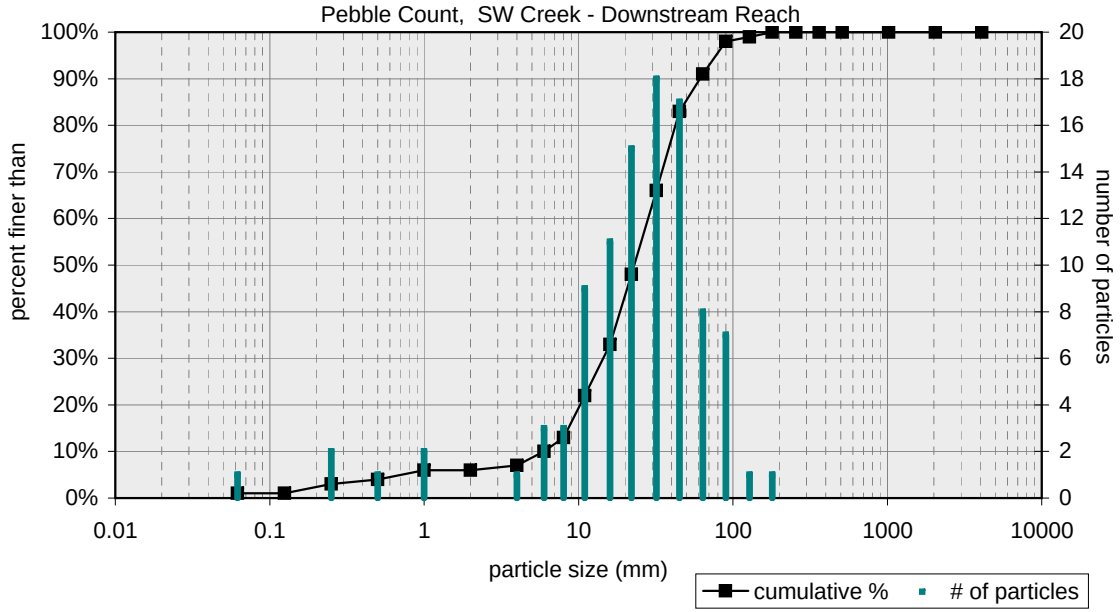
SW Creek - Downstream Reach

Holly Grove Site

Note:

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**1**	##
very fine sand	0.062	0.13		##
fine sand	0.13	0.25	**2**	##
medium sand	0.25	0.5	**1**	##
coarse sand	0.5	1	**2**	##
very coarse sand	1	2		##
very fine gravel	2	4	**1**	##
fine gravel	4	6	**3**	##
fine gravel	6	8	**3**	##
medium gravel	8	11	**9**	##
medium gravel	11	16	**11**	##
coarse gravel	16	22	**15**	##
coarse gravel	22	32	**18**	##
very coarse gravel	32	45	**17**	##
very coarse gravel	45	64	**8**	##
small cobble	64	90	**7**	##
medium cobble	90	128	**1**	##
large cobble	128	180	**1**	##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
	total particle count:		100	

bedrock		
clay hardpan		
detritus/wood		
artificial		
total count:		100



based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	8.896	16.69	22.9	31	47	78	2.3	20.5	2.3

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	1%	5%	85%	9%	0%	0%	0%	0%	0%

Pebble Count of Channel Reach

Pebble Count,

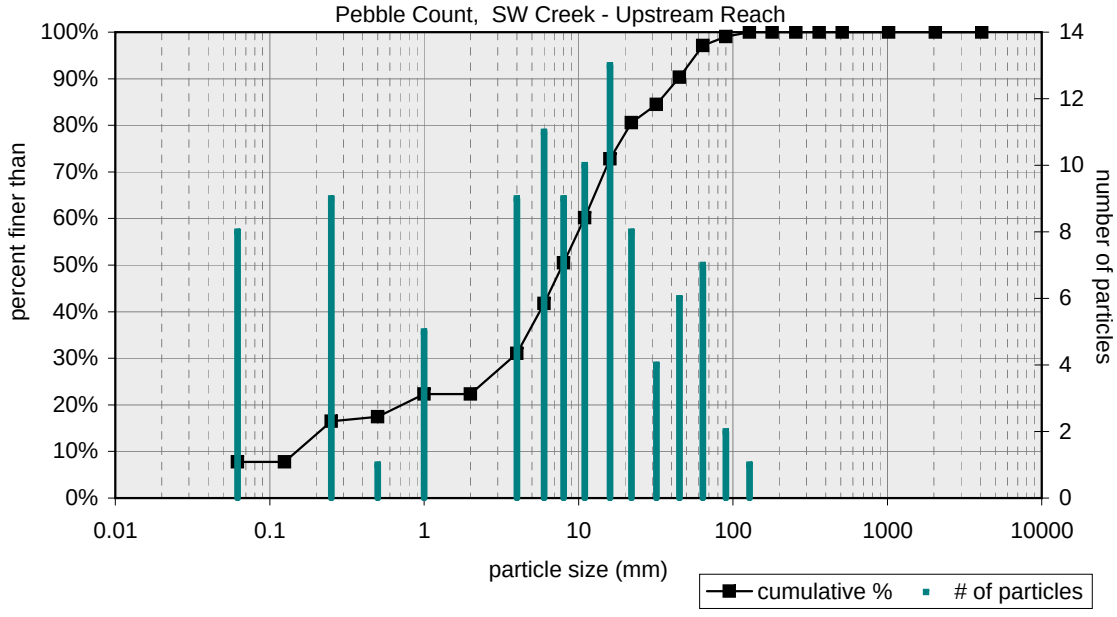
SW Creek - Upstream Reach

Holly Grove Site

Note:

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**8**	##
very fine sand	0.062	0.13		##
fine sand	0.13	0.25	**9**	##
medium sand	0.25	0.5	**1**	##
coarse sand	0.5	1	**5**	##
very coarse sand	1	2		##
very fine gravel	2	4	**9**	##
fine gravel	4	6	**11**	##
fine gravel	6	8	**9**	##
medium gravel	8	11	**10**	##
medium gravel	11	16	**13**	##
coarse gravel	16	22	**8**	##
coarse gravel	22	32	**4**	##
very coarse gravel	32	45	**6**	##
very coarse gravel	45	64	**7**	##
small cobble	64	90	**2**	##
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:	103	

bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	103



based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	0.240	4.64	7.9	13	31	57	18.3	2.7	11.3

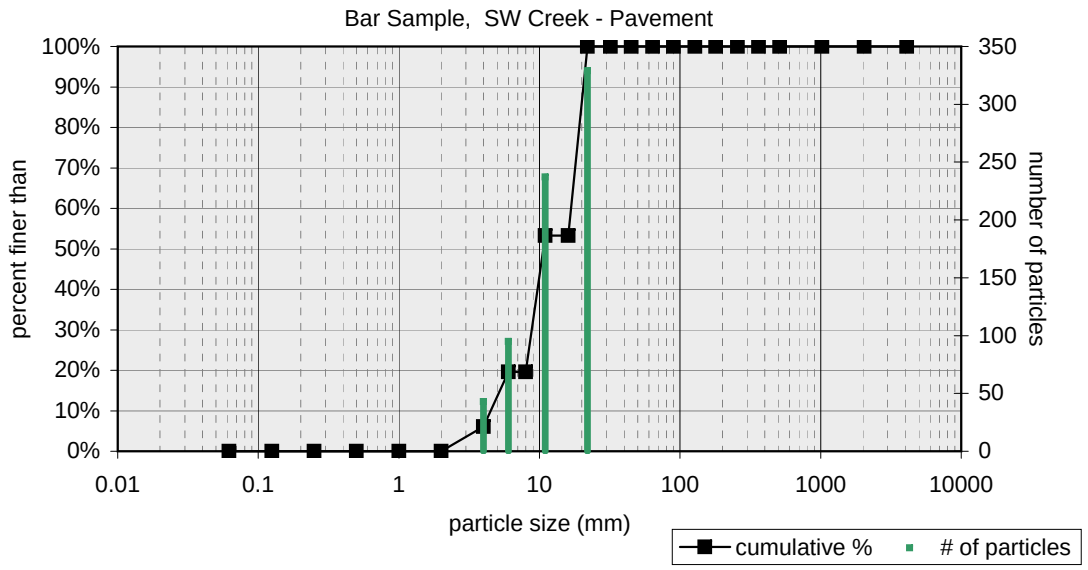
based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	8%	15%	75%	3%	0%	0%	0%	0%	0%

Bar Sample

material	size range (mm)		weight	
silt/clay	0	0.062		##
very fine sand	0.062	0.13		##
fine sand	0.13	0.25		##
medium sand	0.25	0.5		##
coarse sand	0.5	1		##
very coarse sand	1	2		##
very fine gravel	2	4	**43**	##
fine gravel	4	6	**95**	##
fine gravel	6	8		##
medium gravel	8	11	**237**	##
medium gravel	11	16		##
coarse gravel	16	22	**329**	##
coarse gravel	22	32		##
very coarse gravel	32	45		##
very coarse gravel	45	64		##
small cobble	64	90		##
medium cobble	90	128		##
large cobble	128	180		##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
	Total Particle Count:		704	

Bar Sample,

	SW Creek - Pavement
	Holly Grove Site
Note:	**Largest Particles: 35mm & 31mm**



size percent less than (mm)						particle size distribution		
D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
5.384	9.25	10.7	17	20	21	1.9	10.3	1.9

Bar Sample

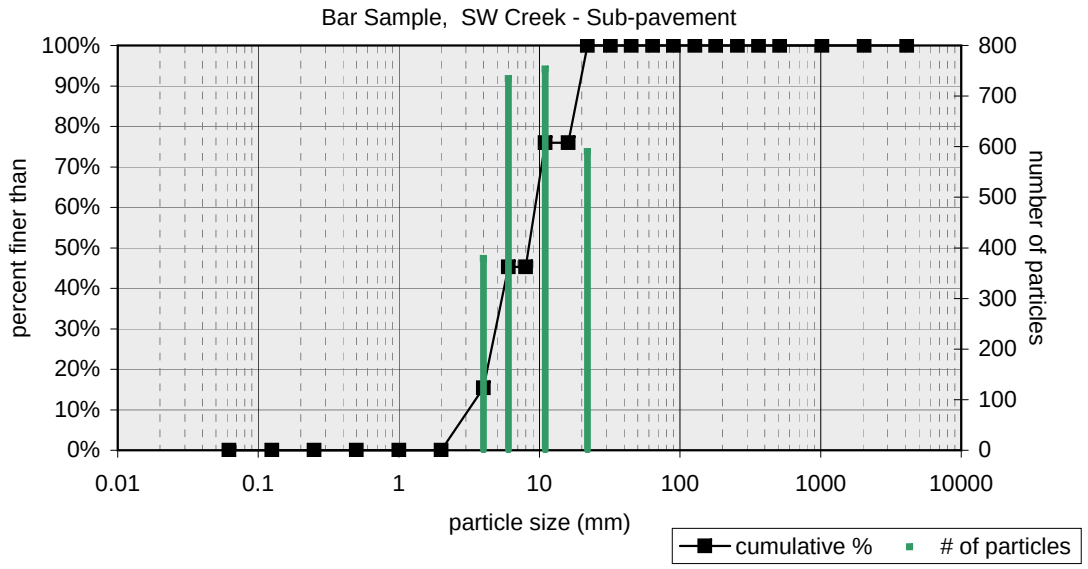
material	size range (mm)		weight	
silt/clay	0	0.062		##
very fine sand	0.062	0.13		##
fine sand	0.13	0.25		##
medium sand	0.25	0.5		##
coarse sand	0.5	1		##
very coarse sand	1	2		##
very fine gravel	2	4	**379**	##
fine gravel	4	6	**734**	##
fine gravel	6	8		##
medium gravel	8	11	**753**	##
medium gravel	11	16		##
coarse gravel	16	22	**590**	##
coarse gravel	22	32		##
very coarse gravel	32	45		##
very coarse gravel	45	64		##
small cobble	64	90		##
medium cobble	90	128		##
large cobble	128	180		##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
	Total Particle Count:		2456	

Bar Sample,

SW Creek - Sub-pavement

Holly Grove Site

Note: **Largest Particles: 37mm & 30mm**



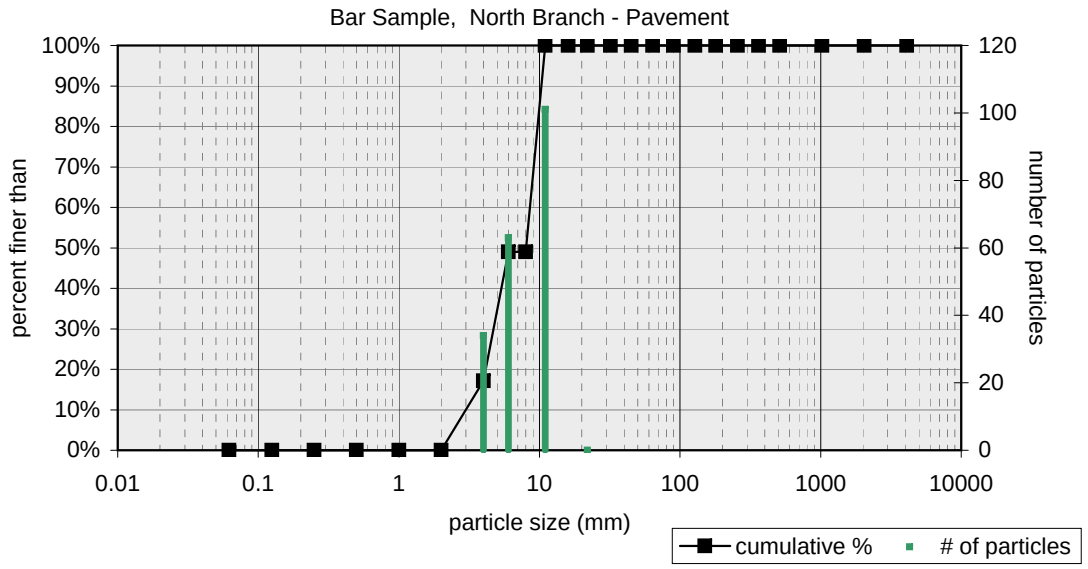
size percent less than (mm)						particle size distribution		
D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
4.031	5.22	8.4	10	18	21	2.1	8.5	2.1

Bar Sample

material	size range (mm)		weight	
silt/clay	0	0.062		##
very fine sand	0.062	0.13		##
fine sand	0.13	0.25		##
medium sand	0.25	0.5		##
coarse sand	0.5	1		##
very coarse sand	1	2		##
very fine gravel	2	4	**34**	##
fine gravel	4	6	**63**	##
fine gravel	6	8		##
medium gravel	8	11	**101**	##
medium gravel	11	16		##
coarse gravel	16	22	**0**	##
coarse gravel	22	32		##
very coarse gravel	32	45		##
very coarse gravel	45	64		##
small cobble	64	90		##
medium cobble	90	128		##
large cobble	128	180		##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
	Total Particle Count:		198	

Bar Sample,

	North Branch - Pavement
	Holly Grove Site
Note:	**Largest Particles: 19mm & 18mm**



size percent less than (mm)						particle size distribution		
D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
3.815	5.02	8.1	9	10	11	1.7	6.2	1.6

Bar Sample

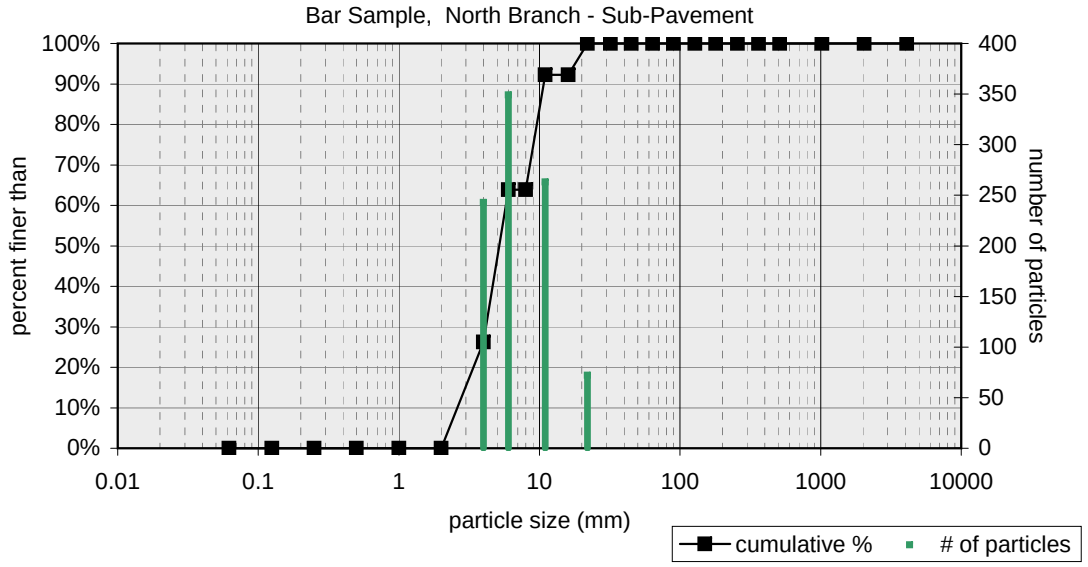
material	size range (mm)		weight	
silt/clay	0	0.062		##
very fine sand	0.062	0.13		##
fine sand	0.13	0.25		##
medium sand	0.25	0.5		##
coarse sand	0.5	1		##
very coarse sand	1	2		##
very fine gravel	2	4	**243**	##
fine gravel	4	6	**349**	##
fine gravel	6	8		##
medium gravel	8	11	**263**	##
medium gravel	11	16		##
coarse gravel	16	22	**72**	##
coarse gravel	22	32		##
very coarse gravel	32	45		##
very coarse gravel	45	64		##
small cobble	64	90		##
medium cobble	90	128		##
large cobble	128	180		##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
	Total Particle Count:		927	

Bar Sample,

North Branch - Sub-Pavement

Holly Grove Site

Note: **Largest Particles: 24mm & 21mm**



size percent less than (mm)						particle size distribution		
D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
3.053	4.40	5.2	8	10	18	1.8	5.5	1.8

Bar Sample

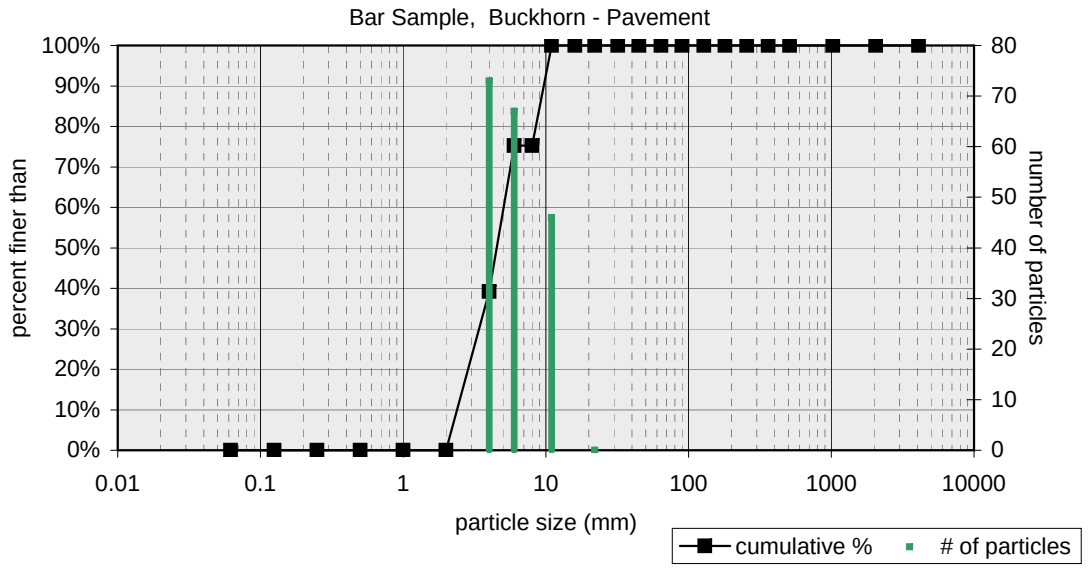
material	size range (mm)		weight	
silt/clay	0	0.062		##
very fine sand	0.062	0.13		##
fine sand	0.13	0.25		##
medium sand	0.25	0.5		##
coarse sand	0.5	1		##
very coarse sand	1	2		##
very fine gravel	2	4	**73**	##
fine gravel	4	6	**67**	##
fine gravel	6	8		##
medium gravel	8	11	**46**	##
medium gravel	11	16		##
coarse gravel	16	22	**0**	##
coarse gravel	22	32		##
very coarse gravel	32	45		##
very coarse gravel	45	64		##
small cobble	64	90		##
medium cobble	90	128		##
large cobble	128	180		##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
	Total Particle Count:		186	

Bar Sample,

Buckhorn - Pavement

Holly Grove Site

Note: **Largest Particles: 17mm & 14mm**



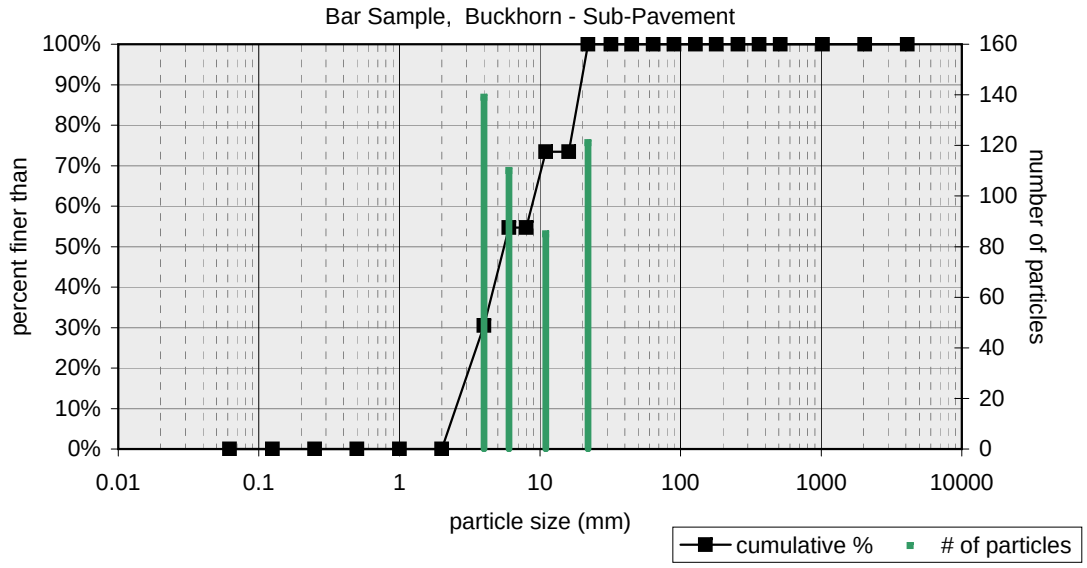
size percent less than (mm)						particle size distribution		
D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
2.653	3.71	4.5	5	9	10	1.8	4.9	1.8

Bar Sample

material	size range (mm)		weight	
silt/clay	0	0.062		##
very fine sand	0.062	0.13		##
fine sand	0.13	0.25		##
medium sand	0.25	0.5		##
coarse sand	0.5	1		##
very coarse sand	1	2		##
very fine gravel	2	4	**139**	##
fine gravel	4	6	**110**	##
fine gravel	6	8		##
medium gravel	8	11	**85**	##
medium gravel	11	16		##
coarse gravel	16	22	**121**	##
coarse gravel	22	32		##
very coarse gravel	32	45		##
very coarse gravel	45	64		##
small cobble	64	90		##
medium cobble	90	128		##
large cobble	128	180		##
very large cobble	180	256		##
small boulder	256	362		##
small boulder	362	512		##
medium boulder	512	1024		##
large boulder	1024	2048		##
very large boulder	2048	4096		##
	Total Particle Count:		455	

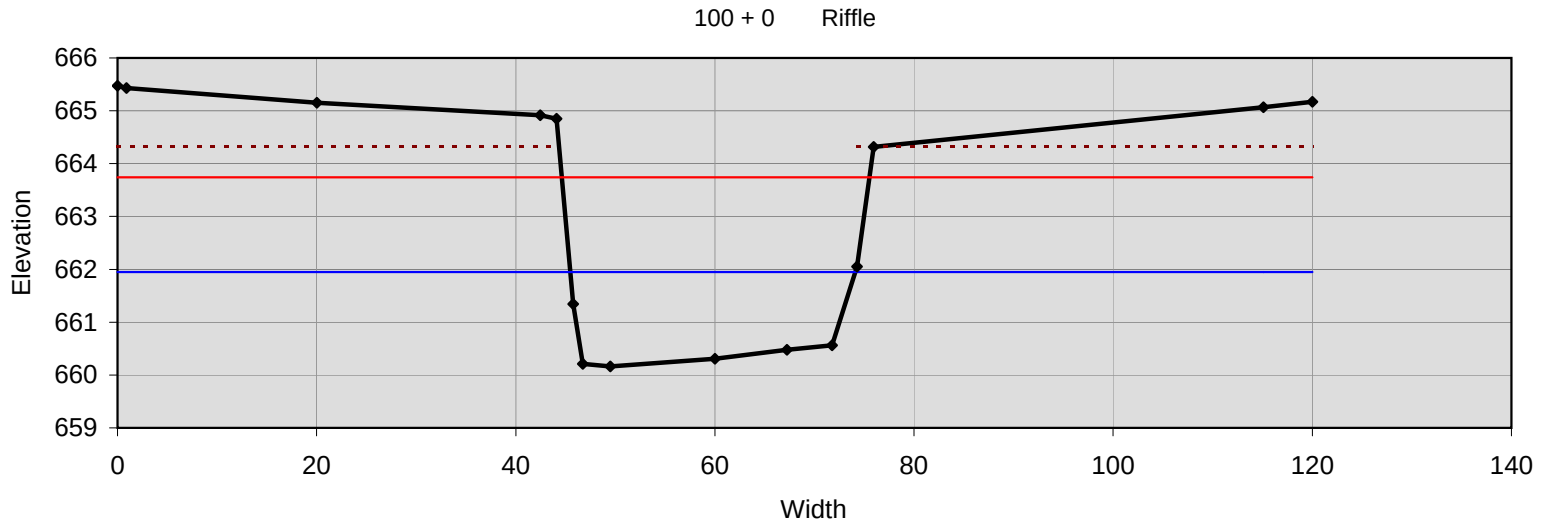
Bar Sample,

	Buckhorn - Sub-Pavement
	Holly Grove Site
Note:	**Largest Particles: 34mm & 28mm**



size percent less than (mm)						particle size distribution		
D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
2.875	4.31	5.5	10	18	21	2.6	7.2	2.5

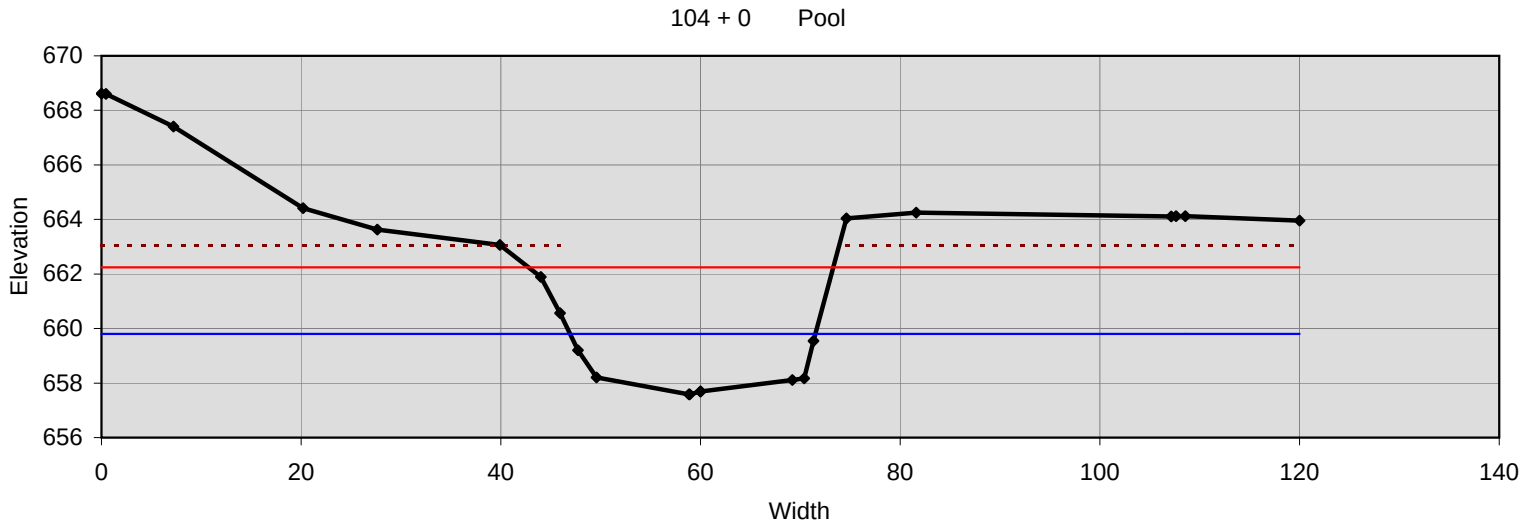
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
43.5	x-section area (ft.sq.)	30.9	W flood prone area (ft)	---	D50 (mm)
28.6	width (ft)	1.1	entrenchment ratio	---	D84 (mm)
1.5	mean depth (ft)	4.2	low bank height (ft)	---	threshold grain size (mm):
1.8	max depth (ft)	2.3	low bank height ratio		
29.9	wetted parimeter (ft)				
1.5	hyd radi (ft)				
18.8	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

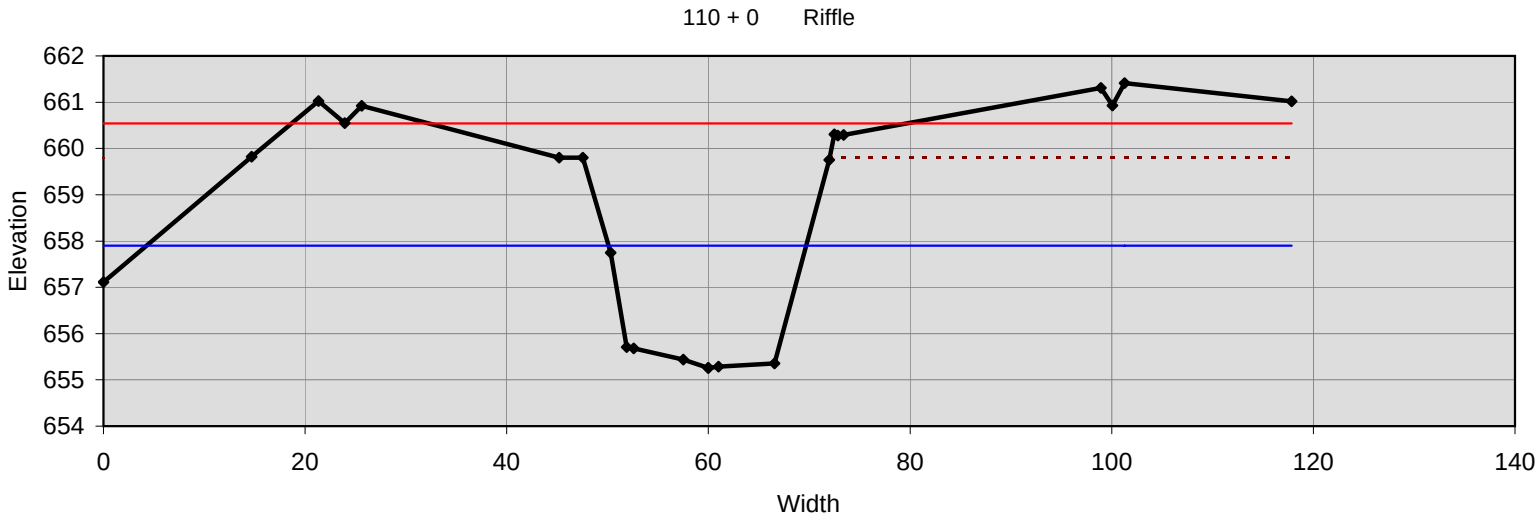
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
42.7	x-section area (ft.sq.)	30.5	W flood prone area (ft)	---	D50 (mm)
24.6	width (ft)	1.2	entrenchment ratio	---	D84 (mm)
1.7	mean depth (ft)	5.5	low bank height (ft)	---	threshold grain size (mm):
2.2	max depth (ft)	2.5	low bank height ratio		
25.9	wetted parimeter (ft)				
1.6	hyd radi (ft)				
14.1	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

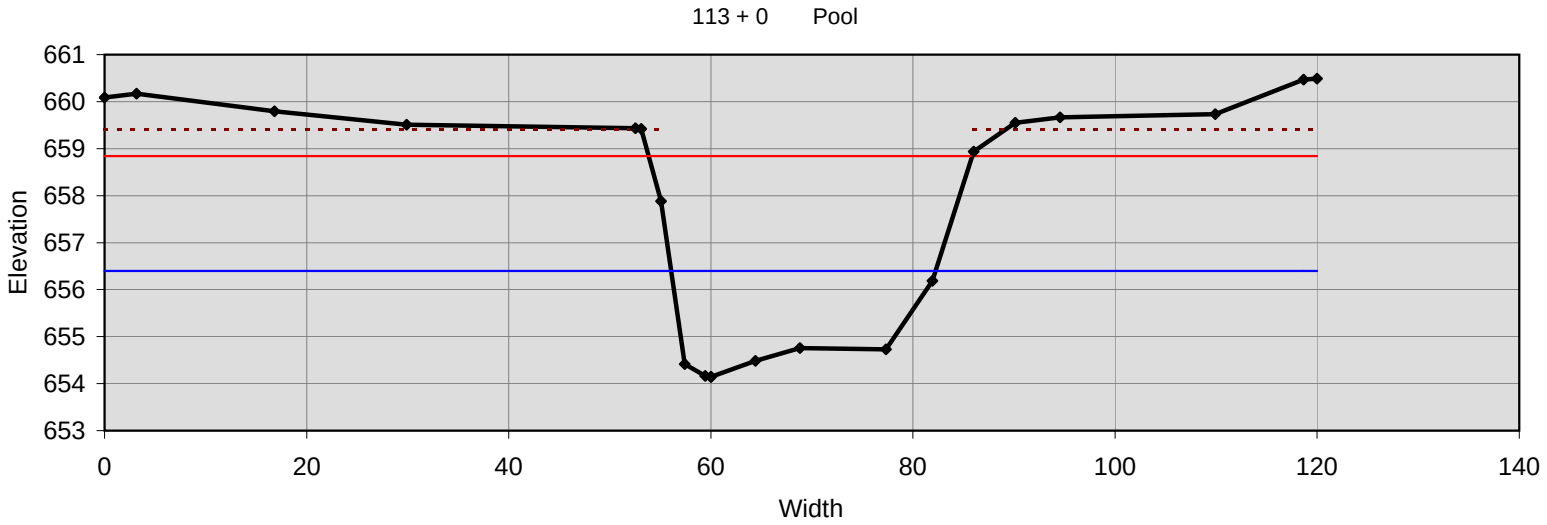
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
43.9	x-section area (ft.sq.)	26.0	W flood prone area (ft)	---	D50 (mm)
23.9	width (ft)	1.1	entrenchment ratio	---	D84 (mm)
1.8	mean depth (ft)	4.5	low bank height (ft)	---	threshold grain size (mm):
2.6	max depth (ft)	1.7	low bank height ratio		
25.9	wetted parimeter (ft)				
1.7	hyd radi (ft)				
13.0	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

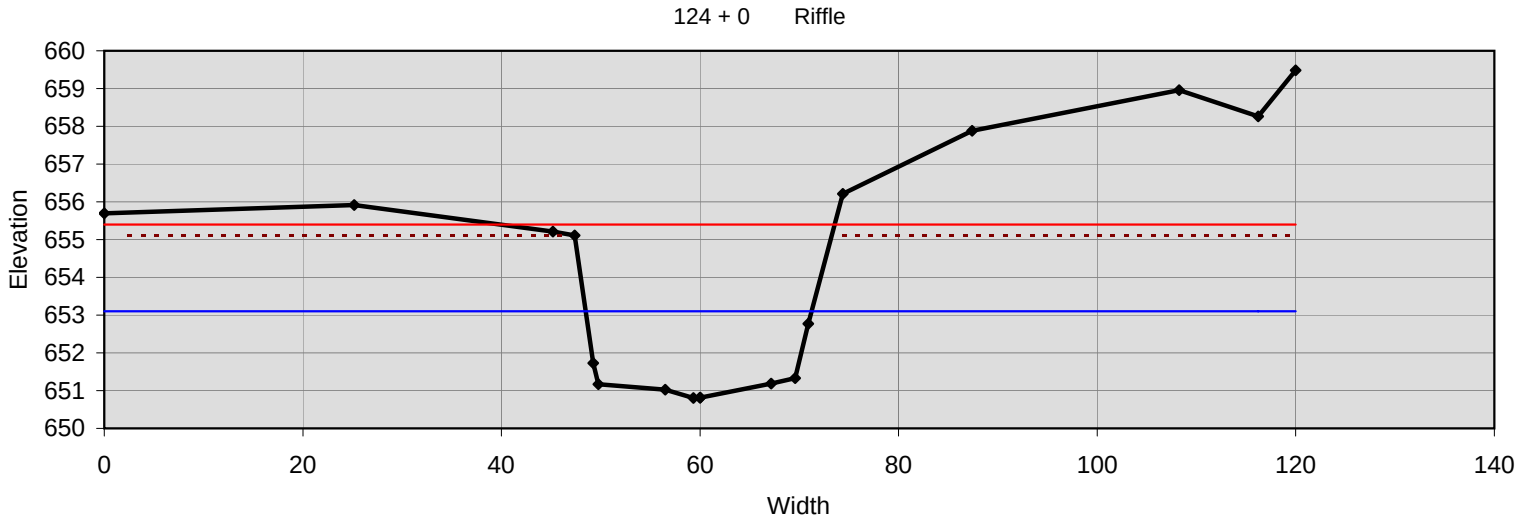
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
42.4	x-section area (ft.sq.)	32.0	W flood prone area (ft)	---	D50 (mm)
26.2	width (ft)	1.2	entrenchment ratio	---	D84 (mm)
1.6	mean depth (ft)	5.3	low bank height (ft)	---	threshold grain size (mm):
2.3	max depth (ft)	2.3	low bank height ratio		
27.5	wetted parimeter (ft)				
1.5	hyd radi (ft)				
16.1	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section



Bankfull Dimensions	
43.5	x-section area (ft.sq.)
22.7	width (ft)
1.9	mean depth (ft)
2.3	max depth (ft)
24.6	wetted parimeter (ft)
1.8	hyd radi (ft)
11.9	width-depth ratio

Flood Dimensions	
27.0	W flood prone area (ft)
1.2	entrenchment ratio
4.3	low bank height (ft)
1.9	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
---	threshold grain size (mm):

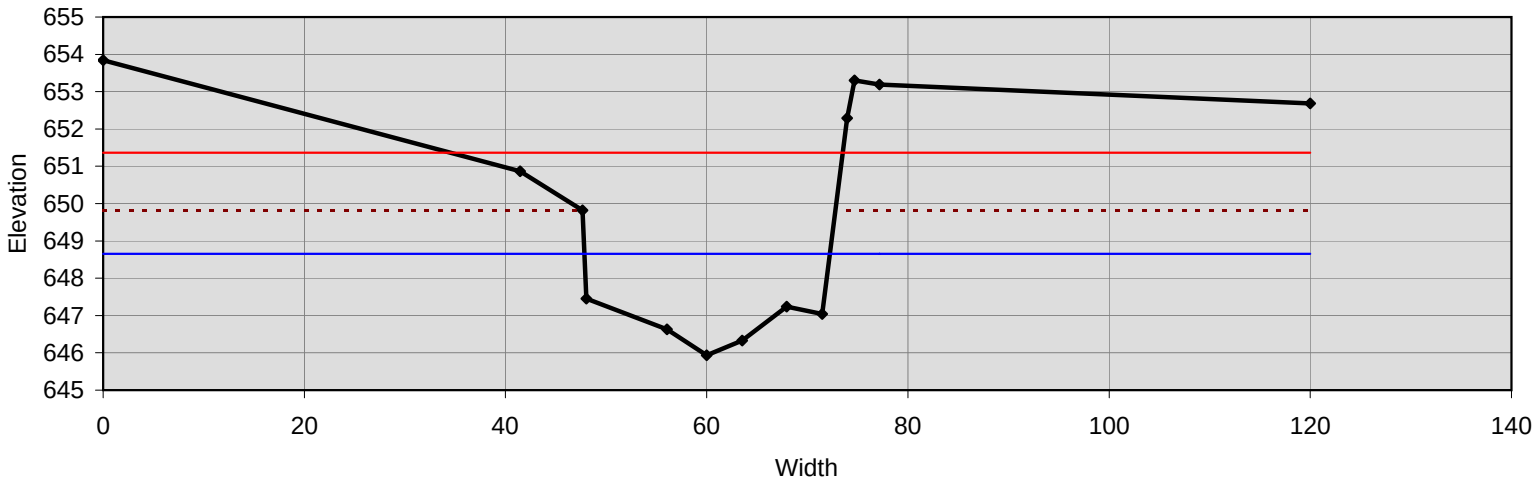
Bankfull Flow	
---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance	
---	Manning's roughness
---	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section 6

133 + 0 Riffle



Bankfull Dimensions	
45.5	x-section area (ft.sq.)
24.4	width (ft)
1.9	mean depth (ft)
2.7	max depth (ft)
26.7	wetted parimeter (ft)
1.7	hyd radi (ft)
13.1	width-depth ratio

Flood Dimensions	
32.0	W flood prone area (ft)
1.3	entrenchment ratio
3.9	low bank height (ft)
1.4	low bank height ratio

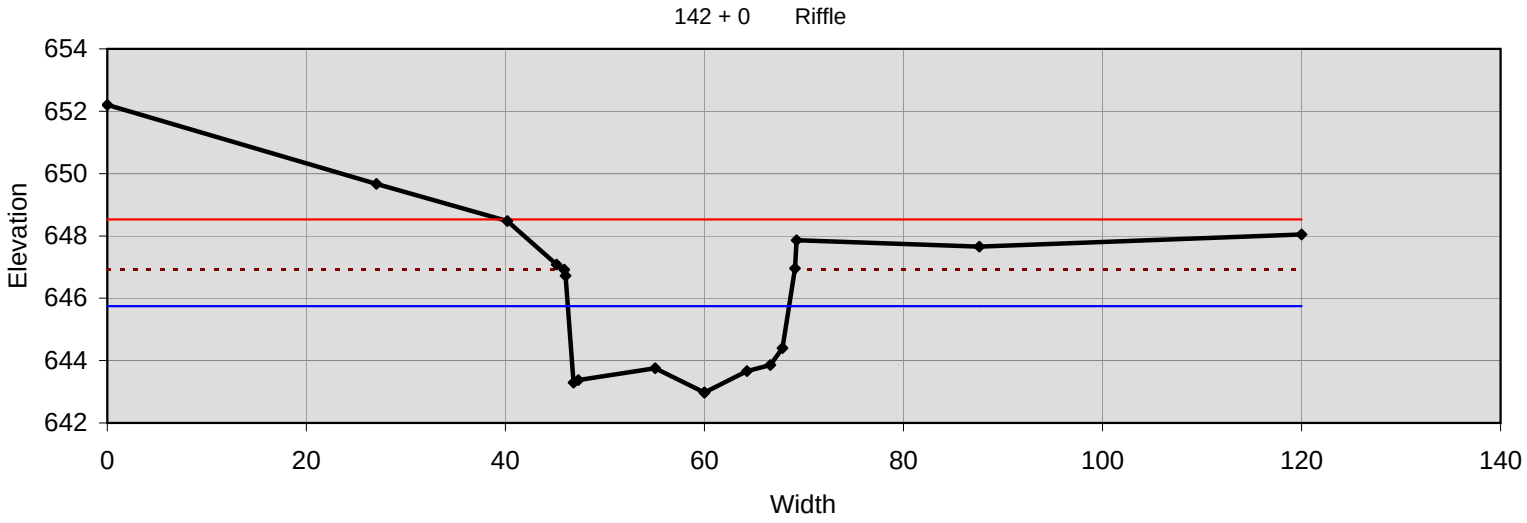
Materials	
---	D50 (mm)
---	D84 (mm)
---	threshold grain size (mm):

Bankfull Flow	
---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance	
---	Manning's roughness
---	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

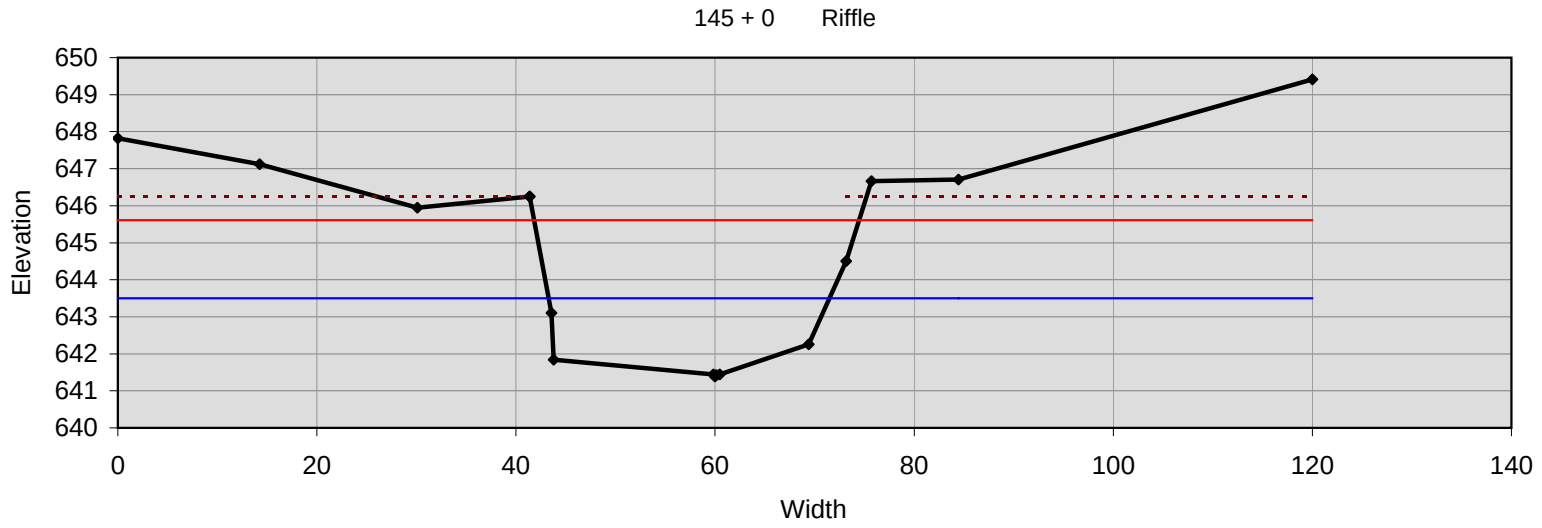
Cross Section 7



Bankfull Dimensions		Flood Dimensions		Materials	
48.0	x-section area (ft.sq.)	29.0	W flood prone area (ft)	---	D50 (mm)
22.2	width (ft)	1.3	entrenchment ratio	---	D84 (mm)
2.2	mean depth (ft)	3.9	low bank height (ft)	---	threshold grain size (mm):
2.8	max depth (ft)	1.4	low bank height ratio		
25.3	wetted parimeter (ft)				
1.9	hyd radi (ft)				
10.3	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

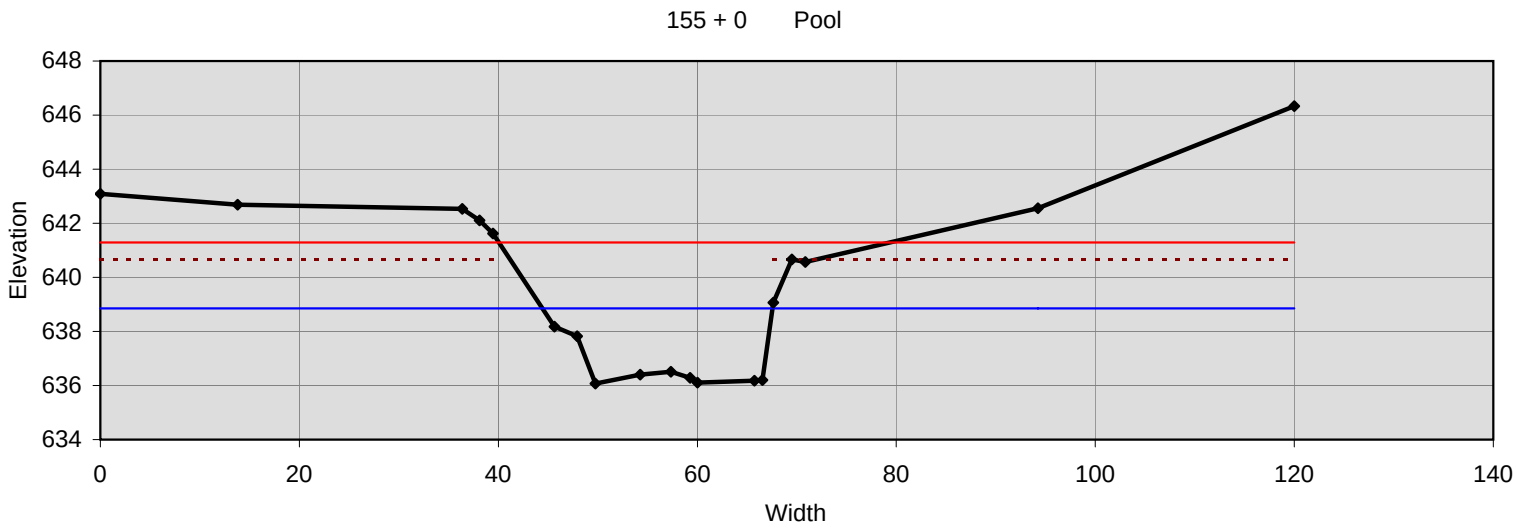
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
47.5	x-section area (ft.sq.)	32.6	W flood prone area (ft)	---	D50 (mm)
28.2	width (ft)	1.2	entrenchment ratio	---	D84 (mm)
1.7	mean depth (ft)	4.9	low bank height (ft)	---	threshold grain size (mm):
2.1	max depth (ft)	2.3	low bank height ratio		
29.9	wetted parimeter (ft)				
1.6	hyd radi (ft)				
16.7	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

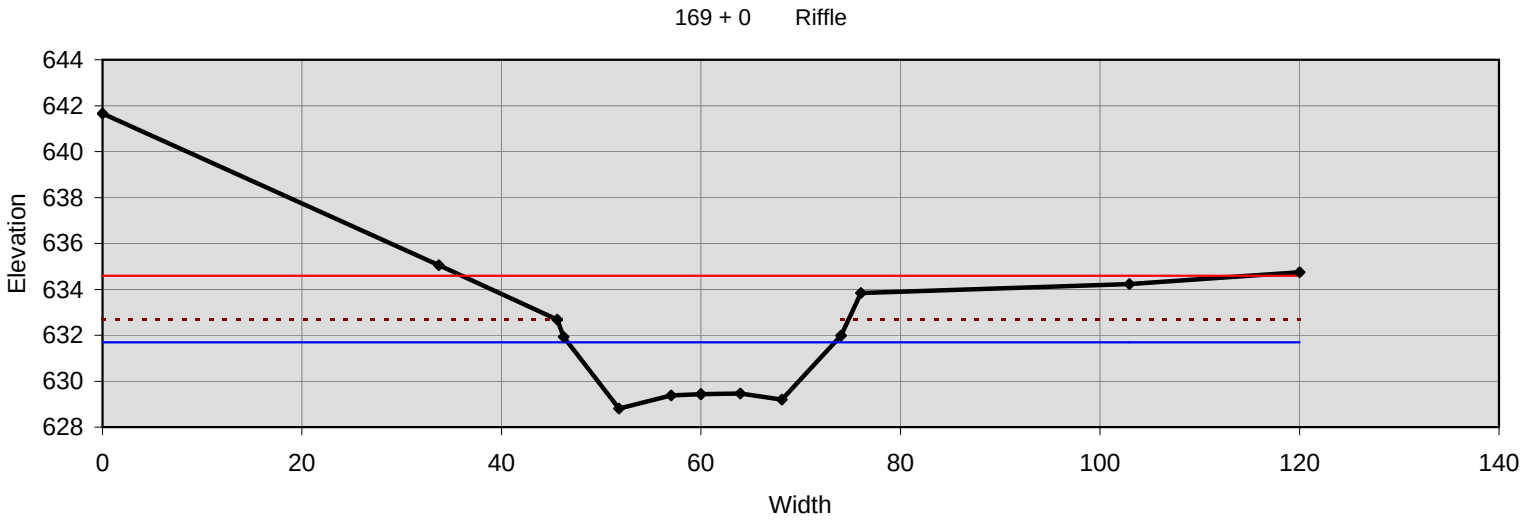
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
50.7	x-section area (ft.sq.)	30.0	W flood prone area (ft)	---	D50 (mm)
23.1	width (ft)	1.3	entrenchment ratio	---	D84 (mm)
2.2	mean depth (ft)	4.6	low bank height (ft)	---	threshold grain size (mm):
2.8	max depth (ft)	1.7	low bank height ratio		
25.9	wetted parimeter (ft)				
2.0	hyd radi (ft)				
10.6	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

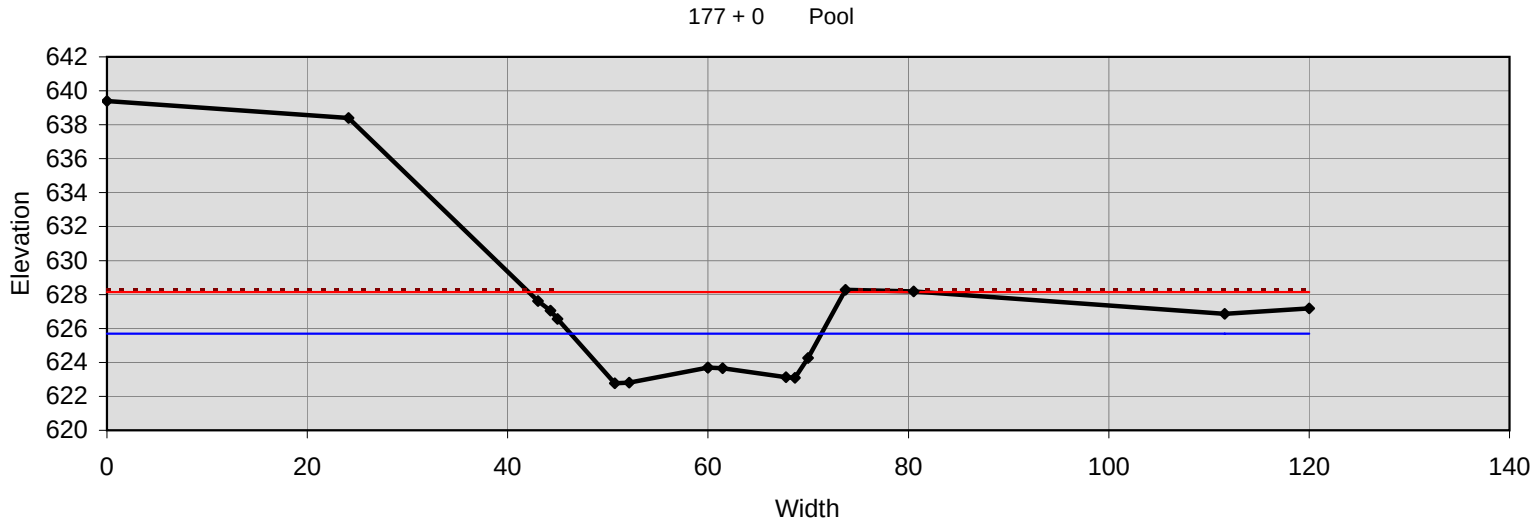
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
53.4	x-section area (ft.sq.)	41.0	W flood prone area (ft)	---	D50 (mm)
26.8	width (ft)	1.5	entrenchment ratio	---	D84 (mm)
2.0	mean depth (ft)	3.9	low bank height (ft)	---	threshold grain size (mm):
2.9	max depth (ft)	1.3	low bank height ratio		
28.2	wetted parimeter (ft)				
1.9	hyd radi (ft)				
13.5	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

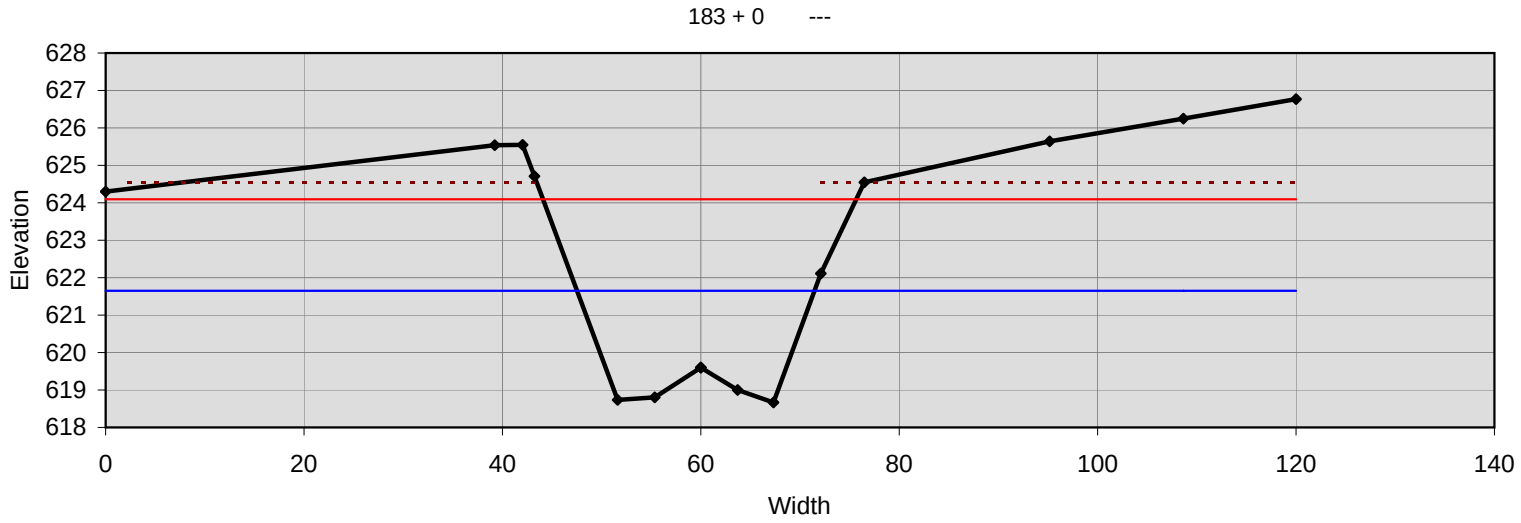
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
53.4	x-section area (ft.sq.)	31.0	W flood prone area (ft)	---	D50 (mm)
25.1	width (ft)	1.2	entrenchment ratio	---	D84 (mm)
2.1	mean depth (ft)	5.5	low bank height (ft)	---	threshold grain size (mm):
2.9	max depth (ft)	1.9	low bank height ratio		
27.1	wetted parimeter (ft)				
2.0	hyd radi (ft)				
11.8	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

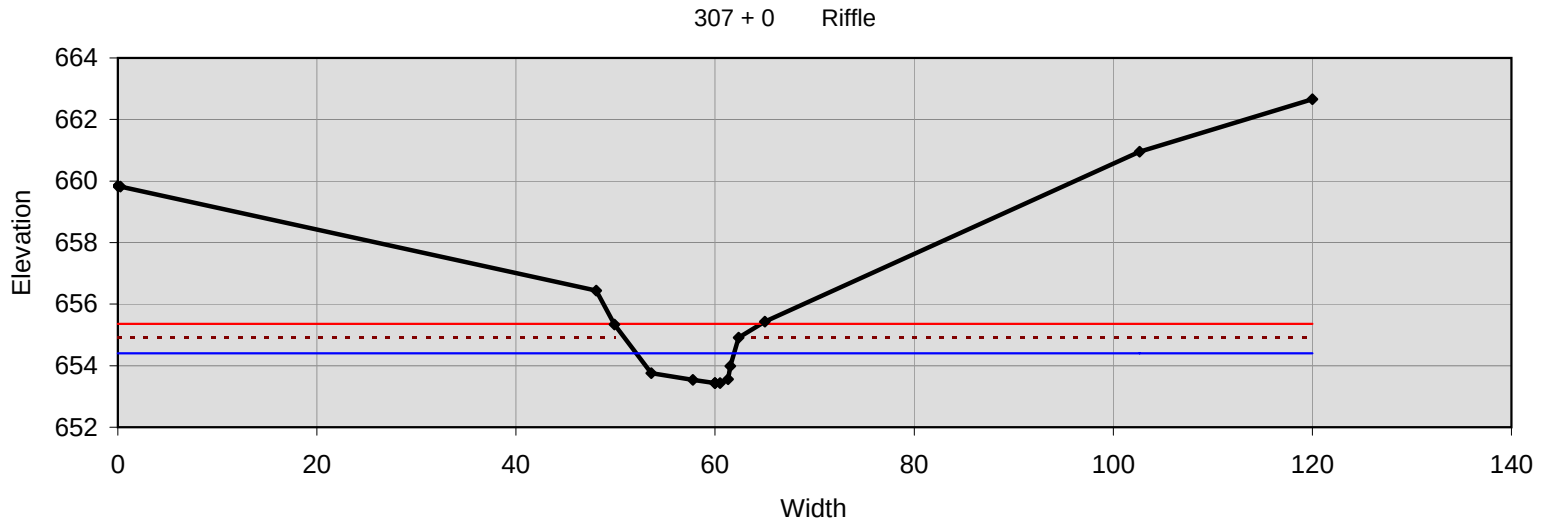
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
53.1	x-section area (ft.sq.)	33.0	W flood prone area (ft)	---	D50 (mm)
23.9	width (ft)	1.4	entrenchment ratio	---	D84 (mm)
2.2	mean depth (ft)	5.9	low bank height (ft)	31	threshold grain size (mm):
3.0	max depth (ft)	2.0	low bank height ratio		
25.9	wetted parimeter (ft)				
2.0	hyd radi (ft)				
10.8	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
4.0	velocity (ft/s)	0.042	Manning's roughness	0.5	channel slope (%)
214.8	discharge rate (cfs)	0.16	D'Arcy-Weisbach fric.	0.64	shear stress (lb/sq.ft.)
0.50	Froude number	---	resistance factor u/u*	0.57	shear velocity (ft/s)
		---	relative roughness	2.8	unit strm power (lb/ft/s)

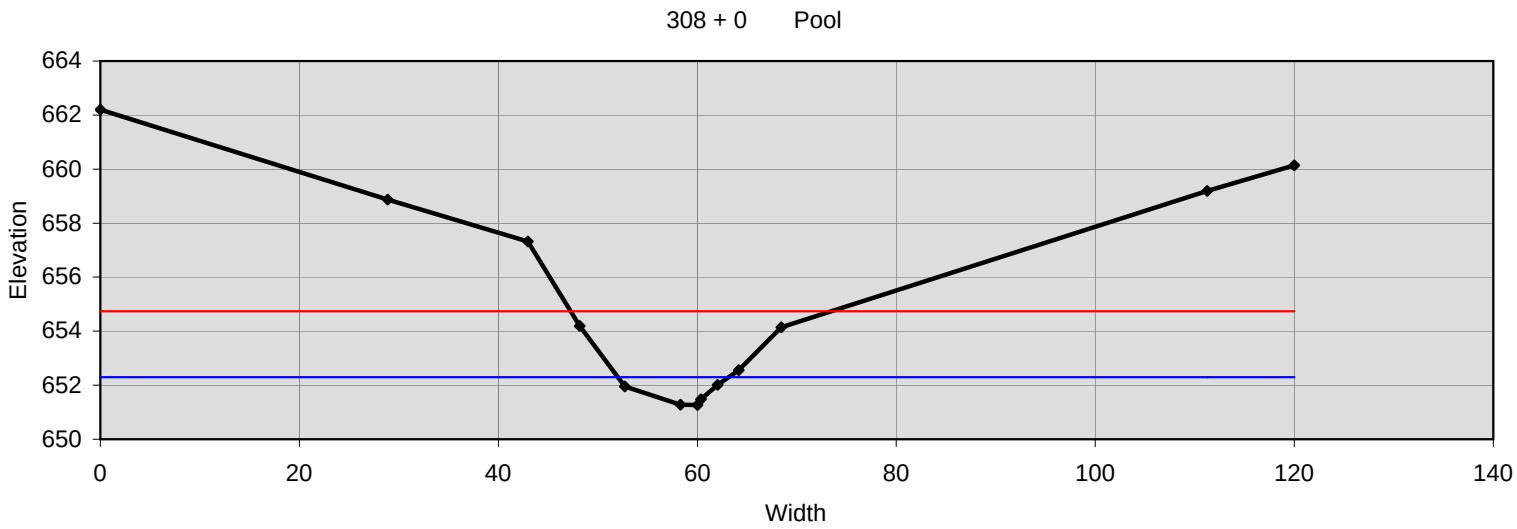
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
7.1	x-section area (ft.sq.)	14.8	W flood prone area (ft)	---	D50 (mm)
9.8	width (ft)	1.5	entrenchment ratio	---	D84 (mm)
0.7	mean depth (ft)	1.5	low bank height (ft)	---	threshold grain size (mm):
1.0	max depth (ft)	1.5	low bank height ratio		
10.4	wetted parimeter (ft)				
0.7	hyd radi (ft)				
13.6	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

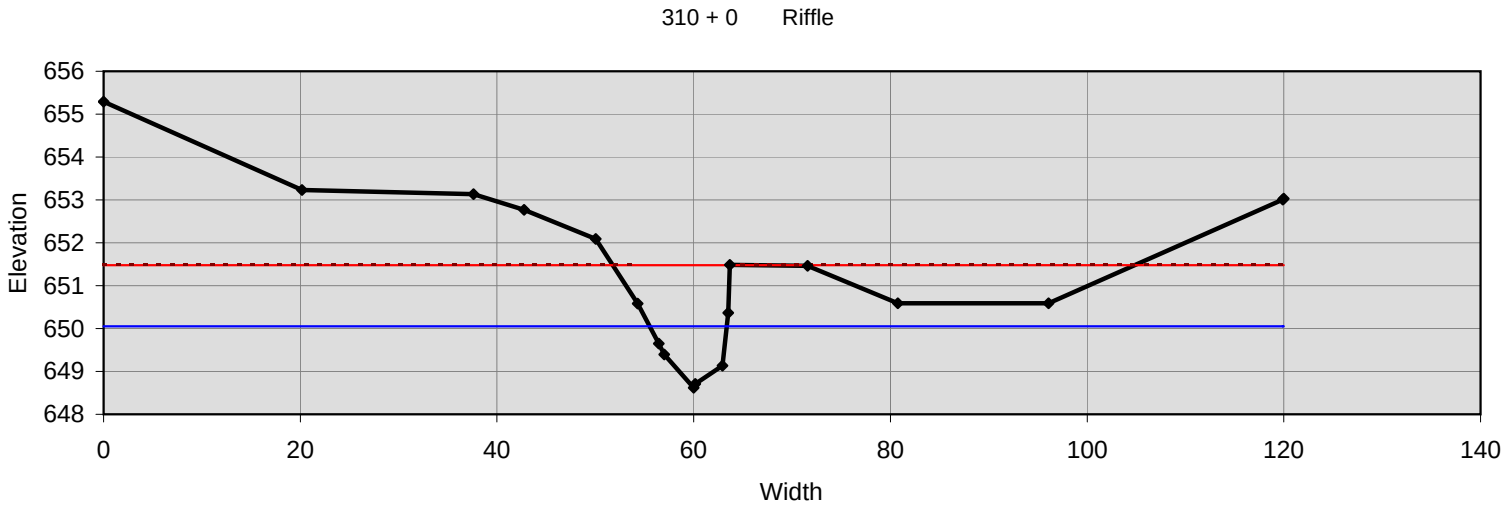
Cross Section



Bankfull Dimensions		Flood Dimensions		Materials	
7.1	x-section area (ft.sq.)	26.3	W flood prone area (ft)	---	D50 (mm)
11.1	width (ft)	2.4	entrenchment ratio	---	D84 (mm)
0.6	mean depth (ft)	---	low bank height (ft)	---	threshold grain size (mm):
1.0	max depth (ft)	---	low bank height ratio		
11.4	wetted parimeter (ft)				
0.6	hyd radi (ft)				
17.5	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

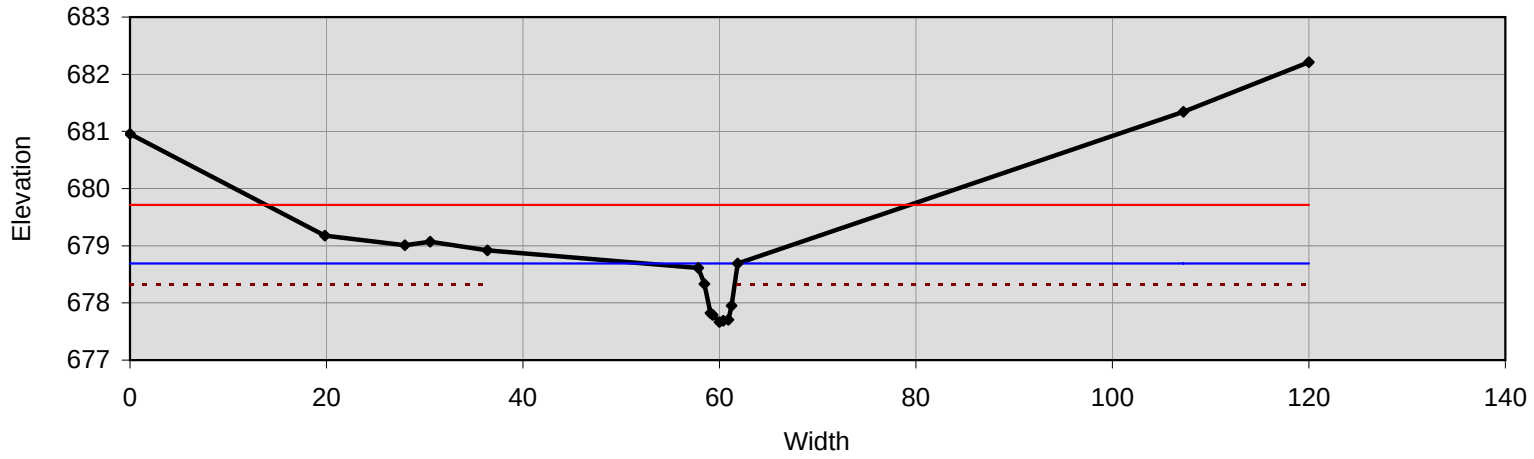


Bankfull Dimensions		Flood Dimensions		Materials	
7.1	x-section area (ft.sq.)	11.0	W flood prone area (ft)	---	D50 (mm)
7.8	width (ft)	1.4	entrenchment ratio	---	D84 (mm)
0.9	mean depth (ft)	2.9	low bank height (ft)	---	threshold grain size (mm):
1.4	max depth (ft)	2.0	low bank height ratio		
8.7	wetted parimeter (ft)				
0.8	hyd radi (ft)				
8.6	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

401 + 0 Riffle

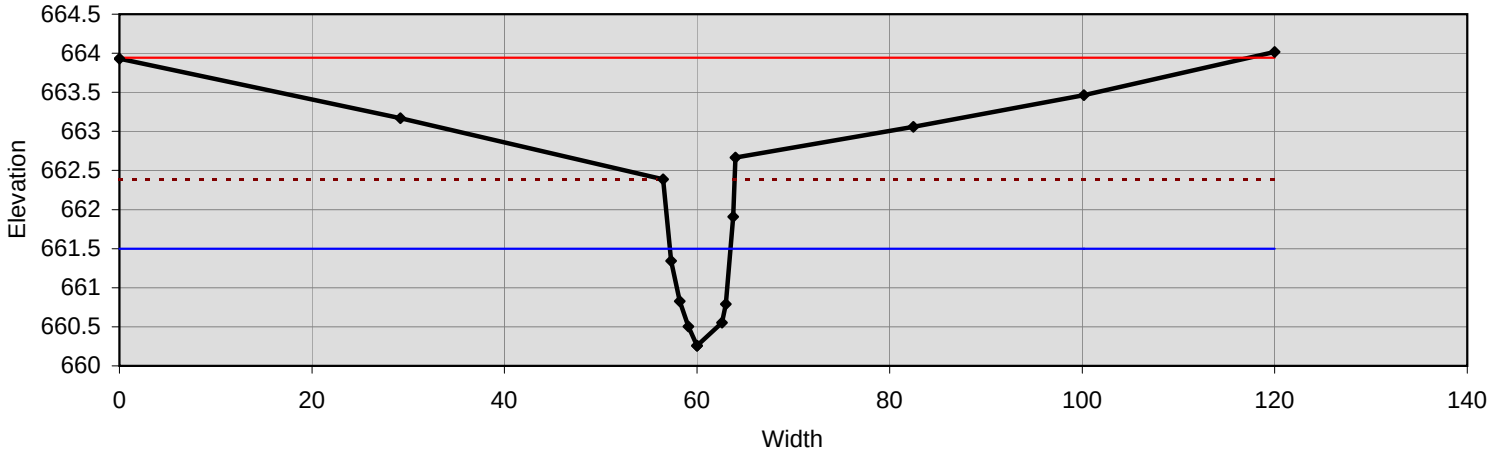


Bankfull Dimensions		Flood Dimensions		Materials	
3.0	x-section area (ft.sq.)	65.6	W flood prone area (ft)	---	D50 (mm)
9.5	width (ft)	6.9	entrenchment ratio	---	D84 (mm)
0.3	mean depth (ft)	0.7	low bank height (ft)	---	threshold grain size (mm):
1.0	max depth (ft)	0.6	low bank height ratio		
10.2	wetted parimeter (ft)				
0.3	hyd radi (ft)				
30.0	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

410 + 0 ---

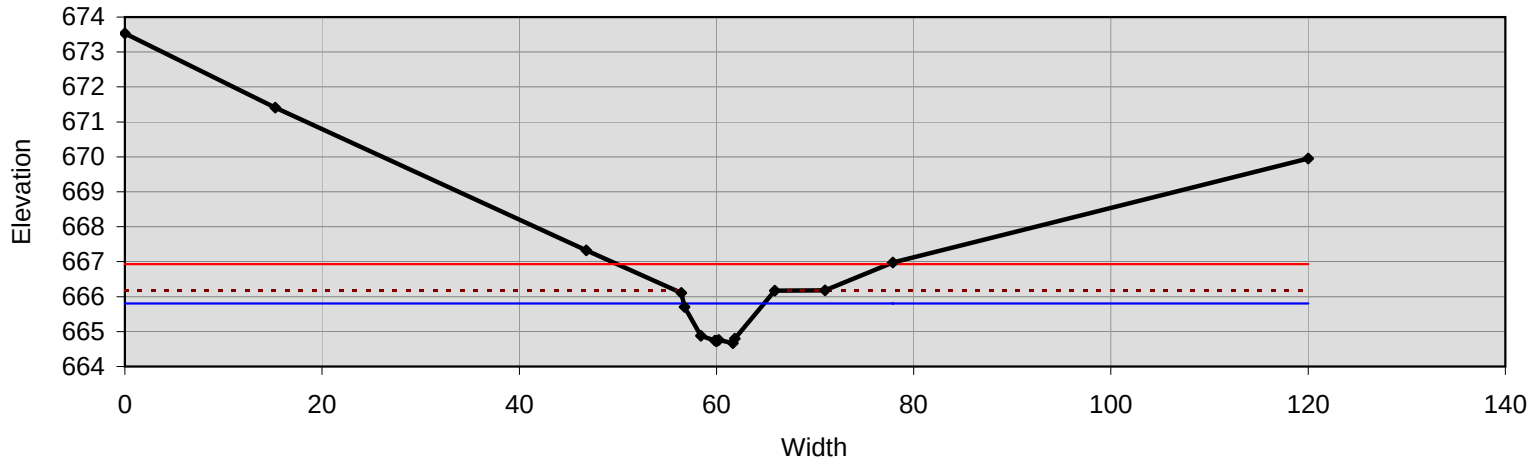


Bankfull Dimensions		Flood Dimensions		Materials	
5.5	x-section area (ft.sq.)	7.5	W flood prone area (ft)	---	D50 (mm)
6.3	width (ft)	1.2	entrenchment ratio	---	D84 (mm)
0.9	mean depth (ft)	2.1	low bank height (ft)	1	threshold grain size (mm):
1.2	max depth (ft)	1.7	low bank height ratio		
7.1	wetted parimeter (ft)				
0.8	hyd radi (ft)				
7.2	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.7	velocity (ft/s)	0.035	Manning's roughness	0.04	channel slope (%)
3.9	discharge rate (cfs)	0.15	D'Arcy-Weisbach fric.	0.02	shear stress (lb/sq.ft.)
0.14	Froude number	---	resistance factor u/u*	0.10	shear velocity (ft/s)
		---	relative roughness	0.016	unit strm power (lb/ft/s)

Cross Section

505 + 0 Riffle



Bankfull Dimensions

5.9	x-section area (ft.sq.)
8.1	width (ft)
0.7	mean depth (ft)
1.1	max depth (ft)
8.6	wetted parimeter (ft)
0.7	hyd radi (ft)
11.2	width-depth ratio

Flood Dimensions

27.6	W flood prone area (ft)
3.4	entrenchment ratio
1.5	low bank height (ft)
1.3	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
---	threshold grain size (mm):

Bankfull Flow

---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance

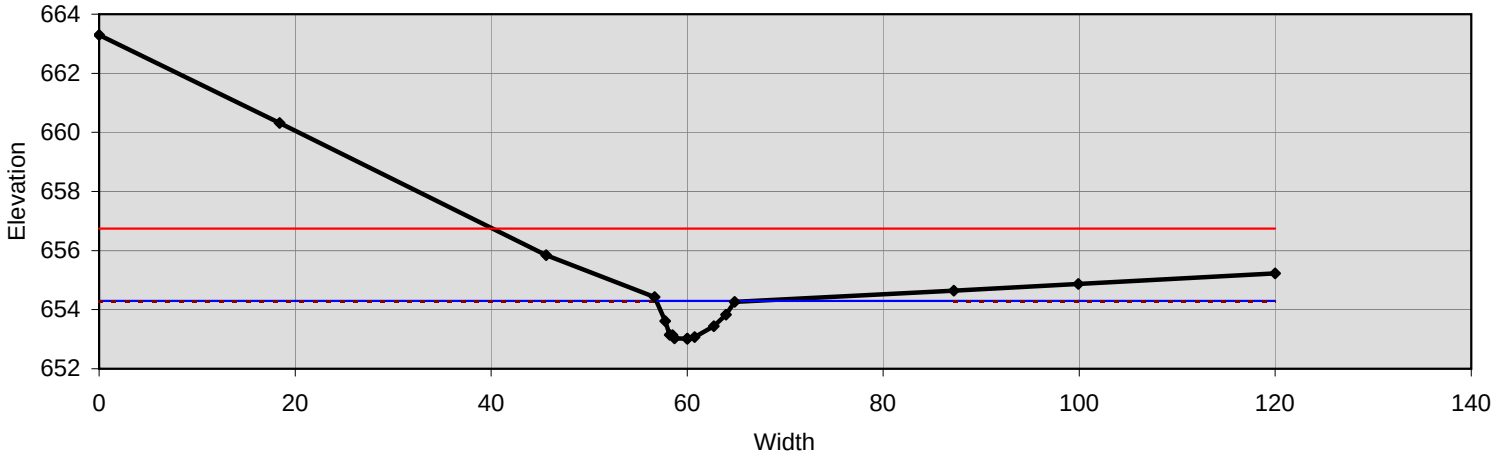
---	Manning's roughness
---	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power

---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section

513 + 0 Pool

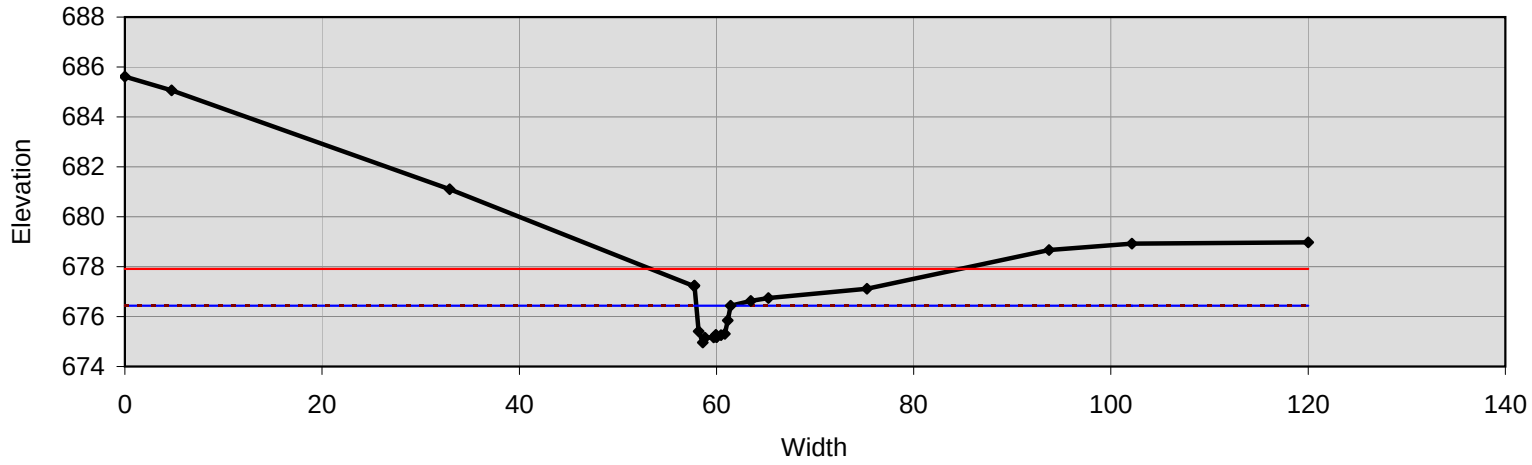


Bankfull Dimensions		Flood Dimensions		Materials	
7.1	x-section area (ft.sq.)	---	W flood prone area (ft)	---	D50 (mm)
10.0	width (ft)	---	entrenchment ratio	---	D84 (mm)
0.7	mean depth (ft)	1.3	low bank height (ft)	---	threshold grain size (mm):
1.3	max depth (ft)	1.0	low bank height ratio		
10.7	wetted parimeter (ft)				
0.7	hyd radi (ft)				
14.1	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

606 + 0 Riffle

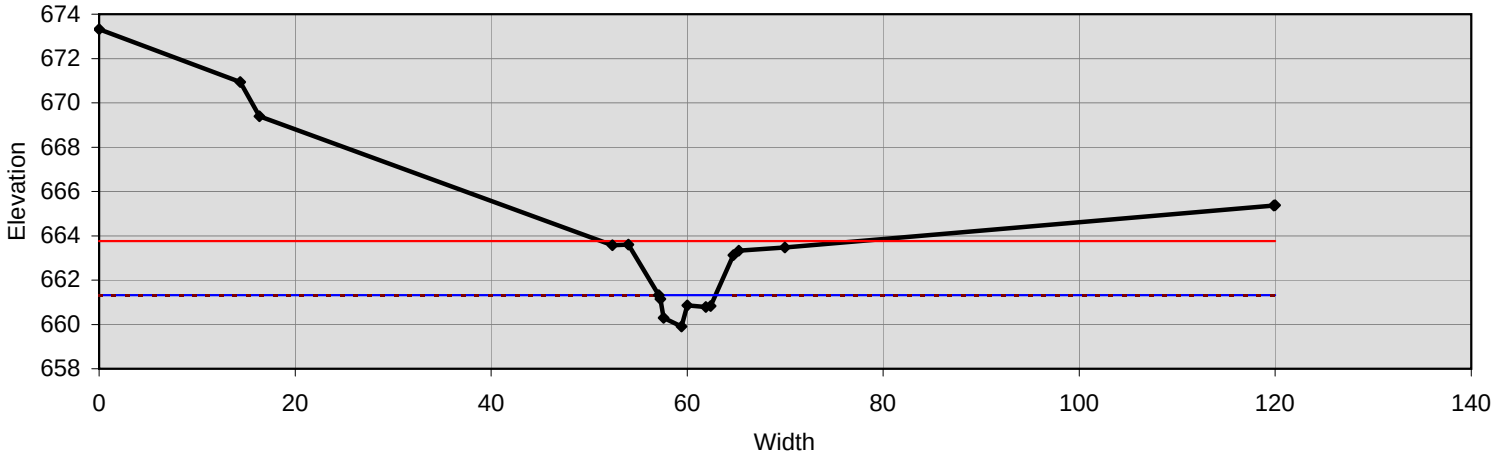


Bankfull Dimensions		Flood Dimensions		Materials	
3.8	x-section area (ft.sq.)	31.5	W flood prone area (ft)	---	D50 (mm)
3.5	width (ft)	8.9	entrenchment ratio	---	D84 (mm)
1.1	mean depth (ft)	1.5	low bank height (ft)	---	threshold grain size (mm):
1.5	max depth (ft)	1.0	low bank height ratio		
5.4	wetted parimeter (ft)				
0.7	hyd radi (ft)				
3.3	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

615 + 0 Pool

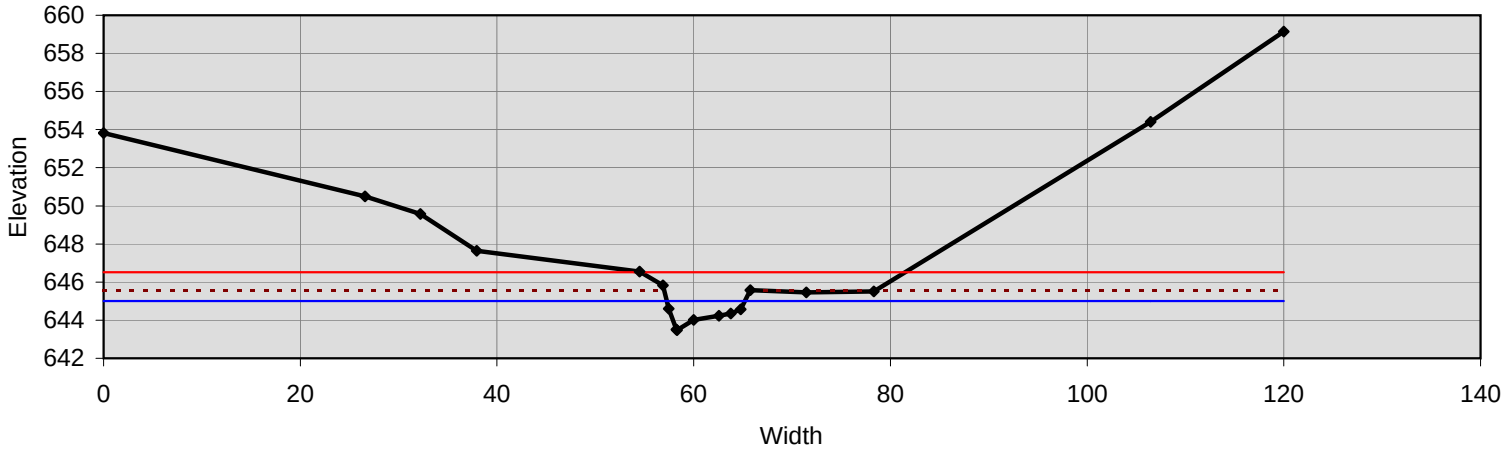


Bankfull Dimensions		Flood Dimensions		Materials	
4.3	x-section area (ft.sq.)	11.0	W flood prone area (ft)	---	D50 (mm)
5.8	width (ft)	1.9	entrenchment ratio	---	D84 (mm)
0.7	mean depth (ft)	1.4	low bank height (ft)	---	threshold grain size (mm):
1.4	max depth (ft)	1.0	low bank height ratio		
7.2	wetted parimeter (ft)				
0.6	hyd radi (ft)				
7.8	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

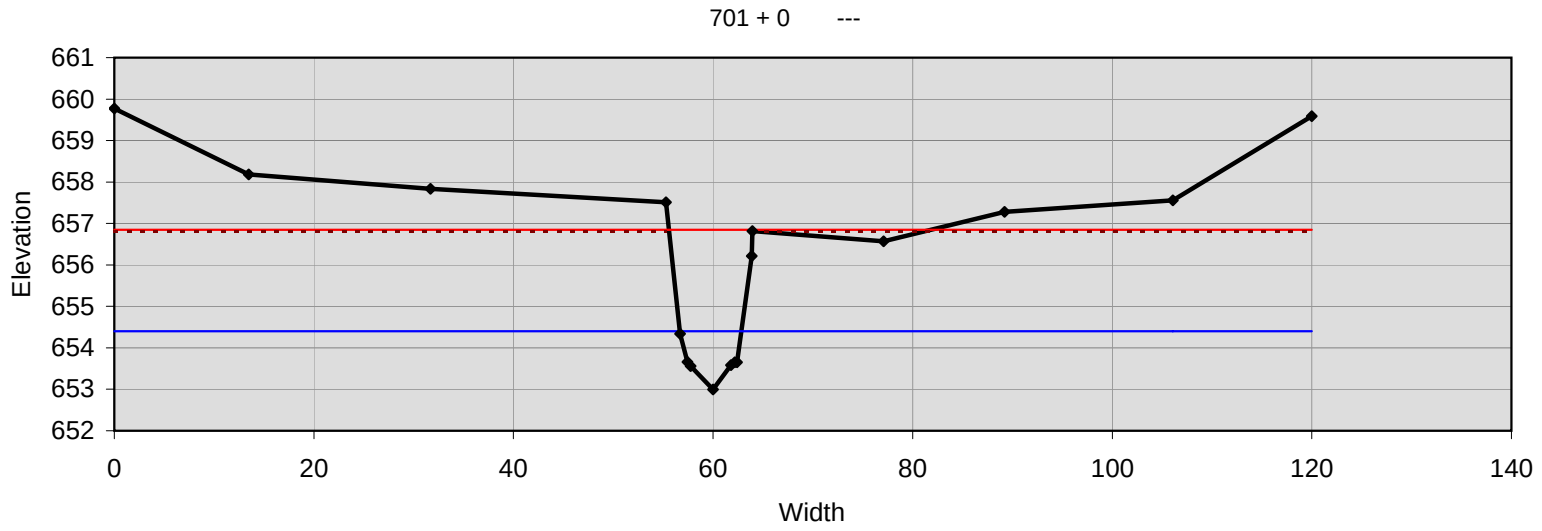
622 + 0 Riffle



Bankfull Dimensions		Flood Dimensions		Materials	
6.8	x-section area (ft.sq.)	26.9	W flood prone area (ft)	---	D50 (mm)
7.9	width (ft)	3.4	entrenchment ratio	---	D84 (mm)
0.9	mean depth (ft)	2.1	low bank height (ft)	---	threshold grain size (mm):
1.5	max depth (ft)	1.4	low bank height ratio		
9.1	wetted parimeter (ft)				
0.7	hyd radi (ft)				
9.3	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

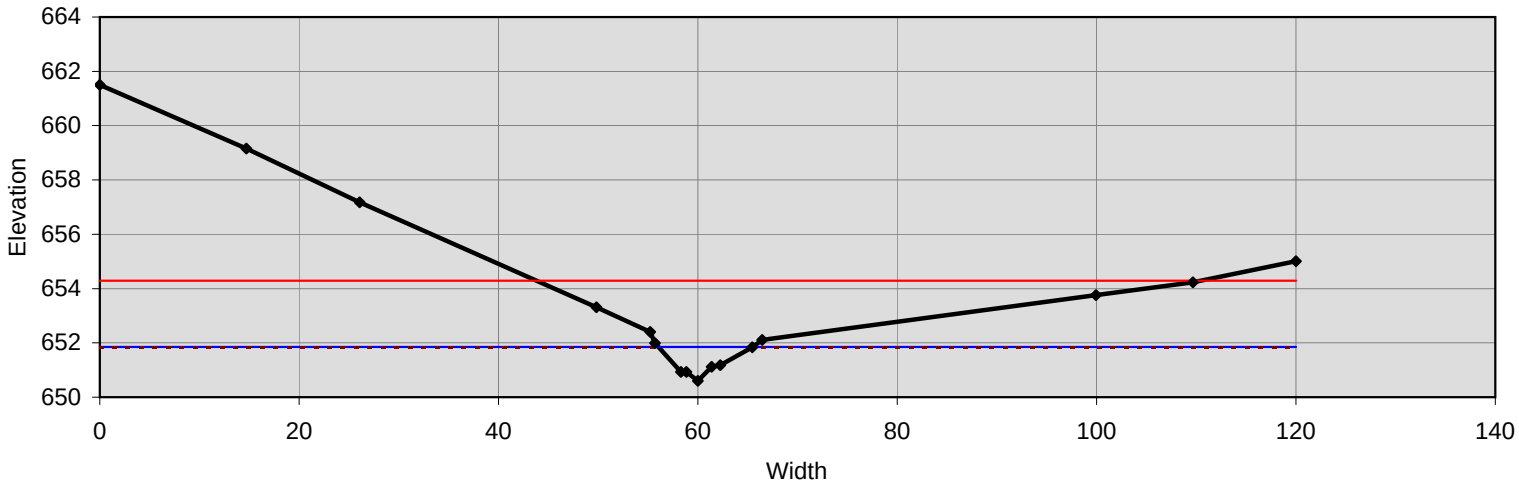


Bankfull Dimensions		Flood Dimensions		Materials	
5.7	x-section area (ft.sq.)	8.6	W flood prone area (ft)	---	D50 (mm)
6.2	width (ft)	1.4	entrenchment ratio	---	D84 (mm)
0.9	mean depth (ft)	3.8	low bank height (ft)	---	threshold grain size (mm):
1.4	max depth (ft)	2.7	low bank height ratio		
7.1	wetted parimeter (ft)				
0.8	hyd radi (ft)				
6.7	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

704 + 0 ---

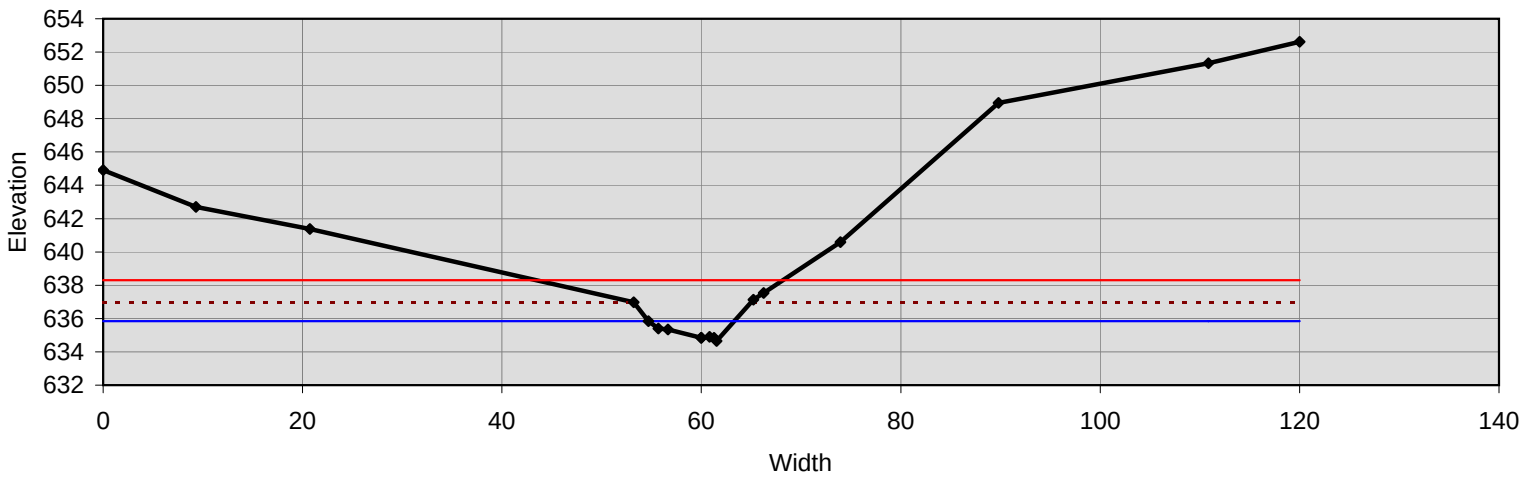


Bankfull Dimensions		Flood Dimensions		Materials	
5.9	x-section area (ft.sq.)	66.7	W flood prone area (ft)	---	D50 (mm)
9.5	width (ft)	7.0	entrenchment ratio	---	D84 (mm)
0.6	mean depth (ft)	1.2	low bank height (ft)	---	threshold grain size (mm):
1.3	max depth (ft)	1.0	low bank height ratio		
9.9	wetted parimeter (ft)				
0.6	hyd radi (ft)				
15.3	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

711 + 0 ---



Bankfull Dimensions		Flood Dimensions		Materials	
5.8	x-section area (ft.sq.)	24.7	W flood prone area (ft)	---	D50 (mm)
8.6	width (ft)	2.9	entrenchment ratio	---	D84 (mm)
0.7	mean depth (ft)	2.3	low bank height (ft)	---	threshold grain size (mm):
1.2	max depth (ft)	1.9	low bank height ratio		
9.2	wetted parimeter (ft)				
0.6	hyd radi (ft)				
12.8	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Appendix C.
SITE NCDWQ Stream Classification Forms

Northern Tributary

NCDWQ Stream Classification Form

Project Name: Holly Grove | River Basin: Cape Fear | County: Guilford | Evaluator: WFL

DWQ Project Number: | Nearest Named Stream: Reedy Fork | Latitude: | Signature: W Grant Jr

Date: 12/28/04 | USGS QUAD: Ossipee | 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	(2)	2	3
4) Is The Channel Sinuous?	0	(2)	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	(2)	2	3
8) Is There A Bankfull Bench Present?	0	(2)	2	3
9) Is A Continuous Bed & Bank Present?	0	1	(2)	3

*(*NOTE: If Bed & Bank Caused By Ditching And **WITHOUT** Sinuosity Then Score=0*)*

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: 16

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

PRIMARY HYDROLOGY INDICATOR POINTS: 1

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: 5

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: 2

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is This Year's (Or Last's) Leaflitter Present In Streambed?	(0)	.5	1	1.5
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 Data 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: 5

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?	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed Is Noted Above Skip This Step UNLESS SAV Present*)*	5	1	.75	(3)	0	0

2

Total 31

Middle Tributary Under Rd

NCDWQ Stream Classification Form

Project Name: Holly Grove | River Basin: Cape Fear | County: Guilford | Evaluator: WGL

DWQ Project Number: | Nearest Named Stream: Reedy Fork | Latitude: | Signature: W Grant Lee

Date: 12/28/04 | USGS QUAD: Ossipee | 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?	0	(1)	2	3

*(*NOTE: If Bed & Bank Caused By Ditching And **WITHOUT** Sinuosity Then Score=0*)*

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: 16

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

PRIMARY HYDROLOGY INDICATOR POINTS: 3

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: 4

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: 1.5

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is This Year's (Or Last's) Leaflitter Present In Streambed?	(0)	.5	(1)	1.5
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: 0

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?	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
*(*NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step **UNLESS** SAV Present*)*	3	1	(.5)	.5	0	0

1.75

Total 32.25

Appendix D.
Reference Reach Photographs

Fork Creek: Riffle

Fork Creek: Pool

Fork Creek: Riffle

Fork Creek: Pool

Fork Creek: Riffle

Fork Creek: Pool

UT to Polecat Creek

UT to Polecat Creek

UT to Polecat Creek

UT to Polecat Creek

Appendix E.
Reference Reach Data

Summary

Stream:	Fork Creek
Watershed:	Cape Fear I
Location:	South of Asheboro
Latitude:	35.57167
Longitude:	79.74500
State:	NC
County:	Randolph
Date:	March 2, 2006
Observers:	SGG, EA, BAM, AMH
Channel type:	B4c
ıe area (sq.mi.):	2.2
notes:	---

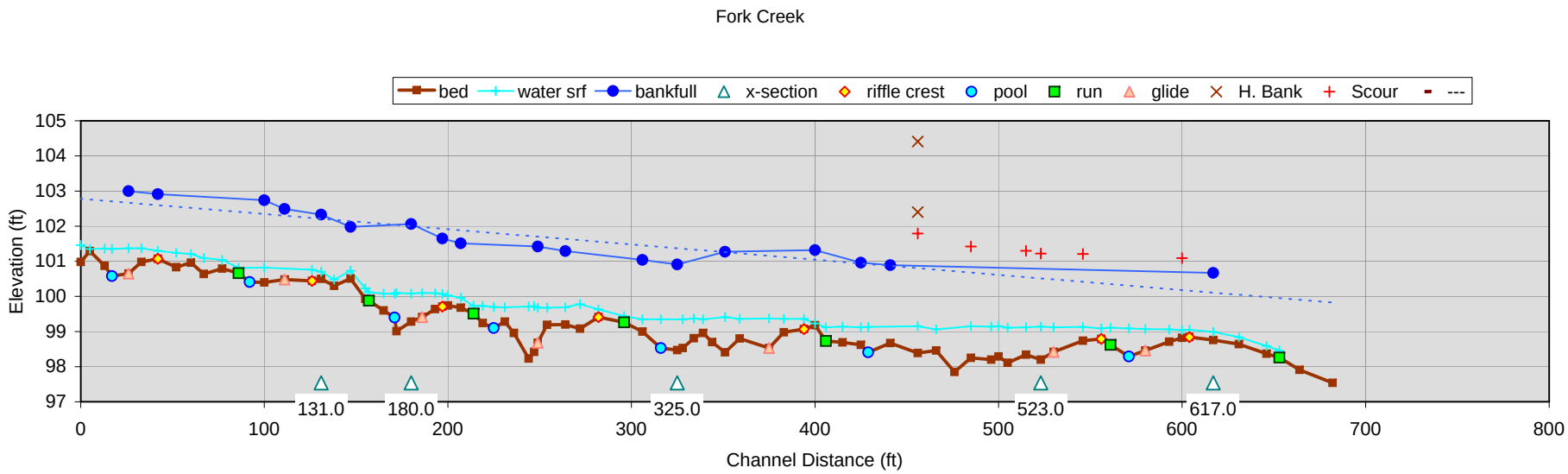
Dimension		ınkfull chanr typical	min	max	
floodplain:	width flood prone area (ft)	63.0	54.0	63.0	
	low bank height (ft)	2.4	2.3	2.4	
riffle-run:	x-area bankfull (sq.ft.)	34.8	34.8	39.7	
	width bankfull (ft)	20.1	20.1	23.6	
	mean depth (ft)	1.73	1.7	1.7	
	max depth (ft)	2.0	2.0	2.0	
	hydraulic radius (ft)	1.6			
pool:	x-area pool (sq.ft.)	37.5	32.2	51.1	
	width pool (ft)	19.9	16.3	21.5	
	max depth pool (ft)	2.6	2.6	2.9	
	hydraulic radius (ft)	1.9			
dimensionless ratios:		typical	min	max	
	width depth ratio	11.6	11.6	14.0	
	entrenchment ratio	3.1	2.7	3.1	
	riffle max depth ratio	1.2	1.1	1.2	
	bank height ratio	1.2	1.2	1.2	
	pool area ratio	1.1	0.9	1.5	
	pool width ratio	1.0	0.8	1.1	
	pool max depth ratio	1.5	1.5	1.7	
hydraulics:		typical	min	max	
	discharge rate (cfs)	163.0	88.5	163.6	
	channel slope (%)	0.79			
		riffle-run	min	max	pool
	velocity (ft/s)	4.7	2.2	4.7	4.3
	Froude number	0.65	0.32	0.66	0.31
	shear stress (lbs/sq.ft.)	0.789	0.174	0.771	0.937
	shear velocity (ft/s)	0.638	0.300	0.631	0.695
	stream power (lb/s)	80.4	43.6	80.6	
	unit stream power (lb/ft/s)	3.998	0.421	4.015	
	relative roughness	16.0	---	---	
	friction factor u/u*	7.3	7.2	7.2	
	ıld grain size (t*=0.06) (mm)	37.9	8.6	37.9	
	Shield's parameter	0.070			

Pattern	typical	min	max
meander length (ft)	148.0	37.0	172.0
belt width (ft)	33.0	33.0	40.0
amplitude (ft)	---	---	---
radius (ft)	107.0	47.0	318.0
arc angle (degrees)	---	---	---
stream length (ft)	682.0		
valley length (ft)	650.0		
Sinuosity	1.0		
Meander Length Ratio	7.4	1.8	8.6
Meander Width Ratio	1.6	1.6	2.0
Radius Ratio	5.3	2.3	15.8

Profile	typical	min	max
pool-pool spacing (ft)	78.0	71.0	134.0
riffle length (ft)	30.7	17.0	44.0
pool length (ft)	16.8	9.0	24.0
run length (ft)	10.3	6.0	14.0
glide length (ft)	18.8	11.0	33.0
channel slope (%)	0.79		
riffle slope (%)	1.3	0.1	2.1
pool slope (%)	0.1	0.1	0.22
run slope (%)	1.2	0.1	4.2
glide slope (%)	0.2	0.05	0.44
measured valley slope (%)	---		
ley slope from sinuosity (%)	0.8		
Riffle Length Ratio	1.5	0.8	2.2
Pool Length Ratio	0.8	0.4	1.2
Run Length Ratio	0.5	0.3	0.7
Glide Length Ratio	0.9	0.5	1.6
Riffle Slope Ratio	1.6	0.1	2.7
Pool Slope Ratio	0.1	0.1	0.3
Run Slope Ratio	1.5	0.1	5.3
Glide Slope Ratio	0.3	0.1	0.6
Pool Spacing Ratio	3.9	3.5	6.7

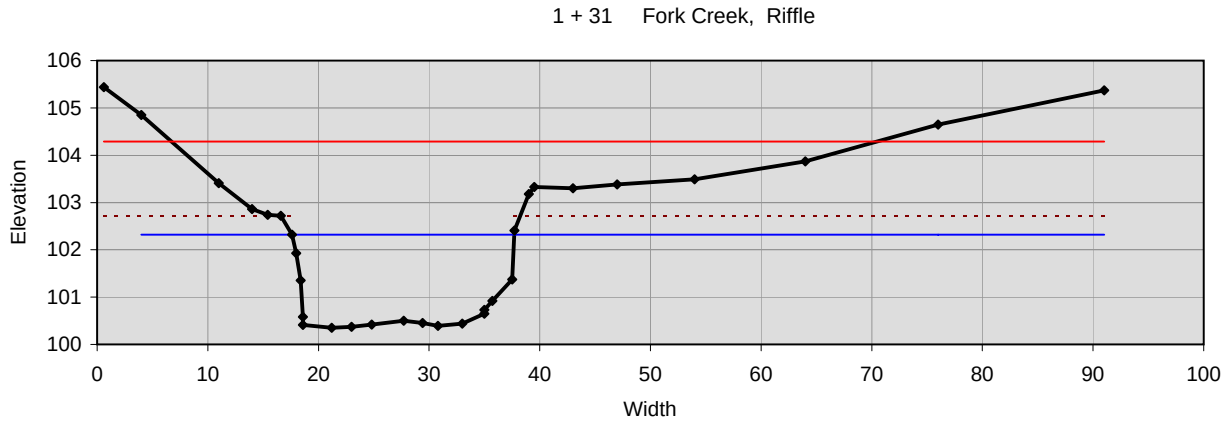
Channel Materials	Riffle Surface			BkF Channel
D16 (mm)	6.4	---	---	1.1
D35 (mm)	15	---	---	11
D50 (mm)	33	---	---	28
D65 (mm)	52	---	---	44
D84 (mm)	90	---	---	81
D95 (mm)	160	---	---	130
mean (mm)	24.0			9.4
dispersion	3.9			14.2
skewness	-0.1			-0.3
Shape Factor	---			
% Silt/Clay	1%	---	---	
% Sand	9%	---	---	20%
% Gravel	64%	---	---	48%
% Cobble	26%	---	---	23%
% Boulder		---	---	
% Bedrock		---		9%
% Clay Hardpan		---		
% Detritus/Wood		---		
% Artificial		---		
Largest Mobile (mm)	---			

Longitudinal Slope Profile



	slope (%)		slope ratio		length (ft)		length ratio		pool-pool spacing (ft)		p-p ratio	
reach	0.79		---		682.0	(33.9 channel widths)	---		---		---	
riffle	1.3	(0.1 - 2.1)	1.6	(0.1 - 2.7)	24.6	(17 - 44)	1.5	(0.8 - 2.2)	---		---	
pool	0.1	(0.1 - 0.22)	0.1	(0.1 - 0.3)	16.8	(9 - 24)	0.8	(0.4 - 1.2)	78.0	(71 - 134)	3.9	(3.5 - 6.7)
run	1.2	(0.1 - 4.2)	1.5	(0.1 - 5.3)	10.3	(6 - 14)	0.5	(0.3 - 0.7)	---		---	
glide	0.2	(0.05 - 0.44)	0.3	(0.1 - 0.6)	18.8	(11 - 33)	0.9	(0.5 - 1.6)	---		---	

Cross Section R1



Bankfull Dimensions	
34.8	x-section area (ft.sq.)
20.1	width (ft)
1.7	mean depth (ft)
2.0	max depth (ft)
22.3	wetted parimeter (ft)
1.6	hyd radi (ft)
11.6	width-depth ratio

Flood Dimensions	
63.0	W flood prone area (ft)
3.1	entrenchment ratio
2.4	low bank height (ft)
1.2	low bank height ratio

Materials	
33	D50 Riffle (mm)
90	D84 Riffle (mm)
38	threshold grain size (mm):

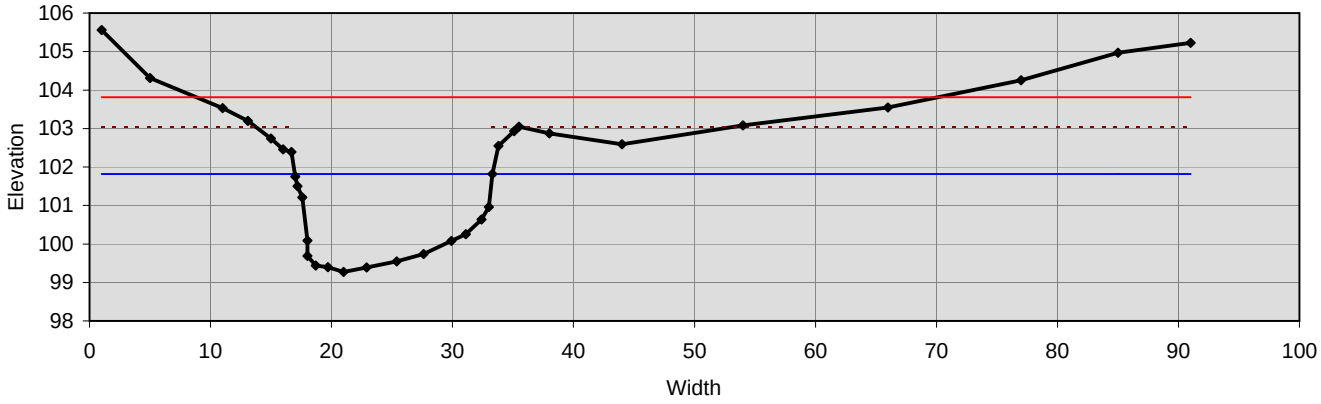
Bankfull Flow	
4.7	velocity (ft/s)
163.6	discharge rate (cfs)
0.66	Froude number

Flow Resistance	
0.038	Manning's roughness
0.14	D'Arcy-Weisbach fric.
7.2	resistance factor u/u*
5.9	relative roughness

Forces & Power	
0.79	channel slope (%)
0.77	shear stress (lb/sq.ft.)
0.63	shear velocity (ft/s)
4	unit strm power (lb/ft/s)

Cross Section P1

1 + 80 Fork Creek, Pool



Bankfull Dimensions	
32.2	x-section area (ft.sq.)
16.3	width (ft)
2.0	mean depth (ft)
2.6	max depth (ft)
18.6	wetted parimeter (ft)
1.7	hyd radi (ft)
8.3	width-depth ratio

Flood Dimensions	
61.4	W flood prone area (ft)
3.8	entrenchment ratio
3.8	low bank height (ft)
1.5	low bank height ratio

Materials	
33	D50 Riffle (mm)
90	D84 Riffle (mm)
42	threshold grain size (mm):

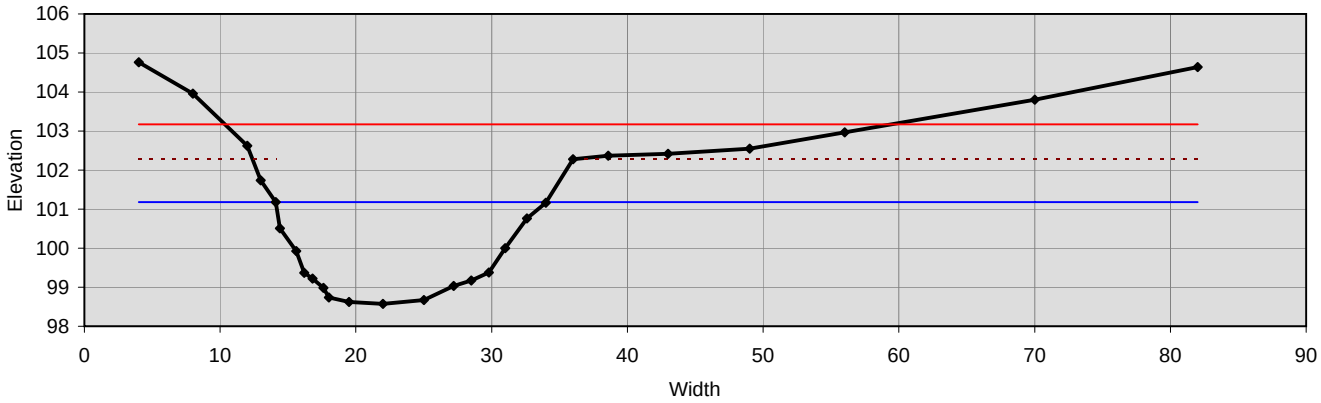
Bankfull Flow	
5.0	velocity (ft/s)
161.6	discharge rate (cfs)
0.67	Froude number

Flow Resistance	
0.038	Manning's roughness
0.14	D'Arcy-Weisbach fric.
7.6	resistance factor u/u*
6.7	relative roughness

Forces & Power	
0.79	channel slope (%)
0.85	shear stress (lb/sq.ft.)
0.66	shear velocity (ft/s)
4.9	unit strm power (lb/ft/s)

Cross Section P2

3 + 25 Fork Creek, Pool



Bankfull Dimensions	
37.5	x-section area (ft.sq.)
19.9	width (ft)
1.9	mean depth (ft)
2.6	max depth (ft)
21.3	wetted parimeter (ft)
1.8	hyd radi (ft)
10.6	width-depth ratio

Flood Dimensions	
49.1	W flood prone area (ft)
2.5	entrenchment ratio
3.7	low bank height (ft)
1.4	low bank height ratio

Materials	
33	D50 Riffle (mm)
90	D84 Riffle (mm)
10	threshold grain size (mm):

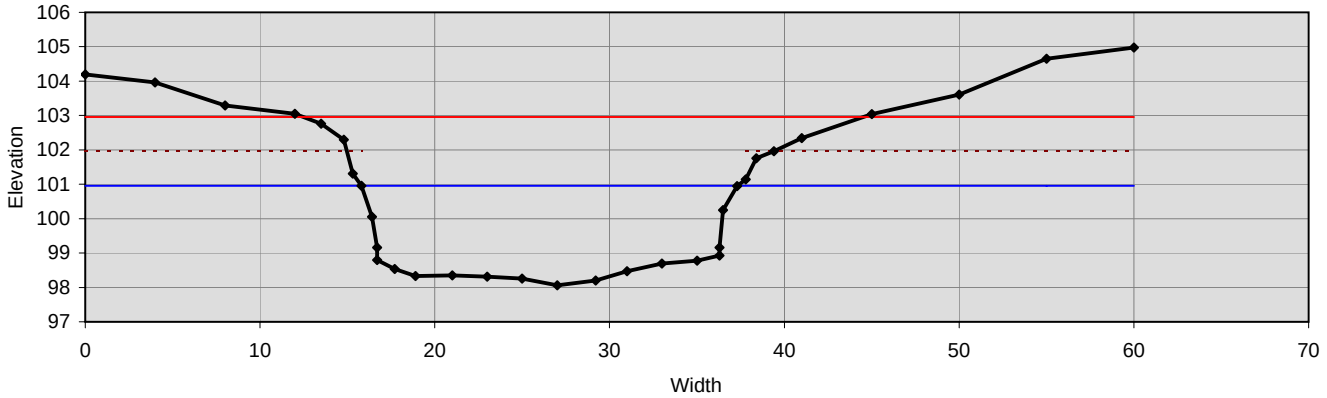
Bankfull Flow	
2.4	velocity (ft/s)
90.8	discharge rate (cfs)
0.32	Froude number

Flow Resistance	
0.038	Manning's roughness
0.14	D'Arcy-Weisbach fric.
7.7	resistance factor u/u*
6.4	relative roughness

Forces & Power	
0.18	channel slope (%)
0.20	shear stress (lb/sq.ft.)
0.32	shear velocity (ft/s)
0.51	unit strm power (lb/ft/s)

Cross Section P3

5 + 23 Fork Creek, Pool



Bankfull Dimensions	
51.1	x-section area (ft.sq.)
21.5	width (ft)
2.4	mean depth (ft)
2.9	max depth (ft)
24.5	wetted parimeter (ft)
2.1	hyd radi (ft)
9.1	width-depth ratio

Flood Dimensions	
32.0	W flood prone area (ft)
1.5	entrenchment ratio
3.9	low bank height (ft)
1.3	low bank height ratio

Materials	
33	D50 Riffle (mm)
90	D84 Riffle (mm)
12	threshold grain size (mm):

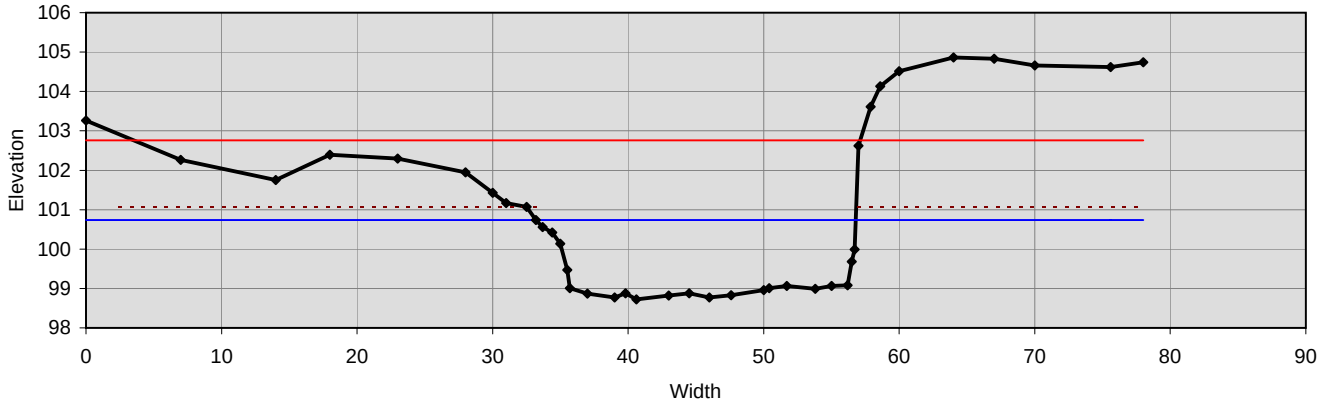
Bankfull Flow	
2.7	velocity (ft/s)
138.8	discharge rate (cfs)
0.33	Froude number

Flow Resistance	
0.038	Manning's roughness
0.13	D'Arcy-Weisbach fric.
8.0	resistance factor u/u*
8.0	relative roughness

Forces & Power	
0.18	channel slope (%)
0.23	shear stress (lb/sq.ft.)
0.35	shear velocity (ft/s)
0.72	unit strm power (lb/ft/s)

Cross Section R2

6 + 17 Fork Creek, Riffle



Bankfull Dimensions	
39.7	x-section area (ft.sq.)
23.6	width (ft)
1.7	mean depth (ft)
2.0	max depth (ft)
25.6	wetted parimeter (ft)
1.6	hyd radi (ft)
14.0	width-depth ratio

Flood Dimensions	
54.0	W flood prone area (ft)
2.3	entrenchment ratio
2.3	low bank height (ft)
1.2	low bank height ratio

Materials	
33	D50 Riffle (mm)
90	D84 Riffle (mm)
9	threshold grain size (mm):

Bankfull Flow	
2.2	velocity (ft/s)
88.5	discharge rate (cfs)
0.32	Froude number

Flow Resistance	
0.038	Manning's roughness
0.14	D'Arcy-Weisbach fric.
7.2	resistance factor u/u*
5.7	relative roughness

Forces & Power	
0.18	channel slope (%)
0.17	shear stress (lb/sq.ft.)
0.30	shear velocity (ft/s)
0.42	unit strm power (lb/ft/s)

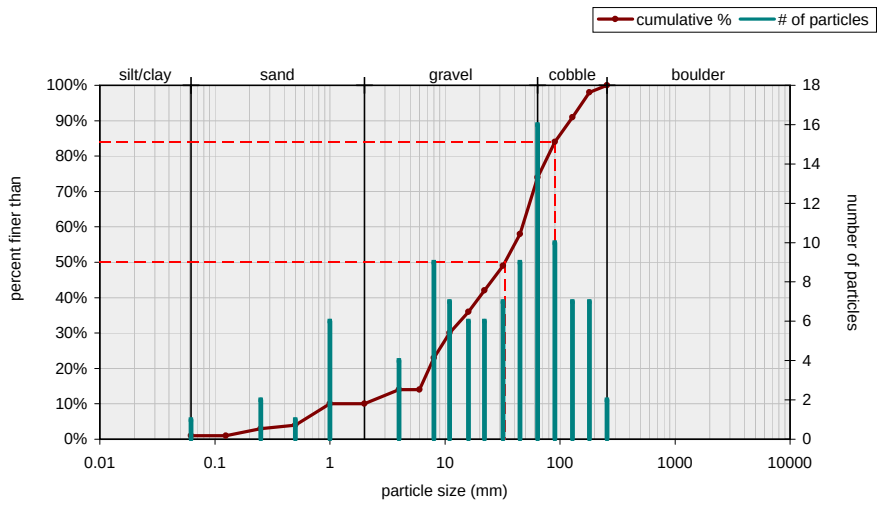
1) Individual Pebble Count

Two individual samples may be entered below. Select sample type for each.

Riffle Surface

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

Note: Riffle



Size (mm)	
D16	6.4
D35	15
D50	33
D65	52
D84	90
D95	160

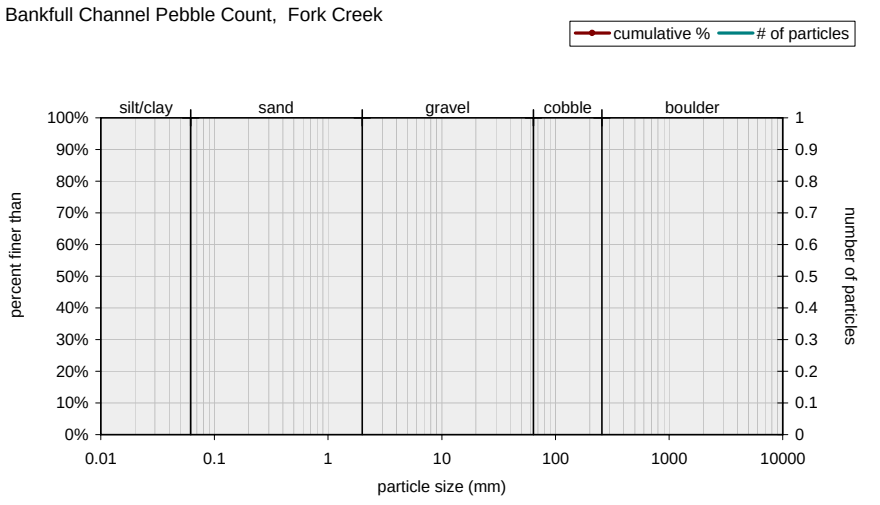
Size Distribution	
mean	24.0
dispersion	3.9
skewness	-0.13

Type	
silt/clay	1%
sand	9%
gravel	64%
cobble	26%
boulder	0%

Bankfull Channel

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

Note:



Size (mm)		
D16	---	3.4
D35	---	12
D50	---	17
D65	---	20
D84	---	29
D95	---	39

Size Distribution	
mean	---
dispersion	---
skewness	---

Type	
silt/clay	---
sand	---
gravel	---
cobble	---
boulder	---

2) Weighted Pebble Count

Feature Percent of Reach

Riffle, Pool, Run, Glide

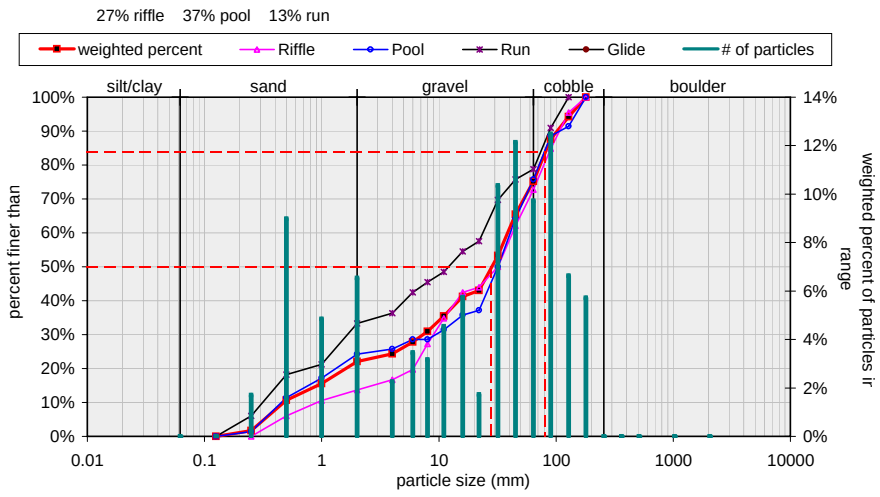
Riffle	27	%	Run	13	%
Pool	37	%	Glide		%

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	0.0
very fine sand	0.062 - 0.125	0.0
fine sand	0.125 - 0.25	1.3
medium sand	0.25 - 0.5	6.9
coarse sand	0.5 - 1	3.7
very coarse sand	1 - 2	5.0
very fine gravel	2 - 4	1.7
fine gravel	4 - 6	2.7
fine gravel	6 - 8	2.4
medium gravel	8 - 11	3.5
medium gravel	11 - 16	4.4
coarse gravel	16 - 22	1.3
coarse gravel	22 - 32	8.0
very coarse gravel	32 - 45	9.3
very coarse gravel	45 - 64	7.5
small cobble	64 - 90	9.6
medium cobble	90 - 128	5.1
large cobble	128 - 180	4.4
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

total particle weighted count:	77
bedrock ----------	7.4
clay hardpan ----------	0.0
detritus/wood ----------	0.0
artificial ----------	0.0
total weighted count:	84.4

Note:



Size (mm)	
D16	1.1
D35	11
D50	28
D65	44
D84	81
D95	130

Size Distribution	
mean	9.4
dispersion	14.2
skewness	-0.35

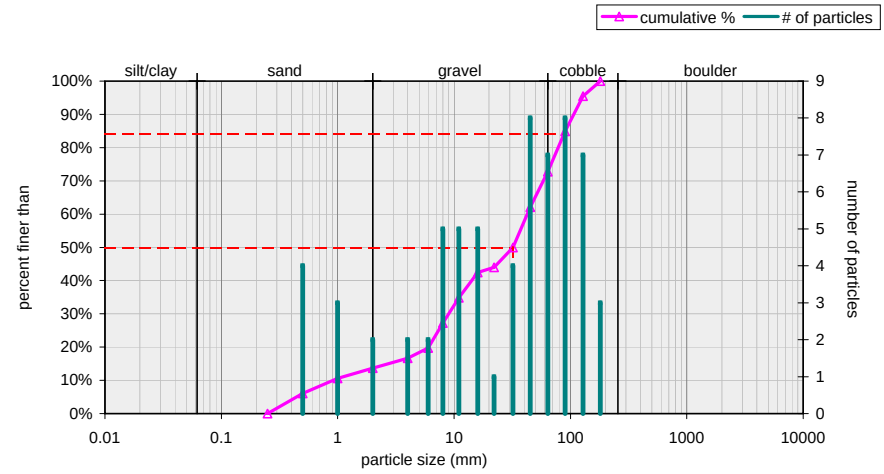
Type			
silt/clay	0%	bedrock	9%
sand	20%		
gravel	48%		
cobble	23%		
boulder	0%		

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**4**
coarse sand	0.5 - 1	**3**
very coarse sand	1 - 2	**2**
very fine gravel	2 - 4	**2**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**5**
coarse gravel	16 - 22	**1**
coarse gravel	22 - 32	**4**
very coarse gravel	32 - 45	**8**
very coarse gravel	45 - 64	**7**
small cobble	64 - 90	**8**
medium cobble	90 - 128	**7**
large cobble	128 - 180	**3**
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:	66
bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	66

Note:



Size (mm)	
D16	3.4
D35	11
D50	32
D65	50
D84	88
D95	130

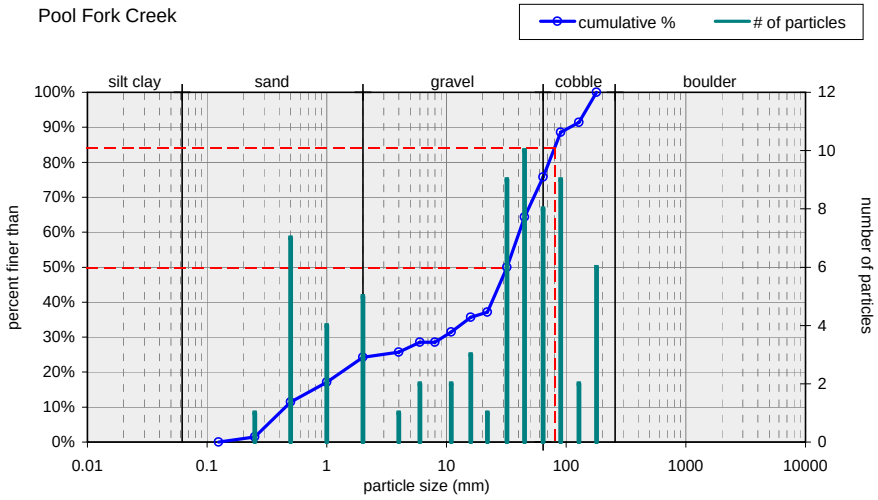
Size Distribution	
mean	17.3
dispersion	6.1
skewness	-0.22

Type	
silt/clay	0%
sand	14%
gravel	59%
cobble	27%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**1**
medium sand	0.25 - 0.5	**7**
coarse sand	0.5 - 1	**4**
very coarse sand	1 - 2	**5**
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	
medium gravel	8 - 11	**2**
medium gravel	11 - 16	**3**
coarse gravel	16 - 22	**1**
coarse gravel	22 - 32	**9**
very coarse gravel	32 - 45	**10**
very coarse gravel	45 - 64	**8**
small cobble	64 - 90	**9**
medium cobble	90 - 128	**2**
large cobble	128 - 180	**6**
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:		70
bedrock		**8**
clay hardpan		
detritus/wood		
artificial		
total count:		78

Note:



Size (mm)	
D16	0.87
D35	15
D50	32
D65	46
D84	80
D95	150

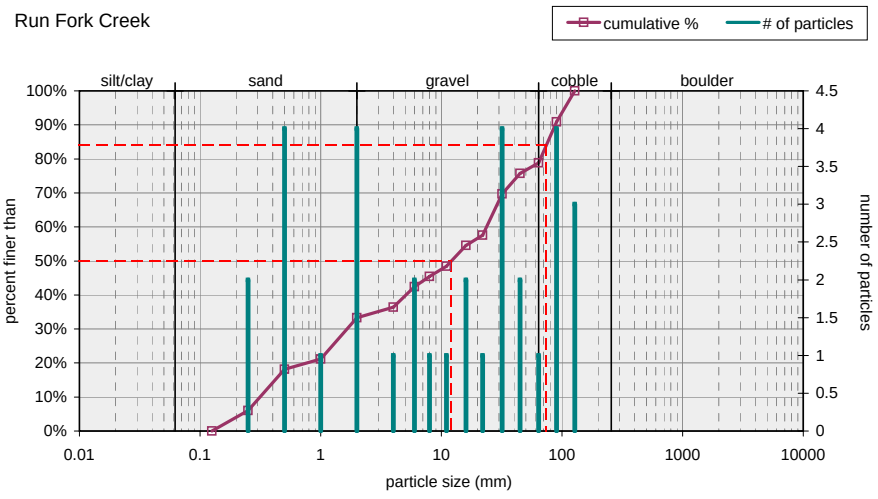
Size Distribution	
mean	8.3
dispersion	19.6
skewness	-0.42

Type			
silt/clay	0%	bedrock	10%
sand	22%		
gravel	46%		
cobble	22%		
boulder	0%		

Run

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**2**
medium sand	0.25 - 0.5	**4**
coarse sand	0.5 - 1	**1**
very coarse sand	1 - 2	**4**
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**1**
medium gravel	11 - 16	**2**
coarse gravel	16 - 22	**1**
coarse gravel	22 - 32	**4**
very coarse gravel	32 - 45	**2**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	**4**
medium cobble	90 - 128	**3**
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:		33
bedrock		**8**
clay hardpan		
detritus/wood		
artificial		
total count:		41

Note:



Size (mm)	
D16	0.44
D35	2.9
D50	12
D65	28
D84	74
D95	110

Size Distribution	
mean	5.7
dispersion	16.7
skewness	-0.22

Type			
silt/clay	0%	bedrock	20%
sand	27%		
gravel	37%		
cobble	17%		
boulder	0%		

3) Bulk Sample Sieve Analysis

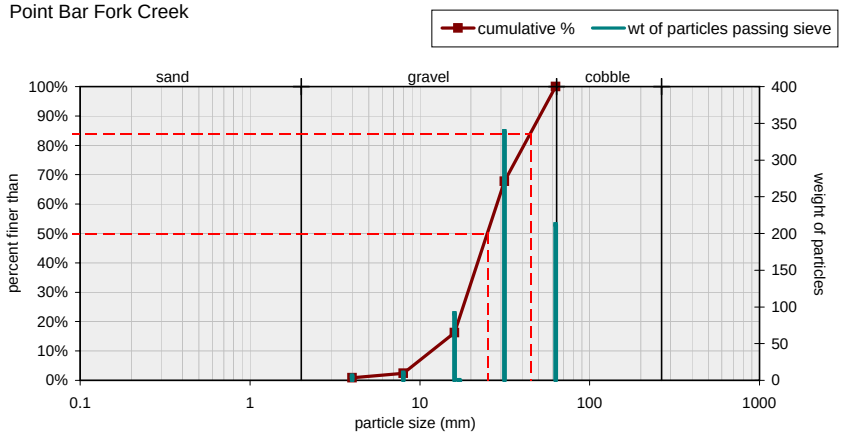
Two samples may be entered below. Select sample type for each.

Point Bar

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
2	**680**	**686**	6	1%	---	---
4	**742**	**752**	10	2%	1%	1%
8	**742**	**833**	91	14%	2%	2%
16	**812**	**1151**	339	52%	14%	16%
31.5	**823**	**1035**	212	32%	52%	68%
63	**0**	**0**	0	0%	32%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%

total wt retained in sieves: 658

Note: Surface Material: Largest Particles 45mm and 40mm



Size (mm)			
D16	16	D65	30
D35	20	D84	45
D50	25	D95	57

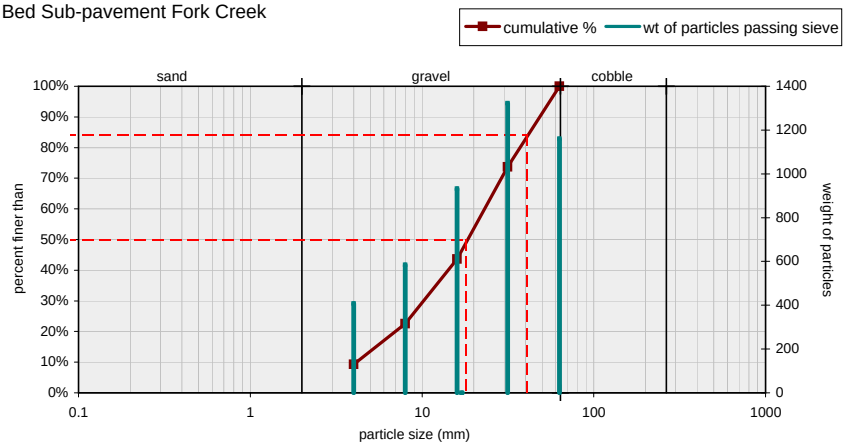
sand 100%

Bed Sub-pavement

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
2	**686**	**1094**	408	9%	---	---
4	**736**	**1320**	584	13%	9%	9%
8	**736**	**1669**	933	21%	13%	23%
16	**808**	**2131**	1323	30%	21%	44%
31.5	**816**	**1976**	1160	26%	30%	74%
63	**0**	**0**	0	0%	26%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%

total: 4408

Note: Sub-pavement: Largest Particles 70mm and 45mm



Size (mm)			
D16	5.7	D65	26
D35	12	D84	41
D50	18	D95	55

Summary

Stream:	UT to Polecat Creek
Watershed:	Cape Fear River Basin
Location:	Fred Lineberry Road, New Salem, North East of Randleman
Latitude:	35.85333
Longitude:	79.77833
State:	NC
County:	Randolph
Date:	February 23, 2006
Observers:	SGG, EA, BAM, AMH
Channel type:	E4
Drainage area (sq.mi.):	0.4
notes:	---

Dimension		bankfull chanr typical	min	max
floodplain:	width flood prone area (ft)	50.0	35.0	66.0
	low bank height (ft)	1.9	1.9	2.4
riffle-run:	x-area bankfull (sq.ft.)	10.6	7.8	10.6
	width bankfull (ft)	9.4	7.4	9.4
	mean depth (ft)	1.13	0.8	1.2
	max depth (ft)	1.6	1.4	1.8
	hydraulic radius (ft)	1.0		
pool:	x-area pool (sq.ft.)	10.0	9.2	14.8
	width pool (ft)	7.1	7.0	9.5
	max depth pool (ft)	2.0	1.7	2.2
	hydraulic radius (ft)	1.0		

dimensionless ratios:	typical	min	max
width depth ratio	8.3	6.4	10.8
entrenchment ratio	5.3	3.7	7.0
riffle max depth ratio	1.4	1.3	1.6
bank height ratio	1.2	1.2	1.5
pool area ratio	0.9	0.9	1.4
pool width ratio	0.8	0.7	1.0
pool max depth ratio	1.8	1.5	2.0

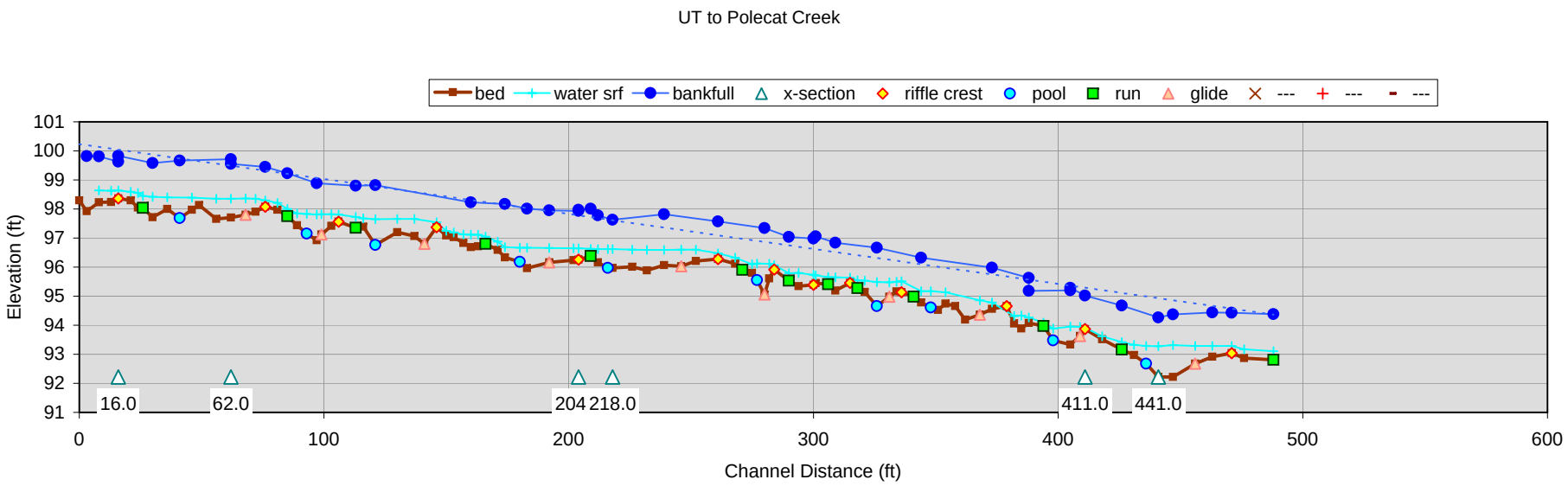
hydraulics:	typical	min	max	
discharge rate (cfs)	37.4	27.4	37.5	
channel slope (%)	1.2			
	riffle-run	min	max	pool
velocity (ft/s)	3.5	3.4	3.5	3.7
Froude number	0.62	0.61	0.73	0.43
shear stress (lbs/sq.ft.)	0.749	0.580	0.680	0.749
shear velocity (ft/s)	0.622	0.547	0.593	0.622
stream power (lb/s)	28.0	20.6	28.0	
unit stream power (lb/ft/s)	2.979	2.396	2.825	
relative roughness	48.4	---	---	
friction factor u/u*	5.7	5.6	6.2	
ıld grain size (t*=0.06) (mm)	30.3	28.5	33.4	
Shield's parameter	0.311			

Pattern	typical	min	max
meander length (ft)	62.0	56.0	85.0
belt width (ft)	30.0	28.0	50.0
amplitude (ft)	---	---	---
radius (ft)	20.0	19.0	50.0
arc angle (degrees)	---	---	---
stream length (ft)	425.0		
valley length (ft)	305.0		
Sinuosity	1.4		
Meander Length Ratio	6.6	6.0	9.0
Meander Width Ratio	3.2	3.0	5.3
Radius Ratio	2.1	2.0	5.3

Profile	typical	min	max
pool-pool spacing (ft)	43.0	34.0	52.0
riffle length (ft)	9.8	3.0	20.0
pool length (ft)	14.8	3.0	30.0
run length (ft)	9.1	6.0	15.0
glide length (ft)	8.8	4.0	15.0
channel slope (%)	1.18		
riffle slope (%)	2.7	0.4	4.7
pool slope (%)	1.7		16
run slope (%)	2.3	0.14	5.8
glide slope (%)			1.5
measured valley slope (%)	---		
valley slope from sinuosity (%)	1.6		
Riffle Length Ratio	1	0.3	2.1
Pool Length Ratio	1.6	0.3	3.2
Run Length Ratio	1	0.6	1.6
Glide Length Ratio	0.9	0.4	1.6
Riffle Slope Ratio	2.3	0.3	4
Pool Slope Ratio	1.4		13.6
Run Slope Ratio	1.9	0.1	4.9
Glide Slope Ratio			1.3
Pool Spacing Ratio	4.6	3.6	5.5

Channel Mater	Riffle Surface			BkF Channel
D16 (mm)	0.14	---	---	0.51
D35 (mm)	0.82	---	---	6
D50 (mm)	7.1	---	---	15
D65 (mm)	48	---	---	37
D84 (mm)	93	---	---	91
D95 (mm)	140	---	---	130
mean (mm)	3.6			6.8
dispersion	31.9			17.7
skewness	-0.2			-0.2
Shape Factor	---			
% Silt/Clay	14%	---	---	7%
% Sand	24%	---	---	18%
% Gravel	34%	---	---	48%
% Cobble	24%	---	---	22%
% Boulder		---	---	
% Bedrock	4%	---		5%
% Clay Hardpan		---		
% Detritus/Wood		---		
% Artificial		---		
Largest Mobile (mm)	---			

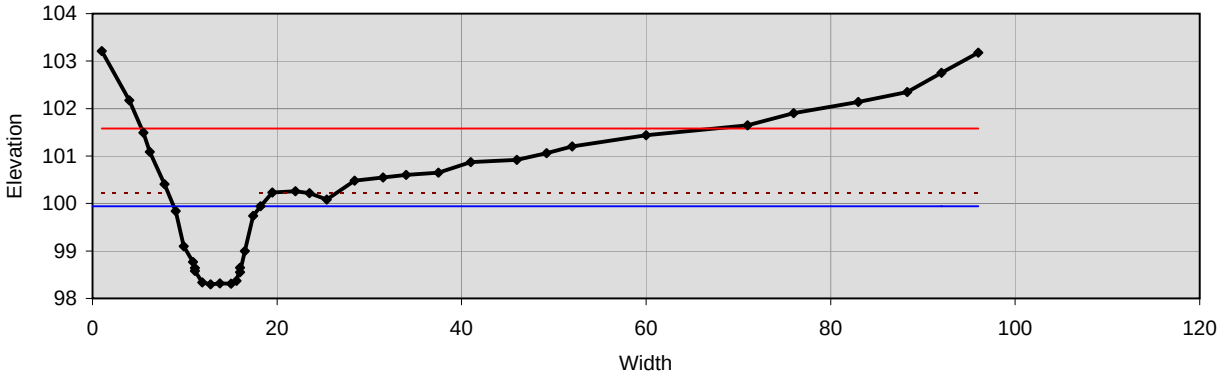
Longitudinal Slope Profile



	slope (%)		slope ratio		length (ft)		length ratio		pool-pool spacing (ft)		p-p ratio	
reach	1.18		---		488.0	(51.9 channel widths)	---		---		---	
riffle	2.7	(0.4 - 4.7)	2.3	(0.3 - 4)	8.9	(3 - 20)	1	(0.3 - 2.1)	---		---	
pool	1.7	(0 - 16)	1.4	(0 - 13.6)	14.8	(3 - 30)	1.6	(0.3 - 3.2)	43.0	(34 - 52)	4.6	(3.6 - 5.5)
run	2.3	(0.14 - 5.8)	1.9	(0.1 - 4.9)	9.1	(6 - 15)	1	(0.6 - 1.6)	---		---	
glide	0	(0 - 1.5)	0	(0 - 1.3)	8.8	(4 - 15)	0.9	(0.4 - 1.6)	---		---	

Cross Section R1

0 + 16.2 UT to Polecat Creek, Riffle



Bankfull Dimensions	
10.6	x-section area (ft.sq.)
9.4	width (ft)
1.1	mean depth (ft)
1.6	max depth (ft)
10.5	wetted parimeter (ft)
1.0	hyd radi (ft)
8.3	width-depth ratio

Flood Dimensions	
66.0	W flood prone area (ft)
7.0	entrenchment ratio
1.9	low bank height (ft)
1.2	low bank height ratio

Materials	
7.1	D50 Riffle (mm)
93	D84 Riffle (mm)
30	threshold grain size (mm):

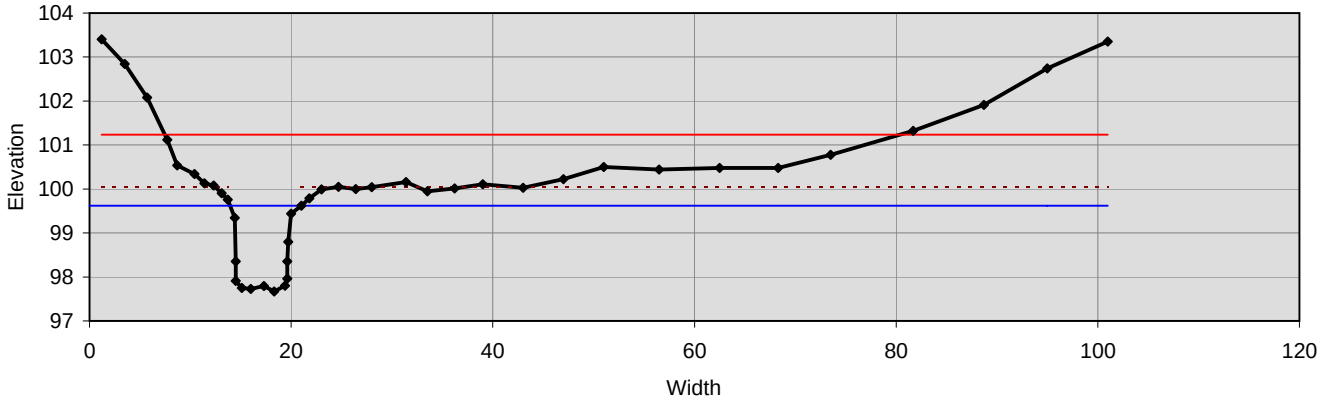
Bankfull Flow	
3.5	velocity (ft/s)
37.5	discharge rate (cfs)
0.62	Froude number

Flow Resistance	
0.042	Manning's roughness
0.20	D'Arcy-Weisbach fric.
6.2	resistance factor u/u*
3.7	relative roughness

Forces & Power	
0.98	channel slope (%)
0.62	shear stress (lb/sq.ft.)
0.56	shear velocity (ft/s)
2.4	unit strm power (lb/ft/s)

Cross Section P1

0 + 60.8 UT to Polecat Creek, Pool



Bankfull Dimensions	
10.0	x-section area (ft.sq.)
7.1	width (ft)
1.4	mean depth (ft)
2.0	max depth (ft)
9.7	wetted parimeter (ft)
1.0	hyd radi (ft)
5.0	width-depth ratio

Flood Dimensions	
---	W flood prone area (ft)
---	entrenchment ratio
2.4	low bank height (ft)
1.2	low bank height ratio

Materials	
7.1	D50 Riffle (mm)
93	D84 Riffle (mm)
31	threshold grain size (mm):

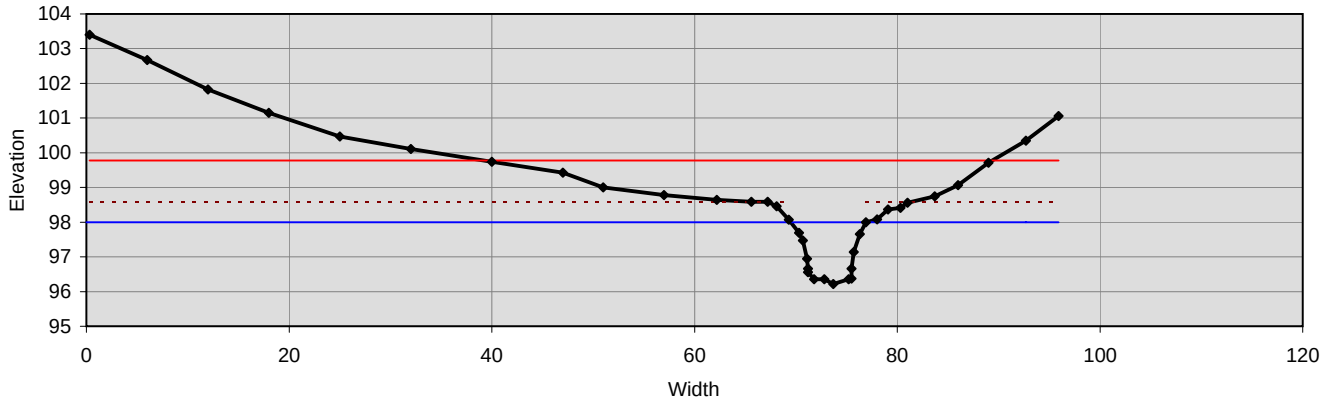
Bankfull Flow	
3.6	velocity (ft/s)
35.6	discharge rate (cfs)
0.62	Froude number

Flow Resistance	
0.042	Manning's roughness
0.20	D'Arcy-Weisbach fric.
6.4	resistance factor u/u*
4.6	relative roughness

Forces & Power	
0.98	channel slope (%)
0.63	shear stress (lb/sq.ft.)
0.57	shear velocity (ft/s)
3.1	unit strm power (lb/ft/s)

Cross Section R2

2 + 3.8 UT to Polecat Creek, Riffle



Bankfull Dimensions	
8.6	x-section area (ft.sq.)
7.4	width (ft)
1.2	mean depth (ft)
1.8	max depth (ft)
9.0	wetted parimeter (ft)
0.9	hyd radi (ft)
6.4	width-depth ratio

Flood Dimensions	
50.0	W flood prone area (ft)
6.7	entrenchment ratio
2.4	low bank height (ft)
1.3	low bank height ratio

Materials	
7.1	D50 Riffle (mm)
93	D84 Riffle (mm)
29	threshold grain size (mm):

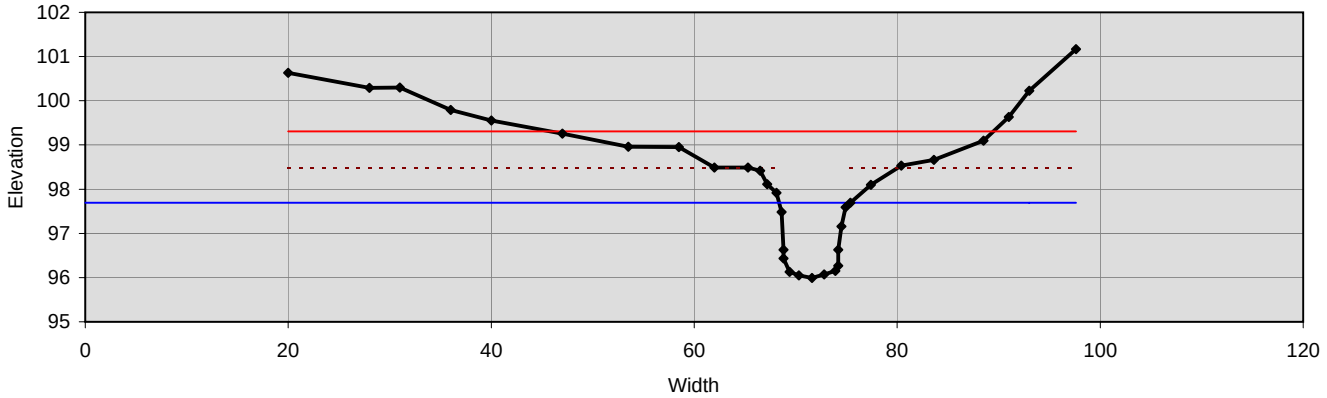
Bankfull Flow	
3.4	velocity (ft/s)
29.1	discharge rate (cfs)
0.61	Froude number

Flow Resistance	
0.042	Manning's roughness
0.21	D'Arcy-Weisbach fric.
6.2	resistance factor u/u*
3.8	relative roughness

Forces & Power	
0.98	channel slope (%)
0.58	shear stress (lb/sq.ft.)
0.55	shear velocity (ft/s)
2.4	unit strm power (lb/ft/s)

Cross Section P2

2 + 18 UT to Polecat Creek, Pool



Bankfull Dimensions	
9.2	x-section area (ft.sq.)
7.0	width (ft)
1.3	mean depth (ft)
1.7	max depth (ft)
9.0	wetted parimeter (ft)
1.0	hyd radi (ft)
5.4	width-depth ratio

Flood Dimensions	
---	W flood prone area (ft)
---	entrenchment ratio
2.5	low bank height (ft)
1.5	low bank height ratio

Materials	
7.1	D50 Riffle (mm)
93	D84 Riffle (mm)
31	threshold grain size (mm):

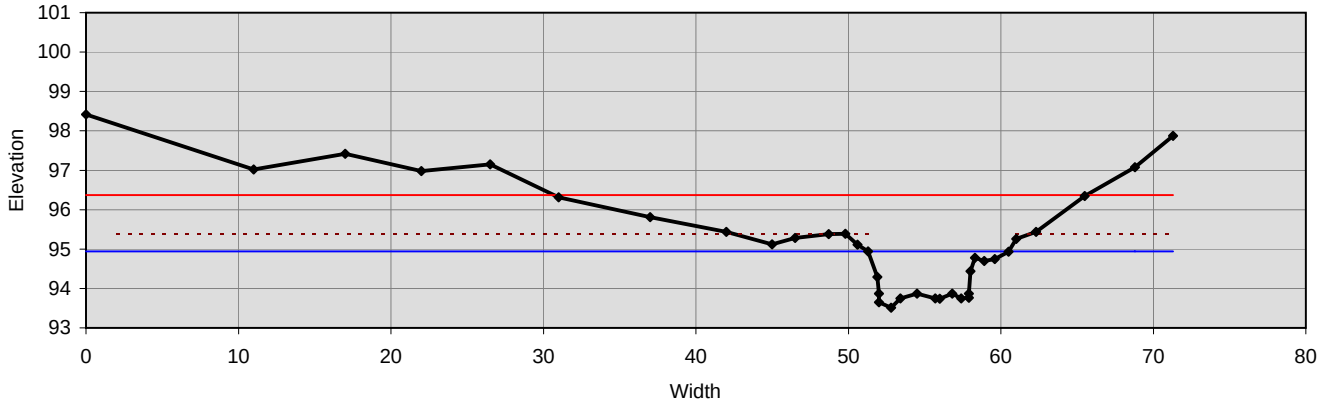
Bankfull Flow	
3.6	velocity (ft/s)
32.7	discharge rate (cfs)
0.62	Froude number

Flow Resistance	
0.042	Manning's roughness
0.20	D'Arcy-Weisbach fric.
6.3	resistance factor u/u*
4.3	relative roughness

Forces & Power	
0.98	channel slope (%)
0.63	shear stress (lb/sq.ft.)
0.57	shear velocity (ft/s)
2.8	unit strm power (lb/ft/s)

Cross Section R3

4 + 11.3 UT to Polecat Creek, Riffle



Bankfull Dimensions	
7.8	x-section area (ft.sq.)
9.2	width (ft)
0.8	mean depth (ft)
1.4	max depth (ft)
10.9	wetted parimeter (ft)
0.7	hyd radi (ft)
10.8	width-depth ratio

Flood Dimensions	
35.0	W flood prone area (ft)
3.8	entrenchment ratio
1.9	low bank height (ft)
1.3	low bank height ratio

Materials	
7.1	D50 Riffle (mm)
93	D84 Riffle (mm)
33	threshold grain size (mm):

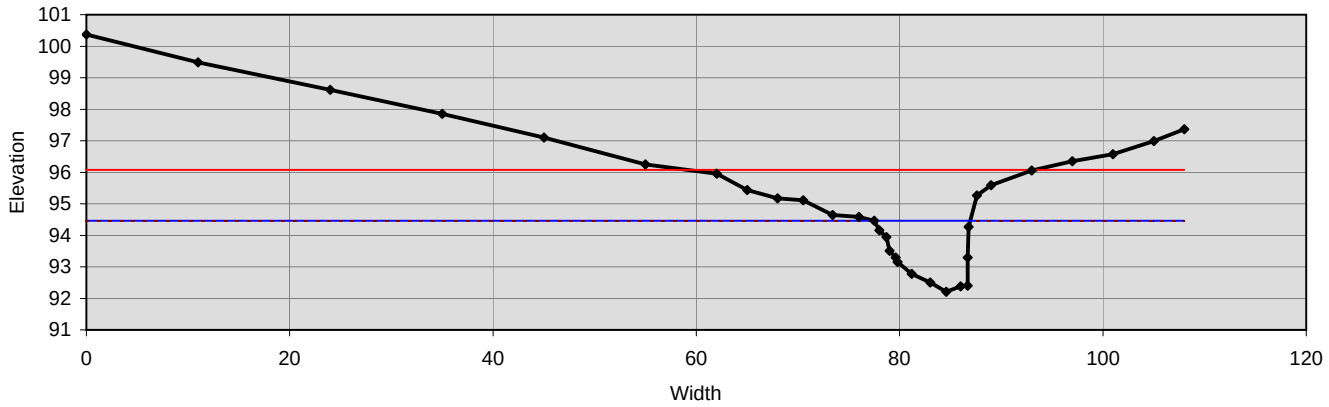
Bankfull Flow	
3.5	velocity (ft/s)
27.4	discharge rate (cfs)
0.73	Froude number

Flow Resistance	
0.042	Manning's roughness
0.23	D'Arcy-Weisbach fric.
5.6	resistance factor u/u*
2.8	relative roughness

Forces & Power	
1.52	channel slope (%)
0.68	shear stress (lb/sq.ft.)
0.59	shear velocity (ft/s)
2.8	unit strm power (lb/ft/s)

Cross Section P3

4 + 41 UT to Polecat Creek, Pool



Bankfull Dimensions	
14.8	x-section area (ft.sq.)
9.5	width (ft)
1.6	mean depth (ft)
2.2	max depth (ft)
11.9	wetted parimeter (ft)
1.2	hyd radi (ft)
6.1	width-depth ratio

Flood Dimensions	
---	W flood prone area (ft)
---	entrenchment ratio
2.2	low bank height (ft)
1.0	low bank height ratio

Materials	
7.1	D50 Riffle (mm)
93	D84 Riffle (mm)
58	threshold grain size (mm):

Bankfull Flow	
5.1	velocity (ft/s)
74.8	discharge rate (cfs)
0.80	Froude number

Flow Resistance	
0.042	Manning's roughness
0.19	D'Arcy-Weisbach fric.
6.9	resistance factor u/u*
5.1	relative roughness

Forces & Power	
1.52	channel slope (%)
1.18	shear stress (lb/sq.ft.)
0.78	shear velocity (ft/s)
7.5	unit strm power (lb/ft/s)

Appendix F.
Design Calculations

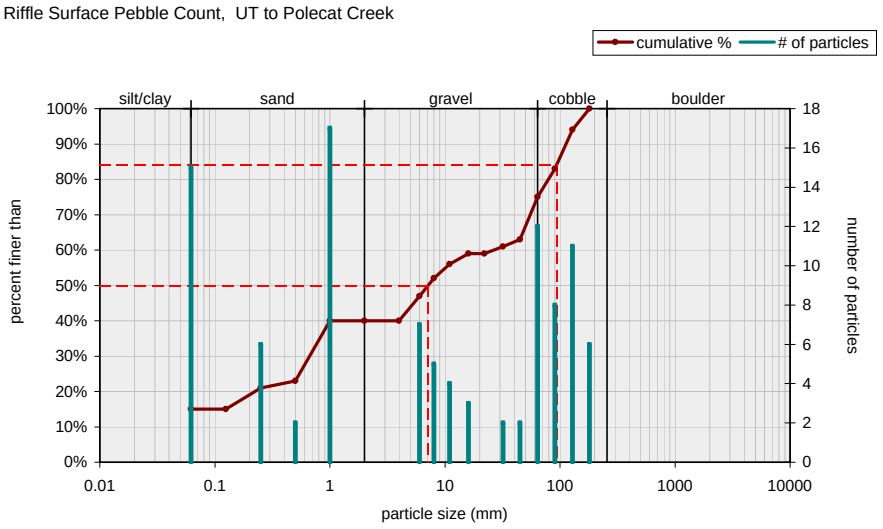
1) Individual Pebble Count

Two individual samples may be entered below. Select sample type for each.

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**15**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**6**
medium sand	0.25 - 0.5	**2**
coarse sand	0.5 - 1	**17**
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	**7**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**3**
coarse gravel	16 - 22	
coarse gravel	22 - 32	**2**
very coarse gravel	32 - 45	**2**
very coarse gravel	45 - 64	**12**
small cobble	64 - 90	**8**
medium cobble	90 - 128	**11**
large cobble	128 - 180	**6**
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 ----------		**4**
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		104

Note:



Size (mm)	
D16	0.14
D35	0.82
D50	7.1
D65	48
D84	93
D95	140

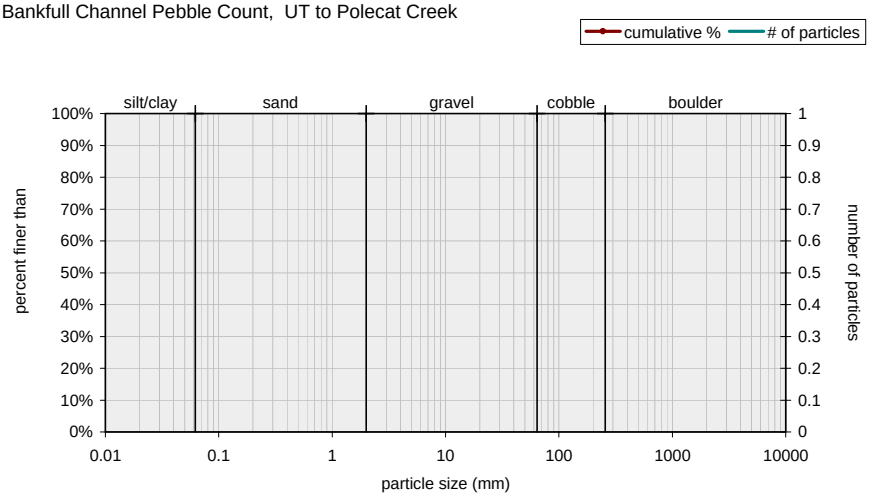
Size Distribution	
mean	3.6
dispersion	31.9
skewness	-0.17

Type			
silt/clay	14%	bedrock	4%
sand	24%		
gravel	34%		
cobble	24%		
boulder	0%		

Bankfull Channel

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

Note:



Size (mm)		
D16	---	3.4
D35	---	12
D50	---	17
D65	---	20
D84	---	29
D95	---	39

Size Distribution	
mean	---
dispersion	---
skewness	---

Type	
silt/clay	---
sand	---
gravel	---
cobble	---
boulder	---

2) Weighted Pebble Count

Feature Percent of Reach

Riffle, Pool, Run, Glide

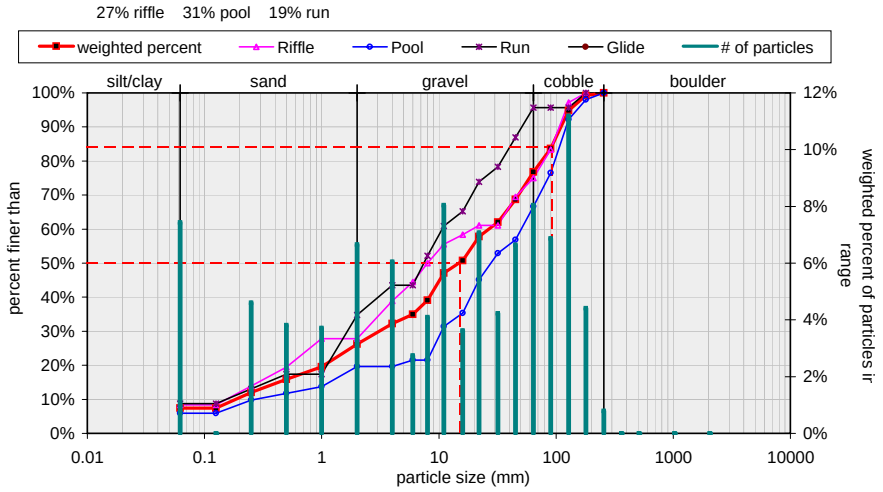
Riffle	27	%	Run	19	%
Pool	31	%	Glide		%

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	5.7
very fine sand	0.062 - 0.125	0.0
fine sand	0.125 - 0.25	3.5
medium sand	0.25 - 0.5	2.9
coarse sand	0.5 - 1	2.9
very coarse sand	1 - 2	5.1
very fine gravel	2 - 4	4.7
fine gravel	4 - 6	2.1
fine gravel	6 - 8	3.2
medium gravel	8 - 11	6.2
medium gravel	11 - 16	2.8
coarse gravel	16 - 22	5.4
coarse gravel	22 - 32	3.3
very coarse gravel	32 - 45	5.1
very coarse gravel	45 - 64	6.2
small cobble	64 - 90	5.3
medium cobble	90 - 128	8.6
large cobble	128 - 180	3.4
very large cobble	180 - 256	0.6
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

total particle weighted count:	77
bedrock ----------	3.9
clay hardpan ----------	0.0
detritus/wood ----------	0.0
artificial ----------	0.0
total weighted count:	80.9

Note:



Size (mm)	
D16	0.51
D35	6
D50	15
D65	37
D84	91
D95	130

Size Distribution	
mean	6.8
dispersion	17.7
skewness	-0.23

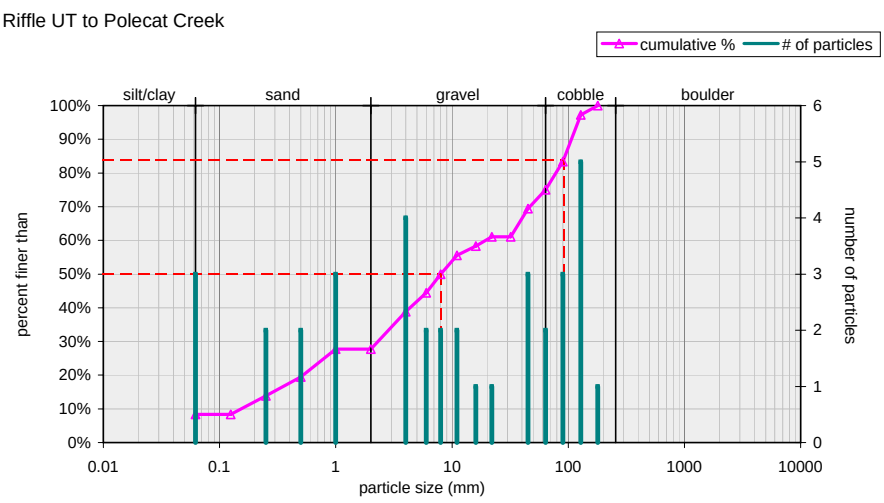
Type			
silt/clay	7%	bedrock	5%
sand	18%		
gravel	48%		
cobble	22%		
boulder	0%		

Riffle

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

total particle count:	36
bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	36

Note:



Size (mm)	
D16	0.33
D35	3.1
D50	8
D65	38
D84	92
D95	120

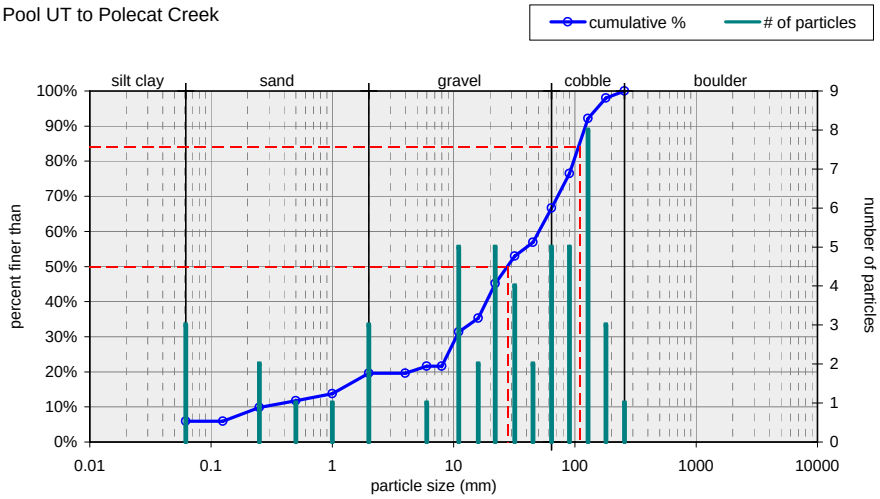
Size Distribution	
mean	5.5
dispersion	17.9
skewness	-0.10

Type	
silt/clay	8%
sand	19%
gravel	47%
cobble	25%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	3
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	2
medium sand	0.25 - 0.5	1
coarse sand	0.5 - 1	1
very coarse sand	1 - 2	3
very fine gravel	2 - 4	
fine gravel	4 - 6	1
fine gravel	6 - 8	
medium gravel	8 - 11	5
medium gravel	11 - 16	2
coarse gravel	16 - 22	5
coarse gravel	22 - 32	4
very coarse gravel	32 - 45	2
very coarse gravel	45 - 64	5
small cobble	64 - 90	5
medium cobble	90 - 128	8
large cobble	128 - 180	3
very large cobble	180 - 256	1
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		51
bedrock	----------	1
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		52

Note:



Size (mm)	
D16	1.3
D35	16
D50	28
D65	60
D84	110
D95	150

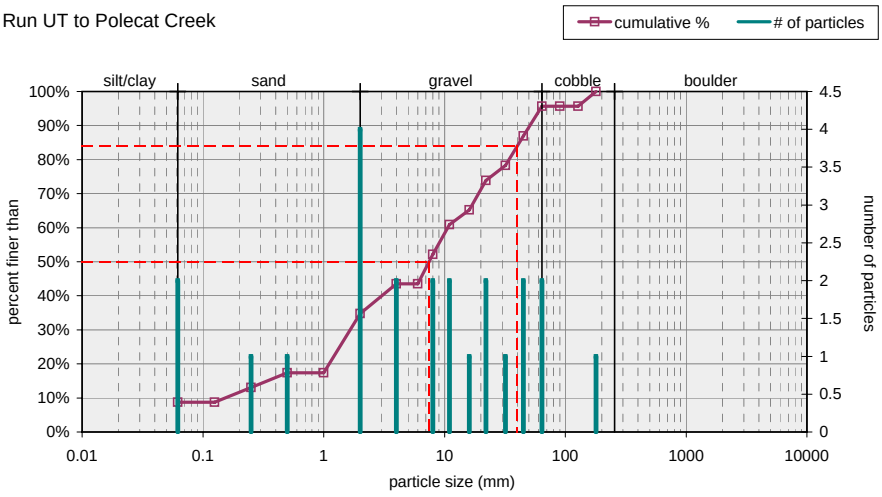
Size Distribution	
mean	12.0
dispersion	12.7
skewness	-0.27

Type			
silt/clay	6%	bedrock	2%
sand	13%		
gravel	46%		
cobble	33%		
boulder	0%		

Run

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	2
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	1
medium sand	0.25 - 0.5	1
coarse sand	0.5 - 1	
very coarse sand	1 - 2	4
very fine gravel	2 - 4	2
fine gravel	4 - 6	
fine gravel	6 - 8	2
medium gravel	8 - 11	2
medium gravel	11 - 16	1
coarse gravel	16 - 22	2
coarse gravel	22 - 32	1
very coarse gravel	32 - 45	2
very coarse gravel	45 - 64	2
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	1
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		23
bedrock	----------	4
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		27

Note:



Size (mm)	
D16	0.4
D35	2
D50	7.4
D65	16
D84	40
D95	62

Size Distribution	
mean	4.0
dispersion	12.0
skewness	-0.19

Type			
silt/clay	7%	bedrock	15%
sand	22%		
gravel	52%		
cobble	4%		
boulder	0%		

3) Bulk Sample Sieve Analysis

Two samples may be entered below. Select sample type for each.

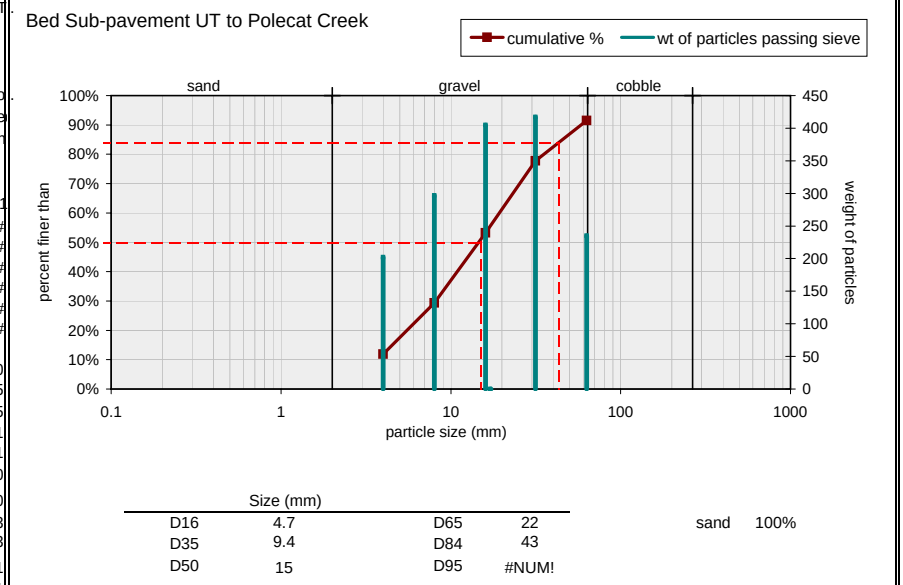
Bed Sub-pavement

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
2	**688**	**890**	202	12%	---	---
4	**735**	**1032**	297	17%	12%	12%
8	**732**	**1137**	405	24%	17%	29%
16	**811**	**1228**	417	25%	24%	53%
31.5	**819**	**1054**	235	14%	25%	78%
63	**710**	**854**	144	8%	14%	92%
			0	0%	8%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%

total wt retained in sieves: 1700

Note: SupPav't Sample 1 1+48 / largest 2 particle middle axis lengths = 80 &

Enter sieve size that passed 100% of sample.



Size (mm)

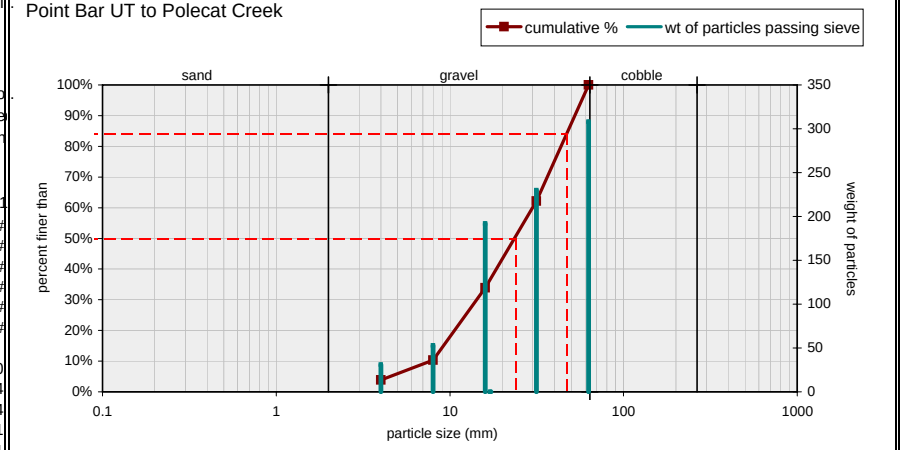
D16	4.7	D65	22	sand 100%
D35	9.4	D84	43	
D50	15	D95	#NUM!	

Point Bar

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
2	**679**	**710**	31	4%	---	---
4	**746**	**799**	53	7%	4%	4%
8	**735**	**927**	192	24%	7%	10%
16	**811**	**1041**	230	28%	24%	34%
31.5	**823**	**1131**	308	38%	28%	62%
63	**0**	**0**	0	0%	38%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%

total: 814

Note: Pav't Sample 1 1+48 / largest particle middle axis lengths = 45 & 27 mm



Size (mm)

D16	9.5	D65	33
D35	16	D84	47
D50	24	D95	57

Project: Holly Grove Stream Restoration Site
Guilford Co., NC
Project No: 1024-HLGR

Location	Hec-Ras Station	D.A. (mi^2)	NC Regional Curves (Rural Piedmont) Area$_{bkf}$ (ft^2)	Width$_{bkf}$ (ft)	Depth$_{bkf}$ (ft)	Q_{bkf} (cfs)
Buckhorn Creek - Reach 1 (100+00 to 124+00)		2.78	42.95	18.46	2.08	185.91
Buckhorn Creek - Reach 2 (124+00 to 137+00)		3.04	45.64	19.18	2.14	198.27
Buckhorn Creek - Reach 3 (137+00 to 151+00)		3.24	47.66	19.71	2.19	207.58
Buckhorn Creek - Reach 4 (151+00 to 166+00)		3.51	50.33	20.40	2.24	219.89
Buckhorn Creek - Reach 5 (166+00 to 186+00)		3.76	52.74	21.01	2.29	231.06
Buckhorn Creek - Reach 6 (186+00 to 191+00)		4.02	55.19	21.63	2.34	242.45
West Branch - D/s End		0.20	7.17	5.95	0.90	27.95
Middle Branch - U/s End		0.09	4.17	4.22	0.69	15.73
Middle Branch - D/s End		0.20	7.17	5.95	0.90	27.95
East Branch - D/s End		0.20	7.17	5.95	0.90	27.95
Little Branch - D/s End		0.02	1.50	2.21	0.43	5.33
SW Creek - U/s End		0.09	4.17	4.22	0.69	15.73
SW Creek - D/s End		0.19	6.93	5.82	0.88	26.93
SE Creek - U/s End		0.14	5.63	5.11	0.80	21.62
SE Creek - D/s of UT		0.18	6.68	5.69	0.87	25.90

Location	Hec-Ras Station	D.A. (mi^2)	Composite Curves Area$_{bkf}$ (ft^2)	Width$_{bkf}$ (ft)	Depth$_{bkf}$ (ft)	Q_{bkf} (cfs)
Buckhorn Creek - Reach 1 (100+00 to 124+00)	0	2.78	41.88			178.52
Buckhorn Creek - Reach 2 (124+00 to 137+00)	0	3.04	44.50			190.80
Buckhorn Creek - Reach 3 (137+00 to 151+00)	0	3.24	46.47			200.06
Buckhorn Creek - Reach 4 (151+00 to 166+00)	0	3.51	49.07			212.34
Buckhorn Creek - Reach 5 (166+00 to 186+00)	0	3.76	51.41			223.49
Buckhorn Creek - Reach 6 (186+00 to 191+00)	0	4.02	53.80			234.88
West Branch - D/s End	0	0.2	7.01			25.20
Middle Branch - U/s End	0	0.09	4.08			13.91
Middle Branch - D/s End	0	0.2	7.01			25.20
East Branch - D/s End	0	0.2	7.01			25.20
Little Branch - D/s End	0	0.02	1.47			4.54
SW Creek - U/s End	0	0.09	4.08			13.91
SW Creek - D/s End	0	0.19	6.77			24.26
SE Creek - U/s End	0	0.14	5.50			19.33
SE Creek - D/s of UT	0	0.18	6.53			23.30

Location	Hec-Ras Station	D.A. (mi^2)	USGS Regression Equations (Piedmont) Q_5 (cfs)	Q_{10} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)
Buckhorn Creek - Reach 3 (137+00 to 151+00)	0	3.24	546.43	740.38	1302.94	1600.51
Buckhorn Creek - Reach 4 (151+00 to 166+00)	0	3.51	576.63	780.36	1370.21	1681.67
Buckhorn Creek - Reach 5 (166+00 to 186+00)	0	3.76	603.92	816.44	1430.82	1754.72
Buckhorn Creek - Reach 6 (186+00 to 191+00)	0	4.02	631.67	853.11	1492.27	1828.74
West Branch - D/s End	0	0.2	84.09	118.80	226.02	286.27
Middle Branch - U/s End	0	0.09	49.17	70.30	136.78	174.77
Middle Branch - D/s End	0	0.2	84.09	118.80	226.02	286.27
East Branch - D/s End	0	0.2	84.09	118.80	226.02	286.27
Little Branch - D/s End	0	0.02	17.90	26.17	53.11	68.99
SW Creek - U/s End	0	0.09	49.17	70.30	136.78	174.77
SW Creek - D/s End	0	0.19	81.24	114.86	218.84	277.34
SE Creek - U/s End	0	0.14	66.17	93.98	180.59	229.64
SE Creek - D/s of UT	0	0.18	78.34	110.85	211.52	268.23

Holly Grove Stream Restoration Site Guilford Co., NC 1024-HLGR										
Location	Top Width (ft)	Thalweg Width (ft)	Side Slope (X:1)	Max Depth (ft)	Depth at Toe (ft)	Bottom Width (ft)	Toe Slope (X:1)	XS_{Area} (ft^2)	D_{Mean} (ft)	W/D Ratio
Buckhorn Creek - Reach 1 (100+00 to 124+00)	22	3	2	2.3	1.7	15.2	10.2	37.1	1.69	13.1
Buckhorn Creek - Reach 2 (124+00 to 137+00)	23	3	2	2.4	1.8	15.8	10.7	40.6	1.76	13.0
Buckhorn Creek - Reach 3 (137+00 to 151+00)	23	4	2	2.4	1.8	15.8	9.8	40.9	1.78	12.9
Buckhorn Creek - Reach 4 (151+00 to 166+00)	24	4	2	2.5	1.8	16.8	9.1	44.0	1.83	13.1
Buckhorn Creek - Reach 5 (166+00 to 186+00)	24.5	4	2	2.6	1.9	16.9	9.2	46.6	1.90	12.9
Buckhorn Creek - Reach 6 (186+00 to 191+00)	25	4	2	2.6	1.9	17.4	9.6	47.8	1.91	13.1
West Branch - D/s End	9	1.5	2	0.95	0.7	6.2	9.4	6.3	0.70	12.9
Middle Branch - U/s End	7	1	2	0.7	0.55	4.8	12.7	3.7	0.53	13.3
Middle Branch - D/s End	9	1.5	2	0.9	0.65	6.4	9.8	6.0	0.67	13.5
East Branch - D/s End	9	1.5	2	0.9	0.65	6.4	9.8	6.0	0.67	13.5
Little Branch - D/s End	4	0.5	2	0.4	0.3	2.8	11.5	1.2	0.30	13.5
SW Creek - U/s End	7.5	1	2	0.75	0.6	5.1	13.7	4.2	0.57	13.3
SW Creek - D/s End	9	1.5	2	0.95	0.7	6.2	9.4	6.3	0.70	12.9
SE Creek - U/s End	8	1	2	0.85	0.6	5.6	9.2	4.9	0.61	13.0
SE Creek - D/s of UT	8.7	1.5	2	0.9	0.65	6.1	9.2	5.8	0.66	13.1

Holly Grove Stream Restoration Site
Guilford Co., NC
1024-HLGR

							Transition Reach Shear			
Location	Wetted Perimeter	Hyd. Radius	Channel Slope	Shear Stress	Particle Range		Shear Stress	Sheilds	Rosgen	Average
Buckhorn Creek - Reach 1 (100+00 to 124+00)	23.6	1.57	0.005	0.49	22.55	83	0.98	45.50	256	151
Buckhorn Creek - Reach 2 (124+00 to 137+00)	24.7	1.64	0.004	0.41	18.81	89	0.82	38.01	200	119
Buckhorn Creek - Reach 3 (137+00 to 151+00)	24.8	1.65	0.004	0.41	18.90	89	0.82	38.19	201	120
Buckhorn Creek - Reach 4 (151+00 to 166+00)	25.8	1.71	0.005	0.53	24.56	98	1.06	49.53	287	168
Buckhorn Creek - Reach 5 (166+00 to 186+00)	26.4	1.77	0.006	0.66	30.62	144	1.32	61.64	378	220
Buckhorn Creek - Reach 6 (186+00 to 191+00)	26.9	1.78	0.004	0.44	20.41	97	0.89	41.22	224	133
West Branch - D/s End	9.7	0.65	0.013	0.53	24.24	96	1.05	48.88	282	165
Middle Branch - U/s End	7.5	0.49	0.019	0.58	26.85	115	1.16	54.10	321	188
Middle Branch - D/s End	9.6	0.62	0.013	0.50	23.28	88	1.01	46.96	267	157
East Branch - D/s End	9.6	0.62	0.014	0.54	25.10	102	1.09	50.61	295	173
Little Branch - D/s End	4.3	0.28	0.02	0.35	15.82	74	0.69	32.04	154	93
SW Creek - U/s End	8.0	0.53	0.016	0.53	24.25	96	1.05	48.90	282	165
SW Creek - D/s End	9.7	0.65	0.02	0.81	37.51	196	1.62	75.42	482	279
SE Creek - U/s End	8.6	0.57	0.007	0.25	11.30	50	0.50	23.00	86	55
SE Creek - D/s of UT	9.3	0.62	0.007	0.27	12.22	55	0.54	24.85	100	63

Holly Grove Stream Restoration Site
Guilford Co., NC
1024-HLGR

Location	Top Width (ft)	P-P ratio		Rc Ratio		P-P ratio		Rc Ratio		Tangent Length		Chord Length		Max Riffle Depth	D_{Pool}/D_{Riff} Ratio	Max Pool Depth	Difference
Buckhorn Creek - Reach 1 (100+00 to 124+00)	22	4	6	2	3	88	132	44	66	44	66	42	63	2.3	1.5	3.5	1.15
Buckhorn Creek - Reach 2 (124+00 to 137+00)	23	4	6	2	3	92	138	46	69	46	69	44	66	2.4	1.5	3.6	1.20
Buckhorn Creek - Reach 3 (137+00 to 151+00)	23	4	6	2	3	92	138	46	69	46	69	44	66	2.4	1.5	3.6	1.20
Buckhorn Creek - Reach 4 (151+00 to 166+00)	24	4	6	2	3	96	144	48	72	48	72	46	69	2.5	1.5	3.8	1.25
Buckhorn Creek - Reach 5 (166+00 to 186+00)	24.5	4	6	2	3	98	147	49	73.5	49	74	47	70	2.6	1.5	3.9	1.30
Buckhorn Creek - Reach 6 (186+00 to 191+00)	25	4	6	2	3	100	150	50	75	50	75	48	72	2.6	1.5	3.9	1.30
West Branch - D/s End	9	4	6	2	3	36	54	18	27	18	27	17	26	0.95	1.5	1.4	0.48
Middle Branch - U/s End	7	4	6	2	3	28	42	14	21	14	21	13	20	0.7	1.5	1.1	0.35
Middle Branch - D/s End	9	4	6	2	3	36	54	18	27	18	27	17	26	0.9	1.5	1.4	0.45
East Branch - D/s End	9	4	6	2	3	36	54	18	27	18	27	17	26	0.9	1.5	1.4	0.45
Little Branch - D/s End	4	4	6	2	3	16	24	8	12	8	12	8	12	0.4	1.5	0.6	0.20
SW Creek - U/s End	7.5	4	6	2	3	30	45	15	22.5	15	23	14	22	0.75	1.5	1.1	0.38
SW Creek - D/s End	9	4	6	2	3	36	54	18	27	18	27	17	26	0.95	1.5	1.4	0.48
SE Creek - U/s End	8	4	6	2	3	32	48	16	24	16	24	15	23	0.85	1.5	1.3	0.43
SE Creek - D/s of UT	8.7	4	6	2	3	34.8	52.2	17.4	26.1	17	26	17	25	0.9	1.5	1.4	0.45

Appendix G.
Categorical Exclusion Form

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information	
Project Name:	Holly Grove Stream Restoration Site
County Name:	Guilford
EEP Number:	Contract # D06028-B
Project Sponsor:	Restoration Systems, LLC
Project Contact Name:	Tara Alden
Project Contact Address:	1101 Haynes Street, Suite 107, Raleigh, NC 27607
Project Contact E-mail:	tara@restorationsystems.com
EEP Project Manager:	Guy Pearce

Project Description

The Site is located in northeastern Guilford County within 14-digit hydrological unit 03030002020070, approximately 20 miles northeast of the City of Greensboro. The Site encompasses approximately 80 acres, consisting of 19,235 linear feet of existing stream and riparian buffer along unnamed tributaries to Reedy Fork. The Site is located approximately 5 miles upstream of the Haw River. Approximately 13,350 linear feet of stream restoration and 5,940 feet of stream enhancement (Level II) will be implemented for a total of 15,726 Stream Mitigation Units.

For Official Use Only

Reviewed By:

Date — EEP Project Manager

Conditional Approved By:

Date — For Division Administrator FHWA

☐ Check this box if there are outstanding issues

Final Approval By:

1-9-07

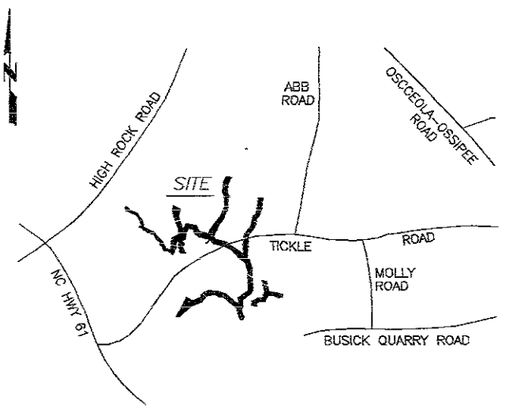
Date — For Division Administrator FHWA

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☑ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☑ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☑ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☑ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a "full-delivery" project?	☑ Yes ☐ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☑ No ☐ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☑ No ☐ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☑ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☑ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☑ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☑ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☑ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☑ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☑ Yes ☐ No
2. Does the project require the acquisition of real estate?	☑ Yes ☐ No ☐ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☑ No ☐ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☑ Yes ☐ No ☐ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☐ Yes ☑ No
2. Is the site of religious importance to American Indians?	☐ Yes ☐ No ☑ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☑ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☑ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☑ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☑ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☑ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☐ Yes ☑ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☐ No ☑ N/A
4. Is the project "likely to adversely affect" the species and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☐ No ☑ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes ☐ No ☑ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☑ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☐ Yes ☑ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☑ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☑ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☑ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☑ Yes ☐ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☑ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☑ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☑ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☑ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☑ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☑ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☑ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☑ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☑ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☑ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☑ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☑ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☑ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☑ N/A

Appendix H.
Wetland Plat and Data Sheets



VICINITY MAP (NTS)

GENERAL NOTES

NO ABSTRACT OF TITLE, NOR TITLE COMMITMENT, OR RESULTS OF TITLE SEARCH WERE FURNISHED TO THE SURVEYOR. ALL DOCUMENTS OF RECORD REVIEWED ARE NOTED HEREON. THERE MAY EXIST OTHER DOCUMENTS OF RECORD THAT MAY AFFECT THIS SURVEYED PARCEL.

NO HORIZONTAL CONTROL EXISTS WITHIN 2000 FEET.

THIS PLAT IS NOT FOR RECORDATION, CONVEYANCES OR SALES.

ALL JURISDICTIONAL WETLAND LINES DETERMINED AND FLAGGED BY RANDY TURNER WITH RESTORATION SYSTEMS, LLC DURING JANUARY 2007.

RED COLOR INDICATES LINES SURVEYED BY K2 DESIGN GROUP, P.A. ALL OTHER LINES WERE SURVEYED BY TRUE LINE SURVEYING, P.C. AND NO VERIFICATION OR SURVEY WAS PERFORMED ON THOSE LINES (ENTITLED: "CONSERVATION EASEMENT SURVEY FOR RESTORATION SYSTEMS, LLC. ECOSYSTEM ENHANCEMENT PROGRAM HOLLY GROVE FARM PROJECT" DATED: FEBRUARY 4TH, 2007.) CAD FILE PROVIDED BY RESTORATION SYSTEMS, LLC.

CORPS OF ENGINEERS CERTIFICATION

This certifies that this copy of this plat identifies as waters and wetlands all areas of waters and wetlands regulated pursuant to Section 404 of the Clean Water Act as determined by the undersigned on this date. Unless there is a change in the law, or our published regulations, this determination may be relied on for a period not to exceed five years from this date. This determination was made utilizing the 1987 Corps of Engineers Wetland Delineation Manual.

U.S. Army Corps of Engineers Representative

Title

Date

TOTAL WATERS OF THE UNITED STATES

THE TOTAL AREA IS 1.37 ACRES± BY COMPUTER.

TOTAL AREA IN CONSERVATION EASEMENT

THE TOTAL AREA IS 61.543 ACRES± PER TRUE LINE SURVEYING, P.C.

SURVEYOR'S DISCLAIMER: NO ATTEMPT WAS MADE TO LOCATE ANY CEMETERIES, WETLANDS, HAZARDOUS MATERIAL SITES, UNDERGROUND UTILITIES OR ANY OTHER FEATURES ABOVE, OR BELOW GROUND OTHER THAN THOSE SHOWN. IF NO RED COLOR IS PRESENT ON THIS DOCUMENT, IT IS TO BE CONSIDER A COPY AND NO RELIANCE MAY BE PLACED ON ITS ACCURACY.

I, CERTIFY THAT THE SURVEY IS OF ANOTHER CATEGORY (JURISDICTIONAL WETLANDS), SUCH AS THE RECOMBINATION OF EXISTING PARCELS, A COURT-ORDERED SURVEY, OR OTHER EXCEPTION TO THE DEFINITION OF A SUBDIVISION.

I, JOHN A RUDOLPH, CERTIFY THAT THIS MAP (WETLANDS ONLY) WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION. THAT THE RATIO OF PRECISION IS ONE:10,000+. THAT THIS MAP WAS PREPARED IN ACCORDANCE WITH THE STANDARDS OF PRACTICE FOR LAND SURVEYORS IN NORTH CAROLINA. WITNESS MY HAND AND SEAL THIS 12th DAY OF FEBRUARY, 2007.

NORTH CAROLINA PROFESSIONAL SEAL L-4194 LAND SURVEYOR JOHN A. RUDOLPH

SURVEYOR L-4194

K2 DESIGN GROUP, P.A. CORPORATE SEAL 2000 NORTH CAROLINA

DRAWN BY: FGR

DATE: 2/12/07

DWG. NO.: FSS933WET07

SURVEYED BY: J.A.R.

K2 DESIGN GROUP, P.A.
5758 U.S. Hwy. 70 East
Goldsboro, NC 27534
TEL: (919) 751-0075
email: k2design@icomnet.com

SHEET 1 OF 4

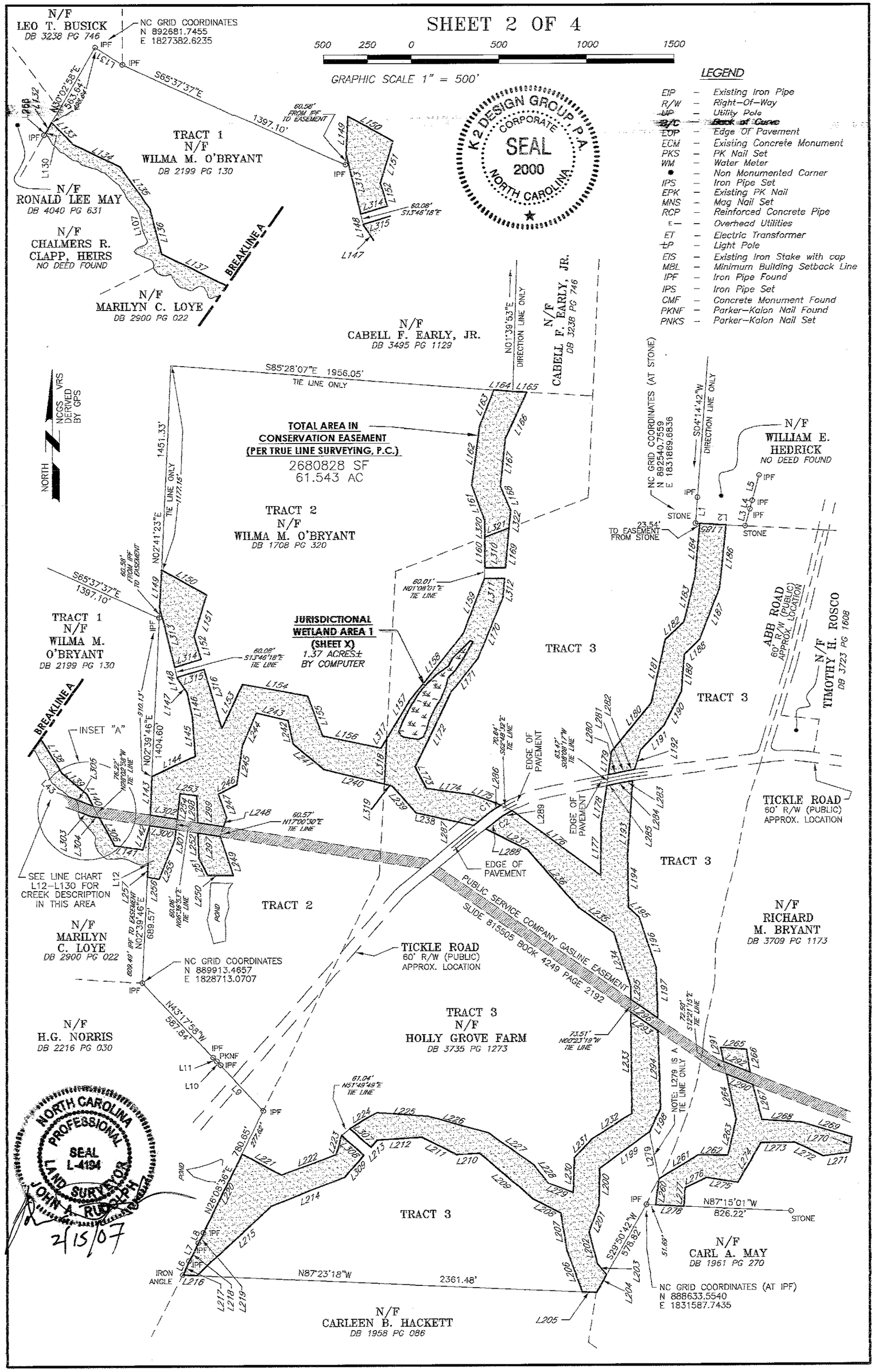
JURISDICTIONAL WETLANDS LINE(S) OF DESCRIPTION FOR

RESTORATIONS SYSTEMS, LLC

WASHINGTON TOWNSHIP

GUILFORD COUNTY NORTH CAROLINA

SHEET 2 OF 4


500 250 0 500 1000 1500
GRAPHIC SCALE 1" = 500'
LEGEND
EIP – Existing Iron Pipe
R/W – Right-Of-Way
UP – Utility Pole
B/C – Back of Curve
EOP – Edge Of Pavement
ECM – Existing Concrete Monument
PKS – PK Nail Set
WM – Water Meter
● – Non Monumented Corner
IPS – Iron Pipe Set
EPK – Existing PK Nail
MNS – Mag Nail Set
RCP – Reinforced Concrete Pipe
E – Overhead Utilities
ET – Electric Transformer
LP – Light Pole
EIS – Existing Iron Stake with cap
MBL – Minimum Building Setback Line
IPF – Iron Pipe Found
IPS – Iron Pipe Set
CMF – Concrete Monument Found
PKNF – Parker-Kalon Nail Found
PNKS – Parker-Kalon Nail Set
K2 DESIGN GROUP, P.A. CORPORATE SEAL 2000 NORTH CAROLINA
N/F LEO T. BUSICK DB 3238 PG 746
NC GRID COORDINATES N 892681.7455 E 1827382.6235
TRACT 1 N/F WILMA M. O'BRYANT DB 2199 PG 130
N/F RONALD LEE MAY DB 4040 PG 631
N/F CHALMERS R. CLAPP, HEIRS NO DEED FOUND
N/F MARILYN C. LOYE DB 2900 PG 022
BREAKLINE A
S65°37'37"E 1397.10'
60.58' FROM IPF TO EASEMENT
60.08' S13°46'18"E
N/F CABELL F. EARLY, JR. DB 3495 PG 1129
N/F CABELL F. EARLY, JR. DB 3238 PG 746
N01°39'53"E DIRECTION LINE ONLY
S85°28'07"E 1956.05' TIE LINE ONLY
NCGS VRS DERIVED BY GPS
NORTH
TOTAL AREA IN CONSERVATION EASEMENT (PER TRUE LINE SURVEYING, P.C.)
2680828 SF
61.543 AC
TRACT 2 N/F WILMA M. O'BRYANT DB 1708 PG 320
1451.33'
TIE LINE ONLY
1172.15'
N02°41'23"E
60.01' N01°09'01"E TIE LINE
JURISDICTIONAL WETLAND AREA 1 (SHEET X)
1.37 ACRES± BY COMPUTER
TRACT 1 N/F WILMA M. O'BRYANT DB 2199 PG 130
S65°37'37"E 1397.10'
60.58' FROM IPF TO EASEMENT
60.08' S13°46'18"E TIE LINE
BREAKLINE A
INSET "A"
910.13'
N02°39'46"E 1404.60'
N/F MARILYN C. LOYE DB 2900 PG 022
N02°39'46"E 689.57'
608.49' IPF TO EASEMENT
60.08' N06°36'35"E TIE LINE
SEE LINE CHART L12-L130 FOR CREEK DESCRIPTION IN THIS AREA
POND
TRACT 2
NC GRID COORDINATES N 889913.4657 E 1828713.0707
N43°17'53"W 587.84'
N/F H.G. NORRIS DB 2216 PG 030
TRACT 3 N/F HOLLY GROVE FARM DB 3735 PG 1273
TICKLE ROAD 60' R/W (PUBLIC) APPROX. LOCATION
PUBLIC SERVICE COMPANY GASLINE EASEMENT SLIDE 81550S BOOK 4249 PAGE 2192
EDGE OF PAVEMENT
61.04' N87°49'48"E TIE LINE
780.65' 277.62'
N26°08'36"E
POND
TRACT 3
IRON ANGLE
N87°23'18"W 2361.48'
N/F CARLEEN B. HACKETT DB 1958 PG 086
NOTE: L279 IS A TIE LINE ONLY
N87°15'01"W 826.22'
S29°50'42"W 578.82'
N/F CARL A. MAY DB 1961 PG 270
NC GRID COORDINATES (AT IPF) N 888633.5540 E 1831587.7435
NC GRID COORDINATES (AT STONE) N 892540.7559 E 1831869.6836
S04°14'42"W DIRECTION LINE ONLY
23.54' TO EASEMENT FROM STONE
N/F WILLIAM E. HEDRICK NO DEED FOUND
ABB ROAD 60' R/W (PUBLIC) APPROX. LOCATION
N/F TIMOTHY H. ROSCO DB 3723 PG 1608
TRACT 3
TICKLE ROAD 60' R/W (PUBLIC) APPROX. LOCATION
N/F RICHARD M. BRYANT DB 3709 PG 1173
NORTH CAROLINA PROFESSIONAL SEAL L-4194 LAND SURVEYOR JOHN A. RUDOLPH
2/15/07

NUMBER	DIRECTION	DISTANCE
L1	S04°14'42"W	148.39'
L2	S86°51'40"E	283.67'
L3	N15°29'40"E	100.30'
L4	N15°23'49"E	50.04'
L5	N15°23'34"E	149.72'
L6	N24°46'52"E	86.73'
L7	N26°52'40"E	115.25'
L8	N26°08'53"E	64.88'
L9	N42°37'55"W	357.37'
L10	N47°06'43"W	31.16'
L11	N43°19'27"W	30.02'
L12	S65°50'58"W	27.92'
L13	N87°30'29"W	20.76'
L14	N67°49'25"W	28.57'
L15	N63°04'58"W	37.33'
L16	N75°56'25"W	22.38'
L17	N80°11'50"W	27.75'
L18	S87°26'18"W	46.55'
L19	S87°33'17"W	31.13'
L20	N64°13'57"W	13.85'
L21	N48°07'04"W	28.54'
L22	N42°47'14"W	28.65'
L23	N25°35'03"W	19.42'
L24	N16°57'49"W	28.43'
L25	N11°21'38"E	24.92'
L26	N09°24'48"W	12.87'

NUMBER	DIRECTION	DISTANCE
L27	N36°47'21"W	33.44'
L28	N41°33'49"W	27.93'
L29	N35°37'22"W	31.85'
L30	N43°50'15"W	21.00'
L31	N62°18'37"W	18.31'
L32	N09°18'28"W	10.68'
L33	N18°36'36"W	24.34'
L34	N03°38'06"E	19.08'
L35	N03°03'37"W	28.35'
L36	N17°10'07"W	20.97'
L37	N41°33'54"W	21.03'
L38	N73°40'15"W	23.57'
L39	N45°22'37"W	25.63'
L40	N49°05'07"W	37.27'
L41	N63°50'59"W	25.28'
L42	N48°38'16"W	24.81'
L43	N45°31'23"W	31.93'
L44	N24°00'34"W	30.91'
L45	N20°40'37"W	34.24'
L46	N29°49'33"W	14.42'
L47	N31°44'11"W	19.10'
L48	N39°09'23"W	24.03'
L49	N32°55'08"W	13.29'
L50	N23°38'02"W	22.23'
L51	N26°32'40"W	19.32'
L52	N24°20'04"W	16.06'
L53	N40°02'50"W	20.85'
L54	S79°57'49"W	11.82'
L55	S82°43'23"W	14.03'
L56	S67°19'41"W	11.80'
L57	S57°33'40"W	6.84'
L58	N88°45'03"W	8.21'
L59	N77°06'26"W	11.43'
L60	N27°33'12"W	11.47'
L61	N11°33'38"W	21.15'
L62	N29°16'02"W	7.34'
L63	N40°46'47"W	9.79'
L64	N22°08'12"W	14.11'
L65	N45°45'53"W	9.88'
L66	N84°14'17"W	14.79'
L67	S85°56'26"W	12.06'
L68	S56°26'57"W	13.88'
L69	S63°43'07"W	14.12'
L70	S51°56'18"W	18.17'
L71	N80°40'45"W	9.72'
L72	N63°35'02"W	15.56'
L73	N74°32'09"W	22.76'
L74	N80°00'14"W	13.09'
L75	N59°44'42"W	16.29'
L76	N42°42'40"W	19.17'
L77	N37°02'55"W	16.91'
L78	N21°57'33"W	10.12'
L79	N40°34'30"W	15.01'
L80	N15°35'05"W	16.71'
L81	N62°17'25"W	10.65'
L82	S74°24'18"W	13.63'
L83	S78°22'16"W	18.38'
L84	N79°37'35"W	24.87'
L85	N58°47'37"W	17.45'
L86	N44°01'29"W	17.96'
L87	N35°46'51"W	14.09'
L88	N16°53'57"W	8.56'
L89	N04°03'48"E	16.15'
L90	N16°33'30"W	17.46'
L91	N43°45'42"W	16.30'
L92	N77°21'47"W	2.02'
L93	N66°57'12"W	31.27'
L94	N67°31'49"W	28.94'
L95	N61°05'35"W	13.45'
L96	N74°56'45"W	18.29'
L97	N34°42'40"W	16.03'
L98	N33°39'26"E	12.99'
L99	N52°35'57"E	15.39'
L100	N59°03'21"E	15.64'
L101	N80°27'20"E	12.04'
L102	N66°58'34"E	14.88'
L103	N52°11'53"E	11.47'
L104	N21°07'00"E	17.84'
L105	N24°09'12"W	29.79'
L106	N22°41'53"W	34.90'
L107	N11°34'08"W	75.32'
L108	N23°15'35"W	28.10'
L109	N30°00'41"W	28.64'
L110	N38°13'38"W	90.86'
L111	N22°02'39"W	17.21'
L112	N33°34'33"W	30.01'
L113	N32°03'46"W	29.95'
L114	N55°07'45"W	37.08'
L115	N46°54'17"W	77.09'
L116	N84°20'20"W	12.57'

NUMBER	DIRECTION	DISTANCE
L117	N57°41'10"W	27.33'
L118	N79°11'33"W	31.36'
L119	N71°46'51"W	32.71'
L120	N73°52'07"W	26.44'
L121	N47°51'48"W	34.24'
L122	N77°46'02"W	31.06'
L123	N48°38'25"W	22.55'
L124	N50°52'18"W	38.45'
L125	N70°20'28"W	25.30'
L126	N40°03'25"W	38.71'
L127	N54°21'39"W	21.47'
L128	N31°33'47"W	37.41'
L129	N34°54'21"W	28.93'
L130	N14°54'48"W	14.12'
L131	S57°14'29"E	184.49'
L132	N30°02'58"E	65.00'
L133	S44°26'38"E	178.59'
L134	S64°29'10"E	294.67'
L135	S35°08'14"E	296.49'
L136	S14°35'05"E	266.76'
L137	S63°53'15"E	414.34'
L138	S31°34'11"E	228.15'
L139	S49°48'01"E	185.24'
L140	S28°02'58"E	336.17'
L141	S82°02'24"E	163.27'
L142	N16°25'43"E	143.66'
L143	N02°39'46"E	218.88'
L144	N64°53'05"E	272.69'
L145	N04°15'47"W	225.35'
L146	N12°14'48"W	139.48'
L147	N33°29'54"W	99.67'
L148	N13°46'18"W	9.16'
L149	N02°41'23"E	213.60'
L150	S61°04'09"E	293.31'
L151	S16°45'30"W	248.11'
L152	S16°45'46"E	136.84'
L153	N25°14'43"E	276.94'
L154	S79°28'26"E	378.13'
L155	S20°24'13"E	242.90'
L156	S78°00'41"E	339.35'
L157	N30°44'39"E	249.03'
L158	N38°38'43"E	497.50'
L159	N21°06'10"E	335.70'
L160	N00°12'30"W	174.69'
L161	N19°31'03"W	215.85'
L162	N07°19'38"E	343.91'
L163	N21°41'16"E	222.61'
L164	S85°28'07"E	109.43'
L165	S86°28'23"E	78.45'
L166	S25°03'38"W	290.59'
L167	S05°39'33"W	278.72'
L168	S23°00'15"E	148.03'
L169	S05°10'33"W	228.70'
L170	S22°16'50"W	373.50'
L171	S38°19'53"W	248.18'
L172	S25°39'16"W	475.25'
L173	S27°41'27"E	137.87'
L174	S81°56'16"E	275.58'
L175	S69°27'02"E	164.43'
L176	S53°36'20"E	627.68'
L177	N00°14'49"E	296.53'
L178	N08°36'03"E	220.18'
L179	N07°40'08"E	131.96'
L180	N39°10'48"E	362.58'
L181	N12°19'30"E	368.75'
L182	N46°59'51"E	147.64'
L183	N13°09'24"E	267.24'
L184	N05°33'27"E	305.68'
L185	S86°51'40"E	150.18'
L186	S05°07'49"W	365.09'
L187	S20°56'19"W	310.89'
L188	S45°20'08"W	125.26'
L189	S04°38'23"W	211.60'
L190	S27°16'45"W	223.20'
L191	S43°46'20"W	188.83'
L192	S16°38'26"W	119.29'
L193	S03°59'00"W	424.87'
L194	S00°55'53"E	304.48'
L195	S47°19'09"E	81.90'
L196	S18°50'53"E	303.64'
L198	S24°06'09"W	148.60'
L199	S54°00'40"W	352.52'
L200	S00°51'30"W	210.05'
L201	S20°29'55"W	167.67'
L202	S14°43'16"E	189.56'
L203	S39°12'51"E	80.41'
L204	S29°50'42"W	113.85'
L205	N87°23'18"W	80.15'
L206	N20°38'54"W	247.86'

NUMBER	DIRECTION	DISTANCE
L207	N09°12'49"W	221.40'
L208	N62°21'20"W	174.67'
L209	N49°08'21"W	407.26'
L210	S86°27'33"W	133.38'
L211	N62°54'33"W	219.66'
L212	S86°19'11"W	256.17'
L213	S41°12'33"W	53.50'
L214	S68°23'24"W	449.55'
L215	S47°07'46"W	581.06'
L216	N87°23'18"W	79.58'
L217	N24°46'52"E	86.73'
L218	N26°52'40"E	115.25'
L219	N26°08'53"E	64.88'
L220	N26°08'36"E	503.03'
L221	S61°22'03"E	254.69'
L222	N69°32'04"E	333.92'
L223	N15°18'57"E	114.83'
L224	N58°49'20"E	181.28'
L225	S85°30'36"E	293.02'
L226	S74°15'39"E	353.27'
L227	S54°42'27"E	319.75'
L228	S38°11'12"E	134.81'
L229	S68°41'58"E	154.17'
L230	N01°26'50"E	202.18'
L231	N43°45'26"E	144.88'
L232	N57°04'02"E	270.98'
L234	N17°18'49"W	323.68'
L235	N54°11'07"W	247.01'
L236	N40°57'12"W	440.78'
L237	N63°32'55"W	269.19'
L238	N77°40'32"W	335.35'
L239	N41°30'00"W	207.26'
L240	N76°24'08"W	356.68'
L241	N49°41'53"W	226.22'
L242	N11°40'39"W	138.27'
L243	N76°59'06"W	186.77'
L244	S23°06'23"W	205.38'
L245	S08°02'51"W	222.21'
L246	S62°06'19"W	118.95'
L247	S19°15'27"E	141.47'
L250	N89°56'06"W	145.55'
L251	N27°40'56"W	108.32'
L253	N81°40'56"W	95.16'
L254	S06°36'53"W	148.33'
L255	S21°44'56"W	244.85'
L256	N79°39'49"W	66.66'
L257	N02°39'46"E	80.42'
L258	S30°02'58"W	19.96'
L260	N07°13'06"E	151.21'
L261	N58°49'19"E	262.18'
L262	S89°45'36"E	168.08'
L263	N13°26'58"E	210.09'
L265	S85°53'58"E	149.12'
L266	S08°22'55"E	131.48'
L267	S14°38'52"E	210.66'
L268	S86°02'13"E	225.41'
L269	S73°20'39"E	300.74'
L270	S09°50'09"W	89.28'
L271	S82°25'39"W	150.96'
L272	N63°55'12"W	183.98'
L273	S89°22'55"W	192.12'
L274	S29°24'28"W	262.35'
L275	N80°51'00"W	181.01'
L276	S63°05'58"W	137.37'
L277	S03°33'25"W	102.39'
L278	N87°15'01"W	161.20'
L279	S11°20'04"E	274.39'
L280	N79°06'35"E	54.02'
L281	N79°22'00"E	48.59'
L282	N80°15'11"E	50.28'
L283	S80°15'11"W	27.61'
L284	S79°22'00"W	47.99'
L285	S79°06'20"W	74.58'
L286	S59°02'56"W	36.23'
L287	S51°22'58"W	123.48'
L288	N51°22'58"E	83.74'
L289	N59°02'56"E	74.47'

NUMBER	DIRECTION	DISTANCE
L290	S68°11'47"E	162.10'
L291	S12°21'15"E	82.54'
L292	S68°11'47"E	161.82'
L293	S55°05'52"E	188.03'
L294	S01°39'07"E	446.01'
L295	S00°23'19"E	73.20'
L296	S55°05'52"E	186.02'
L297	S80°53'47"E	128.34'
L298	S02°00'48"E	152.36'
L299	S80°53'47"E	148.46'
L300	S80°53'47"E	150.94'
L301	S06°36'53"W	56.00'
L302	S80°53'47"E	155.11'
L303	S69°30'32"E	74.99'
L304	S80°53'47"E	48.31'
L305	S69°30'32"E	139.82'
L306	S28°02'58"E	182.86'
L307	S48°47'27"E	160.03'
L308	S48°47'27"E	171.28'
L309	S41°12'33"W	168.43'
L310	N90°00'00"E	117.83'
L311	N90°00'00"E	113.58'
L312	S05°10'33"W	112.49'
L313	N13°46'18"W	352.65'
L314	S73°14'14"W	157.39'
L315	N73°14'14"E	160.53'
L316	S16°45'46"E	351.88'
L317	N30°44'39"E	64.70'
L318	S03°06'42"W	261.61'
L319	N76°24'08"W	46.33'
L320	S00°12'30"E	94.09'
L321	N69°06'42"E	148.88'
L322	N05°10'33"E	102.50'

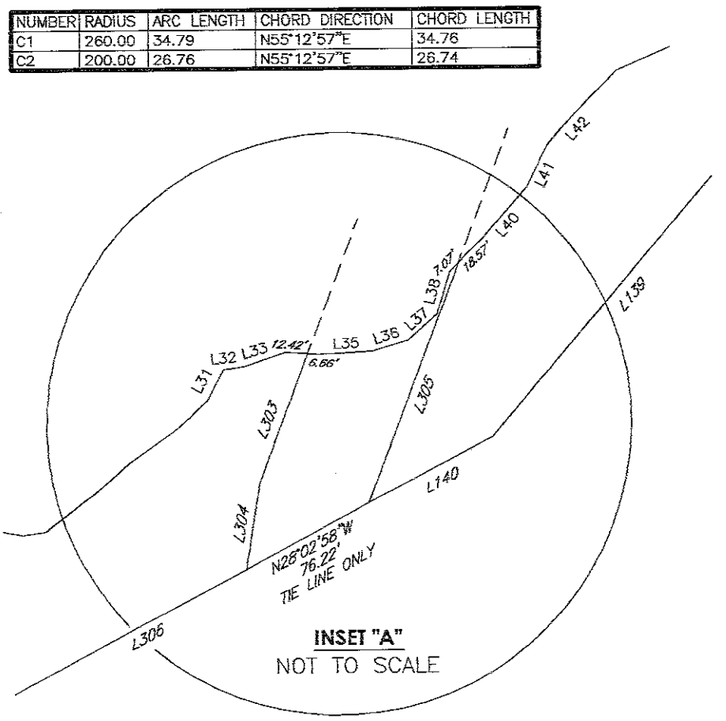
K2 DESIGN GROUP, P.A. CORPORATE SEAL 2000 NORTH CAROLINA

NOTE:

INSET A AND LINE DATA ON THIS SHEET ARE OBTAINED FROM TRUE LINE SURVEYING, P.C.

SHEET 3 OF 4

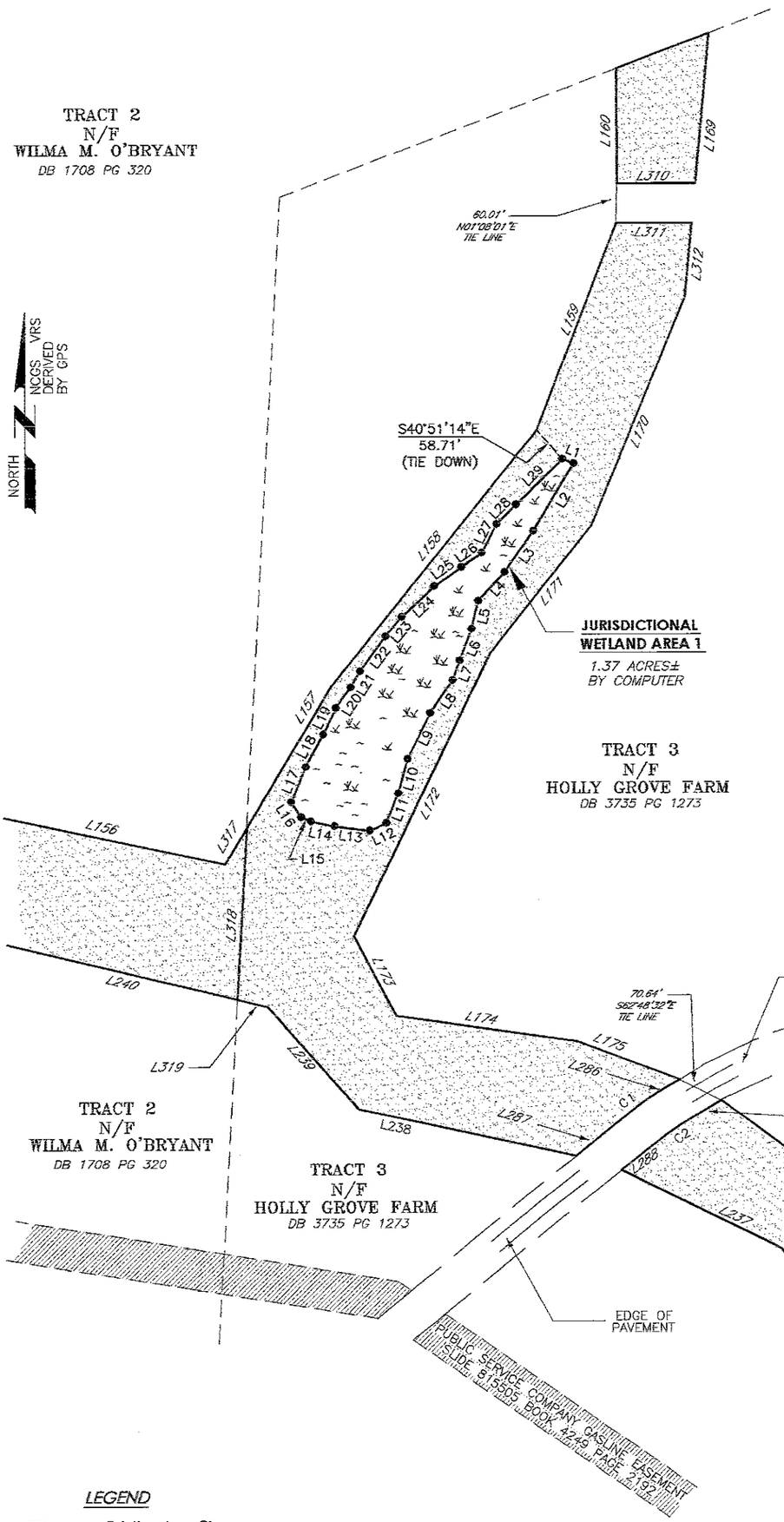
NUMBER	RADIUS	ARC LENGTH	CHORD DIRECTION	CHORD LENGTH
C1	260.00	34.79	N55°12'57"E	34.76
C2	200.00	26.76	N55°12'57"E	26.74



INSET "A"
NOT TO SCALE

NORTH CAROLINA PROFESSIONAL SEAL L-4194 LAND SURVEYOR JOHN A. RUDOLPH

2/15/07



LINE DATA ALONG JURISDICTIONAL WETLANDS		
LINE	LENGTH	BEARING
L1	18.56'	S68°42'17"E
L2	119.17'	S30°49'17"W
L3	76.12'	S34°45'08"W
L4	58.98'	S42°07'07"W
L5	43.36'	S13°20'48"W
L6	51.14'	S20°53'59"W
L7	31.61'	S20°12'14"W
L8	60.55'	S33°57'31"W
L9	77.13'	S26°00'28"W
L10	54.28'	S15°30'05"W
L11	48.61'	S21°48'32"W
L12	27.24'	S65°25'06"W
L13	53.67'	N82°25'44"W
L14	36.65'	N78°32'59"W
L15	15.62'	N67°09'47"W
L16	26.84'	N32°34'38"W
L17	57.93'	N21°47'40"E
L18	55.49'	N28°13'24"E
L19	44.74'	N25°46'51"E
L20	38.14'	N34°59'59"E
L21	28.39'	N30°25'41"E
L22	65.34'	N36°08'40"E
L23	38.35'	N39°18'37"E
L24	67.51'	N46°49'13"E
L25	50.14'	N54°44'59"E
L26	37.65'	N54°40'34"E
L27	49.08'	N27°40'21"E
L28	41.35'	N44°42'10"E
L29	98.38'	N45°09'05"E

LEGEND

EIP	–	Existing Iron Pipe
R/W	–	Right-Of-Way
UP	–	Utility Pole
B/C	–	Back of Curve
EOP	–	Edge Of Pavement
ECM	–	Existing Concrete Monument
PKS	–	PK Nail Set
WM	–	Water Meter
•	–	Non Monumented Corner
IPS	–	Iron Pipe Set
EPK	–	Existing PK Nail
MNS	–	Mag Nail Set
RCP	–	Reinforced Concrete Pipe
—E—	–	Overhead Utilities
ET	–	Electric Transformer
LP	–	Light Pole
EIS	–	Existing Iron Stake with cap
MBL	–	Minimum Building Setback Line
IPF	–	Iron Pipe Found
IPS	–	Iron Pipe Set
CMF	–	Concrete Monument Found
PKNF	–	Parker-Kalon Nail Found
PNKS	–	Parker-Kalon Nail Set

2/15/07

200 100 0 200 400 600

GRAPHIC SCALE 1" = 200'

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

WETLAND

Project / Site: Holly Grove **Applicant / Owner:** Restoration Systems, LLC **Investigator:** M. Randall Turner	**Date:** 09/27/2006 **County:** Guilford **State:** NC
Do normal circumstances exist on the site? Yes X No ____ **Is the site significantly disturbed (Atypical situation)?** Yes ____ No X **Is the area a potential problem area?** Yes ____ No X **(explain on reverse if needed)**	**CommunityID:** PEM01 **Transect ID:** Flag 02 **Plot ID:** ____

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Ulmus americana*	T,S,Sh	FACW	9.		
2. *Salix nigra*	T,S	OBL	10.		
3. *Scirpus* sp.	S, Sh	OBL	11.		
4. *Juncus effusus*	H	FACW+	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 100%

Remarks: Community PSSO1C could also be classified as PFO1C strictly based on canopy size (see Cowardin); subsets of community are PEM1E, but both communities are intimately mixed

HYDROLOGY

___ **Recorded Data (Describe In Remarks):**
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X **No Recorded Data Available**

Field Observations:

Depth of Surface Water: 0-3 (in.)

Depth to Free Water in Pit: 0-6 (in.)

Depth to Saturated Soil: 0 (in.)

Wetland Hydrology Indicators

Primary Indicators:
- ___ Inundated
- X Saturated in Upper 12"
- X Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators:
- X Oxidized Roots Channels in Upper 12"
- X Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

UPLAND

Project / Site: Holly Grove **Applicant / Owner:** Restoration Systems, LLC **Investigator:** M. Randall Turner	**Date:** 09/27/2006 **County:** Guilford **State:** NC
Do normal circumstances exist on the site? Yes X No ____ **Is the site significantly disturbed (Atypical situation)?** Yes ____ No X **Is the area a potential problem area?** Yes ____ No X **(explain on reverse if needed)**	**CommunityID:** Mixed **Transect ID:** Flag 02 **Plot ID:** ____

VEGETATION

Dominant Plant Species	Stratum	Indicator
1. *Liquidambar styraciflua*	S,Sh	FAC+
2. *Juniperus virginiana*	Sh	FACU-
3. *Solidago* sp.	Sh , H	-
4. *Rubus* sp.	Sh, H	-
5. *Lonicera japonica*	V, H	FAC-
6.		
7.		
8.		

Dominant Plant Species	Stratum	Indicator
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 20%

Remarks:

HYDROLOGY

___ **Recorded Data (Describe In Remarks):**
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X **No Recorded Data Available**

Field Observations:

Depth of Surface Water: - (in.)

Depth to Free Water in Pit: >15 (in.)

Depth to Saturated Soil: >15 (in.)

Wetland Hydrology Indicators

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12"
- _ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators:
- ___ Oxidized Roots Channels in Upper 12"
- _ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

WETLAND

Project / Site: Holly Grove **Applicant / Owner:** Restoration Systems, LLC **Investigator:** M. Randall Turner	**Date:** 09/27/2006 **County:** Guilford **State:** NC
Do normal circumstances exist on the site? Yes X No ____ **Is the site significantly disturbed (Atypical situation)?** Yes ____ No X **Is the area a potential problem area?** Yes ____ No X **(explain on reverse if needed)**	**CommunityID:** PSS01 **Transect ID:** Flag 03 **Plot ID:** ____

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Ulmus americana*	T,S,Sh	FACW	9.		
2. *Salix nigra*	T,S	OBL	10.		
3. *Scirpus* sp.	S, Sh	OBL	11.		
4. *Juncus effusus*	H	FACW+	12.		
5. *Lonicera japonica*	V	FAC-	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 80%

Remarks: Community PSSO1C could also be classified as PFO1C strictly based on canopy size (see Cowardin); subsets of community are PEM1E, but both communities are intimately mixed

HYDROLOGY

____ **Recorded Data (Describe In Remarks):**
- ____ Stream, Lake, or Tide Gauge
- ____ Aerial Photographs
- ____ Other

X **No Recorded Data Available**

Field Observations:

Depth of Surface Water: ____ (in.)

Depth to Free Water in Pit: 9 (in.)

Depth to Saturated Soil: 0 (in.)

Wetland Hydrology Indicators

Primary Indicators:
- ____ Inundated
- X Saturated in Upper 12"
- X Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators:
- ____ Oxidized Roots Channels in Upper 12"
- X Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- X Other (Explain in Remarks)

Remarks:

Prominent H2S smell in some holes

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

UPLAND

Project / Site: Holly Grove **Applicant / Owner:** Restoration Systems, LLC **Investigator:** M. Randall Turner	**Date:** 09/27/2006 **County:** Guilford **State:** NC
Do normal circumstances exist on the site? Yes X No ____ **Is the site significantly disturbed (Atypical situation)?** Yes ____ No X **Is the area a potential problem area?** Yes ____ No X **(explain on reverse if needed)**	**CommunityID:** Mixed **Transect ID:** Flag 03 **Plot ID:** ____

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Liquidambar styraciflua*	S,Sh	FAC+	9.		
2. *Juniperus virginiana*	Sh	FACU-	10.		
3. *Solidago* sp.	Sh , H	-	11.		
4. *Rubus* sp.	Sh, H	-	12.		
5. *Lonicera japonica*	V, H	FAC-	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 20%

Remarks:

HYDROLOGY

___ **Recorded Data (Describe In Remarks):**
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X **No Recorded Data Available**

Field Observations:

Depth of Surface Water: - (in.)

Depth to Free Water in Pit: >15 (in.)

Depth to Saturated Soil: >15 (in.)

Wetland Hydrology Indicators

Primary Indicators:
- ___ Inundated
- ___ Saturated In Upper 12"
- _ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators:
- ___ Oxidized Roots Channels in Upper 12"
- _ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

03 UPLAND

Map Unit Name
(Series and Phase): Not Mapped due to Impounding
Drainage Class: _____

Taxonomy (Subgroup): _____ **Confirm Mapped Type? Yes** ___ **No** ___

Profile Description:

Depth (Inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-9	A	7.5YR4/6	10YR5/8	10 %	Sandy-Loam
9-15	B	2.5Y6/3	10YR5/8	<10%	Sandy-Clay-Loam

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
___ Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed On Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ___ No X
Wetland Hydrology Present? Yes ___ No X
Hydric Soils Present? Yes ___ No X

Is the Sampling Point Within a Wetland? Yes ___ No X

Remarks:

SOILS **03 WETLAND**

Map Unit Name
(Series and Phase): Not Mapped due to Impounding
Drainage Class: _____

Taxonomy (Subgroup): _____ **Confirm Mapped Type? Yes** ___ **No** ___

Profile Description:

Depth (Inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-7	A	10YR4/2	10YR5/8	20+ %	Sandy-Loam
7-15	B	10YR5/2, 5/4	10YR5/8	10-40%	Clay-Loam to Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
_X_ Sulfidic Odor
___ Aquic Moisture Regime
_X_ Reducing Conditions
_X_ Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking In Sandy Soils
___ Listed On Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes _X_ No ___
Wetland Hydrology Present? Yes _X_ No ___
Hydric Soils Present? Yes _X_ No ___

Is the Sampling Point Within a Wetland? Yes _X_ No ___

Remarks:

SOILS **02 UPLAND**

Map Unit Name
(Series and Phase): Not Mapped due to Impounding
Drainage Class: _____

Taxonomy (Subgroup): _____ **Confirm Mapped Type? Yes** ___ **No** ___

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-9	A	7.5YR4/6	10YR5/8	10 %	Sandy-Loam
9-15	B	2.5Y6/3	10YR5/8	<10%	Sandy-Clay-Loam

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
___ Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed On Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ___ No X
Wetland Hydrology Present? Yes ___ No X
Hydric Soils Present? Yes ___ No X

Is the Sampling Point Within a Wetland? Yes ___ No X

Remarks:

SOILS **02 WETLAND**

Map Unit Name
(Series and Phase): Not Mapped due to Impounding
Drainage Class: _____

Taxonomy (Subgroup): _____ **Confirm Mapped Type? Yes** ___ **No** ___

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-6	A	10YR5/2	10YR5/6	20+ %	Sandy-Loam-Clay
6-15+	B	Gley 2 5/5BG	10YR6/8	<20%	Clay

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- X Sulfidic Odor
- ___ Aquic Moisture Regime
- X Reducing Conditions
- X Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed On Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is the Sampling Point Within a Wetland? Yes X No ___

Remarks:

Appendix I.
EEP Project Approval Letter

June 8, 2007

Restoration Systems, LLC
Attn: Tara Disy Allden
1101 Haynes Street, Suite 107
Raleigh, North Carolina 27604

Subject: Holly Grove Stream and Wetland Restoration Site
Cape Fear River Basin - Cataloging Unit 03030002
Guilford County
Contract # **D06028-B**

Dear Ms. Allden:

On June 6, 2007 Restoration Systems, LLC submitted the subject Restoration Plan for the Holly Grove Stream and Wetland Restoration Full Delivery Project. The plan proposes to restore, enhance and preserve approximately 21,000 feet of stream, 1.11 acres of riparian wetland and 42 acres of riparian buffer.

The Ecosystem Enhancement Program (EEP) has completed its review of the restoration plan and has no additional comments at this time. Please proceed with acquiring all necessary permits and/or certifications and complete the implementation of the earthwork portion of the mitigation project (Task 4). A copy of this letter should be included with your 401/404 permit applications.

For the purpose of obtaining approval of the erosion and sedimentation control plan for this project, I have also attached a memorandum confirming that Restoration Systems, LLC is the Owner and Financially Responsible Party, and has full operational control for all matters pertaining to construction of this project. Please sign and attach this memorandum to the Financial Responsibility/Ownership form of the erosion and sedimentation control plan application. Failure to do so may delay approval of the plan.

If you have any questions, or wish to discuss this matter further, please contact me at (919) 715-1656 or email at guy.pearce@ncmail.net.

Sincerely,

Guy C. Pearce
EEP Full Delivery Program Supervisor

Appendix J.
Land Quality Letter

Ecosystem Enhancement PROGRAM

June 8, 2007

Restoration Systems, LLC
Attn:Tara Disy Allden
1101 Haynes Street, Suite 107
Raleigh, North Carolina 27604

Re: Responsibility for Erosion and Sedimentation Control
Holly Grove Creek Stream and Wetland Restoration Project - Full Delivery Project
Guilford County – Cape fear River Basin – CU#03030002
Contract No. – D06028-B

This memorandum confirms the responsibility for compliance with the Sedimentation Pollution Control Act of 1973 and North Carolina Administrative Code Title 15A, Chapter 4 on the project that is the subject of the above-referenced contract between the Ecosystem Enhancement Program (EEP) and Restoration Systems, LLC.

Pursuant to the contract, the above-referenced project is a full delivery project. This means that Restoration Systems, LLC has full operational control over the project. As the "developer or other person who has or holds himself out as having … operational control over the land-disturbing activity" Restoration Systems, LLC will be responsible for compliance with or any violation of the Sedimentation Pollution Control Act of 1973 or North Carolina Administrative Code Title 15A, Chapter 4. See 15A NCAC 04A .0105(8) and (9). Accordingly, any plan, revised plan, compliance request, notice of violation, fine, penalty or other enforcement action associated with this project remains the responsibility of Restoration Systems, LLC to resolve with regulatory or permitting agencies.

Please sign below and attach this memorandum to the Financial Responsibility/ Ownership form of the erosion and sedimentation control plan application in order to obtain plan approval and responsibility for erosion and sedimentation control solely in your name.

Respectively,

for

Jeff Jurek
Project Control and Research Director

To DENR Land Quality Section

Restoration Systems, LLC hereby certifies that it has full operation control of this project for all matters pertaining to the construction of this project and that it constitutes the "Person Who Violates" and the "Person Conducting Land Disturbing Activity" as defined in 15A NCAC 4A.0105(8) and (9). Restoration Systems, LLC also understands that it is responsible for implementing any actions or measures necessary to comply with the Sedimentation Pollution Control Act.

Signed,
Restoration Systems, LLC

_____

[Person with Authority to Bind Contract Signature, Printed Name and Title]